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HANFORD LABORATORIES OPERATION MONTHLY ACTIVITIES REPORT

JULY, 1959

AUGUST 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

GENERAL ELECTRIC

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HW-61374

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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
JULY, 1959

Compiled by
Operation Managers

August 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

[redacted]

PRELIMINARY REPORT

This report was prepared only for use within General Electric Company in the course of work under Atomic Energy Commission Contract AT(45-1)-1350. Any views or opinions expressed in the report are those of the authors only.

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TABLE I. HLO FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE August 5, 1959

	At close of month			At beginning of month			Additions		Separations	
	Exempt	NonExempt	Total	Exempt	NonExempt	Total	Exempt	NonExempt	Exempt	NonExempt
Chemical Research and Development	139	101	240	133	98	231	6	4	0	1
Reactor & Fuels Research & Development	195	159	355	193	158	351	3	3	1	2
Physics & Instrument Research & Development	72	39	111	72	36	108	2	3	2	0
Biology Operation	39	47	86	37	47	84	2	0	0	0
Operation Res. & Syn.	17	4	21	17	3	20	0	1	0	0
Radiation Protection	34	102	136	33	101	134	1	1	0	0
Laboratory Auxiliaries	47	194	240	48	187	235	0	9	1	2
Financial	13	12	25	14	12	26	0	0	1	0
Prof. Plcmt. & Rel. Prac.	98	29	127	92	30	122	13	1	7	2
Programming	16	3	19	16	4	20	0	0	0	1
General	1	2	3	1	2	3	0	0	0	0
Totals	671	692	1363	656	678	1334	27	22	12	8
Totals Excluding Internal Transfers	671	692	1363	656	678	1334	23	20	8	6

Composite Separations Rate 1.4673

Separations Rate (based on separations leaving G. E.) ..... .6603

Controllable Separations Rate ..... .2934

BUDGETS AND COSTS

Costs for July were $1,669,000 or 8% of the annual operating budget of $21,917,000. The only program which appears out of line with budget is IPD-NPR Research and Development which experienced costs of $90,000 in July or 14% of the $650,000 annual budget. The FY 1960 budget prepared last spring has been used as the control budget with the following changes occurring in July:

IPD Metallurgy I and II	Increased $19,000
IPD Reactor I and II	Increased 22,000
CPD Separations	Decreased 75,000
Environmental Sciences Research	Decreased 28,000
Project Whitney	Decreased 10,000
Service Assessments	Decreased 40,000
Special requests (off-site)	Reduced to amounts currently authorized.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

PRTR Phase III is about 10% complete versus 10% scheduled. Work was seriously curtailed during July as a result of a construction labor dispute not related to this work. PRTR Phase II-A (River Structure) is about 85% complete versus 100% scheduled. Fabrication of the calandria and the top and bottom shields was stopped at the vendor's plant as a result of the steel strike.

Results of calculations of tritium build-up in the PRTR D_2O system are reported in HW-61151.

The PFPP building was accepted, with exceptions, from the Phase II contractor on June 30, 1959, and was partially occupied by Plutonium Metallurgy Operation in July. Installation of equipment (Phase III) is estimated at 69% complete versus 81% scheduled. One major equipment item, the swage, was orally accepted from construction, with exceptions, on July 6, 1959, and shakedown work has been initiated.

The use of thick-walled centrifugally cast Zircaloy-2 stock has materially reduced the scrap loss incurred in the fabrication of end fittings for the nested tubular UO_2 PRTR element.

Vibratory compaction of 0.505-inch tubes, eight feet long, filled with fused UO_2 has resulted in a core density of 89 to 90 percent of the theoretical crystal density.

The Zyglo fluorescent dye penetrant test has been successfully adapted for the inspection of the internal surface of Zircaloy-2 PRTR fuel tubes with the aid of a small borescope. Ultrasonic inspection techniques have also been developed which will detect an internal crack defect 0.002-inch in depth.

The results of two in-reactor tests of wire-wrapped UO_2 cluster elements clad in Zircaloy-2 both show that fretting corrosion does not appear to be a serious problem with these fuel designs as long as the wire remains attached at both ends.

Conclusive evidence has been gathered to show that the tracks observed in irradiated thin UO_2 films are indeed the consequence of the fission event.

Studies on the sinterability in hydrogen of the system UO_2-PuO_2 show a minimum density in the range from 20 to 40 w/o PuO_2 for any temperature up to 1600 C, and sintering times up to eight hours.

PuO_2 (produced by decomposing the oxalate at 300 C) sinters in hydrogen to appreciably higher density than ball-milled PWR grade UO_2 under the same conditions.

Thermal cycling tests of Zircaloy-clad aluminum and plutonium-aluminum elements under PRTR conditions have demonstrated generally satisfactory performance up to 19 cycles. Between 19 and 50 cycles different degrees of bowing, bumping, and distortion occur. One full length element was satisfactory after 100 cycles. Tests to establish optimum conditions are continuing.

Successful weld closures have been made on 0.5-inch diameter, 0.005-inch wall 17-7 precipitation hardened stainless steel jacket tubing, and on 0.5-inch diameter, 0.008-inch wall 304-L stainless steel tubing.

Sixteen Al-Pu capsules, two PuO_2-impregnated graphite capsules, and one 3-foot long, 7-rod Al-Pu cluster are now being irradiated in the MTR or ETR. Four capsules and one 4-rod cluster of Al-Pu are now being evaluated after irradiation.

Work has been completed on the Irradiated Slug Rupture Prototype Loop to be used to study NPR decontamination procedures, and shakedown runs are in progress.

Fabrication of ribbed Zircaloy-2 BDF process tubes has been started at each of four contractors' plants. Delivery of the first pilot lots should be made late this year. Fabrication of small lots of ribless, C Reactor size, Zircaloy-2 process tubes and NPR process tubes has also been started.

Four experiments containing NPR candidate graphites are now installed in the ETR. The first two experimental assemblies for HAPO graphite irradiations at 800 to 1000 C in the GETR have been completed and are scheduled for installation the week of August 3.

In studies of molybdenum, it has been shown that highly immobile clusters of point defects are formed by irradiation above 10^{19} nvt. A considerable amount of damage can be built up, since as irradiation proceeds, clusters formed by the neutron bombardment add nucleation sites for further cluster growth.

Little or no dependence of dimensional stability upon clad thickness (in the range 0.020 to 0.030-inch) was demonstrated on the irradiation of 1.6 percent enriched, coextruded uranium fuel to an integrated exposure of 1200 MWD/T at 200 C.

A simple ultrasonic test has been developed to evaluate the quality of welds on self-supported fuel elements.

