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HAN-79280

HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT

JUNE, 1961

JULY 15, 1961

[redacted]

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

GENERAL ELECTRIC

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Compiled by
Operation Managers

July 15, 1961

HANFORD ATOMIC PRODUCTS OPERATION
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PRELIMINARY REPORT

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TABLE I. HL FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE June 30, 1961

	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	116	243	125	113	238	4	9	2	6
Reactor & Fuels Research & Development	199	190	389	193	181	374	7	14	1	5
Physics & Instrument Research & Development	96	62	158	88	62	150	8	1	0	1
Biology Operation	37	47	84	34	47	81	5	1	2	1
Operation Res. & Syn.	18	4	22	16	4	20	2	0	0	0
Radiation Protection	40	99	139	39	100	139	2	2	1	3
Laboratory Auxiliaries	50	182	232	50	184	234	1	2	1	4
Financial	20	15	35	20	14	34	0	2	0	1
Prof. Placement & R. P.	94	11	105	51	11	62	46	0	3	0
Programming	18	3	21	15	3	18	3	0	0	0
General	2	4	6	2	4	6	0	1	0	1
Totals	701	733	1434	633	723	1356	78	32	10	22
Totals excluding internal Transfers	701	733	1434	633	723	1356	76	30	8	20

BUDGETS AND COSTS

June operating costs totaled $2,793,000; total fiscal year 1961 costs were $26,200,000 or 98% of the $26,766,000 budget.

Hanford Laboratories research and development costs for June, compared with last month and the control budget, are as follows:

(Dollars in Thousands)	Cost Current Month	Cost Last Month	Cost FY To Date	Budget	% Spent
HLO Programs					
02 Program	$ 44	$ 65	$ 620	$ 661	94%
04 Program	1 263	706	9 960	9 937	100%
05 Program	60	60	778	806	97%
06 Program	202	231	2 306	2 402	96%
	1 569	1 062	13 664	13 806	99
IPD Sponsored	286	232	3 105	3 170	98%
CPD Sponsored	188	161	1 992	1 994	100%
Total	$2 043	$1 455	$18 761	$18 970	99%

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

The design criteria for the PRTR Rupture Loop water plant have been revised to reduce pumping capacity and costs, and a revised project completion date of June 1962 has been submitted. The CPFF Contractor started Critical Facility equipment installation on June 27, 1961, after the building was accepted with exceptions.

PRTR Gas Loop construction is approximately 89% complete versus 97% scheduled as of June 30, 1961.

The PRTR outage which began May 18 continued, but startup preparations were in progress at month-end. Efforts were concentrated on identification and repair of corrosion damage caused by contamination of the primary system D_2O with chloride and fluoride derived from freon. Repairs or replacements were made to PuAl fuel element bands, fuel element hanger components, metal-asbestos gaskets in the high temperature portions of the primary system and inlet jumper flow meter venturis. To guard against future corrosion, measures were taken to minimize oxygen content, including installation of a deoxygenating ion exchange unit in the primary cleanup system, installation of an inert gas shielded fuel charging funnel, incorporation of hydrogen addition facilities at the helium bulk storage, and installation of an in-line analyzer to monitor primary system O_2 concentration.

The initial PRTR operating experience was reviewed by the General Electric Technological Hazards Council on June 16. The Council expressed concern over the contamination of the primary coolant with chloride and fluoride. It was recommended by the Council that the process tube monitoring program be expanded to insure that the process tubes are performing as anticipated.

A computer code has been written to calculate the xenon poison status of the PRTR for any operating history. The code has been successfully applied in accounting for the xenon effects observed to date in the PRTR.

Mercury contamination was found in the process cell, in D_2O cleanup equipment, and in primary system ion-exchange piping. None, however, was found in the reflector and moderator circuits which contain aluminum which is particularly sensitive to mercury. Extensive cleanup was completed by month-end.

Analysis of water, gas and resin samples from the last operating period in early May indicates the probability of a ruptured fuel element. Special tests have been devised to try to confirm or disprove this when the reactor is next brought to low power operation.

Hydraulic resistors were developed to attenuate the oscillations of PRTR flow monitors that were causing spurious reactor scrams during normal flow conditions.

Experiments were performed with an electrically heated mockup of a PRTR 19-rod bundle fuel element to investigate cooling by boiling capabilities following the loss of electrical pumping power. It was found possible to remove two to four times as much heat by natural convective boiling as would be generated during the reactor shutdown conditions, providing sufficient water was available to cover the fuel elements.

Twenty mesh arc-fused UO_2 when swaged to 90% theoretical density released ten times as much gas at 1000 C as the starting material. The increased gas release is attributed to the greater diffusion from smaller particles. Outgassing tests at 1000 C are too low in temperature and give erroneous results on large particle sizes.

Techniques have been developed for blending UO_2 and PuO_2 fines which result in a maximum plutonium variation between samples of plus or minus 1.5%. Variations in Pu content of PuO_2-UO_2 fines/coarse UO_2 mixtures are larger. Techniques to correct this variation are being tested.

A Zircaloy-clad aluminum-plutonium seven-rod cluster was intentionally ruptured, thermal cycled, and water logged under simulated PRTR conditions in the ETR. Nearly negligible release of activity occurred and no visible damage to the element resulted.

Melting experiments on UO_2-PuO_2 appear to indicate oxygen evolution is responsible for the lattice expansion which is observed.

An irradiated capsule containing high-energy impact formed UO_2 was metallographically examined. There were surprisingly few circumferential or radial cracks in this fuel material.

Spherical fused UO_2 single crystals were provided for several European sites through Euratom. The crystals will be used for measuring diffusion rates of fission gases in UO_2.

Initial thermoconductivity measurements of single crystal UO_2 were completed at BMI. Thermoconductivity of the single crystals and polycrystalline material are nearly identical at room temperatures, but the conductivity of the single crystal is 50% greater than that of the polycrystalline material at 800 C.

Zr-4 continues to demonstrate a significantly greater resistance to hydriding than does Zr-2. Post-irradiation examination of both materials used as cladding of defected rods showing approximately 15 ppm hydrogen in Zr-4 under the same conditions that Zr-2 picked up more than 500 ppm of hydrogen.

KSE-3 (NPR type) single tube fuel elements exposed to 1200 MWD/T in KER loops were found to be in good condition with fuel swelling of 1.3%. Examination of KSE-3 single tube elements exposed to 2000 MWD/T is nearing completion with fuel swelling of 3.0% measured and indicating that the inside diameter is decreasing non-uniformly by buckling of the inner clad. A third group of KSE-3 single tube elements has been discharged at 3600 MWD/T. Measurements indicate fuel swelling of 4.4% and severe bumping on the inside bore of the two downstream elements indicates an advanced stage of inner clad buckling.

Two KER inner tube fuel components, one containing natural uranium and one U - 2 w/o Zr alloy, both irradiated to 3000 MWD/T, were defect tested in the IRP (ex-reactor) loop at 300 C. Comparison of activity release rates for the two elements indicates an order of magnitude slower release rate from the U - 2 w/o Zr element. A seventh in-reactor rupture test has been carried out in the ETR.

Further experimental development of the welding method used to attach supports to the outer NPR tube has shown greater reproducibility and strength if the welded tabs on the supports are flat rather than curved to conform to the fuel surface.

Initial measurements of the diffusion rate of water vapor through hot NPR core graphite indicate that sufficient water vapor migrates through to the Zircaloy process tube surface to maintain an adequate oxidation rate to inhibit rapid hydriding. Capsules for in-reactor testing have been prepared

to obtain more precise information on the protective qualities of various thicknesses of zirconium oxide films exposed to simulated NPR atmospheres in a radiation field.

A capsule containing EGCR graphite was removed from the GETR after a maximum exposure of 40,000 EGCR, MWD/AT. The samples appear to be in good condition. A flux monitoring capsule is being irradiated during the current reactor cycle.

A review of experimental heat transfer knowledge gained in the past year indicates that outlet water temperature limits for individual fuel channels in the Hanford production reactors probably could be increased, if desired.

A computer code for calculating neutron and gamma attenuation in thick shields has been completed. An initial check shows good agreement with experimental bulk shielding data for ordinary concrete.

Two second generation creep capsules are now operating in the reactor at temperatures of 350 C and 460 C. Stress has not yet been applied to either specimen.

Recovery studies have been terminated for Fe, Ni, Cu, and Zr. Yield points have been observed in electrolytic Ni, Type "A" Ni, Cu, and Zr at exposures of 1.3×10^{18} nvt for the nickels and 7.0×10^{19} nvt for Cu and Zr. Development of yield point upon irradiation appears to be independent of purity for face centered cubic and close packed hexagonal materials.

2. Chemical Research and Development

Operation of the High Level Radiochemistry Facility in behalf of the interim strontium-90 recovery program was concluded during the month. Somewhat over 72,000 curies of highly purified strontium-90 were recovered during the Hot Cell operations compared to a commitment of 60,000 curies.

Laboratory investigations indicated that pressure build-up in the Decalso-filled HAPO-IA strontium shipping cask could largely be obviated by removing the interstitial liquid from the ion exchange bed subsequent to the strontium-90 loading operation. Elution of strontium-90 from the Decalso, however, must be carried out at elevated temperatures to afford the near quantitative recovery of product.

The second Hot Semiworks strontium recovery run resulted in the acquisition of 175 kilocuries of strontium-90. The recovered product met all specifications except for cerium-144, which was about seven-fold high. Scavenging of the product solution with either cerium hydroxide or ferric hydroxide shows promise of effecting the necessary decontamination from radiocerium.

Substitution of diethylenetriamine acetic acid (DTPA) for ethylenediamine tetracetic acid (EDTA) in the Hot Semiworks solvent feed was shown in laboratory studies to effect a substantial reduction of radiocerium extraction and thereby permit the recovery of a purer strontium-90 product.

Sufficient decontamination of the Hot Semiworks solvent to permit disposal, or possibly sustained re-use, is likely to be achieved through successive solvent washes with sodium acetate-DTPA, nitric acid and alkaline tartrate solutions.

Eight samples of Columbia River water were taken from near 100-B reactor between February and June, 1961, to characterize the fluctuations in arsenic, zinc, lanthanum and uranium salt concentrations with season. While arsenic and uranium concentrations remained relatively constant, the zinc concentration peaked at 28.7 ppb in April; the lanthanum values varied erratically.

X-ray diffraction studies indicate that electrolytically formed "co-deposits" of uranium and plutonium oxides out of sodium chloride-potassium chloride melts are of the mixed crystal type rather than a solid solution of PuO_2 in UO_2.

Results obtained from the first well completed on Project CAH-921 in the vicinity of the separations areas showed the presence of basalt at depths less than ten feet below the ground water table. The close proximity of the relatively impervious basalt to the ground water is now known to affect flow directions over a five mile area.

The temperatures of water in Hanford wells were measured with a thermistor probe. This temperature measuring device shows promise of considerable utility for Hanford hydrology studies.

Added calcium and/or iron salts were shown to improve the scavenging of radioisotopes from NPR decontamination wastes. The addition of 200 ppm calcium effected a five-fold and ten-fold improvement in radiocerium and radiostrontium removal, respectively; 200 ppm iron more than doubled the scavenging of cobalt. Both calcium and iron were effective in improving the scavenging of radiozinc.

The removal of radioisotopes from Purex condensate waste by ion exchange is substantially improved by the prior steam stripping of the waste to remove ammonia and organic materials. Over 8,000 column volumes of condensate waste have been processed through the 271-CR ion exchange pilot plant without the process effluent exceeding 0.1 MPC_W for strontium, cerium, zirconium and niobium radioisotopes. Radiocesium remained at a concentration of less than 0.1 MPC_W for 5,600 column volumes, while radioruthenium was less than its MPC_W for only 800 column volumes.

3. Physics and Instrument Research and Development

The first experiment in the Critical Mass Laboratory began on June 29. A fourteen-inch diameter bare sphere was filled with plutonium nitrate solution containing 300 grams of plutonium per liter. It was determined that these conditions would not result in criticality. Performance of the experimental equipment was good.

Our knowledge of the critical mass limits applicable to molten plutonium in a crucible in the 235 Building was improved with the completion of experiments begun and reported in earlier months in which sub-critical multiplication measurements were made in the hoods themselves using disks to mock up the molten metal.

The limiting safe concentration of plutonium in dilute solutions was also determined by the completion of the series of experiments in the PCTR designed to determine this basic nuclear safety parameter.

In Air Force supported programs in Atmospheric Physics, the first series of diffusion experiments at Cape Canaveral, Florida, was completed on June 16, some two weeks ahead of schedule. A total of 23 field trials were completed in meteorological conditions ranging from strong atmospheric stability to strong atmospheric instability. Start-up of similar diffusion experiments at Vandenberg Air Force Base, California, proceeded on schedule with the first field trial completed on June 12.

In the NPR program, added confidence in the reactor physics calculations resulted from exponential pile experiments. Migration area measurements in the mock-up and in the "condensed" lattices gave values of 647 cm^2 and 297 cm^2, respectively. Their ratio, 2.17, is in good agreement with a calculated ratio of 2.19. Meanwhile, work continued to improve the methods used in analyzing data from such experiments. PCTR measurements of k_∞, in N-Reactor mock-up and "condensed" lattices gave values which are essentially the same. This is what one would expect, thus furnishing additional evidence of the soundness of the PCTR technique.

Continued laboratory and field testing of the developmental area radiation monitor for NPR indicates better performance than obtained from commercial monitors plus the added advantage of both linear and logarithmic responses.

Reactor process channel distortions will be measurable to an accuracy of ± 0.005 inch per eight inch length with a new optical traversing device. A unit is to be fabricated for NPR use based on the prototype design.

After minor changes in the self-shielding expression in the MELEAGER code, the Advanced Pressurized Water Reactor fuel cycle computations were completed. Sensitivity of results to temperature, thermal utilization, slowing down power, and fuel density was determined by variation of these parameters independently and in a few combinations.

The development of more efficient IBM-7090 programs will be aided by a new device developed for timing selected portions of programs.

In the program for irradiation of plutonium samples off-site, pre-irradiation reactivity measurements were completed in the ARMF (Advance Reactivity Measurements Facility) at ARCO preparatory to irradiation of samples in the MTR.

An improved nuclear detector scaling system has been developed for use at the PRP Critical Facility.

Computer calculations for the extended lifetime Neutron Flux Monitor program show that the sensitivity of Pu isotope detectors is nearly independent of mode of burnout, whereas this does not hold true for combination U-Pu detectors. Further computations are proceeding to refine the Pu detector design for experimental testing.

A method has been invented for stabilizing the temperature of eddy current nondestructive test coils.

The microstructure, hence corrosion resistance, of X-8001 aluminum is not changed by plasma arc heating during "nondestructive" heat transfer testing of fuel core-cladding bonds.

Hall Effect voltage measurements on hydrided Zircaloy have shown a sensitivity to hydride concentration; however, the relationship is not single valued over the range from zero to 1000 ppm by weight of hydrogen. Measurements also will be made at higher hydrogen concentrations. Nuclear magnetic resonance techniques and Young's Modulus measurements also are being explored in the search for a nondestructive measurement of Zircaloy hydriding.

A workable miniature dosimeter has been developed which uses an ionization chamber detector and indicates accumulated dose on a register.

The whole body counter has been calibrated for measuring P-32 content of persons. This was made possible through the availability of patients receiving known amounts of this material while undergoing treatment at the University of Oregon Medical School.

4. Biology

Virulence continues to be associated with diploid columnaris. Strains which are moderately virulent show survival curves characteristic of either haploid or diploid.

Susceptibility to columnaris of fish exposed to reactor effluent treated by aluminum turnings did not increase.

That transpiration of water via evaporation from the surface of leaves does not control the differential rate of uptake into plants of strontium and calcium was shown by topping the plants and examining the liquid exuded by the top of the stem. As with intact plants, strontium moved more readily early in the exposure, but later calcium moved more readily through the plant.

Experimental evidence was obtained to clearly show that plutonium can be excreted into the bile duct in bile cannulated rats. This could explain the increased fecal excretion of plutonium when DTPA is administered because this chelating agent caused acceleration of plutonium excretion through the bile duct.

Particle size of $Pu^{239}O_2$ dusts definitely affects translocation of plutonium deposited in the lungs. This is further evidence for the need for revising the lung model used in radiation protection.

5. Programming

The IBM-7090 computer was used for an over-all evaluation of five enrichment materials (three plutonium isotopic compositions, U-233, and U-235) in two alternative fertile materials (U-238 and thorium) of various densities and various lattice spacings. Preliminary analysis of data for about 10,000 cases includes the observation that the specific power limitation with thorium fuel (because of parasitic neutron capture in Pa-233) is less restrictive with plutonium enrichment than it is for either U-233 or U-235 enrichment.

In plutonium recycle analysis, a new mode of operation for salt-cycle reprocessing has been recognized which substantially reduces the fraction of new reactor fuel which is plutonium-bearing. This concept involves segregation of fuel from different zones in the reactor for separate re-processing.

The hazards associated with accidental releases during shipments of kilocurie quantities of cesium and strontium fission products have been analyzed and are reported in HW-69561 REV.

TECHNICAL AND OTHER SERVICES

There were no cases of plutonium deposition confirmed during the month; thus, the total on record remains at 267, with 194 employees on the active rolls.

There are 20 currently active projects having combined authorized funds in the amount of $19,546,300. The total estimated cost of these projects is $24,881,300. Total expenditures through May 1961 were $15,180,000. In addition, project proposals have been submitted to the Commission requesting authorization of $362,000 total project funds on 4 new projects.

Project CGH-834, Modifications and Additions to High Pressure Heat Transfer Apparatus - 189-D Building, was completed during the month. This project was authorized April 8, 1959 for $700,000 for priority performance on a design and construct basis utilizing J. A. Jones Company. Beneficial use for steady state reactor process tube heat transfer experiments was achieved March 22, 1960. Final completion for operation on transient tests (coolant excursion) was delayed due to equipment delivery. Estimated final cost is $745,000 as authorized.

The IBM Card-a-type equipment to be used in the mechanization of the Classified Files document issuance, routing and mailing procedures was installed June 15. On June 19, the operator began processing the first HW documents through the system. There is every indication that the machines will be able to handle an even larger volume of documents than originally planned.

A trip to the uranium feed sites to discuss the data processing and statistical aspects of fuel element performance has resulted in the incorporation of pertinent feed site data into the Quality Certification Program.

An exhaustive literature search on numerical methods for obtaining solutions to the unsteady state nonlinear diffusion equation has resulted in a scheme incorporating the best characteristics of several methods which has considerable promise. A computer program is now being written.

Complete specifications for the cam necessary to control the Gorton lathe during a specific machining operation were calculated and submitted for fabrication.

The final report for the Safeguards Design Review Project was completed and will be distributed in early July.

SUPPORTING FUNCTIONS

HOO-AEC has extended the CPFF Construction Service Contractor (J. A. Jones Construction Company) contract for two years. The new expiration date is June 30, 1963.

During FY 1961, 189 items valued at $77,000 were placed by the Laboratory Equipment Pool in lieu of purchase. Total operating costs were $10,986. Since inception of this program, equipment valued at $90,000 has been placed in lieu of purchase whereas total expenses, including the cost of the 3718 Building, amount to $54,000.

Total Heavy Water expenditures for PRTR in FY 1961 were $152,000.

Advanced Degree - Fourteen Ph. D. applicants visited HAPO for professional employment interviews. Four offers were extended; five outstanding offers were rejected. No acceptances occurred during the month. Current open offers total ten.

BS/MS - One hundred and sixteen candidates were considered, eleven visited HAPO for interviews; twenty-two offers were extended and seven acceptances received.

Technical Graduate Program - Two Technical Graduates were placed on permanent assignment. Forty-three new members were added to the program rolls and one terminated. Current program members total eighty-one.

Sixty-one people have been hired for the various summer programs as follows: College juniors, 13; Graduates, 10; Professors, 14; High School Teachers, 5; former employees for specific assignments, 19.

A complete review of job hazard breakdowns is underway throughout the Laboratories as a step toward improvement of safety performance. Two hundred and twenty-five job hazard breakdowns for Reactor and Fuels Research and Development Operation were reviewed during the month.

The incidence of security violations and medical treatment injuries remained relatively stable with three security violations and 34 medical treatment injuries occurring.

J. N. Dearnley
for Manager
Hanford Laboratories

HM Parker:IHD:mlk

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Gaseous Hydriding of Zircaloy-2. It has been found in previous studies that a continuously growing ZrO_2 film will strongly inhibit gaseous hydrogen pickup by Zircaloy-2. In order to maintain film growth at a normal rate, there must be a constant supply of water to the metal surface which is in excess of a certain minimum requirement. An oxidation rate of about 0.5 mg/dm^2/hour is required to inhibit the reaction of Zircaloy-2 with molecular hydrogen at 400 C. The required oxidation rate is less at lower temperatures.

A series of experiments has been started to measure the rate of transport of water through NPR core graphite as a function of temperature, graphite structure and water, hydrogen and carbon monoxide content in the helium. The first runs have shown that water sufficient to maintain ZrO_2 film growth (0.5 mg/dm^2/hour) diffuses through a 1.13" thick graphite diaphram held at 650 C when the water content of the inlet helium gas is above 0.1 mm (dewpoint -39 C). This result is encouraging because it indicates that the graphite is relatively permeable to water vapor and local depletion of water in a tube channel may not be a serious problem if the minimum water content of the bulk gas is correctly regulated.

In-Reactor Hydriding Corrosion Capsules. Two capsules for exposing Zircaloy-2 and Zircaloy-4 samples with various surface preparations to proposed NPR atmosphere are in the final stages of assembly. One capsule will be charged into the reactor and the other will be placed outside. The capsules will be the same, except for irradiation. Each capsule will have three temperature zones - 325, 375 and 425 C - and each zone will contain an identical set of samples. Each zone contains two samples of Zircaloy-2 and Zircaloy-4 with the following surface preparations: etched, etched and autoclaved for 72 hours at 400 C in 1500 psi steam, and etched and autoclaved for 1300 hours in 1500 psi steam at 400 C.

The capsule is scheduled for the 2A test hole at KE, which is a side-to-side dry hole. Charging will take place during the next reactor shutdown, scheduled for the middle of July.

Radiometallurgy Laboratory Studies

Replicas of samples from two swelling capsules containing thermocouples were obtained for electron microscopy of the Zr-2 cladding fractures (RM-559). Metallography of two unfailed KER single tubes from K-3-12 was performed along with a study of the internal annulus of a KER single

tube irradiated to 2000 MWD/T. No failure was detected when the suspect (NIE-1) from KER-4 was visually examined.

Basic Metallurgy Studies

Radiation Effects in Structural Materials. Two additional X-basket assemblies (GEH-14-229 and 230) containing zirconium and Zircaloy 2 have been irradiated in the MTR and are being shipped to Radiometallurgy. This completes the irradiation phase of the program.

Electron and Optical Microscopy. Microstructural changes or damage in metals due to fission fragment and neutron bombardment have been studied by electron microscope techniques. High purity, aluminum foils, 0.003" and less than 0.0005" thick, in the annealed state, have been thinned and examined after neutron doses of 2×10^{20} nvt (thermal). For a given dose, the thicker foils contain a greater number of prismatic dislocation loops than the thinner specimens. These loops are thought to result from the formation of vacancy clusters. Diffusion of vacancies to the surface of the foil has apparently taken place resulting in fewer clusters.

Since fission fragment damage has been observed in thin evaporated films, as well as thin foils, an experiment to evaluate fission fragment damage in a solid material is in progress. High purity, annealed, aluminum wires were electrolytically thinned to a diameter of 0.003". Uranium dioxide was then evaporated on one-half of the circumference and the wires placed in special holders and irradiated in the Quickie facility. Following irradiation, the wires will be embedded in epoxy resin and sectioned on the ultra microtome. Electron microscope examination of thin sections made from the wire should disclose if fission fragment damage to the massive aluminum has occurred.

In order to determine what interaction occurs between a moving dislocation and a fission fragment track in pre-thinned aluminum foils, additional foils of aluminum are being prepared for irradiation. The use of molybdenum foils for similar studies is also being investigated.

X-Ray Diffraction Studies. Orientation of extruded uranium tubes and rods with various fabrication and heat treatment histories is being determined by several x-ray methods. Pole figures of 620 C alpha extruded rods show a 110 fiber texture. The corrugated 001 planes are oriented parallel to the outside surface of the rod. The tubes exhibit a very similar distribution of poles with respect to the tube surface and extrusion axis. It is very difficult with conventional techniques to determine preferred orientation of rods and tubes after beta heat treatment. This is due to two factors which act together to reduce the accuracy of a given determination. The first is that the structure tends toward randomization. The second is that the grain size increases. Large grain size is a recognized problem. Randomization provides another since with a given grain size, the more random the structure becomes, the less chance there is of finding a representative number of grains oriented with diffracting planes parallel to the surface. Studies here show that in order to obtain reproducible, meaningful inverse pole figure or pole figure data of beta heat treated

uranium at least 10 to 20 square inches of surface area must be examined. This is necessary in order to obtain a statistically valid sampling. These facts have apparently been recognized at other sites. Sturkin in DP-150 mentions that in his x-ray work with beta heat treated uranium, 15 square inches of surface area was required in order to reproduce a G.I. value. If crude data on beta heated stock are required, a G.I. value from a single x-ray scan of a typical specimen would indicate whether the stock had been beta heat treated, but it certainly would not show subtle differences in texture caused by two different heat treatment procedures.

Zirconium Alloy Fabrication. The fabrication of hot and cold rolled sheet product from 13 zirconium base alloys has been completed (November 1960, February and March 1961 monthly reports).

Three of the 34 separate alloy additions missed the intended composition. The other 31 additions fell within seventy to one hundred percent of the intended composition. Alloying elements consisted of Cr, Fe, Cu, Nb, Mo, Sn, Ni, and V. Oxygen values on the finished sheet range from 600 ppm to 1000 ppm on material melted from quartered primary ingots. Forged primary ingots gave oxygen values as high as 1800 ppm. Supplier's analysis of zirconium was 855 ppm oxygen. Nitrogen values ranged from 6 ppm to 40 ppm with 17 ppm in the original starting zirconium.

Metallic Fuel Development

Fuel Irradiations. Radiometallurgical examination of KSE-3 single tube fuel elements exposed to 1200 MWD/T in KER has been completed. At this exposure, fuel performance was very good. Fuel swelling amounted to 1.3 percent. The Be-Zr eutectic braze-bonded end closure showed no indications of shortcomings, no excessive hydrogen was detected in the Zr-2 clad, and no adverse performance was noted in the uranium, clad, or coextruded bond in the braze heat-affected zone.

Examination of KSE-3 single tube fuel elements exposed to 2000 MWD/T in KER is nearing completion. Some white areas on the Be-Zr braze-weld closures were seen at discharge, but no indications were found that corrosion of any serious consequence has occurred. No inadequacies of the closure or heat-affected zones have been noted. Fuel swelling of 3.0 percent was determined by volume displacement measurements made in the basin after discharge. Outside diameter measurements have increased an average of 0.012 inch. Current observations indicate the inside diameter is decreasing nonuniformly by buckling of the inner clad.

A third group of KSE-3 single tube elements have been discharged from KER after attaining an exposure of 3600 MWD/T. Volume displacement measurements made in K Basin reveal an average fuel swelling of 4.4 percent. There were no indications of corrosion of the braze-weld closures such as was observed on the 2000 exposure tubes; however, the 3600 MWD/T exposure tubes were operated at somewhat reduced temperatures. Severe bumping in the inside bore of the two downstream elements was noted, and it is believed that this is the advanced stage of inner clad buckling observed on the 2000 MWD/T exposure pieces. These elements will be shipped to Radiometallurgy in July for detailed examination.

Two KER inner tube fuel components irradiated under identical conditions to about 3200 MWD/T were defect-tested in the IRP loop at 300 C, 1650 psi. One tube was natural uranium and the other was U - 2 w/o Zr alloy. The U fuel tube ruptured after only 7-1/2 minutes at temperature. Four minutes after rupture, loop filter activity reached 20 R and fast cooling of the test facility was started. In spite of cooling to 200 C in the next four minutes, the loop filter activity reached 40 R. The tubular element was severely damaged and was broken into three major pieces during this brief failure test.

The U-Zr alloy fuel tube ruptured after 10-1/2 hours at temperature. Twenty-one R activity in the loop filter was accumulated after 88 minutes, and the loop was fast cooled with the addition of only two R activity. Comparison of the activity release rates for the two tests indicates a marked improvement in failure performance resulted from the 2 w/o Zr addition to the fuel core.

An NPR inner tube element that was discharged from KER because of neutron activity after attaining only 250 MWD/T exposure was subjected to non-destructive examination at Radiometallurgy. Nothing was observed to indicate that the element had failed or was even in a stage of incipient failure. This element will be tested in the IRP facility and upon positive indications of failure will be rapidly cooled and examined at Radiometallurgy. It is important to determine the cause of failure, if failure does occur; it is important to determine the source of neutron activity, if failure does not occur.

Two irradiated, defected, NPR fuel elements which had been sent to the ETR were returned to Hanford. These fuel elements were to be ruptured "in-reactor" as part of the current in-reactor rupture test program. One of the two pieces had failed in handling; the other was cleaned, returned to the ETR, and ruptured in-reactor. Behavior was as anticipated; the induction period was approximately ten minutes and activity terminated the test after an additional four minutes.

An old geometry NPR inner tube (KSN-1) failed in a KER loop after an average exposure of 1700 MWD/T. The exposure of the failed element was approximately 2000 MWD/T (0.26 a/o burnup) as determined by radiochemistry. Two additional elements irradiated in the same charge were examined in Radiometallurgy. The OD of all tubes increased and the ID of all tubes decreased. A table of averaged diameter increases is given below:

Element	OD	ID
Failed uranium element	+0.017"	-0.005"
Uranium element	+0.010	-0.004
U-2 w/o Zr element	+0.021	-0.004

The diameter increase of the U - 2 w/o Zr tube was about twice as great as the uranium core element for approximately the same exposure.

All of the elements examined had incipient failures at the base of the flush-fitted and welded end caps.

Measurements were made at the ETR on a KER tube-tube fuel element exposed to 1700 MWD/T at high specific power (350 kw/ft). The element was U - 2 w/o Zr, 36 inches long, and extruded by NMI. The element appeared to be in excellent condition when removed from the experimental basket. Optical measurements showed both components had warped in the same plane to the extent of 0.250 inch. The OD of the outer tube increased an average 0.011 inch and the OD of the inner tube increased an average 0.012 inch. The measured diameter increases were proportional to the reactor flux and coolant temperature and varied over the length of the tubes from a minimum of 0.006 inch to a maximum of 0.019 inch.

Ten 15-inch long elements of NPR inner tube stock, processed with variable beta heat treatment, were irradiated in KER Loop 1 to an average charge exposure of 1050 MWD/T. The average and maximum element power was 48 and 54 kw/ft, respectively, and the weighted average tube outlet temperature was 286 C. The elements operated without any unusual incidents and were subjected to a total of 24 shutdowns during irradiation. The elements have been visually examined in Radiometallurgy and are waiting measurement. Seven of the ten elements exhibited some degree of crud deposit on the heat transfer surfaces. This was primarily on the upstream end of individual elements, but those having crud were dispersed throughout the charge. One element had lost two supports and approximately seventy-five percent of the supports were slightly buckled. No appreciable warp was evident, but most of the elements appeared to have increased in diameter. Warp and dimensional measurements will be made on all the elements. No cladding defects have been observed.

Radiometallurgical examination of the coextruded tubular component, closed with an Fe-Be-Zr braze which failed in the MTR, has revealed the following facts:

1. It appears probable that the element failed through shearing of the clad on the inner bore, not through a cladding defect as previously reported. This failure was initiated by cracking of the braze layer between the uranium and the Zircaloy cap. Repeated thermal cycling due to reactor startup and shutdown caused the jacket to be subjected to repeated shear forces which caused eventual failure during the fifth cycle of startup.

2. The coextruded bond was completely separated for 180° in the heat-affected zone above the rupture blister. Bond separation appeared to progress by cracking both through the Zircaloy jacket and along the bond.

3. Several cracks were observed in the inner weld above the rupture blister. These cracks were superficial in nature and did not extend into the braze zone.

4. Uranium cracking in the heat affected zone was quite evident. Of particular interest were the cracks which extended 45° from the end cap to the outer jacket. Bond separation appears to start below the juncture of the 45° crack and jacket.

5. Swelling was quite evident in these elements. The necked-in region just below the end cap had expanded to a width exceeding that of the end cap. The length of the elements had decreased somewhat.

The sequel to the above test, GEH-4-63, 64, has been scheduled for five irradiation cycles starting July 5, 1961. This test has end caps brazed with the Zr-2 + 5 Be alloy.

The two tube-tube KER elements, GEH-10-39, 40, 41, 42, which were irradiated in the ETR 6x9 for one cycle, have arrived in Radiometallurgy. These elements, also brazed with the Zr-2 + 12 Fe and 4 Be alloy, ran at a specific power of 317 kw/ft, minimum clad temperature of 380 C and core temperature of 627 C. The outer tube accumulated 1200 MWD/T (0.14 a/o burnup on 6.8×10^{19} fission/cm^3) and the inner tube accumulated 825 MWD/T (0.09 a/o burnup on 4.0×10^{19} fission/cm^3). Examination will be concentrated on the heat affected braze region with particular emphasis on the cape-to-core braze zone.

Another MTR irradiation is being prepared, GEH-4-68, 69, 70, which will provide a comparative irradiation on fuel elements with variable braze widths. The presently accepted NPR fuel will use a braze width of 0.070 to 0.10 inch. Most of the irradiations to date have used braze widths from 0.015 to 0.030 inch.

Fuel Deformation Studies. A series of NaK capsule irradiations of Zr-2 clad fuel rods is planned for the Hanford reactors. Twelve capsules each containing three Zr fuel rods clad with Zr-2 have been filled with NaK and sealed. Eight more capsules have been assembled for NaK filling. Four capsules each containing a single Zr-2 clad uranium rod and a thermocouple to measure the central uranium temperature are in the final stages of assembly prior to filling with NaK.

Heat Treatment Studies. Post-heat-treatment measurements have been completed on the two NPR inner tube extrusions for warp studies. One extrusion was Zr-clad and the other bare uranium. Both pre-heat-treatment and post-heat-treatment warps were greater for the bare uranium extrusion than for the Zr-clad extrusion and the amount of increase in warp upon heat treatment was also greater for the bare tube extrusion, indicating that the Zircaloy clad does not contribute to the warp and may be effective in restraining the warp to a certain extent. Shift was measured on the Zr-clad tube and wall thickness measurements were made on both tubes. Attempts were made to correlate the plane of the shift and the planes of the maximum and minimum wall thicknesses with the plane of warp before heat treatment, the plane of warp after heat treatment, and the vector direction of the change in warp upon heat treatment. Ten out of the twelve Zr-clad fuel elements showed a correlation between the lead shift

and the pre-heat-treatment warp while eight of the twelve showed a correlation between the lead shift and the post-heat-treatment warp. These were the best correlations found. No other significant correlations were found. Shift could not be measured on the bare tube extrusion, and all other measurements also showed only random correlation. As-extruded sections of the tubes are being studied by x-ray diffraction to determine if an appreciable difference in preferred orientation can be detected between one side of the tube and the other, since this might contribute to the warp. The Zr-clad tubes are being beta-heat-treated a second time to determine if the plane of warp or magnitude of warp will change. Difficulty has been encountered in obtaining reproducible x-ray results on beta-treated uranium due to the large grain size of beta-treated material. Recently, excellent x-ray results were obtained on a section of uranium rod which had been beta-treated and then alpha-recrystallized; before recrystallization, the beta-treated rod had given the normal non-reproducible x-ray results. Available literature indicates that the major texture of uranium is unaffected by recrystallization. This method is being studied as a possible means of obtaining better x-ray information from beta-treated material.

Fuel Geometry Development. The operating stress pattern in the OD clad of a fuel element with the outside cross section approximating a six-pointed curtate hypocycloid shape may be more desirable than a circular shape. Three Zr-2 clad coextrusions of NPR inner weight with this shape have been fabricated for evaluation. The first was unbonded in the points due to improper die design. The die was modified and provided good overall bonding in the second and third extrusion. The clad on the radiused points of the cross section is 50% thicker than that in the valleys. Elements from this stock are being made up for irradiation testing.

Fuel Straightening. Fuel straightening experiments are being carried out on the three-roll straightener in 306 Bldg. Tests are in progress on a group of six extrusions of N inner tubes that were extruded by Fuels Fabrication Development. The six extrusions were cut into 24-inch long elements, end caps beam welded in place, and the elements were beta heat-treated. The elements were randomly segregated into three groups of eight elements each. Group A, following beta heat-treatment and warp measurement, was annealed four hours at 600 C, straightened, and autoclaved. In the straightening step, the elements were heated to 575 C in an argon atmosphere and quenched in the straightener. The autoclave cycle was 72 hours in 400 C steam. Warp measurements were taken between each step in the process. All warp measurements are recorded as double throw warp. The average beta heat-treated warp for group A was 0.056 inch. Average stress relieved warp was 0.053 inch. Average warp following straightening was 0.006 inch, and average warp following the autoclave cycle was 0.012 inch. Group B, following beta heat-treatment and warp measurement, was straightened, will be stress relieved for four hours at 600 C, and autoclaved. This group is in process. Group C, following beta heat-treatment was straightened and autoclaved. Warp measurements indicate average double throw warp after heat treatment to be 0.053 inch. Average warp after straightening was 0.010 inch, and following autoclaving the average warp increased to 0.015 inch. Further tests are planned to determine if this method can be used to satisfactorily straighten warped production fuel.

Closure and Joining. Several new end cap step designs have been tried for use with the Metal Inert Gas welding process, which is being investigated as a method of making the final closure on the NPR fuel elements. One step design shows very promising results. This design requires a groove in the step immediately over the braze, thus actually cutting out a ring of braze ten thousandths of an inch deep. The zirc wall is then bent over the groove. This forms a pocket from which the braze cannot escape to contaminate the weld filler metal. Besides keeping the braze from the weld, another advantage of this groove is that it allows a higher welding voltage to be used making it easier to obtain the desired weld profile.

Attempts have been made to improve the strength of the projection welded resistance brazed closure by machining the face of the closure cap which contacts the uranium into a 60° wedge. This wedge shape has the advantage that the projection welds and the braze interface are not in the same transverse plane as is the case with this closure using a flat faced cap. This modification was tried on Zircaloy-2 clad KER inner tubes with encouraging results.

Approximately 0.025 inch of uranium was acid milled from the end of the element to provide uranium-free cladding projections and a V-groove is machined in the uranium to match the wedge on the closure cap. The cap wedge was copper immersion plated to aid in bonding the Zircaloy-2 cap to the uranium.

Approximately sixty to seventy percent of the cap area was bonded to the uranium with indications that a complete bond may be possible using a greater force on the cap during the brazing cycle. The wedge shaped cap appears to bond to the uranium more readily than a flat cap under the same conditions.

The welds which are used to attach supports to NPR outer fuel tubes must be of high quality, must be reproducible, must not produce a heat-affected zone in the uranium, and must not damage the Zr-U bond. A group of 50 welds was made on an NPR outer tube. Cladding on the samples welded averaged 0.027". Supports were formed from 0.040" stock. Nine welds were examined metallographically, the others were shear tested. All shear strengths fall between 1000-1300 pounds. There was no visible disturbance of the bond and no heat-affected zone in the uranium at 200x. The heat-affected zone extended from the weld into the Zircaloy cladding 0.020".

Weld tabs on the supports were formed flat. Earlier attempts using tabs of a radius the same as the fuel element were not as consistent. The welds were made with a 100 KVA resistance welder operating single phase.

Zircaloy Lubrication. A new lubricant has been developed. It is to be used primarily for the cold sizing of Zircaloy-2 tubes, rods and coextruded materials. The lubricant consists of a solution of "Bull Dog" (Marshall Wells Co.) belt dressing in toluene. For deep drawing of Zr-2 sheet or the free sinking of Zr-2 thin-walled tubing in a draw bench it is only necessary to paint on the solution and let it dry before using. Where heavy-walled tubing or coextrusions are to be resized, it is best to add a

small quantity of MoS_2. It is extremely difficult to get the MoS_2 type lubricants to cling to a smooth clean Zr-2 surface. The belt dressing causes adherence and in addition acts as a good lubricant.

Swaging Studies. The Zr-2 free sink tests are near completion. The profilometer readings, on the tubes that have been swaged to 75% of their original diameter in one pass, are being plotted as a function of the feed rate and also of the die throw. The present indications are that the feed rate has little or no effect over a wide range. The surface finish as a function of the die throw is still under test.

2. REACTOR PROGRAM

Coolant Systems Development

Decontamination. It is desirable to reduce the quantity of rinse water required for complete removal of the alkaline permanganate used in most decontamination procedures. The use of a reducing acid solution has been suggested as a rinse to reduce the manganese compounds to the soluble manganous compounds which could be easily removed. The first loop tests with the rinsing compound were unsatisfactory, probably because of a large holdup of alkaline permanganate in the low spots of the system. Additional tests are warranted since the principle is sound. In the next experiment sufficient acid will be added first to bring the pH down to the desired value.

Two new commercial bisulfate compounds have been tested in the laboratory and in ELMO-10. Both compounds were quite effective in the laboratory and in the ELMO-10, giving decontamination factors of 150-300 with low corrosion rates for carbon steel. Further evaluation is in progress.

Corrosion of Materials at pH 9. A test to determine uniform corrosion rates at pH 9 has been started. Prior to startup, samples of 1031 c/s, 1051 c/s, normalized A212 c/s, sensitized and nonsensitized 304 s/s, and Zr-2 were charged. Control of pH is by flow through a LiOH regenerated ion exchange bed. Samples of 406 s/s, 420 s/s, Hastelloy-C, Monel, and Zircaloy-2 which were being exposed during the pH 10 test are continuing their exposure in the pH 9 test.

Autoradiography of KER Pipe Sections. During autoradiography of portions of pipe removed from the KER Loop 2, cracks in the primary heat exchanger were discovered on a pipe section immediately upstream of the by-pass tee weld. These cracks were found in both transverse and longitudinal orientation with respect to the pipe. Autoradiographs also showed the presence of these defects.

Instrumentation for NPR. Procedures for the determination of hydrazine and phosphate with an autoanalyzer were studied. A modification of the recommended hydrazine procedure was developed which is satisfactory for use in the 0 to 250 parts per billion (ppb) range. The accuracy and sensitivity of the procedure are approximately ± 5 ppb. The modified procedure eliminates the difficulty encountered with the recommended procedure

(dissolution of the Tygon pump tubing) that was reported previously. This procedure could be adapted for higher concentration ranges if desired.

Although an initial evaluation of a procedure developed for phosphate analysis in the 0 to 250 ppb range indicates that this procedure should be both accurate and sensitive enough to meet our requirements, the procedure has not yet been evaluated in detail. An alternate procedure for phosphate analysis in the 0 to 250 ppm range has not been evaluated. Replacement parts have been received so that evaluation of the chloride procedure can now be resumed.

Rupture Tests of Unirradiated Fuel Elements. A total of eight coextruded fuel elements were rupture-tested in ELMO-4 during the month. The tests were designed to compare the relative behavior of: (a) unalloyed and alloyed (U, 2.0 Zr) cores, and (b) brazed and unbonded end caps. The alloy cores react more slowly at first, but once the reaction has started, it proceeds at an increasingly rapid rate. No difference in rupture behavior could be detected between brazed and unbonded end caps.

Structural Materials Development

Zircaloy Retubing Program. Sixteen smooth-bore Zr-2 tubes, needed for the scheduled expansion of the overbore test at 105-C, have been produced by a new and promising process utilizing warm extrusion, low annealing temperatures, and one large tube reduction. The extrusion and cold forming tooling have been improved, and the process is now being used to make forty additional overbore tubes. These tubes are undergoing the second warm extrusion prior to annealing and tube reducing to final size. Delivery is scheduled for late July.

NPR Process Tubes. Nine samples of NPR tubing representing the product of three different vendors were analyzed for hydrogen content. The results ranged from 15 to 45 ppm. The samples were then autoclaved with a group of NPR tubes in the production autoclave in the Hanford tube inspection facility at White Bluffs. The hydrogen content was then found to range from 10 to 40 ppm. The same specimens were autoclaved a second time and analyzed. Hydrogen contents ranged from 20 to 40 ppm. It is concluded that any hydrogen picked up during the 425 C autoclave is less than the limit of accuracy of the test procedure.

Areas of enlarged grain have been observed on seven NPR process tubes after the pre-autoclave etch. These areas vary in size from spots about the size of a quarter to streaks several feet long and about an inch wide. The tubes affected were produced during the early part of the order when the surfaces of the tubes were oxidized in air to form a lubricant base for subsequent drawing. Any scratching of the film during drawing was repaired by grinding. Oxidation of repaired areas was accomplished by heating with a welding torch prior to the next drawing pass. This treatment of Zircaloy containing some degree of cold work can result in grain growth or, if heating is severe enough, in phase transformation.

Nonmetallic Materials Development

Radiation-Induced Cracking of Graphite. A recent document, BMI-1503, has predicted longitudinal cracking of the monolithic graphite bars in the Experimental Gas Cooled Reactor due to differential, radiation-induced contraction.

The calculations, if correct, would probably also predict eventual cracking of the graphite in the NPR. However, rather drastic assumptions were necessary in order to perform the analysis for the EGCR. Since the radiation-induced stresses in the EGCR lattice are relatable to those in the Hanford reactors, it was suggested that observations of the condition of the graphite in the Hanford reactors may provide some indication of the adequacy of the EGCR calculations. Preliminary observations were made in the bare channel 2780 in C Reactor, and longitudinal hairline cracks were seen in all bars in the rear of that channel. Most of the cracks extended the full length of the bar. These cracks cannot be definitely identified as being induced by radiation; however, a more careful analysis of C Reactor is under way to ascertain the probability of that cause.

