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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
JULY, 1961

Compiled by
Operation Managers

August 15, 1961

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PRELIMINARY REPORT

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TABLE OF CONTENTS

TABLE I. HL FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE July 31, 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	128	118	246	127	118	245	1	4	0	4
Reactor & Fuels Research & Development	205	193	398	199	189	388	10	8	4	4
Physics & Instrument Research & Development	99	60	159	96	62	158	3	1	0	3
Biology Operation	38	48	86	37	47	84	2	2	1	1
Operation Res. & Syn.	19	4	23	18	3	21	1	1	0	0
Radiation Protection	41	97	138	40	99	139	1	0	0	2
Laboratory Auxiliaries	47	183	230	50	182	232	0	4	3	3
Financial	20	15	35	20	15	35	0	0	0	0
Prof. Placement & R. P.	98	11	109	94	11	105	13	0	9	0
Programming	18	4	22	18	3	21	1	1	1	0
General	2	4	6	2	4	6	1	0	1	0
Totals	715	737	1452	701	733	1434	33	21	19	17
Totals excluding internal transfers	715	737	1452	701	733	1434	25	16	12	11

BUDGETS AND COSTS

July operating costs totaled $2,067,000 or 8% of the $26,371,000 tentative control budget. The budget is based on data contained in the initial AEC financial plan and the proposed departmental allocation of funds by the General Manager, HAPO.

Hanford Laboratories research and development costs for July, compared with the tentative control budget are as follows:

(Dollars in Thousands)

	July Cost	Annual Budget	% Spent
HLO Programs			
02 Program	$ 37	$ 605	6%
04 Program	755	9 930	8
05 Program	61	993	6
06 Program	197	2 665	7
	1 050	14 193	7
FPD Sponsored	105	1 400	7
IPD Sponsored	100	1 325	8
CPD Sponsored	108	1 525	7
Total	$1 363	$18 443	7%

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

PRTR power tests were resumed on July 3, concluding an extended outage of about six weeks. Full power of 70 MW was achieved for the first time on July 21, and was maintained for 60 hours. From a physics standpoint, reactor operation is as anticipated. Accumulated evidence indicates the existence of one or more failed fuel elements in the reactor.

A preliminary evaluation of the heat removal performance of certain of the PRTR auxiliary systems made during reactor operation at 35 and 45 MW, indicates that the moderator heat removal system will operate satisfactorily at designed operating conditions but that the reflector system heat load is larger than anticipated and may require periodic cleaning of the heat exchanger surface or adjustment of operating conditions if significant surface fouling occurs.

In ex-reactor fretting tests of prototypical PRTR process tube-fuel element assemblies, fretted areas 2 to 5 mils deep developed on the process tube within two weeks at the fuel support areas each time the position of the fuel element was changed. However, the depth of pitting did not increase significantly with increasing exposure time.

Examination of a Zircaloy-clad plutonium-aluminum alloy fuel element which was in the PRTR at the time of the chloride and fluoride contamination showed no increase in hydrogen content around the pitted area. UO_2 elements recently discharged from PRTR have been excellent in external appearance.

On the basis of PRTR neutron flux measurements made through the primary shields, it is concluded that core gamma leakage rather than piping activation will be the major component of shutdown dose rates.

Preliminary tests of a powder loading machine for incremental loading of PuO_2-UO_2 fuel elements indicate that plutonium distribution can be controlled to within plus or minus five percent of a nominal 0.5 weight percent plutonium. Experiments to produce uniform feed for incremental loading have shown that -325 mesh UO_2 and PuO_2 powders can be blended to a maximum variation of plus or minus 1.5 percent plutonium content.

Pulverized arc-fused UO_2 was found to evolve 0.275 cc of gas per gram at 1000 C. The gas evolved is principally nitrogen.

Studies on plutonium carbide and the system plutonium carbide-uranium carbide continued. Synthesis of plutonium silicides and fabrication of PuO_2-ZrO_2 irradiation specimens were performed. Measurement of electrical resistivity and thermal emf of plutonium ceramics is being initiated.

Pre-irradiation reactivity measurements of Phoenix fuel capsules are nearly finished and irradiation of the samples in MTR is about to proceed.

The final report on the Supercritical Pressure Power Reactor (SPPR), HW-68420, "Economic Evaluation of a 300 MWe Supercritical Pressure Power Reactor," has been completed and is being prepared for publication. It is concluded that the main unknown to the successful exploitation of the supercritical pressure concept is the long exposure, high temperature properties of irradiated Hastelloy "X", the pressure member material selected for this study.

In NPR fuel development studies (tubular, Zircaloy-clad, metallic uranium), examination of elements irradiated to 1200 and 2000 MWD/T showed continued good irradiation performance by the Be-Zr braze closure. Also, an empirical equation was developed which correlates irradiation temperature and burnup with swelling, elements irradiated in a high flux gradient were shown to warp in the plane of the flux gradient, and in-reactor rupture testing and post-irradiation defect testing continued to show increased fuel element damage with increased fuel burnup.

Capsule irradiations of uranium metal have established an irradiation temperature below which cracking does not occur.

The oxidation and hydriding behavior of Zircaloy-2 and -4 in a simulated NPR gas atmosphere are being compared by parallel capsule tests in- and ex-reactor.

Contraction rates of EGCR graphite samples during the second 20,000 EGCR MWD/AT exposure in the GETR do not show the beginning of contraction saturation, but were actually slightly higher than during the first irradiation period. Samples have been recharged for a third exposure period.

2. Chemical Research and Development

The high alum reactor water treatment process at F Area was found to reduce the concentrations of the Cu-64 and As-76 radioisotopes, originally formed by upstream reactor operations and present in the F reactor source water, by 10 and 40 percent, respectively. Little change in concentration was noticed for Np-239, Na-24 and Cr-51. The production of As-76 at F Area is substantially lower than that anticipated assuming the As-75 parent behaves as does As-76 in the high alum water treatment process.

Preliminary laboratory results indicate that no significant release of fission products from an NPR fuel element would occur during the first hour after loss of coolant providing the fuel temperature does not exceed 1200 C. At 1300 C loss of the Zircaloy cladding protection can be expected in times less than one hour with the anticipated result that fission gases would be released.

Final inspection and evaluation operations were completed on the loaded (120 kilocuries Sr-90) HAPO-IIA strontium carbonate shipping cask. Pressure buildup after sealing the cask was less than one psig over a 24-hour period.

Laboratory studies on solvent extraction and precipitation processes show promise of utility at the Hot Semiworks and the Purex plant, respectively, for the acquisition of a mixed rare earth product which is relatively free of cerium and strontium radioactivities. The mixed rare earth product is of importance since this material is required as feed for the ion exchange separation and recovery of a final, purified promethium-147 product.

Preliminary laboratory studies indicate sodium tetraphenyl boron (dissolved in an inert organic diluent) to be effective for the extraction of radiocesium from high level waste supernate solutions. Cesium distribution coefficients are extremely dependent upon the nature and concentration of diluent.

The presence of stable cobalt salts in mixed NPR decontamination waste at concentrations of 10 to 100 ppm was shown to effect a substantial improvement in the scavenging of radiocobalt by freshly precipitated manganese dioxide.

3. Physics and Instrument Research and Development

The experimental program in the new Critical Mass Laboratory, which got under way at tne end of last month, continued with measurements on plutonium nitrate solutions in a 14-inch diameter unreflected sphere. None of the solution concentrations used produced criticality in the unreflected sphere, but the addition of a partial reflector allowed achievement of the first critical in the laboratory on July 21. A week later a second chain reaction was obtained with a more dilute solution. With the exception of some valves, the equipment operated satisfactorily.

More liberal nuclear safety limits for the processing and storage of NPR fuel elements and for other slightly enriched elements have resulted from an improved extrapolation and interpolation from available data. Meanwhile development continued on methods for treating the interaction between vessels, pipes, etc., each of which is not critical by itself.

Continuous running tests on the mockup of the backup NPR fuel failure monitor were resumed following incorporation of improvements suggested by previous accelerated tests. Three weeks of satisfactory operation had accumulated at month end.

Measurements have begun to determine the changes in control rod strengths and other physics properties which would result from the proposed retubing of C-reactor. Meanwhile improvements in techniques for analyzing exponential experiments have increased confidence in the results by removing a long standing discrepancy in interpreting experiments of this type.

Detection of cracked reactor rear face fittings by ultrasonic methods was demonstrated on pieces with simulated cracks.

A new idea for a last ditch safety system fuse for the PRPCF is being evaluated in the laboratory. It is hoped that fission heating of mercury in a capillary will provide a faster response than did thermostat schemes previously tested.

The extent of hydriding of Zircaloy-2 may be determined nondestructively by use of Hall coefficient measurements according to promising results obtained in laboratory tests on concentrations between 5,000 and 15,000 ppm. Use on lower concentrations may prove infeasible due to the complex relationship between Hall coefficient and concentration in that range.

Fuel cycle analyses of the APWR and Dresden reactors continued. Meanwhile analyses of Th-U-233 cycles has indicated the importance of Pa-233 burnout and has prompted a search for the best data available on the cross section of that isotope in the resonance energy region.

Development of automatic reactor control systems continued with analytical studies and development of a device to read out control rod positions for reactor experiments.

Increased understanding was achieved in the field of atmospheric diffusion, where a method for treating cases involving changes of wind direction near the ground was developed; and in radiation physics, where a study of the fundamental field equations of radiation dosimetry was completed in collaboration with Dr. Rossi of Columbia University.

Accomplishments in the radiation measurement field included completion of development and testing of the automatic film badge densitometer; improvements in techniques which produce more uniform thermoluminescent dosimeters; satisfactory test results on a newly developed versatile sensitive radiation detector for Project Chariot; and borrowing from the vendor for testing for possible use in the Whole Body Counter of the largest NaI scintillation counter ever made.

4. Biology

Death from columnaris infection of juvenile rainbow trout held in troughs supplied with regular Columbia River water was shown to occur only under crowded conditions -- no deaths with 150 fish per trough, 2.2% mortality with 450 fish per trough, 3.4% with 900 fish per trough. The extrapolation of data obtained in hatchery troughs under crowded conditions to river conditions is very questionable.

The virulence of columnaris strains was shown to be correlated with their proteolytic activity, suggesting that their ability to attack fish is related to the activity of the protein-hydrolyzing enzymes of the organism and offering a possible means for easy identification of virulent strains.

Ten months following intradermal injection of plutonium nitrate, 3 to 4% of the injected dose remained at the injection site in those animals where the scab resulting from the injection was removed surgically. This compares with 30 to 40% retention at the sites where scabs were left intact.

Studies of the transfer of radioisotopes to milk in sheep indicate that plutonium levels in the milk at seven hours' post-injection are only about 5% of the average concentration in the plasma during the preceding post-injection period. In the case of Ce^{144}, the concentration in the milk is about equal to the average plasma concentration. In the case of I^{131}, concentrations in milk over a 24-hour period ranged from 15 to 25 times the concentration in the blood plasma.

5. Programming

Computation efforts were greatly accelerated during July (at the expense of other activities) in compliance with a special request by the AEC that all possible information on value of plutonium and of uranium-233 be assembled by August 11, 1961. Fissile plutonium values about 50% greater than the price for fully enriched uranium are being encountered for the hypothetical case of high exposure plutonium used with natural uranium as fuel for the Advanced Pressurized Water Reactor described in TID-8002.

TECHNICAL AND OTHER SERVICES

Continuing study of the use of polynomials to describe irradiation induced fuel element distortion has shown that this method has several advantages over the method traditionally used. It permits classification of distortion into one of twenty-four different types and provides an objective means of detecting those fuel elements with unusual distortion and those which were probably measured with gross error.

A method of estimating the slope parameter in the rupture model has been developed using information only from lots which sustained ruptures. This was done under a generalized rupture model which permits each lot to have a different location (or intercept) parameter. Confidence limits were also found.

Boolean matrices have proved to be a useful tool in analyzing systems for reliability. Several examples of the application of this technique have been worked out, including a practical demonstration of reliability analysis as applied to a standby electrical power system.

An IBM 7090 Program designed to obtain numerical solutions to transient state non-linear diffusion problems has been written and is in the process of being tested. The program has thus far been restricted to one space dimension slab geometry with fairly simple boundary conditions. It is planned to extend the program to more space dimensions as well as to a cylindrical geometry.

There were no new cases of plutonium deposition confirmed during the month. The total number of plutonium deposition cases that have occurred at Hanford is 267 of which 193 are on the active roles.

The incremental increases up to 70 MW in power level of the PRTR did not cause any significant radiation control problems. Air contamination associated with startup and changes in power level was frequent. Without exception, however, the air contamination displayed the characteristic half-life of the short-lived noble gases, Xenon and Krypton, and their decay daughters. Radiation surveys of the reactor during incremental power increases reveal a generally linear increase in dose rates at selected locations near the pressurizer vessel. Although the presence of tritium was measurable in bioassay samples of PRTR personnel, the concentrations detected had minor radiological significance. The discharge of aqueous and gaseous radioeffluents from the PRTR during operation and up to a power level of 70 MW were well below the recommended levels.

Some difficulty was experienced in maintaining good radiation control at the Hot Semiworks facility. Pressurization of the atmosphere of three cells at the Hot Semiworks caused excessive air contamination with radiostrontium. Ten HLO and one CPD employee were bioassayed. Four of the involved persons showed positive but minor deposition of strontium. Release of radioactive materials from the Hot Semiworks stacks during the most recent process run was lower by a factor of 50 than release rates that were measured prior to the installation of the additional ventilation filters last month. Stack filter samples taken upstream and downstream of the filter indicated an overall efficiency of 99%.

An aerial survey flight made over the Columbia River from Hanford to the Pacific Ocean showed a three-fold increase in radiation level of the mud flats at the mouth of the river as compared to the surrounding terrain. Plans were made to obtain core samples from these mud flats for isotopic analysis.

There are 20 currently active projects having combined authorized funds in the amount of $5,493,000. The total estimated cost of these projects is $10,778,000. Total expenditures on them through June 30, 1961 were $1,992,000. In addition, project proposals have been submitted requesting authorization of $658,000 total project funds on 5 new projects.

The first draft of the General section for the new local classification guide for Hanford was distributed to select HAPO personnel for review and comments. This section covers the general aspects of Hanford and its operation such as site description, maps, photographs, utilities, construction, etc. Work on drafting the Fuels Preparation section for the new guide is being undertaken.

Advanced Degree - Four candidates visited HAPO for professional employment interviews. Nine offers were extended (all HL - two were joint offers with IPD and FPD); four offers were accepted (all HL) and four (all HL) were rejected. Current open offers total eleven.

BS/MS - Five experienced candidates visited for interviews; eleven offers were extended; six acceptances and five rejections were received. Current open offers total eleven. Program recruitment consisted of one extended offer, one acceptance and one rejection.

Technical Graduate Program - Seven Technical Graduates were placed on permanent assignment. Thirteen new members were added to the program rolls and one terminated. Current program members total 86.

Tentative assignments in HL and IPD have been agreed upon for four members of the AEC Technical Training Program. The trainees will arrive early in September.

Nineteen requisitions were filled during the month with a total of 32 active requisitions remaining to be filled.

There were two security violations during July and 38 medical treatment injuries.

Investment in Plant and Equipment at June 30, 1961, amounted to $67,300,000 compared with $43,900,000 at June 30, 1960. The increase of $23,400,000 consists principally of major projects such as PRTR, PFPP, and 306 Building Addition.

W. H. Rean
for Manager
Hanford Laboratories

HM Parker:WHR:mlk

[redacted]

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

In-Reactor Hydriding Corrosion Capsule. A capsule containing Zircaloy-2 and Zircaloy-4 alloy samples was charged into the 2-A side-to-side test hole in KE Reactor on July 20. The test will compare the oxidation and hydriding behavior of samples exposed to a simulated NPR gas atmosphere in-reactor with a parallel test conducted ex-reactor. Test variables include surface condition (as etched, autoclave surface) and test temperature (nominally 325, 375, 425 C). Initial indications are that the monitoring and temperature control circuits are functioning properly although partial evacuation of the helium atmosphere in the cooled test hole chamber was necessary to achieve the maximum design temperature.

Erosion Corrosion of Aluminum Alloys. Samples of X-8001 were exposed to 300 Area tap water adjusted to pH-8 at 105 C and a flow velocity of 88 ft/sec for six hours. The amount of corrosion was measured by taking the cross-sectional area of the corroded groove which was 165 mils^2. The depth of the groove was 6.5 mils. Another sample of X-8001 was exposed to the same conditions as above except that 0.05 ppm sodium dichromate was added to the water. The result was no measurable corrosion for the six-hour test. Further tests are planned using other alloys and water conditions.

Corrosion Resistant Coatings for X-8001 Aluminum. The feasibility of a dual cycle application of a protective autoclave coating for aluminum fuel element jackets is being investigated. The initial autoclave treatment has been limited to deionized water or steam and is intended to prevent "worm-tracking" during the subsequent chromic acid autoclaving step. Either process would allow for a suitable inspection of the fuel element jackets for inclusions or defects, before a final treatment in chromic acid which produces a dark film.

An accelerated corrosion test for the autoclave coatings is being evaluated. Corrosion resistance is estimated from the average of weight losses in boiling 5% sodium carbonate, and in boiling 1% HCl-3% NaCl solution.

Currently, experiments are being conducted to determine which of the initial coatings, water or steam, will provide the best base for the chromic acid treatment. Subsequent tests will establish optimum time and temperatures for the water or steam and the 1% chromic acid cycles.

Radiometallurgy Laboratory Studies

Data are currently being analyzed for 16 nickel-base super alloy irradiated samples which were tensile tested at 700 C (RM-511).

Results of fuel examinations performed during the month are reported in other portions of this document.

Basic Metallurgy Studies

Electron and Optical Microscopy. Study of fission fragment damage in metals has continued. High purity, annealed aluminum wires, 0.003" OD, were coated on a side with UO_2 and then irradiated to exposures as high as 2×10^{18} nvt (thermal). After embedding in epoxy resin, thin transverse sections, approximately 200 A thick, were prepared by microtoming. Examination in the electron microscope did not show positive evidence of fission fragment damage. Since recovery of damage in bulk aluminum may occur at ambient temperatures, similar irradiation at lower temperatures or with higher melting point metals is being considered.

High Strength Zirconium Alloys. The heat treatability and mechanical properties of eight alloys are being studied in an effort to evaluate a high strength zirconium base alloy for reactor applications. Initial heat treatments consisting of quenching alloy coupons from 850 and 800 C show the following alloys quench harden considerably: (1) Zr - 1% V, (2) Zr - 0.5% Nb - 0.5% V, (3) Zr - 1% Nb - 2% Sn - 1.0% V, and (4) Zr - 3% Nb - 2% Sn - 0.1% Fe - 0.05% Ni. Alloys of zirconium with 4.0% Sn + 2.5% Mo and 2% Sn + 2% V hardened only slightly. Two other alloys, Zr - 2.0% Sn - 1.0% Nb - 1.0% V - 0.5% Cr, and Zr - 1% Cr - 1% V - 0.5% Nb have not yet been heat treated.

Skull Melting. Two successful Zircaloy-2 heats have been made using the skull melting attachment for the consumable arc furnace. A proposed design for an NPR mixer piece was cast. The part consists of a four fluted spiral, three inches long by 2-3/4 inches OD. Two parts per heat were cast. These two test heats demonstrate the feasibility of making small complicated parts of Zircaloy for reactor hardware. Corrosion studies and metallurgical evaluation of the castings are in progress.

Zirconium Alloys of Variable Tin and Oxygen Content. Electrode preparation is under way for the double vacuum arc melting of seven zirconium base alloys. These alloys are a Zircaloy-2 composition with tin contents ranging from 0.10 to 1.50 percent. Each alloy will be made using two different oxygen levels, 1300 ppm and 560 ppm, representing 143 BHN and 120 BHN sponge, respectively. Materials from these 14 ingots will be used to study the effect of tin and oxygen on the extrusion constant of Zircaloy. A zirconium cladding with a lower extrusion constant could lead to a more uniform clad thickness.

[redacted]

Metallic Fuel Development

Fuel Irradiations. The production brazed irradiation test GEH-4-63, 64, was placed in the MTR on July 7, 1961. This test is a sequel to GEH-4-57, 58, which was the only brazed end closure failure obtained to date. The objective of the irradiation is to determine whether a shear failure mechanism is operable with production brazed material. In order to obtain a flux pattern, flux wires were placed in the reflector block to determine the flux during each cycle and another attached to the basket for the integrated flux. This test was calculated to operate at a specific power of 62 kw/ft. Six MTR cycles of irradiation were requested.

Another test, GEH-4-68, 69, 70, is being prepared to provide a comparative irradiation on the effect of braze thickness. Production brazed I&E fuel with 0.015 and 0.030-inch wide braze will be used. This test will develop 81 kw/ft. Five MTR cycles have been requested. The charging date has not been determined.

Radiometallurgical examination of two KER-size tube-tube metallic elements has begun. An increase in double throw warp of 0.120 inch was observed. This warp appeared to be a maximum at the corresponding inflection point on the flux map. The bow appeared to be toward the reactor core. This test operated at 320 kw/ft and was exposed to 1200 MWD/T. The closure was brazed with the 12 Fe + 4 Be + Zry brazing alloy.

Radiometallurgical examination of KSE-3 single tube fuel elements is continuing. Hot extraction of hydrogen from a clad sample obtained from a 1200 MWD/T element indicated 70 ppm hydrogen; a concentration approximately twice that expected. Pre- and post-irradiation densities of the fuel indicate a 1.35 percent increase in volume. This compares very well with 1.3 percent as determined by fuel element displacement measurements made in the reactor basin follwoing discharge. Additional sections of the closures of the 2000 MWD/T elements have been made, and some fine radial cracks across the uranium wall in the braze-closure heat-affected zone have been seen. These cracks terminate at the clad. No deficiencies have been noted in the Be-Zr brazed closures. The three percent fuel swelling observed in these fuel elements has produced some distortion of the inner bore by buckling of the inner clad.

An empirical expression for the swelling observed on the 1200, 2000, and 3600 MWD/T KSE-3's (1.0 to 5.4 percent) has been derived which relates the swelling to the 1.7 power of the burnup and the temperature (T - 340 C) in the range of mean fuel temperatures of 400-470 C.

Radiometallurgy examination of three KSN-1 fuel elements (obsolete N inner-tube geometry) continued during the month. One of the three had failed in KER after 1700 MWD/T exposure. The failure was due to thermal stress incompatibility existing between the fuel and the welded end caps. Density decreases show an appreciable dependence of swelling as a function of burnup and temperature. The density decrease of the coolest element (0.204 percent burnup at 450 C) was about one percent compared to 2.6 percent for the hottest element (0.256 percent burnup at 470 C). A third

element contained a U-2 w/o Zr alloy fuel. The measured density decrease indicates that swelling was approximately 25 percent greater than would be expected in an equivalent unalloyed fuel element.

The seventh in the current series of in-reactor rupture tests was performed at the ETR using an NPR inner tube fuel element pre-irradiated to 1670 MWD/T. Nine minutes after the defect cap was sheared off, loop activity began increasing. During the next five minutes the activity continued to increase and the test was terminated. Although the results of the seven tests have not yet been completely analyzed, the following conclusion seems warranted: Irradiated fuel elements have shorter incubation periods and corrode more rapidly following the incubation period than do unirradiated fuel elements of the same geometry. This is primarily the result of internal cracking of the uranium which occurs at high exposures, thus exposing a greater fuel surface to the attack of the water coolant once the cladding has been penetrated.

Three 18-inch long coextruded fuel elements representing a major modification of an NPR inner fuel tube are being prepared for irradiation. These fuel elements have a 0.440-inch inside diameter but, instead of a circular outside cross-section, the section contains six cusps. (The shape is a modified hypocycloid.) The objective of using this geometry is to avoid pure tensile strains in the clad as the uranium swells during exposure. The three test elements were successfully braze-closed and are now ready for non-destructive testing and end welding.

Heat Treatment Studies. Eleven 24-inch long NPR inner tubes have been beta-heat treated for a second time to determine the warp characteristics of a tube which has had the preferred orientation removed and to see if any better warp correlations present themselves than were found on the first heat treatment. The change in warp on the second heat treatment was as great as the change in warp on the first heat treatment. The plane of the warp remained approximately the same in only five of the eleven tubes and the vector change in warp remained nearly the same in direction in only three of the tubes. No correlations could be found between the plane of the warp, the vector direction of the change in warp, the plane of the shift, or variations in wall thickness. X-ray results have not yet been obtained on these tubes, but results of previous tubes given the same heat treatment have shown that very little, if any, preferred orientation remains after the first heat treatment. Since the change in warp was as great on the second heat treatment as on the first, it appears the preferred orientation has little to do with the warp. These tubes are to be hot straightened and given a third beta-heat treatment.

Fuel Component Development. A fixture has been designed to establish the N outer fuel element support circle diameter during support attachment. The support circle diameter is specified $2.685 \pm \begin{smallmatrix}.000\\.005\end{smallmatrix}$ inches. The fuel element diameter tolerances are 2.404 ± 0.010 inches. The support must be sized to prevent selective fitting and to meet the above specification. It is proposed to rigidly restrain the support crown contour and

to index this point with reference to the fuel centerline. Any sizing required will be done by longitudinal movement of the support tabs. Restraining the crown contour during welding prevents "pulling the support out of specs" by the crimping action of the shoe attachment.

A second generation of locking clips to hold the NPR outer tube and the inner tube together during discharge was made. Eight two-foot long fuel element assemblies were run through the simulated NPR discharge test and none of the element components separated significantly during the test. Another design of locking clip, which contains a positive lock to prevent disengagement of the clip by rotation of the inner tube, is being prepared for testing.

Welding and Joining. Redesign of the locking device which pins NPR outer fuel tubes to NPR inner fuel tubes has necessitated a change in tooling for attaching this hardware. A new set of tooling designed to fit the Weldex Model 10 Spike Power Welder is being built by Tech Shops.

Approximately one thousand supports have been attached to NPR fuel elements for sorting machine tests. These have been done on a three-phase 100 KVA Sciaky welder operating as a single phase welder. Two magnetic force welders have been installed in the 333 Building and temporary tooling is in place on one to permit determination of proper machine settings for support welding.

Closure and Joining. Roll bonding of 406 SS to uranium has been accomplished. A good tough bond has been produced by using two-mil Mo foil as a bonding agent. A sandwich was made with a core of uranium covered on both faces by two-mil Mo foil which in turn was covered by 406 SS. The entire sandwich was encased in an evacuated 304 SS container. This assembly was heated to 640 C and rapidly reduced approximately fifty percent in thickness by use of the forge. The reduced compact was then heated for two hours at 640 C after which it was cross rolled down to twenty percent of its original thickness. The cross rolling was done at 640 C. Another soak at 640 C for one hour was done prior to air cooling. The maximum temperature at which the sandwich can be worked (640 C) is low for the Mo-U diffusion to take place. Because of this limitation, long soaking times at temperature and severe working at temperature are required to produce alloying at the interface.

It was found that the bond formed at the interface between the Zircaloy cap and the uranium core in the self-brazing process employing a thin copper plate for the bonding medium tended to be brittle. Fracturing in the Cu-U phase commonly occurred due to differential expansion when the assembly was salt-bath heat treated.

To overcome this tendency, the procedure was modified to add a flash coat of nickel plating over the copper on those surfaces of the cap that are to contact the uranium. Destructive tests indicate greatly improved toughness in the interfacial layer.

Fuel Deformation Studies. New fuel element measuring equipment, made by Sheffield Company to HAPO specifications, is installed and in use. This equipment measures and records outside diameter, inside diameter, wall thickness, and warp at any number of selected positions along the fuel length. Preliminary evaluation of the equipment indicates the measurements are accurate to within ± 0.001 inch. A method of analyzing the continuous circumferential radial displacements and thicknesses has been proposed. A program which reduces the machine measurements to mean diameter, mean axial displacement, ovality, eccentricity of cladding surfaces, and radii of curvature of the mean axial displacement is being written.

A series of NaK capsule irradiations of Zircaloy-2 clad uranium rods is planned for the Hanford reactors. The final eighteen test sample capsules have been filled with NaK. All that remains for completion is the attachment of devices for centering the capsules in the process tubes. Five capsules each containing a single Zircaloy-2 clad uranium rod and a thermocouple to measure the central uranium temperature have been filled with NaK, and the thermocouple trains for three of these capsules are now being assembled.

Allied Studies. Two 3200 MWD/T exposure coextruded KER inner fuel tubes, one unalloyed uranium and one U-2 w/o Zr, were defect-tested in 300 C, 1650 psi water in the IRP facility. An order of magnitude slower fuel corrosion rate was observed with the alloyed fuel. The unalloyed uranium fuel tube has been examined in Radiometallurgy and was broken into three major pieces and six minor pieces. The tube had a spiral split from one end to the other end, and both end caps (unbonded) had separated from the clad.

Equipment Development (Project CAH-901). Modification of the ETR 6x9 loop under Project CAH-901 is approximately 50 percent complete. The Zircaloy-2 pressure tube for the M-3 position will be inserted in the reactor on or about August 1. Present schedules indicate beneficial use of the new facility approximately the first of September. The first test in the 6x6 M-3 position will be a gamma probe to determine gamma heating, followed by a full-size NPR element fuel. The 6x9 G7 position will be used for the structural materials program. The first specimens will be loaded at the next reactor startup.

2. REACTOR PROGRAM

Coolant Systems Development

Effluent Activity and Corrosion Testing Program in Single-Pass Tubes. The deionizers to supply two tubes for effluent activity testing have been received from the manufacturer. The project to build a pilot sedimentation and filtration plant to supply water to two tubes has been approved by the Washington AEC. Completion is estimated for February 1962. The start of a series of effluent activity tests involving additions to process water awaits the installation of suitable facilities for injecting these chemical additions. Corrosion and thermocouple-slug

tests will be started after the writing and approval of a Production Test. In order to maintain comparable conditions in both the aluminum and Zircaloy tubes, it has been tentatively decided to use K-IV-NS (self-supported) elements in ribless Zircaloy tubes, and a charge of K-IV-NS is being made up for experimental verification of the expected pressure drop.

Redeposition of Activities from Decontaminating Solutions. The eastern portion of the 183 KE Laboratory has been modified so that it can be used for radioactive work to study the factors influencing redeposition of activity from decontaminating solutions. A one millicurie solution of Cr^{51} in a dilute solution of chromic acid has been obtained from Radiochemical Analysis Operation and preliminary experiments have been started. It is planned to utilize TF-14 in 242B for dynamic studies after the preliminary laboratory studies have been completed. The loop is being modified to permit radioactive studies.

Old Reactor Decontamination (PT-IP-323-AE). Corrosion was measured for aluminum, carbon steel, and Zircaloy-2 at C-Reactor during in-reactor testing of three decontaminating mixtures: (1) inhibited sulfuric-oxalic acids, (2) Turco 4306-C, and (3) Turco 4306-B. Test conditions were approximately 40 minutes contact at 35 C for all solutions.

The inhibited sulfuric-oxalic solution was the least corrosive; while Turco 4306-B was definitely the most corrosive of the three solutions, and the only one of the three considered unsatisfactory because of high corrosivity. Turco 4306-B was the only reagent corrosive to Zircaloy-2, giving a corrosion rate of 2 mils/treatment. A 40-mil Zircaloy-2 tube would be corroded halfway through after 10 decontaminations. Turco 4306-B was also the only reagent corrosive to carbon steel, with a corrosion rate of 0.2 mil/treatment. This reagent also is more corrosive to aluminum, with a corrosion rate of approximately 2 mils/treatment.

Cyclic Decontamination Studies in TF-4. The TF-4 (CEP-4) system has completed three cycles to date and is prefilming on the fourth cycle of eight scheduled cycles evaluating the Wyandotte-1113, Wyandotte-5061 process under the procedure of air exclusion from the system. The general appearance of the coupons was good. There was only a very slight indication of pitting or localized galvanic attack on the carbon steel samples both welded and non-welded. The Type 420 stainless steel, however, was covered with many very small pits after the third cycle. The AMS-5616 alloys discharged after the second cycle appeared to have been corroded uniformly and of the same order of magnitude as the carbon steel and 420 stainless steel samples. There was a very slight indication that pitting may develop during further testing of this alloy.

Rupture Tests in TF-9 (ELMO-4). One test was conducted at 300 C employing a pre-defected, coextruded U-Zr-2 rod which had been heat treated at 800 C for eight hours to weaken the bond. The objective of the test was an attempt to duplicate the irradiated rupture mechanism more closely in order that a series of programmed cooldowns at NPR conditions could be made with results closer to irradiated slug results. The fuel element was exposed for 40 minutes after detection of the rupture with a hydrogen

detector. After the test the element exhibited a swelled area about 2 inches long by 3/4 inch wide and 1/4 inch high. The weight loss of about 22 grams compares very closely with previous weight losses for the 2000 MWD/T KER irradiated rods ruptured for the same length of time. The most apparent difference, however, was that the unirradiated piece ruptured along the longitudinal axis while the irradiated pieces ruptured both radially and longitudinally. Thus, although the unirradiated bond was definitely weakened by the heat treating, its mechanism of rupturing was apparently different than observed for the irradiated bonds.

Breakaway Corrosion Loop (TF-15). Fabrication of the loop is 35% complete. No defects in the welds tested so far have been found. The use of the Gray Tool Company test section connectors has been approved. The Hayward Tyler pump for the loop has been shipped from England.

Stress Cracking Corrosion of Stainless Steels. A testing program to determine the susceptibility of AMS 5616 to stress-cracking has been initiated. This material has been selected for diversion valve components in the NPR primary system. Initially the test specimens consist of two strips of material fabricated from an actual diversion valve shaft heat treated to a hardness of 40 Rockwell C. However, more specimens are being obtained, fabricated under conditions proposed for the NPH valve material at a hardness value of 35 Rockwell C. The initial strips were stressed to 50,000 to 70,000 psi in a sealed ampoule in an environment of air-saturated water at a pH of 10.0 and 290 C temperature. The strips were examined after five and ten days of exposure. No cracking occurred, but very minor crevice corrosion was observed where the strips contacted each other or strips of type 304 stainless steel. However, since the volume of the ampoule was very small, it is suspected that the oxygen present was depleted. Also, the pH decreased from 10.0 to 6-7 during each five-day period. Consequently, the specimens were removed after the second five-day period and cleaned. The specimens were then stressed to 70,000 and 150,000 psi and charged into TF-1 loop for testing at 300 C and pH 10.0 in air-saturated water. Crevice coupons of type 410 and 420 stainless steel are also being exposed for evaluation. The loop test is expected to provide accelerated evaluation of these materials.

Corrosion Studies of Hastelloy-C. Eight out of a total of twelve scheduled discharges of Hastelloy-C from a corrosion test in recirculating, 290 C, pH 10 (LiOH) water have been completed for a total of 2350 hours of exposure. At about 1500 hours of exposure an inflection was observed in both the non-descaled and descaled corrosion curves in the direction of an increased corrosion rate. This verifies previous data published in HW-67644, reporting that Hastelloy-C corrosion rates increased after 1500 hours of exposure. The initial corrosion rate was 0.18 mil/year, and the second stage corrosion rate after 1500 hours of exposure was 0.35 mil/year. No localized corrosion was observed by examination with a low power microscope; however, samples are to be submitted for more detailed metallographic examination.

NPR Secondary System Tests. Shakedown testing of the instrumentation on the Rocking Autoclave was completed, and a corrosion test on a small, dummy heat exchanger at NPR steam generator conditions has been started. The dummy heat exchanger is being exposed to alternate drying and wetting action in an attempt to promote deposition of water impurities on its surface. These deposit areas will be inspected for evidence of localized attack or stress cracking. However, examination after a one week testing period did not reveal any deposit build-up. A corrosion test on NPR secondary system materials at NPR secondary system conditions is being planned to be conducted in TF-8 as soon as chemical addition facilities are added to the loop.

Process Technology. A test is in progress to compare the corrosion resistance of 17-7 PH stainless steel and carbon steel present-reactor nozzle snap rings in uninhibited process water. The rings are being tested in place on sections of aluminum process tube. The 95 C water periodically covers the samples and then is dried away by evaporation. After three weeks of testing, a carbonate scale approximately 0.1 inch thick has built up on the samples. Pits were found up to 9 mils deep on the carbon steel, and up to 2 mils deep on the 17-7 PH stainless steel.

Structural Materials Development

Zircaloy Retubing Program. Smooth-bore Zircaloy-2 tubes needed for expansion of the overbore test at C-Reactor have been produced by a new and promising process utilizing warm extrusion, low annealing temperatures, and one large tube reduction. Fourteen tubes are at Hanford and about 40 tubes, now undergoing final inspection, are scheduled to be shipped by air on August 2. Six tubes have been rejected because of fine cracks believed to have resulted from rough extruded surfaces. Such rejects should be avoided on future production by improved tooling for extrusion and closer quality control.

NPR Process Tubes. Seven NPR tubes produced by Harvey Aluminum on their pilot order exhibit areas of enlarged grain size. Evidence indicates the cause to be localized overheating during a repair operation late in the fabrication process. Such treatment would remove the effects of cold work resulting in failure of those areas of the tube to meet the 15% to 40% cold work specified. A short length of normal NPR process tubing from the same vendor was heated with a welding torch in the Hanford Laboratories to duplicate the large grain effect. That portion of the material held at bright red heat for 30 seconds or more developed a grain structure similar in surface appearance to that of the seven tubes in question. When the material was examined in cross section, the coarse grain structure was observed through the entire thickness of the tube wall. Examination of the structure under polarized light at magnifications up to 100 X revealed only residual beta grains indicating that complete transformation had occurred. Such treatment completely removes the effects of cold work. The seven tubes received less than 10% cold work after the localized thermal treatment. Those areas fail to meet the 15% minimum cold work specified. On this basis the tubes could be rejected or at least held to limited service.

Harvey Aluminum Company has over 130 NPR process tubes in reject category at their plant. Most of these were rejected for one or more tears on the inside surface of the tube. Harvey has devised a method which they feel is capable of reclaiming 75 or more of these tubes. The defect is removed by grinding, leaving in its place a smoothly blended depression in the inner tube surface. This spot may typically be 5 to 30 mils below specification in wall thickness. However, by applying an axial compressive load on the tube and heating the defective area with an induction coil, plastic flow occurs causing the diameter to bulge outward and the wall to thicken. The outside diameter is returned to normal by pressing in a die and the excess metal is removed from the inside. The process has been observed in operation and appears acceptable. The material is heated in a few bursts of about 10 to 15 seconds duration which produces a maximum temperature lower than that of the final three-day autoclave treatment at Hanford. If the repaired tubes meet specified inspection criteria, there appears to be no obvious reason to reject them. However, thorough destructive tests will be made on sample specimens before final acceptance is recommended.

Burst Test Facilities. An aluminum-sandwich blast shield was fabricated and tested to evaluate its capability to absorb a missile impact in the unlikely event an axial tensile break or an end closure failure occurs during burst testing. The blast shield operated as planned, preventing damage to the furnace. An impact absorbing device of this type will be included in the prototype furnace order.

The building proper for the stress rupture test facility (Project CAH-896) is essentially complete. Project completion is estimated at 78% versus a scheduled 85% (July 30, 1961).

The project proposal for an irradiated burst test facility (CAH-922) was approved by HOO on July 13, 1961, and has been forwarded to obtain AEC Washington approval.

Nonmetallic Materials Development

Graphite Burnout Monitoring. During the early part of December 1960, the reactor atmosphere at KE-Reactor was changed to a He-N_2 mixture. From December 18, 1960 to March 22, 1961, monitoring samples in channel 3066 showed burnout rates below the limit of 2%/1000 operating days. The latest results, from samples exposed from March 22, 1961 to June 22, 1961, are shown on the following page.

Carrier No.	Distance from Front of Graphite Stack to Centerline of Carrier (in feet)	*Burnout Rate (%/1000 Operating Days)
1	2.7	0.16 ± 0.03
2	9.2	2.73 ± 1.04
3	16.0	0.72 ± 0.08
4	22.5	0.29 ± 0.04
5	29.0	0.33 ± 0.07

*Mean burnout rate (five samples in each carrier).

Monitoring samples from three carriers in 3580-F were discharged on June 24, 1961, after 108 operating days and were within prescribed burnout limits.

Gas-Graphite Systems. Twenty-four quartz capsules containing graphite and various gases at pressures up to 500 psi were discharged from "Y" test hole at C-Reactor. These capsules are awaiting measurement.

Thermal Diffusivity of Graphite. The measurement of irradiated graphite thermal conductivity at elevated temperatures has required large samples and careful thermal guarding techniques. An apparatus is being constructed to measure a related property, thermal diffusivity. Thermal conductivity is obtained from the product of thermal diffusivity, density, and specific heat. A pulse of thermal energy will be directed to the front surface of a 0.7-inch diameter graphite sample and the resulting rear surface temperature increase will be observed on an oscilloscope. Construction of the apparatus is 20% complete. A time delay generator and sample holder were assembled during the month, and construction of the power supply is under way.

Thermal Hydraulic Studies

Heat Transfer Conditions for Fuel Elements With a Non-uniform Coolant Annulus. Experiments were continued to determine the heat transfer conditions when fuel elements are not situated coaxially within a process tube. Laboratory data applicable to I&E fuel elements in a BDF process tube were obtained for the case of 75% eccentricity. (Percent eccentricity is the fraction of the normal annulus thickness that the fuel element is displaced from a coaxial position toward the wall of the process tube).