Copper plating of coextruded fuel rods prior to draw-sizing continues to appear promising. Alternate application methods employable on tubular elements are being investigated.

A double ring projection weld for closing the tubular NPR element appears feasible as the result of preliminary tests.

2. Chemical Research and Development

An improved process for cerium recovery was developed which is specific for recovery of a purer cerium fraction from the Purex waste crude sulfate product. The cerium peroxy acetate precipitate produced in the new process was free of trivalent rare earths which are found in the sulfate crude material.

Neptunium concentration ratios between 300 and 1,000 were demonstrated in a laboratory mixer-settler designed to simulate a proposed Purex plant extraction column. The proposed column would "trap" neptunium from the 3WB backcycle waste stream while the Purex plant operates.

Completion of fundamental studies of uranyl nitrate mass transfer across the water - TBP interface showed the basic mechanism changes as equilibrium is approached and the rate-limiting process is clearly a physical phenomenon.

Sufficient testing of the Radiant Heat Spray Calciner was achieved to establish excellent de-entrainment characteristics of the laboratory pilot scale equipment. Solids and non-volatiles were removed with less than one part in one million leaving the unit in the non-condensible off-gas.

Pilot scale study of a flooded-tray dissolver concept showed, in initial tests, that conventional Hanford fuel elements dissolved as rapidly in the new geometry as they do in a conventional dissolver. Along a competitive conceptual line, satisfactory initial operation was achieved for a prototype recirculating dissolver utilizing air-lift pumping. Satisfactory results were also reported on the operation of a pilot-scale sulfex dissolver system.

No instability was evident in uranium-molybdenum alloy dissolver solutions which were stored for periods of nine to eighteen weeks to check their longer term characteristics. Solutions were typical of the Darex process and conventional nitric acid stabilized with ferric ion.

Well defined UO_2 crystals were smoothly electrodeposited from a solution of uranyl chloride in fused alkali halide salt. The process was simple and has application for chemical processing of ceramic reactor fuels or the preparation of reactor fuel material.

Laboratory experiments of fission product behavior in irradiated uranium specimens subjected to heating in a steam atmosphere showed that a considerable amount of the radioxenon remained non-volatile in the uranium dioxide phase formed by steam oxidation of the uranium metal. The test was run for two and one-half hours at 1100 C.

A method was devised to sample ground water from deep wells at elevations far below the ground water surface. Samples taken 400 feet below the surface of the water table one mile south of the 200 East Area showed measurable beta activity and nitrate ion concentrations up to 13 ppm, a value higher than that measured at the ground water surface.

3. Physics and Instrument Research and Development

In the Improved Production Reactor Program, exponential pile measurements began with tube and rod geometry fuels. This rounds out the program of measurements on cluster and tube in tube elements which were carried out previously. Large diameter solid elements are included to achieve improved knowledge of neutron behavior in such lattices.

PCTR experiments on an enriched uranium cluster type element revealed a reactivity nearly 2% k lower than predicted for this fuel by IPD computations. Sources of possible trouble in the computer code used for prediction are being investigated.

A study of the possible consequences of a nuclear incident in a Redox dissolver was completed. The maximum credible incident was found to be one in which a final charge takes the dissolver to a near prompt critical situation. Most of the fission heat is retained in the fuel elements and severe exothermic

chemical reactions would likely follow. The available energy release in such an incident would be sufficient to rupture the dissolver, cause severe damage to process lines and possibly to the dissolver cell.

A re-evaluation of previous work on k for UO_3-H_2O mixtures has confirmed earlier results; namely, k is less than unity for U^{235} enrichments less than one percent.

A new concept for a fuel failure detection system for the NPR has been favorably received and is being included in the design criteria by CEO. It involves rapid scanning in blocks of samples from 100 process tubes followed by a more leisurely examination at higher sensitivity. Compared to alternate systems which use individual detectors to monitor samples from each tube, this proposal offers an opportunity for substantial initial and operating cost savings, improved reliability and reduced ambiguity of interpretation. A program for development of demonstration prototypes for this system is being prepared.

The experimental phases of the Gas Cooled Reactor core experiments in the PCTR have been completed for the first fuel enrichment This includes measurements of reactivity parameters, control rod strength and fuel temperature coefficient.

Routine full-scale operation of the joint AEC-AF atmospheric dispersion experiments was achieved when favorable meteorological conditions became persistent. As of July 31, fifteen experiments had been completed.

Orderly progress was made on the many projects in the radiation monitoring instrument field, among which was preliminary investigation of a concept which may improve by a factor of 10 the sensitivity of detection of airborne plutonium.

In the basic data field, work is under way to fill a long existing need in reactor calculation of the automatic machine type by compiling all this data on tape. Also, a final tabulation of the HLO-measured fission cross section of Pu^{241} has been prepared and revised values of the resonance parameters have been obtained. The fission cross section of Pu^{240} at the 1 ev resonance has been reconfirmed with a foil containing 99.75% Pu^{240}.

4. Biology

Radish and lettuce plants were driven to an Air Force test site in Utah where they were exposed to fission products released by a fuel element burn. These plants will be treated with various chemicals and techniques in decontamination studies.

In gonad studies using chronically administered Cs^{137} to rams, the liver, kidney, and testes were found to receive the highest internal gamma dose rates.

In a preliminary observation it was noted that DTPA effectiveness for the removal of plutonium was significantly improved when glutathione was administered with it.

Something of a break-through occurred in Biological Analyses during the month. After several months of attempting to develop a satisfactory electron microscope autoradiography technique, success was achieved. The method has been applied to identify radioactive particles collected on millipore filters.

5. Programming

Computer calculations on the irradiation of a mixture of Th-232 and Th-230 showed that a reasonable yield of Pa-231 could be expected in a practical length of time. This material could then be recovered and further irradiated for an annual production of kilogram quantities of U-232 for power production purposes.

Compilation of the cross-section library for use in the full scale application of the RBU computer code is about 30 percent complete.

Through July, 44 lectures and 21 tours were completed for the participants in the SINE program. Numerous off-site speakers were brought in to lecture on special subjects.

TECHNICAL AND OTHER SERVICES

Work in the area of FPD process control and experimentation included a thorough investigation of the can cleaning process as a means of eliminating "non-wet" rejects and an evaluation of the effects of several variables on dimensional distortion during heat treatment in the co-extrusion process.

Work on 10 operations analysis programs continued during the month. In addition, statistical and mathematical assistance on 14 problems was given within HLO and to other departments and operations.

There were 22 authorized projects at month's end with total authorized funds of $8,530,100. (Note: PRTR and PFPP are considered separately.) The total estimated cost of these projects is $8,658,100. No projects were completed during the month and no new projects were authorized. Seven new projects are awaiting AEC approval. Four project proposals are in preparation.