NPR Graphite Irradiations. The GEH-13-7 capsule, which was built to compare NPR core and reflector graphites, failed on May 10. It was removed from the F-6 position of the ETR on May 21. The cause of failure was shearing of the lead tubing apparently due to excessive vibration from water turbulence in the reactor. Redesign of the lead bracketing is under way to prevent a reoccurrence. The samples from the capsule were all recovered, but they were pitted and eroded and have a loose scale-like material on them. This was caused by irradiation in reactor water for the 11 days prior to removal after lead failure. Currently, attempts are being made to recover the flux monitors from the capsule. Samples and flux monitors will be returned to HAPO for examination and measurement.

NPR Core Graphite. In order to clarify the apparently low ratio of coefficients of thermal expansion (CTE) for parallel and perpendicular samples reported recently, a sampling study was run on a single 5x6" bar of NPR core graphite. Fifteen parallel samples, four inches long, were taken along the bar center lines from edge to edge. Eight transverse samples, six inches long, were also tested. The CTE measure parallel to the extrusion axis ranged from 0.78 to 10^{-6} per °C to 0.86 x 10^{-6} per °C with an average of 0.82 x 10^{-6} per °C; for perpendicular samples the range was from 3.36 x 10^{-6} per °C to 3.91 x 10^{-6} per °C and the average was 3.62 x 10^{-6} per °C. There was a definite change in values across the bar, particularly in samples cut perpendicular to the extrusion direction. Depending upon the position from which samples were taken, the ratio CTE ($\perp$)/CTE($//$) varied from 5.02 to 3.91. For samples chosen according to standard Hanford sampling procedures, the CTE ratio for NPR core material is 4.75 as compared to 4.02 for KC and 4.79 for NPR reflector graphite.

Thermal Hydraulic Studies

Re-evaluation of Thermal Hydraulic Conditions for Maximum Allowable Tube Powers. The maximum outlet water temperature limits for the Hanford production reactors are based to a large extent on the thermal hydraulic characteristics of the fuel channels as determined by laboratory experiments. These heat transfer experiments have been performed with hydraulic fittings and fuel elements exactly as used in the reactors, and the resulting limits have been restricted to reactor tubes with fittings of these sizes. A general re-evaluation of the methods used to establish outlet water temperature limits was started to enable better extrapolations of the limits to reactor tubes with modified fuel elements and hydraulic fittings and to define optimum thermal hydraulic conditions which will allow the maximum tube powers commensurate with reactor safety.

As the first phase of this study, a review was made of the heat transfer knowledge of present reactor process channels which has been gained in laboratory experiments during the past year. It was concluded that the present outlet water temperature limits probably could be increased without any reactor modifications, if desired. This would be done by relaxing the requirements of the Panellit pressure gages so as to trip a reactor shutdown in time to prevent fuel damage rather than to scram the reactor when hydraulic instability occurs as is now required. This would not result in increased reactor power levels, since the reactors are limited by other considerations such as bulk outlet water temperatures and tube powers associated with ruptures, but savings could be realized in administering the Panellit gage system and by reducing the number of unnecessary reactor scrams.

Test Sections for NPR Experiments. Fabrication was completed of a full scale electrically heated test section of the downstream half of a train of NPR tube-in-tube fuel elements. The heated portion of two coaxial tubes is 17-1/2 feet long and is made from seven different metals to obtain a decreasing heat distribution along the length and to maintain a proper proportion of heat generation between the two tubes. Small ceramic pieces are used to maintain both support and electrical resistance between the two tubes and between the outer tube and process tube. These pieces are shaped and spaced very similar to those support pieces used in the actual fuel elements. The test section is instrumented with 16 thermocouples to measure surface and core temperatures and with pressure taps to measure pressure drop across each of the three flow channels.

The test section will fit into a 2.702-inch ID steel tube installed in the high pressure heat transfer apparatus. Provisions have been made to adjust and measure the flow to each of the three flow passages of the test section during experimentation. The test section was designed for heat generation rates of 2700 kw under steady state conditions and 3800 during overload periods of one half an hour.

Shielding Studies

The computer program for calculating neutron and gamma attenuation for use in design of bulk shields is complete. Using boundary conditions at the interface between the core and the reflector in the top shield of 105 DR Reactor, neutron and gamma fluxes were calculated through the fringe poison region, graphite reflector, iron thermal shield, and in this case through ordinary concrete. The total thickness of the shield was about 220 cm. The calculation gave the correct shape of the thermal neutron flux and compared with experimentally determined thermal fluxes within a factor of two. The gamma calculation compared with experimental data within a factor of 1.5. The shielding program will calculate the following information at any point in the shield:

1. Neutron fluxes for 31 energy groups.

2. Total neutron dose rate.

3. Approximate neutron spectrum.

4. Gamma fluxes for seven energy groups.

5. Total gamma dose rate, with a breakdown as to the contribution of each region in the shield to the total dose rate.

6. Approximate gamma spectrum.

A study will now be made on all of the concretes which have been tested experimentally to date to check the reliability of the program as applied to various types of shield materials.

B. WEAPONS - 3000 PROGRAM

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

C. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

PRTR Project Management and Design

PRTR Construction. Construction of the Maintenance and Mockup Facility is estimated at 99% completed versus 100% scheduled as of June 30, 1961. The PRP Critical Facility and Rupture Loop Annex buildings have been accepted with minor exceptions. The painting, tiling, piping, and electrical work in the M & M Building are completed. Remaining work concerns equipment testing and correction of deficiencies. The motor on the water chiller unit is overloading, and the circulating pump is not operating at the specified capacity.

The PRTR and PFPP paving and landscaping contract is estimated at 98% complete versus 98% scheduled predicted to June 30, 1961. All paving and road work has been completed. Landscaping has been completed, but the recent hot windy weather has made the replacement of several trees and replenishing of some top soil necessary. The remainder of this contract, ground maintenance, will continue through July 21, 1961.

Installation of Fuel Element Examination Facility equipment in the reactor cell proceeded during the month. The control console, relay cabinet, and motor generator cabinet with interconnecting piping and wiring have been completed. The manipulator was positioned in the cell to verify the location of mounting and guide brackets, auxiliary piping, and interconnecting piping and wiring. The brackets have now been seal welded to the cell cladding and the manipulator cleaned and fitted with the experimental air ducts in preparation for final installation. The wide angle viewer has been installed and preliminary work completed on the profilometer. The facility was used for examination of fuel elements prior to the installation of the manipulator by suspending the elements from the charge-discharge machine and viewing them through the lead glass windows in B Cell.

The load-out facility cask was used to transfer an irradiated rod which had been removed from a 19-rod PuAl element. Some difficulties were encountered with the operation, primarily with the load-out facility hoists, which were modified. The handling tools which had not been previously tested with the cask, also received some modifications.

Plutonium Recycle Critical Facility (CAH-842). Funds have been assigned to the CPFF contractor, and installation of equipment started on June 27, 1961.

The fuel transfer lock testing program has been completed by the vendor. One cylinder on the cell door latching mechanism was too small and will be replaced. The compression seals have been installed on both doors, and the remote controls are now operable.

All specifications for the instrument package have been received, reviewed, and returned to the vendor. Promised shipping date was June 1, although the Government Inspection Agency indicates that delivery will probably not be realized until the middle of September. Expediting has been requested to follow this order and endeavor to improve delivery.

Control and safety rod development was continued. The control rod readout mechanism was received from the vendor; however, there is some doubt as to whether the vendor used specified radiation resistant grease. A clarification has been requested.

The temperature monitoring equipment bids were reviewed. The readout equipment order was placed. Bids on the temperature sensors were rejected because of excessive cost. A re-bid has been requested.

Testing of the reactor tank has been completed, and the tank is being prepared for shipment. During testing a leak was observed around the inner grid plate gasket. Additional tie-downs will re required during installation. An additional problem resulted when the inner wall of the tank corroded during the ten days that city water, used for testing, was in the tank. The degree of pitting, reported as 0.005 to 0.010 inch deep, was not sufficient to structurally damage the tank. Restoration of the finish will be accomplished locally to permit installation work to proceed.

Fuel Element Rupture Test Facility (CAH-867). The water plant design criteria revision to reduce pumping capacity and costs has been approved. A revised project completion date of June 1962 has been submitted. Changes in the design drawing and specifications have been completed and will be released for bidding early in July.

The makeup ion exchange system (RL-105), deaerator (RLT-7), inlet shutoff valve (RL-504), and Zircaloy reactor tube (RL-501) have been received during the month. An order was placed for the motor control center and power feeder system. An estimate has been received from the CPFF contractor for installation work in B Cell and the annex which is within the project proposal estimate.

The vendor of the primary injection pump was visited during the month to witness acceleration, full capacity, and de-acceleration tests. The full capacity and de-acceleration tests were satisfactory, but the acceleration from low speed to high speed exceeded the time specified. This condition will not permit the use of standard overload heater protective devices. It has been determined that the motor vendor was in error, and corrective measures are being taken.

Component Testing and Equipment Development

PR-10 - Primary Loop Mockup. The spare primary pump operated 335 hours during the month for a total of 6823 hours. The leakage rate for the last 240 hours has been consistently in the range of four to five gallons per hour.

The prototype pump with the self-adjusting seal assembly operated an additional 350 hours for a total of 8271 hours. The present seal leakage is 0.7 g/hr.

The seal test stand operated an additional 143 hours and 19 starts for a total of 1180 hours and 158 starts.

Testing of the Aldrich Injection pump resumed on June 26, 1961, using Disogrin U-cups. Initial operation at 1100 psig has shown no overheating and no measurable leakage.

Shroud Tube Replacement. The borescope which is to be used for inspection of shroud tubes and to facilitate the placement of tools was shipped June 21.

Minor Construction submitted an estimate of $10,000 labor and $2,000 material for fabrication of the "Shroud Tube Replacement Mockup".

PRP Critical Facility Prototype. Minor modifications have been made to the source positioner and the unit is now being reassembled in preparation for testing.

Redesign of the adjustable weir lower limit switch system is required before testing of this component is started. Approximately one man week total of engineering, design, and fabrication will be required to complete the weir to the point where it is ready for testing.

The thimble is ready for testing upon receipt of flexible hoses. Redesign of the safety and control rods to incorporate new safety and reliability features is nearly complete. The synchro systems for the control rod position indicators have been received and from physical appearance look quite satisfactory. No testing will be started until material certifications and test data required of the vendor are received and found acceptable. Electromagnets per the latest report were to be shipped on June 23, 1961. New lead screws have been ordered to replace the 17-4 PH lead screws. Receipt of these lead screws will not interfere with fabrication and testing since the 17-4 PH lead screws can be used for initial testing.

An order was placed for a recorder for the PRP Critical Facility moderator temperature monitor. Delivery is expected about August 1. Bids on the resistance temperature detectors for this system were reviewed, and the low bidder was asked to furnish further information to enable evaluation of his bid. This information was expected by July 1. It is probable that this system will not be available during the first one or two months of PRP Critical Facility operation.

Review of submittal data and acceptance tests for the PRP Critical Facility instrumentation continued during the month. Several conflicts in dimensions and specifications were resolved with the manufacturer. Major problems remaining to be resolved on Critical Facility instrumentation include a power supply for the safety and control rod magnets, interconnections to PRTR area radiation monitors and seismoscopes, and instrumentation to actuate the poison injection system.

PRTR Rupture Loop Prototype. Heaters were received on June 26, 1961, for testing the mockup of the outlet nozzle Zr-2 to stainless steel flanged joint and associated holddowns and gas seals. Testing is to begin immediately.

The Grayloc unions for the outlet nozzle to jumper connections and the inlet shutoff valves from Aero Supply were received during the month.

Design Analysis

PRTR Startup Activities. A Fortran code, designated XENTRAN, was written to assist in the analysis of xenon poisoning measurements made during PRTR operation. The calculation provides a continuous xenon poison reactivity accounting for any operating history. Xenon poisoning observed during the initial period of operation appears to be in good agreement with the calculation and with the xenon tables.

Several Operating Standards for reactor control were completed. They include I-C Reactor Flux; I-2, Flux Chambers; and I-H, Manual Reactor Control. In addition, assistance was provided in the revision of Operating Procedures and in preparation of special instructions and data sheets for Power Tests.

Critical Test analysis work was continued during the month. All of the fuel element temperature data obtained from the thermocouple fuel element during previous power operation was examined and correlated with variations in moderator level and power level. Fuel temperature coefficients deduced from these measurements are in the range from -1×10^{-5} to $2 \times 10^{-5} \frac{\Delta k}{k}/C$, in reasonable agreement with calculation.

Discussions were held with WAPD personnel on CVTR critical test results. Where conditions were comparable, experimental data were found to be generally in agreement with PRTR critical test results.

PRTR Safeguards Studies. The initial operating experience with the PRTR was reviewed by the General Electric Technological Hazards Council on June 16, 1961. The Council expressed concern over the potential consequences of the contamination of the primary coolant with chloride and fluoride. It was recommended by the Council that the process tube monitoring program be enlarged to insure that the process tubes are performing as anticipated.

PRP Critical Facility. Work continued during the month on the Final Safeguards Analysis for the PRP Critical Facility. Major comments received to date on the rough draft are concerned with the poison injection system and with procedures for performance of experiments in the facility.

PRTR Operations

Reactor Testing and Activation. The PRTR outage which began May 18 continued through the month of June. Major efforts during the month were concentrated on inspection and repair of the PRTR primary cooling system

because of stress corrosion damage which resulted from contamination of the heavy water with freon during helium system leak detection work in March. Startup preparations are in progress at month-end.

All fuel elements were discharged to the storage basin for inspection and necessary repairs. All bands on the PuAl elements were replaced. Stress corrosion also affected pins in the fuel element hangers connecting the fuel element to the hanger and holding the hanger head and shaft together. A new modified pin design was devised so that the damaged pins could be removed and new pins inserted on the irradiated assemblies under water in the storage basin. Hanger heads were welded to the shafts to enable removal of the upper pins.

After the fuel elements were discharged and the primary system was drained, inspection of the primary system was made. Stress corrosion attack was observed in two locations: at the spiral wound metal-asbestos gaskets on the process tube flanges and at the instrument line connections to the inlet jumper flowmeter venturis. Inspection of welded connections on the jumpers and outlet nozzles, and of jumpers and jumper fittings disclosed no evidence of similar attack. Because of the damage to gaskets and the possibility that such gaskets could retain excessive concentrations of corrosive elements, all metal-asbestos gaskets in the high temperature portions of the primary system were replaced. This work required dismantling of the inlet and outlet reactor piping. Instrument line connections to the venturis were redesigned and all inlet jumpers were rebuilt, cutting out the corroded areas.

The primary coolant system ion-exchange resin was replaced with fresh neutral commercial grade resin through which the primary coolant was circulated for removal of halogen ions. Following this, the primary system was drained to a temporary storage tank. Special attention was given to draining all dead legs of the system. The temporary cleanup resin was subsequently removed and replaced with a nuclear grade neutral resin for a brief operating interval with the primary coolant at pH 7. This resin was then replaced with a nuclear grade lithium-based resin for the next operating run at pH 10.

Because of the need to maintain stringent limits on oxygen concentration in future operation of the primary system, a deoxygenating ion exchange unit with provisions for regeneration and deuterization was installed in the primary cleanup system. To reduce aspiration of air into the system during fuel charging operations, an inert gas shielded fuel charging funnel was designed and put into use.

During the month the entire inventory of "used" D_2O was passed through cleanup ion exchangers. Following cleanup, each drum was tested for isotopic purity, total conductivity, and halogen content before being approved for reuse in the primary system. This work was complicated by the appearance of an organic odor in much of the reprocessed D_2O inventory. This odor was not positively identified; however, the odor was removed by air sparging.

Late in the month gross mercury contamination was found in the process cell near the primary and moderator flow transmitters (both of which contain mercury). Also, mercury was found in some of the "used" D_2O drums, the D_2O cleanup equipment, and in some of the in-process ion exchange piping. Extensive cleanup corrected this situation by month-end. All mercury formerly in the service building and the containment vessel has been moved to 300 Area except that in enclosed instruments such as the primary and moderator flow transmitters, pressure switches, and mercury vapor lights.

Installation of piping and controls for cold D_2O injection to primary pump seal chambers was completed during the month. The remote pump venting valve installation was also finished. Pumps have been returned to normal operation.

All previously reported leaks in the primary and helium systems were repaired, although some further leakage in the primary piping may be anticipated because of the extent to which it was dismantled during the shutdown. The primary system air assisted check valve was repaired and was modified to provide satisfactory closing and limited shutdown flow control.

Helium system work included incorporation of hydrogen addition facilities at bulk storage, revision of recombiner piping, fabrication and installation of a recombiner in the helium supply to the primary system pressurizer and repair of a high pressure compressor head and oil regulator valves. The helium system has been placed in operation at month-end.

The PRTR loadout cask was lowered into the basin and a single canned fuel rod was loaded into the cask for shipment to Radiometallurgy. To eliminate jerking of the crane when the cask was being changed from the horizontal position to the vertical position or vice versa, a special bearing type clevis was designed and installed. The tools for handling and loading the fuel, and for opening and closing the cask were satisfactory. However, some refinement of these tools will be made.

Analysis of water, gas, and resin samples from the last operating period in April indicates the probability of a ruptured fuel element. Special tests have been devised to try to confirm or disprove this when the reactor is next brought to low power operation. A gas sample line has been installed from the degasser to the rupture monitor bulk sample chamber, all needle valves (61 of 85) that failed to date have been repaired, a glass encased gas separater has been installed in one of the tube flow sample lines, and special sampling points have been established to aid in the rupture detection program. By spectrum analysis of both bulk D_2O and He samples, an attempt will be made to evaluate the existence of a rupture. Analyses of the spectrum from D_2O and/or He samples from individual tubes will be attempted to try to locate the rupture if it exists. Longer range efforts to obtain a usable rupture detection and location system continued.

"Snubbers" (4-foot long, 1/16" SS lines) were installed in the low and high pressure sensing lines (3/16" lines) to 20 flow monitors. The snubbers

were installed in lines from tubes with inlet jumper takeoffs near the inlet header bull-tee since these have exhibited the greatest (± 7%) fluctation. Flow monitor response time with snubbers installed is within specifications.

The backup instrument air reserve installation was completed during the outage. A minimum of one hour of instrument air is now provided for critical instruments. A longer supply is available if integrity of the air receiver is maintained.

An in-line analyzer to monitor primary system O_2 concentration was installed. Checkout of the analyzer is not yet complete because laboratory techniques for intermittent checking of O_2 concentration are not yet reliable to use as a standard.

The secondary and top and bottom shield O_2 analyzer was also put in service. Indications are that the sulfite added to the secondary system water will mask our efforts to determine O_2 concentration. Efforts to obtain a true value of O_2 will continue.

As reported last month, the aqueous activity monitor low trips were put in service. Oscillation of the monitor indication, believed to be caused by overloaded inverter power supplies or by the battery charger in the system, may require reducing the response time of the monitors to avoid unnecessary reactor shutdowns. A higher capacity inverter is currently under test and utilization of a new concept for powering the monitors is being studied.

The first factory reworked dump valve actuator was installed. The replaced actuator has been returned to the factory for chrome plating. The dump valve plugs have shown signs of wear where they slide through valve body sleeves. After consultation with the factory, it was decided to stellite coat portions of the plug. Arrangements to have this done are currently in progress.

Operating Standards and Procedures. The major effort during the month was the revision of the standards and proeedures pertaining to the quality and samples of the heavy water, light water, and helium systems. All other standards and procedures will be subjected to a review and updating.

The maximum impurity concentrations of the three heavy water and the top and bottom shield system were established as follows:

MAXIMUM CONCENTRATION

Impurity	Primary System	Moderator and Reflector Systems	Top and Bottom Shield System
Chloride	0.2 ppm	0.2 ppm	0.2 ppm
Fluoride	1.0 ppm	1.0 ppm	1.0 ppm
Copper	0.05 ppm	--	0.5 ppm
Oxygen	0.14 ppm	--	1.0 ppm
Peroxide	--	--	1.0 ppm
Total Solids	10.0 ppm	1.0 ppm	20.0 ppm
Conductivity	80 micromho/cm	1.0 micromho/cm	--
pH	9.5 - 10.5	6.0 - 7.5	9.5 - 10.5

The maximum impurity concentrations of the portions of the helium system were established as follows:

MAXIMUM CONCENTRATION

Impurity	Core Blanket and Gas Balance System	Primary Coolant Pressurization System
Oxygen	--	0.01%
Nitrogen	--	0.5%
Nitrogen plus oxygen	0.5%	--
Deuterium plus hydrogen	2.0%	0.7 - 1.7%(range)

Thermal Hydraulics Studies

Natural Convective Cooling of the PRTR. An investigation of the problem of adequately cooling the PRTR during a total power outage was completed. Previous studies have shown that natural convection circulation of the primary coolant would be adequate to transfer heat from the fuel during a total electric power outage without boiling. However, there are several means by which the required convective head would be lost (e.g., excessive evolution of helium from the coolant) and the water in the process tubes would then boil. The effects on fuel element temperatures of this boiling was determined in the heat transfer laboratory.

Experiments were performed with an electrically heated mockup of a PRTR 19-rod bundle fuel element placed in a vertical position. Hot water at 200 F was made available to the bottom of the test section at a constant head which would cover the top of the heat generating section with five inches of water. The outlet of the process tube was open to the atmosphere. The experimental procedures consisted of gradually increasing the heat generation rates in the test section while data were obtained of the natural circulation flow rate and surface temperatures.

When the heat generation rate of the test section was increased, vigorous bulk boiling occurred and at 90 kw the flow rate started to fluctuate at

a frequency of five cycles per minute. At 120 kw the test section temperature also started to fluctuate with the same frequency as the flow rate. At 150 kw the cycle frequency was nine cycles per minute with minimum flow rates of four gpm and maximum surface temperatures of 965 F. The tests were terminated at this point to avoid damaging the test section.

It was concluded from the experiments that it would be possible to remove two to four times as much heat by natural convection boiling as would be generated during the reactor shutdown conditions, providing sufficient water was available to cover the fuel elements.

Development of Pressure Surge Suppressors for PRTR Flow Meters. The Panellit flow indicators used by the PRTR to monitor individual process tube flow rates were found to have a fluctuation of from ± 2 to ± 8 percent while in use on the reactor. Since the high and low flow trips are set at ± 10 percent from the operating tube flow, the Panellit fluctuations of those tubes with the larger fluctuations were nearly as large as is trip span and would cause occasional flow trips. As an interim measure, valves in the sensing lines to the flow meters were partially closed to suppress the magnitude of the fluctuations. This was recognized as not being the best practice, since the effect of the valve closure on the response of the instruments was neither fixed nor known. Laboratory experiments were therefore performed to determine the response time of the meter as a function of the degree of valve closure, and, more important, to devise an alternate means of suppressing the flow meter oscillations.

A PRTR flow indicator and a fast responding pressure transducer were both connected to a venturi. The flow through the venturi was increased stepwise by use of a quick opening valve and the resulting changes in the pressure differential as detected by the PRTR flow monitor and the pressure transducer were monitored on a high speed recorder.

The tests showed that the Panellit flow monitors are under-damped and can therefore undergo oscillations larger than those imposed upon it. Valve closures to between 1/8 and 1/4 turn open were sufficient to provide near critical damping and thus eliminate the gage oscillations. These valve closures would not cause an undue increase in the instrument response time, but they are very close to a closure of 1/16 turn open which gave an unacceptably long response characteristic.

The tests also showed that a better means of obtaining the desired suppression of meter fluctuations would be to place about a four-foot length of 1/16-inch tubing in the meter sensing lines. The flow resistance offered by this length of tubing was enough to cause the meter and sensing line system to be very nearly critically damped. This very nearly eliminated the meter oscillations without greatly affecting the response time of the system except to show that it is 0.5 second or shorter. This is an acceptable value.

Plutonium Fuels Development

PRTR Fuel Examination. An aluminum-plutonium spike fuel element was discharged from the PRTR for examination after operating for about two weeks. The maximum reactor power level during this time was about 15 MW and the maximum coolant temperature was about 530 F. An underwater examination revealed that the unautoclaved Zircaloy bands around the element were badly corroded and some had come completely loose. A closer examination of the bands showed that severe corrosive attack had occurred in areas where crevices were present. The corrosion was attributed to poor water quality. The surface of the element was then examined with the aid of an underwater periscope and pitting attack of the fuel element was observed in areas where the bands were in contact. One of the wire wrapped fuel rods was cut from the cluster and has been taken to Radiometallurgy for further examination. The degree of pitting attack will be determined and the element will be examined for crevice type corrosion under the wire wrap and in areas where the wire is attached.

It was decided that all of the original Zircaloy bands should be replaced before the fuel elements were recharged into the reactor. A technique was devised for rebanding the fuel elements in the reactor basin. For the rebanding step, the vertically-hung elements were moved from the storage racks into an aluminum tray, the basin hanger member removed, and the element and tray pulled up into a horizontal position. With the element six feet below the water surface the radiation level was about 70 mr/hr. For the rebanding operation, the element depth was adjusted (to about seven and one-half feet) so the activity level was 5-10 mr/hr. The technique for rebanding involved the use of a snare-like loop of autoclaved Zircaloy wire (0.072-inch diameter) of which the cross-over sections passed through a small two-hole Zircaloy block. The wire ends were held in a tightening device. The wire loop was slipped along the fuel cluster to the proper position and tightened. A crimping tool was employed to mechanically secure the wire in the Zircaloy block and the residual wire ends were trimmed off to within about one-fourth inch of the block. Three wire bands were symmetrically placed on each element. A nylon ring gage, sized to just clear the fuel element brackets, was passed over each band to insure that the band components did not protrude excessively.

The corrosion pitted area on the fuel rods were approximately one-eighth inch in diameter and centered under the high pressure contact point of the bands on the rods. All twelve outer rods exhibited some corrosion pits under the band at six points along its length corresponding to the location of the original Zircaloy bands. The white corrosion product, identified as ZrO_2 by x-ray diffraction, was located at the border of the corrosion pitted area. This border would be at the interface of the static and the refreshed coolant surface. The corrosion was more severe in the high flux positions in the reactor.

The corrosion pits were cleaned in the storage basin under approximately seven feet of water. A rotary nylon bristle brush and a water jet were used for this purpose. The elements were positioned horizontally during cleaning on a special rack which was loaded vertically and then tilted

90 degrees. The completeness of the corrosion product removal was measured visually with the aid of an underwater periscope. This periscope also enabled the examination of the total cluster for abnormal signs of surface damage and for the inspection of re-band tightness.

In an attempt to eliminate the wear observed on the inside of the process tubes caused by the fuel element end brackets, a special element has been assembled to be charged with the next PRTR loading. The contact areas of the end brackets on this element have been increased by a factor of 30 by welding a Zircaloy pad one-half inch long by one-fourth inch thick to each spacing gusset.

When handling the fuel elements for the rebanding and pit cleaning operations, some of the ball-lock pins which attach the element to the hanger assembly fell out of place. Three of these pins were examined in Radiometallurgy, and it was found that the 17-7 stainless steel springs inside the pins had deteriorated due to corrosion. This necessitated replacing all the pins on the hangers.

Fabrication Development. A rod swaged with prewelded ends to a density of 90 percent theoretical was opened in the analytical laboratory. Samples taken from each end and the middle were weighed and loaded into the vacuum gas collection system within 15 minutes of the opening time. These showed an average gas release of 0.57 cc/gram at 1000 C. This is a greater release by more than a factor of ten than was measured on the starting -20 mesh material. Since the gas available to the oxide during swaging was limited to that contained in the tube void volume, the maximum possible gas pickup (during swaging) can be calculated. This amounts to some 0.03 cc/gram, not nearly enough to explain the unusual increase. There are two possible explanations for these results. The first, and most logical one, is that the outgassing technique used is far too short a time at too low a temperature. This would mean that the tests run on large particle sizes would show an erroneous gas release on the low side. The second possibility is that the swaging has increased the surface activity of the particles to the point where they readily adsorb gas. The following data support the former theory. Three size fractions (-60 +100, -100 +200, -325) were sampled from the fused and crushed swaging stock and total gas release at 1000 C measured. If it is assumed for the sake of calculation that the average diameter of the -325 mesh material is 20 microns, and if it is further assumed that all the gas is released from particles of this size, then it is possible to calculate an expected percentage gas release from each particle size. The measured data are presented in the following table along with the calculated values:

MEASURED AND CALCULATED GAS RELEASE

Mesh Size	Average Particle Diameter (microns)	Measured Gas Release (cc/gram)	Normalized to -325	Calculated Fractional Release
-60 +100	197	0.54	0.21	0.27
-100 +200	110	1.1	0.43	0.45
-325	0.20	2.6	1.00	1.00

The agreement between the calculated and measured values is good. Whether or not this is fortuitous will be proved by further experiments. It does, however, lend considerable weight to the diffusion explanation for the increased gas content of swaged rods.

Compaction of UO_2, preliminary to UO_2-PuO_2 studies, by hot rolling sandwiches of UO_2, contained in stainless steel, was studied with various powder combinations. As reported previously, a compact was rolled at 900 C and 50 percent reduction to obtain material which was 97.7 and 98.2 percent of theoretical density. The O/U ratio of this material after rolling was 2.022. The UO_2 powders used to obtain these densities were predominantly arc-fused with minor amounts of ceramic grade powder.

A similar experiment was run with ceramic grade only which had a tap density of 34 percent. The density achieved with this powder under identical conditions was 72 and 76 percent of theoretical density. Next, a 50-50 mixture of fused and ceramic grade UO_2 was hot rolled at 900 C and 50 percent reduction. The tap density of this powder was 33.5 percent, and the final density obtained was 82.9 and 85.8 percent. There is apparently an optimum combination of fused and ceramic grade powders which will permit relatively high tap densities and result in high final density. Future experiments will include a mixture of 80 weight percent -325 mesh fused UO_2 blended with 20 weight percent PuO_2 to determine if high density mixed oxides can be obtained.

As previously reported, two methods of loading fuel tubes to obtain uniform PuO_2 distribution along the length of a fuel rod were developed. One method consisted of preparing and mixing one tube batches of oxides with 20 percent fines (-325 m) in the batch. The other consisted of incrementally loading the tube so that each small increment contains the required amount of plutonium. Both of these methods were developed and demonstrated using UO_2 fines as a stand-in for plutonium and screen analysis for evaluation.

The goal of both loading methods is to obtain a plutonium distribution along the tube length within $\pm$ five percent of the nominal plutonium concentration. The nominal composition of the uniformly enriched UO_2-PuO_2 elements for the PRTR will be approximately 0.500 weight percent plutonium so that the tolerance along the length will be 0.475 weight percent to 0.525 weight percent. Since it is unlikely that a nondestructive test which is capable of 100 percent inspection will be developed to detect

these small absolute differences in plutonium content, uniform plutonium concentration will have to be insured through process control, which may require extensive destructive evaluation of each process step.

In the incremental loading method, the key control areas in the process require:

1. PuO_2 of uniform plutonium content.
2. A UO_2-PuO_2 fines mixture of uniform plutonium content.
3. A uniform batch (increment) mixture of coarse UO_2 and PuO_2 fines.
4. A loaded tube with uniform mixture.
5. A swaged tube with a uniform mixture.

For requirement one, the theoretical 88.4 percent plutonium in PuO_2 is not obtained in as-received PuO_2 due to the low and varying temperatures used in calcining the oxalate. A 950 to 1000 C calcination in air of the as-received PuO_2 gives approximately a three percent weight loss. Analysis of this high temperature calcined PuO_2 should indicate plutonium concentration close to theoretical.

The second process requirement calls for mixing UO_2-PuO_2 fines uniformly and two blending experiments were completed. Five grab samples taken from the first blend indicated a ± 30 percent variation in plutonium content. Mixing techniques were modified in the second experiment, and six samples indicated a ± 1.5 percent variation in plutonium content.

The third requirement calls for a device which will deliver uniform increments of UO_2-PuO_2 fines and -20 mesh UO_2. Several manufacturers were contacted, and a small prototype machine which is capable of feeding small amounts of powders of the required particle sizes within ± two percent is being purchased for test and evaluation.

Investigation of requirements four and five are in progress.

Although it is felt incremental loading is inherently more accurate than the high percentage of fines method because of closer control, further evaluation of the latter method is continuing. A tube was loaded containing 0.5 weight percent PuO_2-UO_2. Five 2.5-inch samples were cut along the length of the rod. The plutonium analysis in the bottom four samples varied from 0.399 weight percent to 0.414 weight percent plutonium, or a variation of ± two percent from the mean. In the top sample, however, the analysis was 0.569 weight percent plutonium or approximately 40 percent above the mean analysis. Additional tubes will be sampled with slightly modified loading techniques.

Attempts to cut five-inch irradiation capsules from full length swaged rods have thus far been unsuccessful due to decontamination difficulties. An experiment in fabricating a five-inch capsule by swaging is now being performed using swagable end caps.

Fuel Evaluation. One rod of a Zircaloy-clad aluminum-plutonium seven-rod cluster was intentionally ruptured while the element was operating at full power. This element and the operating conditions were as prototypical of the PRTR aluminum-plutonium spike elements and conditions as could be obtained. The element operated for about 18 full power days prior to rupture and the heat flux at the point of rupture was estimated to be about 200,000 Btu/hr-ft^2. Activation of the hydraulic mechanism broke off the brazed rupture tip and exposed a 0.035-inch diameter hole through the cladding. Loop conditions at the time of failure were as follows:

Reactor Power	175 MW
Inlet Temperature	486 F
Outlet Temperature	497 F
Loop Pressure	1200 psi
Flow	55 gpm
	12 ft/second
pH	11

The rate of fission product release to the coolant and, hence, the degree of core corrosion was indicated by measuring the delayed neutron and gross gamma activity in the coolant. Release rates were so small that activity increases were barely discernible. After about six hours of operation, the cleanup resin columns in the loop were by-passed in an effort to obtain higher readings on the radiation monitors. The activity in the cubicle as indicated by one of the instruments increased slowly from 290 mr/hour at the beginning of the test to a maximum of only 410 mr/hour during the 47-hour period the element was operated after rupture. The test as approved permitted this particular instrument to read an activity level of 40 r/hour before the reactor was to be shut down. During the 47-hour operating period after rupture, the element was subjected to four power cycles of the ETR and the coolant temperature dropped to about 400 F. Activity levels would increase slightly while the loop temperature was brought back to 500 F, then the activity would decrease again after the operating temperature was attained. An attempt was made to waterlog the element. To accomplish this, the reactor power level was reduced to less than 1 MW, and the loop coolant temperature was reduced to about 100 F with the pressure remaining at 1200 psig. The reactor power was brought back to 175 MW in a period of about one hour and the loop temperature was raised to 500 F in about two hours. During this time the loop activity rose to a maximum of 410 mr/hour and then decreased slightly. This was the highest activity level attained throughout the run. Water samples were taken periodically throughout the course of the experiment which confirmed the presence of fission products in the coolant. A complete analysis of these samples has not been finished at this time.

The element has been removed from its stainless steel basket and examined in the ETR canal with the aid of the underwater periscope. There was no evidence of swelling or distortion of the element in the area of the rupture hole. Some discoloration of the Zircaloy cladding was observed for a distance of about one-fourth inch downstream from the hole. After a suitable cooling period, the element will be returned to Hanford for a detailed radiometallurgical examination. The center rod of this element

had an average diametral gap between the core and cladding of 0.007 inch. The results of the aluminum-plutonium in-pile rupture test have been very encouraging, and the behavior of the element in the reactor was similar to the results obtained with ex-reactor experiments. The results of this experiment have further demonstrated the virtues of the Zircaloy-clad aluminum-plutonium fuel element concept for power reactor application.

Of all the 11 irradiated UO_2-PuO_2 capsules to be recharged into the MTR for additional exposure, the six low-density pieces were inserted on June 12, 1961 (MTR Cycle 158). At the request of the reactor personnel, the power generation calculations for the remaining specimens in the test proposal (HW-69156) were reviewed. The values were found to be as stated. The discrepancy between the values calculated at the MTR and at HAPO appear to be due to the selection of the appropriate macroscopic fission cross-sections for the various fuel materials.

The AEC Form 22 authorizing the plutonium reactivity experiment (Phoenix Experiment) has been approved, and the program will be designated GEH-21. Some preliminary reactivity measurements have been made with the samples in the Advanced Reactivity Measurement Facility (ARMF) at the MTR. The data are being analyzed to determine if the accuracy of the measurements is sufficiently adequate to achieve the objectives of the experiment. It was found that the orientation of the samples in the ARMF had a noticeable effect upon their reactivity contribution. It will be necessary, then, to always orient the samples in the same direction when making measurements in the ARMF. There was good agreement between samples cut from the same extruded rod indicating very little segregation of the plutonium. Also, the accuracy of the measurements was reproducible to within one-third μk which is considered quite acceptable.

The test proposal (HW-69281) for the in-reactor sintering studies on UO_2-PuO_2 and the direct comparison of the radiation behavior of UO_2-PuO_2 and enriched UO_2, operating under identical conditions, has been issued. The proposed test has not received Reactor Safeguards Committee approval at the MTR as of this date. The highly enriched UO_2 for use in these fuel elements was received in June, and fabrication of the required pellets has been initiated. Jacketing components for these elements which are to be irradiated in the MTR hydraulic rabbit facility (VH-4) have been completed with the exception of the outer aluminum sheathing section.

UO_2 Fuels Development

Fuel Irradiation. A three-foot long prototypic nested tubular (PRTR Mark II-C) fuel element that was discharged from ETR after a fission gas leak, was disassembled and visually examined in the MTR hot cells. No obvious cladding break was visible, but blemishes were apparent on the cladding of the central rod and on the inner cladding of the inner tube. Further investigations are scheduled.

All PRTR fuel elements which have been in-reactor were visually examined. Most elements exhibit slight surface scratches and small deposits of crud.

The second Hanford UO_2 defect test element (HD-2) successfully completed 17 weeks of irradiation. Only very small amounts of fission products are being released to the coolant.

The third Hanford UO_2 defect test element (HD-5) was fabricated for irradiation with a heat generation rate approximately 2-1/2 times that of the present test element.

VBWR irradiation of a thin-walled stainless steel clad 9-rod cluster UO_2 fuel element continues without incident.

Hydriding of Zircaloy. Zircaloy-4 continues to indicate a significantly greater resistance to hydriding than does Zircaloy-2. The latest evidence comes from an irradiation test of a seven-rod cluster (GEH-12-20) that included purposely defected Zircaloy-2 and Zircaloy-4 clad fuel rods. Post-irradiation examination of a Zircaloy-4 clad rod, defected at the center with a 0.006 inch diameter hole, revealed less than 50 ppm hydrogen in the cladding near the defect. Examination of a similarly defected, adjacent Zircaloy-2 clad rod revealed greater than 500 ppm hydrogen. The pre-irradiation hydrogen concentration in both cladding materials was about 50 ppm. The fuel element operated for 17.8 equivalent full power days at a maximum surface heat flux of 275,000 Btu/hr-ft^2. It is also noteworthy that the hydriding of the Zircaloy-2 occurred without the presence of fluoride in the UO_2.

Hot Swaged Fuel Elements. A marked improvement of the surface finish of hot swaged Zircaloy-clad fuel rods was achieved using a new method of lubricating. The technique consists of periodically spraying a graphite-water suspension into the die cavity during swaging.

The density to which fused UO_2 can be hot swaged apparently depends upon the characteristics of the particular batch of UO_2 being used. Recently, fuel rods containing -60 mesh fused UO_2 from one batch of material yielded

Corrosion and Materials Studies

Corrosion Evaluation. After a short period of operation of the PRTR at a coolant temperature of about 225 C, corrosion was found in several parts of the system. The coolant was deionized water (D_2O) made up to pH 10 with lithium hydroxide. Analysis of the coolant revealed approximately 40 ppm chloride and 125 ppm fluoride present as the lithium salt. This contaminated coolant had a pH of 10.8 and a conductivity of 666 micromohs. The oxygen concentration is not known. An investigation into the cause and extent of corrosion has been started. Only the primary coolant system was seriously affected.

The fuel cladding, in-reactor tubes and other Zircaloy components showed evidence of a crevice attack characteristic of Zircaloy corrosion which occurs in the presence of fluoride. The unautoclaved Zircaloy bands around the PuAl fuel elements showed this corrosion attack most severely. Several 10-mil bands were completely penetrated in the tight crevices.

The upper and lower gasket surfaces of the Zircaloy process tubes showed rings of white corrosion product where the stainless steel gasket ridges penetrated the autoclave film. This attack was usually confined to the inner spiral of the gasket unless the joint was leaking. The depth of this attack was only qualitatively determined on one tube to be about three to five mils. The top-face gasket surfaces were generally more severely attacked than the lower-face surfaces. A tube was removed which will be examined in more detail. Most autoclaved surfaces that were not mechanically penetrated appeared normal to the unaided eye.

Several parts of the type 304 stainless steel primary system were examined for stress corrosion cracking. The examination was made optically or by the dye-penetrant test. The tube-to-nozzle gasket on Tube 1857 was found to be stress-cracked on the outer three stainless steel layers. This gasket was leaking, and when the deposit just outside the gasket was analyzed, it was found to contain 61% F^- and 0.05% Cl^-. Several nozzle-to-cap gaskets were found to have stress corrosion in the outer layers of the stainless steel gasket. The highest incidence of gasket stress corrosion appears in the nozzle-to-cap gaskets. However, the tube-to-nozzle gasket from Tube 1144 was cut apart by layers and fluoride contamination of the asbestos was found at least out to the eighth layer. A similar test on the bottom tube-to-jumper gasket for Tube 1144 showed no appreciable fluoride contamination of the asbestos. Many of the gaskets from the primary system have not yet been examined.

The nozzles from Tubes 1144 and 1552 were cleaned of smearable contamination in 0.5 M diammonium citrate and checked for cracks by fluorescent dye penetrant. The jumper from Tube 1144 was similarly treated. No interior cracks were found. Several small manufacturing imperfections were found on the outside. The stainless steel pieces are type 304 in the as-welded condition. Four more jumpers were penetrant-tested in suspicious areas on the outside. No cracking was found.

An examination of the lower jumpers revealed that the venturi blocks were severely cracked on many of the jumpers (15 to 20). The cracking took the form of inter- and transgranular cracking in the vicinity of the welded instrument lines. Some of the cracks penetrated about 0.3 inch and allowed coolant to leak out, leaving craters over the cracks. Metallurgical investigation of these failures showed cracks radial to the welded instrument fitting which proceeded out as intergranular cracks with some transgranular cracking. Transgranular cracks were also found in the vicinity of the fitting which proceeded inward from the outside. These latter cracks were frequently associated with severe pitting.

The inside of the 3/16" instrument line showed severe rusting. The instrument fitting was 316 stainless steel. Two very minute cracks (0.4 mil deep) were found in two of three socket welds examined in another part of the venturi. Thus, it appears the severe cracking is associated with the dead-ended instrument line. Visual examination of several other parts of the system did not reveal any gross cracking of 300 series stainless steel.

The 400 series stainless steels used as valve trim, pins, and orifices showed extensive rusting and cracking. A valve shaft from a P-11 valve (annealed 410) showed severe pitting and two cracks. These cracks could have been mechanical in origin and are being metallurgically examined. Cracking was also observed in several hardened pins used in the primary system. However, examination of several unused assemblies also revealed cracked pins. Pin springs made of a hardened stainless steel showed some cracking. The lower orifice plates showed severe rusting.

The oxygen content of the primary loop during the period when this corrosion occurred is not known; however, it could have been reduced to a very low level because of the rapid corrosion which occurred. A low oxygen condition would explain the lack of stress corrosion cracks on the interior parts of the system that were examined. Even though the venturi cracked at the instrument lines from the inside, oxygen may have been present from trapped air in the dead-ended line.

PRTR Activity and Film Studies. Some loose particulate material was removed from four PRTR nozzle caps. Two different forms of particulate matter were found: one reddish brown in color and the other a grayish-white. The results from the x-ray diffraction analyses showed the material to be gamma Fe_2O_3 (or Fe_3O_4) and LiF. A stainless steel nozzle was removed from the PRTR and autoradiographed. The negatives showed radioactivity adsorption similar to other stainless steel except that there were several longitudinal marks indicating that the fuel elements may have scraped against the nozzle walls at discharge.

Process Tube Monitoring - PRTR. Eighty-four of the process tubes in PRTR were visually inspected. Thirty-nine tubes were examined with a TV camera and 55 were examined with an M-2 borescope. All tubes examined exhibit localized corrosion at areas where the upper and lower fuel element end brackets contact the tube surface. Normally there were two corroded areas at both the upper and lower fuel element end bracket locations. Five of the 55 tubes examined with the borescope had double marks at the fuel

element end brackets which suggests that the fuel element had rotated slightly during operation. Localized corrosion occurred also at the areas of contact between the spiral wire wrap of the fuel element and the process tube. Usually these spiral corrosion marks were located along one side of the process tube and at axial spacings corresponding to the pitch of the spiral wrap of the fuel element. The upstream edge of a spiral corrosion mark was normally rather smooth with a sharp edge while the downstream edge was rough and ragged. Only film discoloration was noted at areas opposite the bands on the PuAl fuel element. Depth of the most severely corroded areas is estimated to be five mils.