The test section used was a 30-inch long electrically heated rod, 1.445 inches in diameter, positioned within a 1.604-inch tube. All of the heat generated within the rod was transferred to water flowing through the annulus. Flow conditions corresponding to those in the flow annulus of I&E fuel elements in the fringe zones of a BDF reactor (23 gpm at 121 psig) were held constant. During collection of data, the heat generation in the test section was gradually increased while temperature measurements were made of the heated surface and cooling water at points around the annulus of the test section.

As in previous runs, the heat generation rate was increased until boiling burnout conditions were reached as indicated by a large temperature excursion at some point on the surface of the heated rod. For this test section, a hole was melted near the inlet of the test section at the same time the thermocouples, which are near the outlet, indicated a temperature surge. This was unexpected since boiling burnout generally takes place only near the outlet where water temperatures are highest and pressures are lowest. Subsequent visual inspection of the heated surface indicated that the top of the heated surface had been hot over its complete length with the "hottest spots" midway between the small longitudinal ribs used to maintain spacing of the test section in the process tube.

The conditions at the point of boiling burnout were a heat flux of 587,000 B/hr-sq ft, a flow of 4,400,000 lb/hr-sq ft, and the bulk water temperature 98 F below the boiling point. When compared with previous data, this information indicates that at this flow rate and eccentricity, the boiling burnout conditions are fairly independent of bulk water temperature.

Heat Transfer Characteristics of NPR Fuel Elements. The studies to determine the boiling burnout conditions for the NPR tube-in-tube fuel elements were continued. Thirty-eight boiling burnout points were obtained in the laboratory with a test section which is the circular channel hydraulic diameter equivalent of the outer flow annulus of the NPR fuel assembly.

The test section for this investigation consisted of a 32-inch long tube, 0.315-inch ID, with flow through the inside. The tube was heated by electrical resistance heating, and boiling burnout conditions were detected by noting temperature excursions as measured by thermocouples attached to the outside wall of the test section.

The major portion of the experiments was run at 1500 psig, where 28 boiling burnout points were obtained, and the remaining data were collected at 1000 psig. Flow rates were varied between 1,000,000 and 5,000,000 lb/hr-sq ft, and the coolant conditions at the burnout point were varied from 0 to 35% steam by weight. The burnout heat fluxes for these conditions varied from 500,000 to 1,740,000 B/hr-sq ft.

The data will be compared with data obtained previously for an annular flow test section to determine the feasibility of simulating annular flow channels with circular channels for boiling burnout experiments. An initial examination of the "raw" data indicates that such a procedure is not too valid.

Shielding Studies

Multigroup Code for Shielding Calculations. Calculations have been compared with experimental data obtained in the shield facility on ordinary concrete. For the 100 C, 200 C, and 300 C baking temperatures, the agreement between experimental and calculated neutron and gamma attenuations

was very good. The thermal neutron fluxes were calculated within 30% and the gamma dose rates within 60%. In the as-cured case, the calculated thermal neutron fluxes were low by a factor of about four. A possible explanation for the discrepancy between the experimental and calculated values is the temperature distribution through the slabs during irradiation. The slabs did lose water during the initial irradiation and no allowance was made in the calculation for variations in water content from slab to slab. Further work is being done to compare measured and calculated shielding properties of various types of concrete tested in the shield facility.

Reactor Concept Studies

Low Cost Reactor Study. A study was initiated to determine the feasibility of constructing a 100 Mw(th) reactor for one million dollars or less. In general, a light water moderated and cooled swimming pool type reactor is visualized; however, all phases of the design are being considered for ways and means of lowering the capital cost. In addition, standard criteria and practices in the nuclear field are being reviewed to determine their appropriateness to this reactor and where revisions may be required to permit achievement of the cost objective. It is planned to conceptually design the low cost reactor (LCR) during the present fiscal year.

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 (including the PRTR Rupture Loop Annex and PRP Critical Facility buildings) is completed. The chilled water pump was changed out to one size larger in order to meet the specified design conditions. Mechanical difficulties were encountered with the water chiller compressor. Repairs have been made and the chiller appears to be functioning satisfactorily. The water chiller motor continues to overload. Larger size heaters have been ordered to correct this condition. The maintenance shop equipment has been placed, and personnel now occupy the building.

The paving and landscaping contract is 99% complete versus 100% scheduled predicted to July 31, 1961. The contractor mowed and reseeded the lawn in front of the 308 and 309 Buildings. Lawns in front of 308 and 309 Buildings and the north side of the M&M Facility were fertilized. Difficulty is encountered in obtaining an acceptable stand of grass on the south side of the entrance to the M&M Building and in various spots throughout the seeded area. Several shrubs and trees will require replacing this fall.

Installation of Fuel Examination Facility Equipment was completed by the CPFF contractor. Performance of design testing is scheduled as maintenance manpower becomes available. Preparation of an operating manual has begun.

Additional piping supports are required on the primary system to provide earthquake protection. The method of support will use two hydraulic snubbers on each of the three primary pumps, plus two hydraulic and one static snubber on the steam generator inlet piping. A purchase requisition for the hydraulic snubbers has been issued.

* Plutonium Recycle Critical Facility (Project CAH-842). Installation of equipment, which began on June 27, continued during the month. The moderator storage tank, the reactor assembly, and the thimble coolant loop heat exchanger have been installed, along with the -26'-0" and -17'-0" floor gratings. Piping installation has been started but is proceeding slowly since the CPFF contractor has not received all the necessary material. The contractor is 35% complete.

Delivery of the instrument package continues to be a problem. The earliest promised shipping date is still September 15, 1961 -- nearly four months late.

Fuel Element Rupture Test Facility (Project CAH-867). A revised project proposal requesting extension of the project completion date from October 30, 1961 to June 30, 1962, has been submitted for approval.

J. A. Jones Construction Company started piping and equipment installation in the annex area and in B Cell. At month-end, this work is approximately three percent complete. Over-all construction is 11% complete against 62% scheduled.

The water plant bid package was completed and issued for fixed price bidding. Bid opening is scheduled for August 17, 1961.

Drawings were revised and approved in accordance with the modified overload arrangement for the drive motors of RLP-1A, 1B. This modification consists of substituting temperature relays in each phase of the stator winding and over current relays in the motor control center for the more standard overload heater-relay arrangement.

To date, all GE-procured items have been delivered except for the regenerative heat exchanger, electric immersion heaters, makeup pumps, electric switchgear and motor control center, and major components of the instrument packages. Delivery dates on the first three items are near August 1, 1961, and will not cause significant delays in the installation work. It is estimated that the electric switchgear will be delivered about mid-October 1961. Complete shipment of the instrument package is expected by August 15, 1961.

Ion exchange tank RL1X-5 was returned to the vendor, Illinois Water Treatment Company, for modification when it was discovered that the tank height exceeded the specification. Modification of the tank will be performed by the vendor.

Component Testing and Equipment Development

PR-10 - Primary Loop Mockup. The spare primary pump operated 374 hours during the month for a total of 7197 hours. On July 19, 1961, the leakage exceeded the makeup capacity of the mockup and the pump was disassembled for inspection. The pump seal temperature reached 200 F at the maximum leakage rate of 1/2 gpm. The primary seal faces had not changed noticeably from the previous seal inspection at 3531 hours of operation. The high leakage was due to buildup of corrosion products at the U-cup stationary seal resulting in leakage between the U-cup and shaft sleeve. Filtering the water recirculated by the auxiliary impeller had been discontinued during the last few months of operation because of the high pressure drop through the filter.

The prototype pump with the self-adjusting seal assembly operated an additional 533 hours for a total of 8804 hours. The present seal leak rate is 0.3 g/hr.

The seal test stand operated an additional 176 hours and 19 starts for a total of 1356 hours and 177 starts.

The Aldrich Injection Pump testing with Disogrin U-cups gave the following results during the month:

	Hours	Leakage (ml/hr)	Remarks
Plunger #1 (1st run)	212	5000	Failed
(2nd run)	250	250	In operation
Plunger #2	462	150	" "
Plunger #3	462	6000	Failed

Only the central plunger is still operating satisfactorily. Failure appears to be by splitting the U-cup base, with resultant wearing through of the lip at the split section. There is no apparent overheating or abrasive damage to plungers.

Critical Facility Components. Testing of the source positioner was begun; however, it was found that the return spring was too stiff. New springs have been ordered, and testing will resume as soon as they are received. Delivery is expected August 1, 1961.

The adjustable weir has been completed except for the installation of the synchro position indicator. The unit is now being set up for testing which should be started by August 1.

Delivery of the flexible hoses required to complete the thimble is expected about 8/1/61. Testing of this unit may then be started.

Redesign of the safety rods has been completed, and comment prints have been out since July 20. Swaging operations have been started on the actual safety rods, and a purchase requisition has been issued for the cadmium plating of these rods. It is planned that fabrication be started on the miscellaneous mechanical components this week. Some aluminum pipe and tubing must be purchased; however, this should not delay fabrication.

Redesign of the control rods has been completed, and comment prints will be issued by July 26, 1961. Swaging of the aluminum tubing required for the shutter rod has been started, and a purchase requisition has been issued for the cadmium plating of these rods. The possible material inadequacies of the position indication synchro transmitter assemblies have not been resolved. The AEC purchasing unit has been working on obtaining the required material certifications; however, no information is yet available. It is now planned that one of the transmitter receiver assemblies be set up for testing as soon as possible without waiting for material certifications. The electromagnets for the rods have been received and testing of these components started.

Rupture Loop Components. Material procurement for two complete in-reactor test sections is essentially complete, and machining is complete on one test section and on one of the two special mockups. Testing has been started using one mockup. All tests are described in the Design Test document, which was issued for comments. All test section drawings have been revised and reissued.

PRTR Operations

Reactor Operation. Power tests were resumed on July 3, concluding an extended outage of about six weeks. The PRTR achieved full power of 70 MW for the first time on July 21. Core exposure was increased by 578 MWD during the month.

Problems contributing to a delay in initial startup included: primary system pH had increased to 11.2 during the outage; subsequent reduction to within limits was accomplished by circulation of loop water through a temporary neutral ion exchange unit by-passing the installed lithium-based resin; the desired rate of moderator level rise was achieved only after fixing the flow rate to the recombiner and then making several trial-and-error adjustments to the gas balance control valve; the new seal injection system for the primary pumps was placed in service only after extensive troubleshooting and modification.

From July 3 to July 12, the reactor was operated at gradually increasing power levels from 5 MW to 45 MW. During this operating interval, major attention was directed to the steam generation equipment, particularly the deaerator, boiler feed piping, and related instrumentation. Control difficulties with deaerator pressure and deaerator liquid level resulted in water being fed to the boiler well below its boiling point and, on at least one occasion, the boiler feed pumps lost prime when the deaerator emptied. The boiler feed piping system suffered several failures during this operating interval. Excessive light water and steam leakage to the process cell resulted due to fractured piping on boiler feed pump relief lines, plus one blown gasket on the deaerator inspection plate. This operating interval was terminated on July 12 due to seal failure of primary pump #1. Seal failure indications had begun on July 9, and failure was possibly accelerated on July 11 when a second injection pump was started in order to recover from instability which was caused by an attempt to place the rupture detection system in service. By July 12, flow of hot D_2O through the failed pump seal threatened to raise ion exchange temperatures above limits.

The reactor was started up again on July 14, with achievement of 70 MW for the first time occurring July 21. Operation at 70 MW was maintained for 60 hours. The reactor was shut down on July 24, one day prior to a scheduled outage, due to failure of high pressure helium compressor #1 which resulted in lowering of the high pressure helium storage pressure to its lower limit. A D_2O leak occurred on July 26 during repair of the H-94 check valve.

Reactor Maintenance and Modification. Following the extended outage of May-June, during which the mechanical seals in all three primary pumps had been replaced, operation was resumed using a newly installed seal injection system. The previous seal failures were attributed to helium accumulation at the seals, causing inadequate lubrication. The improvised seal injection system incorporates a manually controlled valve in the D_2O makeup line to provide an increase in the pressure of the primary

injection pumps sufficient to inject approximately 1 gpm of cold, helium-free D_2O into each seal chamber. Pressure lines were extended to C Cell to monitor the injection pressure head of about 100 psi.

Failure of a bolt on HP-1 compressor and inability of HP-2 compressor to maintain storage tank pressure caused a reactor shutdown on July 24. HP-1 compressor was repaired. HP-2 was inspected and modifications were made to the oil system, but no satisfactory explanation for its lower capacity has been discovered. HP-2 has always been somewhat low in capacity. During the last operating period, pressurizer pressure control was creating an excessive demand for helium because of valve leakage and pressure fluctuation. Leakage was corrected and fixed bleed from the pressurizer has been increased slightly to provide more stable control. It is expected that this will reduce helium demand during high temperature operation to less than the capacity of HP-2.

Design change No. 81 was issued to modify the oxygen removal resin facility in the primary cleanup system. These modifications consist of adding isolation and bleed valves between the S-10 resin tank and the primary cleanup system to prevent contamination of the primary system with the S-10 regeneration solutions which are light water based. A further modification consists of reinforcements for the flat heads of the resin tank.

The vent blower for the hood around the helium condensate line valves in the Hot Shop was installed, completing Phase III-A, Change 188.

A purchase requisition to return the spare reflector heat exchanger, HX-3, to the manufacturer for testing was issued. The manufacturer wishes to run flow tests at the factory in an attempt to determine the cause for the vibration noted in the installed PRTR heat exchangers HX-2 and HX-3 when secondary coolant flow rates through the exchangers exceed 500 gpm.

A design change is being prepared to allow addition of hydrogen to the helium pressurization system directly instead of indirectly via addition of hydrogen to the bulk helium storage. This will reduce hydrogen consumption and the use of manpower in making hydrogen additions manually and will enable reduction of hydrogen concentration in the core blanket system which surrounds the Zircaloy process tubes.

Considerable improvement in control stability of the secondary system was exhibited during the month. Modifications made to the system include: (1) addition of reset action to the boiler level controller; (2) addition of a proportional reset controller for control of deaerator level; (3) addition of a positioner to the boiler feedwater valve. Operation of the system at power demonstrated that the water inlet valve to the deaerator and the boiler feedwater valve are oversized. Reduced trim for these valves is on order.

Design changes were issued for duplication of DC power supplies to components in the light water injection system and for system changes giving improved control over certain valves.

An Industrial Instruments Company oxygen analyzer, utilizing a thallium bed, was borrowed from the 1706-KER facility and installed to monitor oxygen content of the primary system. The instrument worked well during shutdown conditions but was not satisfactory with the primary system pressurized because of excessive gas evolution from the primary coolant. It is planned to obtain a similar unit capable of operation at full system pressure.

Instrument air backup facilities for critical controls were completed and tested.

Secondary coolant activity monitor readings are now being obscured by high radiation background in -11' C Cell. A shielding survey was performed and shielding for the system will be designed and installed.

Installation of a third log flux and period channel and revision of the intermediate channel period trips to 2 of 3 logic for trip was completed. The triplication of log high level (overlap) trip and on-scale trip circuits has not been decided upon at this time. No automatic controller period signal output amplifier is planned for this third channel at present. The installation of those and other features presently found on the original two log flux channels will be considered on their individual merits. The present arrangement is expected to reduce spurious reactor scrams from log reactor period trips to an acceptable number. To make a step plug location available for the ion chamber for the new log flux channel, the fission chambers for the two startup channels were combined in a single housing and installed in the flux monitor hole which originally contained startup channel #1. This permitted the use of a single positioner for the startup channels. A 1/8-inch Boral neutron shield was added in front of these chambers to reduce the signal to the startup channels at full power in order to extend fission chamber life and avoid saturating the log count rate meters. New step plugs and chamber housings were fabricated for both the ion chamber and fission chambers. During replacement of the step plugs, a radiation beam of 240 R/hr was encountered. This did not interfere with the replacement operation, since it was possible to keep personnel in moderate radiation fields and minimize the time that the plugs were out of the reactor. Activation of the step plugs was negligible. Of the three fission chambers available for use when the dual chamber housing was being closed, only one showed completely satisfactory electrical characteristics. One of the others had marginal electrical resistance from collector to shell, and this resistance on the third chamber was unacceptable. The good chamber was installed in channel #1, and the marginal one was installed in channel #2. Channel #2 has proved to be inoperative because of voltage breakdown in the chamber or its connecting cable. A new chamber is to be installed in channel #2 and the connector remade for channel #1 at the first opportunity.

Accumulated evidence may indicate the presence of one or more failed fuel elements in the reactor. Activity levels of fission gases in the primary coolant continued to be higher than expected for the known uranium impurity in coolant water and in reactor components. Activity was observed after power level increases with subsequent decreases to much lower equilibrium levels at constant power. The coolant activity level has not proved to be an operating problem. The high air-borne activity levels experienced during early operation in the power range have not reoccurred. This is due to better ventilation air-flow channeling and fewer gas leaks from the primary system. Work continued on rupture monitor revisions required to get this system to routine operational capability. Preliminary tests on gas separation indicate that the separators are functioning satisfactorily but that the gas lines are plugging from condensation. Termination modification is in progress to provide a signal suitable for scanning.

The preventive maintenance basic card system and policies have been set up. Control features are only partly covered for the reactor and little work has been done on loop installations. Check lists are in draft form for all mechanical seal pumps except the primary pumps. Preparation of check lists will continue.

Engineering Analyses. Neutron flux measurement through the primary shields were made for PRTR operation at 45 MW and from the data obtained an extrapolation was made for 70 MW operation. The fluxes reported previously were low by a factor of 0.63 due to a recalibration of the power recording instruments. Allowing for a factor of 0.63 in the first measurement, a comparison of the two measurements has been made. It is concluded from these measurements that core gamma leakage rather than piping activation will be the major component of shutdown dose rates.

Considerable data were accumulated during the month on the various power tests. Shielding surveys as part of Power Test No. 3 (Shielding Adequacy) showed no serious neutron streaming. The cadmium shielding which has been installed around the lower piping to the reactor has eliminated any serious activation problems. Completion of Power Test No. 1 (Ion Chamber Positioning) showed that the chambers had the desired range. The startup channels were found to be located in too high a flux field and were shielded to reduce the flux at the chambers.

Data obtained for Power Test No. 4 (Vibration and Noise Monitoring) showed no unusual vibration or sounds. Under Power Test No. 7 (Ventilation System Testing) a high steam drum enclosure temperature of 152 F maximum was revealed during reactor operation. This temperature was carefully monitored and corrections are being made in the ventilation system to reduce this temperature. All other temperatures were satisfactory.

Data were obtained for the following tests and is currently being evaluated:

Power Test No. 6 - Planned Malfunctions
Power Test No. 9 - Heat Transfer Coefficients
Power Test No. 10 - Moderator Flow and Temperature
Power Test No. 11 - Photoneutron Flux
Power Test No. 12 - Reactivity Coefficients
Power Test No. 14 - Flux and Power Distribution
Power Test No. 16 - Xenon Poisoning
Power Test No. 18 - Shim Rod Heating
Power Test No. 20 - Fuel Element Inspection
Power Test No. 23 - Process Tube Inspection
Power Test No. 24 - Raw Water, Secondary & Effluent System.

From a physics standpoint, reactor operation is as anticipated. Changes are being made in the Xenon Tables to bring them into better agreement with observed xenon transients. Data sheets and procedures have been prepared to permit the shift engineers to evaluate the reactivity status of the reactor. A machine program is being prepared to permit more rapid calculation of tube power distribution. Data obtained to date showed a peak to average power distribution ratio of 1.3 under equilibrium conditions.

Evaluation of potential corrosion problems in the reactor system continued. Major efforts have been devoted to secondary coolant water quality, particularly in the main steam generator, and the consideration of the elimination of hydrogen overpressure in the helium stream in the reactor core blanket system.

A check of process water use rates was made because of an apparent low process water pump discharge pressure. The results revealed that gauge calibration was the cause of the problem.

Revision of Operating Procedures and Standards continued during the month as experience was gained in reactor operation. At the end of the month two standards and four procedures remain to be written. An extensive review of standards and procedures is planned to bring them up to date.

Thermal Hydraulics Studies

Heat Transfer Calculations for the PRTR. Calculations were performed to determine if boiling could occur on the outer surfaces of the primary treatment heat exchanger (HX-5), possibly resulting in increased chloride concentration at these surfaces with consequent stress corrosion. The calculations showed that no boiling should occur with the heat exchanger clean. With the heat exchanger tubes fouled, slight vaporization of water at the tube surfaces or in the fouling layer could occur.

Limited data taken during reactor operation at 35 and 45 MW were analyzed to determine if there was any evidence the moderator and reflector system would be inadequate for reactor operation at 70 MW. The analysis indicated that the heat load in the moderator is about six percent of the total reactor power. This heat load is approximately equal to that used in designing the moderator cooling system but is about twice the load expected from later calculations.

Analysis of preliminary data for the reflector system indicates a heat load of approximately 1.2 percent of reactor power as compared with a design value of 0.75 percent. The fouling allowance included in designing the reflector heat exchanger should allow satisfactory operation of the system at design conditions so long as the heat exchanger is clean. Some cleaning of the heat exchanger or adjustment of conditions may be necessary as fouling progresses.

Plutonium Fuels Development

PRTR Fuel Fabrication. The PRTR schedule calls for 28 replacement plutonium-aluminum spike fuel elements to be used at the rate of one per week after the reactor reaches full power on the original core loading. Six Mark I-H (Al-2 Ni-1.8 Pu alloy core and 35-mil wall Zircaloy-4 sheath tubing) 19-rod clusters are completed. Fuel element rods for 25 additional clusters are awaiting etching and autoclaving.

Zircaloy sheath tubing is being prepared for the 22 high exposure plutonium-aluminum spike fuel elements which are scheduled to follow the 28 replacement elements in the PRTR. The tubing is being gaged, cut to length, counterbored and the first end cap welded in an attempt to have all tubes ready for loading by the time the high exposure plutonium arrives in August.

Fabrication Development. A loading method was developed to accurately control plutonium distribution along the length of the UO_2-PuO_2 fuel elements. The goal of this loading technique is to obtain a plutonium distribution along the tube length within plus or minus five percent of the nominal plutonium concentration which is 0.500 weight percent plutonium. Since it is unlikely that a nondestructive test which is capable of 100 percent inspection will be developed to detect these small absolute differences (0.007-gm/inch) in plutonium content, uniform plutonium concentration will have to be insured through process control, which may require extensive destructive evaluation of the process steps. A manual powder loading machine has been purchased to obtain the accurate increments required in the process. Preliminary results indicate that the reproducibility of the increments is within the desired limits. Further tests are being conducted to determine the capabilities of the instrument in delivering increments of fused UO_2 of various screen sizes.

Since a uniform blend of fine (-325 mesh) UO_2-PuO_2 is required as feed material for the incremental loader, an experimental blend was made, and analytical samples taken. The blend was obtained by sprinkling the PuO_2 uniformly over the surface of the UO_2, mixing the powder manually, and then blending for two hours in a twin shell blender. These mixing precautions were undertaken to minimize agglomeration of the plutonium oxide particles which have a high surface activity. A plus or minus 1.5 percent variation in plutonium content was obtained from the samples taken. Material balance for the experiment was within one percent which is within the analytical precision.

Five-inch capsules and several short rods, for a seven-rod cluster, have been fabricated as prototypes of irradiation pieces using UO_2 as a stand-in material for the UO_2-PuO_2 mixed oxide. The density of the fuel material in these pieces following swaging was 88 percent of theoretical. The irradiation capsules and seven-rod cluster will be uniformly enriched and are to be incrementally loaded with the mixed oxide. Four test capsules have been incrementally loaded with the mixed oxide. Two of the capsules were sampled for chemical analysis following loading. The other two capsules were swaged and then had samples cut, to determine whether swaging affects the plutonium distribution. The capsules for irradiation studies will be fabricated when the analytical results on the above pieces are received. Similar experiments are planned for the seven-rod cluster elements.

Since large quantities of adsorbed and absorbed gases may be associated with the fabrication of physically mixed oxide fuels, preliminary studies were undertaken to determine the severity of the gas evolution problem. Gas evolution samples were taken from six particle sizes of arc-fused, pulverized UO_2 at 1000 C. The following results were obtained:

Mesh Size	cc/g *
+ 60	0.091
- 60 + 100	0.219
-100 + 150	0.197
-150 + 200	0.288
-200 + 325	0.517
-325	0.832

*Average of three samples.

Grab samples of the pulverized UO_2 contained 42 percent plus 60 mesh, 21 percent minus 60 plus 100 mesh, 10 percent minus 100 plus 150 mesh, eight percent minus 150 plus 200 mesh, eight percent minus 200 plus 325 mesh, and ten percent minus 325 mesh particles. Two gas evolution samples of this material taken at 1000 C averaged 0.275 cc/g. The value calculated from the gas evolution of the particle size ranges for a sample containing these particle sizes is 0.251 cc/g. Spectrographic analysis show that the gas is principally N_2.

An assembly is being prepared to explore the feasibility of hot rolling UO_2-PuO_2 powder mixtures to obtain high density fuel core feed material. A mixture of 20 w/o PuO_2 - 80 w/o minus 325 mesh fused UO_2 was ball milled for two and one-half hours. This material will be loaded into a stainless steel container and hot rolled at 900 C. It is hoped that the mixed oxides will partially sinter and form a solid solution during the hot rolling. One compact which contained only UO_2 was hot rolled to 98 percent of theoretical density. Hopefully, comparable densities may be obtainable with mixed oxides.

Fuel Evaluation. One of the aluminum-plutonium fuel rods was removed from an irradiated PRTR element and is being examined in Radiometallurgy. The degree of corrosion which occurred during operation of these elements in the fluoride and chloride contaminated primary coolant is of particular interest. The spacing wire was removed from the rod, and no signs of corrosion between the wire and the fuel rod was observed. The fuel rod was sectioned through the corroded areas where the Zircaloy bands were in contact with the cladding. Two such areas have been examined, and more than one pit was found in each. The maximum depth of the pits examined has been 0.003-inch, and some pits are as large as 0.030-inch in diameter. No increased hydrogen content has been observed in the pitted areas on the samples examined thus far. A generally dispersed hydride concentration of 20-30 ppm was observed in the Zircaloy-4 cladding.

Both end caps were sectioned in the areas where the spacing wire goes through the cap and is welded. Corrosion of the wire and end cap has occurred in this region. Some of the areas had corroded about 0.005-inch deep. Localized regions containing high hydride concentrations were observed in the corroded areas. Apparently the temperatures were not high enough to permit the hydrogen to diffuse. The wire material generally had about 20-30 ppm hydrogen whereas the end cap material had very little. Both the wire and end cap are Zircaloy-2.

Also, a section of the Zircaloy-2 end bracket has been examined. It was sectioned where two pieces are joined by projection welding. Some corrosion has occurred in the crevice.

From observations which have been made thus far, it appears that the corrosion of the cladding is not severe and no increased hydriding has resulted. The amount of corrosion and hydriding which have occurred where the wire is attached is probably of little concern at this point. If, however, corrosion proceeds even in good quality water, spacing wires may start coming loose. Any protection afforded by the Zircaloy autoclave film is not apparent at this time. If a crevice is present, autoclaved and unautoclaved Zircaloy both corroded about the same. Examination of this element is continuing.

An analysis of the accuracy of the preliminary calibration measurements made with the Phoenix capsules in the Advanced Reactivity Measurement Facility (ARMF) has been completed. It was determined that the accuracy of the measurements is satisfactory for achieving the objectives of the experiment. A final check of the calibration measurements will now be made before irradiation of the samples commences. A plot of the data illustrates the reactivity effect of the different plutonium concentrations and the reactivity sensitivity of the ARMF for the same samples measured in different positions in the ARMF. It also illustrates the self-shielding effects of the higher plutonium concentration samples even though this effect is quite small. A standard sample which contains no fuel or boron was furnished for confirming the point at which the calibration curves converge. Work is progressing on casting aluminum-plutonium-boron alloys which will be used for the poison sensitivity standards.

The 11 irradiated UO_2-PuO_2 capsules have been recharged into the MTR for additional exposure and include six low-density and five high-density pieces. All specimens are to be irradiated for four cycles. The current exposure on some of the low-density specimens is estimated to be on the order of 7000 MWD/T of fuel core material.

The capsules 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 are being fabricated. Jacketing components for the specimens, which are to be irradiated in the MTR hydraulic rabbit facility (VH-4) have been completed, and the fuel core pellets are being ground to final dimensions. The latest information from the MTR indicates that the tentative charging date for the four capsules is about mid-August. The specimens are to operate with a specific power of 20 kw/ft.

A more advanced capsule model for use in the hydraulic rabbit facility on future experiments is presently being designed. Detailed design work on the in-reactor temperature monitoring equipment for the UO_2-PuO_2 test elements for the SNOUT Facility is currently in progress. A mockup of the proposed unit has been designed and parts are being fabricated and assembled.

Euratom UO_2-PuO_2 Fuel Pins. Twenty-one fuel pins are currently being fabricated for a Euratom program being run by Vallecitos Atomic Laboratory. These pins each contain 18 sintered oxide pellets 94-98 percent theoretical density, about 3/8-inch in diameter by one-half inch long. The oxide is mixed UO_2 - 1.5 w/o PuO_2. The latter is high exposure (nominally 17 percent Pu-240) material. The pellets are to be ground and inserted into Zircaloy cans. During the month exploratory sintering runs were made, a die for the automatic Kux press was designed and built, and a fabrication technique was developed. Test sintering runs show that four hours at 1550 C in hydrogen are sufficient to bring the pellets into the required density range. The shrinkage checks with the calculated values. Only one to three mils will have to be ground off the diameter to size the pellets.

Fabrication of Reactivity Test Standards for Bettis. Bettis requested the fabrication of aluminum-gold, aluminum-uranium, aluminum-plutonium, aluminum-uranium-boron, and aluminum-plutonium-boron alloys clad in zirconium for physics experiments. The aluminum-gold, aluminum uranium, and aluminum-plutonium alloys have been cast and extruded. Analyses of the gold and uranium alloys, although incomplete, were satisfactory. Attempts to make accurate boron alloys using amorphous boron were unsuccessful; the boron recoveries in the alloys were very low. A new series of alloys will be made using aluminum-boron master alloy additions.

UO_2 Fuels Development

Magnetic Force Welding. An investigation of welding sintered aluminum product (SAP) simulated fuel rod closures is being conducted under the joint AECL-AEC program, using the laboratory magnetic-force resistance butt welder. Alloy M-257 will be used for the first part of the program and both M-257 and M-583 will be used in the latter part of the program. These alloys contain seven percent oxide. The M-257 is Alcoa prepared powder with the M-583 being Swedish prepared powder, processed into rod and tubing by Alcoa.

Two weld joint designs will be evaluated: (1) an insert weld with a taper cap pressed into the tube to form a joint between the OD of the cap and ID of the tube, and (2) a butt weld between the cap and the end of the tube. The initial welding studies have been performed with the insert weld joint design. This joint design has the advantages of (1) self-aligned parts, (2) forcing of upset metal end-wise only, and (3) a large weld cross-section. A non-segmented cylindrical electrode of high resistance material is employed to carry the weld current to the tube. The electrode opening is 0.004 inch larger in diameter than the tube. The tube is recessed 1/16 inch in the electrode and is expanded out against the electrode by the tapered cap, during the initial pressure application. The weld area produced by the insert welding technique is larger than the cross-sectional area of the tube wall. The large weld requires the use of maximum machine welding current. The point of greatest heat buildup is at the interface of the moving electrode and the cap. Arcing at this point has resulted in damage to the electrode before a satisfactory weld is obtained. A new electrode is being fabricated. Immediate effort will be directed to produce the heat required at the weld interface without overheating the cap electrode.

Hot Swaging. Zircaloy-clad fuel rods were hot swaged at 800-850 C, and 80% passed all quality control tests. The rods rejected during radiographic testing of the closures and during fluorescent penetrant testing of the rod surfaces are being reclaimed by rewelding the end caps and regrinding the fuel rod surfaces.

Screen analyses made of various batches of crushed fused UO_2 revealed considerable variation in particle size distribution between batches. These materials will be hot swaged in Zircaloy cladding at 800 C to determine whether or not particle size distribution significantly affects the bulk UO_2 density after hot swaging.

Micronized UO_2 was heated at 800 C for 24 hours to expel gases adsorbed on the surfaces of the particles and loaded, in helium, into Zircaloy, stainless steel, and Inconel-X tubing. These fuel rods will be hot swaged. This degassing treatment is expected to eliminate the gas pressure problem encountered in previous attempts to hot swage micronized UO_2.

Inspection of the components of the swage used for hot swaging showed surface pitting, presumably because of the graphite-water suspension used as a lubricant during hot swaging. Other hot swaging lubricants are being evaluated.

Hydriding of Zr-2 and Zr-4. The second Hanford defect test (HD-2) was discharged from KE Reactor after successfully completing 20 weeks of irradiation. The element will be metallographically examined to determine the effect of long term irradiation at relatively low power generation on the hydriding characteristics of defected Zr-2 and Zr-4 (low nickel Zr-2). The third Hanford defect test, which will have a heat generation rate ~2-1/2 times that of HD-2, will be charged as soon as scheduled reactor modifications are completed.

PRTR Fuel Elements. Swaged UO_2 19-rod cluster fuel elements operated satisfactorily in the PRTR at maximum reactor design power (70 MW). Two fuel elements were visually inspected after irradiation at full power and revealed no evidence of corrosion or structural weakness. The improved coolant quality appears to have removed a light crud film visible on some of the rods during an earlier inspection.

Nested Tubular Fuel Elements. Planned studies involving three 8-foot long Mark II-C tubular fuel elements include extensive out-of-reactor and in-reactor testing. One assembly will be flow tested in the PRTR mockup coolant channel in 314 Building. One assembly is scheduled for irradiation in the PRTR in the near future. The third assembly will be used for critical testing and/or PRTR irradiation.

The bulk density of the vibrationally compacted fused UO_2 is 87-89% TD. The crushed and sized fuel material was vacuum outgassed for six hours at 750 C before loading to minimize gas release during irradiation.

The cladding for the three fuel assemblies is 0.060-inch wall Zircaloy-2. Spacer ribs were attached to the cladding by a continuous, high frequency resistance welding process. The welds were ultrasonically inspected. End caps for the tubular segments were attached by a double closure technique involving resistance seam welding followed by inert gas tungsten arc welding. The closures were examined by radiography.

The fuel segments were etched, autoclaved, and visually inspected. Gamma attenuation measurements are being performed prior to final in-reactor evaluation.

Fuel Evaluation. Preliminary examination revealed that the failure of the prototypic nested tubular fuel element (GEH-12-22) occurred on the inner surface of the inner tube. This surface experienced the greatest heat flux during irradiation and may have overheated during the flow stoppage in the reactor coolant tube during the irradiation test. The element is being returned to Hanford for metallographic examination.

Preliminary examination revealed that at least four rods of a large diameter (0.906" OD), seven-rod cluster (GEH-12-19) split during irradiation in the ETR, possibly indicating a limit to the feasible diameter of swaged fuel elements. Failure of the swaged, stainless steel clad rods occurred during reactor startup while the element was operating at about 80% of full power.

Corrosion and Materials Studies

PRTR Corrosion Examination. The Zircaloy-2 process tube flanges in PRTR were corroded under the gaskets during the incidence of high fluorides in the primary coolant for the first three weeks of May. Tube #1154 was removed and the flange examined metallurgically to determine the extent of the corrosion. The remainder of the tube is being evaluated by Structural Materials Development Operation.

The corrosion of the upper flange took place under the first three or four rings of the laminated stainless steel-asbestoes gasket. The remaining seven or eight rings in the gasket left marks through the autoclave film on the Zircaloy; however, no significant corrosion took place in these crevices. The corrosion ring was fairly uniform over about 270° of arc on this tube. Some other tubes showed corrosion under the full width and circumference of the gasket. The corrosion ranged between 2 and 3 mils of metal penetration with very localized hydriding for an additional 2 to 3 mils. Several pits from 10 to 15 mils deep were found on the gasket surface apparently associated with a fusion weld attaching the flange to the tube proper. It is concluded that these pits predate reactor service. One pit was observed to have a small amount of corrosion on its bottom. None of the pits in the tube examined penetrated through the weld to the threaded joint between the tube and flange.

Four sectors of a similar flange were defected through the weld into the threads with a 13-mil drill in order to determine if a defected tube would pass inspection after etching and autoclaving. These defected segments were welded at cut ends and given a standard etch and autoclaved for 36 hours at 400 C. Only one of the four segments showed white corrosion product in the vicinity of the defect detectable under ordinary inspection. Microscopic examination revealed a small amount of white corrosion product in the bottom of the defect holes. Three of these defected sections will be vacuum loaded with contaminated reactor coolant and autoclaved further.

400 Series Stainless Steel Corrosion. A roll pin from the fuel element hangers and a shaft from P-11 valve were both examined metallurgically. These are both of 400 series stainless steel and were cracked. The roll pins had a hardness of R_C-45 while the shaft was R_B-80. The metallurgical examination revealed the roll pins had been extensively cracked before going into the reactor; however, a further intergranular attack took place on the surfaces in reactor service. The two cracks in the soft shaft were judged to be mechanical in origin. The shaft displayed pits to a depth of 21 mils.

300 Series Stainless Steel Corrosion. No new examples of cracks have been found in PRTR 300 series stainless steel specimens examined during the month.

Fretting of Zircaloy. The PRTR fuel element fretting test is continuing in a prototypical, ex-reactor facility. Examination of the element and process tube section after two additional two-week exposure periods revealed that fretted areas 2 to 5 mils deep develop on the process tube at the fuel support areas each time the position of the fuel element is changed. However, the depth of pitting does not appear to significantly increase with increasing exposure time.

PRTR Process Tubes. The physical integrity and corrosion resistance of the 33 PRTR spare process tubes will be determined by the following tests: ultrasonic flaw detection, radiography, fluorescent penetrant, ultrasonic wall thickness measurement, and pickling and autoclaving. As shown by the ultrasonic flaw detection test, 28 tubes are free of defects on the large diameter while the discontinuities that were detected on the other five tubes are expected to be readily removed in pickling or conditioning. Testing is expected to be completed on the first six tubes in August, and the remaining tubes should be completed at a rate of about six tubes per month.

PRP Sheath Tube Program. An experiment was designed and performed to investigate the effect of certain variables in the fluorescent penetrant nondestructive test on the outside surface of sheath tubing. The variables studied were: operator effect on tube preparation, penetrant oil bath time effect, emulsification bath time effect, developer drying time, and operator reading effect. Each of these variables was considered at two levels using sixteen tubes which had been previously rejected in the fluorescent penetrant test for four or more indications. The tubes were processed in batches of two, each batch being prepared and read four times using four distinct factor level combinations.

Making multiple runs on the same tubes, even though the tubes were thoroughly cleaned between runs, was recognized as another possible variable. However, analysis of the data shows that there was no significant difference in the number of flaws read due to this factor.

A statistical analysis of the data showed that on the average an operator will detect 74% of the defects on a tube. Furthermore, the analysis indicates that the reliability of the fluorescent penetrant nondestructive test is not significantly affected by the change in levels of the variables in the ranges considered. This information is valuable in that it indicates no need to put rigid time ranges on the various bath times and drying times. However, there is a slight indication that the longer developer dryer time resulted in fewer indications being detected. A test will be designed and run on the inside diameter of the tubing to determine the reliability and efficiency of this portion of the test.

The use of the line-focused lithium sulphate ultrasonic crystal has materially speeded up the ultrasonic test of sheath tubing by almost doubling the scanning speed. This crystal is now being used in routine testing to detect both longitudinal and transverse defects. However, two separate scans of the tube are required to detect both types of defects.

A total of 183, 0.680-inch ID tubes from the new tubing order HLK-58863 was tested with fluorescent penetrant. These tubes were fabricated by a new process which was to have resulted in improved tube quality.

[redacted]

percent had indications on the outside surface. Examination of the

2. PLUTONIUM CERAMICS RESEARCH

Plutonium-Uranium Carbides

Efforts to identify the carbon deficient zeta phase in several PuC_{1-x} alloys by x-ray powder photographs have been unsuccessful. One sample gave several lines which could not be indexed on the basis of either PuC or zeta. The inability to observe zeta, which corresponds to a formula of Pu_3C_2, may be due to the decomposition of this phase with time. Several PuC_{1-x} alloys are presently being subjected to a low temperature anneal in an additional effort to detect this phase.

Lattice parameters of arc-melted PuC-UC alloys do not appear to vary uniformly with composition. This is probably due to the fact that both PuC and UC are hypostoichiometric with respect to carbon and can exist over a compositional range. Experiments are presently in progress to verify the range of carbon solubility in PuC-UC solid solutions.

Additional experiments on quenching arc-melted PuC-UC solid solutions from above the PuC peritectic of 1660 C have indicated that 25 a/o UC completely stabilizes the decomposition. The phase relations above 1600 C and below 25 a/o UC are a coexistence of Pu_2C_3 and a PuC poor PuC-UC liquid. Lattice parameters of the solid solution phase after the quench are nearly constant at 4.9705 A.

Plutonium Silicides

Prior to detailed characterization of the plutonium silicides, a single-phase product must first be obtained. A stoichiometric mixture of PuO_2 and SiC was compacted and heated in an oxidized tantalum crucible to 1400 C for 25 minutes at a pressure of 2×10^{-5} mm Hg in an attempt to form such a single-phase product, Pu_2Si_3. The furnace was cooled at approximately 120 C per minute to room temperature. There was no reaction with the crucible. X-ray and chemical analyses will be used to identify the product.