Construction progress was low during the month due to a construction crafts work stoppage of about three weeks. Project CA-744, Metallurgical Development Facility - 306 Building is ahead of the official project schedule but the contractor is substantially behind his scheduled progress. The contractor plans to start a

two shift operation as soon as possible. The work stoppage further delayed the contractor on the High Level Radiochemistry Facility, Project CA-749, and it is estimated that contract completion will be about September 1, instead of August 3. Project CGH-790, 327 Building Addition, is now 50% complete compared to 55% scheduled. This project was proceeding on schedule until the work stoppage.

Activity for the Radiographic Testing Operation leveled out satisfactorily this month. Operations are becoming smoother and more efficient following the move of the field facilities from 200-E Area to White Bluffs. Four thousand and twelve tests were made.

Three new cases of plutonium deposition were confirmed during the month. One case was the result of a contaminated minor injury and two cases were detected through the routine sampling program. The total number of deposition cases which have occurred at Hanford is 232 of which 164 are currently employed.

The contaminated minor injury occurred during a routine maintenance operation in the Recuplex recycling and blending hoods. Initial contamination levels in the vicinity of the wound area on the finger were >40,000 d/m Pu Normal decontamination efforts were relatively unsuccessful. Measurement of the contamination in or near the wound in the Shielded Personnel Monitoring Station indicated $\sim$0.016 μc Pu in the wound site. Excision of tissue at the wound site reduced the contamination level to $\sim$0.001 μc. The initial estimate of the internal deposition is <10 percent of the maximum permissible limit (0.04 μc Pu).

SUPPORTING FUNCTIONS

Hanford Laboratories has been allocated $28,000 for Attendance at Meetings of Professional Societies and $3,300 for Attendance at Off-Site Courses during FY 1960. An allocation of these funds to sections is currently under way. The FY 1959 allocations to Hanford Laboratories were $28,300 and $3,000, respectively.

Preparations were completed and a procedure distributed for the FY 1960 physical inventory of uninstalled cataloged equipment in the custody of Radiation Protection Operation. The inventory which began July 20th is scheduled for completion of all field work by August 12, 1959.

The new Prime Contract which became effective July 14, 1959 had some delaying effect on Approval and Agreement letters then in process. Most of this delay has been overcome. Two requests for approval covering Assistance to Hanford work during FY 1960 have met with considerable delay and do not yet have Commission approvals. However, informal contacts between Hanford Laboratories operating managers and the Commission indicate that authorization will be forthcoming in the near future.

As of July 31, the staff of Hanford Laboratories totalled 1363 employees, including 671 exempt and 692 nonexempt. There were 585 exempt employees possessing technical degrees, including 355 BS, 118 MS and 112 PhD's.

HLO's first disabling injury was sustained by an employee. He tore a cartilage in his knee while stepping onto a stool. This terminated a run of 1059 injury-free days in the Hanford Laboratories. This covered 6,641,000 man-hours.

The medical treatment frequency for July was 1.86 as compared with 2.02 last month.

There were 4 security violations during the month of July, bringing the total for the year to date to 26.

Acceptances were received from 1 experienced Ph.D. physicist, 8 experienced BS/MS candidates, and 4 technical graduates. For the recruiting year to date there have been 79 acceptances from technical graduates, 74 from experienced BS/MS candidates, and 14 PhD's.

At month's end there were 83 technical graduates on the program, and a total of 107 on all training programs, including summer employees.

Twenty-one requisitions were filled during July, with receipt of 26 new requisitions and 3 cancellations. There are currently 35 nonexempt openings for which 16 candidates are in process and 10 transfers pending, leaving 9 candidates to be procured.

HM Parker

Manager,
Hanford Laboratories

HM Parker:kss

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Hydriding of Zircaloy-2. Previous short term tests of one hour or less have shown that the presence of water vapor in molecular hydrogen inhibits the hydriding of Zircaloy-2, presumably by forming new ZrO_2. Longer term experiments have been started to define whether this inhibition is simply an increased induction time followed by hydriding or whether the inhibition is permanent.

The results to date indicate that:

(1) At 500 C or above, water vapor pressure of 23 mm Hg is not sufficient to prevent hydriding indefinitely.

(2) Induction times before hydriding are observed, and the variation is probably related to the type and thickness of the oxide film present.

The region below 500 C is generally considered the stable area for the ZrO_2 film. A long term test is in progress to determine whether water vapor will prevent extensive hydriding at temperatures below 500 C.

Zircaloy-2 Corrosion in Water Vapor. The corrosion rate of Zircaloy-2 was measured at 400 C in pure water vapor at 23 mm Hg pressure. The data indicate that the corrosion rate is only slightly less than in 400 C, 1500 psi steam, and thus show the pressure independence of the reaction over quite a wide pressure range.

ZIRCALOY-2 WEIGHT GAINS AT 400 C

Time	23 mm Hg H_2O Vapor	1500 psi Steam
24 hrs.	9 mg/dm^2	12 mg/dm^2
48 "	12 "	15 "
74 "	14 "	17 "
7 days	20 "	21 "

Nickel Plated Fuel Elements. Some nickel plated aluminum clad fuel elements have lost pieces of nickel plate during reactor exposure. Similar flaking and blistering of nickel plate was produced in the laboratory by making the nickel plated aluminum the cathode of an electrolytic cell. An hypothesis that atomic hydrogen diffuses through

the nickel plate to the aluminum-nickel interface and then combines to form molecular hydrogen and blisters the plate is consistent with the data obtained to date. In order to apply the laboratory procedure as a test to nickel plated aluminum, it was necessary to examine the variables in the procedure. The test currently being investigated employs a platinum anode and a nickel plated aluminum cathode in a glass cell at 10 volts potential for seven to 24 hours. Results of variations in the electrolyte and nickel plate were observed as follows:

1. The Electrolyte

   The electrolytes tested were weak sodium acetate-acetic acid buffers at pH 4 and 7, and a sodium carbonate-bicarbonate buffer at pH 10. All tests were operated at room temperature.

   The blistering of the nickel plates was most severe at pH 7, the pH of present reactors, and appeared roughly proportional to the exposure time. The blistering was much less at pH 10 and was absent at pH 4. Exposed aluminum was corroded at pH 10.

2. The Nickel Plate

   a. Etching the nickel plate with 25% H_2SO_4 before testing had no effect on the blistering.

   b. Heat treatment of the plate by immersion in a lead bath at 400 C for 10 minutes reduced the blistering during the electrolytic test considerably.

   c. No difference in blistering was observed between 0.1 and 0.5 mil plates.

   d. No difference was observed between the products of two vendors.