The PRTR tube section in ELMO-7 and the Single Tube Mockup in 314 Building were both examined to compare the extent of localized corrosion in these test loops with that observed in PRTR. The fretting corrosion at the lower fuel element end brackets appears to be somewhat comparable to that in PRTR. The corrosion associated with the spiral wrap and upper end bracket of the fuel element appears to be appreciably less severe than observed in PRTR. The reasons for this difference are not known. The presence of chloride and fluoride ion in the PRTR primary coolant may have contributed to the increased severity of corrosion in the PRTR process tubes; however, differences in mechanical vibrations in the systems also may influence the variation in results. At least four tubes will be examined in detail during each reactor shutdown to maintain a current record of the progress of this localized corrosion.

A process tube has been discharged for detailed examination including measurement of localized corrosion, detection of possible hydriding and destructive testing. Equipment for in-reactor measurement of depth of penetration by localized corrosion is designed and should be available for use before the next PRTR shutdown.

Zircaloy Sheath Tubing. During the month 236 low-nickel Zr-4 tubes, 0.505 inch ID, were inspected; 70 percent of the tubes were found to be acceptable for reactor use. One hundred and nine low-nickel Zr-2 tubes, 0.495 inch ID, were inspected and 80 percent were acceptable. This acceptance rate is an improvement over recent months. Many of the acceptable tubes had minor blemishes on the outer surface which were removed prior to final testing. The major source of rejects continues to be impressed particles of Zircaloy. About 100 Zr-4 tubes, 0.680 inch ID, fabricated by what promises to be an improved process were received. Testing will be complete next month.

Though several thousand pieces of low-nickel Zr-2 have been produced with acceptable corrosion rates as measured by the 400 C steam test, the product from Wah Chang ingots K and M have given questionable and erratic results. Duplicate samples of tubing fabricated from ingot M were distributed to NUMEC, Babcock and Wilcox, Wah Chang, and HAPO for comparative corrosion tests. The following results were reported after 14 days in 400 C, 1500 psi steam.

Laboratory	Weight Gain mg/dm^2	Surface Appearance
Babcock & Wilcox	30 to 160	Black with heavy grey streaks.
NUMEC	24 to 45	All light to moderate grey streaks.
HAPO	25 to 26	Black lustrous surface (two samples had one white spot each).
Wah Chang	25 to 30	Black lustrous surface.

The HAPO tests were performed in a refreshed autoclave and the others in static autoclaves. Other tests on this material at HAPO have shown occasionally rejectable surface appearance. Two conclusions are drawn from these results: (1) the material has questionable corrosion resistance and should be used for short exposure fuel only, and (2) many of the variables affecting the corrosion of zirconium alloys in steam are not well understood.

Non-Destructive Testing of Zircaloy Sheath Tubing. The USAEC-AECL Cooperative Program on Non-Destructive Testing of Sheath Tubing was begun this month.

To compare the response of the existing ultrasonic equipment to defects on the inside and outside surfaces of Zircaloy sheath tubing, grooves of the same depth and orientation were machined in the inner and outer surfaces of 10-inch long sections with the Electrojet spark machining unit. Defects one and three mils deep were machined. The grooves were oriented paralleled, perpendicular and 45 degrees to the tube axis. New techniques are being developed to reduce the width of the grooves.

Using these calibrating standards, work was initiated to choose the best crystal and operating frequency. Preliminary results indicate that the line focused crystal will be best for transverse defects. More than one crystal may be required to detect cracks of all orientations in the tube wall.

Thermal Decomposition of Freon-22. Water adjusted to pH 10 with LiOH was exposed to freon-22 at 100 psi partial pressure during a heating-cooling cycle. The water temperature was raised to 225 C over a period of one hour, held at that temperature for 15 minutes and cooled to room temperature in four hours. The freon was quite soluble in the water. Considerable hydrolysis took place, resulting in about 5000 ppm each of chloride and fluoride in the water. The pH dropped from pH 10 to about pH 2. The resulting hydrochloric and hydrofluoric acids severely attacked the stainless steel autoclave.

The fully saturated freons are probably more stable than freon-22, but none were tested. Since freon-22 is very unstable in the presence of pH 10 LiOH at 225 C, it should be used with extreme caution whenever

contamination of reactor water is possible. The use of helium leak checking of stainless steel - Zircaloy systems appears preferable to the use of freon, since no potential chloride or fluoride ion contamination is possible.

Solubility of Mercury in Water. Mercury is very slightly soluble in water with the oxygen content of the water being an important variable in the extent of mercury solubility. When liquid mercury was shaken with pH 10 LiOH saturated at room temperature with oxygen, the mercury solubility was 7 ppm. When the oxygen content was reduced by sparging with hydrogen, the mercury solubility at room temperature dropped to 0.19 ppm for pH 10 LiOH and 0.16 ppm for deionized water.

Mercury-saturated samples of deionized water were passed through separate cation and anion ion exchangers, and the mercury-saturated pH 10 LiOH was passed through separate anion, cation, and mixed bed (Li form) ion exchange resins. All of the resins, regardless of type, reduced the mercury concentration to 0.02 to 0.05 ppm for both pH 10 LiOH and deionized water. Since the solubility of liquid mercury in deaerated water is reported to be 0.02 ppm, it would appear the resins removed various ionized mercury species but were not effective in removing the non-ionized soluble mercury.

High Temperature Oxidation of Zircaloy-2. The detailed oxidation behavior of Zircaloy-2 in the temperature range 600 to 900 C in dried oxygen is being investigated. Distinct cyclic behavior is observed. The end of the first, second, and third cycles occur at times given by relationships of the form

$$\log t = AT + B$$

where t is the time, T is temperature, and A and B are parameters. The weight gains (or film thicknesses) at the cycle terminations exhibit a complex, unpredictable temperature dependence.

Corrosion of Stainless Steels in Supercritical Water. Samples of 304, 430, 406,446 stainless steels along with ASTM grade 212B carbon steel are presently being corrosion-tested in the new supercritical autoclave facility. The effects of various steam pressures on stainless steel corrosion in the supercritical temperature range will eventually be determined.

Following 14 days of exposure at 550 C, 1000 psi, in air-saturated steam, corrosion of the various alloys appears to be related to the chromium content. The penetration of 406 stainless steel alloy with 13% chromium was 0.35 mil as compared to 0.007 mil for 446 stainless steel with 27% chromium. The penetrations of 304 and 430 stainless steels were 0.26 and 0.29 mil, respectively. The penetration of ASTM grade 212B was 1.25 mils for the same exposure period. Following the completion of this test at 30 days, various nickel base alloys will also be tested.

Pu-Al Rupture Test. A test was run in the GEH 3x3 loop in the ETR to determine the buildup of rupture products in the coolant following a Pu-Al fuel element rupture. The test was run for approximately two days, and

only small amounts of rupture products were released to the coolant, indicating a very low corrosion rate of the element in the 500 F, pH 10 coolant. This low corrosion rate had been noted in the ex-reactor rupture test of an irradiated fuel element performed in IRP last month. Radiochemical analyses are being performed to determine the concentrations of various isotopes in the coolant as a function of time after the fuel element was ruptured.

Fretting Tests of PRTR Fuel Assemblies. The UO_2 wire-wrapped, PRTR fuel element and PRTR process tube were discharged from the ELMO-7 loop after seven weeks of continuous exposure in 300 C high purity, deionized water with pH adjusted to 10.0 with LiOH. Previous examinations at two-week intervals had indicated that the fretted areas in the process tube could not be realigned with the fuel element supports so that new fretted areas were initiated after each discharge. The object of this test was to determine what effect increased exposure time had on the depth of fretting. Visual observation indicated that the depth of fretting after seven weeks in the process tube was not greatly different from the depth observed after two weeks of exposure (1-4 mils deep). The width and length of the fretted areas corresponded to the width and length of the contact area on the fuel element supports. Fretting was also found on the fuel element supports and on some areas of the outer wire wrapping where it contacted the process tube.

Radiometallurgical Examinations. Little change occurred in the UO_2 fuel during the irradiation of GEH-10-8, a three-foot long, vibrationally compacted, seven-rod cluster. A caustic dissolver was fabricated and placed in the cell to dissolve the outer aluminum wall from nine Zr-2 clad UO_2 fuel capsules to facilitate fission gas collection with the lamprey unit.

2. PLUTONIUM CERAMICS RESEARCH

The System UO_2-PuO_2

Efforts during the past month have been spent on completing the UO_2-PuO_2 melting work. The data have been summarized and will be reported shortly in HW-69832. X-ray data from recent melting experiments on UO_2-PuO_2 compositions are listed in the following table.

Sample	Composition	Predicted Parameter	Observed Parameter
C64-5	UO_2-90 PuO_2	5.403 A	5.415 $\pm$ 0.004 A
C64-5	UO_2-90 PuO_2	5.403	5.414 $\pm$ 0.006
C64-6	UO_2-75 PuO_2	5.414	5.411 $\pm$ 0.001
C72-1	UO_2-75 PuO_2	5.414	5.4223 $\pm$ 0.0004
C69-4	UO_2-40 PuO_2	5.440	5.451 $\pm$ 0.001
C76-2	UO_2-25 PuO_2	5.451	5.4567 $\pm$ 0.0005
C67-3	UO_2-10 PuO_2	5.461	5.468 $\pm$ 0.002
C76-1	UO_2- 5 PuO_2	5.465	5.4684 $\pm$ 0.0007

There were no indications of plutonium sub-oxide phase, but it can be seen that for all compositions the melted lattice parameters are slightly greater than anticipated. When plotted, these data fall on a straight line which parallels Vegard's Law line for UO_2-PuO_2, but with a 0.2 percent upward displacement. There are two possible explanations for the lattice expansion, namely a loss of plutonium or a loss of oxygen during melting. If the UO_2-40 PuO_2 composition is considered, extrapolation of the melted lattice parameter to Vegard's line would indicate a melted composition of UO_2-25 PuO_2, which is a considerable plutonium loss. Chemical analyses of this composition gave 36.6% PuO_2 in the melted sample, and it thus appears that the lattice expansion is due to an oxygen evolution. The PuO_2 content is still slightly below 40 percent, however, and additional experiments to determine whether preferential vaporization of Pu from UO_2-PuO_2 occurs at high temperatures are planned. From the data reported last month, it is presently postulated that the compound $PuO_{1.62}$, which is isostructural with UO_2, is formed during melting and then forms a complete series of solid solutions with UO_2. What occurs at UO_2 rich compositions needs to be clarified by additional work.

Plutonium Carbides

The majority of the 39 arc-melted PuC alloys used in determination of the PuC composition limits were analyzed for carbon during the past month. The technique consisted of heating the sample in flowing oxygen and collecting the CO_2 formed in ascarite. In general, the carbon contents were about two a/o less than that calculated on making up the alloys. When the x-ray data reported previously are plotted versus these carbon contents, the PuC phase appears to exist over the range 42 to 48.5 a/o C. Debye photographs below 42 a/o C yield some unindexed lines which may be due to the zeta phase reported by LASL. Additional experiments to confirm the presence of zeta are in progress.

Plutonium Silicides

The majority of the past month was spent obtaining powder diffraction data. Prior to loading the glass capillaries with the pyrophoric silicides, they are evacuated and filled with argon. Data obtained indicate that a mixture of phases, yet unidentified, is the consequence of arc-melting solid alpha-plutonium and compacted silicon powder. Effort has been directed toward the synthesizing of a single phase product, having the composition Pu_2Si_3. Evidently the stoichiometric balance of the reaction is disturbed by the arc, vaporizing one or both of the reactants before a reaction can occur. Chemical analysis of these products has been requested but not yet received. Photomicrographs have been taken of two arc-melted specimens near the composition Pu_2Si_3. These appear to confirm the existence of a multi-phased product.

During the next reporting period alpha plutonium powder and powdered silicon will be mixed and compacted for subsequent arc-melting. This more intimate contact of the reactants may minimize the loss of either component and tend to maintain stoichiometry.

3. UO_2 FUELS RESEARCH

Fuel Evaluation

An irradiated capsule (GEH-14-193) containing high energy impact formed UO_2 was metallographically examined. There were surprisingly few circumferential or radial cracks in this fuel material. An essentially void-free band was observed in the outermost portion of the large columnar grain region. In general, the grain growth patterns and extent of in-reactor sintering of this fuel were similar to those observed in other forms of UO_2 after irradiation.

Fission gases from this fuel were lost through cracks in the Zircaloy cladding. The cracks were revealed when the aluminum can, into which the capsule was shrunk-fit prior to irradiation, was dissolved to facilitate radiometallurgical examination. Cracks have also been found in the Zircaloy cladding of several other capsules processed in a similar manner. They have not been found in capsules which were not subjected to the dissolution step. The cause of these cracks has not been determined.

Single crystals of UO_2 (0.35" x 0.35" x 0.055") are being irradiated in the ETR core. This irradiation test will provide basic information concerning the effects of irradiation on the UO_2 lattice.

Capsules containing non-stoichiometric UO_2 (O/U ratios between 1.93 and 1.98) are being irradiated in the MTR core.

Hot swaged Zircaloy-clad UO_2 was successfully irradiated in the MTR. The four-rod cluster element (GEH-4-60) attained an exposure of 550 MWD/T_U, with a maximum surface heat flux of approximately 320,000 $Btu/hr\text{-}ft^2$.

A ThO_2-UO_2 fuel mixture was successfully irradiated in the MTR. The test element (GEH-4-61) operated for approximately 15 equivalent full power days with a maximum surface heat flux of 580,000 $Btu/hr\text{-}ft^2$. The stainless steel clad element was a single rod, 1.1 inches OD and 12 inches long. The fuel, which contained 10 w/o ThO_2 + 90 w/o UO_2 enriched to 1.38 w/o U-235 in U, was vibrationally compacted to 86% T.D. A second, similar element (GEH-4-65) is being irradiated. The fuel in this element is 86 w/o ThO_2 + 14 w/o UO_2 enriched to 10 w/o U-235 in U.

Materials

The microstructure of fused UO_2 containing inclusions was homogenized remarkably by annealing in dry hydrogen four hours at 1700 C, as suggested by Dr. Rough of BMI. Inclusions 0.06 mm in diameter before annealing disappeared, leaving voids 0.008 mm in diameter or smaller. The inclusions exhibit etching behavior similar to uranium metal inclusions in fused UO_2 identified by G. R. Cole of SRL with the aid of an electron microprobe analyzer.

Spherical fused UO_2 single crystals were provided for several European sites through Euratom. The crystals will be used for measuring diffusion rates of fission gases in UO_2. The crystals were annealed in hydrogen at 1700 C to relieve stresses and insure stoichiometry before grinding them into spheres, and were analyzed individually for microstructure, O/U ratio, density and purity. Diameters of the finished spheres were between 0.25 and 0.10 inch. Spherical specimens were also fabricated from electrodeposited UO_2 crystals and from high energy impact formed UO_2.

Reactor Simulation Experiments

A series of three specimens was tested under conditions which appear to simulate in-reactor thermal hydraulic conditions. The test specimens were four-inch segments of swaged PRTR fuel rods centrally heated to obtain surface heat fluxes between 0 and 310,000 Btu/hr-ft^2.

Two of the specimens were heated continuously from room temperature to the temperature at which the tungsten heater melted, which corresponded to a maximum heat flux of 200,000 Btu/hr-ft^2. Sections of these specimens showed UO_2 sintering and grain growth comparable to that observed in some irradiated fuel cores. The extent of grain growth indicated a maximum fuel temperature between 2000 and 2500 C.

A third capsule was operated at 180,000 Btu/hr-ft^2 for 30 minutes, after an initial abrupt increase to 192,000 Btu/hr-ft^2, corresponding to a maximum tungsten temperature of 3400 C. The heat input was then increased until the tungsten again reached 3400 C. The second temperature maximum occurred at a heat flux of 310,000 Btu, indicating that the "smeared" thermal conductivity had increased significantly (an estimated 60%), presumably because of sintering and grain growth which occurred during the 30 minutes at 180,000 Btu/hr-ft^2.

Electron Microscopy

Two general methods for photographic correction of image distortion produced in reflection electron micrographs were investigated. Use of tilted image or object planes in the normal photographic enlarger arrangement gives suitable correction but requires a very long depth of field to give sufficient image quality. The use of two crossed cylindrical lenses appropriately spaced appears more promising, on the basis of initial experiments.

A hot stage for use in the electron microscope was successfully heated to 2000 C while observing behavior of a sample of UO_2 deposited on a thin supporting carbon film laid on a tungsten grid. The sample was observed to recrystallize at an increasing rate as the temperature was raised, until rapid melting occurred. Crystal patterns and melting behavior were reminiscent of those observed with the high temperature optical microscope. A series of micrographs and electron diffraction patterns was taken for further study and evaluation. Temperatures determined from power input to the resistance heater specimen grid are considered accurate to about ± 100 C.

Conductivity of UO_2

Initial thermal conductivity, "k", measurements of single crystal UO_2 were completed at BMI. Although comparison with polycrystalline material shows nearly identical thermal conductivities at room temperature, "k" for single crystal UO_2 is 50% greater at 800 C. Single crystal UO_2 and irradiated sintered UO_2 "k" curves are nearly parallel, approaching zero slope at 800 C.

A curve of thermal conductivity versus temperature in the range 0 - 600 C was defined for irradiated sintered UO_2 (0.06 a/o burnup, 1.45×10^{20} nvt). Annealing behavior was similar to that of previous samples of lesser irradiation exposures. All specimens had essentially the same thermal conductivity at 600 C. Longer irradiations (constant nv) appear to produce more damage of the type annealed out at less than 200 C, but little difference in the "permanent" damage. Annealing temperature of the "temporary" damage decreases with increasing irradiation time at constant flux.

Thermal conductivity of isostatically pressed disc specimens was appreciably higher than that of extruded rods at temperatures to 1000 C. All non-irradiated samples (fabricated by isostatic pressing, die pressing or extrusion) appeared to approach a common thermal conductivity value at about 1400 C.

Electrical conductivity of irradiated sintered UO_2 was measured to 900 C on specimens irradiated to 1.16×10^{19} nvt and 3.48×10^{19} nvt. At room temperature the respective conductivities were 1/5 and 1/10 that of non-irradiated UO_2 of similar density. All samples approached a common (higher) value at 900 C, but relative differences reappeared upon cooling. Absolute values of all samples were appreciably higher after the heating and cooling cycle. Recent data from Oak Ridge do not agree.

4. BASIC SWELLING PROGRAM

Irradiation Program

At the present time two capsules (Nos. 7 and 8), each containing three, hollow, split, uranium cylinders, are being irradiated at constant temperatures of 525 C and 575 C, respectively. Simultaneously, two laboratory capsules containing specimens identical to their in-reactor counterparts are being annealed at temperatures identical to the irradiation temperature of the in-reactor capsules. In-reactor capsule No. 9 is now completed and is being bench tested. Four additional capsules are being assembled simultaneously for future irradiation. The two unmonitored NaK-filled capsules, GEH-14-281 and 282, each containing a precharacterized U-U diffusion specimen, have been discharged from the MTR and are being shipped to Radiometallurgy for examination.

Post-Irradiation Examination

Radiometallurgical examination of the specimens from capsules 4, 5, and 6 has continued, and a few replicas have been studied in the electron microscope. More replicas have been received and are in process. The preliminary examination of replicas from a sphere irradiated at a volume average temperature of 615 C to 0.3 a/o burnup revealed a uniform dispersion of pores having a size range of 0.2 to 3.0 microns. By far the greater number of pores are less than 0.5 microns in diameter. Although no quantitative measurements have yet been made, there appears to be no difference in either the size or the number of pores from the center to the edge of the specimen. Examination of areas in the vicinity of cracks revealed no difference in pore size and number. This suggests that the fission gases do not diffuse from existing pores to cracks, and hence to the environment. However, the cracks may have been formed subsequent to the high temperature irradiation, perhaps during handling in Radiometallurgy. Examination of the specimen with the light microscope showed a well-defined grain structure that did not markedly differ from the pre-irradiation structure. This is in sharp contrast, of course, to the severely worked structure that is obtained when irradiating uranium at lower temperatures. For example, the GEH-14-36 sample, discussed last month, that had been irradiated at less than 150 C to a burnup of 0.26 a/o in the MTR showed profuse swirled twinning and lineage structure. Further examination of this low temperature sample has revealed the presence of a few scattered pores 1000 A in diameter in the core of the sample. This agrees with the change in density that was observed.

Pore Size and Distribution

Optical and electron microscopy are being used as a direct means for determining the size and distribution of pores in irradiated uranium. Void fractions have been determined by the point count technique from optical micrographs for a sample of uranium having a burnup of 0.41 a/o and subjected to post-irradiation annealing temperatures of 600, 650, 700, and 880 C for one and one-hundred hours. The values obtained are inconsistent with observed density changes as well as void fraction determinations made from electron micrographs. Further analysis of the data is required to establish the applicability of this technique toward determining void fraction from optical micrographs.

Comparison of In-Reactor and Ex-Reactor Swelling

The swelling that occurred in uranium spheres during irradiation in controlled temperature capsules has been compared with the swelling associated with the high temperature irradiation of clad rods in thermocoupled, NaK-filled capsules, and that associated with the long-time post-irradiation annealing of uranium that had been irradiated in a high pressure, high temperature, water loop. The data from the spheres fall on the temperature-swelling curve that had previously been derived from an analysis of the other two experiments. This corroborates the previously advanced concept that there may exist a much closer correspondence between in-reactor and ex-reactor temperature effects than has hitherto been thought to be the case.

Fission Product Mobility

Two approaches are currently being pursued to determine the mobility of inert gas in uranium. In the first, krypton gas is being introduced into uranium by cathodic glow discharge. In the second, U-U diffusion couples are being studied that have fission products in one portion of the couple, but none, or very few, in the other. Irradiation of the diffusion couples has been completed. The specimens are 1/2" thick by 1/2" diameter disks cut from an extrusion that has a core of depleted uranium (0.15% U-235) and a shell of enriched uranium (3.0% U-235). The shell was irradiated to a calculated burnup of 0.3 a/o while the core accumulated 0.015 a/o burnup. The specimens will be examined as-irradiated and after annealing by hardness and quantitative metallography. Uranium foil was shaped into a cylinder and subjected to "glow discharge" in two mm of krypton for about a day. After the glow, the foil was cut into eight sections and the krypton gas evolution characteristics of the sections examined by heating to above the melting point while continuously monitoring the gas evolved with a mass spectrometer. Surprisingly, the behavior of the sections of the cylinder was quite similar to that of the disks discussed previously, i.e., a peak occurred in the evolution rate in 300-500 C temperature range and a second peak at the melting point. The "glow discharge" work is being interrupted in order to build a new facility and to redirect some of the effort to other phases of the program.

Restrained Irradiations

Swelling experiments of Zircaloy-2 clad uranium fuel rods with selected uranium temperatures, cladding thicknesses, and burnup are being conducted employing NaK-filled temperature-monitored capsules. Three more capsules, GEH-14-98, 14-104, and 14-105, have been opened. Only one rod of the six taken from the capsules survived the irradiation with no apparent cladding damage. The remaining five have cladding splits and end caps missing and are so badly distorted that dimensional measurements cannot be made on all of them. Length and diameter measurements will be made on the two rods from 14-105. Macro-photography is complete on all the rods and cutting for metallography, burnup, and density has been started. Burnups and estimated maximum outer uranium temperatures for 14-98, 14-104, and 14-105 are respectively 0.43, 0.56, 0.62 a/o and 600 C, 700 C, and 375 C.

5. IN-REACTOR MEASUREMENT OF MECHANICAL PROPERTIES

In-Reactor Creep Measurements

Two second generation capsules are now operating in the reactor at temperatures of 350 and 460 C. The stress has not been applied to either specimen. The control and recording instrumentation is being tested simultaneous with the capsule startup. The instrumentation has suffered the usual failures and malfunctions associated with new equipment. A capacitor shorted on a controller to one capsule heater circuit,

a small transformer burned out in a magnetic amplifier and the data recording printer shorted completely. The entire data recording system has been returned to the manufacturer's plant for warranty replacement. Test startup is not possible until this unit is returned. In the interim one capsule is at temperature and the mechanical transducer is being checked for accuracy as a function of temperature and radiation with no stress on the specimen. The other capsule has been checked for extensometer behavior, and power is now being applied to the heaters to attain a level temperature, the final step before the creep test begins.

Capsule and Instrument Development

A visit to the vendor's plant was made to observe the final assembly of three of the six capsules being constructed. No significant changes or modifications in procedure were requested. Work was proceeding on schedule, and three capsules will be ready for delivery this month. In addition to the calculations that have been made for the thermal behavior of the new capsules, a laboratory mockup is being assembled to determine the thermal characteristics in the laboratory. Small heaters are being inserted in the parts. These are proportional in power rating to the weight of the component to duplicate, as closely as possible, the gamma heating effect. The laboratory mockup is using the same components and materials, with the exception of the simulated gamma heaters, that are used in the assembly of an in-reactor capsule. The purpose of the thermal mockup is to more accurately define the heat transfer parameters in the capsule.

Laboratory calibrations are now being performed on the multiple-range variable permeance transducers used in the second generation capsules. Preliminary calibrations, made before the capsules were charged, indicated considerable thermal drift in the transducers, particularly when one range was correlated with another range. The later calibrations now confirm this, but also show that the effect can be greatly minimized if each range of the transducer is considered as an independent and separate transducer. A very real difficulty with the multi-range transducers is their early failure when interrogated continuously. Interogation has to be limited to a half minute duration no oftener than every five minutes. These multi-ranged transducers will not be used in the new series of capsules. The new capsules contain a single range, low impedence, variable permeance transducer as part of the independent electrical system in the electro-mechanical system.

Pre-Irradiation Material Characterization

Activation energies for creep of annealed Zircaloy-2 at 50 C, 25,000 psi, and pre-determined strain rates of 1×10^{-4}/min and 2×10^{-4}/min were found. The values observed were 21,500 cal/mole and 17,500 cal/mole, respectively. A short time relationship between time, temperature, and creep strain has been developed for annealed Zircaloy-2 in the 50 to 200 C temperature range. Equations of the form

$$\epsilon = B \log \Delta T \log \alpha t + C$$

where T = time
A, α, C, B = constants
ϵ = total creep strain

can be used to predict the creep in annealed Zircaloy-2 for times up to six hours at relatively high stresses. The relationship was not extended to periods longer than six hours, but might possibly be valid over the entire creep curve. The effect of stress has not yet been determined.

6. GAS-GRAPHITE STUDIES

EGCR Combustion Hazard Evaluation

Experiments were conducted in the EGCR combustion prototype to test uncoated graphite sleeves under a series of credible depressurization accident conditions. Reactor air flow, inlet air temperature, moderator temperature, and after-heat decay for the following conditions are duplicated:

1. Reactor air flow - 40,000 lb/hr
   Channel air flow - 186 lb/hr
   Moderator temperature - 1095 F.

2. Reactor air flow - 85,000 lb/hr
   Channel air flow - 394 lb/hr
   Moderator temperature - 1095 F.

3. Reactor air flow - 63,000 lb/hr
   Channel air flow - 287 lb/hr
   Moderator temperature - 1200 F.

With an inlet air temperature of 700 F, the fuel channel cooled under each set of conditions and no self-sustained burning occurred.

Further tests were run with both coated and uncoated fuel sleeves at higher temperatures to determine conditions which would initiate self-sustained combustion. With 287 lb/hr channel flow, combustion occurred in the assembly when moderator temperatures reached 1310 F with uncoated graphite fuel sleeves and 1370 F with silicon carbide coated sleeves.

EGCR Graphite Irradiation

The H-3-2 capsule containing EGCR graphite was successfully removed from the GETR and disassembled during the week of June 5. All samples appeared to be in excellent condition, and they are now being measured. The maximum exposure received by the samples located at reactor midplane now totals approximately 40,000 EGCR MWD/AT. All flux monitors in the capsule were recovered and are being counted. Preparations are under way for immediate assembly of the H-3-3 capsule. This capsule will contain 18 samples from the H-3-2 capsule for further irradiation, four samples from the H-3-1 capsule for further irradiation, and two new samples. H-3-3 will be installed in the GETR during the week of July 10.

A flux monitor capsule is being irradiated in the E-7 position of the GETR during the current cycle while the H-3 capsule is out. The monitors should add to the general understanding of the GETR flux as well as provide specific information for the EGCR graphite irradiations.

In-Reactor Graphite Creep

Five test assemblies containing graphite samples under a 150 psi compressive stress have been reassembled and are ready for recharging when the 300 psi assemblies are discharged during the next reactor outage. The 150 psi ex-reactor samples have been measured for length changes during the constant temperature loading and the results are being analyzed. Five 300 psi ex-reactor assemblies have been constructed and are being tested at the present time.

The changes in a spacing and L_a, which occurred during the irradiation, do not seem to be influenced by the applied loads. In the future, routine x-ray measurements will not be made on the compression test samples.

Microwave Activation of Nitrogen Gas

The intensity of the microwave glow discharge in N_2 versus the gas pressure has been measured by a photocell. Ninety to one hundred percent of maximum intensity is observed throughout the pressure range 100 to 400 μ of Hg. The peak intensity occurs at approximately 250 μ Hg.

Gas-Graphite Reactions

The use of H_2 as a coolant for high temperature, graphite-moderated reactors has been considered. An equilibrium system of H_2-graphite at atmospheric pressure and 800 C would contain about 5% CH_4, while at temperatures above 1000 C, there would be less than 1% CH_4 formed; however, the effects of in-pile irradiation and pressure are uncertain. Accordingly, several quartz capsules containing H_2-graphite and H_2-CH_4-graphite mixtures in the pressure range 20 to 400 psi were prepared for reactor irradiation.

It appears that N_2 is a compatible coolant with graphite, although there is a possibility that HCN would be formed in the presence of H_2. Consequently, sealed capsules were prepared for irradiation containing N_2-graphite and H_2-N_2-graphite in the pressure range 80 to 400 psi.

To investigate the effect of pressure on the polymerization of CO, three sealed capsules of CO-graphite at 20, 40, and 200 psi, respectively, were prepared for reactor irradiation. High pressures of these gases and gas mixtures were attained by condensation at liquid helium temperature.

Gas Loop Project Management and Design (Project CAH-822)

Gas loop construction is approximately 89% complete versus 97% scheduled predicted to June 30, 1961. Construction will be limited to 92% until the in-reactor section is installed, which is contingent upon successful completion of the blower testing by the vendor, Bristol-Siddeley. The

J. A. Jones installation work is 86% complete versus 90% scheduled (the work has been supplemented by the addition of piping insulation, emergency gas addition, control room lighting, and necessary installation work not included in the original package). The NaK heater, which was modified to reduce the NaK to an amount compatible with the maximum allowable reactor containment pressure, has been re-installed, and all Hastelloy-X welds on the equipment package have been completed. Pressure testing of the piping and equipment trials are in progress.

The steel shielding has been completed by Pacific Car and Foundry and shipped. Total weight was 136,000 pounds. The six, one and one-half ton sample casks are scheduled for delivery before the end of the month.

Fabrication of the prototype in-reactor test section, which will be tested with the temporary blower in B Cell at rated temperature of 1500 F, is complete except for installation of thermocouples which have not yet arrived.

Component Testing. Repair of the pressure tube assembly for the gas cooled loop B Cell test assembly has been completed and radiographed and is ready for installation in B Cell. Fabrication of the pressure tube for in-reactor use is complete, and the welds are ready for radiography. Completion of the sleeve for use in the B Cell and in-reactor pressure tubes has been delayed pending receipt of thermocouples.

All Hastelloy-X and stainless material to be used in the nozzle support assembly has been received.

7. GRAPHITE IRRADIATION DAMAGE STUDIES

Electron Microscopy

Replicas prepared from polished graphite samples which have been cathodically etched normally show systems of grooves. Relatively flat regions occur between the grooves in which structural details are not evident. A chemical etch (potassium dichromate-phosphoric acid) simply widens the grooves without revealing more detail. Oxidation by a gas (one hour at 850 C in flowing helium containing 125 ppm water) after the cathodic etching revealed small grooves in the regions between cathodically etched grooves. The structure in these regions was parallel to that revealed by cathodic etching. The sample was suspended from a semi-microbalance during oxidation. No weight loss was detectable. Oxidation of the sample and examination of identical areas will be continued to determine the amount of treatment required to develop structural details more clearly.

8. ADVANCE EVALUATION STUDIES

Conceptual Design - Fuel Element Fabrication Plant

The final draft of Part III, "Design Study of Plants for Plutonium-Enriched Fuel," has been completed and transmitted for approval. Information on plant and equipment costs have been received from Estimating Operation, and

the final part of this study, "Estimates of Capital Costs of Plants; Estimates of Costs of Completed Fuel Elements," is being prepared.

Supercritical Pressure Water Reactor Study

The final report on the Supercritical Pressure Power Reactor, HW-68420, Economic Evaluation of a 300 MWe Supercritical Pressure Power Reactor, is being completed. Final estimates of capital costs and fuel cycle costs are being prepared. Comments from the interim report on the Supercritical Pressure Power Reactor, HW-69246, are being incorporated on the drawings and in the calculations.

Power Cycle. The heat balance supplied by the turbine vendor (General Electric Company) indicates a gross heat rate of 7180 Btu per kwh (including boiler feed pump turbine operation and generator losses) for a gross thermal efficiency of about 47.5%. Based on station power requirements of 5 MW and moderator heat generation and losses of 41 MW, the plant net efficiency is about 43%, compared to 41.2% reported last month. Unfortunately, all fuel cycle cost studies have been run based on the lower figure. The possibility of incorporating the higher figure at this late date will be investigated.

The turbine recommended for use in the Supercritical Pressure Power Reactor study is a 3600/1800 rpm cross compound double flow unit with 38-inch last stage buckets operating with initial steam conditions of 3500 psig and 1050 F with two reheats to 1000 F.

Fuel Element Design. Two vendors have replied, and a third vendor is preparing his proposal, to the preliminary proposal for the fabrication of the pressure bearing member in the fuel element. Both vendors concurred in the feasibility of the design. One vendor suggested that the bundle components could be fabricated by microbrazing the entire assembly in a furnace. Their proposal contained only two pressure bearing welds. For lots of 1000 units complete with inspection one vendor quoted $1330 each. The second vendor's quotation has not been received to date. This figure compared with an estimate of $2000 used in establishing the fuel element fabrication cost of $75 per pound of UO_2.

The calculations to determine compatible pressure drops through, and maximum temperatures in the Supercritical Pressure Power Reactor fuel elements were continued to insure that temperatures and pressures are less than the maximum allowable values determined by stress limitations.

The pressure drops and tube wall temperatures were initially determined using a step-wise hand calculation. However, this proved impractical due to the number of variables in the design (i.e., peaking factors, tube diameters, bulk temperatures, etc.) which necessitated that the calculations be revised frequently, often requiring several days per reactor pass. Also, the calculation requires the assumption of a pressure, and the results are often very sensitive to the value assumed, and, therefore, an iterative calculation process is required.

To simplify the process, a computer program was written. During the debugging period a hand calculational method was devised which averages the fluid properties at the boundaries short-cutting the step-by-step procedure. The results presently being obtained show that the pressure drop through the reactor will be less than 1000 psi (~150/150/650 per stages I, II, and III, respectively), and the maximum wall temperatures will be less than 1300 F, which are allowable. The lower pressure drops than those reported last month were arrived at by adjusting the temperature rises in the three passes and by gaining a better understanding of which flux peaking factors affected pressure drop calculations and which influenced the "whistle effect" limit.

Reactor Physics. A survey of the reactor physics of several possible Supercritical Pressure Power Reactor cell and reactor configurations is near completion. The "SWAP" reactor code has been modified to perform such a survey by building a specified gamut of cases whose compositions are based on changes in an original cell and reactor. Some conditions being varied in this study are enrichment, coolant density, moderator-to-fuel ratio, control rod material, and reactor loading zone configuration. Final debugging of the modified code is in progress. Results of this computer program will be used to verify and expand the previous hand calculations on which the Supercritical Pressure Power Reactor design has been based.

Plant Layout. The revised estimate of the pressure buildup in a 180-foot diameter containment hemisphere upon release of the primary coolant in the Supercritical Pressure Power Reactor is less than two psi. With the smaller turbine installation it has been possible to locate all equipment within the containment shell with ample operational and maintenance space. The vessel size is comparable to the BONUS reactor. Construction costs should not be unlike those incurred in the BONUS reactor construction, which are available for comparison.

9. ALUMINUM CORROSION AND ALLOY DEVELOPMENT STUDIES

Corrosion Studies

Testing continued on the corrosion of X-8001, Zr-2, and sensitized 304 stainless steel at 300 C in water adjusted to a pH of 4.5 with H_2MoO_4. Data after 900 hours indicate a corrosion rate of 0.20 mil/month for X-8001 aluminum and 0.004 mil/month for the 304 s/s. No measurable corrosion occurred on the Zr-2 samples. Considerable spalling of the black oxide crud occurred on the aluminum coupons after about six weeks.

Except for the in-reactor piping, installation of the Inhibitor Study Loop has been completed at C Reactor. The loop was operated for 30 hours at 200 C at which time the loop pump apparently failed. The pump will be examined to determine the cause of failure.

The preliminary project costs estimated for the H-1 in-reactor corrosion loop are being revised in accord with changes in loop modifications to reactivate the loop. Bids for deionization equipment for supplying high

purity backup water have been received. Modifications have been made in the proposed equipment, and the specifications will be sent out for another bid review. The project proposal cost estimate will be firmed up in another month.

D. RADIATION EFFECTS ON METALS - 5000 PROGRAM

Radiation damage in various metals, including aluminum, copper, iron, molybdenum, nickel, titanium, zirconium, and type 347 stainless steel, is being studied by a number of techniques. Electrical resistance, x-ray diffraction, and mechanical properties measurements are the primary methods being used. The variation of properties with irradiation and the kinetics of property recovery upon annealing are being analyzed to arrive at a damage model.

Recovery studies have been terminated for iron, nickel, copper, and zirconium. In cases where microhardness and electrical resistance recovery stages occurred over the same temperature range, the activation energies determined by the two measurements were often not in agreement. In addition, the activation energies determined by microhardness measurements for processes thought to be self-diffusion were about 20% higher than accepted values for self-diffusion. The probable cause of these discrepancies is the complex nature of a microhardness measurement. The techniques used in arriving at a value of the activation energy of a process are based on the assumptions that the recovering property is linearly proportional to the number of defects and that the defects are uniformly distributed. These assumptions are probably valid for electrical resistance measurements at temperatures below 300 K on specimens irradiated at low temperatures, where there is a limited amount of clustering of defects or changes in distribution during irradiation, both of which presumably occur during irradiation at 50-80 C. It is, therefore, felt that reaction kinetics determined for specimens irradiated at reactor ambient temperatures have an accuracy of about ± 20% for microhardness measurements and are slightly more accurate in the case of electrical resistance recovery.

Yield points have been observed in electrolytic nickel, type "A" nickel, copper, and zirconium at exposures of 1.3×10^{18} nvt (electrolytic Ni and "A" Ni) and 7.0×10^{19} nvt (copper and zirconium). Copper, which contains from 1-2% foreign atoms introduced by transmutations at this exposure, and "A" nickel, with about 0.8% impurity atoms present before irradiation, respond similarly to deformation and aging treatments in that they appear to strain-age. Unirradiated "A" nickel also shows this effect, but unirradiated copper does not. Electrolytic nickel, with about 0.2% impurity atoms, and zirconium will not strain age. The development of a yield point upon irradiation appears to be independent of purity for face-centered cubic and close packed hexagonal metals. It is possible that the stacking fault energy of the metal is important in determining the exposure at which a yield point is first developed.

The analysis of x-ray diffraction effects in strain-free single crystal surfaces is being continued. Primary and secondary extinction effects are being studied by diffraction measurements with two or more x-ray wavelengths. Primary extinction for a given crystal varies but slightly with wavelengths while secondary extinction is greatly affected. The Al single crystals being used in this study show predominantly primary extinction, suggesting coherently diffracting domains so large that most of the diffraction takes

place within a single domain. The domain sizes vary from crystal to crystal, ranging from 2.5 microns to about six microns.

Arrangements are completed for irradiating selected specimens. Following irradiation, the diffraction measurements will be repeated.

E. CUSTOMER WORK

Radiometallurgy Service

A non-uniform film on one element was the only abnormal feature observed during the visual examination of two overbore elements (RM-410). Measurements of diameters and cladding thicknesses of one of three self-support elements from PT-IP-272A indicate that the most serious corrosion occurred in the central portion of the elements between the sets of supports (RM-425).

Metallography Service

A Zircaloy-clad fuel element with a five percent beryllium braze closure which had been subjected to temperatures of approximately 1300 C for one hour in circulating air was examined metallographically. The examination showed that most of the Zircaloy can was gone, having either alloyed with the uranium or scaled off as oxide. Examination is not complete enough to determine the degree of alloying or the integrity of the cap braze.

Work has continued on development of a technique for examination and identification of oxides formed during autoclaving of zirconium alloys. As reported earlier, it has been possible to expose an island of oxide surrounded by Zircaloy-2 by gently polishing away the metal. An effort was made to determine the crystal structure and preferred orientation of the oxide by x-ray back reflection techniques. The 0.008" diameter oxide area was too small to diffract the pinhole collimated x-rays. Additional polishing has exposed an oxide island with a diameter of greater than 0.016". A second attempt at x-ray diffraction will be made by focusing on the larger island.

Other work during the month will be reported in connection with the respective research and development programs served.

Samples Processed During the Month:

Total Samples	548
Replicas	58

Photographs:

Micrographs	940
Macrographs	135
Electron Micrographs	230
	1305

NPR Charging Machine

Fabrication and assembly of all mechanical components is estimated to be 95% complete. Installation of hydraulic components is estimated to be 85% complete. Electrical work was started during the month and is estimated to be 15% complete.

A work order was received for fabrication and installation of the mockup to be used in testing the machine. Work was started on the mockup and is estimated to be 15% complete.

Assistance was given in testing magazine tube and liner assemblies.

For Manager, Reactor and Fuels Research and Development
J. J. Caldwell

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

JUNE 1961

FISSIONABLE MATERIALS - 02 PROGRAM

FUELS

Nuclear Safety in FPD

A waiver of the nuclear safety specification covering the shipment of reject 0.95% U-235 enriched, I and E uranium cores to NLO[1], was approved. The waiver permits the maximum quantity of 0.95% U-235 enriched uranium in a railroad car to be increased from 5,300 lb. up to 19,875 lb. Limits are placed on the packaging of the fuel elements and on loading the car. Approval of this waiver is based on revised critical parameters for Hanford 0.95% U-235 enriched fuel elements, which is in turn based on an improved method of calculating the material buckling of slightly enriched uranium tubes in light water.[2]

REACTOR

Exponential Measurements for NPR

The infinite multiplication factors measured in the PCTR for the mockup and condensed lattices and the material buckling results were used to derive the migration area for both lattices. The bucklings and infinite multiplication factors were determined for 0.946% enriched uranium fuel with water coolant in an air atmosphere. The migration area of the mockup lattice is 647 cm^2. The migration area of the condensed lattice is 297 cm^2. Thus, the change in migration area from mockup to condensed lattice is 350 ± 36 cm^2. The uncertainty in the change in migration area was calculated assuming uncertainties of 0.003 in k_∞ and 4 x 10^{-6} cm^{-2} in the bucklings. The ratio of migration areas is 2.17 which compares favorably with a calculated ratio of 2.19.

PCTR Measurements for NPR

A correction to the lattice parameters measured in the condensed lattice has been made to compensate for the lower graphite density relative to the mockup. The corrections were calculated by the program IDIOT. The corrected parameters for the condensed lattice with an air atmosphere are given in Table I. The values of k_∞ for the condensed and mockup measurements agree to within 0.001.

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(1) Specification NS 3.10 a, Nuclear Safety Specifications - Fuel Element Manufacturing Processes, HW-47013, December 1956.

(2) Brown, C. L., A Semi-Empirical Method of Estimating Material Bucklings for Slightly Enriched Uranium Tubes in Light Water, HW-69300, May 18, 1961.

TABLE I

	Wet	Dry
k_∞	1.074 ± .003	1.016 ± .002
f	.881 ± .003	.943 ± .003

NPR Fuel Temperature Coefficient

Some experiments have been analyzed which yield the change in k_∞ with fuel temperature as the sum of a volume term and a surface term. The results may be expressed in the form

$$\Delta k_\infty(T) = CS_p\left\{\alpha_v + R\,\alpha_s\right\}\left(\overline{T_f^{\frac{1}{2}}} - T_o^{\frac{1}{2}}\right)$$

$$\text{where } R = \left(T_s^{\frac{1}{2}} - T_o^{\frac{1}{2}}\right)/\left(\overline{T_f^{\frac{1}{2}}} - T_o^{\frac{1}{2}}\right).$$

T_s is the temperature of the surface of the fuel, $\overline{T}_f$ is the volume-weighted average temperature of the fuel, and T_o is the room temperature initial condition, all are in °K. This formulation permits computation of Δk_∞ (T) for very non-uniform radial temperature distributions in the fuel.

The preliminary numerical results for the dry NPR lattice are the following:

$$\Delta k_\infty(T) = -(5.96 \times 10^{-3})\left\{0.257 + R(0.0399)\right\}\left(\overline{T_f^{\frac{1}{2}}} - T_o^{\frac{1}{2}}\right)$$

It may be possible to express α_s in terms of a surface-to-mass ratio. Work is continuing on this aspect of the problems.

General Exponential Pile Studies

A complete listing of physical and nuclear parameters for past buckling measurements at Hanford has been submitted for publication as a formal document, HW-69525.