A chemical analysis of a product formed by arc-melting plutonium metal rods and silicon pellets indicated 82.3 w/o Pu - 19.7 w/o Si. The reactants were mixed with 85 w/o Pu - 15 w/o Si. Obviously, a total of 102 percent indicates an analytical error and a more accurate procedure is being developed. X-ray diffraction analysis indicates this product to be primarily Pu_2Si_3(beta-$PuSi_2$). It is thought that the stoichiometric balance may be better maintained by pressing pellets of plutonium and silicon and arc-melting. This will be done during the next reporting period.

Plutonium-Zirconium Oxide

Capsules which contain PuO_2-ZrO_2 fuel cores are being fabricated for irradiation testing in the MTR. This fuel material has possible application as a ceramic type spike enrichment fuel. The irradiation test consists of eight one-half-inch diameter Zircaloy-4 clad capsules each containing five pressed and sintered PuO_2-ZrO_2 pellets. The variables that will be investigated during this test are the effects of plutonium composition, center core temperature, and exposure on the irradiation performance of this type of fuel material. ZrO_2 which contains one and five mole percent (2.18 and 10.39 w/o PuO_2) will be irradiated at two different core temperatures to two different exposures. In both cases the PuO_2 additions stabilize the monoclinic ZrO_2. The poor thermal shock resistance usually associated with monoclinic ZrO_2 is caused by the tetragonal-monoclinic transformation. This transformation does not occur in the PuO_2-ZrO_2 system. A single-phase face-centered cubic solid solution is present at all compositions above 1200 C. In the composition range of interest, the solid solution transforms from face-centered-cubic to a two-phase mixture of monoclinic ZrO_2 and a face-centered-cubic solid solution. Evidently the severity of this transformation is not of such a magnitude as to upset the dimensional stability of the material, thus its thermal shock resistance is greatly improved. One set of four samples will be irradiated with a calculated maximum core temperature of about 1800 C, which is above the sintering temperature. The other set of samples will be irradiated with a calculated maximum core temperature above 2800 C which will cause center core melting. The flux will be varied to provide the desired operating conditions.

Fabrication of the ZrO_2 - 5 m/o PuO_2 pellets has commenced. PuO_2 powder was heated in air at 800 C for seven hours to assure complete oxidation. It was then ball milled for 24 hours. Minus 325 mesh ZrO_2 was mixed with the PuO_2 to form the desired composition and the mixture was blended in a twin shell blender for 72 hours. The PuO_2 is minus 325 mesh also. Chemical analysis samples for PuO_2 content were taken from three different areas of the blended material. Three weight percent Carbowax was added as a binder and the material was then dried by heating to 90 C for about 45 minutes. Pellets are being pressed at 1500 psi to a green density of about 53 percent of theoretical. The pellets are 0.570-inch diameter and 0.573-inch long. After weighing and measuring, the pellets will be sintered to final density in helium. It is expected that the final density will be about 85 percent of theoretical. They will be centerless ground to final dimensions before loading. No end clearance will be provided in the capsules; however, MgO spacers will be used to prevent the ZrO_2-PuO_2 fuel from coming in direct contact with the end caps.

Surface Area Measurement

The BET facility has been expanded to include an apparatus for the measurement of total gas volume evolved from a specimen. These will include absorbed, dissolved, and entrapped gases as well as decomposition products An induction coil provides a heat source which should be capable of

producing temperatures up to 2000 C. Initial investigations will be concerned with UO_2 gas evolution. The evolved gas will be collected and the species identified by mass spectrometry. Metallographic, chemical, and x-ray techniques will be used to determine the gas source.

Conductivity Studies

Apparatus and instrumentation has been designed for initiating a study of some of the semi-conducting properties of various plutonium compounds. The properties to be determined are electrical resistivity and thermal emf which will not only be of interest in themselves, but will also be used to detect phase changes and nonstoichiometric effects in plutonium compounds. Resistivity measurements will be made from room temperature to 1000 C; however, thermal emf determinations will initially be limited to near room temperatures.

3. UO_2 FUELS RESEARCH

Electron Microscopy

Previously reported studies using the high temperature stage to 2000 C were repeated, and results were reproducible. A serious problem of maintaining sufficient cleanliness within the microscope under these conditions has developed. Substantial deposits of a reaction product formed on internal surfaces in the vicinity of the sample stage, and adversely affected the microscope performance. The deposit appeared to result from reactions of the tungsten support grid with sample materials, and/or with residual air in the microscope column. Other grid materials, improvement of the operating vacuum of the microscope, and modifications to allow partial isolation of the sample chamber from the rest of the microscope are being considered.

Experiments were performed to determine limits of usefulness of a Vidicon closed circuit TV system to assist in electron microscope observations. Good quality pictures on the monitor were obtained by focusing the camera of the fluorescent screen, to obtain a brilliant image. However, the camera was unable to pick up low-level images from the microscope screen, or reproduces them with excessive background "noise". Other types of cameras are being investigated.

A pair of cylindrical lenses was made in HLO Optical Shop for photographic correction of the distortion inherent reflection microscopy images. Experiments are in progress to determine the quality of the corrected photographs.

Melting Point Studies

Coprecipitated ThO_2 - 4.8% UO_2 was examined under the microscope at temperatures to the melting point, which was 3240 C $\pm$ 20°. Neither vaporization nor reaction was evident at temperatures below the melting

point; however, the molten oxide apparently wet the tungsten and reacted quite rapidly to form a dull gray product.

Pure ThO_2 also was heated to the melting point; it behaved like the ThO_2-4.8% UO_2. The melting point of the ThO_2 was not accurately measured because it was too near that of the tungsten filament.

Conductivity of UO_2

All measurements of electrical and thermal conductivity of UO_2 specified in the BMI/HLO contract for 1960-61 were completed. Final data are being evaluated and correlated, and a formal joint Battelle-Hanford report will be issued covering all aspects of the program.

Thermal conductivity measurements on the UO_2 irradiated to 0.06% burnup were extended to 886 C (250 C higher than any previous irradiated samples in the series). At temperatures above 700 C the thermal conductivity of the irradiated specimen was less than 10% below that of non-irradiated material. Subsequent measurements at room temperature to determine extent of permanent recovery of conductivity have not been made.

Electrical conductivity was measured on UO_2 crystal agglomerate prepared by electrodeposition in the salt cycle process. At all temperatures up to 575 C (the maximum attained), the electrical conductivity was about one-fifth that of sintered polycrystalline cylindrical specimens measured previously.

Measurements have also been completed for electrical conductivity of UO_2 irradiated to 0.06% burnup, and of a non-irradiated fused UO_2 single crystal. The thermal conductivity of a vibrationally compacted disc also has been measured. Evaluation of data is in progress.

Irradiation Effects

Two capsules containing non-stoichiometric UO_2 (O/U ratios between 1.93 and 1.98) were discharged from the MTR core after successfully completing two cycles of irradiation. The capsules will be returned to Hanford for radiometallurgical examinations.

Irradiation of UO_2 single crystal wafers continues in the ETR core.

Irradiation of a thin walled stainless steel clad 9-rod cluster continues in the VBWR without incident.

Ex-Reactor Defect Tests

The Zircaloy-2 microstructure in the vicinity of a 0.005-inch defect drilled through the cladding of a reactor simulation capsule showed no hydriding. The capsule operated for 30 minutes at a surface heat flux of 200,000 Btu/hr/ft^2 with a maximum bulk coolant temperature of 45 C and a pressure of 80 psig. Studies will be conducted with higher heat fluxes.

Fuel Evaluation

Phosphor screens of zinc sulfide have been prepared for the autoradiographic examination of irradiated, UO_2 fuel cores. The phosphor screens, when placed one-half inch from approximately five grams of irradiated UO_2, produced a soft luminescence which could be seen in a totally dark room. Cross-sections of irradiated UO_2 fuel cores have been prepared for autoradiographic examination with these phosphor screens.

Materials

Uranium dioxide scrap generated offsite during preparation of fused UO_2 is being converted to electrodeposited UO_2 crystals by Chemical Engineering Development Operation, for evaluation in swaged and vibrationally compacted irradiation test elements. The scrap was oxidized to U_3O_8 in an air furnace to facilitate dissolution in the fused salt bath.

4. BASIC SWELLING PROGRAM

Irradiation Program

Irradiation of capsules numbers 7 and 8, each containing three, hollow, split, uranium cylinders, is continuing at constant temperatures of 525 C and 575 C, respectively. Capsule #9 has been completed and successfully bench tested. It will be used to check out a recently completed instrumentation facility at the reactor. The new instruments and capsule power supply units will be used to control temperatures on future swelling capsules.

Capsules numbers 10 through 14 are being assembled simultaneously and are approximately 30% complete. Two capsules each will be entrained in a single reactor test tube and irradiated simultaneously at different constant temperatures. Assembly has been initiated on an additional capsule, No. 15, to be used as a back-up unit if needed or for subsequent irradiation.

Two unmonitored NaK-filled capsules, GEH-14-281 and 282, each containing a precharacterized U-U diffusion specimen, have been received in Radiometallurgy and will be opened in the coming month. The specimens consist of a depleted core of uranium metallurgically bonded to an enriched shell. Four similar capsules, each containing six cylindrical U-U diffusion specimens are being prepared for irradiation.

Post-Irradiation Examination

The radiometallurgical determination of the density and microhardness of as-irradiated specimens from capsules 4, 5, and 6 is essentially complete. Most of the samples have been polished, etched, and replicated, and numerous replicas have been processed and examined in the electron microscope laboratory. Additional replicas await processing. Certain samples

will be annealed at select temperatures and hardness, density and metallography redetermined.

Beta heat treated uranium spheres irradiated unrestrained at volume average temperatures of 575 C and 615 C to burnups of 0.05 and 0.3 a/o contain numerous cracks that appear to be primarily intergranular in nature. The cracking is much more extensive in the higher burnup specimens. Specimens irradiated to 0.3 a/o burnup, but at 615 C and 575 C, respectively, exhibit no significant difference in cracking, although small differences would be difficult to detect. The uranium hollow cylinders irradiated at about 300 C to 0.03 a/o burnup exhibited no cracking. Neither did short solid cylindrical diffusion specimens previously discussed that had been irradiated below 200 C to burnups as high as 0.26 a/o. It would appear that the cracking is associated with high irradiation temperatures and becomes worse as the burnup increases. The 0.26 a/o burnup solid cylindrical specimen is being polished for hardness and dimensional measurements. It will then be annealed in vacuum at 600 C to determine the amount of swelling and cracking that can be induced in this specimen.

Restrained Irradiations

Swelling experiments of Zircaloy-2 clad uranium rods with selected uranium temperatures, cladding thicknesses, and burnup are being conducted employing NaK-filled temperature monitored capsules. Samples from eight rods that were irradiated in the MTR are being prepared for density determinations and burnup analyses. The swelling information derived from these data will be compared with that obtained from dimensional measurements of the rods and calculated burnups.

Additional capsules are being assembled for irradiating Zircaloy-2 clad uranium rods.

5. IN-REACTOR MEASUREMENT OF MECHANICAL PROPERTIES

In-Reactor Creep Measurements

Final power and control apparatus adjustments are being made on capsule II-2 prior to starting a creep test. Gamma heating in capsule II-2 reached a new high in the early part of July raising maximum temperatures to the neighborhood of 500 C for a short time. The creep test will, therefore, have to be conducted at 525 C, rather than the 495 C previously reported. A life test conducted on the extensometer of capsule II-4 indicates an early failure of the 20,000:1 gear box. During laboratory checkout of capsule II-3, another gear box failure was encountered. The capsule was opened and the gear box removed and examined. The fear failure was the result of a spur gear slipping on its shaft, a condition which cannot be repaired. Welding is impossible as the material is air hardened tool steel, and operational temperatures are too high for brazing. A replacement gear box is being obtained. The gear ratio of the new gear box has been reduced from 20,000:1 to 2000:1

to increase useful life, and the materials of construction changed from tool steel to austenitic stainless. The gear box weight has also been reduced to reduce gamma heating.

Capsule and Instrument Development

Work has continued on the capsule thermal mockup, design and component fabrication is completed, and assembly is now in progress. The thermal mockups are intended to measure the heat transfer coefficients in the capsule in the laboratory by supplying electrical heat to simulate the gamma heating of all components and then measuring the exact heat transfer values.

Pre-Irradiation Material Characteristics

Determination of activation energies for the creep of Zircaloy-2 has continued. Activation energies found for annealed material at 367, 376, and 393 C were 56,100 ± 3,100; 52,500 ± 1,100; and 54,000 ± 3,000. These values are lower than the average value found at temperatures between 300 C and 350 C.

6. GAS-GRAPHITE STUDIES

EGCR Graphite Irradiation

Extrapolating from the origin, preliminary results from the H-3-2 capsule (ca. 40,000 MWD/AT) show a departure from linearity in contraction rate per 10^{21} nvt. This departure, in the direction of a higher rate, may represent a change in mechanism or simply an expansion of small magnitude during the initial phases of the first irradiation period. Measurement of the samples at the termination of the H-3-3 irradiation will confirm which of the possibilities exist. Rates for parallel cut samples of NC-7 needle-coke graphite between the terminations of the first and second irradiations were -0.021 and -0.026 percent per 1000 MWD/AT for 800 C and 475 C irradiation temperatures, respectively. Flux monitors are being measured and when complete will allow firm representation of the exposures achieved.

The H-3-3 capsule, containing graphite from two previous irradiations, was installed in the GETR during the week of July 10. The samples, at peak exposure positions, should accumulate an exposure of 60,000 MWD/AT (EGCR) during the next four reactor cycles. Startup temperatures at full reactor power were consistent with previous irradiation temperatures.

In-Reactor Creep

Five compression test boats at 300 psi (nominal) have been discharged from 2B at KW-Reactor. During the in-reactor test, a slow diffusion of carbon through the protective Al_2O_3 layer slowly reduced the PbO weight material lowering slightly the pressures on the samples during the irradiation period.

Five previously irradiated 150 psi compression test boats have been recharged in 2B at KW-Reactor for an additional four months of irradiation.

Thermal Cycling of Coated Graphite

A Si-SiC coated sample previously irradiated to 3000 MWD/AT at 500 C is undergoing thermal cycling in air from 250 C to 1200 C at a frequency of seven cycles/hour. After 27 hours of test there has been a slight weight gain of 2.3×10^{-4} gm.

Surface Complex Studies

The surface area of a sample of SP-7 graphite was found to increase after being used for surface sorption runs in CO_2 and O_2. The increase may be resulting from an oxidation of the sample (weight loss of ~four mg after each surface sorption set). The sorption tests consisted of two runs in CO_2 followed by two runs in O_2 all at 350 C, with intermediate helium treatment after each run. Between the two sets of sorption runs the sample was treated with 0.002 M $FeCl_3 \cdot 6H_2O$ solution in which it gained 2.5 mg. The ratio of CO_2/O_2 total weight gained is shown in the table:

RATIO OF WEIGHT GAINED DURING SORPTION RUNS

Sorption Test	CO_2/O_2
Before $FeCl_3 \cdot 6 H_2O$ treatment	1.41
After $FeCl_3 \cdot 6H_2O$ treatment	1.52
Theoretical ratio (correcting for saturation and helium)	1.43

The impurity (Fe) apparently enhanced the amount of CO_2 adsorption - possibly by increasing a chemisorption phenomena of the CO_2.

Argon has been found to adsorb on the graphite at a rate similar to the other gases and proportional to its molecular weight.

It has been found that k, the rate of adsorption, according to the following equation:

$$\log(w_f - w) = -kt + \ln w_f$$

is directly proportional to the flow rate. This has been verified for O_2 at 300 C and CO_2 at 25 C in the range 0.5 to 2.5 CFH. Furthermore, a gas mixture of ~50% He ~50% CO_2 at a flow rate of 2.5 CFH adsorbed at the same rate as a 100% mixture (2.5 CFH at 25 C) and saturated at ~ one-half the total weight gained. These results are consistent with adsorption being independent of the gaseous species.

Steam-Graphite Reaction

Construction of an apparatus for the investigation of the steam-graphite reaction has been essentially completed. Calibration of water flow rates

into the steam generator and preliminary rate measurements will be initiated shortly. Difficulties in resolving the CO and CO_2 peaks experienced during the calibration of a Fisher Model 25 Gas Partitioner have been completely resolved by replacing both the silica gel and molecular sieve columns. This instrument will be employed to analyze products of the steam-graphite reaction.

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

Gas loop construction is approximately 91% complete versus 97.5% scheduled predicted to July 31, 1961. The J. A. Jones installation work is 90% complete versus 90% scheduled. Significant work remaining to be completed includes installation of the emergency gas addition line, installation of the in-reactor section prototype in B cell, and calibration and adjustment of all instruments.

The primary gas loop piping was tested at 535 psig pneumatically, and all joints were "sniffer" tested at 50 psig helium. The pressurizer and storage tanks were tested at 620 psig and connecting piping was "sniffer" tested using 50 psig helium. Three minor leaks were found which were corrected.

Mr. D. E. Jones of Bristol-Siddeley arrived from England to assist in startup of the main gas-bearing compressor supplied for temporary usage. Mr. Jones observed a dye-penetrant check of the pressure casing in the vicinity of the flanges and checked for possible shipping damage and correct phasing of power leads. The blower was run at 3600 and 6000 rpm using room air at atmospheric pressure and 3600 and 6000 rpm using carbon dioxide at 125 psig pressure. Mr. Jones arrived July 11, and departed July 20, after successful operation of the blower.

The steel shielding and sample casks have arrived and are in temporary storage at the PRTR warehouse.

7. GRAPHITE IRRADIATION DAMAGE STUDIES

Flux Intensity Dependence of Radiation Damage

A series of TSX samples were irradiated in the MTR for 30.3 effective days at an estimated temperature of 50 C to augment data on the intensity dependence of low temperature radiation damage. Changes in both length and $\underline{c}$ spacing were used as indicators of damage. At an average flux intensity of 1×10^{13} nv (> 1 Mev) to a total exposure of 3×10^{19} nvt, the rate of length change was 1.0% per 10^{20} nvt. At an intensity of 3.2×10^{13} nv to a total exposure of 10.5×10^{19}, the rate of length change was 1.3% per 10^{20} nvt. Thus, there was a 30% increase in rate associated with a three-fold increase in flux intensity. Measurements of $\underline{c}$ spacing change were made at fluxes ranging from 6×10^{12} to 4.5×10^{13} nv. The $\underline{c}$ spacing results indicated a slight decrease in the rate of expansion with increasing flux intensity.

These results suggest that even closely related damage phenomena such as length and c spacing do not possess the same flux intensity dependence. Therefore, flux intensity measurements which are intended to guide estimates of radiation induced length changes should monitor length changes primarily and not rely on measurements of other properties which might be more conveniently measured.

8. ADVANCE EVALUATION STUDIES

Supercritical Pressure Water Reactor Study

The conceptual design and economic evaluation of a 300 MWe Supercritical Pressure Power Reactor (SPPR) was completed and is being issued as document HW-68420. The following conclusions were drawn from the study:

1. The feasibility of the reactor concept selected for evaluation (light water cooled and moderated with the inverted cluster fuel element as the pressure member) depends primarily on the successful long term exposure (25,000-40,000 MWD/T) at high coolant temperatures (1000-1200 F) of the inverted cluster fuel element. This implies that the irradiated properties of the materials used in the fuel element should not be greatly different from the unirradiated properties.

2. Based on the Nuclear Power Plant's Cost Evaluation Handbook method of computing unit power costs, the SPPR unit power cost is 6.43 mills per kwh using the pre-June 1961 uranium price schedule.

3. Using the revised uranium price schedule, the unit power cost for the SPPR is 5.96 mills per kwh.

4. The simplicity of the direct power cycle with the absence of expensive reactor core components had led to capital costs of $175 per kw (net).

5. The potential capital cost for SPPR type reactors in the 300 MWe size range based on unit costs of fossil fueled supercritical power plants and the Cost Evaluation Handbook ground rules is about $145 per kw (net). The potential unit power cost is about 5 mills per kwh.

6. It is believed that the necessary R&D effort in support of the SPPR can be accomplished in an orderly manner in the five-year period established as a basis for this study.

The net thermal efficiency of the SPPR power cycle which utilizes 3500 psi, 1050 F turbine throttle conditions with two reheats to 1000 F, is 43%. The gross efficiency is 44.9%.

The entire facility including the turbine-generator is housed in a 180-foot hemispherical containment vessel similar to that used with the BONUS reactor.

Conceptual Design - Fuel Element Fabrication Plant

The final section, Part IV, "Estimates of Capital Costs of Plants; Estimates of Total Product Cost of Completed Fuel Elements," and the "Summary and Conclusions" for insertion in Part I have been issued for comments. No further work is planned following transmittal of the above for approval.

9. ALUMINUM CORROSION AND ALLOY DEVELOPMENT 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. However, at the time of this report no further corrosion data on these materials had been obtained.

The proposed H-1 loop revisions have been reviewed and modified to reduce the cost of the project to a minimum, retaining only those revisions required for reliable loop operation. Since the original bids for the deionizers were considerably greater than expected, the deionizer specifications have been rewritten to eliminate all but essential features and sent out for new bids.

A rod of PuAl coextruded with Al cladding appears to be a promising fuel element for corrosion testing of Al cladding. Such elements can be fabricated experimentally by Plutonium Metallurgy.

USAEC-AECL Cooperative Program

Response of the ultrasonic test to various geometrical and metallurgical variables in Zircaloy tubing is being measured. Some of these variables are more readily produced in strip than in tubing, although facilities for fabricating both strip and tubing are available. Samples 20, 30, and 60 mils thick will be used to determine whether responses to wall thickness changes are similar in strip and tubing, with all other variables held as constant as possible. In addition, a tube drilled and honed from a solid rod, with very close wall thickness tolerances, will be examined ultrasonically to help evaluate whether orientation of the grains is an important variable.

Improved methods of controlling the geometry and size of standard defects are being developed. The electrojet machine has been altered slightly to reduce the current and consequently the width of the cut. These alterations have resulted in reducing the defect width from about 3.5 mils to 2.0 mils, using a one-mil-wide brass electrode. The surface finish on the cut also is improved. This work is continuing in an effort to produce better standard defects.

10. IRRADIATION EFFECTS IN STRUCTURAL MATERIALS

As reactor concepts become more diversified, it is increasingly more difficult to keep pace with the need for information about the effects of irradiation on reactor structural materials. The purpose of this program is to investigate the combined effects of radiation and reactor environment on the mechanical properties of structural materials. Special attention will be given to the determination of mechanical property changes produced in metals by irradiation at elevated temperatures in contact with water.

Modification of the ETR 6x9 loop for the purposes of this program is nearly complete. Piping and instrumentation are presently being installed during Cycle 39 shutdown, and beneficial use of the loop will commence during Cycle 39 of the ETR. The first specimen loading consists entirely of Zircaloy-2 tensile specimens, with a total of 504 specimens. Goal exposures range from 2.0×10^{19} to 1.6×10^{22} nvt. The specimens were machined from rolled Zircaloy-2 plate in transverse and rolling directions. The specimens have various levels of cold work, including 0 (annealed), 10, 20, and 40% reduction of area. The entire charge was autoclaved for 48 hours in 300 C water prior to irradiation. As the Zircaloy-2 specimens reach their goal exposure, they will be discharged and replaced with types 348 and 304 stainless steel tensile specimens, which are presently being machined.

Low temperature irradiations are also in progress on Zircaloy-2 tensile specimens with histories identical to those prepared for irradiation in the ETR 6x9 loop. A series of 19 capsules was charged into the ETR F6 and G6 positions; eight of these have been discharged and are presently being unloaded at the Radiometallurgy facility. Included in this series of capsules are a limited number of Zircaloy-2 notch tensile specimens; special testing techniques will be employed with these specimens to determine their fracture toughness. A difficulty which has been encountered in conducting this test on unirradiated Zircaloy-2 is excessive plastic deformation in the vicinity of the notch, which results in spurious values of K_c (measure of fracture toughness).

D. RADIATION EFFECTS ON METALS - 5000 PROGRAM

Precision measurements of the intensities of diffracted x-rays from single crystal surfaces are being continued. Three selected single crystals of 99.995% pure Al are being irradiated at room temperature to 10^{19} nvt. Pre-irradiation examination of these crystals showed that the observed extinction was of the primary type. The indicated size of the coherently diffracting domains was about 6 microns. The lack of secondary extinction shows that the incident beam penetrates little deeper than the size of a single domain. Additional crystals are being prepared for analysis. These crystals will also be irradiated. They will be exposed for longer times than the first group. Further experiments will be performed using molybdenum single crystals of known impurity content. A number of reports are currently being written to summarize results of the annealing studies.

E. CUSTOMER WORK

Radiometallurgy Service

Measurements of wafers from an overbore element showed that about 10 mils of aluminum cladding had been removed by corrosion, and the diameter of the uranium fuel had increased about 15 mils during irradiation (RM-410). Non-uniform growth of the uranium was observed in three self-supported production fuel elements, and up to 15 mils of aluminum cladding was removed by in-reactor corrosion (RM-425). The fractured surfaces of a transverse failure crack in an aluminum process tube removed from 1578-H were identical to those of three previously-examined process tube failures from 105-H which were identified as fatigue fractures (RM-429). Twenty-six samples from various programs were dissolved for burnup analyses, and eight samples were declad in the chemical processing facility.

Metallographic examination of two hollow half cylinders of uranium from capsule No. 6 and microhardness testing of specimens from capsule No. 5 were completed in support of the Basic Swelling Program. Vacuum annealing of selected specimens from each capsule has begun (RM-510).

Metallography Service

Zircaloy clad fuel elements with and without five percent beryllium alloy brazed end caps were examined after exposure to furnace temperatures of approximately 1300 C for one hour. The uranium metal in both cases had melted, and some had escaped through breaks in the cladding. The element with the brazed end caps had lost most of the Zircaloy jacketing metal, as reported last month. Sections through the end caps revealed nearly all of the Zircaloy metal of the end caps had been replaced by an alloy of uranium and Zircaloy. Metallic Zircaloy was found only in small spots on the surfaces exposed to air during the heat cycle.

The element with plain welded Zircaloy end caps had also suffered complete oxidation of the can wall. The amount of alloying between the Zircaloy and the uranium appears to have varied between the two elements. Further investigation is proceeding to determine to what degree this difference exists and whether the small amount of beryllium present had any effect on the alloying behavior.

Metallographic examination of some of the first NPR 2-5/8 inch carbon steel pipe (ASTM A106 Grade B) as heat treated by Huico was found to be decarburized 10 to 12 mils on the OD and three to five mils on the ID. An examination of the material as received from the mill by Huico was little better, being seven to nine, and one to three mils, respectively. Also checked was some NPR eight-inch carbon steel pipe, schedule 120, ASTM A106 Grade B. Decarburization on this pipe was found to be spotty and was found chiefly on the OD.

Work continued on identification of the oxides fromed during autoclaving of zirconium alloys. As stated in the monthly report for May, an oxide island,

surrounded by Zircaloy-2, had been exposed by gently polishing away the metal. An x-ray diffraction back reflection pattern has been obtained by focusing the x-ray beam on an oxide island with a diameter of 0.016 inch. The reflections on the film indicate zirconium metal. It is reasonably certain that the x-ray beam covered the oxide, but evidently it also struck the metallic Zircaloy surrounding the island. Diffraction lines for cubic ZrO_2 were not observed. An attempt will be made to remove the specimen from its mount and retain the oxide island intact. If this is possible, a transmission x-ray diffraction pattern will be made to check for the presence of tetragonal or monoclinic ZrO_2.

Samples Processed During the Month:

Total Samples	256
Replicas	19

Photographs:

Micrographs	520
Macrographs	85
Electron Micrographs	133
	738

NPR Charging Machine

The charging machine requirements for NPR include handling multiple length fuel elements from behind substantial barriers. An individual monotube magazine concept that can hold a complete tube charge using a floating piston to move the column has been proposed. Development, fabrication, and testing of the first machine is proceeding as the design is approved. The mechanical components of the 58-foot long charging machine are 97% complete and initial testing has commenced. The electrical and hydraulic work is 35 and 90% complete, respectively. Installation of the mockup equipment for testing the nine-ton machine plus six tons of fuel include rail assemblies for the machine to run on, wall storage racks for the loaded magazines and a front face mockup for charging evaluation. Installation of the mockup assemblies is 50% complete. Testing of components and the machine is eight percent complete.

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[redacted]

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

JULY 1961

FISSIONABLE MATERIALS - 02 PROGRAM

FUELS

Nuclear Safety in FPD

Revised nuclear safety limits for processing and storing 0.95% U-235 enriched, I and E fuel elements were submitted to the Engineering Operation.(1) These limits, which are based on an improved method of calculation,(2) are 40-80% higher than limits used in the past. The new limits will be used as the basis for revising the 313 Building nuclear safety specifications.

Limits for processing and storing 0.95% U-235 enriched, NPR fuel elements were also submitted to the Engineering Operation.(3)

These limits will be used as the basis for NPR fuel element nuclear safety specifications.

REACTOR

Optimization of Retubed C-Pile Lattice

An 8-foot exponential pile has been constructed for the C-pile retubing program and measurements of the material buckling have been started. The first measurements are being taken in the pile loaded with standard C-II-N dry fuel elements. The relaxation length for this assembly is 77.83 cm. A spare C-pile safety rod has been obtained and prepared for experimental use. The 8-inch aluminum cans for the natural uranium overbore fuel elements have been received.

Lattice Parameters for Large Diameter Fuels

The ratio, P(t), between observed fission product gamma activities and fission events in uranium foils has been measured in the Physical Constants Test Reactor (PCTR). This ratio is used in measurements of ϵ. The value obtained for P(t)

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(1) Brown, C. L., Nuclear Safety Specification Basis for Hanford 0.95% U-235, I and E Fuel Elements, HW-70351.

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

(3) Brown, C. L., Nuclear Safety Specification Basis for NPR Fuel Elements, HW-70500.

for times greater than 4 hours after reactor shutdown is a constant:

$$\frac{\text{fission product gamma activity per fission in U-235}}{\text{fission product gamma activity per fission in U-238}} = 1.119.$$

The resonance escape probability (p) has been measured in a 10½-inch graphite lattice containing 2.5-inch solid, natural-uranium fuel. The measurement was made to compare several methods of measuring p. Two methods of interpretation have been applied to the foil data. The results reproduce an earlier measurement.

TABLE I

Measurement	P
Original	.789
Repeat	.787
Bare foils	.792

The repeat measurement used the normal cadmium ratio technique. The bare foil measurement compared bare foils in the fuel to bare foils in the TTR thermal column to derive P.

Cadmium ratios for copper, sodium, and gold have been compared to that of a BF_3 tube at two lattice positions in the same lattice. The results are listed in Table II.

TABLE II

Position	Material	Cadmium Ratio
Graphite	BF_3	22.87
	Gold (5 mil)	4.01
	Copper (5 mil)	12.00
	Sodium (2 mil)	20.20
Fuel Center	BF_3	8.98
	Gold (5 mil)	2.39
	Copper (5 mil)	4.22
	Sodium (2 mil)	7.96

Sodium is a much better detector for 1/v fluxes than copper since the excess resonance correction is much smaller. The inaccuracy of the assumption of a 1/E epithermal spectrum will have much less effect on sodium than on copper.

Exponential Measurements of Large Diameter Fuel Elements

The computer programs used in the analysis of exponential pile data have been modified to use age-diffusion theory harmonic corrections to data taken with the shutter technique. The equations are given in BNL-77. The boundary condition imposed by the cadmium shutter is properly treated. The fact that the thermal flux goes to zero at the shutter was ignored in previous methods of analysis.

The error in analysis seems to be most apparent for experiments where the neutron sources are clustered together at the pile centerline. A horizontal traverse with clustered sources has been analyzed with the modified program. The analysis yielded an extrapolation length of 0.8-inches. The same data analyzed with the old computer program yielded an extrapolation length of 2.50-inches. The data were taken in an 8 x 8 foot exponential pile which had a concentric tube fuel element at a lattice spacing of 8-3/8-inches. The modified program will be used to analyze other data taken previously with the shutter technique.

Small Source Theory Treatment of Exponential Pile Traverses

A theoretical analysis of several exponential pile horizontal traverses has been completed. The small source theory treats the fuel as individual line sources and sinks. Thus the deviations from the overall $\sin \frac{\pi x}{a}$ distribution can be predicted for heterogeneous systems. The theoretical form of the flux distribution along the vertical cell edge is $\phi(x) = \sin \frac{\pi x}{a} + A \sin \frac{\pi x}{a} \cos \frac{2\pi x}{d} + B \cos \frac{\pi x}{a} \sin \frac{2\pi x}{d}$, where a is the pile size and d is the lattice spacing. Higher order harmonics are neglected in the present form of the analysis. The second term is the normal fine structure along the cell edge and can be understood as the usual effect of flux depression in the fuel. However, the third term is an oscillation which appears because of the finite pile size ($B \longrightarrow 0$ as $a \longrightarrow \infty$). The oscillation has been found in analyses of eight different horizontal traverses. The calculated magnitude of the oscillation is slightly low ($B \sim 0.003$ instead of ~ 0.004), but the shape of the experimental traverse is well reproduced. Furthermore the coefficient of the cell edge fine structure varies slightly with the pile width ($A = 0.0289$ for a large pile and $A = 0.0297$ for a five-foot wide pile). Thus cell flux traverses taken in small piles should be corrected if applied to calculations for large piles.

The equations for the vertical flux distribution have not yet been solved. However, qualitative considerations indicate that an asymmetry in the cell flux should occur which would be only weakly dependent on the vertical position in the pile. This asymmetry has been found experimentally (R. C. Lloyd, HW-61844), but the analysis is not yet available.

PCTR Safety Specifications

Solutions for the neutron flux as a function of time have been obtained from a set of reactor kinetics equations which are applicable to PCTR operations. Both the analog computer in Systems Research Operation, and the digital IBM 7090 were used in this work, the latter with the HAIREK code. Different input values of the prompt neutron lifetime and total delayed fraction were used for the several cases which were solved. This work was done in support of the revised PCTR Hazards Report, and will be used to determine level-trip settings for the PCTR.

Transport Theory Development Work

In order to provide improved methods of analyzing the effect of cell fine structure, two of the most versatile and complete machine analyses of multi-energy transport theory in existence were acquired from the G-E Aircraft Nuclear Pro-

pulsion Department, and incorporated into the Hanford machine library. Brief summaries of analysis capability follow, for each of the two programs.

a. Neutron Transport Theory, Annular (r,z) Geometry, LASL Program TDC, GE-ANPD Automatic Operator Version

This program was formulated for the IBM-704 by the Los Alamos Scientific Laboratory and converted to the IBM-7090 by GE-ANPD. The transport field is constructed by use of a last-free-flight outer iteration loop combined with a flexible inner iteration loop for each energy. The analysis employs Carlson's discrete S_n digital representation and lattice integration. Machine time is minimized by starting with a gross angular lattice and shifting to a fine angular lattice after gross convergence.

Input consists of the radial-axial-energy-angle lattice, concentrations, cross sections (collision, fission production, isotropic endoergic-and-exoergic transfer, production, sensor), surface albedos, and isotropic volume source or surface source.

Output includes isotropic flux radial-axial-energy distribution, eigenvalue (critical material loading, critical region size, fission reactivity, prompt inverse period), radial-axial power distribution, flux-weighted cell homogenization both by regions and by materials, radial-axial sensor-activation traverses, and restart field.

Typical running time is about one hour (for 16384-word problem), with a probable maximum of about two hours (for 32768-word problem), for a three-figure eigenvalue from a rough-flux-guess start.

b. Neutron and Photon Transport, Variational Optimum Formulation, Plane-Cylinder-Sphere, GE-ANPD Program S

This variationally optimized generalization of the S_n analysis method constructs the dual adjoint-and-flux transport field by use of an iterative next-free-flight adjoint loop locked in momentum-image synchronism with a last-free-flight flux loop. All input-output transmission and all calculations proceed under parallel-logic automatic error control.

Input consists of the space-energy-angle lattice, concentrations, cross sections (collision, fission production, isotropic-and-anisotropic endoergic-and-exoergic transfer, production, sensor), isotropic-and-anisotropic volume-surface-line-point source, surface albedos, and cross section statistical uncertainties.

Output includes the space-energy-angle distribution of both adjoint and flux, eigenvalue (critical fuel loading, critical moderator loading, critical poison loading, reactor period with inclusion of delayed production), performance trends (provided as perturbation-theory derivatives spanning coupled variation of all eigenvalues and the loading of all reactor materials), variational optimum gross reactor kinetics, material action traverses (giving the perturbation worth of materials as a function of location), eigenvalue statistical uncertainty, energy distributions, space distributions, power traverse, absorption traverse, biological dose traverse,

sensor activation traverses, space-energy distributions, variational optimum space-energy cell homogenization, photon energy production distribution, photon energy deposition, all sorts of perturbation-theory integrals weighted with the product of adjoint and flux, all sorts of flux-weighted reaction-rate integrals, and restart field.

The S_n analysis method has well-evaluated reliability, limited principally by cross section accuracy, and spanning both neutron and photon aspects of core, reflector, control-rod, and inner-shield analysis of high-performance fission reactors. Typical running time is ten minutes (maximum twenty minutes) for a four-figure eigenvalue from a flat-field start.

Digital Computer Programs for Reactor Analysis

Development of HFN, the multi-group neutron diffusion theory code, is continuing. Most of the available options have been checked and found to be working properly.

The flux and reactivity values from a one-dimensional spherical geometry calculation appear to be reasonable, but have not been verified with a hand calculation. This completes a qualitative check on the accuracy of HFN calculations using the three available one-dimensional geometries (slab, cylindrical, spherical).

HFN succeeded in calculating reactivities, fluxes, adjoints, flux gradients, adjoint gradients and perturbation integrals (volume integrals of direct and adjoint flux and flux gradient products) for two cylindrical systems.

HFN was also used to compute theoretical detector activation traverses from the multi-group fluxes. In addition, the activity ratio (e.g., cadmium ratio) and activity fraction (e.g., cadmium ratio minus one) calculations are proceeding properly.

A multi-group cross section data tape, containing data read from input cards, was successfully generated, then updated, then used in an HFN calculation. The use of a data tape can materially reduce the number of input data cards required for HFN calculations.

An outline of the HFN descriptive document has been started.

Green's Function and Exponential Piles

The previously reported results of a Green's function treatment of one region exponential piles have been prepared for inclusion in the April, May, June Physics Research Quarterly Report.

Currently the use of Green's functions is being extended to two region systems. The Green's function for a two-region pile has been derived, and various systems are being analyzed.

Computational Programming Services

The General Atomics Fortran I code KERNEL has been rewritten as a subroutine compatible with the thermal spectrum calculations procedure under development here. KERNEL calculates the total scattering kernel between specified pairs of

energies, using either free or bound hydrogen formulations. A number of alterations have been made, including optimization of arithmetic statements, use of subroutines, and inclusion of options regarding type and amount of output and computation of certain quantities. A calling program was written permitting KERNEL to be used alone. Both the calling program and KERNEL are being debugged.

A scheme to compute the array $I_n(x)$ as a function of order for a given x was lifted from KERNEL and made into a subroutine. This subroutine, ISUBN, has been checked out over the range $.01 \leq x \leq 8$ with very good results. The maximum order used is determined from the x value and ranged from n = 11 for x = .01 to n = 28 for $x > 1$.

A FAP coded function subprogram to compute $\cos^{-1} x$ was written, checked out, and submitted to the Fortran Program Library as ACOS. Debugging of the binary input/output routines WTBX/RTBX in their expanded form was completed, and they have also been submitted to the Fortran Program Library. An HW document describing the uses and restrictions of the routines is in rough draft form.

Changes were made in the input, output, and harmonic correction sections of COFIT2. Added input capabilities extend the number of permissible sources to 8, and permit the use of source weighting factors. Output changes concern only the printing of intermediate information. Reformulation of the harmonic corrections principally affected only the fast source terms. All alterations are apparently debugged, and have been incorporated into the production deck.

Instrumentation

All circuitry fabrication was completed for the prototype experimental Fast and Slow Scanning Type Fuel Failure Monitor, and accelerated testing was commenced. Modifications were completed on the slip ring assembly to prevent high voltage breakdown, and the slip ring assembly was reinstalled and satisfactorily tested. The complete system has been in satisfactory continuous operation for three weeks. The initial rough draft report concerning the system is nearly completed.

All scheduled testing and evaluating was satisfactorily completed on the two prototype experimental Logarithmic and Linear Scintillation Transistorized Building Radiation Monitors. The two units have performed better than any of the more expensive commercial units which were determined to be inadequate for HAPO use.

In cooperation with Instrumentation Design, CE&UO, the slow scan scintillation portion bid package for the NPR Fuel Failure Monitor was reviewed. The returned bids of various manufacturers were reviewed to determine compliance with the required specifications.

The scintillation surface uranium contamination monitor for NPR fuel elements is nearly completed. The detector heads have been tested and installed, and only a few cables need to be completed before final testing of the method can start.

The NPR reactor nuclear instrumentation procurement conference, with Kaiser Engineers and GE-APED, was attended. Efforts to clarify the guiding specification, HWS-6510, were continued in preparation for future technical information exchange meetings.

A brief experiment was conducted concerning the signal-to-noise problems with various types of fission counters used with high capacity cable. A recommendation was written concerning the desired properties of NPR fission counters and the related experience with old-reactor subcritical monitors.

Further scoping and cost estimation work was done in preparation for the proposed NPR diffusion length measurement problems.