The effects of electrolyte temperature are currently being investigated.

Reactor Decontamination Studies. The possible use of Turco 4501, a proprietary decontaminating agent, in NPR and PRTR has produced an interest in the effective ingredients of this mixture. Analyses of this mixture show the following contents: potassium, 24.2%; sulfur, 0.06%; chlorine, bromine, and iodine as chloride, 0.003%; fluorine, none detected; nitrogen, 1.46%; and water, 29.9%. A previous compound analysis indicated the presence of potassium hydroxide, tri-ethanol amine, and potassium salts of phenol, a steam volatile acid, and a non-volatile acid.

Examination of Reactor Pigtails. The failure of several H Reactor rear face pigtails by cracking late last year created considerable interest in the cause of the cracking failure as well as the condition of pigtails

at other reactors. Samples of pigtails from B, D, DR, and H Reactors have been decontaminated by the Turco 4501 process and dye checked. Many crack indications obtained by dye checking were evaluated by metallurgical sectioning, and the results to date are summarized below:

EXAMINATION OF REACTOR PIGTAILS

Reactor	No. Examined	No. Showing Cracks in Dye Check(a)	No. Sectioned	Evaluation of Sections	
				Typical(b)	Other(c)
H	46	7	6	4	2
D	15	3	2	1	1
DR	43	3	2	1	1
B	23	1	0	-	-

(a) Only those showing the diagonal or circumferential crack were counted. Many pigtails from all reactors showed pits and longitudinal imperfections.
(b) A typical crack starts on the outside surface of the pigtail, frequently at a pit. It proceeds transgranularly with branching to form a root-like pattern. This type of crack is usually associated with stress corrosion in 304 stainless steel.
(c) These are all other cracks, pits or tears that are not clearly the typical type described above.

The samples of the pigtails from H, B, and DR Reactors are random and thus give an estimate of the extent of cracking at these reactors. Those taken from D Reactor were not chosen to assure a random sampling. Since the samples were taken, most of the rear face pigtails have been replaced at H Reactor. Because each reactor has different vibrational problems, the level of cracking that requires replacement may vary from one reactor to another.

Radiometallurgy Laboratory Studies

A Zr-2 clad natural uranium rod, immersed in NaK and irradiated according to GEH-3-32 to 3500 MWD/T in a stainless steel container, was examined. A longitudinal crack was observed in the Zr-2 cladding that extended from the weld for approximately two inches. Another crack, in about the same plane, was observed at the other end of the Zr-2 (RM-250). A second Zr-2 clad, natural uranium rod contained in NaK was irradiated in the ETR according to GEH-3-57 to an exposure of 2100 MWD/T. Single throw warp on the five-inch long, 0.570 diameter capsule was 0.0183 inch. Metallography and density work is continuing (RM-275).

Five 7-rod cluster fuel elements were examined, and dimensional and density changes following irradiation were determined. The results and conclusions from this work will be reported in other sections of this report.

Basic Metallurgy Studies

Radiation Effects in Structural Materials. A series of metals representing the common crystal types was irradiated at Brookhaven, Hanford, and the MTR under various exposure conditions. These metals include copper, nickel, titanium, zirconium, iron, molybdenum, and type 347 stainless steel. Work performed during the month included the initiation of metallographic studies of irradiated copper, iron, and nickel; the completion of preliminary x-ray studies of irradiated zirconium and titanium; and the completion of microhardness measurements on irradiated molybdenum and zirconium. No changes in the microstructures of copper and iron due to irradiation were observed at magnifications below 1000 X.

Changes in line broadening and lattice parameters for irradiated zirconium were measured for the (220) and (302) reflections. For exposures of 4.7×10^{18} and 1.5×10^{20} nvt (fast) the broadening of the (220) reflection increased 33 and 160 percent, respectively, compared to increases of only 2.4 and 51 percent for the (302) reflection. The separation of these peaks varied with exposure indicating the formation of extended defects similar to stacking faults. The "A" parameter increased with exposure, whereas the "C" parameter first increased and then decreased with respect to the unirradiated value.

For exposures of 4.5×10^{18} and 1.5×10^{20} nvt, respectively, the zirconium hardened by 28 and 36 DPH numbers (average) and the molybdenum by 37 and 59 DPH numbers. Hardness recovery at room temperature during the interim period between KAPL and HAPO investigations was not observed; however, a slight recovery in electrical resistance for zirconium has been observed.

A Zircaloy-2 tube which has been exposed to neutron radiation over a 25-month period, and a similar unirradiated tube were removed from the KER facility. These tubes will be mechanically tested and examined metallographically to determine the effects of high neutron exposures at elevated temperatures on Zircaloy-2 and to establish testing methods for monitoring NPR tubing. The outside surfaces of sections cut from the irradiated tube were photographed in the Radiometallurgy facility. The inside surface of one piece was photographed obliquely from one end. In general, the outside surfaces appear bright and the wall thickness uniform. Although light colored deposits occur on the inside of the tube, the nature of these deposits is undefined as yet.

A report on radiation effects in irradiated molybdenum is nearing completion. It is shown that highly immobile clusters of point defects are formed by irradiations above 10^{19} nvt. These clusters grow first at small substitutional impurity atoms. As irradiation proceeds clusters formed by the neutron bombardment itself add new nucleation sites for cluster growth. In this way, a considerable amount of damage can be built up in a metal.

An analysis has been performed which shows that the maximum damage level sustained by a metal during irradiation is a function of the neutron flux level and that it is improper to compare the behavior of a structural material irradiated under various fluxes only on the basis of total integrated flux.

A report on the high temperature annealing of radiation damage in molybdenum has been prepared. It is shown that at least two recovery reactions proceed simultaneously from 500 to 800 C.

A metallographic study on a 10 percent C.W. Zircaloy-2 specimen, irradiated to a total integrated thermal neutron flux of 9×10^{19} nvt at 220 C was completed during the month. The specimen examined was irradiated in a helium filled capsule with other samples representing annealed, 25 percent C.W., 50 percent C.W., and beta quenched conditions. Before irradiation, specimens were cathodically etched and pre-characterized by scribing the surface for location of grains, with optical microscopy, high resolution metallography, DPH hardness, and precision x-ray diffraction measurements. Damage annealing kinetic studies will follow the as-irradiated examination. A gold tint was observed on the irradiated specimens, but this did not interfere with optical or high resolution metallography. The optical microscope examination was made with replicas and using the specimen itself. One hundred twenty-two days after discharge the 0.354 x 0.490 x 0.061 inch specimen had a measured radioactivity level of 13.5 RAD/hr including the 1 r/hr at one inch. Personnel exposure limits dictate that replicas be used for future work unless exposure levels drop to practical limits. The identical area was examined on the 10 percent C.W. specimen using pre- and post-irradiation replicas. No observable change was detected in the microstructure by use of optical and high resolution metallographic techniques.