Lattice Parameters for Large Diameter Fuels

An experiment to determine the resonance and thermal flux distribution for a 2.5 inch diameter solid uranium rod in a 10½ inch lattice was started in the PCTR. The 256 channel analyzer was set up and checked out for use in foil analyses. The residual background of some gold and uranium foils was measured in preparation for the irradiations in the PCTR.

Values of η for the 2.5 inch solid and tube-in-tube fuel in a 10½ inch lattice have been derived. Copper cadmium ratios were used to determine r and the effective neutron temperatures were obtained from lutetium activities. The values of g and s_4 from Westcott's latest compilation (CRRP-960) were used with cross sections from BNL-325 (Supplement 1 to second edition). The results are compared to the values of η from $k_\infty/fp\epsilon$ in the table below.

Fuel and Coolant	$\eta = k_\infty/fp\epsilon$	$\eta = \nu\Sigma_f/\Sigma_a$
2.5" solid, water	1.275	1.289
2.5" solid, air	1.256	1.282
Tube-in-tube, water	1.295	1.306
Tube-in-tube, air	1.304	1.300

Optimization of Retubed C-Pile Lattice

An 8-foot exponential pile will be constructed next month for safety rod measurements with both standard and overbored fuel in the C-pile lattice. Graphite tube blocks are being bored out to permit flooding measurements with the overbored fuel. Fifteen hundred standard fuel pieces have been received from FPD. The aluminum cans for the overbored fuel have been shipped to FPD.

Note on the Resonance Activation Integral of Natural Copper

Dahlberg, et al, of Sweden have reported(3) a new value of the "resonance integral" of natural copper. It is defined as $\int_{0.5\ ev}^{\infty} \sigma_r^{Cu}(E)\,\frac{dE}{E}$ and has a value of 2.54 ± 0.10 bns. where $\sigma_r^{Cu}(E) = \sigma(E) - \sigma_o\sqrt{E_o/E}$. This value was found from cadmium ratio measurements of BF_3 (thin), Cu^{64}, and Cu^{66} and the thermal cross sections $\sigma_o^{Cu63} = 4.4 \pm 0.15$ bns. and $\sigma_o^{Cu65} = 2.0 \pm 0.3$ bn. The value of 2.54 ± 0.10 bn. is in significant disagreement with the Hanford value(4) of 1.62 ± 0.05 and the British(5) value of 1.2 ± 0.5. The errors in the Hanford and British values do not include spectral uncertainties and are based upon an assumed 1/E epithermal spectrum. The Swedish result is based upon measured spectra, with and without cadmium, and in this respect may be significantly better. From the published data, however, it is not possible to check their calculations. An inquiry for more details is being made.

The significance of this difference in resonance integrals can be seen in calculation of the fast to slow flux ratio, β, using Swedish copper and gold cadmium ratios(6) and Hanford or Swedish resonance integrals. (The resonance integral

(3) Dahlberg, R., K. Jirlow, and E. Johansson, "Measurements of Some Resonance Activation Integrals", Reactor Science and Technology (J.N.E. Parts A and B) 14: 53-54, April, 1961.
(4) Bennett, R. A., "Effective Resonance Integrals of Cu and Au", Nuclear Physics Research Quarterly Report, October, November, December, 1960, HW-68389.
(5) Tattersall, R. B., H. Rose, S. K. Pattenden, and D. Jowitt, "Pile Oscillator Measurements of Resonance Absorption Integrals", Reactor Science (J.N.E. Parts A and B) 12: 32-46, May, 1960.
(6) Johansson, E., E. Lampa, and N. G. Sjostrand, "A Fast Chopper and Its Use in the Measurement of Neutron Spectra", Ark. Fys., 18: 513, 1960.

for Au has been taken, by Hanford, British and Swedish, from a review by Macklin and Pomerance(7).) The Hanford β is 0.051 and the Swedish β is 0.040. The entire difference is due to the 58% difference in resonance integrals. It is expected that calculations of p which were based upon resonance integrals of Cu would reflect some uncertainty because of this difference. All additional error evaluation is being deferred until additional data are received.

Neutron Rethermalization

The absorption rod experiments (5-5/16 inch dia. copper rod) described in the April and May Monthly Reports have been completed. Traverses were taken of the bare and cadmium covered activity of Cu, Lu^{176}, Lu^{177} and Eu^{151}. These activated detectors have been counted. The data are presently being decay corrected with IBM 7090 codes.

Digital Computer Programs for Reactor Analysis

Development of HFN, the multi-group neutron diffusion theory code, is continuing. The generalized input routine, mentioned last month is debugged. The portions of the program which calculate fluxes and reactivities appear to be in working order.

HFN has successfully computed both direct and adjoint fluxes and eigenvalues using one-dimensional slab and cylindrical geometries. Calculations using spherical geometry have not been attempted. A bug exists in the section of the program which calculates the flux gradient from the results of the flux calculation. This bug has not been definitely located.

The FIT-1 descriptive document(8), with a supplement containing the program listings and test case input and output, has been released.

Computational Programming Services

An informal document, HW-68807, entitled, "COFIT2 - A 709 Program for Determining Extrapolation Length from Horizontal Traverse Data," was issued. This document is intended to serve as a manual for the users of the code, as well as a record of the formulation and procedure used by the code. The HW document on INELASCAT is in rough draft form.

The use of the FORTRAN tape-selection subroutine, (IOS), with non-FORTRAN programs was investigated. The binary input-output subroutines WTBX/RTBX are being converted to use (IOS).

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(7) Macklin, R. L. and H. S. Pomerance, "Resonance Capture Integrals", Progress in Nuclear Energy, Series 1, Physics and Mathematics, Vol.1: 179-189, Pergamon Press, London and New York, 1956.

(8) Lilley, J. R., "Correlation of Experimental Activity Traverses Using Few Group Neutron Diffusion Theory - Computer Program FIT-1," HW-69871, June 7, 1961.

Fast Source Correction for Exponential Piles

The Green's function solution for an exponential pile with an age theory source gives an expression for the fast source correction different from that currently in use. This difference arises primarily from using a finite medium age source in the Green's theory formulation rather than the less exact infinite medium age source in current use. The new expression is being prepared for inclusion in the code VTOCL in order to evaluate its significance.

Instrumentation

All circuit development was completed on the prototype experimental Fast and Slow Scanning Type Fuel Failure Monitor. Nearly all circuitry has now been completed in fabrication and tests will commence shortly. Modifications are being made on the slip ring assembly to prevent high voltage breakdown which could occur due to improper design, and if the modifications are considered inadequate, an alternate approach method of supplying high voltage to the phototubes will be used. The report on the system portions completed and tested to date is 75% done.

Nearly all tests have been satisfactorily completed on the two experimental prototype Logarithmic and Linear (multi-range) Scintillation Transistorized Building Radiation Monitors. All tests to date including drift, calibration error, temperature, line voltage variation, transient effects, vibration, accuracy, response time, and recorder tests have all been satisfactory. One unit is still undergoing satisfactory day-to-day calibration checks on all scales, and the second unit was moved to 100-D Area for demonstration and use. At this point, it would seem that a satisfactory building radiation monitor has finally been designed for reactor areas and general HAPO use, and the units seem to be appreciably better than any of the many commercial monitors of this type previously evaluated.

Experimental data were reviewed concerning commercial in-core flux monitors for Instrument Development, IPD. The units were installed for the KW experiment, and new types will be similarly tested later.

A brief investigation was made, at the request of KER personnel, concerning the possibility of developing a gas chromatograph type fuel rupture monitor for KER experiments. It was concluded that, theoretically, other approaches to the problem would be more promising. Further work on the problem is scheduled in FY-62.

Methods were studied and devised in detail for instrumentation for monitoring the NPR graphite for poisons, measuring diffusion length, and performing special reactor startup monitoring. Possible techniques and preliminary cost estimates were presented to Operational Physics, IPD. A report is being prepared.

A number of instrumentation discussions were held with Instrumentation Design, CE&UO, and several commercial manufacturers concerning NPR instrumentation, intermediate range flux monitors, and critical mass monitors.

The detection head and enclosure to be used for surface uranium contamination monitoring of certain NPR fuel elements was 80% completed in experimental form. Tests should be commenced in early July.

Continued advice and assistance was rendered to Instrumentation Design, CE&UO, and to various manufacturers on the electronics and detector assembly wheel portions of the NPR Fuel Failure Monitor.

A series of tests were performed with the NPR process channel optical traversing mechanism. The unit was run through two wooden test channels. The test channels were built to conform to the worst possible configurations expected in the reactor. The test runs calibrated the unit as to effective magnification and zero reading. Several optical arrangements were tested. In all cases the readings were repeatable to within ± 0.005 inches per eight inch length. The contour of the channels was indicated within the accuracy of their construction. A demonstration of the use and operation of this equipment was given to all persons who were likely to be interested on June 9. About twenty persons saw the demonstration. Design drawings will be made of the unit to be used at NPR and a new unit will be constructed according to the drawings.

Final adjustments and calibrations are being run on the Reactor Moderator Radiation Ratio Pyrometer. In the course of this work calibration of the FPD Radiation Ratio Pyrometer was rechecked and found unchanged from the calibration of last December. Some difficulty was experienced in aligning these pyrometers with the beam of radiation from the Radiation Standard. This standard source emits in a 12-degree cone which is just able to fill the aperture of the lens of the pyrometer. The proper operation of the pyrometer requires that the lens aperture be filled with the radiation beam. Slight misalignments give incorrect temperature readings. With careful focus adjustment, this difficulty can be overcome.

The specifications and prints describing the optical instruments for NPR were reviewed after receiving comments concerning the design from those who normally use this equipment. If the suggestions incorporated in the comments are adopted, it will be necessary to make some major design changes. A letter has been written giving the estimated costs of the required design changes.

Systems Studies

Nearly all of the necessary circuitry for the variable transport lag for the NPR plant simulator has been developed, including a fast voltage comparator. Present observations of the breadboard circuit of the comparator indicate a comparison time of less than one microsecond. The complete system is now being assembled, and further evaluation of accuracy and temperature stability will be made as soon as the necessary parts arrive.

The series of pseudo-automatic reactor control tests in which the control rods were moved manually in accordance with a prescribed set of rules, the rules being those required to simulate the action of an automatic control device, were completed during the month. The final tests consisted of dividing the reactor into six sections, three in the top half and three in the bottom half, and using temperature measurements in these sections as the basis for controlling the rods assigned to each section. Two values of "controller" deadband were

used to determine the relative effects on stability and speed of control. Small changes in power level setpoint were introduced, in both directions, to obtain information on the feasibility of using this type of control to make gradual power level changes. The results of the test were essentially as expected, since a smooth stable response to small power level setpoint changes was obtained. The results of these tests will be summarized in a forthcoming report. Additional tests were made at the 100-D reactor in support of theoretical studies which are aimed at developing an approximate mathematical model of the reactor dynamics. Several five-inch rod movements approximating impulse function disturbances were made while continuously recording six outlet tube temperatures.

The specifications for an experimental digital control computer were sent by AEC Purchasing to prospective sellers for their comments. Proposals and comments returned by fifteen computer manufacturers are being evaluated by Systems Research and Electronic Data Processing Operations, after which revised specifications will be prepared for final bid proposals.

The NPR confiner pressure buildup study was completed and the results forwarded to Reactor Design Analysis. The problem consisted of simulating the pressure transients in the confiner vessel to determine whether the venting was adequate for preventing pressures from exceeding the five (5) psig building design pressure upon introduction of various high pressure steam disturbances. With the analog simulation, it was also possible to determine the time after each disturbance started at which the roof vents could be safely closed.

The analog computer portion of the NPR power conversion study has been completed. Other studies of this type will be made in the future. The problem here was to determine the effects of load changes on the secondary loop. Control parameters were varied in an attempt to obtain approximate controller settings for optimum loop response under various conditions. The system can be made unstable under certain conditions. A more detailed study will have to be conducted on various system components to determine the effects of simplifying assumptions on the response.

SEPARATIONS

Plutonium Critical Mass Experiments

Pre-startup tests of the control instrumentation and solution handling system for the initial criticality experiments were completed.

The processing of selected uranium in the Redox Plant to obtain plutonium with a lower than average Pu-240 content for the initial criticality experiments was completed. During the month 20.1 Kgs of concentrated plutonium nitrate solution were received at the Facility; the average concentration of plutonium in the solution was 300 gm Pu/l. The mass spectrometer isotopic analyses which were run on this material showed the Pu-240 content to be about 4.6 percent. The plutonium was received in 12 PR cans. The plutonium from 10 of these cans was transferred into the storage and mixing tanks at the Facility. No contamination problems were incurred during the transfer operations. The plutonium contained in two of the PR cans will be sent to the 234-5 Building for further concentration.

As an added precaution for nuclear safety, neutron multiplication measurements were made as the plutonium was being transferred into the mixing tank. The multiplication curves showed the mixing tank to be well sub-critical when filled to capacity with the $Pu(NO_3)_4$ solution at the concentration of 300 gm Pu/l. The H/Pu ratio of the solution was, ~ 64; the nitric acid molarity was, 6.3. The volume of the mixing tank is, 68.8 liters; this is a slab tank with dimensions of, 2.5 x 23.5 x 71.5 inches. Further checks will be made on the nuclear safety of the mixing tank as solutions of higher concentrations become available. Previous calculations have shown the 2.5-inch thick slab tanks in the Facility to be safe for concentrations up to at least 700 gm Pu/l, under conditions of a nominal reflector (a neutron reflector equivalent to one inch or less of water).(9) These measurements are being made only as an additional check on the calculations.

On June 29, the critical experiments were begun with the unreflected 14-inch diameter spherical critical assembly vessel. This vessel was filled with $Pu(NO_3)_4$ solution at a concentration of 300 gm Pu/l. The H/Pu atom ratio for the solution was ~64; the nitric acid molarity was 6.3. The vessel contained ~ 6.95 Kg of plutonium when filled. The system was subcritical by an unknown amount; however, the extrapolation of the multiplication curves indicates the vessel would have been critical if the diameter were about 14.8 inches. These results are in qualitative agreement with multi-group diffusion calculations which predict a critical diameter of about 15 inches for the above solution.

On June 30, a second critical approach was made with the 14-inch sphere, but with $Pu(NO_3)_4$ solution adjusted to a concentration of ~ 250 gm Pu/l. The H/Pu ratio was ~ 78 and the acid molarity was again ~ 6.3. The results were similar to the first experiment with the vessel being subcritical when filled to capacity. Again, the critical diameter was estimated to be about 14.8 inches. Before beginning the reflected experiments with this vessel, another attempt will be made to reach criticality in the unreflected state, but $Pu(NO_3)_4$ solution with a smaller acid molarity will be used.

Thus far only one leak has been found in the plutonium solution system. Samples of air taken from the critical assembly hood indicated an increasing amount of air contamination. In checking for leaks, it was noted that a weld on the pedestal supporting the vessel had begun to leak. The leak was arrested by covering the fault in the support with scotch electrician tape.

In Situ Neutron Multiplication Measurements with Plutonium Metal

Further in situ neutron multiplication measurements were made with plutonium metal discs in the 234-5 Building. The measurements were made on the weekends of June 11 and June 25. The series of multiplication measurements as originally planned with Pu metal have now been completed.

Experiments with 2.75-inch diameter discs of α phase metal were completed in May. The latest experiments were conducted with Pu metal discs of diameter, 3.625 inches. These larger pieces were used to more accurately mock up the geometry of the plutonium in the molten state in the melting crucible. The purpose of these experiments has been to obtain critical mass estimates for Pu metal under the operating conditions encountered in the Plant. The data will be used to establish mass limits for nuclear safety. The measurements were undertaken as a cooperative effort with personnel of CPD and Critical Mass

(9) W. A. Reardon, et al., Hazards Summary Report for the Hanford Plutonium Critical Mass Laboratory, HW-66266, August 1, 1960.

Physics jointly participating.

Critical mass estimates were obtained for two slightly different geometries of α phase Pu in the melting furnace of Hood No. C-20. In both cases the Pu discs were positioned in a 3/32-inch thick tantalum crucible for placement within the melting furnace. However, in one case the 3.625-inch diameter stack contained a 1.94-inch diameter cylinder of length 1.57 inches located at the bottom of the 3.625-inch cylindrical array.

The critical mass estimate for the 3.625-inch diameter cylinder with the small cylinder positioned at the bottom was 9.4 Kg Pu. The estimated critical mass for the 3.625-inch discs alone in the melting furnace was 9.0 Kg Pu; this was the smallest critical mass estimate obtained in the series of in situ experiments.

Multiplication measurements were also made of the Pu metal discs to determine the critical mass for an unreflected stack outside the furnace. In this case, the Pu metal was positioned on a light metal support so as to minimize neutron reflection from the hood walls. Under these conditions, the critical mass was estimated to be 11.3 Kg Pu.

Measurement of k_∞ in the PCTR for Dilute Pu $(NO_3)_4$ Solution

Irradiations were completed in the PCTR for determining the limiting concentration of a $Pu(NO_3)_4$ solution; this is the concentration for which k_∞ = unity. The data are under analysis, however, difficulty has been encountered in evaluating the effect of the stainless steel containers on the measured reactivities.

The volumes, solution concentrations, and thicknesses of stainless steel of the tanks used in the measurement are shown in tabular form below. The figure for the stainless steel thickness of the tanks does not include the jackets which were all 1/16-inch thick.

Tank	Vol.	Conc.	Wall Thickness
Annular Buffer Tank (A)	112.0	11.4 gm/l	1/8"
Rear End Buffer (REB)	2.5	11.0	1/8"
Front End Buffer (FEB)	2.1	11.0	1/8"
Core Tank No. 1 (C-1)	8.3	10.4	1/8"
C-2	8.3	11.4	1/8"
C-3	8.2	12.5	1/8"
C-2'	6.9	11.4	1/4"
C-2"	5.8	11.5	1/2"
Helium Tank (He)	8.3	-	1/8"
He'	6.9	-	1/4"
He"	5.8	-	1/2"

Using these tanks, reactivity measurements were made at three reactor loadings--"fast", "intermediate", and "thermal"--to give the differences in reactivity ($\Delta\rho$) between C-1, C-2, and C-3 and the He tank--all of 1/8" stainless steel. In addition the reactivity differences were measured between C-2' and He' (1/4" S.S.) and C-2" and He" (1/2" S.S.).

At all three loadings, the values of $\Delta\rho_{C-1}$, $\Delta\rho_{C-2}$, and $\Delta\rho_{C-3}$ indicated a limiting concentration of 12.0 gm/l, but a plot of $\Delta\rho_{C-2}$, He, $\Delta\rho_{C-2'}$, He', and $\Delta\rho_{C-2''}$, He" versus the thickness of stainless steel between the buffer solution and the core solution, i.e., buffer tank, buffer jacket, core tank jacket, and core tank, shows the stainless steel in these tanks to have a large non-linear effect on the measured value of $\Delta\rho$. The effect causes the core tanks to appear less reactive than they actually are, and this results in an apparent limiting concentration which is too high.

It was previously thought that a plot of $\Delta\rho$ versus S.S. thickness could be used to correct the values of $\Delta\rho$ for the effect of the stainless steel, however, the effect is so large that the corrections to $\Delta\rho$ remain questionable. A proposal to build a core tank and helium tank of much thinner stainless steel and thereby get another point much closer to zero on the $\Delta\rho$ versus S.S. thickness curve is under consideration, and further work is being done in an attempt to evaluate the data. At present the none-too-good "best" preliminary value for the limiting concentration is 9.7 ± 1 gm Pu/l.

After the reactivity measurements had been completed on the core tanks, they were sent back to the 200-West Area to be prepared for the second part of the experiment--the foil irradiations. The jackets of C-1, C-2, C-3, C-2', and C-2" were cut off, and all but C-2 had their spouts cut open. The solutions in C-1 and C-3 were then mixed together and the tanks refilled; the helium tank was filled with solution from C-2' and C-2". This then gave four core tanks at a concentration of close to 11.4 gm/l. The tank spouts were re-welded; the foils were placed in the traverse tubes and new jackets were welded around them. The work of opening and closing the tanks and jackets was done by personnel of Plutonium Metallurgy Operation, and the solutions were transferred by personnel of the Finished Products Operation, CPD.

One tank contained three sets of bare Au and Cu foils doubled up at positions 1-1/4" from each edge and at the center of the six-inch diameter tank to give a lateral traverse through the tank. A second tank contained corresponding sets of cadmium-covered Au and Cu foils. (Previous irradiations in the He tank during the reactivity measurement part of the experiment had established that doubling up the gold and copper foils would have no effect on their cadmium ratios.) The third tank contained two sets of bare plutonium-uranium 235 foils, one at the center of the tank, and one approximately 1/2" from the edge, and the last tank contained the corresponding two sets of cadmium-covered plutonium-uranium 235 foils.

The foils were irradiated at the "thermal" loading; the jackets were cut off the tanks in a hood at the 305-B Building, and the foils were countered there. The data on the plutonium uranium-235 foils have not yet been evaluated, but the gold and copper traverses show a definite peaking of the cadmium ratios in the center of the tanks indicating that the incident flux on the core tanks was not thermal enough. The center cadmium ratio values were 4.83 for the gold and 14.89 for the copper.

Critical Mass Calculations for Homogeneous Pu-239 - H_2O Mixtures

The cause of a disagreement between the critical masses of Pu-H_2O systems as calculated at Hanford and the Los Alamos Scientific Laboratory has been briefly

explored. Prior calculations were summarized in the Monthly Report for April 1961. The critical masses were recalculated using the 9-Zoom Multigroup Diffusion Code for two different cases of input data change. In the first case the fission cross section was adjusted upward by 10% in the resonance region (groups 2-8 inclusive), and the removal cross section of water was also adjusted upward by 10%. For the second case (in addition to the above changes), the thermal fission cross section was taken as a constant 620 b (about 10% lower than the previous values). The results of these calculations are summarized in the following table.

CRITICAL MASSES OF BARE SPHERES OF Pu239 H_2O HOMOGENEOUS MIXTURES FOR VARIOUS ASSUMPTIONS

H/Pu	Pu(gm/cc)	$M_c^{(1)}$	$M_c^{(2)}$	$M_c^{(3)}$	$M_c^{(4)}$
0	19.6	9.66 Kg	10.1 Kg		
.86	12		15		
2	8	19.94	18.5	19.4 Kg	19.4 Kg
3.1	6	20.84	20.5	20.1	19.9
5.3	4	20.24	20.9	19.2	19.0
12	2	16.36	16.3	15.3	14.8
25	1	11.79	10.4	11.1	10.3
32	.8	10.43	7.9	9.8	8.9
43	.6	8.79	7.0	8.3	7.6
65	.4	6.16	5.2	5.8	5.8
131	.2	3.46	2.8	3.3	3.7
264	.1	1.92	1.56	1.8	2.2
529	.05	1.152	1.02	1.12	1.31
872	.03	.961	.92	.93	1.12
1325	.02	1.015	1.08	1.00	1.24
2651	.01	2.82	4.4	2.74	N.C.
3536	.0075	43.3	N.C.	38.	N.C.

(1) Previously calculated, Monthly Report April 1961.

(2) Los Alamos Calculations, estimated from curves of Ref. 1.

(3) Calculated assuming $\sigma_{re}^{H_2O}$ (i = 2 to 8) 10% higher and σ_f^{239} (i = 2 to 8) 10% higher.

(4) Same as (3) but σ_f^{239} = 620 b.

N. C. - Not critical within the range of calculation ($k_\infty < 1.0$).

The calculations under (3) of the table appear to agree with the quoted (and plotted) experiments (Pgs. 34 and 35 of reference (10)), as well as the Los Alamos calculations for concentrations of 400 gm/l and up. Experimental data from the P-11 project are being prepared to make a more detailed check on the assumptions.

Multi-Group Diffusion Code - AIM-6

The AIM-6 multi-group diffusion code has been assembled; the first debug run has shown that the subroutine modification which was recently completed resulted

[redacted] Correlations of Experimental and Theoretical Critical Data, H. C. Paxton, LAMS - 2537.

in a memory overflow. The possible changes to overcome this difficulty are presently being investigated.

A visit to the Bettis Atomic Power Laboratory was made on June 8 to discuss the possible use of the fortran versions of their SOFOCATE thermal neutron spectrum code and MUFT-4 fast neutron spectrum code in conjunction with AIM-6. The fortran TEMPEST code (SOFOCATE) would furnish thermal group constants and the FORM code (MUFT-4) would calculate the fast group constants and transfer functions for AIM-6. The advantages of this procedure over the presently used data library are: (1) the thermal group constants, which are presently dependent only on the concentration of neutron poisons in the medium, will also be dependent on the temperature of the medium, and (2) the resonance self shielding effect can be calculated directly for a large number of isotopes based upon narrow resonance theory. The conclusions drawn from this visit are that it would be quite simple to use the TEMPEST code with the AIM-6 code, but to utilize FORM would require a good deal of modification.

Infinite Homogeneous Monte Carlo Code - HISMC

The calculation of the age of fission neutrons in water using the RBU random number generator has resulted in the location and correction of an error in the neutron birth selection scheme. This particular error resulted in the selection of approximately two neutrons per hundred having a birth energy of 15 MEV which resulted in an age for water that was too large. The recalculation of the age of fission neutrons in water is now being carried out.

Interactions of Subcritical Systems

The study of the interactions of moderated subcritical systems by an approximation method continued. Comparison is being made of predicted critical height vs. separation curves with experimental measurements (ORNL-2389) on several systems of interacting slabs and cylinders of U-235 solutions. The calculational technique being used is to determine the reactivity of the interacting system relative to one of its components by use of the approximation method. The reactivity of the isolated component is in turn determined by a 2-group diffusion theory calculation using AIM-5. The nuclear parameters being used are those appropriate for criticality calculations of reflected cylinders, as reported in WAPD-TM-244. Results obtained so far by this procedure are reasonably good.

Mass Spectrometry

Isotopic analyses were provided on four additional samples of plutonium for possible use as fuels in criticality studies.

Another RCA 6810A electron multiplier phototube was installed in the mass spectrometer for this program after removing the glass envelope. Electrical leakage and dark current in this multiplier are low enough to operate it under high gain and maximum sensitivity conditions. The constancy of its gain as a function of output current has not been determined because of improper operation of the rest of the mass spectrometer. For reasons not understood at present the ion beam focusing properties of the magnetic analyzer depend improperly on ion source focusing conditions to the extent that it is currently impossible to find a satisfactory condition of focus.

The sample sensitivity of this mass spectrometer using a single filament has been increased to a value comparable to that of the triple filament mass spectrometer by carbonizing a trough-shaped filament. The carbonizing process, developed by Dr. M. H. Studier of ANL, is to bake a clean degassed rhenium filament at 1500°C in an atmosphere of benzene vapor for 5 minutes. The benzene pressure is that of its vapor at dry ice temperature. This process allowed a sample of 10^{-7} gms of natural uranium to be successfully analyzed using metallic ions with no interference from oxide ion emission.

Instrumentation

Investigations were resumed on the CPD tracer lathe control systems. Because of failure to find a "quick and dirty" immediate solution, the recent "cut and try" attempts were abandoned and a complete system wiring and grounding cleanup was started.

Plans were completed for the assignment of an Instrument Research and Development engineer to be in-residence at the Critical Mass Laboratory. He will establish an instrument maintenance program, develop new instruments needed for the experimental program, and plan instrumentation system needs for the possible Phase II expansion of the laboratory.

Nuclear Safety Consultations

The nuclear safety of shipping 1736 Kg of 1.47% U-235 enriched uranium to ORNL was approved.(11) The shipment consisted of five hundred, 1.336-inch diameter fuel elements.

Talks were presented at two safety meetings. The first was given to personnel of Power and Mechanical Design, CE&UO, and the second to the Engineering Operation, FPD. The subjects presented were: "Past Nuclear Accidents and Their Causes", and "The Variables That Effect Criticality".

NEUTRON CROSS SECTION PROGRAM

Slow Neutron Cross Sections

More trouble was experienced with the deteriorating masonite sections of the neutron beam defining plug for the 105-DR crystal spectrometer. It was again necessary to vacuum out the hole and clean the gas seal window. Plans have been made to attempt to repair or replace the faulty plug in the near future.

A study was initiated of the effects of thermal shock on the perfection of germanium single crystals. The purpose of this study is to attempt to improve the reflection efficiency of the germanium crystal by providing an increased mosaic due to induced imperfections. One crystal ingot was subjected to three sudden quenches from temperatures of 680°C to 830°C to room temperature. The quenches were carried out in a vacuum furnace by introducing argon gas or plunging the heated crystal into silicon oil. A factor of two increase in reflected

(11) Letter from P. F. Gast to F. J. Zelley, Nuclear Safety of 1.47 Percent U-235 Enriched Uranium Shipment, June 5, 1961.

intensity was achieved with no observable broadening of the crystal moasic within the precision of the measurement of about two minutes of arc. The oil quench produces drastic effects on the macroscopic structure of the crystal: fracture lines, chips, and possible step dislocations. These studies are continuing.

Measurements were made with a germanium single crystal monochromator of the shape of the fission cross section of Pu^{239} at low neutron energies. Preliminary results confirm the absence of any significant fraction of second order reflection from the (113) diffracting planes. The present crystal is indicated to be the best available crystal to use for fission measurements in the range of 0.02 to 0.1 ev. The reflection efficiency is still too low, however, for use as a monochromator at higher energies or in scattering measurements.

Slow Neutron Scattering Cross Sections

The series of measurements of elastic neutron scattering by vanadium at liquid nitrogen temperatures to determine the spectrometer resolution and efficiency functions is still in progress. These measurements are desirable for the interpretation of the results of measurements of slow neutron inelastic scattering from water. Energy analysis runs have been made at 0.10, 0.15, 0.20, and 0.25 ev. Angular distribution runs have been made at 0.10 and 0.25 ev. In addition, a few room temperature runs were made during periods when the automatic liquid nitrogen filling system was inoperative. Due to a variety of difficulties, mostly involving icing of the filling control system, only about one-half of the attempted cold runs have been successful.

Data from last summer's measurements of the quasi-elastic scattering of 0.147 ev neutrons from water have been processed using the INELASCAT data reduction program. The processed data are being prepared for quantitative fitting to gaussian peak shapes using the GAUSSFIT program.

Fast Neutron Cross Sections

The vernier chronotron has exhibited three different types of nonuniformity in channel width in the past: (1) A monotonic change of width with channel number, (2) a localized anomaly, and (3) a periodic fluctuation whose amplitude increases severely towards large delay times. Types (1) and (3) were present to some extent even when the Mark II chronotron was completed two years ago. Type (2) first appeared when the new time-mark generator was installed in March.

Type (1) was shown in April to be due to a definite waveform controlling one of the biases in the start-loop circulating amplifier. It has now been reduced to a fraction of 1 percent by correct setting of the DC biases.

During June an intensive study of Types (2) and (3) was completed. Type (2) was traced to inadequate decoupling of the power supply to the time-mark generator, and has been cured almost completely. Type (3) is still incompletely understood, but a variety of control measures have decreased its amplitude several-fold. The differential linearity is now constant within 0.5 percent over 180 ns, and within 2 percent for another 50 ns. The integral linearity is an order of magnitude better, since the perturbations average out over

nearly the entire range.

Testing of the new pulse-shape discriminator is being extended to a wider range of operating points. Results to date are inconclusive. A coincidence circuit has been installed in the chronotron to permit simultaneous height and shape criteria to be applied to each pulse accepted. Its performance is satisfactory.

A study was completed of the problems attendant with using liquid scintillator with neutron and gamma pulse shape difference characteristics as a fast neutron detector. Studies were also made of the energy resolutions to be expected from the scintillator detector system and the over-all resolution problem for total cross section measurements in the region of 2 to 14 Mev. As a result of these studies two liquid scintillator cells were designed to operate with the 56AVP and 58AVP photomultiplier tubes.

Instrumentation

Tests were made with a mercury relay light flasher on the 58AVP multiplier phototube. This tube is nominally a five inch size, with a curved photocathode, a complicated electron optical system, and a 14-stage electron multiplier. It is designed to have a fast time response, and high output current capabilities.

The rise time, in terms of milliamps per nanosecond, is about twice as fast as the 6810A type tube which is now in use. A more important parameter, for time-of-flight work, is the variation in time of the output pulse as a function of the originating point on the photocathode. With this tube, the electron optics can be adjusted to give a spread of about 1½ nanoseconds over the four-inch-diameter usable cathode. For a three-inch diameter, the spread is negligible; i.e., less than one-half nanosecond. These figures are much better than the 6810 series tubes and this tube should be of value in improving fast neutron time-of-flight instrumentation.

REACTOR DEVELOPMENT - 04 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Small Source Theory Analysis of PRTR Plutonium Loading

The small source theory analysis of the PRTR subcritical tests using only plutonium fuel was continued. A 2-group diffusion theory model of the moderator is being used and fuel element parameters are being evaluated from infinite medium cell calculations using a cylindricized version of the 19-rod cluster fuel elements. For reasonable ranges of values of the material parameters, the calculated reactivities for the experimental 11-rod loading and two postulated 12-rod loadings are high by several percent. The relative insensitivity of the incremental reactivities to these values indicates that these increments can be determined with reasonable accuracy in spite of the low over-all accuracy. To aid in this analysis, the heterogeneous lattice code, HET, was improved and enlarged. The input routine was modified to facilitate introduction of data and a routine to calculate flux traverses along a specified direction was added.

PRTR Startup Experiments

The data which were obtained from lutetium foils mounted on the center element of the reactor loading for Critical Test 15 and 21 have been analyzed. Three sets of data were obtained in Critical Test 15. One set was irradiated when the moderator contained ~ 19 mg of boron per liter of D_2O. Two other sets were irradiated with no boron but at two different heights in the reactor. The foils in Critical Test 21 were irradiated with shims in the reactor but with no boron. Cadmium ratios of the lutetium isotopes and spectral indices have been determined in the analyses. The results are listed in Table I.

TABLE I

Position of Foils (inches above zero moderator level)	Reactor Configuration	Cadmium Ratios Lu-175	Lu-176	Spectral Index (°K)
47.6"	CT 15; no shim; no boron; critical level 61.6"	1.432±0.010	78 ± 9	361 ± 13
37.4"	Same as above	1.427±0.006	84 ± 3	367 ± 8
47.6"	CT 15; boron; no shims; critical level 93.1"	1.437±0.004	81 ± 3	356 ± 6
49"	CT 21; no boron; shims; critical level 101	1.396±0.007	70 ± 2	359 ± 10

Multichannel Analyzer

One type of nickel foil which has been used with plutonium and uranium foils for spectral index measurements has been suspected of being contaminated with manganese. Another type which has been used more recently was believed to be made from more pure nickel. A contaminated foil is not easily detected since the predominant manganese and nickel activities which are produced by neutron capture have the same half life. Foils which were made from the two types of nickel have been irradiated and analyzed with the multichannel analyzer in order to determine the relative purity of the foils.

The gamma ray spectrum of both types of nickel contains peaks characteristic of manganese (Mn^{56}). Each type of nickel has about the same proportion of manganese and approximately 7/8 and 1/8 of the total counts were from manganese and nickel, respectively. A manganese contamination of only about one percent is sufficient to produce the observed activities. Another contaminant was observed with a half life < 2 weeks. This activity was of such a low intensity that it will not cause any special problem.

Effect of Absorbing Rod on Neutron Energy Spectrum

Investigation of the neutron flux in the vicinity of an absorbing rod is continuing. Blackness boundary conditions on the surface of the rod are used to describe 1/v absorption with Breit-Wigner resonance terms. The previous work of Carter, Atlee, and Mahan (HW-62727, HW-67219) has been advanced to include the resonance term. An analytical solution has been found to the difficult integrals that this term presents, and the solution is being programmed.

Code Development

MELEAGER Code

Minor changes in the code were made prior to the APWR computations. They include extension of the resonance self-shielding expression to include thermal non-1/v cross sections and introduction of an empirical thermal flux-depression factor to improve calculations of thermal utilization and spectral index. Effects of these changes are normally small but may be important in cases with high plutonium content in the fuel.

Wessex-II

Reactivity endpoint convergence appears to be extremely difficult to achieve in this code, and was removed from the program. It will be replaced by a curve fitting procedure, which will also serve to provide more data from each run of the code.

RBU

Input has been partially constructed for a calculation of the PRTR core. This consists of a 30 degree vertical sector, containing all regions in full detail except for the shims, which are symmetrized to some extent. The NPR cell problem received further detailed analysis to determine effects of cross section changes.

C-6

A number of minor bugs in the C-6 code have been located and corrected. A subroutine has been coded for C-6 which will punch the calculated group constants in a form acceptable to HFN. This subroutine has not yet been debugged. Work has begun on a code to generate a 100-group cross section library tape for C-6 from the RBU data tape.

The Critical Facility of the PRP

a. PRP-CF Fuel Elements Data have been compiled for the fuel elements which are available for use in the PRP-CF. These data include the percent of theoretical density for each of the UO_2 elements, nominal values of the isotopic composition of the Pu-Al alloy, and the amount of Pu in each Pu-Al element. Two of the UO_2 elements varied between 76 and 79 percent of the theoretical UO_2 density, ten between 82 and 84 percent, and five between 85 and 88 percent. The plutonium content of the Pu-Al elements (30) varied between 258 and 264 grams per element for 8 Mark 1-H elements and between 267 and 274 grams per element for 22 Mark 1-G elements. The Mark 1-H and Mark 1-G differ in the thickness and type of Zircaloy cladding used on the rods.

b. Photoneutron Problem in D_2O Moderator

One of the problems which will be encountered in the heavy water experiments will be a large contribution of photoneutrons from the (γ,n) reaction between the fission-product gamma rays of an irradiated element and the heavy-water moderator. Although this contribution could be greatly reduced by making the measurement in H_2O, there is interest in making the measurements in D_2O also. Various methods are being considered to help separate the (γ,n) effects from the usual reactivity effects which are to be determined. Three of these are:

i) Using cylinders of lead or bismuth to surround the irradiated fuel element and reduce the fission product gamma rays.

ii) Making reactivity measurements at various times when the fission-product gamma rays have different intensities.

iii) Making reactivity measurements at various power levels.

Lead is a little more effective than bismuth for reducing the gamma rays, with an energy $>$ 2.23 Mev, which participate in the (γ,n) reaction. Lead 1.9 inches thick and bismuth 2.2 inches thick will attenuate the gamma rays by a factor of 10. The absorption cross section of bismuth is 0.2 of that of lead. This makes bismuth a little more desirable than lead since it will distort the neutron spectrum less when it is inserted in the critical facility. Information has been requested on the purity of lead and bismuth which is available commercially, and also on the sizes of tubes which can be extruded from lead, bismuth or an alloy of the two materials.

For short irradiation times, the intensity of high-energy gamma rays are reduced by a factor of 10 during the period of one week to six weeks after the irradiation.

Other laboratories have obtained reactivity measurements on small irradiated samples in D_2O moderator by making the measurements at more than one power level. On this technique the (γ,n) neutron source can be determined and its reactivity effect separated from the measurement. This method of measurement has not been attempted on full sized fuel elements where the photoneutron effect would be much larger.

c. ARMF-MTR Experiment

Results of reactivity measurements on the unirradiated fuel samples for the ARMF-MTR experiment have been received. Several reactivity measurements were made on a single sample as well as measurements for each sample in order to determine the accuracy which can be obtained in the ARMF. For one set of measurements the orientation of the sample was always reproduced. For another set the sample was rotated from its normal position. The net reactivity of the samples when compared to the empty reactor was $\sim$ 600 μk. Reactivity values agreed to within $\sim$ 1 μk for three measurements on a single sample. Rotation of the sample had no effect on the value of its reactivity.

Some difficulties have been encountered in the fabrication of the plutonium samples which will contain boron. The value for the amount of boron put in the plutonium alloy is much larger than the value determined in a spectral-chemical analysis of the sample. It is not known whether the problem is metallurgical or analytical. The inconsistency could be caused either by non-uniform dispersion of the boron in the alloy or by failure of the analytical technique. To help resolve the inconsistency a sample will be analyzed by spectrographic techniques.

Low Exposure Plutonium Lattices

The foil activation data from the three graphite lattice experiments ($6\frac{1}{2}$, 8-3/8 and $10\frac{1}{2}$ inch pitch) have been analyzed, summarized and tabulated. Work is continuing to resolve several inconsistencies in the data.

Plutonium Fuel Temperature Coefficient

Fabrication of the heating device and the insulated cell for this experiment is about 20% complete.

Advanced Pressurized Water Reactor Study

The APWR computations were completed at the end of the month. Sensitivity of results to temperature, thermal utilization, slowing down power, and fuel density was determined by variation of these parameters independently and in a few combinations. Analysis of results is currently under way.

Instrumentation and Systems Studies

Enriched uranium (93% U^{235}) was received to permit fabrication of several experimental "last ditch" safety fuses for the PRPCF.

Technical support and assistance continued concerning the PRTR Fuel Element Failure Monitor. The required changes and improvements requested are slowly being incorporated by PRTR maintenance personnel as time permits. Final system tests and modifications will be commenced as soon as the changes have been satisfactorily incorporated.

Advice was rendered concerning improvement of several types of building and effluent radiation monitors now in use at PRTR.

A scaling system has been developed for the Critical Facility. This system is composed of two one-microsecond resolving time scalers, a slow scaler to act as timer for these two fast scalers, and a double scaler to act as a pair of stop-watches to be used in measuring the reactor period. This system will be all solid state, will be adaptable to printout, and will have Nixi readouts. The one-microsecond scalers are being designed as flexible, general purpose instru-

observed. This would indicate that these transducers can provide required sensitivity and linearity.

A mockup, dual coil probe for use with the PRTR Gas Annulus Gauge, was fabricated to evaluate the mechanical problems associated with passing a borescope through the probe assembly. This mockup served a second function, in that it was partially fabricated from a special Dow-Corning molding compound, a radiation-resistant material whose machinability required evaluation. The mockup confirmed earlier suspicions that the addition of a borescope will present some rather difficult mechanical design problems, and that several such mockups will probably be required before a satisfactory design is obtained. The mechanical properties of the molding compound are such that it shapes nicely on a lathe, but thin sections of the material are quite brittle. It is hoped that a "tougher" filler can be found which won't appreciably reduce the present 10^{10} R in-reactor life of the material.

A paper, "An Eddy Current Technique for Measuring the Tube-to-Tube Annulus in a Nuclear Reactor" (HWSA-2213), was written and submitted for clearance for presentation at the National Convention of the Nondestructive Testing Society in October, 1961.

The PRTR Gas Balance System analysis is in progress. The purpose of the study is to determine the values of the system parameters necessary to improve the over-all stability of the system. Of interest is the undamped natural frequency of the system component sections. The undamped natural frequency of the gasometer has been determined to be approximately 0.12 cycles per second. This agree closely with the calculated value. The natural frequency of the system as a whole, as determined by the analog computer, is approximately 1.1 cycles per second. One of the most important unknown quantities associated with the gasometer is its damping coefficient. No method of arriving at a reasonable value for this coefficient mathematically has been found. It appears likely that a determination of this coefficient by making experimental measurements on the actual system will be necessary. Another factor having a considerable bearing on the system stability has emerged from this study. The initial volume of the gasometer must be greater than about 350 cubic feet in order for the moderator level to be raised to its normal operating point and to maintain stable operation around this point. Other parameters which are to be studied include the total weight of the gasometer piston and counterbalance, the sizing of the orifices, and the nominal gasometer pressure.

A request has been received to make some additional analog runs for the PRTR Critical Facility. This additional study has to do with the operation of the poison injection scram system. New information relating to this system has become available making it necessary to rerun this part of the original work.

NEUTRON FLUX MONITORS

The sensitivity of optimal neutron detector compositions was examined as a function of time and variable in-core environments. The various cases, as simulated with the Meleager computer code, showed the plutonium isotope detector neutron flux sensitivity to be nearly independent of mode of burnout throughout the useful lifetime of the detector material. The effect of constant sensitivity does not hold, however, for combination uranium-plutonium isotope detectors. Such

combination units produce unacceptable variations in sensitivity for various burnout modes throughout the detector lifetime. Because of the foregoing and of the following considerations, it becomes apparent that a plutonium isotope detector is superior to the combined type. The additional features which tend to eliminate the combination type from further consideration are as follows:

1. Changes in sensitivity accompanying abrupt flux level shifts;

2. Difficulties in predicting detector sensitivity for even conservative lifetime predictions;

3. The low value of expected detector sensitivity, a small signal magnitude, and a poor neutron to in-core gamma signal ratio;

4. The theoretical determination of only one-half the expected lifetime as compared to a plutonium detector.

Theoretical computer investigations are proceeding to refine the plutonium isotope detector into acceptable form for experimental fabrication.

NONDESTRUCTIVE TESTING RESEARCH

Electromagnetic Testing

Investigation of pulsed eddy current techniques has heretofore been concerned primarily with methods to accurately detect small variations in the response function due to parameter changes. Of the techniques considered for this, it presently appears that those providing the most sensitivity to such changes involve description of the response function on some orthogonal basis.

The next problem, now under study, is to determine with some degree of accuracy the system parameters once the response variations are detected. This is a very difficult problem, because it is necessary to process the response function to provide independent estimates of the parameters of interest. In reality, it is quite likely that changes in one parameter may be approximately equivalent to a combination of changes in others, so it will be necessary to introduce constraints, probably empirical, in order to instrument parameter changes. Professor Huggins at Johns Hopkins University is exploring statistical means of providing these constraints and is exploring optimization of probing signal and response function processing by techniques which show considerable promise.

At HAPO various new and rapidly developing disciplines are being reviewed for techniques which might be applicable to this problem. The field of adaptive control is receiving special attention in this respect, since process identification is basic to it.