Progress was made in the development of infrared pyrometry techniques for measuring reactor graphite moderator temperatures. Two head units have been repeatedly calibrated and tested after a succession of modifications. Most of the modifications have involved adjusting filter thicknesses and aperture shape to cover the proper temperature range. A significant improvement in design has been made by insertion of a two-stage amplifier between the detector cell and the servo amplifier. One unit was operated 25 feet from the object whose temperature it was measuring. With proper focus, the indicated temperatures correlated with those of a thermocouple embedded in the object. The difficulty of adjusting to proper focus may be lessened through use of a field lens or diffuser.

The possibility of obtaining an electrical readout for the reactor process channel optical traversing instrument was briefly investigated. Standard commercial variable permeance transducers appear to meet all the necessary requirements of size, sensitivity, and radiation resistance. Fabrication of the traversing mechanism using optical readout is complete although the unit is not yet fully assembled. Test jigs have been ordered from the carpenter shop. The mechanism will be tested in process tubes. The test jigs are designed to permit bending the process tubes to obtain a variety of configurations.

Systems Studies

Preliminary studies with IPD operations, engineering, and design personnel show that a large NPR plant analog simulator might provide savings of about $4,000,000 during the first 18 months of NPR operation. Joint efforts are under way to develop in detail the benefits to be derived from operator training and engineering analysis with such a simulator. The equipment and facility needs and estimated costs also are being scoped. The variable transport delay units being developed for a small scale NPR simulator are still being fabricated and assembled.

Analytical work continued in support of the reactor automatic control studies. Improved solutions of the neutron diffusion problem were obtained by using finite difference approximations for the spatial dependence. Equations also were developed for a reactor that is defined by several sections, each section being characterized by a set of kinetics equations and thermal diffusion occurring between sections. The source of thermal neutrons in a section is a function of the fissions in all sections. The probability (transfer coefficient) of a neutron being born in one section and thermalized in another section has been derived, but an attempt is being made to find a direct solution. (The first derivation required a numerical integration.) The use of the transfer coefficient will allow an approximate solution of reflected reactors (at present a reflected reactor is transformed to the equivalent bare assembly). An analog program also is being prepared to study reactor stability, considering effects from metal temperature, graphite temperature, coolant temperature, xenon poisoning, and also poisoning to the metastable isomer of xenon-135.

The availability of continuous rod position versus neutron flux and reactor temperature data would be very helpful in experimental reactor control studies. Preliminary investigations at 100-KW reactor indicate that selsyn receivers may be placed in parallel with the existing rod position indicators without disturbing their readings. A laboratory mockup of a rod position readout device for 105-KW has been built and tested. The method utilizes a potentiometer driven by the selsyn receiver that is to be placed in parallel with the present HCR selsyn receiver used in the reactor control room. Measurements show no noticeable loss in torque due to receiver paralleling. Tentative arrangements have been made to install several rod readout devices at 100-KW for use with the planned in-core flux monitor installation. An approved production test procedure will be required prior to installation. A memorandum outlining the proposed test was issued during the month.

A new program is being formulated to study the interchange of energy between two dump condensers and surge tanks in the NPR secondary loop. There is a possibility of oscillations occurring between two or more dump condensers or two surge tanks. This study will help determine under what conditions instability will occur. Previous studies have shown some conditions that will cause oscillations between a single dump condenser and surge tank. Future studies will be made to determine under what conditions there will be an interchange of energy between two or more heat exchangers.

A new one-amplifier reactor kinetics simulator for the NPR primary loop has been designed. This simulator allows one to easily (by turning six potentiometers) change six delayed neutron groups to compensate for various loadings or exposures. This simulator could also be used on other reactors.

Memoranda were partially prepared for the NPR confiner pressure transients problem and the space and time dependent reactor speed of control problem.

Meetings were held with representatives of IBM to acquaint them with our requirements for an experimental digital control computer. They will be offering us the basic model 1620 computer with modified input-output equipment. Although their magnetic core memory looks very attractive from the programming standpoint, it is doubtful that they can compete successfully with the makers of the less expensive drum machines.

At request of IPD, the Consulting Engineer, Systems Research aided and advised them on arranging for an audit of the NPR secondary loop control system. This will be done by D. W. Leiby of the General Engineering Laboratory, who has done a lot of NPR analog simulation work, with some of his colleagues, and with consulting assistance by H. Chestnut, a control specialist with an international reputation. An intensive study of this loop was begun with a view to taking an active part in this study also.

SEPARATIONS

Plutonium Critical Mass Facility

Solution Systems

Critical mass experiments were continued with plutonium nitrate solutions in a 14-inch diameter stainless steel sphere. Six critical approach experiments were

conducted with the sphere bare and partially reflected, with plutonium solutions of various concentrations. Two of these resulted in criticality when the sphere was partially filled and reflected with a 1/2-inch layer of paraffin. Criticality was first achieved in the new Laboratory on Friday, July 21, at 5:45 PM, when the spherical vessel became critical with the control rod partly withdrawn following a small fuel addition.

The experiments were begun in June with plutonium nitrate solutions in the bare sphere at a concentration of 300 gm Pu/l. After each approach the plutonium concentration was changed by diluting with nitric acid and a new measurement was made. The purpose of the experiments is to determine the critical concentration in the full sphere. Thus far in the series the trend has been to reduce the critical mass and volume of the solution as the plutonium concentration was reduced. Critical approaches were made in the bare stainless steel sphere (0.044-inch wall thickness) with plutonium concentrations of 164.2, and 125 gm Pu/l of solution. In both of these cases the full sphere was subcritical. Two approaches were made at a plutonium concentration of 105.2 gm Pu/l. In one of these, a 0.072-inch thick layer of stainless steel was added to the vessel wall; the total thickness of the vessel wall, considering the added layer of stainless steel, was 0.12-inch. Since the vessel was not critical when filled, the 0.072-inch thick layer of stainless steel was removed and the vessel reflected with a 1/2-inch thick layer of paraffin. Criticality was then achieved with the control rod partially withdrawn when the vessel contained 20.58 l of solution (the measured volume of the full sphere is 23.22 l). After a further dilution to 89 gm Pu/l, the vessel was again made critical, but with still a further reduction in both critical mass and volume.

The results of the measurements to date are summarized in the following table. The first two experiments were completed in June, but are listed here for completeness.

In each case the critical mass and volume were determined from extrapolation of the multiplication curves with the control and safety rods withdrawn; criticality was only achieved in the last two experiments in which the vessel was reflected with $\frac{1}{2}$-inch paraffin.

The strengths of the control and safety rods were evaluated in terms of solution volume. Multiplicaton measurements were made with the control and safety rods in the full in and out positions. Thus, an estimate for the control and safety rod worths in terms of solution volume was obtained during the critical approaches; calculations were then made to estimate the rod strengths in terms of reactivity.

For the two cases in which criticality was achieved in the partially filled sphere, the control rod (stainless steel tube) was worth about 0.16 l of solution or in terms of reactivity, about $1.20. The safety rod (cadmium tube with stainless steel cladding) was worth about 2 l of solution, or $14.00.

A further dilution will be made of the plutonium solution to obtain criticality in the full, or nearly full sphere, with the control rod mostly withdrawn. Critical mass experiments will subsequently be made with the 14-inch vessel fully reflected with water and also with concrete.

CRITICAL MASS EXPERIMENTS WITH PLUTONIUM SOLUTIONS IN 14-INCH DIAMETER STAINLESS STEEL SPHERE

(Measured Sphere Volume, 23.22 l; Wall Thickness 0.044 inch; 4.6% Pu-240 Content)

Date	Experiment No.	Pu Concentration (gm/l)	H/Pu Atom Ratio	Acid Molarity	Total Nitrate (gm/l)	Valence State of Pu in Solution Pu^{+4}	Valence State of Pu in Solution Pu^{+6}	Reflector	Critical Volume (liters)	Critical Mass (Kg Pu)
6/29/61	1141001	297.6	65.79	6.3	649.8	-	-	Bare Sphere	~ 28.3	~ 8.42
6/30/61	2	257.3	83.51	5.9	519.9	-	-	"	~ 28.6	~7.36
7/7/61	3	164.2	136.39	3.6	332.5	45.7%	56.3%	"	~ 26.2	~ 4.30
7/17/61	4	125.0	191.44	2.7	340.5	57.4%	42.6%	"	~ 25.2	~ 3.15
7/18/61	5	105.2	221.49	2.4	256.3	58.8%	41.2%	0.072-inch of stainless steel	123.9	2.51
7/20/61	6	105.2	221.49	-	-	-	-	Bare Sphere	~ 24.9	~ 2.62
7/21/61	7	98.3	240.36	2.4	244.4	66.5%	33.5%	½-inch paraffin	20.52*	2.02
7/28/61	8	89.0	271.90	~1.8	180.4	86.7%	13.3%	½-inch paraffin	20.01**	~1.78

* Vessel critical containing 20.58 l of solution with stainless steel control rod partially withdrawn.

** Vessel critical containing 20.10 l of solution with control rod partially withdrawn.

Based on the results of the current measurements, a 15-inch diameter stainless steel sphere has been ordered for subsequent criticality studies.

Some difficulties were encountered with air operated valves which were failing to close properly during the experiments. As a result the experimental progress was delayed nearly a week while the trouble was being isolated and corrected. Several changes were made of "hot" valves without spread of contamination. The original teflon gaskets were replaced with Viton A gaskets in two of the valves which improved their closure properties.

The deluge sprinkler system for the critical assembly room was inadvertently set off for the second time on July 31 due to a malfunction of the air dryer system which cut off the air supply needed for control of the sprinkler system. A total of 500 gallons of water were sprayed into the critical assembly room. No contamination spread occurred and water damage to instruments appears to be slight. The experiments will be delayed several days during the cleanup operations. Following the previous incident, plans were made to install a separate air storage tank for the sprinkler system--to prevent this kind of occurrence; renewed efforts are now being made to have this equipment installed without further delay.

Solid Systems

The split-table critical assembly machine which is needed for plutonium oxide-plastic experiments is currently under construction. A hazards summary report covering the operation of the split-table machine will be prepared during the first half of FY-1962. Following completion and review of the hazards summary report, the criticality experiments will be commenced in the third quarter of FY-1962.

Stage II of Plutonium Critical Mass Laboratory

A project proposal, requesting release of design funds for Stage II, is now being prepared for early submission to the Hanford Operations Office of the AEC during the current quarter.

Pulsed Neutron Source Experiments Applicable to Nuclear Safety

A Kaman Nuclear Pulsatron, together with the TMC 256 Channel Pulse Analyzer System, was received in the fourth quarter of FY-1961. The system will be set up and checked out during the first and second quarters of FY-1962. The first pulsed neutron source experiments with plutonium critical assemblies are expected to get under way in the second or third quarter of FY-1962.

PCTR Experiment with Plutonium Nitrate

This month a quantity of $UO_2(NO_3)_2$ solution containing about seven kilograms of uranium at a U-235 enrichment of 93% was received from Atomics International at Canoga Park, California. This material will be used in an experiment in the PCTR to measure the limiting concentration, i.e., the concentration for which the solution has $k_\infty = 1$, for a 93% enriched uranyl nitrate solution.

This experiment will be similar to a previous one in which an attempt was made to determine the limiting just critical concentration of uranium for a UO_2F_2 solution. During the course of measurements with the UO_2F_2 solutions, difficulty was encountered with the uranium coating out on the walls of the container, and, therefore, the experimental results were unreliable.

Data Correlation - Development of Nuclear Codes for Criticality Calculations

Criticality Calculations for PuO_2-Plastic Mixtures

In preparation for the solid fuel experiments in the Critical Mass Laboratory, criticality calculations were made for a series of cubes with the 9-Zoom multigroup diffusion code (18 energy groups). The cubes were composed of PuO_2-$(CH)_2$ mixtures to mock up the composition of the solid fuels with H/Pu ratios in the range of 0.3-2200. The results, together with the fuel compositions, are summarized in the following table.

Age of Fissions Neutrons in Water

At the present time a discrepancy exists between the experimental and theoretical values for the age of fission neutrons in pure water. A calculation of the age in water has been carried out with the HISMC code (a Monte Carlo code for studying infinite homogeneous systems) with the dual purpose being to 1) check the accuracy of the code in the energy span from fission to the collision which transfers the energy below 1.46 ev and 2) compute the age value with the anisotropic scattering for oxygen in the center-of-mass system defined to a high order of accuracy; the second and fourth moments of the slowing down distribution, and the mean slowing down time of fission neutrons in water were also computed.

The calculations were carried out in three separate runs each consisting of 4,000 neutron histories, on the IBM-7090. The results of the three runs are given below.

Run	Age	Second Moment	Fourth Moment	Mean Slowing Down Time
1	25.159 cm^2	150.95 cm^2	44,320 cm^4	0.815 μ sec
2	25.601	153.61	49,040	0.814 μ sec
3	25.471	152.83	46,750	8.815 μ sec
Mean Value	25.41 ± .19	152.46 ± 1.11	46,700 ± 3,870	0.815 μ sec

The quoted errors in the mean values are the mean square errors. The age values are defined as the age of fission neutrons to the collision that transfers the energy of the neutrons below 1.46 ev. This particular definition of the age is known as the "current" age. A simple correction[4] can be applied to the current age to obtain the flux age (the age of fission neutrons to 1.46 ev). This correction amounts to an increase in the age of 0.43 cm^2. Therefore, the flux age obtained from this calculation is,

(4) Goldstein, H., P. F. Zweifel, and D. G. Foster. The Slowing Down of Neutrons in Hydrogenous Media - Status of Theory and Experiment, P/2375. Proceedings of the Second Geneva Conference, 1958.

CRITICAL MASSES AND DIMENSIONS OF BARE PuO_2-POLYSTYRENE* CUBES

Composition (atoms/cc x 10^{-24})			0% Pu-240		3% Pu-240		6% Pu-240		ρ
Total Pu	Carbon	H/Pu Ratio**	L_c(cm)	M_c(Kg)	L_c(cm)	M_c(Kg)	L_c(cm)	M_c(Kg)	(gm Pu/cc)
.0222	.00618	.278	12.9	18.93	13.1	19.82	13.4	20.98	8.816
.0178	.01458	.819	15.1	24.31	15.3	25.29	15.5	26.29	7.06
.00666	.03565	5.35	21.9	27.79	22.5	29.94	23.2	33.04	2.646
.00444	.03986	8.98	24.0	24.38	25.2	28.23	26.5	32.83	1.764
.00222	.04407	19.9	27.6	18.54	29.8	23.33	31.8	28.35	.8816
1.1107 (-3)	.04618	41.6	30.7	12.76	33.4	16.43	36.6	21.62	.441
5.5553 (-4)	.04722	84.0	32.2	7.36	34.6	9.13	37.2	11.35	.2205
2.2214 (-4)	.04786	215.	33.7	3.38	35.5	3.95	37.4	4.61	.0882
1.666 (-4)	.04800	288.	34.8	2.78	36.0	3.09	37.6	3.52	.0662
1.1107 (-4)	.04807	433.	36.0	2.06	37.3	2.29	38.8	2.58	.0441
9.997 (-5)	.04809	481.	36.4	1.91	37.7	2.13	39.1	2.37	.0397
8.885 (-5)	.04811	541.	37.0	1.79	38.6	2.02	39.5	2.18	.0353
7.775 (-5)	.04813	619.	37.6	1.64	38.9	1.82	40.2	2.01	.0309
6.665 (-5)	.04815	722.	38.7	1.53	39.9	1.68	41.2	1.85	.0265
5.555 (-5)	.04817	867.	40.8	1.50	42.0	1.64	43.5	1.82	.0221
4.443 (-5)	.04820	1085.	44.3	1.92	45.8	2.12	47.5	1.88	.0175
2.221 (-5)	.04824	2172.	70.0	3.03	74.	3.57	78.	4.18	.00882

* Composition of polystyrene taken as $(CH)_2$ at a density of 1.045 gm/cc; L_c is dimension of bare critical cube.

** H/Pu ratio calculated using total Pu.

$$\tau_{flux} = \tau_c + 0.43 \text{ cm}^2 = 25.84 \pm 0.19 \text{ cm}^2$$

The current status of the experimental and theoretical age values are summarized in the following table:

Ref. and Date	Method	Value	Remarks
Certaine & Aronson, 1954	Fourier Transform	25.3 cm^2	Oxygen cross sections, Ref. 5
Hurwitz & Zweifel, 1955	Moments	25.8 cm^2	Oxygen cross sections, Ref. 5
Coveyou, 1956	Monte Carlo Moments	25.6 ± .3 cm^2	Oxygen cross sections, Ref. 5 Age corrected to flux value.
Certaine, 1957	Moments	26.0 cm^2	Same as 4 with slight revision of hydrogen cross sections.
Reier, 1957	Fourier Transform	25.9 cm^2	Unpublished revision of oxygen data by Emmerick, inelastic scattering included.
H. D. Brown, 1957	Monte Carlo Moments	26.7 cm^2	All scattering assumed isotropic in center of mass system & absorption in oxygen neglected. Corrected to flux value.
Goldstein & Certaine, 1957	Moments	26.5 cm^2	Revised oxygen cross section to 3 mev from Ref. 6, above 3 mev from Ref. 5.
Coveyou & Sullivan, 1958	Monte Carlo Moments	25.9 ± .3 cm^2	Oxygen cross sections Ref. 6 corrected to flux value.
Doerner, 1961	Experimental	27.86 ± .1 cm^2	
Richey, 1961	Monte Carlo Moments	25.8 ± .2 cm^2	Oxygen cross sections Ref. 6 corrected to flux value.

(5) Goldstein, H. Fast Neutron Data for Oxygen, NDA 15C-15, 1953.

(6) Lustig, H., H. Goldstein and M. H. Kalos. An Interim Report on the Neutron Cross Section of Oxygen, NDA 086-2, January 1958.

As noted in the summary, the theoretical values all seem to be in good agreement with the exception of Brown's Monte Carlo moments calculation. Brown neglected the very important anisotropic scattering of oxygen in the center of mass system. However, the latest and probably best measured value for the age of fission neutrons in water resulted in a value which is still approximately 10% larger than the theoretical values.

Monte Carlo Calculations of k_∞ for Homogeneous Moderated Systems of Three Percent Enriched UO_3

A series of calculations were begun of the measured values of k_∞ in the PCTR for homogeneous moderated mixtures of three percent enriched UO_3.(7) A quantity of particular interest as regards nuclear safety is the value of k_∞ for the unmoderated UO_3--and if the value is greater or less than unity, i.e., if criticality is possible with the dry salt. The Monte Carlo calculations will be compared with the measured values, and then used to evaluate the k_∞ for dry UO_3; the smallest H/U ratio in the experiments was 3.58. The first system investigated was the one having a hydrogen-to-uranium ratio of 43.87 for which the measured infinite multiplication factor is approximately unity. A tracing of 1,000 neutron histories was initially run for this system, and it was immediately evident that two separate difficulties prohibited an accurate calculation of the infinite multiplication factor: (1) The number of recorded captures and fissions was not large enough to give good statistical results, and (2) the resonance capture in U-238 exceeded the expected value by a factor of two.

The first difficulty has been corrected and the second is now being investigated.

Even though the information obtained from the initial run was limited by the above difficulties, neutrons that became thermal ($E < 1.0$ ev) were moderated into a characteristic thermal spectrum for the system. The resulting spectrum has been plotted in Figure 1. Note that the small resonance in U-235 at 0.3 ev causes a slight depression in the characteristic spectrum at this energy.

Interactions of Subcritical Systems

Evaluation of the approximation method to predict interactions of moderated subcritical systems continued. Comparison was made of predicted critical height vs. separation curves with experimental measurements (ORNL-2389) on partially reflected systems of interacting slabs and cylinders of U-235 solutions. For a system of seven 5-in. diameter cylinders at an H/U ratio of 50:1, in both hexagonal and linear array, the predicted curves followed the experimental curves rather well but gave non-conservative results. The maximum discrepancy occurred at reduction heights giving nearest neighbor separations of about 18 cm for criticality, in which case the predicted separation was about 1 cm less. For systems of 2 and 3 interacting 3-inch thick slabs, at an H/U ratio of 337, the shape of the predicted curves agreed rather poorly with experiment, but gave conservative results. These results have not yet been explained.

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(7) V. I. Neeley, "Measurements of k_∞ for Three Percent UO_3 - Hydrogen Moderated Homogeneous Systems", Nuclear Physics Research Quarterly Report for July, August, September, 1959, HW-62727.

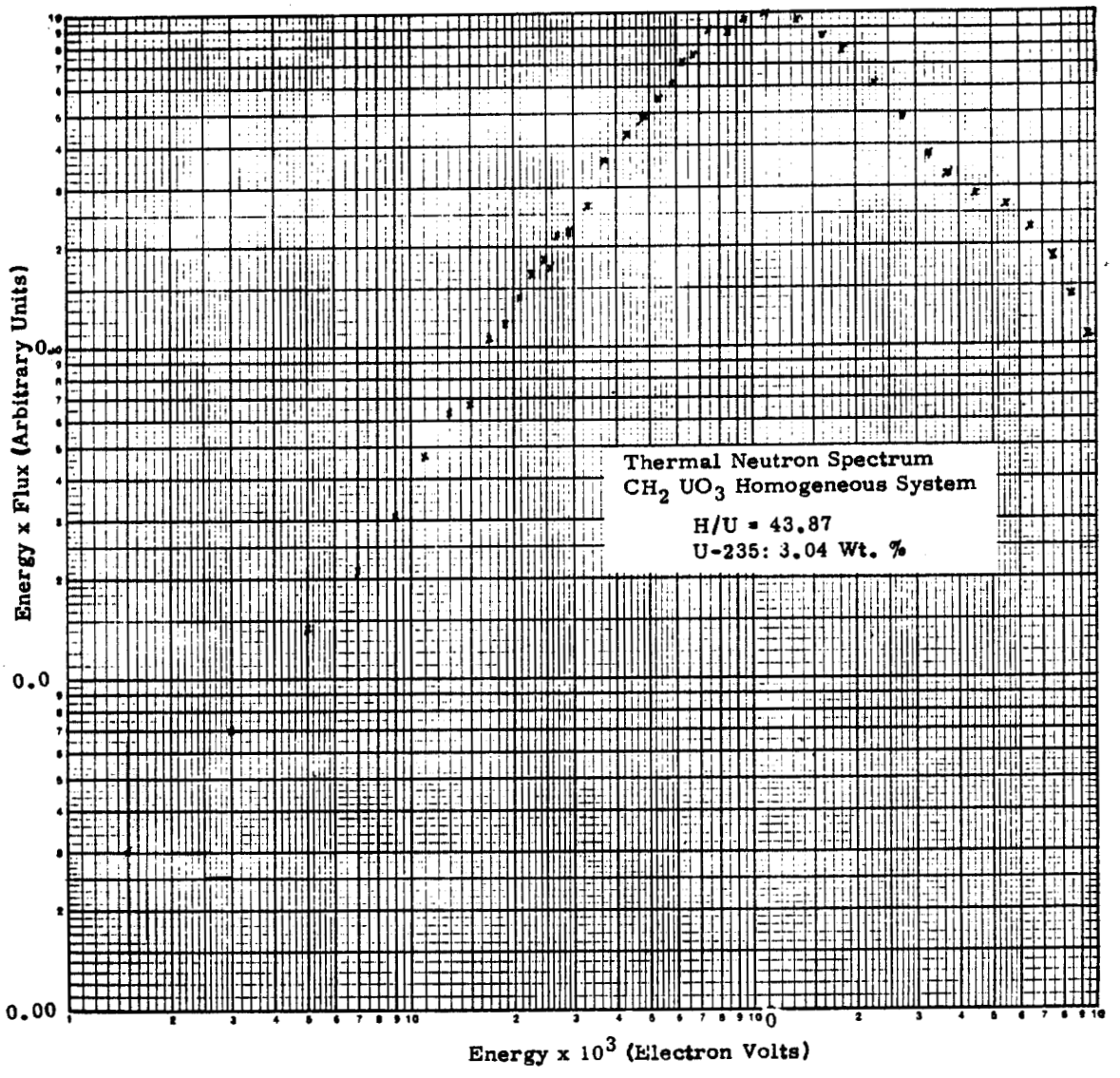

FIGURE 1

The two-group cross sections used in these calculations were obtained from criticality calculations (WAPD-TM-244) of reflected isolated finite cylinders which correlated well with experiments. To correct for the difference in H/U atomic ratio between the (WAPD) isolated cylinder calculations and the (ORNL) interaction measurements, each cross section was assumed to vary as some power of the H/U ratio.

The empirical constants were obtained by a least squares fitting procedure to the WAPD cross sections. The accuracy of this fitting was tested by recalculating the WAPD results using the empirical relations: for $50 < H/U < 350$ and heights greater than 10 cm, the calculated k_{eff} agreed within $\pm$ .015, which is as good as the agreement between WAPD calculations and experiments.

Criticality Hazards Specifications

Nuclear Safety in CPD

Comments on the nuclear safety of transporting various forms of plutonium waste between AEC sites were submitted to the Finished Products Chemical Technology Operation.(8) This information was requested for an AEC study to estimate and compare the costs of recovering Hanford plutonium wastes locally, as compared to the costs of recovering these wastes at an off-site location.

Nuclear Safety - Training and Education

A talk was presented on the subject of nuclear safety to engineering designers in the Drafting Operation of CE&UO.

Mass Spectrometry

It was previously reported that the focusing action of the magnetic analyzer of the mass spectrometer for this program depended improperly on the ion source focusing conditions. An examination of the geometrical alignment of the collimator slits relative to the ion source electrodes and sample filament revealed that the optic axes of these two units were displaced by about 0.018 inches. It is believed that this misalignment made possible unwanted ion reflections with slit edges. After rebuilding and realigning the collimator slits the effect disappeared although the resulting ion peak shapes as they appear at the output of the ion detection system cannot be made quite as flat-topped as is desired.

Studies of the response of the electron multiplier as a function of mass and ion current intensity continued. It appears that this multiplier also behaves as a non-linear element in the ion detection system.

The application of a carbonizing process to the source filament of this spectrometer was previously reported to yield a significant improvement in sample sensitivity. Continued operation has shown that the process is highly reliable

(8) Letter from C. L. Brown to R. B. Chitwood. Comments on the Nuclear Safety of Shipping Plutonium. July 10, 1961.

and consistently yields reproducible sample sensitivity and sample life.

Instrumentation

Consultation continued on the tracer lathe control systems for CPD. Temporary measures were incorporated which permit a cutting operation in eight minutes with a maximum error of approximately 0.0002 inch. This is considered far from perfect. Effort continued on the checkout of system wiring and grounding.

Attention was given to a number of instrument maintenance engineering problems at the Critical Mass Laboratory. Planning also was begun for developing a period meter calibrator, for developing an instrument to measure buckling, and to alter the Panalarm units to annunciate only when not by-passed.

NEUTRON CROSS SECTION PROGRAM

Slow Neutron Cross Sections

Very little operating time was available for the single crystal neutron spectrometer during the month because of reactor outages.

Measurements were continued to study the order effects in the diffraction from a germanium single crystal in the /113/ mode. Measurements of the shape of the Pu^{239} fission cross section indicate the absence of any effects of higher order diffracted neutrons down to a neutron energy of about 0.043 ev to an accuracy of about 1.5 percent. Measurements are in progress in the energy region of 0.02 to 0.04 ev to determine the accuracy with which standard filter techniques can be employed to correct for the presence of third order neutron contamination.

Fast Neutron Cross Sections

About seven days of Van de Graaff accelerator time were used for preparatory studies for the measurement of total cross sections by the pulsed polyergic beam, time-of-flight method. Operation of the Van de Graaff was marginal at first, but after repairs were completed the accelerator, its associated equipment, and time-of-flight complex operated with excellent stability.

The performance of the time-of-flight complex was studied and tested by measurement of the $Be^{9}(d,n)B^{10}$ thin target neutron spectrum. Measurements were made at a deuteron energy of 1.8 Mev, 10 microamp d.c. beam current, and pulsed beam widths as small as 0.8 nanoseconds. The pulse shape discriminator and side channel pulse height discriminator effects were studied and found to work satisfactorily with only slight leakage of pulses caused by energetic gammas. A gamma peak width of 1.5 nanoseconds was obtained with a 1.5 inch diameter, 0.5 inch thick stilbene crystal detector and RCA 6810A photomultiplier without pulse shape discrimination. The $Be^{9}(d,n)B^{10}$ neutron spectrum observed at a flight path of 1.5 meters and an angle of 25 degrees compared favorably with the best previous measurements of others.

An attempt was made to study the thin target $Li^{7}(d,n)Be^{8}$ spectrum, but the readily available targets were found to contain a prohibitive contamination of carbon deposit. The thick target spectrum was studied using a metallic lithium target. Measurements were made at a deuteron energy of 2.0 Mev and a flight

path of three meters. A d.c. beam intensity of 15 microamperes at 2 Mev was successfully maintained. The thick target yield was lower than expected but the observed neutron spectrum had the expected shape. Measurements were made of the total cross sections of Al, Cu, and Fe which cover the energy region of about 2.5 to 15 Mev. These measurements were of low statistical precision (a few percent) but will be of value in planning for the final measurements with improved detector efficiency and higher resolution. The data have not yet been analyzed to yield cross section values.

Fabrication of two and five inch liquid scintillation cells for improved neutron detectors is in progress.

Slow Neutron Scattering Cross Sections

The determination of the spectrometer resolution and efficiency functions by means of elastic scattering by vanadium at liquid nitrogen temperatures is still in progress. The planned series of cold sample runs has been completed, with energy analyses at standard resolution at 0.05 ev and at high resolution at 0.05, 0.10, 0.15, 0.20, and 0.25 ev and an angular distribution at high resolution at 0.20 ev. One correction run employing the cryostat without the vanadium sample has been made at 0.25 ev.

Processing of the data from last summer's elastic scattering runs has continued. The GAUSS-FIT program has been used to fit the elastic peak of the energy analysis runs. Subtraction of various inelastic components is tried to obtain the best fit. For the best fits, at the smaller scattering angles, the program has returned parameters (height, width, location) of the peak with standard deviations of about 2 percent. The fitting is about 50 percent complete.

One run was fit using both energy scale and angle scale with no significant difference in the goodness of fit.

REACTOR DEVELOPMENT - 04 PROGRAM

PLUTONIUM RECYCLE PROGRAM

The Critical Facility of the PRP

The primary aim of the Plutonium Recycle Program - Critical Facility (PRP-CF) is to obtain measurements of changes in reactivity which are associated with changes in exposure of Plutonium Recycle Test Reactor (PRTR) fuel. Some of these measurements will be made in a D_2O moderated environment which is similar to that of the PRTR. Thus the measurements of changes in reactivity will be complicated by the occurrence of photoneutrons in the moderator. The photoneutrons arise from the photo-disintegration of deuterium by gamma rays of energy greater than 2.23 Mev (the threshold for the $D(\gamma,n)$ reaction). These photoneutrons will introduce errors into various types of reactivity measurements. For example, their effects will appear in criticality measurements, subcritical multiplication measurements, and rising period measurements. Preparations are being made to determine the magnitude of the effects so that their relative importance in each of the PRP-CF measurements can be evaluated.

A crude estimate of the extraneous source which results from a UO_2 cluster, 5 days after a 100-hour irradiation in the PRTR is $\sim 10^{10}$ neutrons/second. A standard Pu-Be source emits $\sim 10^{7}$ neutrons/second. Even though the photoneutron source is 10^{3} times larger than the Pu-Be source, the photoneutron flux in the reactor will be about a factor of 10^{4} less than the total flux at 100 watts power level.

The extraneous source which results from the long-lived gamma rays which are emitted by a UO_2 cluster with this irradiation history is relatively constant after 5 days. For this reason consideration has been given to 1) an experimental method for determining when $k_{eff} = 1$ for constant reactor power operation in the presence of a relatively constant extraneous source, and 2) a calculational method for obtaining correction curves from which the "true" or asymptotic period can be determined from a measured reactor period with the extraneous source present.

Information has been received on the purity of lead and bismuth which are available commercially. All impurities in the bismuth are less than 0.01% and in the lead less than 0.1% for the commercial grades. Other grades of higher purity are available. Information regarding the possibility of extruding bismuth and bismuth-lead alloys is to be forwarded at a later date.

Low Exposure Plutonium Lattices

The inconsistencies mentioned last month in the foil activation data for the 8-3/8-inch lattice experiments have been attributed to some experimental errors in the normalizations. A new normalization irradiation has been planned and scheduled in the PCTR.

Attempts to infer neutron temperatures from lutetium and Pu-Al and U^{235}-Al foil data have not been successful. The lack of knowledge of the shape of the neutron spectrum has made it impossible to correct for epithermal effects in a satisfactory way at this time.

The "hardness" of the spectrum in the $6\frac{1}{2}$-inch lattice may be seen in the cadmium ratios of Pu-Al, U^{235}-Al, and BF_3 detectors at various positions in the lattice cell.

Cadmium Ratios (.040" Cd)

	Pu		U^{235}		BF_3	
	Poisoned	Unpoisoned	Poisoned	Unpoisoned	Poisoned	Unpoisoned
Cell boundary fuel (weight ave.)	10.78	12.94	5.34	6.98	5.65	7.43
	6.91	9.09	3.66	5.19		
% Epicadmium fissions in Fuel	14.5%	11.00%	24.3%	19.3%		

[redacted]

Further work has been done in determining the change in $(1 + \alpha)^{239}$ which occurs upon poisoning a plutonium fueled lattice in a PCTR experiment. Absorption and fission rates have been calculated with ACE for Lu, Cu, Pu-239, and Au in Maxwellian and Hurwitz absorption spectra up to 1 ev. The spectrum averaged values of α, weighted with the Pu-239 fission cross section, have also been obtained up to 1 ev. Work is now in progress on making corrections to some of the results obtained above as well as the absorption and fission rates obtained earlier in a Hurwitz flux spectrum for the energy region in excess of 1 ev.

Plutonium Fuel Temperature Coefficient

A study of plutonium diffusion through Zr cladding at elevated temperature is being conducted by Plutonium Fuels Development Operation. No transmission of Pu through the cladding was detectable after a run of 4 hours at 600°C. An 8 hour, 600°C run has been scheduled. The results so far indicate that the planned experiments should not create any contamination problems.

Neutron Rethermalization

Analysis of the absorption rod experiments has continued through the month. Attempts have been made to obtain a numerical solution to this problem using the IBM 7090 codes FIT-1 and HFN with group constants obtained from an "absorption spectrum" model. No solutions have been obtained and no explanation for the apparent failure of the codes can be given. In view of this an analytical solution has been sought.

Uranium Oxide Reactivity

Preparations have been completed for this experiment. Special graphite bridge bars have been made so that a neighboring buffer cell can be removed. This will permit a comparison of reactivity effects of this cell as compared to the central cell. It is hoped that some application in determining when the fluxes have been matched will be found. A special set of stainless-steel spiders and end-caps have been prepared to accept copper wires. After being irradiated, the wires will be cut into sections and counted, so that a detailed flux traverse in this portion of the cell will be obtained.

Multichannel Analyzer

A long-lived activity which is present in the nickel foils which have been used in spectral index measurements has been identified as Co-60. Another activity which has a half life of 2 or 3 months is believed to be Co-59 which would be produced by the reaction Ni-58 (n,p) Co-58.

A purchase requisition has been initiated for nickel which is expected to be much purer than that which is now being used. The purer nickel will be used in spectral index measurements.

The multichannel analyzer has been modified so that the counts in each channel can be added to the counts in previous channels before they are printed. This function makes calculation of the area under photopeaks and calculation of integral curves with desk calculators unnecessary.

Effect of Absorbing Rod on Neutron Energy Spectrum

The effect on the neutron flux of a Breit-Wigner resonance term on the 1/v absorption continues to be investigated. The first analytical solution was found to be numerically unfeasible, and an alternate solution was derived. This solution is being programmed.

Code Development

C-6

Programming of the code to generate a 100-group cross section data tape from the RBU Basic Library is about 75 percent complete, and debugging is just beginning. The code contains two subroutines which will be useful in future programs to obtain cross section information. The first of these subroutines searches the RBU Basic Library for the cross sections associated with a given isotope and places the cross sections in arrays in memory which may be conveniently handled by Fortran programs. The second subroutine will generate group averaged cross sections for up to 400 groups with arbitrary energy ranges.

RBU

Input for the first system representing the innér portion of the PRTR core was completed. Several simple test cases were prepared for the purpose of observing the effect of cross section changes on the thermal spectrum generated in the Monte Carlo. It is intended that these test cases will assist in the interpretation of results on the more realistic problems.

MXW

Debugging of the MXW code, which generates Westcott-type effective cross section data using the Hurwitz spectrum, was begun.

WESSEX II

The convergence difficulties in this code were resolved. Currently the cross section treatment is being modified to conform to that used in Meleager and GPR.

Instrumentation and Systems Studies

Assistance was given to PRTR operational personnel during the July startup on fuel failure monitoring problems. Several detectors and preamplifiers were fabricated for use with the installed fuel failure monitor and for the bulk gas sampler. Confirmation of analytical laboratory results was obtained with the temporary gamma energy analyzer used at PRTR.

Experimental work continued on a new type of "last ditch" safety fuse system for the PRPCF now that the 93% U^{235} has been received. The new fuse idea will use the U^{235} surrounding a center well device filled with mercury and with a capillary tube extended into the well. As the U^{235} heats from effects of the predicted flux levels, the mercury expands up into the capillary to produce an electrical contact at the top to energize an alarm. Tests will now be performed to determine heat rise in the mercury column for various expected PRPCF reactor

periods. Laboratory tests indicate a heat rise of 10 C within 100 to 200 milliseconds after artificial heat application. Further laboratory tests are in order before experimental units are fabricated.

Work has been resumed on the PRTR process tube wall thickness measuring problem. The ultrasonic probe assembly has been returned to the shop and fabrication is estimated at 75% complete. When fabricated, this probe will be used to examine the relative performance of two different crystal sizes, 1.0 x 0.5 inch and 0.5 x 0.25 inch. Comparisons will be made with respect to acoustic coupling and output signal strength.

Mockup testing of a new eddy current probe for measuring the gas annulus in the PRTR (in a radiation field) has continued during July. An estimate of the costs of designing, fabricating, and testing a probe assembly which can accommodate a borescope tube is being prepared for Structural Materials Operation.

During low power operation, the PRTR secondary loop deareator controls appear to be inadequate. Automatic operation must be by-passed and the deareator manually controlled. Equations describing the entire secondary loop have been derived. Adequate description of the deareator requires consideration of the varying steam and water flows as well as variable specific heats, etc. The variable physical properties are required by the low pressure operation. The analog circuits will be started as soon as sufficient data are obtained from PRTR personnel.

The PRTR Gas Balance System Analysis has not been completed. The computer simulation is operating well, but a good deal of difficulty has been experienced in the determination of realistic values for the various damping factors involved. Work on this phase of the problem is continuing.

The poison injection scram runs for the PRTR Critical Facility were re-run this month. The original runs were based on a thermostat mounted such that a fuel element temperature of 124 F would cause it to trip, thereby scramming the reactor. However, tests showed that due to thermal lag in the fuel elements, the actual power level at which the thermostat would actuate depended largely on the type of accident invcived. The re-runs were therefore based on a calculated power level actuating point of 10,000 watts. This work was completed this month. The reactor simulation was programmed to use the idea of point storage or analog memory techniques to automatically perform the rescaling necessary for a multi-decade reactor simulation.

PHOENIX FUEL

ARMF-MTR Experiments with Plutonium Fuel

All of the necessary approvals are obtained for the irradiations in the MTR. Therefore, pre-irradiation measurements will be made of the reactivity of the Pu-Al samples in the ARMF.

Satisfactory Pu-Al samples which contain boron have not been fabricated. Both spectrochemical and spectrographic analyses of the mixed alloy have been made. Theresults of the two types of analyses agree. However, they do not

agree with the amount of boron put into the plutonium alloy. This inconsistency could be caused either by non-uniform dispersion of the boron or by a loss of boron in the mixing process. These possibilities are being investigated further in order to obtain samples in which the boron is uniformly dispersed throughout the alloy.

In the absence of suitable samples which contain boron, the ARMF will be calibrated for neutron absorbers with polyethylene tape which is impregnated with boron. This tape will be mounted on fuel samples which are made with an alloy which has the same plutonium concentration as that being mixed with boron. When the samples which contain boron are available the ARMF will be recalibrated and the results will be compared with those which are obtained with polyethylene tape.

SPECIFIC FUEL CYCLE ANALYSIS

Reactor Analysis

Data from the APWR burnup analysis has been extensively checked for consistency and appears to be satisfactory. The analysis is continuing as planned.

The spectrum of the Dresden reactor as a function of exposure was obtained, and a study of the fission product concentrations during burnup was carried out. With an initial temperature of 470 C, and an r-factor 0.108, the U-235 and Pu-239 concentrations agreed with calculations done by the Dresden group over the entire exposure range.

New resonance cross section data for the isotope Protactinium-233 was incorporated into the cross section libraries for the various burnup codes now in use.

NEUTRON FLUX MONITORS

Tentative specifications were prepared concerning the size and type of Pu isotope detector sleeves to be locally experimentally fabricated. The sleeves will be used to test the various isotopic compositions. Some foil fabrication was started on an experimental basis with no positive results to date. The various Pu isotopes required for the sleeve fabrication were ordered and communication was received that all required compositions will be sent from ORNL. Initial work was started in an attempt to determine if there exists some optimal ionization chamber configuration best suited to in-core flux profiling.