Mechanical and Physical Properties of Materials. The creep properties of Zircaloy-2 are considerably improved by small amounts of residual work. The extent to which increasing amounts of cold work improve creep properties and the effect of recovery occurring in the test temperature range is not known. These effects are being determined in order that Zircaloy-2 fabrication procedures can be specified for process tubing. A portion of the Zircaloy-2 stock was further cold worked to 25 and 45 percent, and flat specimens of the 25 and 45 percent material are now being tested in the vacuum creep units at stress levels of 21,000, 18,000 and 13,000 psi at 400 C (752 F). Results of 2700-hour tests show higher creep rates for the 45 percent cold worked specimens than for the 25 percent material, with initial elongations being lower for the 45 percent samples than for the 25 percent. Elongations after 2713 hours are: initial 0.00030 in/in, final 0.01869 in/in for the 45 percent worked, and initial 0.00221 in/in, and final 0.01586 in/in for the 25 percent material at 18,000 psi stress. The rate changes are more pronounced at the higher stress levels. In addition to the creep tests in the vacuum units, advantage is being taken of the availability of four atmosphere creep units to determine the effect of CO_2 contamination in the helium atmosphere on the creep properties of Zircaloy-2. Similar conditions are being used ~~on the atmosphere~~ machines

to those in the vacuum units except for the carbon dioxide content of the atmosphere.

Electron and Optical Microscopy. The study of the microstructure of cladding and fuel materials is a direct way of detecting radiation damage in these materials. Thin evaporated films of uranium dioxide show straight line tracks after irradiation to an exposure of 2×10^{16} nvt. A similar thin film has been exposed to 2×10^{16} nvt in a cadmium capsule and then examined in the electron microscope. The number of tracks observed were almost nil when compared to the films exposed in an aluminum capsule. The observed tracks are, therefore, due to thermal neutrons which cause fission events to occur in the thin film. Capsules which can be welded in vacuum for subsequent irradiation of similar thin films are being designed.

X-Ray Diffraction Studies. The textures of extruded and drawn Zircaloy-2 tubing are being determined by x-ray diffraction. Preferred orientations are being correlated with results of tube burst tests to determine the relationship of texture to mechanical properties.

Coextruded Zircaloy-2 jacket tubing is being investigated presently. Pole figures of (0002) and $(10\bar{1}1)$ planes for tubing of approximately 20:1 extrusion ratio have been made. A prominent texture of $(10\bar{1}1)$ planes is present perpendicular to the tube radius. Basal planes, (0002), have a highly preferred orientation parallel to the tube radius and longitudinal axis. This texture is considerably different than found in extruded tubing (39:1 extrusion ratio). Burst tests are scheduled for the coextruded tubing.

Growth index values and inverse pole figure data are being obtained for coextruded uranium rods and tubes with various fabrication and heat treatment histories. The rods will be evaluated in-reactor after being characterized by x-ray diffraction.

Texture coefficient and growth index values have been calculated by the methods of Strucken and Morris for the coextruded uranium rods (39:1 extrusion ratio) in as-extruded and beta heat treated conditions. The as-extruded, and extruded and swaged rods have a predominant texture coefficient of (020) parallel to the rod axis. This set of planes shows growth under irradiation. The beta heat treated rods have negative GI values in several cases, indicating shrinkage longitudinally.

A duplex texture of (020) and (110) has been noted in as-extruded U - 2% Zr tube elements of 17.5:1 extrusion ratio. In-reactor tests are currently being completed to establish associated dimensional changes due to irradiation with respect to GI values found.

Solid State Reactions. The kinetics of recrystallization and recovery in zirconium, Zircaloy-2, and Zircaloy-3 are being determined to establish the optimum conditions of heat treatment during fabrication operations. Percent cold work, temperature, time, and heat treatment

atmosphere have been selected as variables. Resistivity specimens of particular interest were selected for a metallographic examination of surface oxide and for a chemical analysis of the base metal hydrogen, oxygen, and nitrogen content. A large variation in oxygen content was observed in the two as-worked control specimens representing each working level. Values ranged from 900 to 1500 parts per million oxygen content, 20 to 40 ppm nitrogen, and 20 to 40 ppm hydrogen content. A comparison of gas content in specimens annealed in vacuum and helium at 700 C for 1000 minutes has been made. Ten percent and 25 percent C.W. specimens annealed in vacuum contain less of the three gases than specimens annealed in helium. Recovery of electrical resistivity was greater for the vacuum annealed specimens. The 50 percent C.W. specimen annealed in vacuum contains more nitrogen and oxygen and less hydrogen than the helium annealed specimen. The recovery of electrical resistivity was still greater for the vacuum annealed specimens. Specimens annealed in vacuum at 400 C for 1000 minutes in the ten percent C.W. condition, show less nitrogen and oxygen but more hydrogen in the vacuum annealed specimen than similar specimens annealed in helium. The recovery of electrical resistivity was still greater for the vacuum annealed specimen. There seems to be no correlation between recovery of electrical resistivity and gas concentration of these specimens. The impurity atom distribution within the base metal may be a controlling factor. Metallography, in progress, may give some explanation of resistivity results.

Three specimens have been prepared within the USi_3-UAl_3 pseudo-binary system. These specimens are being studied metallographically and by x-ray diffraction. The first specimen was made to a nominal composition of 25 a/o USi_3, 75 a/o UAl_3. This specimen appears to be composed of two phases. One phase is simple cubic having a lattice parameter of 4.095 Å. The second specimen, 50 a/o UAl_3, 50 a/o USi_3, has a simple cubic phase of lattice parameter 4.175 Å. In each specimen the second phase was not identified. The third specimen, 75 a/o USi_3-25 a/o UAl_3, appears to have only a simple cubic phase with lattice parameter 4.231 Å.

Metallic Fuel Development

Cluster Fuel Elements. Post-irradiation examination of 7-rod cluster fuel elements irradiated in KER Loop 2 in 200 C coolant to an exposure of 1500 MWD/T was continued. The center rod of one fuel element was approximately 0.030" smaller in diameter near one end than the nominal 0.591" pre-irradiation diameter. The rod was cut longitudinally through this reduced section, and a crack or pipe through the cladding near the cap weld was found. Metallographical examination revealed no evidence of hydriding of the inner surface of Zircaloy-2 cladding as might be expected if water had entered the crack and uranium corrosion had occurred.