Circuits similar to those proposed by E. Mishkin, Brooklyn Polytechnic Institute, show promise of making descriptions of response functions on orthogonal bases much more practical by eliminating the necessity for time-reversal of the response function. These circuits are more complex than those used with the time reversal technique, and the extent to which the advantage of eliminating the need for a time reversal unit may be reduced by added circuit complexity must be determined.

The two 100-section, 100-microsecond delay lines returned to the manufacturer for proper tapping at each section have been received and are ready to be wired into the Hanford artificial transmission line type time reversal device.

An invention disclosure on a scheme to stabilize the temperature of eddy current test coils was written and forwarded.

A report jointly written by R. L. Brown, Jr., and H. L. Libby titled "Detection of Anisotropic Conditions Using Eddy Currents", HW-69271, was written and issued. Clearance has been requested for presenting this paper at the National Convention of the Society for Nondestructive Testing in Detroit in October, 1961.

A formal report, "Broadband Electromagnetic Testing Methods - Part 2, Signal Analysis" by H. L. Libby and C. W. Cox, HW-67639, was issued.

Heat Transfer Testing

Heat transfer tests on a co-extruded Zircaloy-2 clad uranium fuel element showed extremely poor core to cladding heat transfer quality on one side over the entire length. A sonic damping test applied to this fuel element indicated massive unbonded areas in the regions of poor heat transfer.

Metallographic studies have indicated that plasma arc heating of X-8001 aluminum alloy cladding during heat transfer testing does not change its microstructure. Corrosion and Coatings Operation felt this result indicated the corrosion resistance had not changed, and that a metallographic test was the best method available without an actual in-reactor corrosion test. This result is not surprising since the surface temperature drops to less than 85°C in less than 1/30 second after application of the heat.

Feasibility experiments in connection with development of an emissivity independent infrared radiometer are underway. A commercial high sensitivity radiometer, auxiliary heat source, optical band pass filter, and heated surface to be measured were placed in positions indicated in invention report HW-68574. The results were found to be critically dependent on placement of components. Initial results could not be reproduced, probably because positions of components were not fixed rigidly enough in position.

Zirconium Hydride Detection

Hall Effect voltage measurements were made using six standard samples to establish the relationship between Hall voltage and concentration of hydrogen contained in the samples. Between zero and 1000 ppm by weight of hydrogen, the measurements showed the relationship was not monotonic.

A trip was made to the University of California at Berkeley, Stanford University, and Varian Associates in Palo Alto, California, to discuss the feasibility of applying nuclear magnetic resonance to hydrogen detection. Two samples of hydrided Zircaloy were furnished Varian Associates for determination of the relaxation times of hydrogen in Zirconium. Knowing the relaxation times will enable the signal-to-noise ratio for different concentrations of hydrogen to be calculated.

A high uniformity Varian electromagnet was used to check the Hall voltage measurements made using a small permanent magnet. The agreement between the two sets of measurements was very good. At zero concentration of hydrogen, the Hall coefficient of Zircaloy-2 is $4.4 \times 10^{-13} \frac{\text{volt cm}}{\text{amp gauss}}$, approximately 1/3 as great as the reported value in the literature from pure zirconium. This is possibly due to the concentrations of elements other than zirconium in the Zircaloy-2.

Because the shape of the curve connecting the values is not single valued, Zircaloy-2 samples with hydrogen concentrations between 1,000 and 15,000 ppm have been prepared. With these samples, measurements should establish whether some trend of Hall coefficient versus sample hydrogen concentration exists for samples with higher concentrations of hydrogen.

The first draft of the report of the effect of low hydrogen concentrations on Hall Effect in zirconium has been completed. The report will be revised and completed when the higher hydrogen content samples are measured.

A preliminary experimental setup is being made to see if any change in Young's Modulus occurs in Zircaloy-2 as a function of hydrogen content when the sample is placed in a magnetic field. Five samples with dimensions $\frac{1}{4}$ by $1\frac{1}{2}$ by $4\frac{1}{2}$ inches have been prepared by the machine shop. The ends have been ground parallel to a 16-microinch finish. Hydrogen concentration in the samples ranges from 0 to 500 ppm H by weight. The initial plan is to use two ultrasonic barium titanate transducers, the first to pulse one end of the sample and the second at the other end of the sample to look for a change in the velocity of the compression wave when the sample is placed in a magnetic field.

USAEC/AECL Cooperative Program - Nondestructive Testing of Sheath Tubing

The development program for ultrasonic testing of fuel sheath tubing was authorized and begun in early June. Development of the ultrasonic test method, equipment, and theory is the responsibility of Physics and Instrument Research and Development Operation. Development of methods for preparing test standards, characterization of flaws, and related metallurgical studies are the responsibility of Reactor and Fuels Research and Development Operation. Objectives of the program are as follows:

1. Develop equipment requirements and techniques for sensitive and reliable ultrasonic detection of defects in fuel sheath tubing.

2. Prepare standard calibration and testing procedures for suitable application in a tubing fabrication plant.

3. Demonstrate the effectiveness of the developed test methods, theory, equipment, and procedures by testing a variety of tubing types of interest, and by comparing the results with those of other nondestructive test methods and destructive examinations.

4. Advance the theoretical and experimental understanding of ultrasonic energy propagation in thin wall tubing to the extent needed to achieve the above objectives.

Initial work on this program is establishing characteristics of the defect types desired to be detected, defining tubing variables which may affect the test results, and beginning experiments to choose the best ultrasonic crystal and test frequency. Structural Materials Development Operation of RAFRAD is preparing groove type artificial defects for test standards by Electrojet spark machining.

PHYSICAL RESEARCH - 05 PROGRAM

Mechanism of Graphite Damage

Measurements of electron radiation damage to graphite continued. It was found that use of thinner samples of graphite resulted in thermal cycling that gave misleading results. Preliminary results of these studies were reported at the Fifth Carbon Conference.

BIOLOGY AND MEDICINE - 06 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

Work continued into the theoretical formulation of atmospheric diffusion equations to describe the characteristic shear flow found in most of the experiments conducted during temperature inversions. The elements of a diffusion model designed to account for wind direction shear with height were developed jointly with Air Force Geophysics Laboratories' personnel and were presented to the American Meteorological Society this month. Dosage measurements made on the cylindrical surface formed by the horizontal and vertical sampling grids at a given arc distance were found to exhibit maxima in the vertical which changed in height with azimuth angle, such that the line joining peak dosages sloped upwards to the right or left depending upon the sense of the wind direction shear. In a homogeneous, turbulent medium, one would expect that isolines of dosage in a vertical plane perpendicular to the mean flow would be ellipses, with the axes horizontal and vertical. To account for the tilted appearance of the observed isolines, it was hypothesized that the dosage in the cylindrical surface was given by the normal frequency function of two variables, with correlation between the horizontal and vertical positions of the particles on the cylinder. When the correlation is zero, the model becomes the conventional diffusion formula. Both the Green Glow and Prairie Grass data lend plausibility to the model in the preliminary analyses made to date.

In Air Force-supported programs, the first series of diffusion experiments at Cape Canaveral, Florida, was completed on June 16, some two weeks ahead of schedule. A total of twenty-three field trials were completed, of which twenty were subjectively assessed as successful, two were marginal, and one was poor, the latter serving primarily as a training exercise for field personnel at startup of the experiments. Meteorological conditions embraced by these experiments ranged from strong atmospheric stability to strong atmospheric instability, characteristic of the East Coast "sea breeze" climatic regime. All of the exposed membrane filter samplers were received at Hanford and were processed on the Hanford developed assaying equipment to determine the mass of zinc sulfide tracer material collected on each filter, in preparation for more complete analysis of the diffusion data.

Startup of diffusion experiments at Vandenberg Air Force Base, California, proceeded on schedule with the first field trial completed on June 12. The Martin Company's field operating forces were fully trained by General Electric Company personnel during the previous week. By month end, eighteen experiments had been completed. Samples collected during the first nine experiments were received on-site and assayed for tracer loadings.

DOSIMETRY

The facilities at the whole body counter for measuring P-32 were calibrated by counting two patients from the Division of Experimental Medicine, University of Oregon Medical School, both before and after receiving injections of known amounts of P-32. Both patients were counted about five hours after the injections. One of the patients was counted again later. The sensitivity of the counter was found to decrease by 40% due to redistribution of the isotope in the subject during the first three days. It is estimated that if a subject were counted both before and after acquiring a body burden of P-32 that amounts as small as 25 nc could be detected. The studies began last month of the background counting rate from human subjects and indicated considerable variations between individuals. At the present time it is estimated that if we had no previous count on a subject that only amounts as small as 290 nc of P-32 could be detected. If it becomes possible to correlate the background counting rate with measured quantities of other isotopes in the body it should be possible to detect smaller amounts without a previous count.

The positive ion Van de Graaff operated satisfactorily during the month. A gas leak in the high pressure system was found and repaired.

The counting system for the large neutron moderator was completed. Studies are underway with plutonium sources to determine the errors in measurement of their neutron emission produced by uncertainty in positioning the source and the multiplication of the neutron emission by neutrons absorbed through fission in the source itself.

While waiting for the Sb-124 neutron source to be activated an investigation was made of the heat amplifier concept that was conceived several years ago. The heat amplification is produced in the thermistors used for measuring the calorimeter temperature. For a fixed voltage on the thermistor, introduction of heat into the calorimeter reduces the thermistor resistance which results in extra heat being obtained from the thermistor power supply. Heat amplification was shown to actually take place. An amplification factor of 7 was achieved.

INSTRUMENTATION

A personally carried "pocket" experimental indicating dosimeter was fabricated in a seven ounce package of 1.5 x 2 x 6 inches volume. The detector is a modified, automatically recharging pencil-type ionization chamber. The circuitry comprises three transistors, a capacitor chamber voltage supply, a miniature digit register, one shelf-life reference battery, and a single mercury power battery. The register indicates accumulated dose with each register digit equating to about 10 mr. The capacitor chamber voltage supply is charged initially to about 180 V with a pencil charger or power supply. The stored energy is adequate for at least 12 hours of operation, and the single power mercury battery will last for about 50 hours of continuous operation or for four recharge cycles

of the capacitor voltage supply. The unit represents the first known workable miniature, accumulated dose indicating and registering dosimeter using an ionization chamber detector. Extensive tests remain to be done to determine operational limits, life, and complete characteristics; nevertheless, the unit was successful in initial tests and is of the desired "pocket size". Since the unit incorporates digital readout on a miniature electromechanical register, any desired alarming features can be easily added, and the circuitry is directly applicable to telemetry ideas.

Fabrication of final-form transistorized circuitry and cabinet was completed for the experimental scintillation airborne plutonium monitor which uses coincident count techniques to eliminate radon-thoron background effects. Only fabrication of the mechanical removable shroud assembly for the two detector phototubes remains to be done before demonstrations of the system can begin. Continuous running tests have been successfully conducted for several months on the complete system in experimental form. Performance to date has been satisfactory and as good as predicted some five months ago.

Considerable improvement was made in the circuitry and ionization chamber assembly for the second approach to the pocket personnel alarming dosimeter problem. The second approach employs a modified self-reading pencil dosimeter, using a light for fiber illumination, a lens, a CdS photocell detector, and transistorized circuitry. A successful temperature compensated bridge circuit was designed using thermistors to obtain proper photocell readout. In addition, the lens system was reoriented to improve the signal-to-noise ratio by a factor of four over the previous ratio. The detector-bridge circuit is now ready for application to the transistor amplifier and alarming circuitry.

The newly designed scintillation detector probes for the transistorized combined Alpha, Beta, Gamma Hand and Shoe Counter were completed, assembled and tested satisfactorily. Installation of the probes in the instrument is nearly completed after which only final checkout tests remain before the instrument is sent to the 200 Areas for demonstration. All readout is via registers.

Fabrication, assembly, and tests were completed on the scintillation detector probes for the experimental prototype transistorized Beta-Gamma Check-Out Station Monitor for 100 Area use. The electronics portion of the instrument is 90% complete in fabrication. This unit uses rate-meter indication with alarms, gamma background suppression, and it has addenda clothing and area monitor probes.

Extensive troubleshooting and "debugging" work was carried out concerning the Automatic Film Badge Densitometer System. After strenuous effort in grounding, isolation, and filtering, it appears that the complete system is nearly free of the transients which caused faulty operation. The actual transient problems were caused by certain commercial portions of the system such as the digital voltmeters and the card-punch. All circuitry developed and fabricated on site has performed correctly in all tests to date.

A new preparation of CaF_2 was made for fabrication of more experimental CaF_2:Mn gamma thermoluminescent dosimeters. Modification of the metal mounting button used to hold the CaF_2:Mn was made to improve the magnetic coupling with the induction heater work coil. Continued testing shows improvement in performance with each modification devised.

A summary report was prepared concerning development progress on the silicon surface barrier detector diodes over the past fiscal year. The information was presented to Finished Products Chemical Technology, CPD, who are interested in rendering further support on the developmental project for alpha and neutron detection and energy analysis work applications.

Experiments were made with various large air-coupled light pipes for use in inexpensive gross alpha monitoring. One unit using an 8 x 8 inch ZnS effective area and one phototube produced an average geometry of 22% with a signal-to-noise ratio minimum of 3:1. Such units will be used for the experimental Laundry Monitor System.

WASHINGTON DESIGNATED PROGRAM

Isotopic Analysis

No analyses were provided on program samples this month.

More data were accumulated from analyses of uranium standard samples in order to study the nature of the recently observed intensity bias of the ion detection system. The results of 29 analyses on 5 uranium standards are being tested statistically for goodness of fit to a proposed bias function.

TEST REACTOR OPERATIONS

The Hanford Operations Office of the AEC conducted a one-day review of PCTR operations on June 19. The purpose of the review was to determine whether the PCTR had been significantly modified since its hazards summary report was written in 1954. The conclusion reached was that it had not been significantly modified, and that operations under the old report are still permissible. A supplement to the old report is being prepared to reflect up-to-date knowledge of PCTR operating conditions.

The PCTR operated routinely during the month and there were no unscheduled shutdowns. The plutonium nitrate solution k_∞ determination was completed without any contamination problems. A neutron thermalization in heterogeneous rods investigation was completed. Neutron fluxes were measured in the graphite reactor core and inside a large copper bar.

The last ditch safety shutdown mechanism of the PCTR is provided by melting of the highly enriched hollow driver fuel. A series of experiments designed to measure this reactivity loss was completed. The fuel pieces were melted in an induction furnace. The data are being analyzed.

One limit on reactivity reproducibility has always been inexact reposition of the moving face of the reactor. Reactivity measurements easily detect position differences of 0.0005 inch. A sensitive position indicator system was installed. Mechanical changes to the moving face carriage will be made if the position indicator shows it to be worthwhile.

Two sets of foils were irradiated in the TTR, one set for standardization and one to check for possible contamination. There were no unscheduled shutdowns.

CUSTOMER WORK

Weather Forecasting and Meteorological Service

Consultation service was rendered on meteorological and climatological aspects of 1) determination of atmospheric dust loadings for filter system design, 2) NPR containment, 3) siting of a chemical processing plant now under feasibility study, and 4) relative vulnerability of certain areas of the Wahluke Slope to production plant emergency releases to the atmosphere.

Short-range forecast of Columbia River flow continued to be included in tape-recorded messages throughout the month.

Type of Forecast	Number Made	% Reliability
8-Hour Production	90	85.6
24-Hour General	60	86.1
Special	158	82.9

A mean temperature of 74.0 established the past month as the second warmest June of record. June of 1922 (the warmest) had a mean of 75.4. The extreme high of 108 during the past month has been exceeded in June only in 1912, the first year of record in the Hanford Area, when the temperature went as high as 110.

Precipitation for the past month totaled 0.42 inch, which was 60% of normal. All of this occurred during the first eleven days.

Wind speeds averaged a little below normal although there were several days with very strong speeds for brief periods.

Instrumentation and Systems Studies

The combined Alpha-Beta-Gamma Cell Exhaust Monitor for Chemical Research Operation 325-A Building was completed and satisfactorily tested for three weeks. The instrument was demonstrated to interested CRO personnel. For a flow rate of 5 CFM per section, the sections will each alarm in 12 minutes for air concentration levels of 2×10^{-10} μc/cc alpha and 1.6×10^{-8} μc/cc for mixed fission products.

Both High Level Alpha Air Monitors of the vacuum-tube type from 234-5 Building, which had not been performing correctly, have been corrected, improved, and returned to the field. Both were in completely satisfactory operation in 200 West throughout the month. A more dependable high voltage supply was installed in one unit and the circuit prints were changed accordingly. It was suggested in a memorandum report that the new supply be incorporated in all similar monitors in HAPO use. The report also presented detailed instructions concerning maintenance of the vacuum-tube units to forestall future problems as were observed in the two units.

Discussions were held with personnel from the 327 Building concerning operation, adjustment, maintenance, and sensitivity levels of the recently installed prototype moving tape beta gamma air monitor which uses transistorized circuitry

throughout. Operation was satisfactory for the month. Six more units will be fabricated now that correct operation has been attained with the initial prototype.

Experiments continued concerning the combined alpha-beta-gamma conveyor type Laundry Monitor for the Laundry Operation. A prototype air-coupled 8 x 8 inch area alpha probe was successfully tested. Fabrication was started on several test channels, all transistorized, for the system, and a new type of contaminated clothing drop device was fabricated and tested.

The Pu^{239} Wound Monitor system, for detection of imbedded Pu^{239} in wounds using detection of the 17-Kev X-rays, was successfully tested for the month and was installed in the Medical Building, 200-West Area.

Fabrication continued in the 328 Electronics Shop on the following instruments developed for specific application use:

1. A special sensitive scintillation Beta-Gamma Portable Field Monitor for the Biology Operation. The unit, all transistorized, includes amplifier, pulse height analyzer, scaler, count-rate meter, and assorted power supplies.

2. Two experimental prototype transistorized G.M. portable survey instruments incorporating a count-rate meter, high voltage supply, and the amplifier and resonant air column type loudspeaker. These units, after evaluation, will be for Radiation Protection Operation.

3. Two miniature "palm-size" gross alpha monitors using silicon surface-barrier diode alpha detectors, and transistorized amplifliers and resonant air column speakers. These units are for Finished Products Chemical Technology, CPD.

A special heavily shielded scintillation detector plus transistorized circuitry instrument was designed, fabricated, and successfully tested for Coolant Systems Development Operation at KER. The unit includes detector, high voltage supply, amplifier, and count-rate meter.

Advice and assistance was rendered to Environmental Studies and Evaluation, HLO, concerning the Columbia River Monitor which consists of a scintillation detector, high voltage supply, solid state amplifier, and chart recorder.

Installation of the hydrogen detectors on the 333 Building autoclave is complete. Some problems may exist during calibration since it is not known exactly how much hydrogen will be given off during a rupture. There is a possibility that the detectors will not show any substantial hydrogen increase since the rupture-produced hydrogen may be insignificant compared to the normal autoclave hydrogen emission. If this occurs, a possible solution might be a scintillation monitor on the autoclave condensate line to detect any small uranium particles in the condensate.

Fabrication of the prototype model of the Panellit-Heise gage readout device has been started. If no unusual problems are encountered, it should be finished by the last part of July. The adding machine has been received and only some of the minor components remain to be delivered. The breadboard model has yet to be tested

with the adding machine, since fabrication of the solenoid drive circuits is not complete.

An external signal device was fabricated and delivered to the Data Processing Operation. The device is a generator of precisely shaped pulses to be used in an effort to determine the time required by the IBM 7090 to process selected portions of programs.

Calibration of micro-displacement systems, to be used by Physical Metallurgy Operation for in-reactor creep measurements, has continued during June. The characteristics and capabilities of the elevated temperature reference system have been adequately determined and the system is being turned over to Physical Testing Operation for operational purposes. Physical Measurements Operation will continue to supply engineering support in the calibration of micro-displacement readout systems.

Calibration of a Physical Science three-range transducer system was initiated during June, and is now approximately 50% complete. Preliminary indications are that although this system is capable of fairly good reproducibility, it exhibits a marked temperature dependence resulting in both zero shift and range expansion. This is particularly true of the low range whose full scale displacement was 0.130 inch at 30°C and 0.275 inch at 200°C, while a zero shift of about 0.050 inch was observed between room temperature and 200°C. This indicates a range expansion of about 0.145 inch for 170-degree temperature change. This effect is also observed on the medium and high ranges but is considerably less pronounced.

Engineering assistance was given Physical Metallurgy in the operational evaluation of a recently purchased transducer excitation system. The Physical Science Corporation DC/DC translator was bench tested and its characteristics were found to differ somewhat from those supplied. The translator is a transistorized "black box" designed to provide a pulsed excitation to a transducer, and generate a recordable dc output signal, when operated from a 7-12 volt dc input.

Physical Testing

Testing work continued at a high level this month, mostly as a consequence of NPR pressure tube testing. A total of 12,415 tests were made. These tests were made on a total of 4,510 items. The length of material represented by these items amounted to 131,971 feet; again the greater part of this footage, measuring in miles, was NPR pressure tubing. Test work included: autoclaving; borescoping; dimensional measurements (micrometric); eddy current; leak detection; penetrant (fluorescent O.D. and I.D.); radiography (gamma-ray and X-ray); surface treatment (alkaline cleaning, pickling for autoclaving and conditioning, steam detergent cleaning, and vapor degreasing); and ultrasonic (flaw detection and thickness measurements). Work was done for 24 organizational components representing most of the operating departments and service organizations at HAPO. Advice was given on 35 different occasions on general testing theory and applications.

Successful operation of the tube shop in the testing and treatment of NPR pressure tubes, at high throughput rates, has resulted in about half the required number of tubes accepted and ready for reactor installation. Projected production indicates successful completion of the work on schedule on a five-

day-week basis, and the corresponding change has been made. Days and swing shifts will be continued. It is anticipated that the NPR pressure tube work will remain on a five-day week through completion of the tube testing, if the present production rate of completed tubes is maintained and no emergency conditions arise. All butt weld X-rays on NPR pressure tubes have been completed. This completes the radiography required unless 5-mil ultrasonic flaw indications requiring X-ray are found on the remaining tubes to be tested. Fluorescent penetrant testing of the pilot tubes and 10% of the production tubes received to date has been completed. On the five-day operational basis each autoclave will complete one cycle per week which requires only 28 tubes pickled per week. Testing has proceeded routinely with minor equipment maintenance problems. As a result of the reduced schedule, two of the technologists on loan to Physical Testing Operation will return to their respective groups July 1, 1961. It would now appear possible to start the testing and treatment of PRTR spare pressure tubes for utilization at the PRTR reactor. It is anticipated this work will be done on the third shift and, with the assignment of two technologists, will commence immediately.

The field testing activities have been largely involved in X-ray and gamma-ray work at 1706 KER, the PRTR site, and on pump impeller for the reactor areas. The fluorescent penetrant examination of overbored nozzles is proceeding routinely. All preliminary work has been completed on the strain gages (rosettas and single gages) for installation of 50 channels on the rear face of 105 KE reactor. Reactor operations have been notified and installation will begin at the first available rear face down time.

Fuel element sheath tube work on nominal half-inch-diameter tubing remained at low ebb during the month due principally to lack of material. In addition to the above work, testing is being done on the assorted sizes of tubing for use in nested tubular fuel elements.

Continuing the evaluation of eddy current equipment for application to the fuel element sheath tubing work, 102 0.495-inch-I.D. Zircaloy tubes were run through the Radac unit. The machine was adjusted to reject on a wall thinning standard only. Tubes which have signals greater or equivalent to the signal from a 10% wall thinning standard would activate the alarm circuit. Nineteen of the 102 tubes had signals equal to or greater than the standard. These tubes are now being run through the normal production tests. The results will be compared to the eddy current indications. In addition, seven 0.680-inch-I.D. Zircaloy tubes were also evaluated. Again, the 10% wall thinning standard was used. Comparisons are presently being made with production run data previously obtained on these tubes.

Assistance was given to Plutonium Metallurgy Operation in the evaluation of the radiographic image sharpness for resolution of the fluoroscopic unit originally acquired by this group. Initial work shows the unsharpness in all tests to exceed the specified ± 0.0025 inch. It was recommended that a new fluoroscopic screen with higher definition be procured before further acceptance tests are made.

Routine calibration tests are being made of micro displacement readout systems for Physical Measurements Operation. The readout systems are for in-reactor measurements.

A wide band converter was leased to continue development work on the IPD Parker fitting problem. An immersed test showed that 10- and 15-megacycle ultrasonic inspection will detect the prepared fitting defects as well as 25 megacycles. At this point further immersion inspections were discontinued and emphasis placed on adapting the test to contact testing. Various combinations of crystals and contact wedges have been tried. Considerable difficulty was experienced in finding a suitable wedge that would reliably detect the fabricated defects in both the thread relief area and at the thread root. At month end it appeared that a suitable wedge design had been found and would allow field testing of the fittings. There is to be a reactor outage in mid-July for replacement of pigtails, at which time the available Parker fittings would be tested. In an attempt to find more portable equipment than the Immerscope or the wideband converter, a Branson Sonoray was evaluated. Unfortunately, the Sonoray appears to have limited gain and could not detect reliably either of the fabricated defects. It is probable that the initial tests will be made using an Immerscope working through contact wedges.

Six tubes with a total of 33 ribs were tested for tube-rib bonding using the techniques developed last month. No significant unbond areas were found in any of the tubes tested. A method for radiographic correlation of the ultrasonic tests was developed by inclining the rib tube interface at a root angle to give detection of the unbond area.

Optics

Occasional assistance is being given in the installation of the periscopes in the PRTR examination cell.

A Davidson Optronic Model D600 Autocollimator has been received. This unit with its accessory equipment (optical flat mirror, optical square, polygon) will permit us to check the squareness of machine tool equipment, the parallelism of surfaces on finished pieces, angular positions of dividing heads, and prism angles.

A total of 520 man-hours of shop work was performed during the five-week period (May 28 to July 2) included in this report.

The work included:

1. Fabrication of ten magnifying viewers to examine snap rings on the faces of the K reactors.
2. An ACM1 borescope was repaired for Plutonium Fuels Development.
3. Two microscopes were repaired and 40 glass sample holders fabricated for 327 Building.
4. The process tube borescope was repaired for Irradiation Testing Operation.
5. Parts for the traversing mechanism for the old reactors were fabricated.
6. Parts for the PRTR process tube wall thickness measuring probe were fabricated.
7. Parts for an experimental gas gap probe for PRTR were fabricated.
8. Four aluminum oxide insulators were fabricated for Ceramic Fuels.

9. Three aluminum oxide furnace sleeves were altered for Chemical Separations.
10. Two cylinder lenses were fabricated for Ceramic Fuels Development Operation.

Analog Computer Facility Operation

Studies

The major analog computer problems considered during June include:

1. NPR Confiner Pressure Analysis.
2. NPR Power Conversion Study.
3. PRTR Gas Balance System Analysis.

Equipment Operation

The computer operation was as follows:

GEDA		EASE	
56	hours up	141	hours up
110	hours scheduled downtime	31	hours scheduled downtime
10	hours unscheduled downtime	4	hours unscheduled downtime
0	hours idle time	0	hours idle time
176	hours total	176	hours total

Maintenance

The oven conversion of the GEDA was started on June 9 and has continued with very little interruption. A number of changes have been made in the original plan of installation which serve to ease and facilitate the maintenance of the resistor cards and connectors inside the oven. All of the wiring has been completed and the resistor cards are having insulated shims glued to one side to prevent possible shorting when they are inserted in the card trays. Once the cards are installed and the amplifiers placed back in the computer, the checkout will begin to determine how well the new arrangement of the oven will work.

The EASE lost the use of twelve multipliers when the selenium rectifiers of the multipliers plate power supply burned out. The replacement parts were ordered immediately and have subsequently been installed.

Instrument Evaluation

Recycling tests continued on an Ni-Cd rechargeable battery of the 12 VDC, 250 ma-hr size. Twenty-two charge-discharge cycles have been completed with no degradation of performance.

Extensive evaluation testing continued on the two prototype Log-Linear Scintillation Transistorized Building Radiation Monitors for reactor area and other HAPO applications. All tests to date have been successful and include drift, calibration, temperature, line voltage variation, transient effects, vibration, accuracy, response time, and long-term recorded source tests. The testing is nearly complete, and one unit was delivered to 100-D for demonstration and use.

Advice and assistance was rendered to PRTR maintenance personnel concerning the commercial Victoreen Area Monitors that were installed at PRTR. A majority of the units have failed due to cabling shorts, burned out components, and leaking pressurized ionization chambers. A letter was written concerning suggested courses of action pertaining to further use of the units.

Acceptance test methods were devised and written concerning fifty high level (5,000 r/hr) CP-TP type portable instruments and for thirty Model II Scintran line-operated transistorized instruments. The indicated units are on order and should be received soon for HAPO use.

A lecture on the types and uses of HAPO portable radiation monitor instruments was presented to the latest "class" of AEC Radiological Fellowship students.

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CHEMICAL RESEARCH AND DEVELOPMENT OPERATION

RESEARCH AND ENGINEERING

FISSIONABLE MATERIALS - 02 PROGRAM

IRRADIATION PROCESSES

New Production Reactor Effluents

Work was completed on the application of the steady-state groundwater flow computer program to determine the influence of the 100-N disposal crib on the performance of the nearby sanitary tile field. The results of this study were published in HW-70058. Electric analogs were used in conjunction with the computer program to solve two-dimensional boundary value problems describing the flow system. This analysis indicated that the disposal crib would be expected to diminish the available capacity of the tile field by less than 0.2 percent. The remaining capacity of the field was estimated to be ten times the maximum sanitary effluent design flow. The relative effect of constructing a barrier wall of less permeable material between the crib and the tile field was also examined. Based on the conservative assumption that the barrier was completely impermeable, the computed interference of the crib on the tile field decreased from 0.2 percent capacity reduction to 0.18 percent capacity reduction.

The improvement in scavenging cerium, strontium, zinc, and cobalt from NPR decontamination wastes by the addition of iron and/or calcium was studied. The solution containing these isotopes was neutralized phosphoric acid cleaner and mixed three-step decontamination solutions in appropriate combination. Both calcium and iron improved the scavenging of zinc. The addition of 200 ppm calcium ion resulted in a five-fold increase in cerium scavenging and a ten-fold increase in strontium scavenging. The addition of 200 ppm iron more than doubled the scavenging of cobalt, probably as a result of its reaction with part of the EDTA in the system.

Reactor Influent-Effluent Treatment

The isotope interfering with the continuous monitor measurement of As-76 in fresh reactor effluent was identified as Cl-38. As an interim procedure for checking effectiveness of coolant treatments, the instrument was calibrated and used as a batch sample counter rather than as a continuous monitor as originally intended. A decay of three to four hours insures that Cl-38 initially present will decay to an insignificant amount.

Laboratory studies of P-32 adsorption on beds of minerals neared completion. None of the minerals examined removed as much as 90 percent of the P-32 from simulated reactor effluent passed through laboratory columns. Rock phosphate and Florida pebble phosphate adsorbed 65 to 70 percent of the P-32, probably by an isotopic exchange process. Mixed beds of minerals chosen to promote replacement reactions did not give improved P-32 removal. Neither the addition of 10 ppm of sodium sulfate nor 10 ppm of sodium nitrate to the influent sufficiently increased the oxidation rate of epidote or pyrrhotite to provide appreciable improvement in P-32 removal by beds of these minerals.

Trace Elements in Columbia River Water

Activation analyses were completed for arsenic, zinc, lanthanum and uranium on eight Columbia River water samples from near 100-B reactor taken between February and June, 1960. The arsenic and uranium concentrations remained relatively constant at 1.4 and 0.36 parts per billion, respectively. The lanthanum values varied erratically from 0.04 to 0.22 ppb, while the zinc showed an increase from 15 ppb in February to 28.7 ppb in April, followed by a decrease in June. Analyses of more samples for more elements are underway to characterize the fluctuations in the Columbia River salt concentrations with season.

Uranium Oxidation and Fission Product Volatilization Studies

An unirradiated NPR prototype fuel element with beryllium alloy brazed end caps was heated in air at 1300 C for one hour to determine the extent of destruction. No external flowing of uranium occurred. Unlike the element having welded end caps, uranium oxide formed on the upstream cap shortly after the start of cooling. This oxidation indicates extensive uranium alloying with the brazing alloy. A visual inspection revealed that the initially circular cross-section of the element upon cooling was distorted into an oval shape except near the thick end caps which maintained their original shape. An analysis of the off-gas filter deposits showed 7.2 μg of beryllium indicating significant release of this extremely toxic element.

Particle size distributions were obtained for uranium oxide formed during the heating of uranium in air at air velocities of 500 and 1000 cm/min (STP). For the temperatures investigated (400, 500, 600 and 800 C) there is an increase in particle size with increasing temperature. At 1000 and 1200 C a dense oxide forms and remains largely intact. Sedimentation techniques gave mass media diameters of 99, 134 and 153 μ at 400, 500 and 600 C, respectively. At 800 C, only 25 percent of the oxide was less than 230 μ showing the mass median diameter to be considerably greater than for oxide formed at lower temperatures.

Time at temperature has a marked effect on the resulting particle size distribution in the 400 to 600 C range. The main reason can be attributed to thermal-cycling at which time the specimen temperature can rise 300 to 500 C above the furnace temperature. Comparison of sedimentation data for two experiments at 400 C shows a mass median change from 58 to 99 μ on thermal-cycling. As the frequency, magnitude and duration of thermal-cycling varies, the resulting size distribution would be expected to vary from run to run. No effect on particle size could be attributed to the two-fold air velocity increase from 500 to 1000 cm/min.

Measurement of Uranium Contamination on Zircaloy

A non-destructive method, sensitive to sub-microgram amounts of uranium, was obtained by counting alpha tracks on nuclear track emulsion films wrapped around zircaloy, NPR fuel element jackets. Uranium contamination around welds was of particular concern.

SEPARATIONS PROCESSES

Purex 2D Column Scrub Section Studies

Two 12-foot stainless steel nozzle plate cartridges were tested with a water scrub as possible high capacity cartridges for the 2D Column scrub section in the Purex process. Cartridge A had 10 percent free area, 1/8-inch holes, 2-inch

plate spacing, and 60-mil-depth nozzles pointing down. Cartridge B had 6 percent free area, 1/8-inch holes, 2-inch plate spacing, and 29-mil-depth nozzles pointing down. Both cartridges performed well at 70 cycles/min, 0.6-inch pulse amplitude, a 2DS/2DX flow ratio of 0.17, and an organic feed of 87 g U/l at volume velocities up to 900 gph/ft^2. At 70 cycle/min frequency, the cartridge B produced a somewhat finer dispersion than cartridge A. The optimum performance of cartridge A was obtained at 80-100 cycles/min.

Evaluation of Purex Diluents

Solutions of 30 percent tributyl phosphate in Shell E-2342, Shell Code 85030, Soltrol 170 and n-dodecane have been subjected to four cycles of nitric acid - nitrous acid degradation and carbonate-permanganate washing. Following each degradation a small portion of each solvent was carried through the so-called "use test" which simulates extraction, scrubbing and stripping in the first Purex plant cycle. The results confirm previously reported single cycle testing and indicate n-dodecane as the best, as expected, with Soltrol 170, Shell Code 85030 and Shell E-2342 following in descending order. Qualitatively, Soltrol 170 falls about midway between n-dodecane and Shell E-2342. Other comparisons such as thoroughness of removal of radioactivity during washing and disengaging times were also made with the degraded solvents. Retention of activity (Zr-Nb in all cases) through washing was in the order E-2342, 85030, 170 and n-dodecane in the ratios 2300:320:25:1. Increase in disengaging time after degradation was significant for E-2342, present but not as marked for 85030 and absent or negative for 170 and n-dodecane.

Disposal to the Ground

No significant changes in groundwater contamination patterns were shown by well samples taken in the vicinity of the 200 Areas during this month.

A program was established for analyzing groundwater samples for Cs-137 on a "group testing" basis. If successful, savings on analytical services are estimated at 50 to 75 percent on about 300 samples a year. Group testing is applicable where the analytical results are usually negative (below the routine detection limit) as is the case with Cs-137 analyses. Some sacrifice of the sensitivity of the routine detection limit will result, even so, the new limit of 2×10^{-6} μc/cc will be one-tenth of the current groundwater control level. The possibility of using group testing on other isotopes is being studied.

Tritium analyses were obtained for samples of Separations plant waste discharged to the ground and samples of groundwater drawn from wells. Waste samples contained from 0.05 to 0.33 μc/cc tritium, and the tritium content of groundwater samples ranged from background (0.003 μc/cc) to a high of 0.10 μc/cc near the SX tank farm. These results indicate that tritium concentration may be useful for identifying the origin of wastes encountered in groundwater monitoring.

The adsorption of plutonium from chemical decontamination wastes from the T-Plant by local soils was measured. A sample of the waste in 112-T tank was equilibrated with a soil sample from well 299-W14-2 and a K_d of 300 obtained. Thus, the plutonium in this waste would be effectively retained on the local soils if the waste were cribbed.

WASTE TREATMENT

Batch Calcination

Studies of the batch calcination of simulated Purex high-level wastes were continued in pots ranging in size from 3 inches in diameter by 7 inches high to 8 inches in diameter by 7 feet high. The prime objectives of the investigations were to study foaming and internal pressurization.

The large pot extended out of the resistance heated furnace and was fitted with a fluorothene top to permit visual observation of the boil-down step. A liquid level slightly in excess of three feet was maintained during feed addition. After the feed addition was stopped, the solution was boiled down to a semi-solid. The run was terminated when nitrogen oxide fumes obscured vision. The furnace temperature was held at 450 to 500 C. Pertinent observations were:

1. The boil-off rate was a uniform 1.9 liters per hour per square foot of heated surface.

2. Surprisingly, there was no foaming.

3. Some solids deposited on the pot wall 2 to 4 inches above the liquid level reducing the pot cross sectional area by a factor of two.

4. Increasing the liquid level to a point above the solids and allowing the solution to boil down to its normal level did not affect the solids.

5. About 30 percent of the pot wall below the liquid level was coated with solids of irregular thickness. The remainder of the pot wall had no solid deposits.

6. Fine, crystalline solids covered the bottom of the pot to a depth of at least six inches.

A simulated high-phosphate waste solution, which produces severe foaming, was used for runs in a 4-inch diameter by 24-inch high cylindrical pot and in an 8-inch diameter by 24-inch high annular pot. The use of an air sparge permitted a "normal" boil-up rate of about 2 liters per hour per square foot of heated surface. Without the air sparge, a boil-up rate of less than 1 liter per hour per square foot is required to prevent foam-over. The use of a steam sparge (saturated steam) or silicone anti-foam agents were of little value in controlling solution foaming with these high-phosphate waste.

The development of pressures within the calcine has been noted during the calcination step. The internal pressurization occurred when the calcine partially melted and when the sulfate content was in excess of the stoichiometric sodium equivalent. In the previously reported and duplicated runs with 3-inch by 7-inch pots some of the calcine was expelled from the pot in one case and rose as a plug 1-3/4 inches out of the pot in another. During the month duplicate runs were again made with this same simulated waste. After solution boil-down, a sieve plate was placed on top of the solids. The upward force exerted by this calcine on the sieve plate was measured. After allowing for thermal expansion, the measured pressures on the sieve plate were 0.6 and 0 psi.

Prototype Spray Calciner

A prototype spray calciner for simulated radioactive wastes has been approved for installation in the 321 Building. The dual purpose unit will further develop the radiant heated calciner investigated by Johnson and Allemann (see HW-65806) and Mallinckrodt's direct gas heated flame denitrator (see HW-69905).

The pilot plant will consist of an approximately 18-inch diameter, 10-foot long Inconel X tube inside a resistance heated tube furnace. The feed solution, and in the case of gas heat, the fuel will be introduced at the top of the reactor. The dried solids and reaction gases will flow concurrently through the reactor to a battery of gas solids separators. Auxiliary systems include feed makeup, off-gas condensation and scrubbing, solids loadout and instrumentation. Completion of construction is targeted for November.

TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Strontium-90 Program

Hot Semiworks Operation - The second full-level hot run recovered approximately 175 kilocuries of Sr-90 from a total of 193 kilocuries processed, including 27 kilocuries recycled from the first hot run. The product met all specifications except for cerium-144 contamination, which was about 7-fold high.

In contrast to the first hot run (Sr-4) reported last month, this run employed two cycles of solvent extraction rather than one cycle of solvent extraction and one of ion exchange. The slightly high cerium contamination in the product is attributed to (a) a feed pump failure obviating the possibility of backcycling or "spinning" product during the first cycle solvent extraction, and (b) the necessity of processing and collecting the second cycle product in equipment used for the first cycle operations. Run results are as follows:

HSW RUN Sr-5

	Feed	Product 1st Cycle	Product 2nd Cycle(a)	Waste 1st Cycle	Waste 2nd Cycle
			Kilocuries		
Sr-90	193	191	175	6.7	12
Ce-144	2760	13	1.3	3010(b)	23
Zr-Nb-95	35	< 0.15	0.004	40	≤ 0.4
Ru-106	≤ 11	≤ 0.82	< 0.001	≤ 10	< 0.7
			Grams		
Sr(c)	2410	2390	2190	-	-
Ca	2240	120	43	-	-
Ba	450 to 900	400	36	-	-
			Cumulative Decontamination Factors		
Ce-144	-	210	2170		
Zr-Nb-95	-	< 290	1.1×10^4		
Ru-106	-	≤ 13	$< 7 \times 10^3$		
Ba	-	1.1 to 2.3	12×23	-	-
Ca	[redacted]	19	47	-	-

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Notes: (a) Dilute nitric acid was used as the strip vice 1 M citric acid used in the first cycle.
(b) 914 kilocuries of Ce-144 and 5.3 kilocuries of Pm-147 were found in the organic waste. This represents about 33 percent of the Ce and 2 percent of the Pm entering the process.
(c) Sr-90 was analyzed as 56.8 atom percent.

At month's end the first loading of the HAPO-IIA Strontium Carbonate Slurry Filter Cask is underway.

Cerium Decontamination in the Strontium Product Precipitation Step - The solvent extraction product from the second Hot Semiworks run is within specifications except for cerium. An additional cerium decontamination factor of six to eight is needed. Studies have been made in the laboratory and in the pilot plant to see if the additional decontamination could be obtained during strontium carbonate precipitation or by the prior precipitation of cerium.

Addition of citric acid or EDTA to the solution (to complex cerium) in concentration ranging from 10^{-5} to 0.1 M produced essentially no cerium decontamination during the carbonate precipitation. Similarly, addition of DTPA produced some cerium decontamination (maximum DF of 4 at 0.05 M DTPA) but not enough to be practical. Adjusting the pH up or down and redigesting following the strontium carbonate precipitation did not improve the decontamination. Washing the strontium carbonate precipitate with a DTPA solution adjusted to pH 7 produced little cerium decontamination but did dissolve some strontium.

Laboratory tests showed that cerium hydroxide can be precipitated from the solution without appreciable loss of strontium provided the pH is not above 12. Addition of iron(III) or inert cerium in concentrations of 10^{-4} to 10^{-3} M provides a carrier precipitate. Cerium decontamination factors of 20-50 are readily obtained. The precipitate is readily filterable on filter paper.

In the pilot plant two filtration runs were made to investigate potential methods for removal of cerium from Hot Semiworks IXPC strontium-90 product. In the first test, synthetic IXPC was adjusted to 2×10^{-3} M cerium and pH 11.2 (to precipitate cerous hydroxide) and filtered on sintered stainless steel and Fiberglas cartridge type filters. The 35 micron mean pore size sintered stainless blinded rapidly; whereas visually satisfactory filtration was obtained on the 30 micron rated Fiberglas cartridge.

Precipitation and subsequent filtration of 5×10^{-4} M ferric hydroxide was also tested in the pilot plant and the filtration found to be slower than in the case of cerous hydroxide.

Decantation of supernate from a settled cerous hydroxide precipitate was satisfactory, provided a ten percent heel is allowed to remain in the vessel.

Laboratory observations have shown that yttrium, which grows into separated Sr-89 - Sr-90 on standing, precipitates quantitatively with strontium carbonate and is not removed in washing the precipitate.

Comparison of EDTA and DTPA as Complexants - Batch contact studies were made to compare diethylenetriamine pentaacetic acid (DTPA) to ethylenediamine tetraacetuc acud (EDTA) as a complexing agent to prevent

extraction of iron, lead, barium and rare earths in the 1A column of the HSW solvent extraction flowsheet. Conditions for the contacts were carefully chosen to maintain equivalent solvent loading to permit direct comparison of the two reagents. Cerium and strontium distribution coefficients (K_d's) were obtained over a pH range of from four to 4.75. The extraction of strontium was nearly the same with the two reagents and varied only moderately with pH. Values for the K_d's all fell in the range 25 to 55. Cerium extraction was markedly less with DTPA than with EDTA. For instance, the K_d at pH 4.75 was 0.65 with EDTA and 0.009 with DTPA. These data indicate a significant improvement in cerium decontamination should be obtained by using DTPA instead of EDTA. Similar distribution data for iron and lead are being obtained.

Solvent Clean-Up Studies - The same batch of solvent (0.4 M D2EHPA - 0.2 M TBP - Shell Spray Base) was used for both runs made to date in the Hot Semiworks. Following the second run, the solvent contained a high concentration of cerium (ca. 200 curies/l.). A column wash of the solvent with alkaline EDTA solution reduced the cerium to ca. 10-20 curies/l. Samples of the partially washed solvent were used in laboratory scale studies to determine effectiveness of other washing agents. Batch contacts involving equal volumes of the solvent and washing solution were made. Reagents tested included nitric, oxalic, tartaric, phosphoric, acetic and citric acids; EDTA and DTPA; ammonium fluoride, hydrogen peroxide, hydrazine and hydrogen peroxide. In some cases the reagents were made alkaline and in others combinations of the reagents were used. Analytical results are not yet available for all of these experiments. The most promising reagents among those for which data are available are oxalic acid and combinations of acetic acid with DTPA or EDTA made neutral to alkaline with sodium hydroxide. In one experiment in which the solvent was washed successively with sodium acetate - DTPA, nitric acid, and alkaline tartrate the gross gamma activity was reduced from an initial 1090 μc/ml to a final 0.1 μc/ml. These data indicate that the HSW solvent can be cleaned-up adequately for disposal and probably for sustained recycle.