Experimental work on the flux monitoring ideas based on microwave detection of neutron-induced changes in molecular energy states have been delayed by slow equipment deliveries. A crystal harmonic generator was built to act as a frequency doubler until a Hewlett-Packard frequency doubler, on order, is delivered. The doubled frequencies of interest lie between 26 and 36 KMC. The conversion efficiency is low, and variable with frequency. However, it permitted a check on the operation of the signal generator, and will allow some good preliminary experiments to be performed before the commercial unit arrives. A microwave bridge of a type suitable for molecular spectroscopy and a transmission cavity for measurement of very small displacements were built. The results are confusing because of the presence of third harmonics from the harmonic generator, but show good promise. If the Hewlett-Packard doubler

delivery date continues to be advanced into the future, uses of a low-pass filter will be attempted.

NONDESTRUCTIVE TESTING RESEARCH

Electromagnetic Testing

A review of recent developments in the areas of multivariable control and adaptive control has been in progress to determine applicability of results to the problem of parameter identification in broadband electromagnetic testing. This review has revealed that the parameter identification problem has a number of characteristics in common with these disciplines, indicating that continuing developments in both should be watched for new applicable techniques. It has also emphasized that nondestructive determination of parameters under continuous testing will involve techniques of estimation theory now in the infancy of their development and far from complete.

The theory of multivariable controls provides insight into the problem, since it recognizes the principle of "uncertainty of structure"; that is, given a black box whose external behavior is completely known, but whose internal structure is completely unknown, nothing can be inferred about the latter from the former. The internal forms must be assumed, and the type of form assumed has a great influence on the processing of the external signals. Since this discipline is often concerned with the indeterminant portion of system structure and is concerned with measuring and reducing interrelations between variables, it has a great deal in common, in its basic nature, with the problem under study.

Adaptive control also has much in common with the problem, since adaptivity infers that first it is necessary to provide automatic measurement of process dynamics. This identification problem is receiving much attention in the literature at present. However, for systems of high dimensionality, a practical solution for rapid identification is not yet available. Most approaches assume a gaussian variation of the unknowns and search for some minimum-variance estimate. At present, this also appears the most promising approach to our problem. Unfortunately, the published literature has been concerned with systems wherein the unknown variables were dynamic; that is, they can be related by a Lagrangian state function, which is not the case with the parameters of the eddy current test.

Procedures are being formulated for preliminary experimental work to determine parameter excursions in lumped parameter models of the eddy current test. These experiments will investigate the sensitivity of system responses for different types of probing functions and will attempt direct readout of small parameter changes in simple systems.

Heat Transfer Testing

A 40 kilowatt plasma arc jet heat source for application to heat transfer test-

[redacted]

to location on a fuel element is being developed. This system should facilitate correlation of heat transfer test results with results from ultrasonic and destructive tests on a number of fuel elements. The mapping method presently being investigated utilizes pulse width modulation to produce line segments of various lengths on a two-dimensional map. Position of each line segment on the map corresponds to position on the fuel element, and the lengths of the segments correspond to temperatures. Thus, a two-dimensional map allowing both rapid correlation of areas and precise quantitative temperature readout should be obtained.

A report by D. R. Green, "An Instrument for Nondestructively Testing Fuel Core to Cladding Heat Transfer", HWSA-2232, covering the heat transfer testing work thus far has been issued.

Zirconium Hydride Detection

Feasibility of applying Hall effect measurements as a nondestructive method of detecting hydrogen in Zircaloy-2 has been studied and a report is being completed. Measurements of changes produced in Young's modulus of Zircaloy-2 when placed in a magnetic field showed the changes to be extremely small. Preliminary resistivity measurements in Zircaloy-2 are being made to determine the effect of hydrogen concentration on the resistivity.

Measurements of the Hall coefficient in Zircaloy-2 samples with 0 to 15,000 ppm of hydrogen have been completed. From 0 to 1,000 ppm (by weight) the relationship between the Hall coefficient and hydrogen concentration was not monotonic. Therefore, Hall effect measurements alone could not be used to uniquely specify the concentration of hydrogen in Zircaloy-2 at low concentrations. However, between 5,000 and 15,000 ppm of hydrogen the relationship is linear, and application of Hall effect to measurements of hydrogen concentrations in this range in either small Zircaloy-2 corrosion control coupons or reactor process tubes appears promising.

The draft of the report on the effect of low hydrogen concentrations on Hall effect in Zircaloy-2 has been completed and reviewed.

An experiment was conducted to determine if a change occurs in the velocity of propagation of a compression wave due to a change in Young's modulus when a sample of Zircaloy-2 was placed in a magnetic field. It was thought that such a change might be sensitive to hydrogen concentration in the sample.

Two barium titanate transducers were connected so that one was pulsed with a thyratron and high voltage source and the other connected through a video amplifier to an oscilloscope which acted as a detector. By observing a 20-nanosecond portion of the compression wave, after the wave had travelled for approximately 0.5 millisecond, a resolution of 0.0005 percent for any velocity change was achieved. Upon application of a 1.75 kilogauss magnetic field, no propagation velocity change was observed. This test indicates that any change in Young's modulus upon application of such a magnetic field is extremely small, and it is doubtful that the method could be adequately refined for use in detecting hydrogen in Zircaloy-2.

The resistivities of Zircaloy-2 samples containing different hydrogen concentrations are being measured to experimentally determine the relationship between resistivity and hydrogen concentration. An eddy current method for measuring the

resistivity is being tried. In this method, measurements are made by noting the rates of decay of magnetic flux within samples situated in an external magnetic field when it is rapidly reduced to zero. The flux decay rate is determined by the resistivity of the sample and hence, can be used to measure the resistivity. No contact of the test coils to the specimen is required, and localized values of resistivity may be measured. To date, the resistivity of an aluminum rod has been measured as a first step towards refining the experimental procedure and techniques. Agreement with published values for the resistivity of aluminum was within experimental error.

USAEC/AECL COOPERATIVE PROGRAM

Nondestructive Testing of Sheath Tubing

A detailed outline has been prepared which describes the plan under which development work will be conducted. Tubing variables which may affect test results are defined and the types and sizes of defects desired to be detected are established.

A literature search was conducted to establish the status of ultrasonically testing Zircaloy sheath tubing. Canadian GE-CAPD, GE-APED, and HAPO, appeared to be the major sites testing significant quantities of tubing. A summary describing the testing techniques used by each is being prepared and will be issued as a memorandum. Material describing relevant analytical and experimental work has been studied. A memorandum will be prepared to summarize the status of this work also.

Design work on a versatile mechanical system for experimental ultrasonic work is about 75% completed.

PHYSICAL RESEARCH - 05 PROGRAM

Mechanism of Graphite Damage

Measurements of electron radiation damage to graphite continued. Since liquid nitrogen cooling is extensively used in these experiments a study was made of the dangers resulting from the ozone that we found to be produced during the irradiation of the liquid nitrogen. In addition to an inhalation hazard to personnel there is an explosion hazard. The ozone appears as a blue solid in the liquid nitrogen. When the nitrogen has all evaporated the ozone begins to evaporate. If appreciable amounts of it can reach an organic material, explosive combustion of that material may result.

BIOLOGY AND MEDICINE - 06 PROGRAM

ATMOSPHERIC PHYSICS

Progress was noted in atmospheric research with the development of a diffusion model which accounts for the wind direction shear with height in the lower layers of the atmosphere. Until now, there has been no mathematical treatment of this shearing effect which is evident from both visual observations of plumes and from exposure data gathered from many experiments. The magnitude of this shearing effect is correlated with thermal stability, indicating that this model would describe much more realistically the diffusion during nighttime conditions after a temperature inversion has developed. Analyses of extensive data collected dur-

ing actual field experiments lend support to this more generalized concept.

The development of a method for simultaneous collection and subsequent detection of two atmospheric tracers on a single filter continues. Already demonstrated is a technique whereby a mass of less than 10^{-8} grams of zinc sulfide tracer and a mass of 10^{-9} grams of fluorescein can be detected after having been collected on the same filter. Interference in measuring one of the tracers in the presence of the other is negligible when the ratio of their masses is less than 10^{4}. The feasibility of detecting one zinc sulfide in the presence of another by means of pulse discrimination is now being pursued. The advantages in this latter method are that the dependable Rankin Counter, presently employed in analyses, can be used, and no processing of the filter is necessary as it comes from the field.

Concerning the rain scavenging experiments, equipment capable of producing artificial rain has been installed on a tower on the 200 meter arc of the stable diffusion grid. This equipment was satisfactorily operated on two occasions, using supporting sampling equipment designed for sizing the raindrops.

Two stable diffusion experiments were conducted during the month, both of which were successful.

In Air Force-supported programs, the termination of the summer series at Vandenberg Air Force Base is scheduled for August 5. More than fifty field tests will have been completed at that time. Data obtained from the twenty-three tests conducted at Cape Canaveral, Florida, have been programmed, yielding the mass equivalents collected on samplers and also the first four moments of the distribution of the exposure values.

DOSIMETRY

A NaI scintillation counter about fifty percent larger than the one now in use at the whole body counter was obtained from the Harshaw Chemical Company for evaluation. The resolution of this new counter was found to be about ten percent. This is to be compared with 8.6 percent for the present counter. Although the resolution of the new counter is not quite as good, it is still adequate for whole body counting. The counting rate of the new counter is about sixty-five percent greater than that of the present counter. It appears that this new counter might be useful in shadow shield type counting to offset the slightly reduced counting rates in such applications.

It was necessary to replace some of the column resistors in the positive ion Van de Graaff. It is possible that our tests of operation at 2.5 Mev caused the deterioration of the resistors. The accelerator column was realigned and a new ion source installed.

Measurements were completed of the neutron emission from three different size masses of plutonium in the large neutron moderator. It was found that the background counting rate of the large moderator was increased when neutron sources were being used for calibration purposes in nearby buildings. The gamma ray effect in the BF_3 counters was observed to commence quite rapidly. The sensitivity of the large moderator to different energy neutron sources was observed to change quite rapidly with the neutron energy. Some slow drifts in sensitivity have not yet been eliminated.

A plutonium-beryllium neutron source containing the same amount of plutonium as one of our sources was borrowed from the United States Naval Research Defense Laboratory. The two sources were slightly different in size. Double moderator ratios and other characteristics of the two sources were measurably different. This illustrates again that plutonium-beryllium sources cannot be assumed to compare on a stoichiometric basis.

A new method was developed for preparing carbon targets for the Van de Graaff. Following thorough outgassing the carbon was evaporated on to a backing material that was kept very hot. The resulting targets could be made much thicker than by any of the older methods and had better heat and ion bombardment resistance.

The Sb-124 neutron source for the half life measurement is being activated in a Hanford reactor. A study was made that indicated some promise in the application of calorimetry to the determination of the isotopic composition of plutonium. A plutonium sample is being obtained for some test measurements.

A study of the theoretical foundations of radiation dosimetry was completed with the preparation of a report on Field Equations in Dosimetry. The report was prepared in collaboration with Dr. H. H. Rossi, Radiological Research Laboratory, Columbia University. Preparation of the report was stimulated by participation of the authors in the work of the ICRU ad hoc committee on quantities and units. The report shows how the basic definitions and energy balance relations in dosimetry give rise to certain field equations. It also shows the connection of standard radiation transport theory to these field equations and uses the theory to generalize and to develop detailed expressions for the terms of the field equations. This study has already been of use in clarifying the fundamental concepts of dosimetry and should find extensive future use in training radiological scientists and in attacks on complex dosimetry problems.

RADIATION INSTRUMENTS

Fabrication of the mechanical shroud assembly for two phototube detectors for the alpha coincident-count air monitor is nearly completed. All circuitry portions have been completed, tested, and installed. Complete system tests will commence as soon as the mechanical shroud assembly is finished.

Several circuitry improvements were incorporated and planned for the miniature transistor pulse amplifier and register driver for the personally carried "pocket" experimental indicating dosimeter. Although the initial system, fabricated in small package, worked reasonably well, it was decided to further experiment with the circuits to obtain the utmost reliability. A pulse stretching circuit is being incorporated at present.

Investigations and circuit experiments continued on methods to reduce noise effects for low level, low gamma energy counting. Since the particular bothersome noise bursts contain both positive and negative components and the desired signal is of a negative nature, circuits are being developed to gate off the counting portion if the input signal has the positive and negative components. If successful, improvements in detection sensitivity for low level, low energy photons will be obtained.

Investigations and experiments continued concerning the solid state surface barrier silicon diode detectors. Using one-square-centimeter size detectors, an alpha energy resolution of 30 Kev was obtained using a low noise amplifier.

Initial circuit development was started on a portable, battery-operated, automatic recording area monitor of a rugged type for use in remote locations without line power and where environmental conditions may be severe. Solid state circuitry and scintillation detection will be used with initial circuitry being tested at present.

Considerable progress was achieved concerning light detection and readout circuitry for the small "pocket" indicating and alarming dosimeter which uses a modified pencil ionization chamber with a light illuminating the quartz fiber. Since the light detecting CdS photocells are quite temperature sensitive, the output signal changed measurably with temperature. Two methods of alleviating this problem are being investigated. The first method uses two cells with one serving as a reference for temperature compensation, and a regulating circuit with feedback through the illuminating light bulb was developed to hold the CdS cell resistance constant. Thus both the detecting cell and the reference cell are similarly illuminated. A signal-to-noise ratio of five was obtained. The second method employs only a single photocell and a pulsed light source with a pulse frequency of 1 to 10 cps. To date, the signal-to-noise ratio has been about two for the experimental circuit used.

Transient noise problems have been solved concerning the Automatic Film Badge Densitometer System. All tests are now running satisfactorily on a day-to-day basis. The operation and instruction manual is being written, and the complete system is ready for transfer to the Radiation Protection Operation location. If properly used, the system should continue to perform satisfactorily. Recommendations were presented to RPO personnel concerning desirable changes in the "identification dot" punch system which was partly completed prior to Instrument Research and Development effort regarding the system.

Advice and assistance was rendered to Chemical Effluent Technology Operation concerning electronic circuitry problems associated with a reactor effluent monitor for As^{76}.

Alpha readout circuits for the modified experimental Alpha-Beta-Gamma Hand and Shoe Monitor were considerably changed to improve alpha detection efficiency. Decade transistorized scalers were employed in place of the previous electromechanical registers. Since the register dead time approached 100 milliseconds, alpha pulse indicating was noticeably impaired, since even at low count rates, several alpha-caused pulses were not registered for each that was. The decade scalers, with a resolution of ten microseconds, measurably improved the situation. With the new inexpensive probes installed and tested and with the alpha scalers in proper operation, the experimental prototype is nearly ready for demonstration use at Purex and Redox.

All system tests were satisfactorily completed on the experimental prototype Beta-Gamma Check-Out Station Monitor for use in the reactor areas. The instrument utilizes gamma background suppression circuitry to permit retention of adequate sensitivity for monitoring shoes and hands even in relatively high background areas. All indication of both gross and net (background suppressed)

counting is with count-rate-meter circuits employing adjustable set-point meter relays for indication and alarm purposes. In addition to the hand and shoe probes and circuits, a general area monitor circuit and several types of cable-connected clothing checking probes and circuits are employed in the instrument. The shoe, hand, area, and clothing probes are of the scintillation type employing thin sheet terphenyl-in-polyvinyltoluene detectors. In addition, provisions are included for use of GM tubes and BF_3 tubes as desired. The hand and shoe probes can easily detect and alarm with a 10,000 d/m Ra D-E-F source either of the point type or distributed over a 4 x 8 inch area. The scintillation clothing probes can detect both C^{14} and S^{35}, and the clothing probe readout is by both loudspeaker and meter.

Considerable improvements were made in fabrication methods of the CaF_2:Mn thermoluminescent dosimeters. Tests indicate that the method will circumvent batch-to-batch phosphor characteristic differences which have been a problem. Several sets of experimental dosimeters were fabricated and tested using various K-sources, filtered X-rays, and both Ra^{226} and Co^{60}. Irradiations were performed parallel, perpendicular, and at a 45-degree angle to the plane of the metal button holding the phosphor. Qualitatively, it can now be stated that 2π directional independence has been attained; however, energy independence down to 16 Kev has not been obtained to date. A paper concerning the proposed band structure of the CaF_2:Mn phosphor was prepared.

Fabrication was nearly completed on an experimental, transistorized ten-nanosecond-resolution pulse amplitude discriminator circuit. Tests will be conducted as soon as the necessary fast diodes are received and installed.

Experiments continued concerning zinc sulfide particle detection methods for the Atmospheric Physics Operation. Five new Am^{241} sources were obtained and sprayed with plastic to prevent smearing. Two types of ZnS pigment were determined, by experiment, to be best suited to the dual pigment method of detection by pulse height analysis.

A second special terphenyl-in-polyvinyltoluene detector was designed and fabricated for use by Biology Operation personnel studying Ca^{45} uptake in fish. In addition, a mechanism was designed for holding live animals while counting them in the Biology Total Body Monitor. The holder will be fabricated at the 100-F machine shop.

Discussions were held with, and advice and assistance rendered to, personnel of Environmental Monitoring concerning their Columbia River Monitor which uses a scintillation detector, solid state DC amplifier, recorder, and high voltage supply. Since they are attempting to monitor for dose-rate levels of 10 to 30 microroentgens per hour, the phototube noise contributions, which vary with probe temperature, have caused considerable difficulty. Water jacket coil cooling was tried with moderate success; however, it was recommended that a pulse counting system using transistorized circuitry and a larger scintillation detector, be employed to solve the problem. The presently employed system is just not suitable for such very low level monitoring work.

Work continued on improvement of the Whole Body Counter data system. The Laboratory for Electronics magnetic disc memory was received and circuits were developed for gating and driving the read-write heads. The design of the pulse-

height analyzer channel summer was completed. This system provides for the adding together of the counts in up to nine groups of selected channels and the print-out of the resultant totals.

Arrangements were made to check out the new Ampex tape transport mechanism received by Atmospheric Physics Operation. A power supply and record-reproduce amplifier set will be borrowed from the analog computer transport delay tape machine to make the tests. The new tape recorder will be used for recording meteorological data for subsequent analysis on the analog computer.

Initial studies into the needs and requirements of Wind Component Meter data reduction for Atmospheric Physics Operation have been started. Although some unique difficulties may be associated with an analog computer solution to this problem, it appears that satisfactory results can be quickly obtained using analog methods.

WASHINGTON DESIGNATED PROGRAM

Isotopic Analysis

The mass spectrometer for this program provided isotopic analyses for program samples and calibration standards according to goal schedules.

The effect of the carbonizing process applied to the triple filament ion source of this spectrometer was studied. The results of these studies indicated a possible small improvement of about a factor of three in sample sensitivity and sample life under certain conditions of carbonization. It was not anticipated that the performance of the triple filament ion source would be significantly improved by the carbonization process.

TEST REACTOR OPERATIONS

Operation of the PCTR continued routinely during the month with one unscheduled shutdown due to an operating error. There was a scheduled two-day outage to straighten the graphite on the moving face. Six adjustable braces were added to hold the graphite in place on the moving face.

The experiment to determine the resonance escape probability with $2\frac{1}{2}$-inch diameter solid uranium fuel in a $10\frac{1}{2}$-inch lattice was completed during the month.

The experiment to determine the change in reactivity of the PCTR associated with the meltdown of the driver fuel was completed during the month.

Tests to determine the worth of the reactivity control systems of the PCTR as a function of the fuel loading pattern were nearly completed during the month. The data obtained are tabulated in Table I.

DEL

TABLE I

Core Size - Inches	26 1/4	33 3/4	41 1/4	48 3/4
Control Rod #5 - ¢	48.9	55.2	57.5	51.2
Control Rod #7 - ¢	44.1	51.6	55.0	48.2
Disk B - $	2.44	2.68	2.88	2.84
Disk C - $	2.86	3.10	3.15	3.18
Total - $	5.30	5.78	6.03	6.02
Both - $	5.42	5.52	5.78	5.74
Leveling Slugs 3 in. - 2 in.				
Outer - ¢	11.4	9.8		3.7
Middle - ¢	22.3	29.4		27.2
Inner - ¢	22.2	26.0		43.9

The TTR was utilized to calibrate a set of foils for a resonance escape probability experiment and a set of Lu_2O_3 pins to determine their self-shielding properties.

The TTR experienced one unscheduled shutdown during the month due to error in bypassing for range changing.

CUSTOMER WORK

Weather Forecasting and Meteorological Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	93	86.5
24-Hour General	62	88.7
Special	167	91.6

Although the past month was hot, the temperature average of 79.4 was considerably below the record-breaking 81.8 mean of July 1960.

The precipitation total of 0.15 inch equaled normal for July. However, all of this occurred during a thunderstorm on the evening of the 23rd. Twenty-six days were clear and only one was cloudy.

Instrumentation and Systems Studies

The newly-designed automatic unloading mechanism and hangar were satisfactorily tested for use with the experimental Laundry Monitor. Fabrication continued on one electronic circuitry channel of some nine total (final) channels to be used in the Laundry Monitor system. The single channel will be experimented with and perfected before fabrication is started on the remaining sections.

Discussions were held with various HLO and CPD personnel concerning possible system designs of fixed filter air monitors for the 327 Building and of coincident count alpha air monitors for Purex, respectively. The experimental prototype coincident count alpha air monitor, now nearing completion, will be demonstrated at Purex as soon as the laboratory tests are satisfactorily completed.

The special sensitive scintillation Beta-Gamma Field Monitor (battery or line operated) was received from fabrication in the 328 Building Electronics Shop. Extensive debugging and test procedures are now being done. Several design changes have been incorporated to optimize performance. The versatile instrument, which will be used by Biology Operation personnel locally and for Project Chariot in Alaska, is all transistorized and includes amplifiers, pulse height analyzer, decade scalers, count-rate-meter, assorted power supplies, and various types of scintillation detectors both shielded and unshielded. The unit can be operated from integral rechargeable batteries or from 110 VAC lines as desired. When line-operated, the batteries are automatically recharged during instrument use.

Fabrication continues in the 328 Electronics Shop on two prototype transistorized miniature GM survey meters with both count-rate-meter and resonant air column "speaker" readout for the Radiation Protection Operation, and on two miniature "palm-size" gross alpha monitors, also transistorized and using a resonant air column indication, with solid state silicon surface barrier diode detectors. These units are for Finished Products Chemical Technology, CPD.

The combined Alpha-Beta-Gamma Cell Exhaust Monitor for Chemical Research Operation, 325-A Building, operated satisfactorily for six weeks and was delivered to the 325-A Building for installation.

Operation continued to be satisfactory, now for two months, on the experimental moving-tape type transistorized scintillation beta-gamma air monitor for use in the 327 Building. Several more units will be fabricated, and a complete instruction and maintenance manual was prepared.

The breadboard model of the Panellit-Heise gage readout device has been completed and successfully demonstrated to IPD and Data Processing personnel. The only problem seems to be the slow printing speed of the adding-machine-tape punching device. An effort has been made to increase the speed by altering the scanning cycle. Fabrication of the prototype instrument is proceeding, but completion will be delayed until the middle of August because of the lack of instrument craftsmen.

A calciner temperature control system with a programmed setpoint was recently installed by Process Control Development Operation, HLO. A stability analysis of this system was made by Systems Research Operation prior to its final design. Tests made on the actual system during the month showed that satisfactory operation of the system was obtained using the controller settings determined by the computer study.

Calibration of micro-displacement systems, to be used by Physical Metallurgy Operation for in-reactor creep measurements, has continued during July. An evaluation report for the Schaevitz DRS-100 is in preparation and will be submitted to Physical Metallurgy as soon as the results of the data analysis are

completed by Operations Synthesis and Research. Calibration of the Physical Science three-range transducer was completed this month. Preliminary data inspection indicates the transducer experiences an appreciable zero shift on each of the three ranges as the operating temperature is increased from 20 C to 400 C; also, a definite range expansion occurred as a result of the increased operating temperatures. These effects were considerably more pronounced for the "low" range than they were for the "medium" and "high" ranges. A repeat of the room temperature calibrations, performed after a week of elevated temperature operation, showed the transducer's operating characteristics are significantly affected after 400 C operation. The reference system has been moved to the 306 Building and converted into the low range, high precision system in preparation for calibrating the 0.030-inch range, Physical Science transducers for the third generation creep capsule. A mathematical analysis performed on the May, 1961, reference system calibration data has been completed, and it is now possible to make quantitative statements concerning the precision of the reference system. The available ranges and their associated standard deviations follow:

Range	Standard Deviation	
	Inches	Percent
0.3 inch	$\pm$ 71 x 10^{-6}	$\pm$ 0.023
0.04 inch	$\pm$ 40 x 10^{-6}	$\pm$ 0.10
0.004 inch	$\pm$ 6.4 x 10^{-6}	$\pm$ 0.16

The PCTR kinetics were programmed and operated for a ramp reactivity increase. The variable parameters included ℓ^*, β_t, β_i, and λ_i. This work was performed at the request of the Reactor Lattice Physics group and was completed satisfactorily.

Analog computer equipment was evaluated for continuous on-line use as a special purpose computer for the Redox dissolver stream. This work consisted of programming two algebraic equations relating the process stream temperature and specific gravity to the weight percent of uranium and nitric acid in the process stream. A study was made involving the use of the Beckman/Berkeley "EASE" equipment, Donner equipment, and the "PACE" TR-10 equipment. The evaluation was concerned principally with the long-term drift characteristics of the equipment. The results showed quality of the equipment followed the order:

1. Beckman/Berkeley EASE
2. Electronic Associates PACE TR-10
3. Donner

Based on the results of these tests and on the comparative costs of the equipment, a recommendation was made to the Facilities Engineering Operation of CPD that the PACE TR-10 was a probable best choice of equipment.

Physical Testing

Testing work continued at a high level this month, though there was some tapering off of the NPR pressure tube testing. A total of 11,202 tests were made on 3,635 items. The feet of material represented by these items amounted to 76,469 feet; the greater part continues to be reactor pressure tubing and fuel

element sheath tubing. Test work included: Autoclaving; borescoping; dimensional measurements (micrometric); eddy current; penetrant (fluorescent O.D. and I.D.); radiography (gamma-ray and X-ray); stress analysis; surface treatment (alkaline cleaning, pickling for autoclaving and conditioning); and ultrasonic (flaw detection and thickness measurements). Work was done for 23 organizational components representing most of the operating departments and service organizations at HAPO. Advice was given on 43 different occasions on general testing theory and applications.

With the NPR pressure tubing testing nearing completion, the quantity of new tubing tested has tapered off. The availability of new tubes which could be tested has been reduced due to conditioning work both here and at the vendor's site. Before additional new tubes are made to complete the order it is desirable to determine if borderline tubes can be salvaged for reactor use. In the conditioning work, it has been found thatlocalized conditioning on autoclave surfaces can be successfully accomplished if the area to be reworked is small and if a sharp edge can be maintained between the autoclaved and conditioned surfaces. These conditions are met at present by masking of the area to be conditioned and removing the objectionable autoclave film by blasting with aluminum oxide. Pickling and autoclaving of the resultant patch has proved highly successful as long as a sharp edge is maintained. A continuing problem in obtaining acceptable tubes is the elimination in handling marks. Elaborate precautions must be used to avoid scratches, bumps, and marred surfaces arising from handling facilities. A major holdup in the completion of conditioning work on the NPR pressure tubes is the lack of a facility for internal conditioning of the tube. A vacuum blasting machine has been built and will be installed during the month of August to allow conditioning of the I.D. surfaces.

Two work stoppages occurred in the past month. One involved pipefitters and the other, electricians. Two days each were lost because of the work stoppages.

Testing work on the PRTR spare pressure tubes was started and radiography and ultrasonic testing were completed. The ultrasonic testing consisted of separate scans for transverse and longitudinal discontinuities with both scans being made in two directions. Penetrant testing of the tubes will proceed as soon as arrangements can be made for a light preliminary pickle to prepare the tubes. It is not anticipated that any difficulties will be experienced in the pickling of these tubes since modification of existing facilities can be readily accomplished. Some difficulty has been experienced in working out an acceptable schedule with Kaiser Engineers to avoid conflicts with NPR pressure tube processing.

Field testing activities centered around X-ray and stress application work for this month. Radiography of the loops in the 1706 KER facility has continued. Miscellaneous work has been done for the 100-N area. Process vessel work for the separations areas has been started again because of construction of a dissolver for the Purex facility.

Stress application work was done at two sites. At 1706-KER the Elmo-15 test section enclosures were tested. The 105-KE rear face strain gage reactor installation was started.

Testing has been started on a new order of Zircaloy-4 fuel element sheath tubing. The supplier is the same as that of the old order. Initial results show the

outside surface is free of indications, apparently achieved by mechanical conditioning of the outside surface. The inside surface condition is similar to that of the older order. Studies are continuing on the transverse ultrasonic scanning of sheath tubing using a line type focus crystal. In preparation for the large lot of Zircaloy sheath tubing which will arrive commencing in August, the 308 Building tester is being reactivated. A simplified roller mechanism was designed for the ultrasonic tank. Estimated fabrication cost is about one-fifth of the cost of the original design. An emergency order was placed for six-month rental of an additional Immerscope to be used on the 308 tester. Existing ultrasonic equipment is inadequate. Eddy current testing of the sheath tubing using the Radiac unit has been delayed by electronic difficulties in the end suppression portion of the circuit. The ultrasonic cleaning tank with scanning bridge is ready for operation. Ultrasonic cleaning will be used preparatory to penetrant testing to assure more uniform results as a result of maximum cleanliness. Some additional work has been done on the photocell for I.D. fluorescent penetrant indications. Maintaining uniform processing in order to establish a constant background is required for successful operation of such a readout.

The first three completed nested tubular fuel elements from Ceramic Fuels Development were received for radiography of the weld closures to determine the integrity.

A 151 Multi-tron cask arrived on site with an encapsulated 150-Curie cobalt-60 source. The availability of this equipment will now permit high energy gamma radiography of heavy sections. Autoradiography was completed on 63 one-half-inch-diameter-by-four-inch Zircaloy-clad extruded uranium elements. Prior to cladding the sheath material had numerous grooves of varying lengths, depths, and widths machined on both the inside and outside surfaces. These elements will be subjected to pile testing to evaluate failure of the cladding. The autoradiographs will provide a record for the evaluation of results.

Two Zircaloy rib tubes with a total of 12 ribs were tested for unbonds. No significant unbond areas were found.

Considerable experimentation was necessary to permit detection of prepared defects in reactor Parker fittings by ultrasonic contact methods. A workable system is now available. A lucite wedge coupled to a 10-megacycle "Branson Z" crystal was prepared. The wedge angle was adjusted to send longitudinal ultrasound parallel to the fitting axis. The crystal was adjusted to give good reflections from prepared notches in both the thread relief and thread root. Good results were obtained using either an Immerscope or a wide band converter as a driving source. The test should be sensitive to cracks in all areas except the first few thread roots in the fitting. Cracks in these roots are thought to be unlikely. The test is insensitive to cracks in these roots because of a large reflection signal from the tapered portion of the fitting. This signal obscures reflections from defects in the first few thread roots since they occur at nearly the same time. The crystal can be driven through cable lengths of at least 60 feet. This may allow remote placement of the Immerscope so that possible rear face contamination will be minimized. Experiments to determine if detected signals could be gated into an audible or visual alarm circuit gave doubtful results. Signals from thread relief defects can be gated but alarm gating of signals from thread root defects is difficult due to the presence of the large taper reflection mentioned above. Though these signals are difficult to electronically gate, their presence can be verified by observing the scope presentation. Therefore, two operators may be necessary if the Immerscope is placed remotely.

Optics

A second corner-radius-measuring microscope has been designed and is being fabricated. This unit incorporates improvements suggested by use of the first unit, built last January. The improvements include (1) separate optical systems for illumination and viewing, (2) provision for use of a modified grain size measuring eyepiece to permit direct measurement of the corner radius, and (3) a manipulator to position the object in the field of view.

A microscope has been designed for CPD Finished Products Technology Unit to permit viewing of groove contours and to provide for measurement of the depth of grooves. Groove depths on the order of 0.010 inch are expected to be measured with an accuracy of 0.0001 inch with this device. This device and the corner radius measuring microscope use the same principle of optical cross-sectioning as used in previous scratch depth microscopes built by the Optical Shop. The groove depth microscope is being fabricated in Tech Shops.

A total of 440 manhours of shop work was performed during the four-week period (July 2 to July 30) included in this report. The work included:

1. Repair of an underwater periscope at 105-F Building.
2. Repair of three Opton stereomicroscopes for 327 Building.
3. Preparation of thermoluminescent phosphor material for Nucleonic Instrumentation Operation.
4. Fabrication of a traversing mechanism for Process and Reactor Development Operation, IPD.
5. Grinding and polishing of 20 microscope slides for the Exposure Records Unit, HLO.
6. Repair of a borescope for Testing Operation, IPD.
7. Fabrication of components for a wall thickness probe for Physical Measurements, HLO.
8. Repair of three shutters for Photography Operation.
9. Repair of two crane periscope heads for Purex and one for Redox.
10. Reconditioning of two relay lenses of the main crane periscope at Purex.
11. Resurfacing the six pump seals for PRTR.
12. Fabrication of a set of ten glass bearings for Stores.

ANALOG COMPUTER FACILITY OPERATION

Studies

The major analog computer problems considered during July include:

1. PRTR Critical Facility Poison Injection Scram System.
2. PRTR Gas Balance System.
3. PCTR Kinetics.
4. Analog Computer Equipment Drift Tests - On-Line Computer for Redox Dissolver.

Equipment Operation

Computer operations were as follows:

GEDA	EASE	
0	140	Hours up.
120	20	Hours scheduled down time.
40	0	Hours unscheduled down time.
0	0	Idle time.
160	160	Total Hours.

Maintenance

The oven conversion of the GEDA has been completed and a number of checks made to determine how well the affected units work. With the new oven arrangement, it is now possible to determine to a greater extent than before where troubles in the amplifiers and integrators are.

A large number of contacts were replaced on the patchbay which could not be replaced before, and resistor cards were found that needed adjustment.

A great deal of trouble, experienced with the first ten integrators on the GEDA, may now be eliminated by removal of ten microfarad capacitors and wiring installed for special problems.

The EASE lost the use of 12 multipliers when the power supply transformer burned out. The replacement unit was also defective. The company will replace the transformers on warranty and stated they had received a bad lot.

INSTRUMENT EVALUATION

The rechargeable Ni-Cd portable instrument batteries continue to perform correctly after 26 charge-recharge cycles.

All evaluation tests were satisfactorily completed on the two experimental prototype scintillation transistorized Logarithmic and Linear Building Radiation Monitors.

Thirty of fifty ordered, by RPO, high range CP-TP portable instruments were tested and are ready for service. These units have a highest range of 0-5000 r/hr. Slight chamber saturation difficulties, resulting in nonlinear operation, were noted above 3000 r/hr.

Ten of the thirty ordered, by RPO, Model II Scintran transistorized line-operated monitors fabricated to HLO-developed circuit specifications by GE-APED were received. Testing procedure instructions were prepared and given to Calibrations Operation (RPO) personnel.

Evaluation tests, concerning 110 VAC line voltage and temperature variations, were started on an RCL Model 20703 high voltage supply and on an RCL Model 20506

single channel pulse height analyzer. The high voltage supply tests were completed satisfactorily, with results within the limits specified by the manufacturer. Tests are continuing on the pulse height analyzer. Both units are transistorized.

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CHEMICAL RESEARCH AND DEVELOPMENT OPERATION

RESEARCH AND ENGINEERING

FISSIONABLE MATERIALS - 02 PROGRAM

IRRADIATION PROCESSES

New Production Reactor Effluents

The ineffective scavenging of radiocobalt from mixed NPR decontamination waste solution by precipitated manganese dioxide was shown to be caused by the 10 ppm EDTA introduced with the commercial peroxide-carbonate cleaning solution. Similarly, the failure of soil to remove cobalt appreciably from this waste is also ascribed to the formation of the EDTA complex. The addition of 10 ppm stable cobalt to the waste mixture increased Co-60 scavenging to 95 percent, compared to 67 percent removal with no added cobalt. The addition of 100 ppm stable cobalt increased Co-60 removal by scavenging to about 98 percent.

Reduction of Reactor Effluent Contamination

Development continued on an As-76 monitor for reactor effluent. For the present, reduction of interfering Cl-38 is to be accomplished by delay long enough to permit the Cl-38 to decay to insignificance. Because of the rather slow response of As-76 concentration to inlet water treatment a delay of several hours is not impractical. Possible methods for more rapid removal of Cl-38 are nevertheless still being considered.

For greater sensitivity, a digital counter for the 0.55 Mev photopeak counts in the As-76 channel will be used. The Mn-56 Compton correction and field radiation will be subtracted digitally from the As-76 channel count. The counting interval for the Mn-56 channel impulses can be selected such that the appropriate number of counts originating from Mn-56 but appearing in the As-76 channel may be accurately subtracted. Counting interval selections is then equivalent to a ratio subtraction accomplished in analog (dual counting rate meter) instruments for similar application. Mn-56 photopeak to Compton ratios for two crystal configurations and several amplifier gains and source thicknesses were determined using locally prepared Mn-56 standards. The monitor was tested for proper operation and should soon be field operated.

A laboratory study was completed in which various natural minerals were evaluated with respect to their ability to adsorb radioisotopes, particularly P-32, from reactor effluent. Of 26 minerals examined, Florida pebble phosphate, Idaho rock phosphate, sodalite, epidote, goethite, fluorite, diaspore, bauxite and gibbsite were the best P-32 adsorbers, removing 40 to 70 percent from simulated reactor effluent. In experiments with these minerals, the decontamination factors remained relatively steady for operating intervals of up to two weeks and for throughputs in excess of 3000 bed volumes. Aluminum oxide minerals compared favorably with aluminum turnings for P-32 adsorption in laboratory experiments. Beds of aluminum turnings, diaspore, bauxite, and gibbsite, removed 65, 64, 51 and 47 percent of the P-32 from solution, respectively.

Uranium Oxidation and Fission Product Volatilization Studies

Metallographic examination of NPR prototype elements which were heated to temperatures of 1200 and 1300 C for one-hour periods in air showed that at 1200 C the Zircaloy cladding, though considerably reduced in thickness, remained intact. The cladding of elements heated to 1300 C was completely destroyed by a combination of oxidation and diffusion. Since free flow of uranium was not observed, the molten interior must have been contained by a high melting oxide and U-Zr shell. Photo-micrographs of the brazed end caps showed almost complete interdiffusion of uranium and zirconium at 1300 C, with exposure of the uranium to the atmosphere.

This information is useful for making a rough estimate of fission product release from NPR elements during a loss-of-coolant accident. It suggests that no significant release of fission products would occur during the first hour if the fuel temperature does not exceed 1200 C. If, however, the temperature reaches 1300 C, rare gases might be released as a burst at some time less than one hour when the protection of the Zircaloy cladding was lost. The exact time at which this would occur is uncertain, but would probably be within 15 to 30 minutes. Release of other fission products would probably be greatly curtailed by the oxide and U-Zr diffusion layer.

Reactor Effluent Radioisotope Studies

The effectiveness of the high alum water treatment process at F Area in removing radioisotopes from upstream reactors was determined. Very little effect was noticed with Np-239, Na-24, and Cr-51, but Cu-64 was reduced by 10 percent and As-76 by 40 percent. If these materials are good tracers for the inactive parent materials (which past tests seem to indicate is the case), then less than one-half of the As-76 parent material is removed. However, the As-76 production by F reactor as of July 17 was lower than that obtained by normal water treatment by a factor of seven. This again suggests that changes in the water quality other than parent isotope removal play an important part in the radioisotope production and release mechanism.

SEPARATIONS PROCESSES

Disposal to Ground

Concentrations of gross beta emitters in ground water samples obtained near the bottom of three of seven wells sampled were higher than those detected in routine ground-water surface samples. A maximum of 1.5×10^{-5} ucB/ml was detected in a well 1.5 miles north of 200 East Area, which places the extent of the ground-water contamination at least one mile farther north than indicated by previous well sample analytical results. Routine monitoring samples from these three wells consistently contain less than the routine analytical detectable concentrations ($< 8 \times 10^{-8}$ ucB/ml). The sampled wells are located north and northwest of 200 East Area which indicates the abandoned 216-BY scavenged waste cribsite as the possible source of the waste. These findings show that some routine depth sampling is necessary for better definition of the extent of ground-water contamination.

Recent samples from well 699-26-15, located six miles east-southeast of 200 East Area, contained concentrations of radioisotopes slightly greater than the routine detection limit of 8×10^{-8} ucB/ml. The positive evidence of radiocontaminants in this well is in agreement with positive results noted several months ago from the 699-20-20 well which is also located six miles from 200 East Area but in the southeast direction. Sources of the waste in this locale are several of the Purex plant waste cribs. No long-lived radioisotopes have been detected in these and intervening wells between the Purex plant.

[redacted]

Well 699-49-55 encountered basalt more than 20 feet higher than predicted, and less than ten feet below the water table. This unpredicted irregularity further confirms the conclusion previously reached that the basalt surface beneath the northernmost third of 200 East Area was eroded rather than being simply folded. The situation is significant because radioactive contaminants were recently detected in the ground waters just above the basalt in wells in this general area. Movement of these contaminants will be affected by the configuration of that relatively impermeable basalt surface.

WASTE TREATMENT

Batch Calcination

The batch calcination of simulated Purex high-level wastes was studied in bench-scale experiments to ascertain the amount of solution foaming during the boildown step and internal pressurization during the calcination step.