Post-irradiation examination of 1.6 percent enriched 7-rod cluster elements, some with 0.020" Zirealoy-2 cladding and some with 0.030" Zircaloy-2 cladding, irradiated in KER Loop 1 to an exposure of 1200 MWD/T was continued. There appears to be little or no difference in the behavior of the 0.020" and 0.030" clad elements. The average

diameter change was a decrease in each case of less than 0.001". No macro- or micro-cracking of the uranium or the cladding was observed.

Tubular Fuel Elements. An attempt to obtain a quantitative correlation of in-reactor growth of tube-tube elements with uranium texture has been made. One 36", U-2% Zr, tube-tube element in the as-extruded condition was exposed to 300 MWD/T in KER Loop 1. A similar 1.820" OD tube was sectioned for inverse pole, x-ray, texture studies. Three mutually perpendicular sections were cut from the unirradiated tube. These demonstrate a strong duplex (020), (110) texture in the extrusion direction and an intense (002) texture in the circumferential direction (the direction which indicates change in tube diameter). Calculated Growth Index values indicate that, for a section taken near the rear of the as-extruded tube, the element should shorten, decrease in wall thickness, and increase in diameter when irradiated to low burnup at temperatures below 300 C. Transverse sections (perpendicular to the extrusion axis) cut from the center and front of the extrusion also demonstrate a duplex (020), (110), texture; but Growth Index values calculated from data taken with these sections indicate that slight longitudinal growth will take place in-reactor.

A 20-minute anneal at 720 C in vacuum followed by a furnace cool partially randomized the structure. Annealed sections demonstrate a less severe (020), (110) duplex texture in the extrusion direction and (002) texture in the circumferential direction. Growth Index values for the rear of the annealed tube predict slight longitudinal growth, diameter increase comparable with as-extruded tube, and thickness decrease of about one-third of the magnitude of that predicted for the as-extruded tube.

Grain size in the beta annealed tube was observed to increase from 0.180 mm (mean cube diameter) near the rear of the extrusion to approximately one mm near the front with a mixed grain size near the extrusion center.

Dimensional measurements of the irradiated, as-extruded tube will be made in an attempt to correlate growth with the calculated Growth Index values, and thus provide a method predicting quantitatively the growth which will occur in-reactor.

Three tests of tubular elements were discharged from KER and ETR during July. Exposures varied from 25 to 2000 MWD/T. Maximum coolant temperature varied from 240 to 275 C, fuel core temperature from 385 to 700 C. Three of four elements examined at KE basin appear straight and in good condition. One element from KER Loop 1 has warp visible to the naked eye.

Elements from KER Loop 1 are crud-free, whereas elements from KER Loop 3 are covered with a brown-black scaly crud. Diameter measurements were made optically on a tube and rod type element exposed to 2000 MWD/T in KER Loop 3. No changes occurred in the tube outer diameter. The rod diameter increased approximately three percent. The ETR element operated for only 12 hours at temperature. Due to loss of water in the loop after shutdown, the element was discharged. During operation, maximum coolant

temperature in the fuel annuli were measured. The measured temperatures agree closely with those calculated from hydraulic and fission heating data.

Fuel for Present Reactors. A simple adaptation of the Sonic Orientation test equipment has been found to work well in evaluating the quality of the welds attaching aluminum self-support rails to canned slugs. The slug to be tested is supported at each end between V-blocks or rubber-tired rolls, and is vibrated at various audio-frequencies. Sound weld-nuggets transmit certain vibrational frequencies to a probe held against them with little loss of energy, while closely adjacent unattached areas damp the vibrations to such an extent that the oscilloscope image is scarcely affected when the probe is touched to the overlying surface. In the experimental work the probe differentiated between a sound weld nugget approximately 1/16" diameter and the rest of the weld spot (about 1/4" diameter) which was unattached. This test system has not yet been tried on Zircaloy supports, but presumably the same principles would apply in that case.

Component Fabrication. Design work and drawings are completed for a die set for punching spiders from Zircaloy-2 plate. Further tests show that the spiders can be cut from 0.200" stock, employing approximately 22 tons load.

An immersion plating technique for the deposition of copper on Zircaloy-2 is being developed as a possible means to prevent seizure of the cladding material during drawing operations. A drawing operation is being developed as an alternate to the swaging operation presently used for sizing co-extruded stock material. Past experience has shown that a thin electrolytic copper coating was beneficial in preventing seizure of short fuel rods during hot heading operations. Electrolytic plating of longer lengths such as the 10-15 feet used in the sizing operation is not practicable with existing equipment; therefore, alternate means of coating are being investigated.

Pre-treatment of the Zircaloy-2 consisted of degreasing, vapor blasting and rinsing in deionized water. Vapor blasting was found superior to either bright pickling or ammonium fluoride etching. Only a limited number of immersion plated samples have been drawn to date; however, the results appear quite promising.

Other coating techniques under test include a silicate treatment using a one percent aqueous solution of sodium fluosilicate and a phosphate treatment using one percent ortho-phosphoric acid and 0.25% HF. These coatings as well as the copper plating are used as a base for the standard lubrications used in drawing such as powdered graphite and molycote.

A total of nine coextruded uranium rods, 0.260" initial OD, 0.022" Zircaloy-2 wall, and approximately 20 feet long were used during the previous quarter for preparing 7-rod cluster elements for KER irradiation. During the month examination was completed of metallographic sections in

the final heat treated condition. Average uranium grain sizes were 0.180 to 0.210 mm diameter. X-ray examination of as-extruded, swaged, swaged and upset, and heat treated rod was completed and texture coefficients and growth indicies calculated. These values indicate that the element material should be stable during irradiation.

Sections of NPR size ingot uranium coextruded rod prepared from the same billet stock as the KER material have been examined in the extruded and swaged condition. This material also exhibited poor uranium quality with excessive stringers, voids, and inclusions surrounded by hydride. Sections have been prepared for heat treating studies and x-ray examination is being run to determine the base texture of the rod before treatment.

Five coextrusion billets have been prepared for extrusion in the 306 Building facility to produce ingot and dingot rod with the same fabrication for swelling studies. The billets were triple beta heat treated and vacuum outgassed at 600 C before sealing in the Zircaloy-2 containers. One billet was prepared with Zircaloy-2 end plugs to determine whether Zircaloy-Zircaloy bonds could be produced at the 13:1 extrusion ratio employed.

Closure and Joining. The application of resistance ring projection welding to tubes and rods to obtain double closures is being investigated. Double ring projections can be used on both rods and tubes to yield high quality closures with accurate control of the welding variables. High quality joints are obtained consistently. The procedure on rod type fuel elements has been reduced to a method suitable for production applications. On tube closures the process has been proven feasible; however, further work is required to determine the yield and suitability to production applications.