Mini-Mixer Settler Runs with Crude Cut Feed - Analytical data for the third mini-mixer-settler run made in the cubicle at 222-S are now complete. The crude cut sample used came from material which had been stored in the 003 vault and later concentrated in F-8. It had a somewhat different composition than crude cut material used in previous mini runs; it was considerably more concentrated in iron and lead. Hydraulic performance of the mini was excellent. Cerium decontamination in the extraction column (1A) was lower (DF = 2.6) than in a previous run (DF = 15) under similar conditions. This may have been due to inadequate EDTA in the feed to complex cerium in the presence of the greater amounts of iron and lead. Strontium loss to the 1AW was about 1.5 percent. Cerium decontamination in the partition or strip column (1B) was good (DF = 45) and strontium loss to the 1BW was about 3.5 percent.

Corrosion Tests on Resin Wastes - Samples of Dowex-50 resins in contact with aqueous solutions adjusted to a given initial pH were exposed to Co-60 gamma radiation. The solution volume in contact with the resins was about 40 percent greater than the void volume of the settled resin. One set of samples was adjusted to pH 3.82 with nitric acid and another to pH 12.9 with sodium hydroxide. The pH of both types of samples dropped with increased radiation; the pH of the samples initially alkaline was down to about two after an exposure of approximately 7×10^8 R.

Corrosion rates were determined for 1020 mild steel exposed to simulated HSW waste from strontium recovery operations. Liquid phase corrosion rates (at 80 C and boiling) were less than 0.1 mil/m in highly alkaline wastes (pH 11.2). However, in simulated wastes at pH 7, the liquid phase rate at 80 C was 5.6 mils/mo. In another test, the waste was made 0.25 M in sodium carbonate and adjusted to pH 7 (simulating reduction of pH of an alkaline waste by generation of carbon dioxide). Corrosion of 1020 steel in this waste at 80 C was 10 mils/mo. These results emphasize the need to keep these wastes strongly alkaline to counteract possible reduction of pH due to radiolytic decomposition of organic material present.

325-A Strontium Purification - The seventh and final strontium purification run was successfully completed with recovery of 16,500 ± 500 curies of purified strontium-90, for an overall yield of over 90 percent. Purity is expected to be fully as high as previous ion-exchange product, which well exceeded the customer's specifications. Run 7 brings the total purified product recovered in 325-A to somewhat over 72,000 curies, compared with a commitment of 60,000 curies. At month's end loading of the HAPO-IA Decalso cask with the combined 27,100 curies from runs 6 and 7 was in progress for shipment in July. This concludes the 325-A strontium recovery program. A series of runs, aimed at demonstrating flowsheets for the recovery of promethium and technetium, are now scheduled prior to removal of the in-cell ion exchange equipment.

Strontium-Decalso Shipment - Because of the pressure build-up experienced in the last HAPO-IA shipment, experiments were performed to determine the feasibility of shipping in a "dry" condition; i.e., with most of the interstitial liquid siphoned out. This would have the dual advantages of increasing the void volume in which gas can collect (from about one gallon to six gallons) and at the same time reduce the rate of gas production. The result should be to decrease the rate of pressurization to a negligible value. To determine whether strontium shipped in this manner could be satisfactorily eluted, samples of Decalso were loaded with strontium, heated to simulate the worst possible conditions expected during shipment, and then eluted with four molar ammonium nitrate. When heated for one week at 86 C, the maximum calculated temperature which would be achieved in dry shipment with an air atmosphere, 83 percent of the strontium was recovered from moist Decalso (sealed container) and 78 percent from truly dry Decalso (open container) - compared with 91 percent from an unheated control (submerged in distilled water at ambient temperature for the same period of time). Drying for three days at 110 C, well above the expected temperature, reduced the fraction eluted to 60 percent; however, eluting at 80 C increased the recovery to 94 percent, in agreement with ORNL data. It was concluded that the proposed "dry" shipment is satisfactory, provided a heated elutriant is used at ORNL. Discussions with ORNL personnel indicate such a high temperature elution procedure can be undertaken.

Sequential Coulometric Titration of Copper and Iron - Reductions of 30 percent and 50 percent in analysis time and radiation exposure were realized in the measurement of copper and iron impurities in strontium product solutions. Simultaneous reduction to Cu^{+1} and Fe^{+2} was effected at +0.0 volt in molar hydrochloric acid using a platinum gauze electrode. The metals were measured by subsequent oxidation to Cu^{+2} at +0.33 volt and to Fe^{+3} at +0.62 volt. Normally copper is measured in sulfuric acid.

Other Fission Product Development Studies

Bulk Fission Product Packaging - Studies of equipment needs for strontium oxide packaging continued. Full scale tests were conducted on various filter designs to determine their potential value for use in SrO_2 prefiltration and wash operations. Filters were evaluated according to (a) the degree to which the precipitate was transferred to and retained on the filter, and (b) the difficulty encountered in cake removal. Best performance was obtained with a cylindrical, 1-1/4 inch diameter filter installed vertically within an open bottom, cylindrical non-porous shroud. With this arrangement, the liquid level in the precipitator-wash tank was reduced to the level of the bottom of the shroud. Cake removal was readily accomplished by re-submergence or by external spray-down. Backflushing of the prefilter was unsuccessful.

Several fission product intermediates have been calcined in thermal balance equipment. Strontium hydroxide is converted to the oxide at 550 C in an inert sweep gas whereas a temperature of 800 C is required for conversion in a stagnant inert atmosphere. Strontium carbonate pyrolysis required a 900 C temperature for conversion in a sweep gas versus 1300 C in still atmosphere.

A sample of strontium oxide exposed to atmosphere for three months absorbed water to ten percent of its weight and CO_2 to five percent of its weight.

A mixture of 80 percent SrO_2 and 20 percent $Sr(OH)_2$ yielded a granular SrO powder on heating to 600 C in an inert sweep gas. The powder was lightly stuck to this crucible wall, but the mixed components had not melted or fused together.

Preliminary sketches were drawn of a proposed shipping canister. A 23-inch long, 4-inch schedule-80 pipe, internally finned container encases a 1-3/4 inch diameter cylindrical furnace welded stainless steel cloth filter. A metallic bell ring gasket seals the primary closure, deformable metal gaskets seal the process connections during loading, and the final seal is welded. Helium leak detection sensitive to 1×10^{-5} cc/sec is planned for inspection of all closures.

Cask Closure Development - Evaluation of the miniature Hanford connector (1-inch pipe size) has been completed with testing of a third connector at temperature to 550 C and pressures to 500 psig. Helium leakage rate was less than 5×10^{-4} cc/sec in all cases. In other tests the miniature connector was vibrated from 7 to 450 cycles per second at 0.85 to 1.5 g, comparable to normal shock experienced in railroad shipment. No increase in leakage rate was found following vibration.

In other closure development studies, a Natorq Union Seal (Navan Products, Inc.) of 303 stainless steel confined 470 F steam for 45 days at 500 psig with a steam leakage rate of 7.6×10^{-7} grams/sec.

A 2-3/4 inch stainless steel O-ring was hydrostatically tested in a V-groove at a total flange pressure of 3200 lb. Leakage occurred at pressures over 100 psig.

Two 1-1/2 inch tube size, temperature compensating couplings (DSD Mfg. Co) using stainless steel O-rings in V-grooves were tested for leakage at pressures up to 500 psig and at temperatures of 20 to 550 C. In both cases, helium leakage at a rate of 1×10^{-3} cc/sec developed on cooling below 200 C.

Fission Product Glasses - A series of additional high borate strontium glasses were prepared to determine the effect of larger additions of alumina (cf. May 1961 report,. Melting point and pour temperature were decreased and "glassiness" increased by this change; however, the solubility was not improved.

In other experiments, several cesium phosphate glasses were made containing 50 to 59 weight percent cesium. These are dense, glassy and readily cast but are quite water soluble. Approximately 22 percent of the 50 percent glass dissolved in boiling water while the 59 percent formulation was actually deliquescent. However, glasses of this type might be satisfactory for use in sealed sources, where the container serves as the barrier to prevent contact with water.

Hazards in Shipping Cesium-137 - Experiments were performed to study the leaching of radiocesium from a synthetic zeolite following a hypothetical shipping accident in which the adsorption bed loaded with cesium is immersed in a river. Thin beds leached at a high flow rate were used to simulate the diffusion-controlled process expected in the case of a zeolite bed distributed over the bottom of a shallow stream. Water simulating that in a mid-West river gave an initial elution rate of about four percent per hour, decreasing to about three percent per hour after three hours. These results are known to be high because of the Ba-137 daughter which interfered with measurements of cesium elution.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

Coulometric Titration of Gold

Gold in Au-Al alloys was measured by dissolving in aqua regia, removing the nitric acid, and reducing to the metal at +0.45 volt in molar hydrochloric acid. The metal, which plated on the platinum electrode, was subsequently removed by oxidizing at +0.8 volt. A precision of +1.5 percent was observed when titrating 0.2 mg of gold. About 0.03 mg appeared to be the lower limit of detection.

EQUIPMENT AND MATERIALS

Pump, Agitator and Valve Development

Electrical failure of the drive motor has interrupted test of a United Shoe Machinery Co. harmonic drive valve. Operation prior to failure was smooth and uneventful for 2500 on-off cycles.

Failure of the P-5 and P-7 Chempumps in Hot Semiworks has been traced to dry operation caused by blocking of the lubrication lines by dirt. These pumps were modified older models and were not provided with screens for preliminary separation of gross particulate matter. A replacement Chempump is currently being equipped with a screen, tapered bearings and a hydroclone unit. In addition, a new vertical pump without process lubricated bearings has been designed with both pump and motor cantilevered on a common massive tapered shaft.

An in-tank, vane type air compressor providing motivating air for sparging critically safe vessels has been designed for use in 234-5 Building. The system permits sparging of the vessel without overloading the vessel vent system.

A candidate canyon service pump, a totally submersible 0.050 inch Hastelloy-C canned motor pump, has been received and placed on test.

REACTOR DEVELOPMENT - 04 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Salt Cycle Process

Electrochemical Studies - Chronopotentiometry continues to show promise as a means of studying electrochemical processes in molten salts. Even with the present crude apparatus it is found that the product (current density) x (transition time)$^{1/2}$ is linear with uranium(VI) concentration, as predicted by theory for a reversible reduction. Also, the estimated diffusion coefficient in NaCl-KCl for the reducible uranium(VI) species is 3×10^{-5} cm^2 sec^{-1}, which appears consistent with values of 0.6, 1.7, 2.6, and 3.5×10^{-5} cm^2 sec^{-1} reported for bismuth(III), cadmium(II), silver(I), and copper(I), respectively, in LiCl-KCl systems. The uranium(VI) value is as yet only an estimate because of uncertainty as to the true electrode area. This difficulty cannot be resolved until more refined equipment is received which will enable the electrode area to be measured by electrical means.

Exploratory studies show the KCl-$MgCl_2$ system to be a potentially useful lower-melting salt system. Electrodeposition behavior of UO_2 at 550 C is generally similar to that in NaCl-KCl at 700 to 800 C. Current efficiencies are in the range of 50 percent for "partition" conditions and 100 percent for "co-deposition" conditions. The deposits exhibit O/U ratios of 2.02 and less. Cerium behavior in this system is different, however. Under "co-deposition" conditions, cerium decontamination factors are about 1.3, as in NaCl-KCl at 700 C. Attempted "partition" depositions yield cerium decontamination factors of only 3 to 7, vice about 150 at higher temperature in the NaCl-KCl system. In view of the striking similarity in behavior of cerium and plutonium in the NaCl-KCl system, it is felt that studies of cerium and plutonium behavior over the wider temperature range accessible with KCl-$MgCl_2$ should prove informative.

Studies of KCl-$PbCl_2$ Systems - Exhaustive drying of the melt appears to be the most critical variable yet found in producing large, well-formed grains of UO_2 by electrolysis in these systems. Following a 24 hour chlorine sparge drying treatment, electrolyses under a wide range of conditions produced coarse-grained deposits in either 2.5 KCl-$PbCl_2$ or in 3 KCl-$PbCl_2$. Conditions tested included cathode potentials (against a Ag/AgCl (1 molal), KCl, $PbCl_2$ reference) of -0.4 and -0.5 volts, temperatures of 520 and 580 C, cathode areas of about 12 mm^2 to about 400 mm^2, and current densities of about 0.6 amp/cm^2 to about 2 amps/cm^2. This represents the first time a coarse-grained deposit had been achieved at temperatures as high as 580 C.

The absence of gross amounts of agents which can promote redissolution of UO_2 is also apparently desirable for production of coarse-grained powders. A prolonged electrodeposition out of 3 KCl-$PbCl_2$ to which had been added 1 m/o TlCl resulted in a net current efficiency of 23 percent and a very fine-grained deposit. The thallous/thallic couple is, of course, a catalytic dissolving agent for UO_2, and it had been thought that use of this couple during electrolysis might yield smooth surfaced grains via polishing action. However, the deposit produced had a badly corroded appearance, and it is obvious that the redissolution rate must be markedly reduced to achieve any such beneficial effects.

Manner of Growth of Electrolytic UO_2 - Time lapse infra-red photography proves to be a very useful tool for following the accumulation of UO_2 on a cathode during electrolysis. Studies to date in the NaCl-KCl system indicate that few new crystals are initiated after the first few minutes of the deposition. Rather, the deposits tend to grow uniformly with little change in surface irregularities after the initial stages of deposition. In an experiment employing a dry air atmosphere the deposit consisted of fluted spear point grains. The leading edges of these appeared to grow quite rapidly while the sides grew very slowly, if at all.

Growth of Self-Supporting UO_2 Ceramics - Growth of void-free polycrystalline deposits appears to be primarily a matter of achieving a correct balance between parameters which control the deposition and redissolution rates for UO_2. Parameters which are critical in determining deposition rate are the expected electrical variables and the oxygen content of the sparge gas. Parameters which are apparently critical in determining redissolution rate are the hydrogen chloride content of the sparge gas and temperature. Inclusion of oxygen in the sparge is necessary to avoid conversion of the electrolytically reducible uranyl species to soluble reduced species, e.g., uranium(IV), by chemical processes such as the reaction

$$UO_2Cl_2(sol'n) + C(s) + Cl_2(g) \longrightarrow UCl_4(sol'n) + CO_2(g)$$

which occurs at the graphite anode. Inclusion of a dissolving agent such as hydrogen chloride is apparently necessary and may avoid rampant, erratic growth by redissolving new crystallites at an embryonic stage. Experimental observations to date are in keeping with these suppositions. Dense, void-free deposits are obtained with an HCl/air ratio of about 10/1 and a current density of 0.04 to 0.2 amps/cm^2 at 740 C in NaCl-KCl. Higher current densities yield larger void volumes while those near the stated maximum yield coarser grained deposits with irregular surfaces. Current densities near the stated minimum yield a fine-grained deposit with a "glazed" surface while current densities below this minimum yield negligible net deposition.

Plutonium Behavior in NaCl-KCl - X-ray diffraction patterns for "co-deposits" made out of melts in which the U/Pu ratios were 10/1 and 15/1 show these deposits to be of the mixed crystal type rather than a solid solution of PuO_2 in UO_2.

Engineering Development - Development of techniques for production of electrolytic UO_2 from the $PbCl_2$ - 2.5 KCl molten salt system was continued in the 20 liter pilot plant unit. Two runs were made with a 1.5 inch diameter graphite cathode and a 6-inch inside diameter annular graphite anode to test operation with potential control by a reference electrode system, improved over that reported last month (see HW-69822C, p. C-18). The reference electrode consisted of a silver wire inserted into a solution of 1 M AgCl in equimolal $PbCl_2$-KCl contained in a Pyrex tube. It was placed near the cathode in the molten salt and the cathode was maintained at 500 mv oxidation potential by a rectifier control system. The control system worked very well, providing close control of the cathode to solution potential. Partial freezing of the melt during an overnight run caused some disturbance in the electrolysis but did not affect the voltage control system operation.

A third run was made with a 6-inch x 1/2-inch x 36-inch Hastelloy D cathode. The electrolysis potential was controlled by the reference electrode method and a temperature controller was used to prevent the melt from freezing. The electrolysis was accomplished without incident but a finer-than-usual, dendritic product was obtained, probably due to a low current density. No tendency of the Hastelloy D electrode to warp or crack was observed.

Upon completion of the three runs, the molten $PbCl_2$ - 2.5 KCl salt and residual uranium were vacuum transferred to another crucible. This was the first demonstration that the heavier melt could be handled in the same way as the NaCl-KCl molten salt. A sample of a black sludge which remained in the original crucible has been submitted for analysis.

Induction Heating Control System - An automatic control system is being designed for use in controlling the temperature of a fused salt crucible in an induction heating coil. This appears to be an ideal application for solid state silicon controlled rectifiers (SCR's) as the power amplifying control devices with either a thermistor or resistance bulb bridge circuit as the feedback control for the SCR's.

Materials of Construction - Two more experimental alloys from Battelle Memorial Institute as well as samples of Dura-Nickel and Perma-Nickel were exposed to hydrogen chloride sparged equimolar NaCl-KCl melt at 800 C. All corroded at rates in excess of 100 mils/mo. A sample of 87 percent Ni - 13 percent Al alloy was exposed to the NaCl-KCl melt at 800 C alternately sparged with hydrogen chloride and water-saturated air. The sample corroded at about 0.04 mil/mo. Metallographic examination showed the alloy is a two-phase system and the minor phase is the one attacked. Other experimental alloys to be received from BMI will contain less aluminum which should produce a more nearly single-phase alloy.

Ion Exchange Contactor Development

A screened piston to operate on a 4-inch Plexiglas cylinder was fabricated to study the nature of countercurrent flow of solid and liquid phases. Initial experiments on 20-40 mesh resin in water tend to confirm the practicability of simultaneous countercurrent flows of solid and liquid phases under non-pulsing conditions. Water was pumped countercurrent to the resin up to a velocity of 890 ml/min through a plug of resin 8-inches long. The average resin movement was about 170 ml/min. The problems of smooth and reproducible flow under pulsing conditions remains to be solved.

PRTR Studies

Studies of the radiation chemistry of the halogenated hydrocarbons ($CHClF_2$ and CCl_2F_2) used in pressure testing the PRTR were undertaken in an effort to identify the source of chloride and fluoride ions found in the water. It was found that 10^5 rads from the cobalt-60 source would decompose 10 to 30 percent of these halogenated hydrocarbons in D_2O solution. Because of this rapid rate of radiolysis and the low solubility of this material in the water, all of the dissolved hydrocarbons would be readily decomposed in one day at 1 MW operating power level. The decomposition of about 30 pounds of this material would yield the amounts of chloride and fluoride found in the primary coolant following the initial run. At least this much material was added during pressure testing. Radiolysis of these materials also increases the acidity, a phenomenon observed during the reactor operation. Since this acidity change occurred over several weeks, it appears likely that the source of the acidity (and probably the chloride and fluoride ions) continued to enter the reactor system during this period.

The source of the chloride and fluoride ions in the PRTR during the first run have not been definitely determined but the above circumstantial evidence indicates that

it could have been the "Genetron" refrigerants used in pressure testing. Although no Genetron was observed in reactor samples, this could be explained on the basis of the rapid radiolysis of these materials.

Measurement of Chloride in PRTR Coolant

Total chlorine in the primary coolant was found to be 0.1 and 0.2 ppm by activation analysis. Samples of the coolant plus standard HCl were irradiated for ~1 hour in the 100-KE "Quickie" facility. The resultant Cl-38 found was determined by measurement of its 2.1 Mev gamma ray.

RADIOACTIVE RESIDUE FIXATION

Mineral Reactions

A clinoptilolite bed loaded with cesium from a high-sodium solution was eluted with ammonium nitrate. Elution curves for sodium and cesium indicate that the sodium was removed first, being essentially all eluted with the initial ten percent of the cesium. Thus, it is possible to obtain a sodium-free solution of cesium and ammonia by discarding the first eluate. Ammonium salts can later be removed to leave relatively salt-free radiocesium.

A very high cesium capacity was exhibited by a column of phenolic resin receiving a simulated Purex high-level waste supernatant solution. After passage of 75 bed volumes, a cesium breakthrough of only 0.5 percent was achieved. A DF of greater than 10^4 was obtained for the first 40 bed volumes. No dilution of the waste was required, but the OH^- concentration was increased to 2.8 M. The column is being operated at a low flow rate to obtain this high capacity with a column residence time exceeding two hours.

Column experiments were performed to study the improved cesium adsorption of clinoptilolite upon heating. The column results confirmed the improvement previously observed with equilibrium experiments. Clinoptilolite heated at 400 C for four hours was compared with untreated mineral. While no increase in the total adsorption capacity of the mineral was obtained, the heat treated sample had a significantly increased selectivity for cesium. In the case of 1.0 M sodium nitrate solutions traced with Cs-137 the column of treated mineral exhibited twice the cesium capacity of untreated clinoptilolite.

The relative effect of flow rate and dilution on the clinoptilolite adsorption of cesium from simulated Purex waste tank supernatant solution was studied. Four column experiments were performed at four different dilutions and flow rates adjusted to provide the same rate of high-level waste throughput in each case. Although the slope of the breakthrough curves decreased with increasing flow rate, the cesium capacities of the beds, as indicated by the 50 percent breakthrough points, remained nearly constant. The column with the highest flow rate showed a slight reduction (about 5 percent) in cesium capacity. The results indicate that reduced flow rates may be substituted for dilution to achieve maximum adsorption capacity from such wastes.

Pyrochemical Reactions

Scouting experiments were initiated to examine possible pyrochemical fixation reactions. The systems studied involve a metal and a salt intimately mixed and

heated. The reported formation of stable solids from metal-tungstic oxide systems exemplify the type of reactions sought. Initial experiments were performed with molten zinc and the sulfates of barium, iron, potassium, cerium, nickel, and chromium at 500 C. No reactions of interest were obtained.

Condensate Wastes

The effect of dilute ammonium ion on the cesium capacity of Decalso was measured. This zeolite is as effective for adsorbing trace concentrations of Cs-137 as is clinoptilolite when the ammonium ion concentration is below 5×10^{-4} M. Although clinoptilolite is more selective for cesium than is Decalso, the greater ion exchange capacity of the synthetic zeolite attains significance when the competing ion concentration becomes quite small.

Research continued on methods for removing interfering organic residues and ammonia from boiling high-level waste tank condensates prior to radioisotope removal with exchange materials. The 271-CR experimental steam stripper was operated for 500 hours with Purex Tank Farm radioactive condensate waste fuel containing 130 ppm ammonia, 150 ppm butyl phosphates and 35 ppm hydrocarbons. With a boil-off rate of about 5 to 7 percent of the feed rate, the stripper is effective in reducing the ammonia to 5 ppm, the butyl phosphates to 1 ppm and hydrocarbons to 5 ppm. Iodine is the significant radioisotope which remains with the overhead stream and it is present in concentrations of about its MPC_w. Although some ruthenium can be detected in the overhead stream it is present in concentrations less than 10 percent of its MPC_w. The remaining ruthenium and the radioisotopes of strontium, cerium, zirconium, niobium and cesium are found in the stripper bottom stream. This stream was further treated by passage through activated carbon to reduce the residual organic. Over 8000 column volumes of this waste has been passed through a cation exchange resin (Amberlite IR-120) in the hydrogen form. Based on preliminary analytical results, strontium, cerium, zirconium and niobium radioisotopes were always present in the effluent in concentrations less than 10 percent of their MPC_w. Cesium was present in concentrations less than 10 percent of its MPC_w for the first 5600 column volumes of effluent. Ruthenium was present in the column effluent in concentrations ranging from about 10 percent of its MPC_w initially to about the MPC_w when 800 column volumes had passed through the column.

Ruthenium Tetroxide Studies

Additional experiments were performed on the removal of ruthenium from a gas stream with silica gel. Decontamination factors in the range 8×10^3 to 10^5 were obtained with a bed of Sargent silica gel, and the ruthenium was adsorbed as a tight band, which turned black (presumably due to reduction to RuO_2 in situ). Similar experiments with a washed Davison silica gel gave quite different results. The adsorbed ruthenium was yellow in color and migrated through the bed on subsequent use. The initial decontamination factor was 1.7×10^3 and this dropped to the range 22 to 47 when the bed was used again after standing one week. It is evident that migration of RuO_4 may limit the utility of silica gel beds.

In the experimental setup, the ruthenium which passes through the silica gel is trapped for analysis in a two-stage bubbler containing sodium hydroxide and hypochlorite. The first bubbler removed almost all of the activity, decontamination factors with fresh solution being greater than 3×10^4 and dropping to 670 as the activity built up. These results suggest that a properly designed scrubber might be quite effective in removing ruthenium from calciner off-gas, certainly in conjunction with silica gel sorption.

Radiant Heat Spray Calcination

Construction of the in-cell calciner and its associated equipment is progressing satisfactorily. Following completion of all of the components, the unit will be assembled and cold-tested prior to installation in cell A of the 325-A Building.

In related studies, experiments continued on the cataphoretic scrubber. Substitution of a corona discharge tube for a wire point arrangement gave inconclusive results, suggesting that either the particles were not becoming charged or that they were being discharged before they reached the scrubber.

A Haupin-type thermal conductivity apparatus was assembled and calibrated with sodium chloride. Results agreed within two percent with accepted values. A determination takes only ten minutes after the sample is prepared. The apparatus should be of value in determining the thermal conductivity of calcined wastes.

BIOLOGY AND MEDICINE - 06 PROGRAM

Geology and Hydrology

The temperature of water in Hanford wells was measured with a thermistor probe. When complete, the measurements will provide information concerning areas of recharge of thermally warm plant effluents. Temperature profiles were also obtained by measuring the temperature at various depths below the groundwater surface. A geothermal gradient of about one degree F temperature increase per 60 feet of depth was found, which agrees with that found in the exploratory deep-well constructed on Rattlesnake Mountain.

In some cases a uniform temperature profile was observed and ascribed to vertical mixing of water in the well. Thermally hot plant effluents can be traced several miles from their source by temperature measurements. North of Gable Mountain channels of water 6-7 F colder than in surrounding wells probably reflect recharge of cold river water in the erosional channels previously studied.

Basalt, in the vicinity of the Separations areas, was determined to lie relatively close to the groundwater over a larger area than previously believed. Well 299-E34-1, the first well completed on Project CAH-921, encountered basalt more than thirty feet higher than predicted, and less than ten feet below the groundwater table. Relatively impermeable basalt in this area is now known to lie so near the groundwater table as to directly affect groundwater flow directions over an area of more than five square miles. Detailed delineation of the basalt surface accordingly is highly desirable.

Soil Chemistry and Geochemistry

Measurements of strontium removed by zeolites from multi-cation systems were treated statistically to obtain linear regression coefficients. These coefficients enable the investigator to compute the effect on strontium removal of each system variable within the range studied.

The regression equation obtained from the clinoptilolite experiments is:

$$Y = 0.1069 + 0.1526\,a + 0.2725\,b - 0.0222\,c + 0.0792\,d$$

where

Y = strontium C/C_o
a = calcium ion molarity (0.0 - 0.2 M)
b = potassium ion molarity (0.0 - 0.2 M)
c = residence time in minutes (1.01 to 5.02 min)
d = sodium ion molarity (0.0 - 1.0 M)

The strontium breakthrough points calculated by this equation correlate very well the measured values.

Experiments were performed to study the ability of various sulfide minerals to adsorb ruthenium from solution. The minerals studied were pyrite (FeS_2), chalcopyrite (Cu, FeS_2), galena (PbS), Sphalerite (ZnS), Stibnite (Sb_2S_3), and arsenopyrite (FeAsS). Equilibrium experiments with 10^{-2} to 10^{-4} M ruthenium at pH 2.5 gave no evidence of significant adsorption with any of these minerals.

Field Apparatus Development

The thermistor probe for in-well groundwater temperature measurement was completed and given extensive field tests. Satisfactory performance in routine measurements was experienced. A small pressure coefficient, equivalent to + 0.005 C per 75 psi was measured.

W. H. Reas

Manager
Chemical Research and Development

WH Reas:cf

BIOLOGY LABORATORY

A. ORGANIZATION AND PERSONNEL

Dr. M. F. Sullivan started a one-year leave of absence to accept a National Institute of Health Fellowship to do research work under Dr. R. H. Mole of the Medical Research Council, Harwell, England.

Dr. R. A. Hennacy resigned from the Pharmacology Operation to accept a position and study in the Physiology Department at the University of Washington.

Dr. Ahmet Noyan of the University of Ankara, Turkey, arrived for a one-year assignment in Biology. He is the first I.A.E.A. Fellow to be assigned to Hanford. He will be performing research mostly with the Experimental Animal Farm and Pharmacology Operations.

Dr. James Park from the University of Ohio joined the Pharmacology Operation.

Four summer employees were assigned to Biology during June:

George S. Rhyneer, University of Chicago Medical School - to be with the Experimental Animal Farm and Pharmacology.
Beatrice J. McClanahan, Washington State University (on leave of absence from Biology) - Experimental Animal Farm.
Patricia L. Hackett, Washington State University (on leave of absence from Biology) - Metabolism Operation.
Keith R. Price, Washington State University - Plant Nutrition and Microbiology Operation.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 02 PROGRAM

Effect of Reactor Effluent on Aquatic Organisms

The fabrication of the hydraulic test flume proper is completed, but not the installation. Installation should be completed in July.

C. columnaris

Continued checking of the survival curves and relating them to virulence has so far shown no instance of an avirulent form which was not haploid. Highly virulent strains likewise are uniformly diploid. Strains of columnaris which show moderate virulence show in some instances a survival curve which is typical of the haploid and in other instances a survival curve typical of the diploid.

Fish which were grown in the presence of reactor effluent treated by aluminum turnings showed the same susceptibility to acute exposures to columnaris as did fish grown in untreated effluent.

Population Dynamics - Waterfowl

Banding of Great Basin Canada geese in cooperation with the Washington Department of Game was conducted on the Hanford Reservation. Approximately 120 geese, young and adults, flightless due to moulting, were banded.

BIOLOGY AND MEDICINE - 06 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Deuterium

A yeast culture which was cultured in D_2O showed a distinct pink pigmentation. This pink color is reminiscent of an adenine deficiency known to occur in these yeasts, but this seems unlikely in the present case since adenine is not present in the medium. It appears that an unusual mutant type has been produced and it will be extremely interesting to determine whether this mutation is characteristic of deuterium treatment or merely a random mutation event.

Initial studies on the radiation sensitivity of deuterated haploid yeast showed that these cells were more than twice as resistant to X-ray inactivation than were cells of the same strain which had been cultured and irradiated in ordinary H_2O.

Preliminary studies with Tradescantia meiotic cells exposed to D_2O for about eighteen hours show an exceptional number of aberrant divisions in which there are a variety of chromosome abnormalities. These results suggest an effect on the interchromatid binding, supposed to be due to hydrogen bonding, and might lead to a clarification of the problem of chromosome interaction within the cell.

Strontium-Calcium

Experiments with intact plants had previously shown that strontium accumulated in higher parts of the plant at a more rapid rate than did calcium immediately after exposure of the plants to the elements in the root environment. To extend these results and determine whether this discrimination was the consequence of ion movement in the transpiration stream or ion movement through root transport mechanisms, plants were topped, and the exudate examined over the first twenty-four hours. The exudate contained an excess of the labeled strontium over the labeled calcium during the first three hours and thereafter calcium became more concentrated in the exudate. These results are in accord with the previous work with intact plants and show that the processes involved are independent of the foliar portion of the plant.

The effect of dinitrophenol on calcium and water uptake by roots was likewise checked by cutting the stems of beans and replacing the suction normally applied by evaporation from the leaves by a suction of 11 cm of mercury. Previous work had shown that the DNP rapidly closed the stomatal openings on leaves and thus modified the tension placed on the root system. In the present experiments the DNP decreased calcium uptake into the exuded water over the first twelve hours and increased calcium uptake during the following

twelve hours. Water uptake was similarly depressed during the first twelve hours and increased during the last twelve hours of the experiment. From this it appears that the barrier affect of the root is increased at first, but then decreased with prolonged exposure to DNP.

The results of radioanalysis of trout which survived for varying numbers of weeks after 21 weeks (five days per week) oral administration of Sr^{90}-Y^{90} are summarized below:

	Treatment: Low level, 5×10^{-3} μc/g fish per day		Medium level, 5×10^{-2} μc/g fish per day	
	Range	Mean	Range	Mean
Weeks lapsed from end of feeding	2-31	11	5-35	19
Total μc Sr^{90}-Y^{90} fed	89-170	130	750-1700	1200
Body burden μc Sr^{90}-Y^{90} in fish	8.3-31	16	170-300	240
Number of fish		6		7

Calculations show an average body burden of 12 per cent and 20 per cent of the total amount of isotope fed for low and medium level treatment, respectively.

Analysis of data from the radiochromate-tagged erythrocytes study in control and Sr^{90}-fed animals revealed that in both groups survival half time of tagged cells was 30 to 35 days. This observation appeared incompatible with the data on the radioiron studies in the same animals in that Fe^{59} disappeared from the plasma and appeared in the erythrocytes more rapidly in the animals fed 25 μc of Sr^{90} than in the controls. This suggested that erythrocytes were being formed more rapidly and conversely must be dying or destroyed at a more rapid rate in these animals if the erythrocyte population was to be maintained at the same level as control animals.

Several reasons were developed to explain this apparent inconsistency in the data. At this time the most logical explanation is that there is a skewed population of erythrocytes; that is, one where there is not a random distribution of red blood cells with respect to potential life span. If such a skewed population is tagged with radiochromate, the life span will be weighed for the long-lived components, since due to their longer life span there are relatively many more in the circulating blood than would be noted by their rate of formation if life span is not considered.

Iodine

Two ewes administered three mc of I^{131} three years ago are exhibiting a hypothyroid syndrome. The radiation dose to the thyroid was about 40,000 rads.

Following the administration of a tracer dose this month, the maximum thyroid uptake was less than eight per cent compared with a normal value of about 30 per cent.

Plutonium

A study of plutonium excretion into the intestine and the effect of DTPA on this excretion was completed in bile duct cannulated rats. Preliminary results were reported in May. The excretion of plutonium via the bile was clearly indicated as was the acceleration of this excretion with DTPA. It is not clear if these results indicate the normal proportion of biliary plutonium since surgical cannulation itself drastically affected urinary and fecal excretion. In a limited study employing intestinal perfusion techniques, DTPA increased plutonium excretion to the same extent in the perfused duodenum and jejunum but had no apparent effect on excretion into the ileum.

Transfer of Radionuclides to Milk

In order to determine the extent of transfer of various radionuclides from blood to milk, the following pilot study was performed:

	Radionuclides							
	P^{32}	I^{131}	Sr^{90}	Cs^{137}	Ce^{144}	Np^{237}	Pu^{239}	Am^{141}
Dose administered (μc)	100	25	125	200	1 mc	150	150	150
Route of administration	daily-oral				single-intravenous			
Number of ewes	1	2	2	2	2	2	2	2
Stage of lactation	early				late			
Length of study (days)	21	18,21	18,21	18,21	2,10	2,6	10	4

A total of seven ewes were utilized since some of the animals were given more than one radionuclide. The preliminary data indicates that about 15 per cent of orally administered cesium and 25 to 30 per cent of the orally administered iodine and phosphorus appears in the milk each day. It also appears that up to 50 per cent more radioiodine is secreted in the colostrum than in regular milk.

No untoward effects were observed in any of the experimental ewes except the two given neptunium. One of these ewes expired about 55 hours after the neptunium injection, manifesting lesions suggestive of a heavy metal toxicity. The other ewe administered neptunium was sacrificed on the sixth post-injection day after four days of refusing feed. No lesions were observed resembling a heavy metal toxicity. The dose of neptunium metal was about 3 mg/kg body weight. (Whether this dose of metal will produce a heavy metal poisoning would require a considerable number of test animals.)

Radioactive Particles

Studies of the effect of particle size on retention and translocation of inhaled $Pu^{239}O_2$ were continued in experiments with beagle dogs. Greater translocation is consistently seen after inhalation of particles with a mass median diameter of 3 μ and less than after inhalation of 4 μ particles.

In further studies of the acute effects of inhaled $Pu^{239}O_2$, one dog deposited about 700 μc, several times the level required to cause death at two months after exposure. Electrocardiograms and chest radiograms show no changes two weeks after exposure. The mechanism for the development of the lymphopenia observed in this and other dogs after inhalation of PuO_2 is being investigated.

Rats exposed to Np^{237} containing dust retained in the lung about 2 per cent of the total deposited Np^{237} three weeks after exposure. The rate of clearance via fecal excretion changed continuously during the three-week period. There was no appreciable accumulation of Np^{237} in tissues outside the respiratory and gastro-intestinal tract. In acute toxicity tests of the dust only three deaths in 14 rats occurred at the maximum level of exposure, deposition of about 200 picocuries in the lung (or about 1 mg of dust).

Microbiological Studies

A dose of 50 kr of X rays to growing cultures of B. cereus virtually stopped cell division. This same dose applied to cells entering sporulation did not stop the sporulation process, suggesting that sporulation and cell division are quite independent.

Effects of Radioactivity on Populations

Experimental lots of nine different life stages of flour beetles (Tribolium confusum) were exposed to a range of X-ray dosages to determine levels of radiation that produce sterility and lethality.

This study is preliminary to subsequent investigations on the effects of radiation upon population dynamics.

Plant Ecology

Previous studies have shown differences in the production of grass and its content of fallout radionuclides between burned and unburned areas on the Hanford Reservation. Studies in progress to evaluate environmental effects of burning have shown differences in the soil temperature (two inches below surface) of areas harvested by clipping and burning. Little temperature differentiation occurred among the plots during the winter. During the spring when air temperature changes were greater, the maximum and minimum soil temperatures were higher and lower, respectively, by 2 to 5 C for the burned plot than the clipped plot. This is attributed to removal of organic mulch by burning.

Project Chariot

The 1961 limnological and terrestrial field studies were started at Cape Thompson in Arctic Alaska by a field party of four. The field work will continue until freezeup in September.

Caribou are expected to contain higher levels of fallout radionuclides because of their consumption of lichens which contain highest levels of fallout material among the plants. Bone from twelve caribou collected during 1960 contained Sr^{90} levels ranging from 0.2 to 21 picocuries/g dry weight. Muscle from the same animals contained less than 0.06 picocuries/g dry weight. The Cs^{137} content of flesh averaged 1 to 33 picocuries/g dry weight.

Fish as Bio-Dosimeters

As a preliminary test, young rainbow trout fingerlings were subjected to

C. Lectures

a. Papers Presented at Meetings

W. J. Bair, "Effect of particle size and total dose on retention and translocation of inhaled plutonium," Health Physics Society Meeting, Las Vegas, Nevada, June 12-16, 1961.

W. J. Bair, "Translocation and excretion of inhaled $Ce^{144}O_2$ particles," (written by R. A. Hennacy) Health Physics Society Meeting, Las Vegas, Nevada, June 12-16, 1961.

D. A. Barber, "The effect of DNP on calcium accumulation and transpiration in barley seedlings," A.A.A.S. - American Society of Plant Physiology, Davis, California , June 20-22, 1961.

H. V. Koontz, "The accumulation of DNP and its effect on calcium uptake and transpiration," A.A.A.S. - American Society of Plant Physiology, Davis, California, June 20-22, 1961.

J. D. Stewart, "Effect of soil moisture on uptake and translocation of cesium-137 and potassium," A.A.A.S. - American Society of Plant Physiology, Davis, California, June 20-22, 1961.

F. P. Hungate, "Calcium-strontium discrimination in plants," A.A.A.S. - American Society of Plant Physiology, Davis, California, June 20-22, 1961 (senior authors - R. L. Uhler and O. Biddulph).

W. H. Rickard, "Vegetational analyses of a desert shrub community and their applications to radioecology," A.A.A.S., Western Section Ecological Society of America, Davis, California, June 21, 1961.

b. Seminars (Off-Site)

P. A. Olson, "Fish of the Columbia River," YMCA Day Camp, June 29, 1961.

c. Seminars (Biology)

R. T. O'Brien, "Biological effects of deuterium," June 7, 1961.

H. E. Erdman, "Oigins of life by spontaneous generation," June 7, 1961.

Kjell Johansen, Dept. of Zoology, University of Washington, Seattle (visiting scientist from Norway), "Cardiovascular physiology in lower vertebrates," June 26, 1961.

d. Miscellaneous

Radiation Biology Course, University of Washington - Richland Branch:
W. J. Bair - "Inhalation Problems," - June 6, 1961
R. C. Thompson - "Internal Emitters," - June 14, 1961

D. Publications

a. HW Documents

None

b. Open Literature

Bair, W. J. and B. J. McClanahan, "Plutonium inhalation studies. II. Excretion and translocation of inhaled $Pu^{239}O_2$ dust," Arch. Environ. Health 2, 648-655 (1961).

Watson, D. G., J. J. Davis and W. C. Hanson, "Zinc-65 in marine organisms along the Oregon and Washington coasts," Science 133, 1826-1828 (1961).

Smith, V. H., J. E. Ballou, W. J. Clarke, and R. C. Thompson, "Effectiveness of DTPA in removing plutonium from the pig," Proc. Soc. Expt. Biol. and Med. 107, 120-123 (1961).

OPERATIONS RESEARCH AND SYNTHESIS OPERATION
MONTHLY REPORT - JUNE, 1961

ORGANIZATION AND PERSONNEL

Mrs. Kathryn S. Scott terminated effective June 30, 1961, because of her husband's leaving the area.

OPERATIONS RESEARCH ACTIVITIES

Input - Output Model

The first draft of a report presenting simplified models of the HAPO learning process is nearly complete. Some difficulty has been experienced in trying to separate the various types of learning involved.

HAPO Criteria Study

A rough draft report was forwarded to interested parties for comment. Some comments have been received and appropriate revisions which will improve the clarity of the report and eliminate some of the objections have been made.

OPERATIONS ANALYSIS STUDIES

Fuel Element Performance

A trip was made, together with IPD personnel, to the uranium feed sites at Fernald and Mallinckrodt, and to the Savannah River reactor site, in order to discuss the data processing and statistical aspects of fuel element performance. As a result of this trip, steps are being taken to incorporate pertinent feed site data into the Hanford data processing system. This should lead to a determination of reasons for the nonrandomness of metal quality observed in the Quality Certification Program data.

The study concerned with describing fuel element distortion using orthogonal polynomials is continuing. Results to date indicate that this method will prove to be much more descriptive than the present method.

An in-reactor test was designed in which the main objective is to compare ingot with dingot metal, in both the rolled and extruded forms. The test will also enable a determination of the differences between ingots, between dingots, between bars within dingots, between process tubes, between positions within a process tube after correcting for power and temperature, and between reactors or sections within a reactor.

Optimization of Reactor Operations

Comments were given in connection with appropriate decision rules concerning actions to be taken when a situation is noted in a process tube front

face component which could lead to a tube melt-down. Specifically, the consequences of shutting down immediately to correct the situation were compared with the consequences of deferring action until the next outage.

Further nomographs were constructed for use in determining fuel element clip requirements using formulae previously developed.

Z Plant Information Systems Study

Considerable delay in compiling the 312 computer program was experienced the first week in June. Following the compilation, a subtle error was discovered on the computer during debugging activity. This required recompilation of the program. However, other minor flaws in the program requiring considerable computer console correction manipulation were discovered and corrected symbolically in the recompilation.

The computer operational date has been moved to August 1, 1961. This has been brought about by the computer program assembler faults, IBM 7090 down-time and corresponding backlog, and delay in obtaining and training personnel.

Reliability Studies

Work continued on the problem of designing a switch test program.

The Boolean Matrix approach to system reliability studies is being explored. Attention is being focused on the development of a technique which is readily adaptable to digital computer solution in a minimum number of operations. An extensive literature search is also in progress.

Diffusion Studies

An exhaustive literature search was completed on numerical methods for obtaining solutions to the unsteady state nonlinear diffusion equation. As a result, the best characteristics of several methods have been incorporated into a scheme which has exhibited considerable promise on small hand-computed test cases. A computer program is now being written so that the method can be tested on somewhat more realistic and practical problems.

Inventory Studies

The second annual inventory by sampling was conducted in Spare Parts inventory in May. Two problems arose in this year's inventory.

1. A large surplus was found in the category where line items supposedly had a value of zero. Inventorying a larger sample and a breakdown into unit value categories within the zero value line item category was recommended.

2. A good part of the deficit found in other categories turned out to be misplaced items found after the inventory. The question arose

as to whether these "found" items should be included in inventory calculations. These items will be reported both ways in this particular inventory to point out that the original deficit is conservative. However, it was recommended that in more mobile inventories, where goods can be more easily replaced, the results of the initial inventory be taken without correction.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Fuels Preparation Department

Data from a designed experiment conducted in the fuel element pilot plant were analyzed in order to arrive at an optimum set of canning conditions to use in the canning of six-inch I and E fuel elements.

Techniques were given for assigning uncertainty to an average texture coefficient (X-ray diffraction data) given values for samples within fuel element and measurements within samples. Procedures for minimizing this uncertainty at a given cost were also given.