The waste composition that had repeatedly generated internal pressures during the calcination step in 3-inch diameter pots was studied in a 6-inch diameter annular pot. No internal pressurization was evident with the larger diameter pot.

The role of the acetate ion in solution foaming was the subject of another run. Sodium acetate was added to a waste solution which had not foamed badly in a previous run. The presence of 0.1 M sodium acetate had no effect on foaming.

Submerged Combustion Condensate Treatment

Adsorption studies were made to evaluate a bed of Decalso for removing radiocesium from the condensate arising from the evaporation of coating waste by submerged combustion. Synthetic evaporator condensate, based on a decontamination factor of about 4×10^5, was used in the research. The solutions used contained 2×10^{-4} ucCs-137/ml and 1-10 ppm sodium. Decalso had the highest Cs-137 equilibrium distribution coefficient of the seven exchangers tested under these conditions. The Decalso K_d for cesium was greater than 10^5. If half of the cesium adsorption capacity of a bed of Decalso estimated from these results were utilized, it should be possible to decontaminate more than 10^5 bed volumes of condensate to below 0.1 MPC_w for Cs-137.

TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Strontium-90 Program

Hot Semiworks Operation - About 120 kilocuries of specification product recovered last month was loaded into the HAPO-IIA filter cask for shipment as a dry strontium carbonate. The strontium carbonate was precipitated from a solution approximately 4 M in sodium nitrate, 0.13 M in strontium and less than 0.015 M in calcium plus barium. Potassium bicarbonate was added to form the carbonate using a two-hour digestion period at about 80 C. The slurry was then passed through the cask, with approximately 75 percent of the initial batch retained on the filter, less than 5 percent apparently passing through the filter and greater than 20 percent remaining in the feed tank.

Residual moisture from the slurry was baked out at about 460 F for about 5 hours. Because of subsequent moisture leaks during pressure testing, a final "bake-out" at 120 C for 5 hours was carried out before sealing the cask for shipment. Pressure buildup after sealing the cask was not detectable over a 24-hour period.

During the cask loading period minor repairs were conducted to ready the plant for subsequent processing. These included the replacement of the two remote feed pumps with similar chempumps but with modified tapered bearings and hydroclones. Previous failures were attributed to plugging of the hydroclone recirculation coolant line and the loss of bearing adjustment from vibrational loosening of the bearing holding screws.

Solvent Clean-Up Studies - Further studies to define effective wash procedures for the removal of residual radioactive constituents from Hot Semiworks solvent were made. Gross gamma distribution coefficients (E_a^o) of about 10^{-3} were obtained in equal volume contacts of HSW solvent with aqueous solutions containing 0.5 M EDTA or DTPA at pH 12. Best results were obtained with both washes in the pH range 9-12; DTPA appeared to be slightly more effective than EDTA. Nitric acid washes ranging in concentration from one to five molar were tested. Gross gamma E_a^o's ranged from 0.04 to 0.004 with increasing acidity. Cerium removal increased and Zr-Nb removal decreased with increasing nitric acid concentration.

Decalso Shipment - The last HAPO-1A shipment was made "dry," after laboratory study had shown that the absorbed strontium could still be eluted after heating to the maximum temperature expected under these conditions (about 80 C). It is of interest to know the maximum shipping temperature which would still permit elution, since this temperature would define the capacity of the HAPO-IA cask and also the design of a new strontium or cesium cask. Past Hanford and Oak Ridge experiments show that 100 C is acceptable but that strontium cannot be eluted after heating to 400 C. Thermal balance and differential thermal analysis measurements were made on Decalso and on strontium-loaded Decalso in an effort to better define the limiting temperature. Both techniques showed a gradual loss of water of crystallization starting at about 100 C and reaching completion at about 400 C, rather than any abrupt transition. More loading-heating-elution experiments will accordingly be necessary to define the allowable temperature limit.

Other Fission Product Development Studies

Solvent Extraction Separation of Cerium - Studies are underway toward developing a flowsheet applicable to Hot Semiworks equipment for recovering a rare earth fraction free of cerium and strontium from Purex plant crude cut solution. The rare earth fraction would be especially suitable for ion exchange studies on the separation of promethium from other rare earths.

A flowsheet under consideration involves extraction of Ce, Pm (as representative of non-Ce rare earths), Ca and Ba into D2EHPA; removing Sr from the organic phase by partition; stripping Ce, Pm and Ca from the organic with 1-2 M HNO_3; oxidizing cerium to Ce(IV) and extracting Ce(IV) into an organic phase. The aqueous phase could then be used without further treatment for ion exchange studies or subjected to another extraction-stripping cycle to recover Pm in a more suitable solution. Batch contact studies made to date indicate that satisfactory separation of desired constituents from iron and lead present in crude cut solution can be obtained in the initial extraction. In these studies, iron was complexed to prevent precipitation or extraction by adding sodium acetate and HEDTA to the crude cut solution.

Of several reagents tried for the oxidation of Ce(III) to Ce(IV) in 1 M HNO_3, potassium peroxydisulfate appeared to be the best for use in the above flowsheet. In the presence of all organic extractants tried, some reduction of cerium(IV) occurred.

Distribution ratios obtained were influenced by the reduction and decreased with increased times of contact as well as ratios of organic to aqueous volume. Distribution ratios, E_a^o, of about 100 were obtained with a contact time of 15 minutes and organic to aqueous volume ratio of 0.25. Means for preventing reduction of cerium(IV) are being sought.

Some studies were done on the relative extraction of cerium(III) and promethium by D2EHPA. In batch contacts between simulated crude cut solution containing 0.4 M sodium acetate - 0.13 M DTPA and 0.4 M D2EHPA - 0.2 M TBP - Shell Spray Base, distribution ratios for promethium decreased from 2.5 to 0.03 as pH was increased from 2.5 to 4.5. Under the same conditions, distribution ratios for cerium decreased from ca. 20 to 2.5. The distribution ratios differed by a factor of about 10 throughout the pH range 2.5 to 4.5.

Bulk Fission Product Packaging - Continued studies of strontium oxide packaging equipment showed that a 6-inch diameter vacuum disk filter lying flat on the bottom of the precipitator vessel is probably the best means of removing filtrate and wash liquor from the precipitated SrO_2. The advantage of the disk filter is that it interferes very little with the action of the agitator during slurring of the precipitate prior to transfer to the product filter canister. Liquid migrates to the filter by capillary action, leaving a fairly dry cake deposited on the bottom of the vessel.

Calcined SrO exposed to an atmosphere of CO_2 at 600 C quickly absorbed approximately 1/3 the amount of CO_2 that would be anticipated by the reaction $SrO + CO_2 \longrightarrow SrCO_3$. No additional CO_2 was absorbed during two hours of continued exposure. Thus, it is unlikely that there will be a pressure build-up in a SrO product container due to radiolytic decomposition of $SrCO_3$ (assuming the presence of a small amount of $SrCO_3$) because the liberated CO_2 could combine with the SrO present.

Cask Closure Development - HW-70316, "Semi-Remote Connector for Fission Product Casks," was issued. The report describes the three-jawed miniature Hanford connector proposed for use on future fission product shipping casks.

Promethium Recovery - A series of runs are in progress in B-Cell to define a flowsheet for Purex use in producing a promethium concentrate which will serve as feed for the A-Cell ion exchange columns. These represent the first full-level testing of the peroxyacetate process, which is designed to separate cerium from promethium (and the other trivalent rare earths). A typical flowsheet features one rare earth sulfate precipitation (without lead carrier), followed by carbonate metathesis, nitric acid dissolution, oxalate precipitation, nitric acid digestion and peroxyacetate precipitation. Fragmentary results show that decontamination from ruthenium, cesium and zirconium-niobium was virtually complete after the carbonate metathesis.

Solvent Extraction of Cesium - The extraction of cesium from Purex 103A tank supernate, which contains about 10^{-4} M cesium and 9 M sodium, is under investigation. Of solvents tested to date, only sodium tetraphenyl boron (TBP) has given appreciable extraction. With this extractant, the extraction coefficients, E_a^o, were found to be extremely dependent on the diluent used. Thus, at a concentration of tetraphenyl boron of 0.05 M, the distribution coefficients of cesium were 0.06, 3 and 39 for hexone, amyl acetate, and nitrobenzene, respectively. The extraction also increased with about the 1.5 power of the TBP concentration. Other diluents yielding relatively high cesium extraction coefficients were n-butylphthalate (2.7), o-nitroanisole (7.4),

iso-butyl benzoate (8.7), ethyl n-butyrate (5), and diethyl carbonate (0.4). Little or no extraction was observed with acetophenone, n-butyronitrile, cyclohexanone, or isophorone as diluents. Cesium was readily back extracted from amyl acetate solution with 0.1 M HNO_3 whereas over 0.5 M was required from nitrobenzene. Phase separation was also poor with the nitrobenzene system. Evaluation of other extractants and diluents is continuing.

Ion Exchange Recovery of Cesium - Experiments are in progress on the absorption of cesium from 103A supernate with Decalso and with organic resins (such as Duolite C-3) in support of (1) design of an improved cesium shipping cask, and (2) on-site cesium recovery. The capacity of Duolite C-3 was only slightly larger than that of Decalso (factor of 1.2); however, its greater ease of elution is an advantage in any processing scheme. Its major disadvantage as compared with Decalso is the very large volume of ammonium nitrate or sodium nitrate required for elution. A scheme using Duolite C-3 in an intermediate extraction step followed by loading on Decalso may permit much larger shipments per cask.

Hazards in Shipping Cs-137 - New laboratory data were obtained to permit determination of the rate of elution of radiocesium from a synthetic zeolite following an assumed shipping accident resulting in immersion of the material in a river. The experimental design that measures elution rate for diffusion-controlled processes was again used, but elution was determined by analysis of effluent samples rather than direct gamma radiation measurements on the bed. This permitted correction for the differences between the rate of elution of Cs-137 and its Ba-137 daughter. In these experiments a prompt cesium elution rate of 4.7 percent/hour decreasing to 2.2 percent/hour after the first hour was measured. These results are slightly lower than were obtained with the direct-reading technique.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

Elimination of Ruthenium Interfering with Tetraphenylboron Extraction of Cesium

Broad application of the February-reported tetraphenylboron (TBP) extraction method for radiochemical cesium recently confronted a species of radiochemical ruthenium which, along with cesium, was extracted by tetraphenylboron despite preliminary attempts to complex the ruthenium with EDTA. It was finally made effective, however, by preliminarily digesting samples at 95 C with excess sodium hydroxide. The EDTA addition, itself a modification of the earlier reported method, had improved cesium decontamination several fold for ruthenium and zirconium and over a 100-fold for cerium. One hundredth molar EDTA (tetra acid form) is added to the sample solution neutralized with sodium hydroxide.

EQUIPMENT AND MATERIALS

Materials of Construction

Role of Chromium in Corrosion of Stainless Steel by Nitric Acid Systems - Further studies attempting to determine the role of chromium in the corrosion of stainless steel by boiling nitric acid solutions were made. These showed that the presence of chromium(VI) produces a significant increase in corrosion rate at concentrations as low as 0.001 M in nitric acid as dilute as two molar. Chromium(VI) was reduced to Cr(III) appreciably during test periods (24-48 hours) in solutions of intermediate to high concentration (4-13 M) nitric acid. Little or no reduction was observed at lower concentrations. The oxidation of Cr(III) to Cr(VI) in nitric acid increased with boil-up rate when closed (cold-finger) condensers were used. Similar results were obtained with open condensers when the boiling solutions were air sparged.

Failed Heat Exchanger from 100 Percent UNH Concentrator - Huey tests on duplicate samples from one of the failed tubes in this exchanger have been completed. Both corroded at rates of about 11 mils/mo. Analyses on material taken from the outside of the tube show about 0.037 percent carbon content. Samples from all of the tubes in the heat exchanger have been obtained. Oxalic acid etch testing and Huey corrosion testing are in progress on a number of these samples.

Corrosion of Titanium in E-H4 Solutions Containing Fluoride - Samples of A-55 titanium have been exposed to synthetic E-H4 solutions with a nitric acid concentration 5 M; hydrofluoric acid concentrations of 0.025, 0.05 and 0.1 M and aluminum to fluoride mole ratios of 0, 2, 4 and 6. All samples corrode at rates less than one mil/mo; all with Al/F mole ratios of four or greater corroded at less than 0.05 mil/mo, and those at 0.05 M HF or less and Al/F mole ratio of two corroded at less than 0.05 mil/mo. Attempts to define the role of Cr(VI) in inhibiting the corrosion of titanium by nitric acid-hydrofluoric acid systems were non-conclusive due to the reduction of chromium to Cr(III) in boiling solutions. Tests were made in 5 M HNO_3 - 0.025 M HF solutions with initial Cr(VI)/F mole ratios from zero to 4. Some inhibition occurs at Cr(VI)/F mole ratios of 0.25 or greater. However, the lowest corrosion rate observed in these tests was 15 mils/mo. The much lower rates observed in synthetic E-H4 solution containing fluoride but no aluminum are apparently due to some factor other than the presence of Cr(VI).

Corrosion of 304-L and Titanium in Acidic 1WW - Samples of 304-L stainless steel and titanium have been exposed to a boiling synthetic acidic (0.9 M HNO_3) Purex 1WW for about 900 hours. Corrosion rates for 304-L in the vapor and liquid phases were 0.2 and 6 mils/mo., respectively. Corresponding rates for titanium were less than 0.01 mil/mo in the vapor and less than 0.05 mil/mo in the liquid. No evidence of accelerated attack at the interface was noted for either metal.

PROCESS CONTROL DEVELOPMENT

Flow Ratio Development - Recuplex

A ratio control system for the Recuplex CC Column efficiency control was tested in the following manner:

The ratio of hot water to cold water flow was controlled with temperature feedback to the ratio setting mechanism. The system is crudely analogous to the system proposed for the Recuplex CC Column. The flow of hot water (CCX) is controlled in ratio to flow of cold water (CCF) determined by temperature (concentration) feedback to the ratio setting mechanism, such that the temperature (concentration) is held constant.

The control system described above held the output temperature of the water constant in spite of wide fluctuation in the cold water flow and hot water temperature.

This system is to be further tested on the 321 Building C Column facility with the added feature of column capacity control, determined from column density measurement.

This test should yield additional information regarding applicability of this system to the Recuplex facility.

Redox Control System Studies

An analog study diagram of a proposed system for continuously calculating optimum Redox 1A column stream flows has been prepared. Conclusions drawn from a study of the diagram are:

1. Calculations to determine optimum flow could be made most simply and economically by use of electronic rather than pneumatic computing components.

2. Measured 1AF, 1ABS, and 1AA flows used to calculate the optimum 1AX flow rate could be used "as measured" and would not have to be converted to flow ratios for making the calculations.

3. A production rate signal is not required, which eliminates the multiplication of each of the measured stream flow rates by a constant.

Calciner Control System

The shell temperature of the K cell, UO_3 calciner finish section has been successfully controlled to within ±1/4 percent (±2.5°F) of its programmed set point, using an analog computer determined control system and controller settings. Improved accuracy, temperature, stability and operating safety have resulted for both steady state and transient operating conditions of the calciner.

Stainless Steel Gamma Monitor Cell

A gamma monitor cell fabricated from 1/4-inch S/S tubing having a 4-microinch interior finish has been in operation at Purex on the 2EU sample stream. Operation with this cell has shown that finely polished S/S tubing may be suitable as a construction material for gamma monitor cells. Another evaluation will be made on the 2EU sample stream.

Neutron Multiplication Monitor

A neutron multiplication monitor located in the critical mass laboratory has been in operation during the month. The detector and neutron source are located on a 4-inch diameter storage vessel in which the liquid level and plutonium concentration is varied as solutions are transferred in the facility. Multiplications up to 2.5 have been observed with plutonium solutions of nominal 300 grams per liter. This multiplication corresponds to a K_{eff} of approximately 0.6 and agrees with calculations made for a vessel of this size and geometry.

Pot Waste Calciner Instrumentation

The measurement of changes in thermal conductivity appears attractive as a means of foam detection and pointwise liquid level control in the pot waste calciner. In practice this can be accomplished by measuring response of a thermocouple placed between a heat source and a heat sink. Heating the thermocouple with a separate heater resulted in slow response. A new design incorporating AC heating of the thermocouple wire and filtering to separate the DC thermocouple signal was tested. The design results in high sensitivity and fast response and also meets the requirement that the measuring element be inexpensive and disposable. The design can be used in conjunction with a conventional temperature recorder and controller.

C-Column Facility and Data Processing

Fifteen runs of a twenty-run series were completed during the month.

The Absorptiometer Data Logger system has been given a final checkout. The estimates of the variability due to the components of the system are as follows for any given uranium analysis: 0.02 percent for the time measuring constant current integrator, 0.02 percent inherent in the statistical nature of the gamma source, and 0.02 to 0.05 percent in the ion chamber-current integrator. Thus, the total expected variability in a given analysis should not exceed 0.06 percent.

A Beckman Model W pH meter was modified to give 0-mv output for a pH of 2, and 100 mv output for pE of 4. The "Zero Check" and "Standardize" controls were changed to give very fine control in this system. The 0-100 mv output was connected to a Kintel DC differential amplifier having a gain of 30 to 1. This system will be used in the "Absorptiometer Data Logger" system to perform a "HpH" analysis of the aqueous uranium containing phase from the C-Column.

REACTOR DEVELOPMENT - 04 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Salt Cycle Process

Plutonium Oxidation State in Low Temperature Melts - The stable oxidation state in either $PbCl_2$-2KCl or $MgCl_2$-KCl at 570 C in the presence of an HCl sparge is Pu(III). On changing to a chlorine sparge the melt color changes and at least a portion of the plutonium is converted to a higher oxidation state presumed to be Pu(IV). Sparging melts contained one percent Pu(III) with chlorine for one-half hour (a hundred-fold excess of chlorine) has converted only 66 percent of the plutonium to the higher oxidation state. These samples were frozen under a chlorine gas blanket in an attempt to minimize changes in oxidation state on freezing.

Studies of $MgCl_2$-KCl Systems - Exploratory studies continue to show the $MgCl_2$-KCl system to be a potentially useful lower-melting salt system. Studies in this system have been complicated by the difficulty in obtaining and maintaining the melt in a dry state. After extensive drying of the melt, large well-formed grains of UO_2 can be obtained by electrolysis in this system more readily than in the NaCl-KCl system. The primary reason for the improvement appears to be the ability to operate at lower temperatures (as in the $PbCl_2$-KCl system).

Attempts to "partition deposit" UO_2 from plutonium bearing melts have been unsuccessful to date in the $MgCl_2$-KCl system. No separation of plutonium from uranium was obtained even at 725 C and employing an HCl sparge during the electrolysis. The lack of separation may be due to the possibility that the melts were not completely dry.

Deposits recently obtained from $MgCl_2$-KCl melts have exhibited significantly higher oxygen to uranium ratios than were previously obtained under comparable conditions. The only known difference in conditions is that the humidity of the (room) air was significantly higher during the later work.

Studies of $PbCl_2$-KCl Systems - Observations made this month emphasize even more strongly than before the importance of melt "dryness" on the manner of UO_2 crystal

growth. Even after "drying" the melt by a prolonged HCl-Cl_2 sparge, UO_2 deposited initially in the form of needles but eventually a cubic crystal-type growth occurred. The resulting deposits contain considerable void space in the center, formed during the needle growth period. Oxygen to uranium ratios in these deposits have been 2.01 or greater. In a very dry melt, a cubic type growth was obtained initially and the UO_2 crystals grew outward as units in long columns. The deposit as a whole was very dense with few voids, was extremely coherent, and had an oxygen to uranium ratio of 2.003.

The very dry melt which yielded cubic type growth throughout the deposition was prepared by chlorine sparging a melt which contained uranium(IV) formed during a previous deposition. It is presumed that the cubic type growth which follows the needle type growth in melts "dried" by HCl-Cl_2 sparging commences when the melt has been further dried by anodic action.

The lead and potassium contents of some UO_2 crystals were reduced from 500-1000 ppm Pb and 100-200 ppm K to 10-20 ppm Pb and 50 ppm K by etching with nitric acid. This demonstrates that the contamination was principally on the crystal surfaces and indicates that the high lead contamination was not caused by deposition of lead with the UO_2. Apparently, thorough washing of the crystals is all that is required to obtain low lead and potassium impurity levels.

Engineering Development - A 25 pound batch of U_3O_8 produced by air oxidation of UO_2 at 600 C for 24 hours was completely dissolved in a nominal 20 liter $PbCl_2$ - 2.5 KCl salt bath by chlorination at 700 C for eight hours. The bath was sparged with chlorine through a 6 mm tube at a flow rate of 3 liters/min with no special gas dispersion apparatus. A final concentration of 17.0 w/o uranium was attained with 50, 80 and 95 percent dissolution at 1.9, 4.1 and 6.5 hours, respectively. Subsequent electrolysis at 600 C with a Hastelloy D cathode and graphite anodes produced a dense sheet of polycrystalline UO_2 which was easily removed by quenching the electrode in water.

Ion Exchange Contactor Development

The Jiggler contactor was operated with resin slurry directly in contact with the pulse pump bellows. Initial observations were made with 20-40 mesh resin and pulsing at 1-inch amplitude and 3 to 5 cycles/minute. Direct action of the bellows imparts a positive pressure to the resin itself in contrast to operation to prior operations with screened pulser lines requiring the slip water to move the resin by frictional drag. Slip water flows and pressure variations were reduced with much steadier resin flow being qualitatively observed, although resin attrition at the bellows has not yet been evaluated.

PRTR Studies

Analysis of fission products in the primary helium and heavy water systems of the PRTR continue to show the presence of a fuel element (or elements) with a gas leak. Bursts of noble gas fission products representing the amount expected from as much as 100 grams of uranium were observed when the reactor power level was raised following several hours' operation at some lower power level. Very little iodine or products other than the noble gases were observed in the heavy water. Gross fission product activity in the helium system as recorded by the PRTR rupture monitor showed the bursts of activity and does serve to indicate the presence of leaking fuel elements. In order to identify the tube which contains the leaking element, the rupture monitor must be able to compare relative activities in the various tubes at times on the order of minutes following the burst. The present monitor is not capable of this type of operation.

RADIOACTIVE RESIDUE FIXATION

Mineral Reactions

Heat treatment of clinoptilolite at 400 C for two hours significantly improves the cesium adsorption selectivity of the mineral. Laboratory columns of treated mineral receiving a solution of 1.0 M sodium nitrate traced with Cs-137 had about twice the cesium adsorption capacity as did similar columns of untreated zeolite. However, upon elution with 5 M ammonium nitrate solution, these columns gave nearly identical fractional elution curves. The elution results thus do not reveal a fundamental change in the clinoptilolite adsorption sites upon heating.

Laboratory studies of cesium adsorption by sulfonated phenolic resin from neutralized Purex 1WW waste revealed a marked effect of system temperature. The solution used simulated neutralized 1WW waste diluted to double the volume and with the pH adjusted to 11.5. Columns operated at 20 C had about three times the cesium capacity of similar ones operated at 80 C. The breakthrough curves are considerably steeper at the higher temperature. The relatively greater competition afforded by partially dehydrated sodium ions at the higher temperature is probably responsible for these results.

Sulfonated phenolic resin (Duolite C-3) was found to have a relatively low adsorption capacity for strontium from neutralized Purex 1WW waste solution. In laboratory experiments, 50 percent breakthrough was attained in only three column volumes. This is in marked contrast to the nearly 150 column volumes required to give a 50 percent breakthrough of cesium. The resin would probably be ineffective for removing radioactive constituents from high-salt wastes with the possible exception of supernatant solutions from which nearly all radiostrontium was precipitated.

The effectiveness of 5 M ammonium acetate solution for eluting cesium from clinoptilolite was determined. Ammonium acetate would be a particularly useful eluting agent because it could later be removed from the cesium solution by volatilization. As was anticipated, ammonium acetate is much less effective than ammonium nitrate solution for eluting cesium. In addition, less separation of the sodium and cesium elution curves was obtained, about 7 column volumes being required to elute 50 percent of the sodium and 12 column volumes being required to elute 50 percent of the cesium.

Condensate Wastes

The 271-CR experimental steam stripper which has operated for more than 1200 hours continues to remove 97 percent of the ammonia and organic impurities from Purex Tank Farm radioactive condensate waste. When the steam stripper overheads are condensed, two phases are collected. The concentrations of various isotopes present in the organic and aqueous phases are indicated below:

Radioisotope	Concentration in Aqueous Phase, uc/ml	Concentration in Organic Phase, uc/ml
I-131	5.9×10^{-6}	2.7×10^{-3}
Ru-106	5.6×10^{-6}	3.4×10^{-4}
ZrNb-95	9.4×10^{-7}	Not detected
Cs-137	Not detected	Not detected

Because Cs-137 is not detected in the overheads even though it is present in the feed in concentrations greater than any other isotope, entrainment can be considered a minor mechanism by which activity appears in the overheads.

Micro Pilot Plant Run 16 was terminated after the passage of about 3000 liters of waste through Amberlite-IR 120 originally in the hydrogen form. The resin was then regenerated with six column volumes (1500 ml) of 4 N nitric acid. MPP Run 17 was started using this regenerated resin.

Breakthrough for Run 16 occurred after passage of about 5000 column volumes, although during Run 17 this did not occur until after passage of about 7400 column volumes. The capacity of the resin for over-all activity removal appears to be a function of the ammonia content of the feed. The lower capacity experienced during Run 16 is a result of slightly higher ammonia concentrations at the beginning of the run due to a startup fluctuation of the steam stripper. The resin continues to remove strontium isotopes to below their MPC_w for at least 12,000 column volumes even though the other isotopes present have broken through.

Fission Product Glasses

Two promising new cesium glasses were prepared during the month, each containing about 50 w/o cesium. One was a cesium-zirconium-aluminum-phosphate and the other a cesium-lanthanum-aluminum-phosphate. Both gave solubilities of about 0.6 w/o in a standardized four hour test in boiling water, a solubility much lower than previous phosphate glasses containing this much cesium. Pour temperatures were 1400 C and 1375 C and cesium contents 1.29 g/cc and 1.47 g/cc for the zirconium and lanthanum glasses, respectively.

Efforts to prepare cesium silicate glasses resulted in excessive volatilization of cesium, a difficulty which was not experienced with the phosphate systems. The formation of a cesium zeolite followed by heating of this material may avoid cesium loss and is being investigated.

Ruthenium Tetroxide Studies

The vapor pressure of RuO_4 over 6 M H_2SO_4, as a function of RuO_4 concentration, was measured during the month. The behavior was found to be ideal up to 0.2 M and to deviate only slightly from ideality at higher concentrations.

In-Cell Spray Calciner

It was found that use of co-axial cable will make possible induction heating of the in-cell pot calciner (which also serves as melt pot for the spray calciner). An existing 15 KVA TOCCO motor-generator unit will be used as source of power.

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BIOLOGY AND MEDICINE - 06 PROGRAM

TERRESTRIAL ECOLOGY - EARTH SCIENCES

Geology and Hydrology

Repeated measurement of the temperature profile in certain project wells shows small consistent increases in the temperature throughout the well. The maximum rate of change is about 0.5 C every six days. The temperature change is ascribed to the influence of recharged Columbia River water. During this season the river temperature increases approximately 1.0 C every six days. The vertical temperature profile in Hanford wells reflects a normal geothermal gradient in most of those examined. However, in a series of wells along a line extending nearly seven miles southeastward from 200 East Area, a break was detected in the slope of the measured geothermal gradient. This result is tentatively ascribed to thermally hot plant effluents moving in the ground water. The phenomenon reflects the sensitivity of temperature measurements for detecting such movement.

Soil Chemistry and Geochemistry

Research continued in the evaluation of strontium adsorption by natural and synthetic zeolites. The immediate goal is to establish the differences in the adsorption selectivity for strontium of various zeolitic materials. The research design results in a linear regression equation involving the system variables having the greatest influence on strontium uptake within the range of conditions studied. This equation may be used to select the optimum adsorber of those studied for a given application.

The regression equation obtained to fit C/Co values at a given volume throughput for column experiments was only partially successful. It appeared that the variables might not all be linear with C/Co. To study this effect complete breakthrough curves were obtained for several points in the experimental design. These data revealed that the column residence time variable is probably non-linear with C/Co at a fixed column throughput. From experimental data obtained for pelletized Linde 4A zeolite, the 50 percent breakthrough capacity was found to be linearly related to the other independent variables studied and independent of column residence time. It is thus possible to develop a regression equation for 50 percent breakthrough capacity that would give a better fit to experimental results and a more reliable prediction of strontium adsorption than was obtained with the regression equation for C/Co.

Breakthrough data from laboratory soil columns of different lengths were analyzed with the Glueckauf formula for adsorption column calculations. The calculated H.E.T.P. for these columns was again found to change with column length, as was previously found in attempting to apply the Mayor and Tompkins formula and the Hiester and Vermeulen equations. These formulas are all derived with the assumption that the effect of longitudinal dispersion on the breakthrough curves is negligible, which is apparently not valid for the case of soil columns. One set of data which could be corrected for the effects of longitudinal dispersion resulted in nearly constant values of H.E.T.P. after this adjustment, but more information will be needed to confirm the effectiveness of the correction.

Field Apparatus Development

Initial field tests were conducted with the formation testing well packer recently received. The packer and associated equipment functioned properly with the exception

that pins designed to shear at stated pressures above the sealing element pressure did not shear at the proper pressure. On shearing, these pins open a channel to above and below the packing elements, while the elements remain sealed to the well wall. Selection of proper diameter pins corrected this difficulty.

A portable rotary drill, recently received, was given preliminary field tests at the Gable Mountain site. The equipment should prove valuable for placing small diameter test holes to a considerable depth depending upon the formation. With the combinations of tungsten carbide and diamond bits available, the initial tests gave encouragement that depths to about 50 feet could be drilled almost anywhere on the project. The performance will be established in greater detail.

The all-electric-control modification of the vertical well current meter neared completion. With the modified design the meter can be located and sealed into the well for a measurement entirely by electrical controls. A miniature liquid pump replaces the compressed air inflation of the packing element. The success of the present model should permit rapid and reliable measurements of vertical well currents.

ATMOSPHERIC RADIOACTIVITY AND FALLOUT

Radioisotopes as Particles and Volatiles

A particle generator of the vapor condensation type was designed and fabricated preparatory to measurements of particle deposition velocities in larger and smaller diameter tubes than those previously used. Tubes made up into 60-foot lengths and supported vertically were readied for these experiments.

An expression was derived from theoretical considerations for the deposition of particles from a turbulent stream due to a thermal gradient. The expression is:

$$C = C_o \exp\left[-\alpha\beta\left(\frac{To-Tw}{T}\right)\left(e^{ax}-1\right)\right]$$

C = The particle concentration in the stream at a distance, x, downstream from the initial point.

C_o = The initial point particle concentration

α = A dimensionless parameter, $\frac{3\ Pr\ Re}{2\ Nu}$

Pr = Prandtl number
Nu = Nusselt number
Re - Reynold's number

β = A constant = $\frac{Kg\ Km}{2Kg + Kp}$, in which

Kg = Thermal conductivity of the gas
Km = Cunningham correction for Stoke's Law
Kp = Thermal conductivity of particles

To = Absolute inlet temperature of gas

Tw = Absolute wall temperature of the pipe

T = Average absolute temperature of the gas

$a = -\frac{h\pi D}{v\,Cp}$, in which

h = Inside film heat transfer coefficient
D = Pipe diameter
Cp = Heat capacity of gas
v = Mass velocity

The significance of thermal deposition as predicted by this equation in practical application has not been investigated. For larger particles, turbulent deposition will in all likelihood exceed deposition due to thermal effects.

W. H. Reas

Manager
Chemical Research and Development

WH Reas:cf

BIOLOGY LABORATORY

A. ORGANIZATION AND PERSONNEL

R. F. Keough joined the Biological Analyses Operation, coming to us from the University of Idaho.

John F. Cline rejoined the Plant Nutrition and Microbiology Operation following a one-year leave of absence while on assignment with the IAEA in Tunisia.

John E. Stewart terminated from the Plant Nutrition and Microbiology Operation to return to school at UCLA to pursue graduate work.

Dr. Frank Mraz, an exchange scientist from Oak Ridge - UT-AEC Agricultural Research Project, was assigned to the Metabolism Operation on June 1, 1961.

Dr. Ida Mecum joined Biology as a summer employee. She will again teach Biology at Columbia High School in Richland this fall.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 02 PROGRAM

Effect of Reactor Effluent on Aquatic Organisms

Installation of the hydraulic test flume has been completed sufficiently so that preliminary flow calibration has been initiated. Velocity estimates are lower than designed for, for reasons which are not yet determined.

C. columnaris

Although no samples of fish taken from the Columbia River have shown the presence of columnaris, extensive deaths have been noted in the troughs in the Aquatic Biology laboratory. Our first identification of columnaris in the Yakima River was made this month on a chisel-mouth which was obviously infected at the time it was taken and produced numerous colonies from both internal and external samplings.

To study the effect of fish crowding on the incidence of columnaris, four troughs were set up with the following initial fish populations: 50, 150, 450 and 900. These troughs are all receiving regular Columbia River water and infection arises from columnaris endemic to the river. Per cent mortalities arising from columnaris to date are: 50-0, 150-0, 450-2.2 and 900-3.4. The more crowded lots are suffering the greatest and only mortalities. The extrapolation of problems which occur in hatcheries, under crowded conditions, to conditions in the river is clearly a very questionable procedure.

The ability of various strains of columnaris to hydrolyze protein was tested by measuring the size of clear zones in agar plates containing gelatin. The clear zones were largest around colonies of virulent strains of columnaris and smallest around colonies of the non-virulent strains. This suggests that the ability to attack fish is related to the activity of the protease enzymes in these organisms. If this observation can be substantiated, it should make it possible to more easily identify virulent strains of this organism.

Population Dynamics

Two hundred ninety-six ring-billed and California gulls were banded at two major colonies within the Hanford Reservation. This number is approximately one-fourth the total produced during the current season following a disastrous loss of nests, eggs and young by unusually high water levels. Greatest loss occurred among ring-billed gulls and is reflected in the ratio of new bands placed on this species (50 per cent) in comparison to former years (75-90 per cent).

BIOLOGY AND MEDICINE - 06 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Arsenic-74

The uptake of arsenic (as arsenate) was studied by the Neubauer technique, the same method previously used to obtain a relative uptake of a wide variety of fission products by barley plants. The As^{74} was taken into the plants to approximately the same extent as previously found for Sr^{90}. That is, for our local Ephrata sandy soil, the concentration in the dry plant material was from two to four times the concentration in the dry soil.

Uptake from Millville soil was slightly less than from Ephrata soil. In Cinebar soil plants took up less than a tenth as much As^{74} as in either the Millville or Ephrata soils. Addition of phosphate to the soil increased the uptake of As^{74} from the Millville and Ephrata soils but had no affect on uptake from Cinebar soils. These results correlate with the native contents of phosphorus in these three soils; Cinebar soil containing more than a hundred times more phosphorus than Ephrata soil and about 10 times more phosphorus than Millville soil. The effect of added phosphorus, on this interpretation, is anomolous. The organic matter content of the soils, which is highest in the Cinebar soil, intermediate in Millville, and lowest in Ephrata soil, may also be an important factor.

Strontium-Calcium

Blood analyses were made on the surviving trout from the chronic Sr^{90}-Y^{90} feeding experiment of a year ago. No abnormal values for erythrocytes, leukocytes, hemoglobin, or packed-cell volume were found for three medium-level (fed 0.05 μc/g fish/day for 21 weeks) and three low-level (fed 0.005 μc/g fish/day for 21 weeks) fish sampled.

Strontium and calcium were shown to move in the phloem tissue of bean stems by placing a plastic divider between the outer phloem layer and the remainder of the stem. Movement in an upward direction was more rapid than in the downward direction although in both cases the rate was very slow, less than 1 cm per day. During the experiment upward movement in the xylem proceeded at a normal rate of several centimeters per hour.

The previous observation that leaves took up more strontium than calcium during the initial hour of uptake of labeled cations was repeated. However, it also appeared that lateral translocation from the xylem to the phloem tissues favored movement of strontium over calcium. Thus the hypothesis that calcium exchanged from the xylem during assent of the ions does not appear adequate to explain the early appearance of more strontium than calcium in leaves.

Comparative Toxicity of Strontium, Plutonium and Radium

Four animals were sacrificed 18 months post treatment with special emphasis given to collection of specimens that will assist in evaluating early damage. The only gross lesion noted was a severe chronic nephrosclerosis in the animal which had received 6.4 μc Ra^{226}/kg body weight 18 months previously when six months of age. This lesion may not be related to the radium administration.

Examination of radiographs of the disarticulated skeleton showed increased density in the rib in the area where the epiphysis would have been at time of injection. Some of these areas also showed rarefaction.

Iodine

The peak I^{131} content of whole blood and blood plasma in the ewes given 5 μc/day occurred three to six hours after radioiodine feeding. Peak milk concentrations, however, were not attained until six to nine hours post feeding. The ratio of the radioiodine concentrations of whole milk to blood plasma ranged from 15 to 25 during a 24-hour period.

Plutonium

Excretion of plutonium into the intestinal tract following DTPA treatment was studied by in situ perfusion of sections of the intestine of rats injected 60 days previously with plutonium. Results from three rats indicate comparable rates of excretion into the duodenum and jejunum. Excretion into the ileum was a factor of at least ten lower. These results indicate that the enhanced fecal excretion resulting from DTPA treatment can be due only in part to biliary excretion.

DTPA alone and DTPA combined with AECATA (2-(B-aminoethoxy) cyclohexylamine-N, N, N', N'-tetraacetic acid) were administered orally to rats one hour after intravenous injection of plutonium citrate. Treatment with the combined chelates was less effective than an equimolar amount of DTPA alone. Both treatments, however, were quite effective considering that the material was administered orally. Twelve per cent of the plutonium remained in the rat after DTPA treatment and eighteen per cent after treatment with the combined agents.

External monitoring of sites injected with 5 uc of $Pu^{239}(NO_3)_4$ ten months ago revealed 3 to 4 per cent of the estimated injected dose remained in sites where the scab was removed surgically as compared to 30 to 40 per cent in sites with intact scabs.

Fifty-six intradermal injections of $Pu^{239}(NO_3)_4$ in doses varying from 0.0016 to 5 μc per site were made in two miniature pigs. Control sites, 0.0016 μc, 0.008 μc, and 0.04 μc sites show no visible lesions at 14 days post injection while the three higher level sites (0.2, 1.0 and 5.0 μc) show reactions varying from pinpoint red areas at the 0.2 μc level to swollen, erythematous areas up to 3 cm in diameter at the 5 μc sites. The center of the swollen areas at the 5 μc sites have an ulcerated area approximately 1/2 to 1 cm long and 1/4 to 1/2 cm wide.

Transfer of Radionuclides to Milk

Preliminary radioanalysis data indicates that the transfer of intravenously administered $Pu^{239}NO_3$ from plasma to milk is extremely low. Maximum concentrations are noted in the milk seven hours post injection at which time the milk concentration was approximately 10 per cent of the concentration in plasma at that time, and approximately 5 per cent of the average plasma concentration during the first seven hours post injection.

The highest concentrations of intravenously injected Ce^{144} in milk were found seven hours post injection when the milk concentration was approximately six times the plasma concentration. The concentration of cerium in the milk at seven hours was just slightly greater than the average plasma concentration during the first seven hours post injection.

Radioactive Particles

A study of the effects of low doses of inhaled $Pu^{239}O_2$ on life span of the mouse is nearing completion. A number of mice survived more than two years after pulmonary deposition of 1×10^{-3} μc Pu^{239}.

Preliminary results of further experiments on the retention of inhaled plutonium in dogs were obtained. These are summarized in Table 1 for one dog exposed to plutonium dioxide and one dog exposed to plutonium nitrate aerosols. Both animals were sacrificed 30 days after exposure. The high pulmonary retention, accumulation in lymph nodes and very low urinary excretion observed after inhalation of plutonium nitrate was not expected for a relatively soluble plutonium compound as compared with the dioxide. The retention of the plutonium dioxide is much less than that seen in dogs after inhalation of PuO_2 aerosols with mass medium diameters of 1 μ or larger.

Plant Ecology

The annual production of palatable forage provided by cheat grass on an abandoned field near Hanford was estimated on May 15, 1961. Old grass growth from previous growing seasons was removed by burning or clipping in the fall of 1960 so that the harvested grass weights represent current year's growth only. Six plots, each two m^2, were harvested from each treatment. Average oven dry (60-65 C) weights from burned treatments showed a yield of 204.5 grams ± 22.2 while the yield of clipped plots yielded 205.6 grams ± 21.6. Sixty-four per cent of the fresh weight of the grass was lost by oven drying.

Project Chariot

Collections of aquatic and terrestrial invertebrates were made at Cape Thompson for population analyses and for comparisons of abundance during previous years. Samples of bone, antler and flesh from caribou collected during 1960 were analyzed for Sr^{90}. Bone averaged 9.6 pc/g, wet weight; antlers averaged 8.5 pc/g wet weight and all muscle samples were < 0.15 pc/g wet weight.

Development of Blond Miniature Swine

Five blond breeding sows farrowed the past month giving birth to 28 pigs of which 20 were white or blond. Ten white and five blond are still alive. The baby pigs are 13/16, 14/16, 15/16, or purebred and the majority of them are expected to breed true to color. A name will be selected for these blond miniatures in August. (One name suggested is Hanford Miniature Swine.)