Allied Fuel Studies. A number of extrusions of aluminum, uranium, zirconium, magnesium, and some alloys were made on the Dynapak machine at small reduction ratios (4 to 1). Zircaloy-2 and Zircaloy-2-clad uranium billets were extruded successfully from a 700 C salt bath without jacketing the billets in copper. An attempt to coextrude uranium in Zircaloy-2 with integral end closures was encouraging in the following respects: (1) welds in the original Zircaloy-2 billet were metallographically indistinguishable from the remainder of the Zircaloy-2 after extrusion, and (2) over half of the extruded rod displayed a good bond between the core and clad even at the low reduction ratio.

Ex-reactor testing of control specimens for the in-reactor rupture testing of simulated Zircaloy-2 fuel element jackets experiment has revealed unexpectedly high creep strengths in the Zircaloy-2 tubing. For example, some of the annealed specimens have survived 500 hours at 290 C and a hoop stress of 50,000 psi. An upward revision of the in-reactor test pressures may be necessary in order to assure rupture of a significant fraction of the specimens during the proposed 1000-hour test.

In support of NPR fuel element development a series of experiments to obtain data on the dependence of uranium swelling upon cladding and uranium temperatures, cladding thickness, and exposure is being conducted. Examination of GEH-3-32 and GEH-3-57, the second and third of five Zircaloy-2 clad fuel rods irradiated in NaK filled capsules in the MTR and ETR, has been started. Cladding failure on fuel rods GEH-3-32 has been found in the form of cladding splits 2-1/2" long at one end and one inch long at the other. The extent of cracking in the uranium is not yet known. A diameter increase of approximately one percent was found at the middle of the rod where it is unaffected by the splitting. GEH-3-32 operated at 400 C except for the last one-third of the irradiation when the temperature rose to 540 C because of reactor operation changes. Exposure of the fuel was 3500 MWD/T. GEH-3-57 which operated at 550 C to an exposure of 2100 MWD/T shows a maximum diameter increase of 1.5 percent, but in this same region it decreased in length approximately 0.8 percent. More complete measurements and density determinations are being made. No clad failure is evident in this fuel rod. Ten more assemblies containing fuel rods similar to those now being examined have been shipped to the MTR. These irradiations, to begin as soon as space is available, will extend the coverage of temperature, exposure, and cladding restraint parameters.

To attempt a statistical analysis of the effect of temperature, exposure, and cladding upon fuel rod swelling, a series of NaK capsule experiments has been designed for irradiation in process tubes of Hanford reactors. Twenty-eight capsules have been completed. Irradiation should begin in August.

Tubular fuel specimens (coextruded, KER size) have been tested in ELMO-4 flow loop with 0.025" diameter defects through the clad to the uranium on both the inside and outside surfaces. Pieces defected on the outside surface in each of five metallurgical conditions (as-extruded, four beta treatments) deform almost exclusively on the outside surface. Pieces defected on the inside surface in each of the five conditions appear to deform during corrosion failure on the inside surface leaving the outside surface unaffected.

A beta treated, defected, coextruded fuel rod specimen tested in the "heated-rod" loop at 30 kw/ft was more severely damaged and corroded than a similar non-power generating rod tested in ELMO-4. Clad deformation at the 0.025" diameter defect and the cavity under the defect in the uranium fuel appeared larger than in the unheated rod.

Metallurgical Development. The change in extrusion coefficients and extrusion pressures with a variation in billet composition and grain size is being determined. In each instance, the billets will be extruded in the as-cast and heat treated form. Variables to be considered are: (1) a difference in billet cooling rate from the molten state, (2) a variation in carbon content from 50 ppm to two w/o carbon, and (3) a variation in zirconium content from 200 ppm to two w/o zirconium. Approximately one-third of the castings have been completed.

Facilities and Equipment. Stainless steel dummies are currently being fabricated to test out the principle of dismantling fuel elements and making the necessary measurements, and then reassembling for further irradiation. These stainless dummies will simulate the conditions for remote dismantling operation under fifteen feet of water. Elements are being constructed for both the tubular and cluster geometries.

A 4000-watt ultrasonic welding machine was received and installed in 306 Building. The unit is now operating.

Modifications to the seven-ton draw bench to increase its capacity and versatility are approximately 90 percent complete.

2. REACTOR PROGRAM

Coolant Systems Development

Rupture Testing. A single coextruded and predefected uranium and Zircaloy-2 rod with three 0.025" side pinholes was exposed for one hour to 300 C water at 1650 psi, 30 kw/ft power rate, and 20 fps velocity. The rod had been isothermally beta heat treated. Rupture results from this rod were slightly more severe than corresponding rods tested without internal heat generation. The maximum diameter of the rod increased from 0.593" to 0.76". Each of the defected areas swelled to about 0.7" diameter and split the Zircaloy-2 cladding. In contrast to the behavior of unheated ruptures in which the Zircaloy cladding was torn almost completely around the base, a longitudinal split on the swollen mounds was found in the current tests. Further tests of one and two hours are planned on these rods.

In another series of tests the effect of heat treatment was determined on the rupture effects of coextruded uranium and Zircaloy-2 tubes which had been pre-defected on the inside surface with a 0.025" pinhole and exposed to 300 C water for one and two hours. One rod each with the following variations in heat treatment was tested: as extruded; beta heat-treated, furnace cooled; beta heat-treated, air cooled; beta heat-treated, water quenched; beta heat-treated, furnace cooled to 600 C and held for ten minutes. Essentially all rupturing and swelling remained in the inside surface on all tubes. Both the as-extruded and beta treated furnace-cooled pieces ruptured badly, decreasing on the inside diameter from 1.34" to 0.52". The beta heat-treated, air cooled tube had a small amount of swelling during the second hour's exposure. The beta heat-treated, water quenched and beta-600 C heat-treated tubes had not ruptured after two hours.

Four coextruded rods beta heat-treated for 5, 10, 15 and 20 minutes and followed by air cooling have been tested for two hours in 300 C water. Rupture results of the pre-defected rods were consistently the same, one-half inch diameter raised and torn mounds being formed at the defects on each of the rods.

Decontamination Studies. Tests have been completed in ELMO-10 to determine whether the APACE decontamination process will attack the graphitar bearings in the recirculating pumps. After three complete decontaminations, examination of the bearings showed no visible attack. It was concluded that the APACE process can be used to decontaminate loop systems containing pumps with graphitar bearings. Tests are scheduled in the shielded prototype in 1706-KE.

Work has been completed on the IRP Loop in 242-B and shake-down runs are in progress. With the exception that the packing in the Powell valves had to be re-packed, the loop has run very well. The empty cask for the irradiated sample was connected to the system and operated at temperature with no leaks, and the cask is now being loaded with the first sample of irradiated uranium for a "hot" shake-down run in the loop.