Discussions were held with FPD and IPD personnel reviewing some of the production tests currently being readied for execution.

Irradiation Processing Department

The study to assess the feasibility of objectively monitoring electrical pulses showing power consumption in the 100 and 300 areas is continuing. Decision rules to use in deciding when additional power should be generated locally will be evaluated.

The differential equation system governing the time behavior of the helium concentration in a reactor atmosphere subject to feeding and bleeding were derived and closed-form solutions obtained hereto.

A complicated definite integral which arose in the course of a reactor engineering study was evaluated in terms of complete elliptic integrals of the first and second kind.

Work continued on design of an optimum search scheme for inpile detection of neutron sinks.

Chemical Processing Department

A summary of the results obtained in the analysis of final part dimensions, as measured at the various sites, was presented in an informal report. Recommendations were given for better assessing the various sources of error in the future.

An examination was made of the relationship between density and impurity of fabricated parts. Density was measured using three different techniques, and a comparison was also made of these techniques. This is really a part of

a larger study in progress, which is aimed at investigating the effects on button density of impurities in order to better control density, which in turn is believed to affect dimensional stability of the final part.

A comparison was made between reported plutonium isotopic contents for buttons as measured by mass spectrographic analysis and by neutron counting. This was done in order to determine if neutron counting can be used to provide a satisfactory acceptance test for buttons.

Mathematical expressions were derived for the solid angles subtended at specific points on the floor of an open-topped rectangular pit. These expressions are useful in calculating radiation dosages.

Complete specifications for the cam necessary to control the Gorton lathe during the machining operation on the interior surface of the 1251 membrane components were calculated and submitted for fabrication.

Work is continuing on the theory for obtaining and recording the data necessary to guide the Gorton lathe under the proposed new system of numerical control.

STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program

Pulse Column Test Facility

The second set of midcolumn photometer calibration data is currently being processed. Analysis using a linear relationship between uranium solution concentration and normalized phototube output voltage indicates that there is a significant exponential damping for the higher uranium concentrations. Further analysis is being done to build this damping effect into the calibration function. The analysis of the rotometer calibration data and the temperature correction data for the midcolumn photometer has been suspended until the NELLY nonlinear least squares routine has been debugged.

NPR Graphite Studies

Tolerance statements describing the population of graphite bars currently under consideration for use as NPR moderator were constructed using extreme value theory for tensile and compression strength measures and modulus of rupture data. The extreme value theory assumes that breaking strength is a function of the largest defect, while normal theory assumes that strength is an average property. The results of this analysis are being incorporated into a document to be issued shortly by Nonmetallic Materials Operation.

4000 Program

Plutonium Recycle

Statistical analysis of the OD data from the recent fluorescent penetrant experiment conducted by Materials Development Operation has been completed

and a memorandum report is being prepared. The results of the current test will aid in designing an ID test using a boroscope to detect surface defects on the zirconium tubes. An improved method was suggested for estimating the total number of defects on a given tube which uses the measurements obtained from two operators reading independently.

Further analysis of data from the high energy uranium oxide impacting test recently conducted by Fuels Development Operation must await the writing of an IBM program to plot out the confidence region of the stationary point previously determined by a quadratic response surface fit. A report is being written to describe the computer program which fits the response surface for nonorthogonal factor levels of the independent variables, estimates the stationary point of the quadratic surface, and calculates the confidence region for the position of the "true" stationary point.

The mathematical model which describes the behavior of a proposed neutron flux monitor has been incorporated in an optimization program written for the IBM 7090 and selected experiments are being run to study this behavior with respect to isotopic content and combinations.

Additional experiments on particle packing using precalculated particle sizes and size ratios have been completed. Although the results have not yet been completely analyzed, there appears to be remarkable agreement between theory and practice.

Waste Disposal Development

Assistance was given personnel of the Geochemical and Geophysical Research Operation in developing criteria which can be used to determine optimum grid spacing and relaxation factors in the numerical solution of partial differential equations. These equations arose in a seepage study.

Closed form solutions were obtained to a system of linear differential equations which comprise a model used to study the material balance in an ion exchange process.

6000 Program

Biology

At the request of the Biology Operation, work was begun on the design of an experiment involving irradiation of Tribolium confusum (the confused flour beetle) and T. castaneum at low levels.

General

Instrumentation

Statistical analysis of data from a reference system calibration study being conducted by Instrument Research and Development Operation continued this

[redacted]

month. This system will be used to calibrate linear variable differential transducers in connection with the program in-reactor creep testing of zircaloy.

Radiation Protection

A discussion was held with personnel of RPO concerning the statistical correlation of pencil data with film badge data. A plan was suggested for sampling a large body of existing film badge pencil data.

Prior to running correlations the general approach which could possibly be the problem of screening the pencil data to remove defective pencil data prior to the correlation was also considered.

Microscopic Cross Sections

At the request of Reactor and Fuels Operation, an evaluation was done of the precision with which microscopic cross sections can be calculated from appropriate nomograms.

Division of Research Programs

All program sample data have been transcribed onto IBM cards and are in the process of being transferred to magnetic tape master file. The BIMD series of statistical routines has been procured from the Western Data Processing Center and effort is being made to become familiar with the use of these routines. A number of test runs using the least squares procedure for estimating total count at time zero and the half-life of correlated time data have been run and the results proved to be extremely satisfactory.

MISCELLANEOUS

Safeguards Design Review

The final report for the Safeguards Design Review Project was completed in June and will be distributed in early July. The project consisted of the preparation of four reports describing the nuclear materials control systems used in the United States in each of the four operations, research and test reactors, power reactors, fuel fabrication, and irradiated fuels processing. They were prepared for the USAEC Division of International Affairs for distribution to foreign members of bilateral agreements for peaceful uses. The reports are the result of the joint efforts of several HAPO and Phillips (Idaho Falls) personnel; they were edited by Operations Research personnel.

Methods Development

NELLY, the Hanford version of a Los Alamos nonlinear least squares program (LA-2367, "Solution of the General Least Squares Problem with Specific Reference to High Speed Computers") has been debugged and will be ready

for laboratory use in the near future. Test cases using NELLY show marked improvement in the convergence rate over that exhibited by the Los Alamos routine and in some cases converge where the Los Alamos routine fails to converge.

Carl A. Bennett, Manager
Operations Research and Synthesis

CAB:dgl

[redacted]

1252436

PROGRAMMING OPERATION
JUNE, 1961

I. REACTOR DEVELOPMENT - 4000 PROGRAM

A. PLUTONIUM RECYCLE PROGRAM

1. Computer Code Development

The new uranium price schedule and associated use charges were incorporated in the economic codes. The method of finding minimum fuel costs with a reduced number of reactor computations is being revised with the objective of achieving four place accuracy. This accuracy is necessary only because without it, personal judgment must be used at successive points in the computation which would drastically reduce computation speed. The economics code subroutine that handles zoned reactor operation (plutonium-enriched fuel in one zone and uranium-enriched in another) was debugged. The routine allows rapid consideration of an unlimited number of zone areas so that optimums can be selected. However, as anticipated, this is of limited value because for most practical ranges of the data the plutonium enrichment method for minimum fuel cost is with concentration of plutonium in a minimum number of uranium rods; consequently the actual reactor zone is usually established by heat transfer or other limits.

Final debug was completed of the physics and economics code coupling so that fuel costs can be computed for any combination of fissile and fertile materials involving U-233, U-235, or plutonium enrichment of U-238 and/or thorium-232.

Concurrently, a substantial improvement in the physics code is essentially completed. The improvement involves the approximated neutron flux spectrum and associated nuclear cross sections, which adds more realism to the rapid methods used and extends their credibility to a wider range of reactor lattices. This improvement is achieved by self-shielding the thermal as well as epithermal components of the Westcott cross section when computing the neutron spectrum index, "r". This feature is particularly important when considerable amounts of Pu-239 and Pu-241 are involved with moderator temperatures above 200 C, as some portion of the resonances overlap the thermal spectrum. Ratios of the resulting cross sections will be taken to evaluate the resulting nuclear reaction rates and to indicate appropriate modifications.

2. Phoenix Fuel

Additional computations are being made on Phoenix Fuels with the present burnup models, although tight lattices cannot be analyzed with certainty until more advanced models are available. Computations with the present model confirm the previously computed results but use of a broad span of reactor lattices is indicated to provide Phoenix action for different plutonium isotopic compositions. This stems from the fact that self-shielding, as incorporated in the model used, tends to stabilize the reactor cross section of each plutonium isotope and, hence, variations in isotopic compositions are difficult to accommodate by minor adjustments in reactor lattices. On the other hand, it appears that by using burnable poisons with weapons type plutonium, Phoenix action may be achieved as the burnable poison holds down the reactivity until sufficient Pu-240 grows in. The growth of Pu-240 can be increased by elevating the moderator temperature and by reducing the amount of moderator (i.e., approach epithermal).

3. Plutonium Recycle

The analysis of simple plutonium recycle (the plutonium enrichment of a reactor is limited to the plutonium that the reactor produces) is being done on a wide range of reactor and economic variables for "near equilibrium plutonium isotopic composition" and at specific points wherein the actual approach to near equilibrium is examined in detail. The computer codes to accomplish this study are necessarily different in order to reduce computer costs to a reasonable figure. Consequently, the codes are being calibrated against each other so that compatible runs can be made.

4. Salt Cycle Reprocessing Economics

Fabrication of mixed-oxide (PuO_2-UO_2) fuels will be substantially more costly than UO_2 fuels because of the special requirements for handling plutonium. This cost increment, which may be as high as \$60/lb fuel, imposes a severe penalty on the use of recycled plutonium for fuel enrichment. One method of minimizing this penalty is to reduce the amount of mixed-oxide fuel by zoning a reactor (or fuel assembly), with part of the fuel made up of depleted uranium enriched with plutonium and the balance being enriched uranium-only fuel.

The initial evaluations of salt cycle reprocessing indicated substantial cost penalties relative to conventional reprocessing because of a substantially larger proportion of mixed-oxide fuel produced. Consequently the flowsheet possibilities were reviewed and a new concept was developed to minimize the mixed-oxide fuel produced. The new concept provides for multiple salt cycle charges from the uranium-only zone taking only a by-product (UO_2) deposition

followed by a mixed-oxide charge and a product (PuO_2-UO_2) deposition. Substitution of fresh depleted uranium for a portion of the uranium from the spent fuel is also provided for when economical. A proportion of mixed-oxide fuel comparable with conventional reprocessing is thus obtained.

The flowsheet concept has been expressed mathematically in terms of fuel composition for optimum mixed-oxide production in preparation for economic evaluation by a computer program.

B. SPECIFIC FUEL CYCLE ANALYSIS

1. Combined Fuel Cycles

Computer codes MELEAGER, PROTEUS, QUICK, and MINIMIZER have been used for an over-all evaluation of five enrichment materials (three plutonium isotopic compositions, U-233, and U-235) in two alternative fertile materials (U-238 and thorium) of various densities and with various lattice spacings. In all, approximately two thousand basic MELEAGER cases have been computed from which about 10,000 actual cases are derived by PROTEUS and evaluated by cost codes QUICK and MINIMIZATION. While final analysis of these data will take some time, preliminary evaluation indicates that

(a) U-233 can likely best be applied to enrich U-238 to take advantage of the fast effect;

(b) U-235 enrichment of the Th-232 yields very long reactor life times, 50-100,000 MWD/Ton, but not at high specific powers;

(c) Many plutonium compositions will duplicate U-235's performance in Th-232, but some will not; however, plutonium-thorium is not as limited in specific power as is U-235-thorium.

(d) With reduced fertile fuel densities (U-238 or Th-232) plutonium enrichment is less critical to composition (Pu-240 can be utilized more efficiently).

Fuel cycles using Th-232 as a solid fuel have specific power limitations due to the fact that U-233 grows in from protactinium-233 (Pa-233), which is formed from the Th-232 by neutron absorption. The absorption cross section of Pa-233 is approximately 50 barns and its half life is 27 days. Thus, at high specific powers, it burns out and U-233 formation is curtailed. This is illustrated in the following table relating specific power and exposure for a U-233 fueled pressurized water reactor.

SPECIFIC POWER AND FUEL EXPOSURE FOR A THORIUM FERTILE SYSTEM

Specific Power MW/Ton of Thorium	Computed Fuel Exposure MWD/Ton
5	20,840
10	19,540
15	18,320
20	16,870
30	12,770
40	5,250
60	3,190

Currently, reactor designs are balanced with fuel specific powers of 10-15 MW/Ton fertile where thorium is competitive with uranium fertile systems. If the specific fuel power is doubled, the thorium fertile system is at a disadvantage. While doubling the volumetric specific power of reactors may be far off timewise, doubling the specific power of the fuel is not, as reduced density fuels for superheater plates, etc., are under consideration. (To be technically rigorous, Pu-239 is formed by decay of Np-239 which has a three-day half life, but similar computations for U-238 show no significant decrease in exposure below a 100 MW/Ton specific power.) This limitation of specific power for thorium reactors does not necessarily apply to non-rigid fuel reactors if the protactinium-233 can be arranged to decay in reduced neutron fluxes and, as a consequence, blankets are used in many thorium breeder proposals.

Plutonium-enriched rigid thorium fuels will enjoy an advantage in higher specific power areas because of plutonium's higher fission cross section which will lead to the same specific power at nearly one-half the neutron flux. Examination of the data for plutonium enrichment of thorium, i.e., 1/3, 2/3 and 4/3 of theoretical density confirms this prognosis. The effect is so pronounced that careful re-runs are under way to fully substantiate the data.

2. APWR

The APWR analysis was extended further to embrace reactors of the pressurized water type described in a general way with an effort roughly to encompass the APWR design. Several reactors are studied -- each differing by rod spacing, effective neutron temperature, and fuel density. So far, the plutonium values derived in these APWR types are higher than in other machines investigated for comparable economic conditions; hence, some additional perturbations are being made to establish the reasons involved. In some instances, plutonium values in the APWR types are as high as 125 percent of the price of fully-enriched uranium, rather than approximately 85 percent, as in the graphite superheat, D_2O moderated, and some other PWR cases analyzed to date. It appears that the APWR spectra are favorable for Phoenix fuel action, and relatively long plutonium-enriched reactivity life times are observed.

The uncertainty of the reactor constants and physics variables upon computed plutonium values in the APWR was emphasized in a paper describing some results presented at the Pittsburgh ANS meeting in June. This work was with fully-minimized fuel costs for successive plutonium recycle to eliminate reactor design bias, such as control rod limitations. Data shown in the accompanying table relate plutonium value and variations in eta, (the neutron reproduction coefficient) for Pu-239 and Pu-241, and, also, variations in the total cross section for Pu-239 and Pu-241.

PERCENT CHANGE IN FISSILE PLUTONIUM VALUES WITH VARIATION OF ETA AND ABSORPTION CROSS SECTION

Case Number	Δeta% Pu-239	Δeta% Pu-241	Δσa% Pu-239	Δσa% Pu-241	Δ Pu Value %	eta-1	Δ eta-1 in %
1	-18	-18	0	0	-22.6	0.57	-37
2	- 9	- 9	0	0	-12.8	0.74	-19
3(base)	0	0	0	0	0.0	0.91	0
4	+ 9	+ 9	0	0	+13.4	1.08	+ 19
5	+18	+18	0	0	+23.1	1.26	+ 38
6	0	0	-18	-18	- 9.2	--	0
3(base)	0	0	0	0	0.0	--	0
7	0	0	+18	+18	+ 5.9	--	0
8	+18	+18	-18	-18	+21.0	1.26	+38
5	+18	+18	0	0	+23.0	1.26	+38
9	+18	+18	+18	+18	+24.4	1.26	+38

Note that an increase in eta by nine percent, as shown in Case 4, increases the value of plutonium by 13.4 percent; and a decrease of nine percent, as shown in Case 3, decreases the value by 12.8 percent. These results appear to check one's intuition, which was not the case in previously reported examples wherein a control rod limit was imposed. It should be noted that the changes in value are less than changes in eta-1; but, on the other hand, are greater than changes in eta. Data from the table also indicate that changes in cross section will influence the value of fissile isotopes (cases 6, 7, 8, and 9).

II. OTHER ACTIVITIES

1. Power Cost for Mercury-204 Isotope Separation

Since about two years ago when interest in the Hg-204 isotope as a specialty reactor coolant was under consideration among AEC contractors, in addition to HAPO, a figure of $30 per pound of mercury isotope as the power cost for the operation of the photochemical excitation process of isotope separation was fairly generally accepted and referred to in discussions on the subject (except at Hanford). At the Hanford Laboratories this figure was always regarded as questionable in view of realistic figures on electric energy conversion to the 2537 Å line in the mercury spectrum and subsequent high photon yields in producing activated atoms when mercury vapor was irradiated at this wave length. The calculations were then obtained and acknowledged by the originators to be "very crude." Up until recently these figures were not critically analyzed. With the recent AEC request to propose uses for Hg-204 and to estimate the cost of producing this isotope, the calculations have been reviewed and it is concluded that an error in the conversion factor for kilogram calories to electrical energy resulted in the $30 figure and that this figure is high by a factor of exactly one thousand. Therefore, the power cost with the correct conversion factor is about three cents per pound of the mercury isotope rather than $30. This process is then extremely unique among all isotope separations processes in that power cost can be essentially neglected as a factor in the expense of producing mercury isotopes. Also, the raw material cost for the mercury from which the isotope is recovered should be relatively insignificant since, except for some highly specialized and low tonnage uses, the change in isotopic composition should have no effect on the value or use of mercury which is partially or totally depleted in any of its isotopes. The production cost then comes down to those cost factors which are highly dependent on the quantity of annual production, namely manpower and investment charges. Because of extremely limited knowledge on production technology, these factors are the least possible to estimate with assurance. Useful data which could establish a basis for a more realistic estimate of costs could be obtained in about four man-months of effort in the existing laboratory facilities.

2. Hazards Analysis: Shipment of Radicnuclides

The evaluation was completed of accidental releases of Cs-137 or Sr-90 during shipment of large quantities of these materials. The results of the evaluation were reported in HW-69561 REV, "The Consequences of Accidental Releases During Shipments of Radioactive Cesium and Strontium," by E. C. Watson, R. L. Junkins, J. J. Fuquay, and L. L. Zahn, and presented orally to the Risk Evaluations Sub-council of the GE Technological Hazards Council. The shipment problems were reviewed with the Council at their meeting in New York on June 14 and 15. The recommendations of the Council are not yet available.

3. Miscellaneous

Mr. R. L. Junkins addressed the Summer Institute of Radiation Biology at the University of Washington on the subject of "Dose Units and Measurements," on June 29.

Hanford Laboratories off-site visitors totalled 248 during the month. Of this total, 155 visitors were included in four scheduled tours. There was a total of 26 foreign visitors, representing nine different countries.

W. K. Woods

Manager,
Programming

WK Woods:jm

RADIATION PROTECTION OPERATION REPORT FOR THE MONTH OF JUNE, 1961

A. ORGANIZATION AND PERSONNEL

Employees resigning from the General Electric Company during the month included Raymond F. Massey on June 2, Max W. McConiga on June 15, and Wilfred R. Vedder on June 23. Joining the Radiation Protection Operation as summer employees were Harold N. Hauser on June 6 and Calvin E. Gentle on June 15. Myrtle S. Ghent was reactivated on June 26. Lillian J. Whitney transferred into the Radiation Protection Operation on June 26, replacing Jan M. Bullinger who was placed on an educational leave of absence on June 30. Alfred W. Medcalf (Technical Graduate) began a three-month rotation with the Radiological Development and Calibrations Operation on June 16. The work force now totals 139: 40 exempt and 99 nonexempt.

B. ACTIVITIES

There were no cases of plutonium deposition confirmed during the month; thus, the total on record remains at 267, with 194 employees on the active rolls.

A Purex process operator, who incurred a minor hand injury involving plutonium contamination, was examined in the Whole Body Counter. Examination showed 8.4×10^{-3} μc plutonium before excision and 3.0×10^{-3} μc after medical treatment. A measurement of the excised tissue in the Whole Body Counter indicated 7.8×10^{-3} μc of plutonium, which was in good agreement with the radiochemical analysis which showed 7.1×10^{-3} μc of plutonium.

The major fraction of the analyzer time was consumed during June by transferring 1961 Whole Body Counter data from digital print to EDPM coded punch tapes.

Drainage liquids from the IRP loop in 242-B Building, 200-E Area, autoclave and valves overflowed a drain funnel and ran onto the floor. The funnel was contaminated to 17 rads/hour, including 2 r/hour and the floor to 16 rads/hour, including 1 r/hour. The drain valve could have been closed causing the overflow. A 19-hour air sample indicated the cubicle air concentration was on the order of 10^{-7} μc/cc. Operations were notified and decontamination was initiated.

A minor particulate contamination spread went northward across 7th Street from A Courtyard caused by a pump change at the Hot Semiworks Facility on June 7, 1961. Frequent changes of the air samples enabled the time of the release to be correlated with the progress of the work. The release occurred when the pump was placed, with difficulty, into the decontamination tank. Personal clothing, skin, and vehicle contamination followed because of poor step-off pad procedures and the spread of particles. Similar pump changes have been done in A Courtyard since then with excellent contamination control.

Contamination of 8 rads/hour was detected on the glove of an employee working with cerium-strontium in a laboratory of the 325 Building. The glove was peeled off and minor skin contamination removed from the employee's hand. The air sample filter indicated air-borne contamination in the room of 6.8×10^{-10} μc FP/cc.

Release of radioactive materials from the stacks of the Hot Semiworks was comparatively low during the entire month. The improved condition can be attributed to the installation of new filters for the process stack and to a shutdown of operations for maintenance, decontamination, and product sampling.

Seven aerial flights were made over the project area and the southeastern part of the state of Washington as a part of the routine surveillance program. No unusual radiation was noted.

Considerable difficulty was encountered with the continuous water samplers located at Pasco and the Automatic Columbia River Monitoring Station due to mud and silt which frequently clogged the equipment and halted sampling. Replacement of the minipumps and minor adjustment of piping should alleviate this problem which was associated with the flood stage of the river.

A total of 61 fish, c mprising 8 species, principally whitefish and suckers, were collected from Priest Rapids, Hanford, Ringold, and Burbank. Eighty-four tissue samples from these fish are being analyzed for selected radionuclides.

Final details of the creel census were completed with the Washington State Game Department and the first records obtained from fishermen were received the latter part of the month.

Evaluation of possible consequences of accidental releases of Cs^{137}, Sr^{90}, and $Sr^{90}CO_3$ from casks during shipment were completed. The evaluations were prepared for presentation to the G.E. Technological Hazards Council and were issued as document HW-69561 REV.

Recently an audit was made of the number of film badges that were used by each routinely badged employee at HAPO. The audit was conducted over a three-month period during the first quarter of this year and showed that there were a total of 131 employees who wore 6 or more badges during this period. These totals included government and construction workers. Under normal circumstances, each employee would have worn 3 badges during the period since the only obvious reasons for additional badges are when an employee forgets or loses his film badge. This information was transmitted in letters to all Level IV Managers with a list of those employees in their component who had used 6 or more badges during the audit period. The response to these letters has been very gratifying.

An automatic beta radiation calibration jig has been designed for providing precise and automatic timing for the exposure of personnel dosimeters during beta calibrations. Two calibration units having a capacity of twelve dosimeters each will be fabricated by Technical Shops. Timing will be provided by two microflex timers having five to sixty hour capacities. These calibration units will assure precise beta radiation exposures to calibration film without requiring detailed attention by the calibrator.

The radiation encountered at the PCTR facility has been studied with the use of both the current personnel dosimeter and the new personnel dosimeters. The

analysis has indicated that there was no beta or low energy gamma present during the time of this study. Primary densities observed on the personnel dosimeters were created from gamma protons having an energy between 80 and 100 Kev. Studies indicate that this energy region is entirely consistent with PCTR operations and is probably created by the decay of copper-67 which decays with gamma rays in the energy range of 90 Kev. The dosimetry capabilities of the new personnel dosimeter at this particular work location have been highly satisfactory.

On June 22, 1961, the steel metered tape on the south source well in the Calibrations Building broke causing the 1/2 gram radium source and its holder to fall to the bottom of the well. Emergency procedures were followed by all calibration personnel. Radiation Monitoring personnel were notified and air samples were taken from the bottom of the well to check for a possible radium source leak. None was found. A new steel metered tape was carefully installed in the well and the radium source was checked for leakage. To avoid subsequent occurrences the replacement of the steel tapes in both wells will be placed on a routine schedule. The source was reinstalled and extended air samples were taken in and above the well to detect any possible source rupture. Recalibration of the well was performed with the recently calibrated Victoreen r-meters. A significant variation was found between the previous calibration. A new electrical source positioning system has been installed on the north source well. This system provides a heavier duty motor for positioning the radium source in the well. If performance of this system is satisfactory, a duplicate system will be added to the south well to provide complete mechanical operation of both wells.

Biology personnel were assisted in the use and interpretation of results obtained with the microdensitometer. The biology program has advanced to a stage where the microdensitometer will be used on a frequent basis. All necessary modifications to the densitometer and training of personnel for the use of this equipment have been completed.

Twenty scope prints and the design criteria document for the Fuel Recycle Pilot Plant were commented on during the month. The final revised design criteria document will be published by the design group during the month of July. In general, the requirements for radiological design as proposed by the RDCO document, HW-68954 REV 1, have been accepted.

C. TRIPS AND VISITORS

David Montgomery from the University of California studied methods and policies for handling plutonium at HAPO on June 1.

A discussion of radiation monitoring practices was presented to Sid Furman and Larry Sullivan, representatives from Vallecitos Radiomet Laboratory, on June 2.

Walter H. Poppe, Jr., William L. Wilson and Dr. Bartell from the Boeing Airplane Company discussed field monitoring techniques and internal dosimetry programs on June 7.

James R. Watts and J. S. Stutheit, E.I. duPont de Nemours & Company, were counted in the Whole Body Counter on June 8 and June 21, respectively.

Henri Boisson and Vincent Coutrot of the French Atomic Energy Commission discussed radiation protection policies and practices on June 8 and 9.

Discussing details of fish and waterfowl census on June 13 were Robert Rennie, Mitch Kershaw and Frank White of the State of Washington Department of Game.

Hugh Schumacher and Peter Tempus of the Swiss Atomic Energy Commission discussed radiation protection practices and policies on June 8 and 9.

Lt. Col. C. E. Newton of Walter Reed Hospital discussed radiation protection policies and practices on June 19.

Dr. Henry L. Gjorup of the Danish Atomic Energy Commission discussed radiation protection policies and practices on June 20.

Discussing accidental release of fission products from separation plants and during shipment were Clifford Beck and Joseph Di Nunno, AEC Division of Licensing and Regulation, on June 21.

W. W. Towne and D. E. Rushing, U.S. Public Health Service, discussed techniques of sampling and analyses on June 21.

Discussing radiation protection matters on June 22 and 23 were G. A. McKean, V. E. Penton, D. L. Duncan, H. C. Singh, and L. M. Maxwell, all from the University of Idaho.

Arnold Joseph of the AEC Division of Reactor Development discussed Hanford waste disposal problems on June 23.

Starting their summer training session at Hanford on June 19 were David A. Corey, Dale H. Denham, Furm M. Duncan, Jr., William E. Haddican, Robert L. Kelly, James E. Mecca, Heinz G. Wilms, Charles E. Norelius, Keith G. Pailthorp, and Allen E. Raymond, AEC Radiological Physics Fellowship students.

Attending the Health Physics Society meeting in Las Vegas, Nevada, June 12 through June 16 were A. R. Keene, C. M. Unruh, F. Swanberg, Jr., T. C. Mehas, F. L. Rising, and L. C. Rouse.

R. F. Foster participated in a meeting of the National Academy of Sciences - National Research Council BEAR Committee on oceanography and fisheries held at Woods Hole, Massachusetts, July 1 and 2.

D. EMPLOYEE RELATIONS

Six suggestions were submitted by personnel of the Radiation Protection Operation during the month, bringing the year-to-date total to twenty-eight. One suggestion was adopted and eight rejected. Thirteen suggestions submitted by RPO personnel are pending evaluation.

There were no medical treatment injuries during the month. One security violation occurred during June.

Radiation Protection training included: Tours for the AEC Radiological Physics Fellowship students here for summer training; orientation on specific aspects of radiation protection to janitors, patrolmen, Biology Research personnel, Analytical Laboratories Operation personnel, Radiometallurgy personnel, college professors, high school teachers, and new employees.

E. SIGNIFICANT REPORTS

HW-68435 - "Evaluation of Radiological Conditions in the Vicinity of Hanford for 1960" by Environmental Studies and Evaluation Staff.

HW-68954 REV 1 - "Radiological Design Criteria for the Fuel Recycle Pilot Plant" by L. G. Faust and C. M. Unruh.

HW-69561 REV - "The Consequences of Accidental Release During Shipments of Radioactive Cesium and Strontium" by E. C. Watson, R. L. Junkins, J. J. Fuquay, and L. L. Zahn.

HW-70170 - "Monthly Report - June 1961, Radiation Monitoring Operation" by A. J. Stevens.

Papers presented at the Health Physics Society meeting in Las Vegas were as follows:

"Quantitative Measurements of Some Gamma-Ray Emitting Radionuclides in Nuclear Industrial Workers by Whole Body Counting Techniques" by F. Swanberg, Jr.

"Radiological Development within the Hanford Radiation Protection Program" by C. M. Unruh.

"Experience with an Ionization Chamber Pulse Reader at Hanford" and "A Portable Dose Rate Instrument for Measurement of Natural Background Radiation Levels" by F. L. Rising.

"Radiological Protective Apparel Program at Hanford" and "Columbia River Continuous Monitoring System" by T. C. Mehas.

EXPOSURE EVALUATION AND RECORDS

Exposure Incidents above Permissible Limits

	Whole Body	Localized
June	0	0
1961 to Date	3	5

Gamma Pencils

	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
June	4,430	47	2	0
1961 to Date	27,272	327	17	0

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)
June	10,180	892	117	17	24	7.78	19.50
1961 to Date	60,379	5,611	634	135	176	9.08	21.08

Neutron Film Badges

	Film Processed	Readings 50-100 mrem	Readings 100-300 mrem	Readings Over 300 mrem	Lost Readings
Slow Neutron					
June	1,581	0	0	0	3
1961 to Date	9,590	0	0	0	33
Fast Neutron					
June	377	15	23	0	3
1961 to Date	2,313	329	95	0	33

Whole Body Counter

	Male	Female	June	1961 to Date
GE Employees				
Routine	18	1	19	292
Special	3	0	3	43
Terminal	1	0	1	2
Non-employees	4	0	4	28
Pre-employment	0	0	0	0
Total	26	1	27	365

Bioassay

	June	1961 to Date
Confirmed Plutonium Deposition Cases	0	4*
Plutonium: Samples Assayed	346	3,289
Results above 2.2×10^{-8} uc Pu/sample	8	83
Fission Product: Samples Assayed	375	3,646
Results above 3.1×10^{-5} uc FP/sample	0	3
Uranium: Samples Assayed	296	1,690

*The total number of plutonium deposition cases which have occurred at Hanford remains 267, of which 194 are currently employed on plant.

ENVIRONMENTAL MONITORING - RESULTS - (Mid-May 1961 - Mid-June 1961)

Sample Type and Location	Activity Type	Monthly Average	Units
Drinking Water			
100-F Area	Isotopic	0.2	% MPC_w-GI*
Separation Areas	Gross Beta	9.3×10^{-8}	µc/cc
Pasco	Isotopic	2.3	% MPC_w-GI**
Kennewick	Isotopic	1.6	% MPC_w-GI**
Richland	Gross Beta	$< 3.0 \times 10^{-8}$	µc/cc
Columbia River Water			
Above 100-B Area	Gross Beta	$< 3.0 \times 10^{-8}$***	µc/cc
100-F Area	Isotopic	0.9	% MPC_w-GI*
Hanford	Isotopic	0.7	% MPC_w-GI*
Pasco	Isotopic	6.6	% MPC_w-GI**
McNary Dam	Gross Beta	No Sample	
Vancouver, Washington	Isotopic	0.5	% MPC_w-GI**
Atmosphere			
I^{131} Separations Areas	I^{131}	3.6×10^{-13}	µc/cc
I^{131} Separations Stacks	I^{131}	0.9	Combined curies/day
Active Particles - Project	--	4.1	ptle/100 m^3
Active Particles - Environs	--	0.05	ptle/100 m^3
Vegetation (Control limit for vegetation is 10^{-5} µc I^{131}/g)			
Separations Areas	I^{131}	3.0×10^{-6}	µc/g
Residential	I^{131}	$< 1.5 \times 10^{-6}$	µc/g

* The % MPC_w is the percent of the maximum permissible limit for occupational exposure to the gastrointestinal tract calculated from drinking water limits contained in NBS Handbook 69.

** The % MPC_w-GI is the percent of the maximum permissible concentrations for persons in the neighborhood of controlled areas for continuous exposure to the gastrointestinal tract calculated from drinking water limits contained in NBS Handbook 69.

*** This location is now sampled quarterly. The most recent result is tabled.

Uranium Analyses

Sample Description	Following Exposure Units of 10-9 uc U/cc Maximum	Average	Number Samples	Following Period of No Exposure Units of 10-9 uc U/cc Maximum	Average	Number Samples
Fuels Preparation	67.5	5.7	77	20.3	2.9	71
Fuels Preparation*	0	0	0	0	0	0
Hanford Laboratories	16.5	5.5	27	10.3	3.0	32
Hanford Laboratories*	0	0	0	0	0	0
Chemical Processing	18.9	5.1	37	12.4	3.8	38
Chemical Processing*	0	0	0	0	0	0
Special Incidents	26.8	15.0	10	0	0	0
Random	1.3	1.0	4	0	0	0

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

	June	1961 to Date
Thyroid Checks		
Checks Taken	0	0
Checks Above Detection Limit	0	0
Hand Checks		
Checks Taken - Alpha	61,135	211,076
- Beta-gamma	93,746	323,812
Skin Contamination		
Plutonium	27	144
Fission Products	37	288
Uranium	6	33

CALIBRATIONS	Number of Units Calibrated June	1961 to Date
Portable Instruments		
GP Meter	949	5,532
Other	280	1,473
RM	495	3,248
Other	133	1,017
Audits	111	634
Total	1,968	11,904
Personnel Meters		
Badge Film	1,368	8,787
Pencils	-	-
Other	252	2,233
Total	1,620	11,020
Miscellaneous Special Services	309	4,842
Total Number of Calibrations	3,897	27,766

for A. J. Stevens
Manager
Radiation Protection

UNCLASSIFIED

1252451

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - JUNE, 1961

GENERAL

There were no security violations charged to the Operation.

There were no major injuries; the minor injury frequency rate was 2.15 for the month and 2.88 for the year-to-date.

TECHNICAL SHOPS OPERATION

Total productive time for theperiod was 20,333 hours. This includes 14,446 hours performed in the Technical Shops, 4,374 hours assigned to Minor Construction, 122 hours assigned to other project shops and 1,391 hours assigned to off-site vendors. Total shop backlog is 19,309 hours, of which 60% is required in the current month with the remainder distributed over a three-month period.

Distribution of time was as follows:

	Man-hours	% of Total
Fuels Preparation Department	3,254	16.0
Irradiation Processing Department	1,699	8.3
Chemical Processing Department	579	2.9
Hanford Laboratories Operation	14,787	72.7
Construction Engineering & Utilities	14	.1

Requests for emergency service remained at a high level, requiring an overtime rate of 8.7%. Work in connection with the PRTR and Ceramic Fuels in HLO and the Engineering Operation in FPD accounted for the majority of the overtime.

There were six medical treatment injuries, which is considered normal for this type of operation.

CONSTRUCTION OPERATION

There were 61 existing J. A. Jones Company orders at the beginning of the month with a total unexpended balance of $123,933. One hundred and twenty three new orders, 7 supplements and adjustments for underruns amounted to $132,914. Expenditures during the month on HLO work were $133,823. Total J. A. Jones backlog at month's end was $123,024.

Summary

	HL		CE&UO	
	No.	Unexpended Balance	No.	Unexpended Balance
Orders outstanding beginning of mo.	60	$ 122,353	1	$ 1,580
Issued during the mo.(Inc.Sup.&Adj.)	123	106,738	1	26,176
J. A. Jones Expenditures during mo. (Inc. C.O. costs)		121,555		12,268
Balance at month's end	56	107,536	1	15,488
Orders closed during month	103	161,177	-	--

FACILITIES ENGINEERING OPERATION

Project Activity

At month's end Facilities Engineering Operation was representing the Company on 16 projects having total authorized funds in the amount of $2,373,000. The total estimated cost of these projects is $8,453,000. Expenditures on these projects through May 31, 1961, were $1,387,000.

The following summarizes the status of FEO project activity:

Number of authorized projects at month's end 16

Number of new projects authorized in June: 2
- CGH-935 - Metals Storage Building
- CGH-937 - Safety Improvements - 231-Z Building

Projects completed in June: 1
- CGH-834 - Modifications & Additions to High Pressure Heat Transfer Apparatus - 189-D Building

New project proposals submitted to AEC in June: 5
- CGH-918 - Second Whole Body Counter Facility
- CGH-922 - Burst Test Facility for Irradiated Zr Tubes
- CGH-935 - Metals Storage Building
- CGH-936 - Coolant Systems Development Laboratory
- CGH-937 - Safety Improvements - 231-Z Building

New projects awaiting AEC approval: 5
- CGH-918 - Second Whole Body Counter Facility
- CAH-917 - Field Service Center
- CGH-922 - Burst Test Facility for Irradiated Zr Tubes
- CAH-932 - 300 Area Retention Waste Systems Expansion
- CGH-936 - Coolant Systems Development Laboratory

Project proposals complete or nearing completion are as follows:
Modifications to the H-1 Loop - 105-H Building
H-2 Basic Film and Corrosion Loop - 105-H Building

Project CGH-834, Modifications and Additions to High Pressure Heat Transfer Apparatus - 189-D Building, was completed June 29, 1961. The purpose of this project was to modify the thermal hydraulics testing facility in the 189-D Building for the conduct of steady state and transient type experiments with NPR type elements under simulated operating conditions. The steady state phase of the project was completed March 22, 1960 and has been in operation since then. Project funds of $700,000 were originally requested and authorized by Directive dated April 8, 1959. This authorization was for a priority job on a design and construct basis utilizing J. A. Jones Company. Completion was scheduled for August 15, 1960. Directive Modification No. 2 dated April 27, 1961, authorized $745,000 and established the completion date as July 1, 1961. Delays in completion of the transient phase were due to procurement delays, particularly a high speed valve assembly.

Engineering Services

Title	Status
Pressure Vessel and Piping Systems Engineering & Inspection Service	Code engineering service work is being performed on PRTR Systems, Breakaway Corrosion Loop, and Equipment Projects.
"Split-Half" Machine for Critical Mass Studies	Mechanical design of machine is essentially complete. Electrical design is progressing. Components have been purchased and are being assembled. The special instrumentation for remote control is designed.
Control and Safety Rods for Tamper Tank (Critical Mass)	Development work is being performed prior to completion of design.
Electrical Modifications - 3702 Building	Field work is delayed pending availability of craftsmen.
Special Filter Changer - CWS	Material for testing of a proposed design using plastic bags and shielded cart is now on hand.
Material Handling System and Other Shop Improvements - 328 Building a) Material Handling System b) Coating Process Improvements c) Chuck Handling Procedure	Work is in progress. Completion is anticipated in July.

Title	Status
Engineering Studies - 100-F	Counsel and recommendations are periodically offered for maintenance and operation of Biology buildings.
Electrical Load Improvements - 329 Building	Load studies are complete. Engineering design complete. Material is on order.
Cask Storage - 327 Building	Construction completed by the end of June.
Induction Heating Unit - 314 Building	Design is complete. Material is on site.
Install 200 KW Induction Motor - Generator Set - 306 Building	The M-G set was moved into place. Conduit and wire was run. The power pole was set and anchors installed.
Crane Overhaul - 314 Building	Work is proceeding.
Source Positioner - 3745 Building	Work, except for final adjustments, is complete.
Ventilation Improvements - 141-F and 146-FR Building	Sketches and suggestions for system modifications were submitted for review.
Modifications - 325 Building Air Conditioning System	Engineering work was performed on numerous minor modifications to ventilation system in the 325 Building.

Drafting and Design Services

The work load in the 3706 Building drafting room and in the 327 Building is heavy with some overtime required. Backlog of work in 306, 314, 308, and 1707-D drafting rooms are light to moderate with little overtime required.

The equivalent of 176 design drawings were completed this month.

Major design and drafting work in progress includes the following:

1. Process Tube Monitor - Mark III. 6 dwgs. required - 85% complete.
2. Flux Measuring Device for Neutron Counting Machine. 6 dwgs. required - 80% complete.
3. Arc Melting Hood. 7 dwgs. required - 90% complete.
4. Autoclave Facility Modification. 5 dwgs. required - 80% complete.
5. Special Tools Necessary for PRTR Operation - 38 dwgs. completed. No estimate of total number needed.

6. Filter Design Sr-90. 5 dwgs. - 100% complete.

7. Induction Heater Flush Chamber - 5% complete.

8. Gas Loop Test Section - "B" Cell. 4 dwgs. required - 75% complete.

9. Ultrasonic Development Tank. 13 dwgs. required - 50% complete.

10. Uranium Scrap Burner (Project CAH-902). 10 dwgs. required - 90% complete.

Plant Maintenance Operation

May costs were $ 131,390. FY costs to May 31 are 101.3 per cent of forecasted expenditure.

Analysis of Costs

The expenditure to date has risen 0.6% to 101.3% of the forecast. The chief factors in this continue to be greater than expected improvement maintenance activity, and higher than expected steam consumption. All but the most critical work has been deferred.

Improvement Maintenance

Item	
Relocation and alteration	$ 2,141
Repainting	1,174
Reroofing	229
Electrical Modifications	2,253
Piping Modifications	4,555
H&Vent Modifications	1,209
Crane	2
Miscellaneous	40
	$11,603

Waste Disposal and Decontamination Service

Radiation exposure of tractor drivers hauling crib waste to the 200 Area decreased significantly following shielding of the trailers.

A transfer pump was installed in tank number 1. It is sized to lift liquid waste into the storage tanks or into waste trailers.

Plant Engineering and Miscellaneous

Approximately 21,000 square feet of prints were reporduced during the month.

The total estimated value of ten requisitions issued during the month was $80,000. This procurement is primarily for approved HL projects.

The interiors of 3745-A and 3745-B Buildings were painted during the month. Painting in the 325 Building was completed.

TECHNICAL INFORMATION OPERATION

A film "Technical Information Services of the Atomic Energy Commission" was shown to all employees in the Operation. Prepared by the AEC's office of Technical Information, the film illustrates the scope and variety of information services available to the scientific community through the AEC's Technical Information programs. It is planned to publicize the film throughout the Plant and to encourage its showing to technical groups.

Two classification memos were distributed to the field. They are:

HW-69766	"Classification: Plutonium" June 1, 1961
HW-69766 SUP 1	"Classification: Plutonium" June 22, 1961

Both memos presented guidance for classifying information in unclassified plutonium.

The local declassification reviews of the Purex Technical Manual, begun last fall, were completed and the manual has now been sent to the AEC Declassification Branch for review. Numerous deletions will be required before declassification. Copies will then be reproduced for the Eurochemic Information Exchange Program and other interested groups.

Work is underway on a local classification guide which will cover the general aspects of Hanford and its operation such as site description, maps, photographs, utilities, construction, etc. This local guide will be based on the revised Section 100 (General) of the Hanford Classification Guide (now considered a program guide rather than a local guide).

The backlog of formal reports as of June 25 is 34 manuscripts awaiting attention. The addition of a fifth Clerk-Technical Publications has maintained the status quo but has not been able to reduce the backlog. An additional clerk will be added.

Work on the microfilming of documents in the Files vault is progressing steadily. During the month 54 drawers were emptied, 3,212 documents were pulled for microfilming, and 13 boxes of documents were accumulated for routing to the Records Center for retirement.

The IBM Card-a-type equipment to be used in the mechanization of the Classified Files document issuance, routing and mailing procedures was installed June 15. On June 19, the operator began processing the first HW documents through the system. There is every indication that the machines will be able to handle an even larger volume of documents than originally planned.

Special procedures, outlined by the Hanford Operations Office, have been established in Files to handle HAPO documents involved in the cooperative program between the U. S. and Canada.

The annual reports on reprint purchases and on the payment of page costs were sent to the Atomic Energy Commission about three weeks ahead of the July 6 required date.

The book collection in the W-10 Library was reviewed for volumes that should be weeded out. As a result 225 books are being discarded, plus a duplicate run of PHYSICAL REVIEW covering the period 1954 to date.