R. C. Thompson

Acting Manager
BIOLOGY OPERATION

RC Thompson:es

C. Lectures

a. Papers Presented at Meetings

L. K. Bustad, "Toxicity of plutonium," Life Sciences Working Group Meeting, Richland, Washington, July 26, 1961.

W. J. Bair, "Plutonium inhalation studies - retention, translocation, and biological effects," Life Sciences Working Group Meeting, Richland, Washington, July 26, 1961.

R. C. Thompson, "Metabolism and removal of ingested and injected plutonium," Life Sciences Working Group Meeting, Richland, Washington, July 26, 1961.

b. Seminars (Off-Site and Local)

L. K. Bustad, "Biological effects of I^{131}," AEC Health Physics Fellowship Program, 300 Area - July 10, 1961.
J. R. McKenney, "Gonad dose from gamma emitting radionuclides," AEC Health Physics Fellowship Program, 300 Area - July 10, 1961.
W. H. Rickard, "Fallout and Environmental Problems," AEC Health Physics Fellowship Program, 300 Area - July 17, 1961.
R. O. McClellan, "Radiobiology of bone-seeking radioisotopes," AEC Health Physics Fellowship Program, 300 Area - July 24, 1961.
E. M. Uyeki, "Modification of radiation injury," AEC Health Physics Fellowship Program, 300 Area - July 31, 1961.
F. P. Hungate, "Cellular, biochemical and genetic effects of radiation," University of Washington - Radiation Biology Summer Institute, Seattle, Wash., July 12-14, 1961.
S. Marks, "Pathological effects of radiation," Radiation Biology Summer Institute, University of Washington, Seattle, Wash., July 19, 1961.
L. K. Bustad, "Physiological response to radiation," Radiation Biology Summer Institute, University of Washington, Seattle, Wash., July 20, 1961.
L. K. Bustad, "Radiation Carcinogenesis and Life Shortening," Radiation Biology Summer Institute, University of Washington, Seattle, Wash., July 21, 1961.
D. A. Barber, "Calcium-strontium uptake in plants," Department of Botany, University of Washington, Seattle, Wash., July 28, 1961.
L. A. George, "Mechanisms of radiation damage to the cell," Radiation Biology Summer Institute, University of Washington, Seattle, Wash., July 12, 1961.
L. A. George, "Mechanisms of radiation protection," Radiation Biology Summer Institute, University of Washington, Seattle, Wash., July 13, 1961.

c. Seminars (Biology) - none
d. Miscellaneous lectures - none

D. Publications

a. HW Documents

Staff of the Biology Laboratory, "Hanford Biology Research Annual Report for 1960," Document HW-69500, January 10, 1961 (issued in July).

b. Open Literature

Willard, D. H. and W. J. Bair, "Behavior of I^{131} following its inhalation as a vapor and as a particle," Acta Radiologica 55, 486 (1961).

OPERATIONS RESEARCH AND SYNTHESIS OPERATION
MONTHLY REPORT - JULY, 1961

ORGANIZATION AND PERSONNEL

Miss Joanne K. Fremstad joined the Organization on July 5, 1961, as a Junior Scientist working in the Stochastic Processes and Reliability Studies Function.

Mrs. Doris H. Larson was named Secretary to the Manager, Operations Research and Synthesis, effective July 10, 1961.

OPERATIONS RESEARCH ACTIVITIES

Input - Output Model

The first draft of a report summarizing past findings is being typed. In preparing this report, several learning curves were found to describe the HAPO process. While these were satisfactory in describing existing data, there is some question as to their dependence on the chronology of adding new facilities. This possible dependence is being studied further.

HAPO Criteria Study

The third draft of the report is nearly typed. Based on solicited comments, modifications were made in the discussion of net return and a few revisions were made.

OPERATIONS ANALYSIS STUDIES

Fuel Element Performance

Continuing study of the use of polynomials to describe irradiation induced fuel element distortion has shown that this method has several advantages over the method traditionally used. It permits classification of distortion into one of twenty-four different types, which should give added insight into the nature of uranium instability, and provides an objective means of detecting those fuel elements with unusual distortion and those which were probably measured with gross error. Also, it eliminates the bias that exists in the current calculation of diameter change at the fuel element center. A document is being prepared presenting these results.

Using the empirical models based on Quality Certification Data, predictions were made of the diameter growth and warp expected under a specific set of reactor conditions. These conditions apply to the proposed irradiation of about 100 tubes of nickel-plated fuel elements and

were performed in order to assess the risks, such as increased tube corrosion, involved in irradiating this number of tubes to high exposure.

Preliminary analyses have been made of sources of variation in UT-2 readings, which measure grain size in the uranium core. Results will be used in proposing an acceptance sampling plan for ingots to be administered at the feed sites.

It was proposed that a production test be run to evaluate N-quality cores (having different chemical specifications from existing cores) used for NPR fuel elements. These are to be cast as eleven-inch ingots and extruded to seven-inch bars prior to rolling. Seven alternate experimental designs of different size and having different characteristics were proposed for consideration, one of which has been tentatively selected.

A method of estimating the slope parameter in the rupture model has been developed using information only from lots which sustained ruptures. This was done under a generalized rupture model which permits each lot to have a different location (or intercept) parameter. Confidence limits were also found.

Optimization of Reactor Operations

Further consultation was provided in connection with the evaluation of decision rules specifying the action to be taken when a situation which could result in a single tube melt-down is noted in a reactor front face component. Consideration was also given to the problem of determining whether or not partially worn-out components should be replaced completely, or as the need arises on an individual basis.

Information Systems Studies

Additional difficulties encountered during debug trials in the Z-Plant Information Study have been traced to faulty circuitry in the input - output typewriter. Although these, and other faulty circuit panels located during the month, have further delayed the computer operational date, the delay has important side benefits with respect to permitting additional training of the working team members. Trainees have access to the console without risking stored programs.

A tentative list has been made of six study team members for the Redox Systems Study. The study will begin as soon as the Z-Plant and FPD work load permit.

The initial FPD Systems Study Team Meeting is scheduled for August 2, 1961, at which time, the real time and historical data processing system will be delineated. This is to be followed by a description of the approach and techniques used in the Z-Plant Study with appropriate corresponding recommendations and suggestions for the FPD Study.

Reliability Studies

Boolean matrices have proved to be a useful tool in analyzing systems for reliability. Several examples of the application of this technique have been worked out, including a practical demonstration of reliability analysis as applied to a standby electrical power system. The calculations are straightforward and not laborious for small systems, but for larger systems the use of a digital computer seems desirable.

Work was begun on providing an analysis of data on acceptance testing of new, flareless type tube fittings for NPR.

Further work was done on the problem of designing a Panellit gauge switch test program.

Diffusion Studies

An IBM 7090 Program designed to obtain numerical solutions to transient state nonlinear diffusion problems has been written and is in the process of being tested. The program has thus far been restricted to one space dimension slab geometry with fairly simple boundary conditions. Preliminary runs on test cases indicate that the method converges fairly rapidly and apparently possesses excellent stability characteristics. It is planned to extend the program to more space dimensions as well as to a cylindrical geometry.

Inventory Studies

A letter prepared by Inventory Accounting requesting AEC approval for continuance of the sampling procedures now in existence was reviewed. In addition, a letter has been drafted to Accounting Services requesting information on Company practice in some of the areas associated with the sampling procedure.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Fuels Preparation Department

Data were analyzed from a pilot plant test designed to evaluate various deoxidizing solutions used in the cleaning of aluminum components.

Tables and graphs for establishing ninety-five percent confidence limits on the mean, based on a sample mean and range for sample sizes from two to one hundred, were prepared for use in describing certain preirradiation characteristics of production fuel elements.

Irradiation Processing Department

A sampling plan was developed for use in determining which vertical control rod channels in a reactor should be inspected when the object

of the sample is to get the best over-all estimate of the number of cracked blocks. The principle of stratification was employed.

Assistance was given in evaluating a proposed continuous sampling plan for Panellit gauges.

Chemical Processing Department

Consultation was provided in connection with the estimation of variance components in measured dimensions of the final product.

The mathematical theory of and an IBM 7090 program for the computation of gauging data for Gorton lathe x-y templates was completed. Complete gauging data for both interior and exterior contour templates of certain components were computed.

A complete mathematical analysis of the problem of positioning and speed control for the Gorton lathe was completed. The analysis provides a method of interrelating and coordinating the four independent controlling variables of the lathe, ram displacement, table rotation, spindle speed, and feed rate, so as to achieve the correct geometrical shape with the desired surface finish. A method of computing these data and arranging them on magnetic tape suitable for automatic control has been suggested and is presently being studied.

Work continued on the problem of constructing a queueing theory model of motor vehicle usage in the 200 Areas.

Relations Operation

Additional salary curves were fitted as requested. This service is now handled routinely.

STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program

Pulse Column Test Facility

The second set of mid-column photometer calibration data was used to construct a calibration function which relates photometer voltage to uranium concentration in the aqueous phase. This calibration function, which takes account of the significant exponential damping for high uranium concentrations, is a much better explanation of the data than the previous fitted linear function.

4000 Program

Plutonium Recycle

Further discussions were held to firm up the design of the ID fluorescent penetrant nondestructive tests experiment to be run in the near future.

More statistical analysis is being done on the CD test data in hopes of obtaining an improved correlation with the fluorescent bath preparation variables.

Further work was done on a computer program which fits a quadratic response surface when the factor levels of the independent variables are nonorthogonal, estimates the stationary point of the surface, and calculates the confidence region for the position of the "true" stationary point. This program was written in connection with the evaluation of high energy uranium oxide impacting data.

Work continued on the mathematical theory of the neutron flux vector, and on the particle packing problem.

Aluminum Corrosion

Further discussions were held concerning the interpretation of a statistical analysis of data from an M-400 and X-8001 alloy experiment to investigate the effect of heat treating variables on corrosion rate. An experiment was designed to check the first stage parabolic corrosion assumption which was used in the analysis of the experimental data.

Nondestructive Testing

Off-site reference material is being examined to determine its applicability to the broad band electromagnetic testing program.

6000 Program

Biology

A presentation was made to personnel of the Biology Operation - the purpose being to: (1) discuss results of applications of the multicompartment migration model to the data from two animal experiments conducted by the Biology Operation; (2) explore the feasibility of conducting future uptake and retention experiments with the explicit view of analyzing the data by means of the multicompartment model.

Work was begun on the statistical analysis of sampling data on the radio-isotopic content of milk from several milk sampling stations located in various parts of the United States.

Work continued on the problem of constructing a mathematical model of the response of Tribolium confusum (the confused flour beetle), and Tribolium castaneum to low level irradiation.

Geochemical Research

A closed form solution was obtained to a partial differential equation model for the spatial and time behavior of the concentration of solute moving through a long column of absorbing plates.

General

Instrumentation

Statistical analysis of data from a reference system calibration study was completed. Calibration curves with their appropriate confidence intervals were determined for the reference system on three different scales. In connection with the same program, the calibration of the Schaevitz system was initiated. This system includes an electronic recorder and indicator in addition to the other instruments for sensing the distance traversed by a linear variable differential transducer.

Radiation Protection

Data have been assembled concerning the correlation of badge and pencil readings. These data, representing about one year's readings on one hundred different people, are presently being key-punched onto cards. A method to screen out defective pencil data during the subsequent analysis has been devised.

Some additional work was done in determining a proper calibration curve for badges. This has been extended to unshielded gamma readings. A reasonable curve for shielded gamma using all thirteen dose readings in the range 15 mr - 5000 mr can be presented using the equation previously studied.

A sampling plan used to test for significant amounts of Pr^{147} in urine samples was evaluated. Information was also provided on the philosophy and techniques of hypothesis testing using counted data, and a pertinent bibliography was included.

Spectrographic Analysis

Closed form solutions were obtained to a simultaneous set of twelve non-linear algebraic equations which arose in connection with the interpretation of data and the identification of elements from spectrographic analysis.

Safety

A discussion was held with FPD and HLO safety representatives to consider the question of evaluating HAPO minor injury records.

Division of Research Programs

A subcommittee meeting was held at Hanford during July, which was attended by several off-site representatives. Initial processing of the IRA master file has begun. BIMD statistical routines are being used to screen the file for gross input errors. Several statistical techniques are being considered for the reduction of multichannel energy spectrum data.

Methods Development

A bibliography of statistical techniques for the reduction of composite distributions is being compiled. These techniques are applicable to the problem of unfolding multicomponent spectra into their component parts, an important problem in many areas of research.

J. L. Jaech
for Carl A. Bennett, Manager
Operations Research and Synthesis

JL Jaech:dgl

PROGRAMMING OPERATION
JULY, 1961

I. REACTOR DEVELOPMENT - 04 PROGRAM

A. PLUTONIUM RECYCLE PROGRAM

By special AEC request, effort was redirected so that a representative group of plutonium and U-233 fuel values in thermal reactors can be compiled and transmitted by August 11, 1961. The inflection of several programs was altered, work on many fronts was temporarily suspended and computation efforts were greatly accelerated to fill this request. The fuel geometry study was altered to supply comparative results of U-233, U-235 and plutonium enrichment of U-238 and of thorium. This study is arranged to embrace essentially all thermal reactor designs. To supply data on specific reactor types, plutonium (and hopefully U-233) recycle will be examined in detail in generalized versions of APWR, BWR, OMR, and D_2O machines. A gas-cooled reactor case may be run. Also to be included, will be results of other studies such as the detailed analysis of plutonium fueling of the APWR (a reactor described in TID-8502) and the Russian superheat reactor located at Beloyarsk, Russia. Some normalization of these data is necessary by virtue of recent alterations to the uranium pricing system. The foregoing plans account for the emphasis of efforts to be described.

1. Computer Code Development

Specialized versions of the QUICK fuel cost code were formulated and debugged so as to include the U-233-thorium, plutonium-thorium, and U-233-U-238 cycles in addition to the U-235-U-238 and Pu-U-238 cycles. The PROTEUS code, which generalizes MELEAGER data, was similarly extended. In addition, a special hunting code was formulated, programmed, and debugged so that data can be selected from any spot on a "packed" tape for processing. "Packed" tapes are necessary to keep data storage costs at a reasonable figure. At one time, before tape packing, 200 IBM tape reels were temporarily "tied up" with only part of the combined fuel cycle study.

A chained program was written and partially debugged coupling the MELEAGER reactor physics code, the QUICK fuel cost code, and the Fuel Cost Minimizer code so that successive plutonium recycle can be studied automatically. After a given number of minimized fuel cycles the chain then evaluates the plutonium values with the PUVE code and prints out all of the data. The investigator can then compare the plutonium values from PUVE with the estimated values inserted in the code to permit computation of the fuel costs. The estimates can then be improved as necessary and reinserted in the code for another run as many times as necessary to achieve a desired accuracy for the plutonium values.

Following is a summary of the status of several alterations made to the PUCK program, which computes plutonium values for equilibrium and near equilibrium cases:

a. Curve-fitting subroutines were greatly improved by Electronic Data Processing personnel, and PUCK output now shows polyfit minimum fuel costs within 0.001 mills/kwh of the actual data points.

b. A memory overlap has been corrected by Electronic Data Processing personnel. The overlap occurred when the data input consisted of more than one case. Consecutive cases are now run satisfactorily.

c. AEC price schedule and plutonium values were changed in PUCK to agree with those used in QUICK. Cost of fabricating plutonium buttons was eliminated at AEC's request.

d. PUCK output is still unsatisfactory when the Pu-242 concentration is set equal to Pu-241 concentration which simulates the plutonium composition resulting after about 20 years of plutonium recycle in current power reactor types. For reasons unknown, as yet, setting this condition on the plutonium recycle physics "bugs" the non-plutonium recycle physics sections. Such anomalies often are extremely difficult to correct in complicated computer codes such as PUCK.

2. Rigorous Fuel Cycle Cost Code

The Fuel Element Fabrication portion of the fuel cost code functions satisfactorily and can be currently used. There are, however, about five known changes which should be made in the program in order to simplify input and to provide needed flexibility. Additional experience with the code undoubtedly will indicate other areas for improvement and

suggest simplified input routines. Because of the urgency of other activities, the Fuel Element Fabrication and Jacketing (FEFJ) cost demonstration to date has been limited to three fairly complete test cases and extensive variation of the recycle rate. Results in all instances have been about as expected.

On the Nuclear Process Costs (NPC) (i.e., the reactor burn-out costs) portion of the code, several program stoppages, incompatibilities with physics data, and limitations of input have been satisfactorily resolved. A series of variations (37 total) have been run of one test case to determine whether machine selection of alternatives would be made properly. Although these results have not been completely analyzed, no important flaws have been detected to date in the mathematical model.

The Pre-reactor Inventory-Batch phase of the computer code has been satisfactorily completed; however, the startup and close-down amortization phase for graded cycles has not been programmed.

3. Phoenix Fuel

Analysis of nearly 100 computer runs is under way with the view of generalizing criteria for Phoenix fuel action with proper ratios of effective reactor cross sections and other pertinent parameters. By so doing, it is planned that the promise of Phoenix fuel performance in all types of reactors can be readily ascertained.

4. Plutonium Recycle

Efforts are under way to reconcile plutonium recycle data from equilibrium cycles with data from non-equilibrium cycles. The latter data are more accurate but far more costly to obtain as detailed successive recycling is necessary. Furthermore, if any one of many key parameters is altered, all previous work must be redone. For survey work, as many as 40 key parameters are altered which is economically impossible with non-equilibrium cycles. On the other hand, such variations can easily be done with equilibrium cycle analysis. The relative degree of success that will be achieved in such reconciliation cannot be estimated at this time.

B. SPECIFIC FUEL CYCLE ANALYSIS

1. Combined Fuel Cycles

The purpose of the study was to determine the effect of varying reactor geometry and fissile-fertile fuel compositions under optimized conditions. Physics data obtained from MELEAGER are presently being used to obtain economic results with the computer code QUICK. The study was divided into ten series of cases, each series denoting a particular type of fuel composition. For each fuel composition series, from 144 to 272 individual cases were studied with different geometric parameters for each case in a series. The serial numbers and fuel types studied were:

1000-Series - U-235 in Natural Uranium

2000-Series - U-233 in Natural Uranium

3000-Series - Plutonium in Depleted Uranium (Plutonium Composition 70%-239,18%-240, 11%-241, and 1%-242.)

4000-Series - Plutonium in Depleted Uranium (Plutonium Composition 95%-239, 5%-240)

5000-Series - Plutonium Depleted Uranium (Plutonium Composition 31.3%-239, 33.6%-240, 25.0%-241, and 10.1%-242.)

6000-Series - U-235 in Thorium-232

7000-Series - U-233 in Thorium-232

8000-Series - Plutonium in Thorium-232 (Plutonium Composition 70-18-11-1.)

9000-Series - Plutonium in Thorium-232 (Plutonium Composition 95-5.)

10000-Series - Plutonium in Thorium-232 (Plutonium Composition 31.3, 33.6, 25.0, 10.1.)

The geometric parameters chosen were: SNF, SCA, SDPV, and the multiplication factor defined as follows:

(a) SNF = Flux and volume weighted thermal neutron absorption cross section of the non-fuel materials of the cell

$$SNF = N \sigma_{anf} \frac{V_r}{V_{cell}} g$$

where $$g = \frac{\bar{\phi}_{region}}{\bar{\phi}_{cell}}$$

V = Volume

N = Number of atoms per cm^3

σ_a = Microscopic absorption cross section of non-fuel material

$\bar{\phi}$ = Neutron flux

(b) SNF then can be varied to account for different thermal utilization values

SCA = Scattering cross section of the fuel + geometric term

$$SCA = \Sigma'_s = \frac{S}{4V}$$

or for a round rod $\Sigma_s + \frac{1}{D}$

where

Σ_s = Macroscopic absorption cross section

D = Diameter of the fuel rod

(c) SDPV = The slowing down power flux and volume weighted

$$SDPV = \frac{(\xi \Sigma_s V \bar{\phi})_{mod}}{(V \bar{\phi})_{fuel}}$$

Scope of the Study

For each fuel type, the following method of analysis was adopted:

SNF's of 0.01, 0.05, and 0.09 were chosen.

For each SNF, two values of SCA were allowed; viz. 1.0 and 0.5.

Each of these combinations of SNF and SCA were then studied for four values of SDPV. The SDPV values were: 2, 4, 8, and 16.

For each combination of SNF, SCA, and SDPV, the computer code was allowed to search for the proper fuel combination to achieve six desired initial reactivities:

1.048	1.165
1.075	1.225
1.105	1.345

In sub-series where the density was varied eight initial reactivities were desired. They were the above six plus 1.405 and 1.465.

General Observations

As SCA increases, the exposure increases.

As SDPV increases exposure decreases.

As initial reactivity increases exposure increases rapidly.

Changing SDPV has relatively less effect if SCA is low.

As would be expected also, much greater enrichments were needed with an SNF of 0.05 as compared to 0.01.

(For a specific example in the 1000 series, twice as much U-235 enrichment was needed with an SNF of 0.05 as compared to 0.01 to obtain the same initial reactivity.)

As SDPV increased the Westcott spectral index, r, decreased rapidly.

As initial reactivity increased, r increased.

In general, r was low ($r < 0.1$) for SDPV's of four or more.

In each series doubling the enrichment gave 3 to 10 times the exposure. The 2000 series is an exception. The increase in exposure with added concentration was less pronounced in this series.

The data from this study are now being tabulated so that the relative productivity of the various combinations can be assessed. One measure being formulated for all of the cases is the enrichment level necessary to achieve a 15,000 MWD/Ton fuel exposure in a standard reactor. This figure is augmented by a production ratio which is the ratio of fissile fuel density out of the reactor over the fissile fuel density into the reactor at an exposure of 15,000 MWD/Ton. From these data, high and low productivity cases are selected for each fissile-fertile fuel combination. These cases are examined further with supplementary runs to determine more detailed fuel costs and fissile values. The detailed costs and fissile values can then be used to calibrate the more general figures computed for each combination.

2. Advanced Pressurized Water Reactor

The APWR results were summarized in tables and forwarded to Washington AEC. The computed plutonium values are consistently higher in this reactor than in other reactors studied to date. Perturbations of the primary reactor constants indicate that plutonium in this machine improves the thermal utilization and thereby has a high value; but more particularly, Phoenix fuel action is approached in this spectrum. The data were run with the economic parameters listed in Table I.

Plutonium values for case 14 (standard economics) operating in the mode yielding over-all lowest fuel costs are shown in Table II.

These values are high compared to other studies and are being checked further even though rechecking to date confirms these numbers.

TABLE I

ECONOMIC PARAMETERS FOR STANDARD APWR CASE

Economic Case No.	Economic Interest Rate	AEC Use Charge Rate	Separations Cost, $/lb Fuel	Thermal to Electrical Conver. Eff.	Fract. of 7-1-61 U Price Sched.	FEFJ For U Only	FEFJ Delta
1	0.125	0.0475		0.345	1.0	60.0	15.0
2	0.125	0		0.345	1.0	60.0	15.0
3	0	0		0.345	1.0	60.0	15.0
4	0	0.0475		0.345	1.0	60.0	15.0
5	0.125	0.0475		0.345	1.0	60.0	15.0
6	0.125	0.0475		0.250	1.0	60.0	15.0
7	0.125	0.0475		0.345	0.5	60.0	15.0
8	0.125	0.0475		0.345	2.0	60.0	15.0
9	0.125	0.0475		0.345	1.0	30.0	15.0
10	0.125	0.0475		0.345	1.0	90.0	0
11	0.125	0.0475		0.345	1.0	90.0	30.0
12	0.125	0.0475		0.345	1.0	90.0	60.0
13	0.125	0.0475		0.345	1.0	60.0	60.0
14*	0.125	0.0475		0.345	1.0	60.0	0
15	0.125	0.0475		0.345	1.0	0	60.0
16	0.125	0.0475		0.345	1.0	0	0

* Standard Economics Case

TABLE II

PRELIMINARY PLUTONIUM VALUES AS APWR FUEL

Plutonium Isotope Batch Composition Weight Percent				Fissile Plutonium Value as Plutonium Nitrate $/Gram
Pu-239	Pu-240	Pu-241	Pu-242	
70.86	18.35	9.06	1.73	
59.26	21.14	13.73	5.87	
53.90	20.88	15.05	10.17	
49.18	19.38	14.92	16.52	
47.05	18.39	14.42	20.14	

II. OTHER ACTIVITIES

1. Radioactive Heat Sources

The public statement indicating the scheduled use of thorium-232 in the fuel element assembly for the Dresden reactor (R. L. Crowther, Transactions of the American Nuclear Society, June, 1961, page 22) suggests extremely low irradiation costs for the production of protactinium-231 and eventually uranium-232 (the outstanding radioisotopic heat source) by use of thorium-232 containing a few percent of thorium-230. Such thorium compositions appear to be recoverable from certain uranium ore mill process streams. The intended segregation of thorium-bearing fuels at Dresden specifically for the recovery of valuable U-233 further support expectations for major economies in any such program directed toward protactinium-231 (U-232) production. Although the cross section of thorium-230 is about five times as great as that of thorium-232, the thorium-230 content of any recoverable thorium composition is not expected to exceed two to five percent. Direct substitution of such materials for relatively pure thorium-232 is not expected to present any significant problems.

2. Miscellaneous

C. A. Rohrmann presented a lecture on "Radioisotopic Power for Satellites and Space Vehicles" for the Aerospace Education Workshop of the Oregon State System of Higher Education in Portland, Oregon, on July 12.

Dr. D. R. Griffin, the world authority on echo-location or "sonar" among birds, bats, electric fishes and dolphins, has agreed to be a speaker for a fall meeting of the Hanford Science Colloquium.

Dr. Harold C. Urey, Nobel Prize winner and discoverer of heavy hydrogen, has indicated willingness to participate in this program late next year.

Hanford Laboratories off-site visitors totalled 188 during the month. There was a total of 12 foreign visitors, representing five different countries.

R L Jenkins

for Manager,
Programming

WK Woods:RLJ:jm

RADIATION PROTECTION OPERATION REPORT FOR THE MONTH OF JULY, 1961

A. ORGANIZATION AND PERSONNEL

Effective July 1, R. Doug Tillson was transferred from Professional Placement and Relations Operation to External Dosimetry; Frank H. Sanders was transferred from Radiological Development and Calibrations to the Radiation Monitoring Operation. Effective July 24, Merle C. Olson transferred to Reactor and Fuels Research and Development Operation; and Kenneth R. Gordon transferred to Fuels Preparation Department. Warren H. Bischoff was reactivated on July 31. Emily H. Szymanski was transferred from External Dosimetry to Internal Dosimetry on July 31. The work force now totals 139.

B. ACTIVITIES

Occupational Exposure Experience

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 roles.

A CPD process operator received wide-spread contamination to his face, neck, and hands while working in the PR room at the Purex plant. Nasal contamination was readily removed by irrigation. Preliminary bioassay samples indicated an internal deposition of about 10 percent of the maximum permissible body burden of Pu^{239}.

Another CPD process operator received a plutonium contaminated puncture wound while handling plutonium turnings in the 234-5 Building. Examination in the Whole Body Counter showed about 0.024 μc of plutonium in the wound before excision and about 0.003 μc plutonium after excision. Preliminary bioassay results were positive but inconclusive.

Some difficulty was experienced in maintaining good radiation control at the Hot Semiworks facility. Pressurization of the atmosphere of three cells at the Hot Semiworks caused excessive air contamination with radiostrontium. Ten HLO and one CPD employee were bioassayed. Four of the involved persons showed positive but minor deposition of strontium.

Two employees avoided excessive exposure when they immediately left the D cell of the Hot Semiworks facility when the dose rate suddenly increased to a general field of about 2 rads/hour. A remote survey indicated that process material was lodged in a piece of tygon tubing running from a cask to a filter header and the associated dose rate was about 500 rads/hour at one foot.

A leaking steam trap from the Purex First Cycle Waste Cell caused the spread of fission product contamination to the environment of the 200 East Area on July 1. The majority of the ground contamination which ranged from several rads/hour down to 200 c/m was confined to the vicinity of the Purex plant. No ground contamination was detected on areas outside of the 200 East Area, although air samples

showed a 10 to 20 fold increase at locations in the 200 West Area. One involved CPD employee was examined in the Whole Body Counter and showed positive but minor deposition of ruthenium-106 and zirconium-niobium-95.

Four cases of uncontrolled localized exposure to the skin resulted from clothing contamination. The estimated dose to small skin areas ranged from 1.6 rads to 150 rads. The latter case resulted from glove contamination of 1.8×10^4 rads/hour including 5 r/hour.

Environmental Experience

Release of radioactive materials from the Hot Semiworks stack during the most recent process run was lower by a factor of 50 than release rates that were measured prior to the installation of the additional ventilation filters last month. Stack filter samples taken upstream and downstream of the filter indicated an overall efficiency of 99 percent.

Recalibration of the Redox stack 50 foot level sampling system was completed following the installation of an extended range pitot tube. Preliminary sampling data indicated good agreement for I^{131} results at the 20 and 50 foot level sampling locations. Concentrations of radioparticles are consistently higher at the 20 foot level; this is being studied further.

An aerial survey flight made over the Columbia River from Hanford to the Pacific Ocean showed a three-fold increase in radiation level of the mud flats at the mouth of the river as compared to the surrounding terrain. Plans were made to obtain core samples from these mud flats for isotopic analysis.

A limited survey of islands, beaches and Columbia River from the 300 Area to the Ringold area was made to determine the specific radiation conditions as part of a feasibility study of expanded use of the river.

Reply forms were received from about 80 fishermen who were contacted along the Columbia River, primarily from Richland to McNary Dam, by the local game director of the State Game Department. A tabulation of these results of fishing and dietary habits will be started when additional results are obtained.

Studies and Improvements

Leakage tests on the ionization chamber finger rings were completed and dose rate calibrations are nearing completion. The rings performed well to exposure of various doses and gamma energies. For radium gamma, the rings have a 95 percent reliability of being within $\pm$ 10 percent of the unknown exposure. Performance evaluated with the use of the K-fluorescent X-ray source for energies of 16, 58, and 100 kev was satisfactory. Plutonium metal was obtained from the Plutonium Metallurgy Operation for actual calibration of the rings to the plutonium low energy gamma and X-ray spectra. It was found that the rings have essentially the same performance characteristics at various charging potentials and can be calibrated in either the vertical or horizontal position.

The use of Polaroid film with the pinhole camera was investigated. Optical pictures procured by this method were excellent. The radiographic pictures were not satisfactory in that exposures up to several r produced no distinct film darkening. A series of film exposures were made utilizing various combinations of X-ray film and exposure to establish criteria for routine use. Radiation exposures from 25 mr to about 2 r were studied. These studies completed the basic study of pinhole camera techniques.

Design of the film X-ray coding machine to provide X-ray film identification for nonroutine personnel dosimeters progressed throughout the month. Most of the components necessary to fabricate this machine were placed on order. The design of the prototype personnel dosimeter was modified to reduce the overall weight and to facilitate mold construction. Delivery of the prototype dosimeters is scheduled for August 11. The Kensol heat marking unit was used routinely throughout the month of July by External Dosimetry Operation in changing the identifying lead tape in the personnel dosimeters to the binary system.

The automatic film densitometer was moved to the 3705 Building for final adjustments. Calibration film was processed by the automatic densitometer on an experimental basis throughout the last week of the month. Some difficulties in mechanical positioning of the film and in the performance of the punch equipment were noted following the transfer of the equipment to this new location.

Two double moderator criticality dosimeter systems were received from the offsite fabricator. X-ray examination of the double moderators showed that they were free from voids in the paraffin filling. The entire shipment of foil inserts was received. Final performance evaluation of these commercially fabricated moderators will complete development activities on this program. Several indium foils were irradiated with 4.25 mev neutrons to see if the excited state of In^{115} could be readily detected. Foils counted six hours after irradiation indicated a sensitivity of 425 dpm/gm/rad of neutrons. A measurement of this type will be used to measure the neutron flux above 1 mev in both the new personnel dosimeter and the double moderator criticality dosimeter system.

The 0.1 inch silicon diodes were irradiated with radium beryllium spectrum neutrons. Very erratic variations in the forward resistance measurements were observed for doses below 10 rads. Using the measurement techniques previously described, the 0.075 inch silicon diodes have been the most sensitive to fast neutron damage.

The measurement system used to evaluate the forward resistance of silicon diodes was analyzed. A number of improvements to provide a more reproducible measurement were made. For example: a constant current generator was introduced as the power supply in the circuit; a large standard resistor was used with the diodes for more accurate current determination; and a calorimeter with a motor driven stir has been substituted for the previously used manually stirred calorimeter. With the new system preliminary measurements indicate that a dose of 0.2 rads fast neutrons from a PuF_4 source would be detected with a forward resistance change of less than 0.1 percent.

A 40-liter ionization chamber and a vibrating reed electrometer were installed at the Whole Body Counter facility to measure the background radiation in and around the shielded room.

Acceptance testing and calibration of the 50 high range (0 to 5000 r/hour) CP-TP meters neared completion. Twenty-nine of these instruments are currently available for immediate use and were stored in the south room of the 3745 Building prior to assignment to specific field locations.

The new electrical control system for source positioning in the north well was installed and operated satisfactorily throughout the month. All useful calibration exposure positions for the north well were calibrated by use of the standard Victoreen r-meters. Calibration of the south well was completed.

A special study of the Columbia River from H Reactor to F Reactor was made in conjunction with Irradiation Processing Department personnel to determine the effect of radiation patterns as a result of shoreline discharge of H Reactor aqueous waste following plugging of the outfall structure. Dye tests and radiation traverses showed that the effluent followed the shoreline almost to White Bluffs; however, no significant differences in previous levels were noted at 100 F.

A radiological analysis of the PRTR aqueous waste streams lead to the principal conclusions that: (1) methods and procedures for disposal are good; (2) monitoring instrumentation and sampling equipment are adequate for determining the existence of serious problems but could definitely be improved; and (3) the ability to obtain accurate data on the total quantity of radioactive material being discharged to the river is questionable.

An evaluation of environmental consequences of a serious accident in the Fuels Recycle Pilot Plant was completed and will be issued in documentary form shortly. With the installation of proper air filtration and halogen removal equipment the worst environmental effects of an accident appear to be slight.

As an aid to future evaluations of the consequences of accidental releases, meteorological equations for prediction of areas affected by contaminants released at various stack heights, and under various meteorological conditions are being plotted in graphical form. Work was also started on compilation of the total dose which will result from internally deposited radionuclides following an acute intake.

C. VISITORS

The following visitors met with various members of the Radiation Protection staff during the month:

Prof. M. A. Shapiro, University of Pittsburgh, Pittsburgh, Pa.
K. M. Taylor, Carborundum Company, Niagara Falls, New York
Dr. M. Maqsood, Institute of Nuclear Science, Tehran, Iran

Warren E. Nyer, Phillips Petroleum Company, Idaho Falls, Idaho
James S. Smith, Atomic Energy Commission, Washington, D.C.
Jack Neil, Atomic Energy of Canada, Limited, Chalk River, Ontario, Canada
Dr. S. R. Albrectsen, Ministry of Health, Denmark

D. EMPLOYEE RELATIONS

Two suggestions were submitted by personnel of the Radiation Protection Operation during the month and two were reopened, bringing the year-to-date total to thirty-two. Three suggestions were adopted and two rejected. Twelve suggestions submitted by RPO personnel are pending evaluation.

There were six medical treatment injuries during the month for a frequency of 3.15. No security violations occurred during the month of July.

Radiation Protection training included orientation on specific aspects of radiation protection to: PRTR personnel; new personnel in the 327 Building; Biology Research and Plutonium Metallurgy personnel; and HAPO patrolmen.

E. SIGNIFICANT REPORTS

HW-70402 - "The Estimation of Whole Body Dose from Tritium by Urine Analysis" by T. M. Beasley and L. C. Rouse.

HW-70431 - "Analysis of Radiological Data for the Month of June, 1961" by R. F. Foster.

HW-70584 - "Monthly Report - July 1961, Radiation Monitoring Operation" by A. J. Stevens.

The galley proofs of the paper entitled "A Method of Linearizing Thermistor Thermometer Data in Calorimetry" by H. V. Larson and I. T. Myers were sent to the publisher of the Journal of Scientific Instruments.

ENVIRONMENTAL MONITORING - RESULTS - (Mid-June 1961 - Mid July 1961)

Sample Type and Location	Activity Type	Monthly Average	Units
Drinking Water			
100-F Area	Isotopic	0.3	% MPC_w-GI*
Separation Areas	Gross Beta	6.9×10^{-8}	µc/cc
Pasco	Isotopic	2.0	% MPC_w-GI**
Kennewick	Isotopic	1.1	% 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	0.6	% MPC_w-GI*
Hanford	Isotopic	0.7	% MPC_w-GI*
Pasco	Isotopic	5.1	% MPC_w-GI**
McNary Dam	Gross Beta	No Sample	
Vancouver, Washington	Isotopic	0.4	% MPC_w-GI**
Atmosphere			
I^{131} Separations Areas	I^{131}	2.0×10^{-13}	µc/cc
I^{131} Separations Stacks	I^{131}	0.6	Combined curies/day
Active Particles - Project	-	5.6	ptle/100 m^3
Active Particles - Environs	-	0.06	ptle/100 m^3
Vegetation (Control limit for vegetation is 10^{-5} µc I^{131}/g)			
Separations Areas	I^{131}	2.1×10^{-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.

PERSONNEL DOSIMETRY AND RADIOLOGICAL RECORDS

External Exposures Above Permissible Limits

	July	1961 to Date
Whole Body Penetrating	0	0
Whole Body Skin	0	1
Extremity	0	0

Hanford Pocket Dosimeters

Dosimeters Processed	3,738	31,010
Paired Results - 100-280 mr	25	352
Paired Results - Over 280 mr	1	16
Lost Results	0	0

Hanford Beta-Gamma Film Badge Dosimeters

Film Processed	10,526	70,905
Results - 100-300 mrads	925	6,536
Results - 300-500 mrads	115	749
Results - Over 500 mrads	15	150
Lost Results	16	192
Average Dose Per Film Packet - mrad (ow)	6.84	8.75
- mr (s)	20.88	21.05

Hanford Neutron Film Badge Dosimeters

Slow Neutron

Film Processed	1,972	11,562
Results - 50-100 mrem	0	0
Results - 100-300 mrem	0	0
Results - Over 300 mrem	0	0
Lost Results	25	58

Fast Neutron

Film Processed	432	2,745
Results - 50-100 mrem	38	367
Results - 100-300 mrem	11	106
Results - Over 300 mrem	0	0
Lost Results	25	58

Hand Checks

Checks Taken - Alpha	25,695	236,771
- Beta-gamma	38,311	362,123

Skin Contamination

Plutonium	51	195
Fission Products	59	347
Uranium	3	36

Whole Body Counter	Male	Female	July	1961 to Date
GE Employees				
Routine	104	4	108	400
Special	2	0	2	45
Terminal	0	0	0	2
Non-employees	21	1	22	50
Pre-employment	0	0	0	0
	127	5	132	497

Bioassay

Confirmed Plutonium Deposition Cases	0	4*
Plutonium - Samples Assayed	592	3,881
- Results Above 2.2×10^{-8} μc Pu/Sample	14	97
Fission Product - Samples Assayed	732	4,378
- Results Above 3.1×10^{-5} μc FP/Sample	5	8
Uranium - Samples Assayed	238	1,928
Biological - Samples Assayed	0	196

Uranium Analyses

	Following Exposure Units of 10^{-9} μc U/cc			Following Period of No Exposure Units of 10^{-9} μc U/cc		
Sample Description	Maximum	Average	Number Samples	Maximum	Average	Number Samples
Fuels Preparation	499.0	12.8	61	14.1	3.1	49
Fuels Preparation**	0	0	0	0	0	0
Hanford Laboratories	24.0	5.2	23	28.9	4.9	23
Hanford Laboratories**	0	0	0	0	0	0
Chemical Processing	56.1	5.8	37	19.7	4.0	34
Chemical Processing**	246.7	232.7	2	8.7	6.5	2
Special Incidents	16.4	12.9	4	0	0	0
Random	1.6	1.2	3	0	0	0

Calibrations

	Number of Units Calibrated	
	July	1961 to Date
Portable Instruments		
CP Meter	783	6,315
Juno	228	1,701
GM	425	3,673
Other	128	1,145
Audits	86	720

* The total number of plutonium deposition cases which have occurred at Hanford remains at 267, of which 194 are currently employed.

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

Personnel Meters	July	1961 to Date
Badge Film	1,338	10,125
Other	190	2,423
Miscellaneous Special Services	1,101	5,943
Total Number of Calibrations	4,279	32,045

A R Keene
Manager
RADIATION PROTECTION

AR Keene:ljw

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - JULY, 1961

GENERAL

There were no security violations charged to the Operation.

There were no major injuries; the minor injury frequency rate was 3.45 for the month and 2.96 for the year-to-date.

TECHNICAL SHOPS OPERATION

Total productive time for the period was 16,108 hours. This includes 12,087 hours performed in the Technical Shops, 1,742 hours assigned to Minor Construction, 139 hours assigned to other project shops and 2,140 hours assigned to off-site vendors. Total shop backlog is 19,958 hours, of which 60% is required in the current month with the remainder distributed over a three-month period. Overtime hours worked during the month was 6.3% (1,002 hours) of the total available hours.

Distribution of time was as follows:

	Man-hours	% of Total
Fuels Preparation Department	2,739	17.0%
Irradiation Processing Department	1,334	8.3%
Chemical Processing Department	311	1.9%
Hanford Laboratories Operation	11,682	72.5%
Construction Engineering & Utilities	42	0.3%

Requests for emergency service decreased to a level requiring a 6.3% overtime ratio, compared to 8.7% for the previous period.