Work Volume Statistics

	May	June
Document Distribution and Files		
Documents routed and discharged (copies)	22,313	12,990
Documents issued (copies)	15,471	10,832
Documents sent off-site (copies)	8,939	3,385
Document reserves filled (copies)	691	589
Documents picked up and delivered	20,261	16,579
Document Accountability		
Holders of classified documents whose files were inventoried	278	418
Documents inventoried in Files (copies)	--	--
Documents destroyed or retired (copies)	11,625	6,849
Documents revised (copies)	1,450	1,432
Documents pulled and documents filed (copies)	17,982	11,186
Documents reclassified	279	206
Documents microfilmed	4,252	379
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents on-site	191,947	191,703
Reference and Publication		
Books cataloged (new titles)	137	78
Books added to the collection (volumes)	303	272
Ready reference questions answered by professional staff	220	146
Literature searches by professional staff	77	73
Reports abstrated (titles)	302	321
Formal reports prepared (titles)	13	9
Off-site requests for HAPO reports (copies)	421	202
Reports released to CAP (titles)	35	25

Library Acquisitions and Circulation

	May	June
Books ordered (volumes)	390	358
Periodicals ordered	142	115
Books circulated (volumes)	1,613	1,563
Periodicals circulated (issues)	3,012	4,104
Inter-Library loans	87	89
Films borrowed or rented	7	7
Industrial film showings	72	50
Bound periodicals added to the collection	79	296
Bound periodicals discarded	7	15

Library Collection

	Main Library	W-10 Library	108-F Library	Ind. Med.	Total
No. of books	31,783	8,654	1,804	2,052	44,293
No. of bound periodicals	14,758	17	1,911	23	16,709
Total	46,541	8,671	3,715	2,075	61,002

Classification and Declassification

	May	June
Documents, including drawings and photographs reviewed for downgrading or declassification	35	112
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification	59	45
Documents submitted to Declassification Branch, Oak Ridge	2	3

J L Boyd

Manager
Laboratory Auxiliaries

JL Boyd:jw

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. -- Hanford Laboratories

HW 70165

DATE 5-30-61

PROJ. NO.	TITLE	FUNDING
CAH-822	Pressurized Gas Cooled Facility	4141 Operating

AUTHORIZED FUNDS					
$1,120,000	DESIGN $ 40,000	AEC $ 0	COST & COMM. TO 5-28-61	$ 1053,350
	CONST. $ 1,080,000	GE $ 1,120,000	ESTIMATED TOTAL COST	$ 1120,000

STARTING DATES		DATE AUTHORIZED	2-3-61	EST'D. COMPL. DATES	
	DESIGN 3-29-59				DESIGN 4-29-60
	CONST. 10-17-60	DIR. COMP. DATE	9-30-61		CONST. 9-30-61

ENGINEER

REDO - DP Schively

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT-ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	100	100
TITLE I			
GE-TIT. II	100	100	100
AE-TIT. II			
CONST.	100	97	89
PF			
CPFF	17	90	96
FP	7	100	100
Govt. Eq.	76	97	89

SCOPE, PURPOSE, STATUS & PROGRESS

All primary loop piping has been completed and pressure testing is in progress.

The steel shielding from Pacific Car & Foundry & the six sample casks from Pacific Steel Products are due to arrive before 6-30-61.

PROJ. NO.	TITLE	FUNDING
CGH-834	Modifications & Additions to High Pressure Heat Transfer Apparatus - 189-D Building	0290

AUTHORIZED FUNDS					
$ 745,000	DESIGN $ 67,500	AEC $ --	COST & COMM. TO 6-4-61	$ 726,024
	CONST. $ 677,500	GE $ 745,000	ESTIMATED TOTAL COST	$ 745,000

STARTING DATES		DATE AUTHORIZED	4-8-59	EST'D. COMPL. DATES	
	DESIGN 4-20-59				DESIGN 2-13-61
	CONST. 4-22-59	DIR. COMP. DATE	7-1-61		CONST. 6-29-61

ENGINEER

FEO - H. Radow

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		3775
ARCHITECT - ENGINEER		
DESIGN ENGINEERING OPERATION		960
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	100	100
TITLE I			
GE-TIT. II	100	100	100
AE-TIT. II			
CONST.	100	100*	100
PF			
CPFF	100	100*	100
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project provides necessary modifications to existing equipment to simulate more sever in-reactor operating conditions in out-of-reactor facilities for research and development studies.

The project was physically completed, with exceptions, on June 29, 1961.

The major exception involves the corrective action that will have to be taken to get one of the sentry heat exchangers to meet specified performance requirements. Negotiations with the vendor are now under way.

*Based on revised construction status chart schedule submitted for approval.

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70165

DATE 6-30-6_

PROJ.NO.	TITLE	FUNDING
CAH-842	Critical Reactivity Measuring Facility	59-15

AUTHORIZED FUNDS				
$360,000	DESIGN $ 45,000 / CONST. $ 315,000	AEC $ 148,000 / GE $ 212,000	COST & COMM. TO 5/28/61	$ 170,555
			ESTIMATED TOTAL COST	$ 360,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 11-17-59		DESIGN 2-1-61	
	CONST. 10-3-60	DIR. COMP. DATE 8-15-61	CONST 8-15-61	

ENGINEER

REDO - WS Kelly

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT-ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	100	100
TITLE I			
GE-TIT. II			
AE-TIT. II			
CONST.	100	75	47
PF			
CPFF	57	60	4
FP	43	100	100

SCOPE, PURPOSE, STATUS & PROGRESS

Failure of fixed price contractor to complete work on schedule delayed the start of the CPFF Contractor's work until 6-27-61

PROJ. NO.	TITLE	FUNDING
CGH-857	Physical & Mechanical Properties Testing Cell - 326 Bldg.	0290

AUTHORIZED FUNDS				
$ 75,000	DESIGN $ 75,000 / CONST. $	AEC $ / GE $ 75,000	COST & COMM. TO 6-18-61	$ 74,945
			ESTIMATED TOTAL COST	$ 460,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 11-2-59	10-1-59	DESIGN 3-1-61	
	CONST.	DIR. COMP. DATE	CONST.	

ENGINEER

FEO - KA Clark

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT - ENGINEER		
DESIGN ENGINEERING OPERATION		540
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	100	100
TITLE I			
GE-TIT. II	100	100	100
AE-TIT. II			
CONST.	100		
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project will provide facilities for determining physical and mechanical properties of irradiated materials, and involves the installation of a cell in the 327 Bldg.

A project proposal revision requesting the total construction funds is routing for General Electric Company approval.

1252461

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. —

HW- 70165

DATE 6-15-61

PROJ.NO.	TITLE	FUNDING
CGH-858	High Level Utility Cell - 327 Building	0290

AUTHORIZED FUNDS				
$ 400,000	DESIGN $ 50,000	AEC $	COST & COMM. TO 6-10-61	$ 236,475
	CONST. $ 350,000	GE $ 400,000	ESTIMATED TOTAL COST	$ 400,000

STARTING DATES			EST'D. COMPL. DATES		PERCENT COMPLETE		
DESIGN 11-2-59	DATE AUTHORIZED 10-1-59		DESIGN 3-1-61		WT'D.	SCHED.	ACTUA
CONST. 5-15-61	DIR. COMP. DATE 2-28-62		CONST. 2-28-62	DESIGN	100	100	100
				TITLE I			
				GE-TIT. II	95	100	100
				AE-TIT. II			
				Vendor	5	100	100
				CONST.	100	NS	12
				PF			
				CPFF			
				FP			

ENGINEER

FEO - KA Clark

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE	3	140
PLANT FORCES		
ARCHITECT-ENGINEER		35
DESIGN ENGINEERING OPERATION		716
GE FIELD ENGINEERING	.2	6

SCOPE, PURPOSE, STATUS & PROGRESS

This project will provide facilities to prepare specimens from irradiated materials for use in determining their physical and mechanical properties and involves the installation of a cell in 327 Building.

Procurement of the decladding machine is critical. The Invitation to Bid resulted in only one quotation for $33,000 vs. an estimated cost of $5,000. On-site fabrication is planned for this piece of equipment.

PROJ. NO.	TITLE	FUNDING
CAH-866	Shielded Analytical Laboratory - 325-B Building	61-a-1

AUTHORIZED FUNDS				
$ 700,000	DESIGN $ 60,000	AEC $ 546,500	COST & COMM. TO 5-28-61	$ 16,903
	CONST. $ 640,000	GE $ 153,000	ESTIMATED TOTAL COST	$ 700,000

STARTING DATES			EST'D. COMPL. DATES		PERCENT COMPLETE		
DESIGN 9-5-59	DATE AUTHORIZED 5-31-60		DESIGN 11-14-60		WT'D.	SCHED.	ACTUA
CONST. 6-15-61	DIR. COMP. DATE 6-30-62		CONST. 6-30-62	DESIGN	100	100	100
				TITLE I			
				GE-TIT. II	10	100	100
				AE-TIT. II	90	100	100
				CONST.	100	NS	<1
				PF			
				CPFF			
				FP			

ENGINEER

FEO - RW Dascenzo

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT - ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

SCOPE, PURPOSE, STATUS & PROGRESS

This project will allow greater capacity for analytical work involving today's more highly radioactive solutions and consists of adding a shielded laboratory to the 325 Building.

A contractor orientation meeting was held with S & E contractors, Inc. on 6-22-61 in the AEC's field office. First construction activity at the site took place on 6-28-61.

1252462

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70165 I

DATE 6-30-61

PROJ. NO. CAH-867 | TITLE: Fuel Element Rupture Test Loop | FUNDING: 58-e-15

AUTHORIZED FUNDS $1,500,000 | DESIGN $ 130,000 | CONST. $ 1,370,000 | AEC $ 770,000 | GE $ 730,000 | COST & COMM. TO 5-30-61 $ 437,222 | ESTIMATED TOTAL COST $ 1,500,000

STARTING DATES: DESIGN 8-1-60* CONST 11-2-60. | DATE AUTHORIZED | DIR. COMP. DATE 10-31-61 | EST'D. COMPL. DATES: DESIGN 2-15-61 CONST. 10-31-61

ENGINEER

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT-ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	100	100
TITLE I			
GE-TIT. II	91	100	100
AE-TIT. II	9	100	100
CONST.	100	44**	10**
PF	2	0	0
CPFF	24	45	0
FP (1)	10	100	100
(2)	33	30	0
(3)	31	60	0

SCOPE, PURPOSE, STATUS & PROGRESS

(1) G. A. Grant Co.
All design drawingw and construction specifications have been approved.

* Detail Design. Scope design started 11-2-59, and completed 3-15-60.
** Water plant construction was scheduled for starting 3-1-61. Design drawings and specs for water plant and holdup tank forwarded to AEC-HOO early in February.

As a result of AEC-HOO review it was necessary to make several design changes to reduce capacity of filter plant. Revised material will be released for bidding early in July.

PROJ. NO. CAH-870 | TITLE: Facility for Recovery of Radioactive Materials - 325 Bldg. | FUNDING: 60-a-1

AUTHORIZED FUNDS $ 486,000 | DESIGN $ 46,000 | CONST. $ 440,000 | AEC $ 446,000 | GE $ 40,000 | COST & COMM. TO 5-28-61 $ 463,344 | ESTIMATED TOTAL COST $ 486,000

STARTING DATES: DESIGN 11-20-59 CONST. 5-6-60 | DATE AUTHORIZED 3-22-60 | DIR. COMP. DATE 6-1-61 | EST'D. COMPL. DATES: DESIGN 3-1-60 CONST. 5-31-61

ENGINEER: FEO - RW Dascenzo

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT - ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	100	100
TITLE I			
GE-TIT. II	10	100	100
AE-TIT. II	90	100	100
CONST.	100	100	100
PF	1	100	100
CPFF			
FP	100	100	100

SCOPE, PURPOSE, STATUS & PROGRESS

This project will provide a facility for recovery of specific radioisotopes from wastes, and involves an addition to the 325 Building.

The work is completed. Remaining funds in the project were planned to be spent on a design change for either a chemical make-up hood or a longitudinal floor to ceiling partition, but the contractor's two claims that have risen to $51,000 will prohibit this. A reply to the contractor's claim has been written to the Commission.
A Physical Completion Notice was issued in June.

1252463

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

HW 7016[illegible]

DATE 5-30-61

PROJ. NO.	TITLE	FUNDING
CAH-888	Biology Laboratory Improvements	60-h-1

AUTHORIZED FUNDS				
$ 420,000	DESIGN $ 44,000	AEC $ 400,000	COST & COMM. TO 5-28-61	$ 50,767
	CONST. $ 376,000	GE $ 20,000	ESTIMATED TOTAL COST	$ 420,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 8-8-60	9-2-60	DESIGN 3-31-61	
	CONST. 7-6-61	DIR. COMP. DATE 3-31-62	CONST. 6-15-62	

ENGINEER

FEO - JT Lloyd

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT-ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	NS	100
TITLE I			
GE-TIT. II	17	NS	100
AE-TIT. II	83	NS	100
CONST.	100	0	0
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project provides additional space for biological research supporting services, and involves an addition to the 108-F Building.

The AEC awarded the contract to Teller Construction Company. General Electric Co. has been authorized a total of $60,500 to prepare design criteria, provide technical direction of the AEC, perform Title III and related management services, procure the radiation Handling Facilities and perform offsite inspection.

PROJ. NO.	TITLE	FUNDING
CAH-896	Stress Rupture Test Facility	60-1

AUTHORIZED FUNDS				
$ 90,000	DESIGN $ 7,500	AEC $ 78,500	COST & COMM. TO 6-4-61	$ 10,057
	CONST. $ 82,500	GE $ 11,500	ESTIMATED TOTAL COST	$ 90,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 7-29-60	3-6-61	DESIGN 12-1-60	
	CONST. 3-20-61	DIR. COMP. DATE 10-15-61	CONST 10-15-61	

ENGINEER

FEO - H. Radow

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE	7	350
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT - ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	100	100
TITLE I			
GE-TIT. II	100	100	100
AE-TIT. II			
CONST.	100	59	58
PF	2	0	0
CPFF			
FP	98	60	60

SCOPE, PURPOSE, STATUS & PROGRESS

This project involves a facility for deliberately rupturing tubing to establish service conditions.

The roof has been poured & forms are being stripped. The installation of piping & electrical components is continuing. The contractor was requested to indicate the status of his off-site procurement so any potential delaying items could be spotted. A delivery schedule was submitted in which the latest promised shipment was July 31, 1961.

1252464

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70165

DATE 6-30-61

PROJ. NO.	TITLE	FUNDING
CAH-901	Structural Material Irradiation Test Equipment - ETR	0290

AUTHORIZED FUNDS				
$ 125,000	DESIGN $ 12,000 / CONST. $ 113,000	AEC $ / GE $ 125,000	COST & COMM. TO 6-18-61	$ 79,556
			ESTIMATED TOTAL COST	$ 125,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 9-15-60 / CONST. 7-1-61	DIR. COMP. DATE 10-15-61	DESIGN 3-31-61 / CONST. 10-15-61	

ENGINEER

FEO - KA Clark

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT-ENGINEER		
DESIGN ENGINEERING OPERATION		165
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	100	100
TITLE I			
GE-TIT. II	100	100	100
AE-TIT. II			
CONST.	100	NS	NS
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project provides for the installation of equipment at the ETR for which changes in the physical properties of reactor structural materials subjected to in-reactor conditions can be determined.

It now appears that ex-reactor piping modifications started June 26, 1961.

Firm start date for installation of equipment has been requested from the AEC.

PROJ. NO.	TITLE	FUNDING
CGH-902	Uranium Scrap Burning Facility	61-j

AUTHORIZED FUNDS				
$ 36,000	DESIGN $ 5,000 / CONST. $ 31,000	AEC $ 27,500 / GE $ 7,500	COST & COMM. TO 7-1-61	$ 3,034
			ESTIMATED TOTAL COST	$ 36,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 5-15-61 / CONST. 7-1-71	DIR. COMP. DATE 10-15-61	DESIGN 7-15-61 / CONST. 10-15-61	

ENGINEER

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT - ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	100	80
TITLE I			
GE-TIT. II			
AE-TIT. II			
CONST.	100	0	0
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project provides a means of making uranium scrap material safer for storage and off-plant shipment by converting this scrap to a stable uranium oxide. The facility will be adjacent to the 333 Building.

All of the HLO drawings are complete, except for a few minor details. The completed drawings are being checked. Design is slightly behind schedule, but is expected to be complete by July 15, 1961.

*Accepted by the General Electric Company 5-17-61.

1252865

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70165 II

DATE 6-30-61

PROJ.NO.	TITLE	FUNDING
CAH-914	Rattlesnake Springs Radioecology Facility	61-J

AUTHORIZED FUNDS				
$83,000	DESIGN $ 3,400*	AEC $ 64,700	COST & COMM. TO 5-28-61	$ 11,787
	CONST. $ 68,600	GE $ 18,300	ESTIMATED TOTAL COST	$ 83,000

STARTING DATES			EST'D. COMPL. DATES		PERCENT COMPLETE			
DESIGN 3-1-61	DATE AUTHORIZED 12-22-60		DESIGN 6-15-61			WT'D.	SCHED.	ACTUAL
CONST. 7-15-61	DIR. COMP. DATE 10-31-61		CONST 12-1-61		DESIGN	100	NS*	100
ENGINEER					TITLE I			
FEO - OM Lyso					GE-TIT. II	100	NS*	100
MANPOWER		AVERAGE	ACCUM MANDAYS		AE-TIT. II			
FIXED PRICE								
COST PLUS FIXED FEE					CONST.	100		
PLANT FORCES					PF			
ARCHITECT-ENGINEER					CPFF			
DESIGN ENGINEERING OPERATION					FP			
GE FIELD ENGINEERING								

SCOPE, PURPOSE, STATUS & PROGRESS

This project will allow performance of radioecological studies under local environmental conditions. It consists of constructing field facilities for this purpose. Approval signatures for project drawings and specifications were obtained 5-31-61.

*Bovay Engineers.

Bid package has been prepared by AEC and bid opening is scheduled for 6-27-61. A project proposal revision requesting $11,000 additional construction funds has been submitted by the AEC. A directive authorizing the additional funds has been received.

PROJ. NO.	TITLE	FUNDING
CAH-916	Fuels Recycle Pilot Plant	Funds Avail. to Comm.

AUTHORIZED FUNDS				
$ 50,000	DESIGN $ 50,000	AEC $	COST & COMM. TO 5-28-61	$ 43,700
	CONST. $	GE $ 50,000	ESTIMATED TOTAL COST	$ 5,000,000

STARTING DATES			EST'D. COMPL. DATES		PERCENT COMPLETE			
DESIGN 3-1-61*	DATE AUTHORIZED 2-17-61		DESIGN 3-1-62			WT'D.	SCHED.	ACTUAL
CONST. 5-1-62	DIR. COMP. DATE		CONST. 11-1-63		DESIGN	100	NS*	90
ENGINEER					TITLE I		NS*	90
FEO - RW Dascenzo					GE-TIT. II			
MANPOWER		AVERAGE	ACCUM MANDAYS		AE-TIT. II			
FIXED PRICE								
COST PLUS FIXED FEE					CONST.	100		
PLANT FORCES					PF			
ARCHITECT - ENGINEER					CPFF			
DESIGN ENGINEERING OPERATION					FP			
GE FIELD ENGINEERING								

SCOPE, PURPOSE, STATUS & PROGRESS

This project is to provide a facility tc perform a full scope of engineering tests and pilot plant studies associated with fuel reprocessing concepts.

The revised project proposal for detail design funds was transmitted to AEC on 6-20-61 for approval. AEC on 6-16-61 sent a telegram to Washington D.C. AEC requesting $50,000 additional design funds on this project.

All twenty drawings and the Design Criteria have been commented upon. It is planned to issue the Design Criteria early in July.

*Design Scope. 1252466

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

HW 70145

DATE 6-15-61

PROJ. NO.	TITLE	FUNDING
CAH-917	Field Service Center - Atmospheric Physics	61-J

AUTHORIZED FUNDS	DESIGN $	AEC $	COST & COMM. TO	$
$	CONST. $	GE $	ESTIMATED TOTAL COST	$ 154,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
DESIGN	8-15-61		DESIGN	12-1-61*
CONST.	1-15-62	DIR. COMP. DATE	CONST.	5-1-62*

ENGINEER	MANPOWER	AVERAGE	ACCUM MANDAYS
FEO - JT Lloyd	FIXED PRICE		
	COST PLUS FIXED FEE		
	PLANT FORCES		
	ARCHITECT-ENGINEER		
	DESIGN ENGINEERING OPERATION		
	GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100		
TITLE I			
GE-TIT. II			
AE-TIT. II			
CONST.	100		
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project will provide facilites necessary to conduct atmospheric physics research and development programs.

Washington AEC has directed inquiries to the local AEC in regard to using structures available in North Richland. The local AEC has indicated they do not consider these buildings to be an economical substitute for those planned and intend to so advise the Washington representatives.

*Based on AEC authorization by 7-15-61.

PROJ. NO.	TITLE	FUNDING
CAH-921	Geological & Hydrological Wells - FY-61	61-J

AUTHORIZED FUNDS	DESIGN $ 1,000	AEC $ 69,500	COST & COMM. TO 5-28-61	$ 62,135
$ 79,000	CONST. $ 62,000	GE $ 9,500	ESTIMATED TOTAL COST	$ 79,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
DESIGN	4-15-61	3-21-61	DESIGN	5-15-61
CONST.	5-22-61	DIR. COMP. DATE 12-31-61	CONST	12-31-61

ENGINEER	MANPOWER	AVERAGE	ACCUM MANDAYS
FEO - HE Ralph	FIXED PRICE		
	COST PLUS FIXED FEE		
	PLANT FORCES		
	ARCHITECT - ENGINEER		
	DESIGN ENGINEERING OPERATION		
	GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	100	100
TITLE I	100	0	0
GE-TIT. II		75	75
AE-TIT. II			
CONST.	100	20	6
PF	0		
CPFF	3	NS	75
FP	97	20	4

SCOPE, PURPOSE, STATUS & PROGRESS

This project involves the continued drilling of special research, test and monitoring wells.

Contractor is working a 9 hour shift with one rig. He is now 14% behind schedule with 135 calendar days left to complete 4300 ft. of drilling.

Well #11 was completed on June 23, 1961. Contractor averaged 3 feet of drilling per calendar day; actually, contractor should be averaging 30 feet of drilling per day to complete his contract on schedule.

1252467

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70165

DATE 6-30-61

PROJ.NO.	TITLE	FUNDING
CAH-919	Air Conditioning - 314 Building	6-15-61

AUTHORIZED FUNDS					
$ 35,000	DESIGN $ 3,750	AEC $ 28,650	COST & COMM. TO 7-5-61	$ 28,853
	CONST. $ 28,650	GE $ 6,350	ESTIMATED TOTAL COST	$ 35,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 5-2-61	4-18-61	DESIGN 7-5-61	
	CONST. 6-15-61	DIR. COMP. DATE 9-15-61	CONST. 9-15-61	

ENGINEER

FEO - OM Lyso

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT-ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUA
DESIGN	100	NS	100
TITLE I			
GE-TIT. II		NS	100
AE-TIT. II			
CONST.	100	NS	15
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project will supplement existing cooling units, thus providing cooling air supply commensurate with heat load and outdoor temperatures.

Directive AEC-188, dated March 8, 1961, authorized the project and assigned management to the AEC. Work Authority was issued 4-18-61, to the GE Company. A Purchase Order for the coolers has been issued. Delivery is expected on or about July 6. Approved design prints have been issued to J. A. Jones Construction Company. Fabrication of ductwork is scheduled to start week of 6-12-61. It is planned that all fabrication be complete prior to arrival of Cooling Units.

PROJ. NO.	TITLE	FUNDING
CGH-922	Burst Test Facility for Irradiated Zirconium Tubes	61-j

AUTHORIZED FUNDS				
$	DESIGN $	AEC $	COST & COMM. TO	$
	CONST. $	GE $	ESTIMATED TOTAL COST	$ 228,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 11-15-61*		DESIGN 5-15-62*	
	CONST.	DIR. COMP. DATE	CONST. 12-1-62*	

ENGINEER

FEO-H. Radow

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT - ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUA
DESIGN	100		
TITLE I			
GE-TIT. II			
AE-TIT. II			
CONST.	100		
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project will provide facilities to permit deliberate destructive testing of irradiated zirconium tubing. This will provide operating and tube life data not now available because of the limited operating history of Zircaloy-2 pressure tubing in reactors.

The project proposal, which was returned by the Commission without action, has been revised to include supplemental data requested by the Commission. It was resubmitted to the AEC on June 30, 1961.

*Based on AEC authorization 11-1-61.

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70165

DATE 6-30-61

PROJ. NO.	TITLE	FUNDING
CGH-923	Spectroscopy Laboratory	0290

AUTHORIZED FUNDS					
$ 95,000	DESIGN $ 4,500 / CONST. $ 90,000	AEC $ / GE $ 95,000	COST & COMM. TO 5-25-61	$ 73,569	
			ESTIMATED TOTAL COST	$ 95,000	

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
DESIGN 3-21-61	CONST. 5-15-61	DIR. COMP. DATE 11-15-61	DESIGN 5-24-61	CONST. 11-15-61

ENGINEER

FEO-RC Ingersoll

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		6
COST PLUS FIXED FEE	3	20
PLANT FORCES		
ARCHITECT-ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	100	100
TITLE I			
GE-TIT. II		100	100
AE-TIT. II			
CONST.	100	20	25
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project will provide a facility for specialized spectroscopy work.

Partition work is complete. Concrete floor has been cut and removed for tie in work to 325 Bldg. drain system. Digital voltmeter and counter have arrived on site.

The nuclear magnetic resonance spectrometer was shipped by the vendor on June 30, 1961.

PROJ. NO.	TITLE	FUNDING
CAH-924	200 KW Induction Heating System - 306 Building	0290

AUTHORIZED FUNDS					
$ 31,000	DESIGN $ 3,200 / CONST. $ 27,800	AEC $ 24,650 / GE $ 6,350	COST & COMM. TO 5-28-61	$ 5,581	
			ESTIMATED TOTAL COST	$ 31,000	

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
DESIGN 5-1-61	CONST. 8-1-61	DIR. COMP. DATE 2-28-62	DESIGN 7-1-61	CONST. 11-1-61

ENGINEER

FEO - RC Ingersoll

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT - ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	NS	30
TITLE I			
GE-TIT. II		NS	30
AE-TIT. II			
CONST.	100	0	0
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project will provide a source of power for induction heating for R&D work in the 306 Building.

Approved specifications for work stations and voltage regulator have been issued to J. A. Jones for procurement. An interim authorization of 11,000 has been requested of the Commission for procurement.

1252469

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70165

DATE 6-30-61

PROJ.NO.	TITLE	FUNDING
CAH-927	Additions to the 271-CR Building Waste Treatment Demonstration Facility	61-j

AUTHORIZED FUNDS				
$ 80,000	DESIGN $ 4,000 / CONST. $ 76,000	AEC $ 17,500 / GE $ 62,500	COST & COMM. TO 6-18-61	$ 3,500
			ESTIMATED TOTAL COST	$ 80,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 6-16-61 / CONST. 9-16-61	DIR. COMP. DATE 3-31-62	DESIGN 10-16-61 / CONST. 3-31-62	

ENGINEER

FEO - KA Clark

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT-ENGINEER	1	15
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUA
DESIGN	100	NS	0
TITLE I			
GE-TIT. II			
AE-TIT. II			
CONST.	100		
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project provides facilities for pilot plant development of decontamination processes for intermediate level chemical processing plant waste for safe discharge to the plant environs.

Design started 6-15-61. A schedule will be prepared within the next two weeks.

PROJ. NO.	TITLE	FUNDING
CAH-932	300 Area Retention Waste System Expansion	62-k

AUTHORIZED FUNDS				
$	DESIGN $ / CONST. $	AEC $ / GE $	COST & COMM. TO	$
			ESTIMATED TOTAL COST	$ 70,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 9-1-61* / CONST. 12-15-61*	DIR. COMP. DATE	DESIGN 11-15-61* / CONST. 4-15-62*	

ENGINEER

FEO - OM Lyso

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT - ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUA
DESIGN	100		
TITLE I			
GE-TIT. II			
AE-TIT. II			
CONST.	100		
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project will increase the basin capacity commensurate with the increased volumes handled. This will permit transfer to crib waste of contaminated waste if required, and still permit adequate sampling time for the normal flow.

The project proposal was submitted to HOO-AEC for authorization on 5-5-61. Review of this project was deferred by the HOO-AEC Review Board.

*Based on AEC authorization by 8-1-61.

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

HW-

DATE 6-30-61

PROJ. NO.	TITLE	FUNDING
CAH-935	Metals Storage Bldg.	62-j

AUTHORIZED FUNDS	DESIGN $	AEC $	COST & COMM. TO 6-25-61	$ 554
$ 22,300	CONST. $ 21,800	GE $ 22,300	ESTIMATED TOTAL COST	$ 22,300

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 1-2-61		DESIGN 2-10-61	
	CONST. 6-22-61	DIR. COMP. DATE 10-31-61	CONST. 10-31-61	

ENGINEER

FEO - DS Jackson

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE — J. A. Jones	1	7
PLANT FORCES		
ARCHITECT-ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100		
TITLE I			
GE-TIT. II	100	NS	100
AE-TIT. II			
CONST.	100	NS	3
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project will provide a building adjacent to the 328 Building in which fabrication materials and components can be stored for use by the Technical Shops.

Directive HW-525 dated June 16, 1961 authorized the project. Kenneth Cross, the subcontractor to J. A. Jones Construction Company for this project, started work on June 22, 1961. The existing chain link fence was removed and excavation for footings and foundation walls was initiated.

PROJ. NO.	TITLE	FUNDING
CAH-936	Coolant Systems Development Laboratory	62-k

AUTHORIZED FUNDS	DESIGN $	AEC $	COST & COMM. TO	$
$	CONST. $	GE $	ESTIMATED TOTAL COST	$ 93,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 8-1-61*		DESIGN 12-1-61*	
	CONST. 2-1-62*	DIR. COMP. DATE	CONST. 9-1-62*	

ENGINEER

FEO - KA Clark

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT - ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100		
TITLE I			
GE-TIT. II			
AE-TIT. II			
CONST.	100		
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project provides facilities for the conduct of corrosion and decontamination studies for nuclear reactor coolant systems, by the addition of a 2700 sq. ft. laboratory facility on the west side of the 1706 KE Building.

The proposal is being modified by the additionof information relating to the effluent technology programs and the modification of other wording pertaining to present and future work of the Coolant Systems Development Operation.

*Based on AEC authorization by July 15, 1961.

1252471

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. —

HW- 70165

DATE 6-15-61

PROJ.NO.	TITLE	FUNDING
CGH-937	Safety Improvements to 231-Z Bldg.	61-j

AUTHORIZED FUNDS $	DESIGN $	AEC $	COST & COMM. TO $
	CONST. $	GE $	ESTIMATED TOTAL COST $ 45,000

STARTING DATES	DESIGN -1-61	DATE AUTHORIZED	EST'D. COMPL. DATES	DESIGN 1-15-62
	CONST. -1-61	DIR. COMP. DATE 5-15-62		CONST. -1-62

ENGINEER

FEO - DS Jackson

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT-ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	NS	
TITLE I			
GE-TIT.II			
AE-TIT.II			
CONST.	100	NS	
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project provides ventilation system modifications and installation of a fire detection system in the 231-Z Bldg.

A project proposal requesting authorization of this project was submitted to HOO-AEC on June 19, 1961.

The project was approved June 30, 1961.

PROJ. NO.	TITLE	FUNDING

AUTHORIZED FUNDS $	DESIGN $	AEC $	COST & COMM. TO $
	CONST. $	GE $	ESTIMATED TOTAL COST $

STARTING DATES	DESIGN	DATE AUTHORIZED	EST'D. COMPL. DATES	DESIGN
	CONST.	DIR. COMP. DATE		CONST.

ENGINEER

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT - ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100		
TITLE I			
GE-TIT.II			
AE-TIT.II			
CONST.	100		
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

1252472

PROFESSIONAL PLACEMENT AND RELATIONS PRACTICES OPERATION

MONTHLY REPORT

COMMUNICATIONS

Editing of the two-minute news film on the Critical Mass Laboratory has been completed and the final script drafted; clearances are now being obtained. Filming began on a possible TV news film on Strontium 90 recovery facilities.

Prepared press releases on: (1) A. R. Keene's election to the board of directors of the Health Physics Society, (2) W. H. Reas' appointment as Manager - Chemical Research and Development, (3) survey of fishermen conducted by the State Game Department under General Electric auspices. Participated with Relations Operation in the preparation of releases on (1) papers presented at Health Physics Society, (2) radiation "banding" of waterfowl, (3) appearance of a Biology Operation photomicrograph on the cover of Science, (4) vibrational compaction amplifier, (5) two papers by Hanford Laboratories personnel, (6) Hanford Laboratories linguists, (7) the use of a Laboratories-developed ionization chamber reader.

EMPLOYMENT (Professional)

Advanced Degree - Fourteen Ph.D. applicants visited HAPO for professional employment interviews. Four offers were extended (all HL); five outstanding offers were rejected. No acceptances occurred during the month. Current open offers total ten.

BS/MS - One hundred and sixteen candidates were considered, eleven visited HAPO for interviews; twenty-two offers were extended and seven acceptances received.

Technical Graduate Program - Two Technical Graduates were placed on permanent assignment. Forty-three new members were added to the program rolls and one terminated. Current program members total eighty-one.

EMPLOYMENT (Non-Professional)

Thirty-two requisitions were filled during the month with a total of twenty-seven active requisitions remaining to be filled.

HEALTH, SAFETY AND SECURITY

A complete review of job hazard breakdowns is underway throughout the Laboratories as a step toward improvement of safety performance. Two hundred and twenty five job hazard breakdowns for Reactor and Fuels Research and Development Operation were reviewed during the month.

O E Boston

O. E. Boston, Manager
Professional Placement
and Relations Practices

OEB:lmh

TABLE II. PROFESSIONAL PERSONNEL PLACEMENT

A. Technical Recruiting Activity - HAPO - September 1, 1961 to date

	Cases Considered	Visits to Richland: Invited	Visits to Richland: Visited	Visits to Richland: To Visit	Offers: Offered	Offers: Accepted	Offers: Open	Offers: On the Roll
PhD	556	175	74	24	51	12	11	7
Exp. BS/MS	521	105	74	1	100	52	11	35
Prog. BS/MS	399	-	-	-	171	65	1	45

B. Technical Recruiting Activity - HL - September 1, 1960 to date

	Cases Considered	Visits to Richland: Invited	Visits to Richland: Visited	Visits to Richland: To Visit	Offers: Offered	Offers: Accepted	Offers: Open	Offers: On the Roll
PhD	556	175	74	24	51	12	11	7
Exp. BS/MS	291	51	33	1	29	14	2	8

In addition to the above activity, 8 exempt employees have transferred into HL from other HAPO departments and 10 technical graduates have accepted off-program placement in HL to date.

C - Technical Graduate Program
Month ending June 30, 1961

Number Personnel on Assignment	81
(HAPO Tech Grad Program 68	
(Engineering & Science Program 13	

Distribution of Assignments by Departments

IPD	28
HL	35
FPD	4
CPD	11
C&AO	2
CE&UO	1

Distribution of Assignments by Function

Research & Development or Engineering	57
Other	24

FINANCIAL OPERATION MONTHLY REPORT
JUNE 1961

Personnel

There were no changes during the month of June.

Activities

GENERAL ACCOUNTING OPERATION

The status of letters covering actions requiring AEC approval or concurrence is shown below:

Number	Title	Status
AT-52	Expanded Use of Whole Body Counter	Resubmitted to Commission for approval on 6/29/61
AT-104	Fission Products Dispersal Handbook	Still being considered by AEC (Submitted 3/17/61)
AT-105	Symposium on the Biology of Transuranic Elements	AEC Washington is considering
AT-170	Company Utilization of Plant Facilities	In Process. Sent to Commission 6/21/61
AT-171	Delay in Disposition of Residence of Transferred Employee	To Commission 6/23/61
AT-178	Movement of House Trailer	To Commission 6/23/61

Travel activity in June was slightly higher than in June 1960. Although in FY 1961 1,404 trips were started as compared with 1,392 in FY 1960, the total amount charged to cost was slightly less in FY 1961 than in the previous year. The total expended for attendance at professional society meetings in FY 1961 was $46,495 compared with an allocation of $64,500. The underrun is attributed to a shortage of R&D program funds which limited the amount which could be spent for this purpose. (In FY 1960 $34,000 was charged to attendance at meetings.)

Two minor revisions were made to the Travel and Living Expense Manual concerning rental autos and clarification of certain required approvals. A major revision to the manual is currently in process and will be issued in July.

Three IPD forms were revised to meet all related requirements of IPD, CPD, and HLO. New forms processed during the month for Financial included, Diposition of Tickets, Physical Completion Notice (for AR's and WO's), EWIP Report, and revision to Project Cost Weekly Summary.

Fifteen revisions to the AEC Manual were received in June. Details of these revisions are covered in a separate monthly report.

The following OPG's were issued during the month:

New	Revised	Number	Title
	x	22.3.1, p. 1 & 2	Approval Authorizations
	x	22.1.2	Chemical R&D Organization
	x	3.1.3	GE Educational Assistance Program
	x	3.1.4	Absences and Tardiness
x		3.4.18	Technical Graduate Program
	x	22.1.1	Hanford Laboratories Operation Organization
	x	22.1.2	Chemical R&D Organization
	x	3.4.4	Inquiries Relative to Employees
x		1.13	Participation in the Atomic Energy Business
	x	22.1.10	Professional Placement and Relations Practices Organization
	x	44.7	Design Review Council - Appendix

Contracts processed are listed below:

SA-156	State of Washington - Department of Game
CA-293	M. E. Ensminger - Animal Husbandry
DDR-102	Battelle Memorial Institute - Extension of Time
MRO-37	RCA Service Company - Electron Microscope Service
CA-294	Betz Laboratories Inc. - Boiler Water Conditioning
DDR-134	Oregon Metallurgical Corporation

Action as indicated occurred on the following projects during the month:

New Money Authorized HLO

CAH-888	Biology Laboratory Improvements	$40 500
CGH-935	Metals Storage Building	22 300
CGH-937	Safety Improvements - 231-Z Building	45 000

Physical Completion Notices Issued

CGH-785	In-Reactor Studies Equipment
CAH-870*	Facilities for Recovery of Radioactive Materials - 325 Building
CGH-907	Strontium-90 Interim Program

Construction Completion and Cost Closing Statements Issued

CGH-805	High Temperature Tensile Testing Cell - 327 Building
CGH-819	Increased Laboratory Waste Facilities - 300 Area
CAH-885*	Geological and Hydrological Wells - FY-1960

*AEM Services only.

HOO-AEC has extended the CPFF Construction Service Contractor (J. A. Jones Construction Company) contract for two years, new expiration date June 30, 1963.

Reconciliation of the physical inventory of movable cataloged equipment in custody of Reactor and Fuels R&D by HLO Property Accounting is complete and the inventory findings were submitted to C&AO for their review and completion of the reconciliation.

A FY 1962 physical inventory schedule covering the last half of the biennial inventory cycle for movable cataloged equipment was prepared and forwarded to personnel concerned. Inventories scheduled to start in the month of July are for equipment in the custody of Laboratory Auxiliaries, Financial (Laboratory Equipment Pool) and Radiation Protection (Portable Health Instruments only).

Twenty-four items valued at $9,855 were recieved at the Laboratory Equipment Pool Building during the month of June. Six items valued at $2,079 were withdrawn by custodians and nine items valued at $5,806 were transferred in lieu of placement of requisitions. There are currently 613 items valued at $251,187 located in the Pool of which 22 items valued at $22,275 are out on loan.

During FY 1961, 189 items valued at $77,086 were placed by the Laboratory Equipment Pool in lieu of purchase. Total operating costs were $10,986. Since inception of this program equipment valued at $90,294 has been placed in lieu of purchase whereas total expenses, including the cost of the 3718 Building, amount to only $53,878.

Year-end accruals were prepared on zirconium purchase orders in the amount of $26,376. Zirconium accruals by AEC amounted to $67,869.

Heavy Water expenditures for June were $72,429, representing D_2O held for return to SROO for rework ($6,000) and D_2O lost in start-up operation ($66,429). Total Heavy Water expenditures for FY 1961 charged to operating cost were $152,383 representing loss (BPID) $125,021, and $27,362 scrap material (material returned to SROO for rework).

Project unitization reports were issued during the month on the following projects:

CGH-805	High Temperature Tensile Testing Cell, 327 Building	$163 577
CGH-819	Increased Laboratory Waste Facilities	166 275
CAH-885	Geological and Hydrological Wells	66 990

During the month unitization work was completed on Project CAH-744, Metallurgical Development Facility, 306 Building, $2,665,654. The costs will be removed from unclassified account during June business but a formal report will not be issued until July.

Billings to Plant during the month of June totaled $8,293,389 representing closings from EWIP, CWIP and Plant to Plant transfers from the AEC as detailed below:

Equipment Work In Progress

Purchase Orders and Work Orders	$ 349 511
Project CGH-805 - High Temperature Tensile Testing Cell	161 942
Project CGH-907 - Strontium-90	105 000
Project CGH-785 - In-Reactor Studies Equipment - 105-KW	320 983
	$ 937 436

Construction Work In Progress

Work Orders	$ 20 020
Project CGE-819 - Increased Laboratory Waste Facility	165 443
	$ 185 463

Transfers From AEC

Project AEC-167 - Plutonium Recycle Test Reactor	$7 103 500 -1)
Project CAH-885 - Geological and Hydrological Wells	66 990
	$7 170 490
	$8 293 389

(1 - Partial billing enabling HLO to depreciate.

COST ACCOUNTING OPERATION

The June control budget was adjusted to reflect the following:

1. An additional $100,000 of 04 Program funds which we have been advised will be included in a forthcoming Financial Plan from AEC.

2. An additional $2,000 of Studies and Evaluation money given up by IPD.

An R&D Proposal prepared by the Biology Operation on Columbia River Studies was processed by Cost Accounting and submitted to HOO-AEC for consideration in the FY 1962 Budget in the amount of $55,000.

The Hanford Laboratories' estimate for FY 1962 funds required for attendance at Off-Site Courses and Seminars and Meetings of Professional and Trade Societies was prepared and submitted to Contract Accounting in the amounts of $5,000 and $64,500, respectively.

Special request activity during the month was as follows:

.4A Wyandotte Chemical Corporation
Cost of packing and shipping of single pass mock-up tube samples. Estimate under $25.

.4C Union Carbide Nuclear Company
X-ray [illegible] tion Studies on 6 UO_2 specimens. Estimate - $2,000.

Diffraction Analysis of 15 samples of selected control
stimate - $1,800.

15

tion of UO_2-PuO_2 Fuel Pins.
- $19,200.

rs were established in Instrument Research and Development
[illegible]ective July 1, 1961:

7457 - Field Studies
7458 - Special Projects

In addition, a new cost center, "Advanced Engineering Courses", code 7233, was established June 1, 1961, to accumulate associated costs involved in the administration of the new Advanced Engineering Program. Total costs will be split between Engineering Education Service and Hanford Laboratories.

New end program codes established during the month were as follows:

Code	Title	Remarks
.32	Advance Studies	New research and development program sponsored by Division of Reactor Development.
.33	Irradiation Effects on Structural Materials	Program sponsored by Division of Reactor Development included in FY 1961 as part of In-Reactor Measurements program.
.48	FPD - Process Technology AlSi	To differentiate process technology costs for FPD.
.49	FPD - Process Technology-NPR - Coextrusion	

The booklet summarizing the Budget for FY 1963 and Revision of Budget for FY 1962 was completed and distributed to HLO management.

The HLO file on charts and slides was reviewed and several depicting financial data were revised and updated.

In connection with the annual review of routine work orders, we furnished all HLO customers with lists of open orders and requested an examination of the need for services, accuracy of the description, and appropriateness of authorized funds.

Unit Cost Reports for Radiation Protection were discussed and tentative plans made to provide them quarterly. Procedures will be established for preparation of the reports within the next few weeks.

New exempt salary averages and IME rates were calculated for use starting with July 1961.

GENERAL

Payroll Statistics

Number of HLO Employees	Total	Exempt	Non-Exempt
Changes During Month			
Employees on Payroll at Beginning of Month	1 358	633	725
Additions and Transfers In	105	76	29
Removals and Transfers Out	30	8	22
Employees on Payroll at End of Month	1 433	701	732

Overtime Payments During Month	June	May
Exempt	$ 11 345	$ 6 607
Nonexempt	38 041	25 810
Total	$ 49 386	$ 32 417

Gross Payroll Paid During Month		
Exempt	$ 598 725	$571 486
Nonexempt	500 063	406 995
Total	$1 098 788	$978 481

Participation in Employee Benefits Plans at Month End	June Number	June Percent	May Number	May Percent
Pension Plan	1 235	99.4	1 226	99.1
Insurance Plan				
Personal Coverage	377		365	
Dependent Coverage	1 016	99.8	982	99.1
U.S. Savings Bonds				
Stock Bonus Plan	68	34.3	66	32.7
Savings Plan	80	5.6	83	6.1
Savings and Security Plan	1 071	86.8	1 038	89.9

Insurance Claims	June Number	June Amount	May Number	May Amount
Employee Benefits				
Life Insurance	0	$ 0	0	$ 0
Weekly Sickness and Accident	8	497	5	344
Comprehensive Medical	35	6 524	71	8 433
Dependent Benefits				
Comprehensive Medical	89	12 235	157	17 061
Total	132	$19 256	233	$25 838

Good Neighbor Fund	June	May
Number Participating	944	924
Percent Participating	65.9%	68.1%

W. Sale:bk
July 20, 1961

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
J. Dunn	A Means for Agitating Contents of Vessels
R. E. Heineman, in collaboration with H. L. Henry	A possible invention is being investigated. This invention concerns the use of hydrogen containing solids inside of meltable fuel as a quenching mechanism for excursions of reactor systems. R. E. Heineman in HWN-1349, Page 21, 6/20/61, in collaboration with H. L. Henry.
H. L. Henry	A possible invention is being investigated. This invention concerns a method of fabrication of safety-fuse type reactor fuel that will ensure collapse of the fuel when heated. H. L. Henry in HWN-2602, Page 1, 6/29/61.
H. L. Libby	The Stabilization of the Temperature of Eddy Current Nondestructive Test Coils, HWIR-1402.

[redacted]

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