At the close of the reporting period, there was one open requisition for a machinist. A candidate has been processed and requested to report on August 7.

There were ten medical treatment injuries, which is considered normal for this type of operation.

CONSTRUCTION OPERATION

There were 57 existing J. A. Jones Company orders at the beginning of the month with a total unexpended balance of $123,024. Forty-five new orders, 2 supplements and adjustments for underruns amounted to $105,885. Expenditures during the month on HLO work was $46,933. Total J. A. Jones backlog at month's end was $181,976.

Summary

	HL		CE&UO	
	No.	Unexpended Balance	No.	Unexpended Balance
Orders outstanding beginning of mo.	56	$ 107,536	1	$ 15,488
Issued during the mo.(Inc.Sup.& Adj.)	45	105,885	-	--
J.A. Jones Expenditures during mo. (Inc. C.O. Costs)		38,712		8,221
Balance at month's end	51	174,709	1	7,267
Orders closed during mo.	50	35,379	-	--

FACILITIES ENGINEERING OPERATION

Projects

At month's end Facilities Engineering Operation was representing the Company on 16 projects having total authorized funds in the amount of $2,423,300. The total estimated cost of these projects is expected to be $7,708,300. Expenditures on these projects through June 30, 1961, were $458,000.

The following summarizes the status of FEO project activity:

Number of authorized projects at month's end 16

Number of new projects authorized in July 0

Projects completed in July 0

New project proposals submitted to AEC in July 0

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

Engineering Services

Title	Status
Pressure Vessel and Piping Systems - Engineering & Inspection Service	This is a continuing work program on HLO vessels, pressure systems and related safety devices. The work includes periodic inspection and engineering evaluations of plant pressure systems, and engineering service during design, fabriation, installation, and operation to R&D components having process devices subjected to high pressures and temperatures. 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 complete. Electrical design is essentially complete. Components are being assembled.
Control and Safety Rods for Tamper Tank (Critical Mass)	Development work is being performed prior to completion of design.
Special Filter Changer - CWS	Tests will be made during August.
Material Handling System and Other Shop Improvements - 328 Building	
a) Material Handling System	Work essentially complete.
b) Coating Process Improvements	Material is on site. Work to be complete in August.
c) Chuck Handling Procedure	Preliminary work started.
Engineering Studies - 100-F	Engineering service to Biology Operation for plant maintenance and operation.
Analytical Laboratory changes - 3706 Building	Preliminary plans and cost estimates have been produced.
Induction Heating Unit - 314 Building	Design is complete. Material is on site. Completion delayed by lack of Plant Forces personnel to install equipment.
Install 200 KW Induction Motor - Generator Set - 306 Building	Work is essentially complete.
Crane Overhaul - 314 Building	Work is complete.

Drafting and Design Services

The work load in the 3706 Building drafting room and in the 327 Building is steady with some overtime required. Work loads in 306, 314, 308, and 1707-D Buildings are steady with no overtime required.

The equivalent of 143 design drawings were completed this month.

Major design and drafting work in progress includes the following:

1. Process Tube Monitor - Mark III - 2 dwgs. required - 90% complete.
2. Arc Melting Hood - 7 dwgs. required - 90% complete.
3. Autoclave Facility Modification - 308 Bldg. - 5 dwgs. required - 85% complete.
4. Special Tools Necessary for PRTR Operation - 38 dwgs. completed.
5. Induction Heater Flush Chamber - 90% complete.
6. Gas Loop Test Section - PRTR - 4 dwgs. required - 95% complete.
7. Ultrasonic Development Tank - 13 dwgs. required - 50% complete.
8. Uranium Scrap Burner (Project CAH-902) - 10 dwgs. required - complete.
9. Fission Product Packaging Equipment - 9 dwgs. issued for comment.
10. Calandria Mock-up for Test Work - Job started.

Plant Maintenance Operation

Costs for June were $117,006. Total cost for FY 1961 were $1,581,000, which is 101.2% of the control budget.

Analysis of Costs

The expenditure for the year was 1.2% above the reduced budget. The principal areas which contributed to this were improvement maintenance and steam costs both of which ran 6% above forecast.

Waste Disposal and Decontamination Service

Waste Disposal and Decontamination work proceeded without unusual changes in operation. Some overtime work was performed to clean up spills.

Plant Engineering and Miscellaneous

Approximately 21,000 square feet of prints were reproduced during the month.

The total estimated value of the nine requisitions issued during the month was $21,000.

The contingency maintenance work of research equipment moves is progressing in 326, 306 and 231-Z Buildings.

A design is being prepared for special air conditioning for room 22-A, 326 Building.

Plans have been made for replacement of contaminated ductwork for room 324 in the 325 Building.

Electrical loads on HLO buildings are being recorded and studied.

Painting continued in 329 Building.

The exposed walls and ceilings in the 3745 Building, except X-ray room are being covered.

TECHNICAL INFORMATION OPERATION

The AEC has approved topics proposed by HAPO for classification of intermediate and low level liquid wastes from chemical processing plants. Interested personnel were advised of the new topics by memo "Classification: Liquid Wastes From Chemical Processing Plants".

Thirteen pages of the Hanford Classification Guide were revised this month, incorporating new classification items and changes in instructions which have been received over the past few months.

The first draft of the General section for the new local classification guide for Hanford was distributed to select HAPO personnel for review and comments. This section covers the general aspects of Hanford and its operation such as site description, maps, photographs, utilities, construction, etc. Work on drafting the fuels preparation section for the new guide is being undertaken.

The Document Catalog Analyst compiled and issued an up-dated title list on the PRTR. A sample supply of formal reports on the PRTR was also displayed in the 3760 Building display room.

The microfilming program is proceeding on schedule. The microfilming of currently issued documents was begun at HW 70,000 and will be a regular Files procedure from now on. This will eventually mean that HW documents, after a retention period, can be destroyed without further checking since a microfilm copy of the report will already be in Files.

The paperwork in connection with sending periodicals to the bindery has been simplified by eliminating the separate purchase order formerly required for each shipment. Beginning in July, a single requisition was submitted to cover binding for the entire Fiscal Year.

Work Volume Statistics

	June	July
Document Distribution and Files		
Documents routed and discharged (copies)	12,990	14,850
Documents issued (copies)	10,832	13,049
Documents sent off-site (copies)	3,385	6,281
Document reserves filled (copies)	589	504
Documents picked up and delivered	16,579	15,749
Document Accountability		
Holders of classified documents whose files were inventoried	418	217
Documents inventoried in Files (copies)	--	--
Documents destroyed or retired (copies)	6,849	4,346
Documents revised (copies)	1,432	658
Documents pulled and documents filed (copies)	11,186	11,543
Documents reclassified	206	45
Documents microfilmed	379	2,985
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents on-site	191,703	191,832
Reference and Publication		
Books cataloged (new titles)	78	99
Books added to the collection (volumes)	272	275
Ready reference questions answered by professional staff	146	170
Literature searches by professional staff	73	65
Reports abstracted (titles)	321	227
Formal reports prepared (titles)	9	18
Off-site requests for HAPO reports (copies)	202	328
Reports released to CAP (titles)	25	27
Library Acquisitions and Circulation		
Books ordered (volumes)	358	372
Periodicals ordered	115	64
Books circulated (volumes)	1,563	1,300
Periodicals circulated (issues)	4,104	3,151
Inter-Library loans	89	97
Films borrowed or rented	7	7
Industrial film showings	50	46
Bound periodicals added to the collection	296	80
Bound periodicals discarded	15	177

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Library Collection:

	Main Library	W-10 Library	108-F Library	Ind. Med.	Total
No. of books	31,913	8,661	1,818	2,058	44,450
No. of bound periodicals	14,828	17	1,921	23	16,789
	46,741	8,678	3,739	2,081	61,239

Classification and Declassification	June	July
Documents, including drawings and photographs reviewed for downgrading or declassification	112	49
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification	45	25
Documents submitted to Declassification Branch, Oak Ridge	3	2

J L Boyd

Manager
LABORATORY AUXILIARIES

JL Boyd:jw

1237066

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

H-8

HW- 70658 DE

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CAE-822	Pressurized Gas Cooled Facility	4141 Operating

AUTHORIZED FUNDS					
$ 1,120,000	DESIGN $ 40,000	AEC $ 0	COST & COMM. TO 4-29-60	$ 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 8-19-59	DIR. COMP. DATE 9-30-61	DESIGN 4-29-60	
	CONST. 10-17-60		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	98%	91
PF			
CPFF	17	90	90
FP	7	100	100
Govt. Eq.	76	98	92

SCOPE, PURPOSE, STATUS & PROGRESS

Delivery of the 68 tons of steel shielding and the six, one and one-half ton casks were make during the month.

The temporary Bristol-Siddeley blower was operated at atmospheric pressure and at 125 psig CO_2 during the month. Pipe insulation is in progress in preparation for temperature testing.

PROJ. NO.	TITLE	FUNDING
CAH-842	Critical Reactivity Measuring Facility	58-e-15

AUTHORIZED FUNDS					
$ 360,000	DESIGN $ 45,000	AEC $ 148,000	COST & COMM. TO 7-23-61	$ 171,155
	CONST. $ 315,000	GE $ 212,000	ESTIMATED TOTAL COST	$ 360,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 11-17-59	DIR. COMP. DATE 8-15-61	DESIGN 2-1-61	
	CONST. 10-3-60		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	95	63
PF			
CPFF	57	90	35
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.

The Moderator storage tank and the reactor assembly have been installed. Installation of the piping has started.

A revised project proposal requesting an extension of the scheduled completion date is being circulated for approval.

1237067

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SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

H-9

HW- 70658

DATE 7-31-61

PROJ. NO.	TITLE	FUNDING
CEE-857	Physical & Mechanical Properties Testing Cell - 326 Bldg.	0290

AUTHORIZED FUNDS				
$ 75,000	DESIGN $75,000 / CONST. $	AEC $ / GE $ 75,000	COST & COMM. TO 7-23-61	$ 74,945
			ESTIMATED TOTAL COST	$460,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES		PERCENT COMPLETE		
DESIGN	11-2-59	10-1-59	DESIGN	3-1-61	WT'D.	SCHED.	ACTUAL
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		

	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.

The project proposal requesting total project funds is being reviewed by the HAPO General Managers office.

PROJ. NO.	TITLE	FUNDING
CEE-858	High Level Utility Cell - 327 Building	0290

AUTHORIZED FUNDS				
$ 400,000	DESIGN $ 50,000 / CONST. $ 350,000	AEC $ / GE $ 400,000	COST & COMM. TO 7-23-61	$ 239,121
			ESTIMATED TOTAL COST	$ 400,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES		PERCENT COMPLETE		
DESIGN	11-2-59	10-1-59	DESIGN	3-1-61	WT'D.	SCHED.	ACTUAL
CONST.	5-15-61	DIR. COMP. DATE 2-28-62	CONST.	2-28-62			

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

	WT'D.	SCHED.	ACTUAL
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			

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.

Bids are being requested again based on vendor fabrication in accordance with design furnished, with no responsibility assumed by the vendor for pit-up and workability. The first request for quotations resulted in the bid from Western Gear Corporation, the designer of the equipment. It placed responsibility for complete performance on the vendor, which may have resulted in a contingency factor in the bid received.

1237068

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SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories H-10

HW- 70658

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CAE-866	Shielded Analytical Laboratory - 325-B Building	61-a-1

AUTHORIZED FUNDS					
$ 700,000	DESIGN $ 60,000 / CONST. $ 640,000	AEC $ 546,500 / GE $ 153,000	COST & COMM. TO 7-23-61	$ 27,739	
			ESTIMATED TOTAL COST	$ 700,000	

STARTING DATES		DATE AUTHORIZED		EST'D. COMPL. DATES	
	DESIGN 9-5-59 / CONST. 6-28-61	5-31-60	DIR. COMP. DATE 6-30-62	DESIGN 11-14-60 / CONST. 6-30-62	

ENGINEER

FEO - RW Dascenzo

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE	4	44
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	NS	4
PF			
CPFF			
FP			

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.

The sewer line has been relocated and tested, and the vacuum exhaust stack has been relocated.

The plumbing subcontractor has started in on the plumbing modifications in the basement of the 325 Building.

The electrical subcontractor has completed the hook-up of the temporary power.

Driving of the sheet piling around the existing transformer station has been started.

Plant forces have relocated 3 pipes, an exit light and a fire alarm box in the basement of the 325 Building.

1237069

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SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

H-11

HW- 70658

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CAE-867	Fuel Element Rupture Test Loop	58-e-15

AUTHORIZED FUNDS					
$1,500,000	DESIGN $ 130,000	AEC $ 770,000	COST & COMM. TO 7-23-61	$ 495,777
	CONST. $1,370,000	GE $ 730,000	ESTIMATED TOTAL COST	$1,500,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 8-1-60*		DESIGN 2-15-61	
	CONST. 11-2-60	DIR. COMP. DATE 10-31-61	CONST. 10-31-61	

ENGINEER

REDC - PC Walkup

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE	7	140
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	62	11
PF	2	0	0
CPFF	57	70	3
FP (1)	10	100	100
(2)	31	45	0

SCOPE, PURPOSE, STATUS & PROGRESS

(1) G. A. Grant Co.
All design drawings and construction specifications have been approved.

*Detail Design. Scope design started 11-2-59, and completed 3-15-60.
**Water plant released for bidding 7-17-61. Bids due 8-18-61.

Revised project proposal, extending completion date, has been prepared and is being circulated for approval.

***Now includes equipment installation in both the annex and B cell.

PROJ. NO.	TITLE	FUNDING
CAH-870	Facility for Recovery of Radioactive Materials - 325 Bldg.	60-a-1

AUTHORIZED FUNDS					
$ 486,000	DESIGN $ 46,000	AEC $ 446,000	COST & COMM. TO 7-23-61	$ 463,344
	CONST. $440,000	GE $ 40,000	ESTIMATED TOTAL COST	$ 486,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 11-20-59	3-22-60	DESIGN 3-1-60	
	CONST. 5-6-60	DIR. COMP. DATE 6-1-61	CONST. 5-31-61	

ENGINEER

FEC - RW Dascenzo

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT - ENGINEER		

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

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SEMI-MONTHLY PROJECT STATUS REPORT

H-12

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70658

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CAE-896	Stress Rupture Test Facility	60-1

AUTHORIZED FUNDS					
$ 90,000	DESIGN $ 7,500 / CONST. $ 82,500	AEC $ 78,500 / GE $ 11,500	COST & COMM. TO 7-23-61 / ESTIMATED TOTAL COST	$ 10,833 (E) / $ 90,000	

STARTING DATES			ESTIMATED COMPLETION DATES	
DESIGN 7-29-60 / CONST. 3-20-61	DATE AUTHORIZED 3-6-61	DIR. COMP. DATE 10-15-61	DESIGN 12-1-60 / CONST. 10-15-61	

ENGINEER

FEO - E. 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			
		85	76
CONST.	100		
PF	2	0	0
CPFF		87	78
FP	98		

SCOPE, PURPOSE, STATUS & PROGRESS

This project involves a facility for deliberately rupturing tubing to establish service conditions.

The construction phase of the job is essentially complete; however, overall completion has lagged badly because of lack of progress in the installation of equipment. This is mainly due to delay in receipt of contractor procured equipment. The AEC has notified the contractor regarding his liability for any damages that may be incurred as a result of his failure to meet the contract completion date.

PROJ. NO.	TITLE	FUNDING

AUTHORIZED FUNDS				
$	DESIGN $ / CONST. $	AEC $ / GE $	COST & COMM. TO / ESTIMATED TOTAL COST	$ / $

STARTING DATES			ESTIMATED COMPLETION DATES	
DESIGN / CONST.	DATE AUTHORIZED	DIR. COMP. DATE	DESIGN / 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

1237071

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

H-13

HW- 70658 DEL

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CAE-888	Biology Laboratory Improvements	60-h-1

AUTHORIZED FUNDS					
$ 420,000	DESIGN $ 44,000	AEC $ 400,000	COST & COMM. TO 7-23-61	$ 355,234
	CONST. $ 376,000	GE $ 20,000	ESTIMATED TOTAL COST	$ 420,000

STARTING DATES			ESTD. COMPL. DATES	
DESIGN 8-8-60	DATE AUTHORIZED 9-2-60		DESIGN 3-31-61	
CONST. 7-10-61	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		
FF		11	6
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 held a contractor-information meeting on 7-24-61. Considerable quantities of abandoned concrete footings were uncovered during excavation for the new building. Pipe lines, some obsolete, and not shown on the drawings were uncovered. Removal of obstructions and relocation of some drain lines are underway. A design change is being prepared.

A pre-bid conference was held by Purchasing Operation on the Radiation Handling facility order. Representatives from General Mills and Pacific Metal Products attended. The bid opening was scheduled for August 22, 1961.

The contractor has presented a schedule to the AEC for approval.

1237072

SEMI-MONTHLY PROJECT STATUS REPORT

H-14

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 706[illegible] DEL

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CGE-935	Metals Storage Bldg.	61-j

AUTHORIZED FUNDS	DESIGN $ 500 / CONST. $ 21,800	AEC $ / GE $ 22,300	COST & COMM. TO 7-23-61 $ 21,265 / ESTIMATED TOTAL COST $ 22,300
$ 22,300			

STARTING DATES	DESIGN 1-2-61 / CONST. 6-22-61	DATE AUTHORIZED / DIR. COMP. DATE 10-31-61	EST'D. COMPL. DATES	DESIGN 2-10-61 / CONST. 10-31-61

ENGINEER

FEO - DS Jackson

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES	0.5	40
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	20
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.

Footings, foundation walls have been poured. Back fill and steel mesh placement are complete ready for pouring the floor slab the first week in August.

PROJ. NO.	TITLE	FUNDING
CAE-936	Coolant Systems Development Laboratory	62-k

AUTHORIZED FUNDS	DESIGN $ / CONST. $	AEC $ / GE $	COST & COMM. TO $ / ESTIMATED TOTAL COST $ 93,000
$			

STARTING DATES	DESIGN 10-1-61* / CONST. 4-1-62*	DATE AUTHORIZED / DIR. COMP. DATE	EST'D. COMPL. DATES	DESIGN 12-1-62* / CONST. 11-1-62*

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 was submitted to HOO-AEC on 6-28-61.

HOO-AEC approved it on 7-6-61 and forwarded it to the Washington office of the AEC on July 14, 1961 with a request for approval.

*Based on AEC authorization by 9-1-61.

1231013

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SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- [redacted]

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CAE-927	Additions to the 271-CR Building Waste Treatment Demonstration Facility	61-j

AUTHORIZED FUNDS				
$ 80,000	DESIGN $ 4,000	AEC $ 17,500	COST & COMM. TO 7-23-61	$ 11,628
	CONST. $ 76,000	GE $ 62,500	ESTIMATED TOTAL COST	$ 80,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 6-15-61		DESIGN 10-16-61	
	CONST. 9-16-61	DIR. COMP. DATE 3-31-62	CONST. 3-31-62	

ENGINEER

FEC - KA Clark

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		
ARCHITECT-ENGINEER	2	60
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	11	11
TITLE I			
GE-TIT. II			
AE-TIT. II		NS	27
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.

A design schedule is pending approval by HOO-AEC. Design is progressing satisfactorily.

PROJ. NO.	TITLE	FUNDING
CAE-932	300 Area Retention Waste System Expansion	62-k

AUTHORIZED FUNDS				
$	DESIGN $	AEC $	COST & COMM. TO	$
	CONST. $	GE $	ESTIMATED TOTAL COST	$ 70,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 9-1-61*		DESIGN 11-15-61*	
	CONST. 12-15-61*	DIR. COMP. DATE	CONST. 4-15-62*	

ENGINEER

FEC - 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.	ACTUAL
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.

1237074

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SEMI-MONTHLY PROJECT STATUS REPORT H-16

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70658

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CGH-923	Spectroscopy Laboratory	0290

AUTHORIZED FUNDS					
$ 95,000	DESIGN $ 4,500	AEC $	COST & COMM. TO 7-23-61	$ 84,521
	CONST. $ 90,000	GE $ 95,000	ESTIMATED TOTAL COST	$ 95,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 3-21-61	3-9-61	DESIGN 5-24-61	
	CONST. 5-15-61	DIR. COMP. DATE 11-15-61	CONST 11-15-61	

ENGINEER

FEO - RC Ingersoll

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		132
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
AE-TIT. II			
CONST.	100	90	90
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project will provide a facility for specialized spectroscopy work.

All material is on site. All ductwork has been fabricated and installed. Ceiling installation is in progress.

PROJ. NO.	TITLE	FUNDING
CAH-924	200 KW Induction Heating System - 306 Building	0290

AUTHORIZED FUNDS				
$ 31,000	DESIGN $ 3,200	AEC $ 24,650	COST & COMM. TO 7-23-61	$ 6,346
	CONST. $ 27,800	GE $ 6,350	ESTIMATED TOTAL COST	$ 31,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 5-1-61	3-27-61	DESIGN 7-1-61	
	CONST. 8-1-61	DIR. COMP. DATE 2-28-62	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.

The Commission issued an interim authorization to J. A. Jones for $11,000 on 7-6-61 for procurement of induction heating work stations and voltage regulator. J. A. Jones is preparing a bid package. Bid opening on work stations and voltage regulator is scheduled for 8-1-61.

1237075

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories

E-17

HW- 70338 DEL

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CAH-921	Geological & Hydrological Wells - FY-61	61-j

AUTHORIZED FUNDS					
$ 79,000	DESIGN $ 1,000	AEC $ 69,500	COST & COMM. TO 7-23-61	$	62,143
	CONST. $ 78,000	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

FEO - HE Ralph

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	100	0	0
GE-TIT. II		75	75
AE-TIT. II			
CONST.	100	40	11
PF	0		
CPFF	3	NS	75
FP	97	30	9

SCOPE, PURPOSE, STATUS & PROGRESS

This project involves the continued drilling of special research, test and monitoring wells.

Contractor is working two 10 hour shifts with one rig and one 10 hour shift on the second rig. He is now 29% behind schedule with 105 calendar days left to complete 4050 ft. of drilling.

PROJ. NO.	TITLE	FUNDING
CGE-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.	ACTUAL
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 has been forwarded by HOO-AEC to AEC, Washington, with recommendation for authorization.

*Based on AEC authorization 11-1-61.

1237076

SEMI-MONTHLY PROJECT STATUS REPORT H-18

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70658 DRL

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CAE-918	Second Whole Body Counter Cell--747 Bldg.	62-k

AUTHORIZED FUNDS $	DESIGN $	AEC $	COST & COMM. TO $
	CONST. $	GE $	ESTIMATED TOTAL COST $ 110,000

STARTING DATES			EST'D. COMPL. DATES	
DESIGN	9-15-61	DATE AUTHORIZED	DESIGN	1-15-62
CONST.	5-15-62	DIR. COMP. DATE	CONST.	2-15-63

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.	ACTUAL
DESIGN	100		
TITLE I			
GE-TIT. II			
AE-TIT. II			
CONST.	100		
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

Project Proposal Revision was submitted to the Commission on July 5, 1961. The Review Board deferred it indefinitely on July 13. It is expected General Electric Company will be requested to provide additional justifying information.

PROJ. NO.	TITLE	FUNDING
CAE-919	Air Conditioning - 314 Building	6-15-61

AUTHORIZED FUNDS $ 35,000	DESIGN $ 3,750	AEC $ 28,650	COST & COMM. TO 7-23-61 $ 29,853
	CONST. $ 28,650	GE $ 6,350	ESTIMATED TOTAL COST $ 35,000

STARTING DATES			EST'D. COMPL. DATES	
DESIGN	5-2-61	DATE AUTHORIZED 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		70
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		NS	100
AE-TIT. II			
CONST.	100	NS	40
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 G.E. Company.

Units arrived on plant 7-17-61. 2 units have been placed and the associated duct work is being installed.

1237077

SEMI-MONTHLY PROJECT STATUS REPORT

H-19

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70658 DEL

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CAH-916	Fuels Recycle Pilot Plant	Funds Avail. to Comm.

AUTHORIZED FUNDS			COST & COMM TO 7-23-61	$ 100,000
$ 50,000	DESIGN $ 50,000	AEC $	ESTIMATED TOTAL COST	$ 5,000,000
	CONST. $	GE $ 50,000		

STARTING DATES		DATE AUTHORIZED 2-17-61	EST'D. COMPL. DATES	
	DESIGN 3-1-61*	DIR. COMP. DATE	DESIGN 3-1-62	
	CONST. 5-1-62		CONST. 11-1-63	

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	NS*	100*
TITLE I		NS*	100*
GE-TIT. II		NS	
AE-TIT. II			
CONST.	100		
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project is to provide a facility to perform a full scope of engineering tests and pilot plant studies associated with fuel reprocessing concepts.

The revised project proposal for detail funds has been approved by HOO-AEC and has been forwarded to Washington D. C. AEC for approval.

AEC Work Authority Number CAH-916 (2) dated July 13, 1961 was received authorizing another $50,000 to G.E. for continuation of design.

A review was made of control cost estimate and as the budget was exceeded, reductions are being made to bring the estimated costs within the budgeted direct cost figure.

A linear concept of Hot Pilot Cells was investigated and abandoned as it was approximately $3000,000 over the Criteria concept.

Two floor plans that showed promise during the scoping stage were developed further and are being reviewed.

1237078

SEMI-MONTHLY PROJECT STATUS REPORT

GENERAL ELECTRIC CO. — Hanford Laboratories H-20

HW- 70658 DEL

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CAH-914	Rattlesnake Springs Radioecology Facility	61-j

AUTHORIZED FUNDS				
$ 90,000	DESIGN $ 3,400* / CONST. $ 86,600	AEC $ 71,700 / GE $ 18,300	COST & COMM. TO 7-23-61 / ESTIMATED TOTAL COST	$ 13,932 / $ 90,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 3-1-61	12-22-60	DESIGN 6-15-61	
	CONST. 7-12-61	DIR. COMP. DATE 10-31-61	CONST. 12-1-61	

ENGINEER

FEO - OM Lyso

MANPOWER	AVERAGE	ACCUM MANDAYS
FIXED PRICE		
COST PLUS FIXED FEE		
PLANT FORCES		47
ARCHITECT-ENGINEER		
DESIGN ENGINEERING OPERATION		
GE FIELD ENGINEERING		

PERCENT COMPLETE	WT'D.	SCHED.	ACTUAL
DESIGN	100	NS*	100
TITLE I			
GE-TIT. II			100
AE-TIT. II	100	NS*	100
CONST.	100	5	5
PF			
CPFF			
FP			

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.

Contractor work started 7-12-61. Road stabilization to the site 90% complete. Layout work locating the facilities essentially complete. The fire break around the area is partially complete.

PROJ. NO.	TITLE	FUNDING
CAH-917	Field Service Center - Atmospheric Physics	61-j

AUTHORIZED FUNDS				
$	DESIGN $ / CONST. $	AEC $ / GE $	COST & COMM. TO / ESTIMATED TOTAL COST	$ / $ 154,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 9-15-61		DESIGN 1-1-61*	
	CONST. 2-15-62	DIR. COMP. DATE	CONST. 6-1-62*	

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		
TITLE I			
GE-TIT. II			
AE-TIT. II			
CONST.	100		
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project will provide facilities necessary to conduct atmospheric physics research and development programs.

No further word has been received from Washington AEC after submittal of answers to their questions.

*Based on AEC authorization by 8-15-61.

1237079

Del

SEMI-MONTHLY PROJECT STATUS REPORT H-21

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70658

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CAH-901	Structural Material Irradiation Test Equipment - ETR	0290

AUTHORIZED FUNDS	DESIGN $ 12,000	AEC $	COST & COMM. TO 7-23-61 $ 79,500
[illegible]	[illegible]	[illegible]	ESTIMATED TOTAL COST $ [illegible]

[redacted]

SEMI-MONTHLY PROJECT STATUS REPORT

H-22

GENERAL ELECTRIC CO. — Hanford Laboratories

HW- 70658 DEL

DATE 7-31-61

PROJ.NO.	TITLE	FUNDING
CGH-937	Safety Improvements to 231-Z Bldg.	61-j

AUTHORIZED FUNDS				
$ 45,000	DESIGN $ 5,500 / CONST. $ 39,500	AEC $ / GE $ 45,000	COST & COMM. TO 7-23-61	$ 9,925
			ESTIMATED TOTAL COST	$ 45,000

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN 7-12-61	7-5-61	DESIGN 9-29-61	
	CONST. 7-10-61	DIR. COMP. DATE 5-15-62	CONST. 5-15-62	

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	91
TITLE I			
GE-TIT. II			0
AE-TIT. II			
CONST.	100	6NS	2
PF			
CPFF			
FP			

SCOPE, PURPOSE, STATUS & PROGRESS

This project provides supplemental ventilation and installation of a fire detection system in the 231-Z Bldg.

Design by CE&UO is underway.

Work on removal of air conditioning filters was started on July 10, 1961 by J. A. Jones forces. This was performed to expedite the work on the hood.

PROJ. NO.	TITLE	FUNDING

AUTHORIZED FUNDS				
$	DESIGN $ / CONST. $	AEC $ / GE $	COST & COMM. TO	$
			ESTIMATED TOTAL COST	$

STARTING DATES		DATE AUTHORIZED	EST'D. COMPL. DATES	
	DESIGN		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

1237081

PROFESSIONAL PLACEMENT AND RELATIONS PRACTICES OPERATION

MONTHLY REPORT

COMMUNICATIONS

The TV news film on the Critical Mass Laboratory has been completed and cleared. Release will be made shortly.

EMPLOYMENT (Professional)

Advanced Degree - Four candidates visited HAPO for professional employment interviews. Nine offers were extended (all HL - two were joint offers with IPD and FPD); four offers were accepted (all HL) and four (all HL) were rejected. Current open offers total eleven.

BS/MS - Five experienced candidates visited for interviews; eleven offers were extended; six acceptances and five rejections were received. Current open offers total eleven. Program recruitment consisted of one extended offer, one acceptance and one rejection.

Technical Graduate Program - Seven Technical Graduates were placed on permanent assignment. Thirteen new members were added to the program rolls and one terminated. Current program members total 86.

Tentative assignments in HL and IPD have been agreed upon for four members of the AEC Technical Training Program. The trainees will arrive early in September.

EMPLOYMENT (Non-Professional)

Nineteen requisitions were filled during the month with a total of 32 active requisitions remaining to be filled.

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	Visited	To Visit	Offers: Offered	Accepted	Open	On the Roll
PhD	565	178	80	26	60	17	12	9
Exp. BS/MS	574	110	79	1	111	58	11	41
Prog.BS/MS	400	-	-	-	172	66	-	53

B. Technical Recruiting Activity - HL - September 1, 1960 to date

	Cases Considered	Visits to Richland: Invited	Visited	To Visit	Offers: Offered	Accepted	Open	On the Roll
PhD	565	178	80	26	52	15	12	7
Exp. BS/MS	306	53	34	1	34	16	5	13

In addition to the above activity, 12 exempt employees have transferred into HL from other HAPO departments and 14 technical graduates have accepted off-program placement in HL to date.

C - Technical Graduate Program
Month ending July 31, 1961

Number Personnel on Assignment	86
(HAPO Tech Grad Program 73	
(Engineering & Science Program 13	

Distribution of Assignments by Departments

IPD	30
HL	36
CPD	12
FPD	6
C&AO	1
CE&UO	1

Distribution of Assignments by Function

Research & Development or Engineering	61
Other	25

DEL

FINANCIAL OPERATION MONTHLY REPORT
JULY 1961

Personnel

There were no changes during the month of July.

Activities

GENERAL ACCOUNTING OPERATION

The following is a summary of action on approval or agreement letters originating in Hanford Laboratories and the current status of each:

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. Approved 7/12/61
AT-171	Delay in Disposition of Residence of Transferred Employee	To Commission 6/23/61. Approved 7/10/61
AT-178	Movement of House Trailer	To Commission 6/23/61. Approved 7/10/61
AT-181	Movement of House Trailer	To Commission 7/13/61. Approved 7/20/61

A new travel form "Disposition of Tickets" was adopted and placed in effect during the month. This requires that each traveler certify as to the disposition of transportation tickets issued him by the Company. This certification will be required to complete reporting of trips at Company expense. A new system has been developed which will make it possible for HLO employees traveling on Company business to pick up travel advances in the form of either cash or Company checks in the form of fifty dollar denominations immediately upon demand from the cashier in the 3702 Building. Henceforth checks for travel advances will be in fifty dollar denominations only. This new procedure will be placed in effect during the first week of August.

A major revision to the Travel and Living Expense Manual was issued. This revision included (1) the addition of a new chapter covering the use of private and Government vehicles on official business, (2) reporting requirement covering disposition of tickets furnished by the Company, (3) changes in available discounts on rental autos, and (4) restriction placed on travel by private plane.

The semi-annual Index of Revisions to the AEC Manual issued for compliance was distributed to interested parties.

New and revised OPG's issued during the month are listed below:

New	Revised	Number	Title
X		3.5.2	Tuition Refund Program
	X	22.1.3	Reactor and Fuels R&D Organization
	X	3.4.7	Solicitation Among Employees
	X	55.9	Forms Review
	X	6.6	Conflicts of Interest
X		9.1	Contracts and Purchase Orders
X		9.2	Procurement of Equipment, Materials, Services and Supplies
	X	7.1	Responsibility for Security
	X	7.10	Weapon Data
	X	3.4.12	Transfers and Promotions
	X	3.1.5	Assistance to Families of Deceased Employees
	X	22.1.2	Chemical R&D Organization
	X	3.12	Holidays
	X	3.2.5	Overtime Lunches
	X	3.4.14	Removal from Payroll

The following HLO OPG's were cancelled:

99.4.1	Off-Plant Trips Via Government Automobile
99.4.2	Accidents Involving Government Vehicles - Motor Vehicle Safety Responsibility Act
66.1	Contracts and Purchase Orders

Contracts processed in July included:

DDR-128	Zak Machine Works
DDR-119	Pump Development by Deming Company
ATH-HLO-1-62A	General Engineering Laboratory - Poritsky and Apkarian

A table of contents by subject matter was developed for active approval letters. Seventeen categories including miscellaneous were established.

There were nineteen AEC Manual Chapter revisions received, details of which are covered in a separate monthly report.

Action as indicated occurred on the following project during the month:

New Money Authorized HLO

CAH-916	Fuels Recycle Pilot Plant	$50 000

At the request of the Commission, a special report was prepared as to the amount of unirradiated, uranium bearing scrap, generated in the Division of Reactor Development (04) Program in custody of HLO at June 30, 1961, and an estimate of the amount of scrap which may be generated in FY 1962. Quantity on hand at June 30, 1961, was 851.535 lbs. and estimated quantity to be generated in FY 1962 is 2,486.8 lbs.

The physical inventory of movable cataloged equipment in custody of Laboratory Auxiliaries was taken during the month. Reconciliation of the inventory findings by HLO Property Accounting was completed and the results forwarded to C&AO for their review and completion of reconciliation. Inventories of equipment in custody of Radiation Protection and Laboratory Equipment Pool are in progress.

Project unitization work on Project CGH-907 - Strontium-90 is 50% complete and 95% completed on Project CGH-785 - In-Reactor Studies Equipment - 105 KW.

Total investment in HLO Plant and Equipment in Service at June 30, 1961, amounted to $67.3 million compared to $43.9 million at June 30, 1960. The increase of $23.4 million represents major projects such as PRTR, PFPP, 306 Building Addition and other projects of lesser magnitude. The following is a summary of HLO plant investment at June 30, 1961:

Building and Structures	$27 915 132
Equipment	38 203 615
Utilities	1 054 939
Improvements to Land	130 216
	$67 303 902

Ninety-three items valued at $51,989 were received at the Laboratory Equipment and Material Pool during the month. Twenty-four items valued at $10,744 were loaned or transferred in lieu of placement of requisitions and 7 items valued at $3,546 were withdrawn by custodians. There are currently 775 items valued at $288,886 in the Pool of which 66 items valued at $28,778 are held for the convenience of others and 111 items valued at $14,258 are uncataloged type items.

COST ACCOUNTING OPERATION

The FY 1962 control budget was assembled for July reporting using information contained in the initial AEC Financial Plan and the proposed departmental allocation of funds by the General Manager - HAPO. Most program allocations are fairly firm based on the initial AEC Financial Plan, however, a few still require confirmation and allocation within Hanford Laboratories. The operating cost control budget for FY 1962 totals $26,371,000; tentative control budgets for capital equipment by AEC program are as follow:

20 Program	$1 600 000
03 Program	50 000
04 Program	800 000
05 Program	99 000
06 Program	170 000
	$2 719 000

An interim authorization of $100,000 of the $375,000 total authorization for FY 1962 has been received from UCLRL to cover research and development on Project Whitney. Also, a FY 1962 authorization of $25,000 was received for capital equipment purchases for Project Whitney.

Special requests established during the month were as follows:

Accounting Code	Activity
.1T	Energy response calibrations of the APED instrument. Estimated cost - $70.
.2A	Research and development on plutonium alloys for Argonne National Laboratory. Additional authorization - $30,000.
.4G	Consulting of J. J. Fuquay on meteorology problems with APED. Estimated cost - $1,000.
.4H	Wyandotte Chemical Corporation - Cost of shipping irradiated samples.
.4J	Turco Products, Inc. - Cost of shipping irradiated samples.

As a result of changes made by AEC in the "budget and reporting classification" effective July 1, 1961, several new research and development program codes were established. Active cost documents were code changed and FY 1961 costs were recast to the new program classifications to facilitate cost analysis and budget planning by AEC personnel. The new program codes established and those cancelled during the month were as follows:

New Codes	Title
.42	Combating Detrimental Effects of Radiation
.43	Molecular and Cellular Level Studies
.44	Terrestial and Fresh-Water Ecology
.45	Atmospheric Radioactivity and Fallout
.46	Radiological and Health Physics
.47	Radiation Instruments
.70	Toxicity of Radioelements
.34	DR-1 Loop Operation

Cancelled Codes	
.10	Environmental Sciences
.70	Biological Research
.71	Biophysics Research
.72	Dosimetry
.73	Instrumentation

A new cost center, "Hazards Analysis - PRP", code 7510, was established July 1, 1961, to accumulate salaries, material and service charges incurred by this function.

The quarterly Capital Equipment Expenditure Forecast was prepared for Hanford Laboratories and submitted to Contract Accounting.

PERSONNEL ACCOUNTING

Courtesty Discounts Issued to HLO Employees:

Issued by HLO Personnel Accounting	35	$1 640
Issued by Other HAPO Personnel Accounting	9	335
Total July 1961	44	$1 975
Total May 19 to July 31	121	$5 515

During the recent inspection of appliances purchased under this plan the inspector found one Air-Conditioner not considered installed in employee's home as required under the conditions of the plan. The employee agreed to return the $55.00 discount to the Company.

Thirty-nine employees have deferred 183 days of vacation from 1961 to 1962. Seven employees have been granted the privilege of banking their 11th and 12th years vacation days so they will be eligible for 15 days vacation starting in 1963.

Payroll Statistics

Number of HLO Employees Changes During Month	Total	Exempt	Non-Exempt
Employees on Payroll at Beginning of Month	1 432	700	732
Additions and Transfers In	42	25	17
Removals and Transfers Out	22	10	12
Employees on Payroll at End of Month	1 452	715	737

Overtime Payments During Month	June	July
Exempt	$ 8 749	$ 11 345
Nonexempt	28 454	38 041
Total	$ 37 203	$ 49 386

Gross Payroll Paid During Month		
Exempt	$ 650 276	$ 598 725
Nonexempt	387 980	500 063
Total	$1 038 256	$1 098 788

Participation in Employee Benefits Plans at Month End	July		June	
	Number	Percent	Number	Percent
Pension Plan	1 255	99.4	1 235	99.4
Insurance Plan				
Personal Coverage	387		377	
Dependent Coverage	1 024	99.9	1 016	99.8
U.S. Savings Bonds				
Stock Bonus Plan	66	33.5	68	34.3
Savings Plan	79	5.4	80	5.6
Savings and Security Plan	1 092	87.0	1 071	86.8

Insurance Claims	July Number	July Amount	June Number	June Amount
Employee Benefits				
Life Insurance	-	$ -	-	$ -
Weekly Sickness and Accident	12	832	8	497
Comprehensive Medical	32	5 367	35	6 524
Dependent Benefits				
Comprehensive Medical	78	11 821	89	12 235
Total	122	$18 020	132	$19 256

Good Neighbor Fund

	July	June
Number Participating	972	944
Percent Participating	66.9%	65.9%

D. S. Parsley
Acting Manager - Finance
August 14, 1961

DEL

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
L. C. Lemon and W. T. Ross	Head Welded Swageable End Cap, HW-70187. July 5, 1961.
R. G. Wheeler	Reactor Fuel Element Support
W. I. Steinkamp and P. A. Ard	A Process for Nuclear Fuel Element End Closures
K. C. Knoll	Increasing the Selectivity of Clinoptilolite for Cesium
E. J. Wheelwright, L. A. Bray F. P. Roberts and R. L. Moore	An Integrated Process for the Recovery and Purification of Milti-Kilocuries Quantities of Fission Product Strontium from a Purex Crude Strontium Concentrate (HW-70336)
F. P. Roberts	Isolation of Cerium by Anion Exchange (HW-70403)
R. F. Burch, Jr.	Invention in Fabrication of Uranium Dioxide Single Crystal Spheres By Means of Grinding

W. H. Lean