Inhibitor Studies. In a test to determine the effectiveness of sodium dichromate as an inhibitor in high temperature water, coupons of A-212 carbon steel, sensitized and non-sensitized 304 stainless steel and Zircaloy-2 were exposed for 196 hours to deionized water containing 50 ppm dichromate at 300 C and pH 4.5. The weight gains for the Zr-2 were too small to evaluate the effect of the dichromate treatment. The uniform corrosion of carbon and stainless steel was reduced under these conditions to values found in water with no dichromate at pH 10. Pits three to five mils deep due to reduced inhibitor concentration in the crevices were found at the edges of the carbon steel coupons where the coupons were held by the holders. Pitting is a general problem found with all anodic inhibitors when present in insufficient concentration. When crevices cannot be eliminated, the inhibitor concentration should be increased to control pitting corrosion.

Aluminum Corrosion Studies. Loop KER-3 was decontaminated in May, and a new Zr-2 tube was installed in preparation for tests at higher temperatures and pressures. In all previous in-reactor tests the total corrosion has been so low that no accurate measurements could be made. One long-term test was planned on aluminum at a heat flux and water temperatures comparable to those expected in advanced reactors. In preparation for this, two short-term conditioning tests were run to ensure proper water quality and control. The pieces from the first test were discharged after exposure at surface temperatures up to 265 C for 23 days. The slugs appeared to be in very good condition. The second conditioning test consisting of Doe slugs clad in aluminum (C-810 and X-8001) was made up of pieces which had been canned earlier under less favorable conditions, but which were considered satisfactory for the short-term test. After 10 days operation in the region of highest power and highest local water temperature (surface temperature $\sim$ 275 C) a high neutron activity from this test caused the reactor to scram. Upon discharge of the slugs it was found that two X-8001 clad slugs had ruptured. Examination revealed that the ruptured slugs had failed in several spots, and all of these were located at the region where spot-welding had occurred. In a few places slight swelling had occurred, but no serious deformations of the slugs took place. Except at the spot-welded regions, corrosion resistance of the slugs was

generally good. Serious corrosion was found on two adjacent slugs at the point where the ribs were spot-welded to the jacket. Although the exact reason for this localized attack is not known, it demonstrates that the corrosion characteristics of X-8001 can be changed drastically by slight variations in the canning procedure.

After the second conditioning charge had been removed, an attempt was made to charge the long-term test consisting of 20 Doe slugs clad in X-8001 and a thermocouple assembly. The Doe slugs were charged without difficulty, but when the thermocouple assembly would not seal properly, the Doe slugs were discharged and KER-3 was charged with dummies in preparation for the next test.

In preparation for the long-term aluminum test, new Doe pieces are being canned in C-810 and X-8001 by the best available method and will be given rigorous testing. A new improved thermocouple assembly is being fabricated and pre-tested.

Component Testing. An NPR cap sealed with a Flexitallic gasket successfully completed 1369 thermal cycles between 200 and 550 F with no leakage and was removed from testing. A Canadian rolled nozzle-tube seal was removed from the ELMO-7 test loop after completing 4188 thermal cycles from 300 to 525 F at 1430 psi and 3993 cycles from 300-550 F at 1850 psi with no leakage. A flared nozzle-tube joint with 800 ft-lb torque instead of the usual 1200 ft-lb began leaking on the first thermal cycle and was valved out from further testing. A screwed nozzle-tube joint with bell-ring seals has 700 thermal cycles from 250-550 F with no leakage and one with banana ring seals has operated 600 hours at 572 F with no observed leakage.

Structural Materials Development

Zircaloy Retubing. Fabrication of ribbed, Zircaloy-2 BDF process tubes has commenced at each of the four contractors' plants. Allegheny has produced extrusions for processing at Tube Reducing Corporation. After the first pass in the tube reducing machine, progress will cease because of the steel strike unless other arrangements can be made for vacuum annealing. Superior Tube and Harvey Aluminum are each preparing billets and conducting final development tests prior to pilot scale production. Mallory Sharon Metals is still developing the proper tool designs for the Intraform machine. Latest test results are encouraging. Delivery of the first pilot lots of tubing from each vendor should occur during the last quarter of CY-59.

Ribless, C-Reactor size, Zircaloy-2 process tubes are being fabricated by Bridgeport Brass Company and Harvey Aluminum Company. Bridgeport will extrude and finish with a single tube reducing pass while Harvey plans to finish by two cold drawing passes. Initial deliveries are scheduled during late August or September.

NPR Process Tubes. Three vendors have each started work on the production of 70 NPR process tubes. Allegheny-Ludlum Steel Company has produced nine extrusions. These have been sent to Budd Company where they are to be welded to form three tube blanks. From Budd Company they will go to Tube Reducing Corporation to receive the final reduction to NPR size. Because of a long delivery on a critical part, the tube reducing machine will not be ready to receive these tubes until October. Allegheny Ludlum is now shut down by the steel strike, so this contract is temporarily at a standstill.

Harvey Aluminum has one ingot in the mill which is being prepared to form two extrusion billets. Material is now being melted to furnish a third billet needed to provide an economical run on the 8000-ton extrusion press. The three full length blanks will be extruded the week of August 3 as a pilot run. These should be cold plug drawn to final diameter and length by September 15.

Chase Brass & Copper Company has just received the first ingots from the melter. They expect to have their first extrusions made by the end of September.

Nonmetallic Materials Development

MTR Graphite Irradiations. The GEH-19-2 modified shim rod containing four samples of GL-10 graphite and four samples of CSF as reference standards was charged into the MTR on June 29. This experiment worked well throughout the first cycle, but after the shutdown on August 1, difficulty was experienced in holding the rod to the magnet. Seven attempts were made before the rod was necessarily discharged. Examination of the mechanism revealed that considerable sticking is encountered at 2/3 throwout. This is approximately what was observed during post-irradiation examination of GEH-19-1. Selective lubrication failed to disclose the binding parts. If possible, the rod will be repaired and then replaced at an early shutdown since otherwise it is in good condition. Design of the GEH-19 experiments is being modified slightly on the basis of experience gained on GEH-19-1 and 19-2 and fabrication of GEH-19-3 and 19-4 has been started.

Twenty-one capsules containing samples of NPR candidate graphites were also charged into the MTR on June 29, and will receive an exposure approximately equivalent to 2000 MWD/AT at Hanford at a calculated temperature of greater than 800 C.

ETR Graphite Irradiations. The first two GEH-13 graphite irradiation experiments in the ETR continue to operate satisfactorily. Sample temperatures on GEH-13-1 vary from 800 C to 950 C along the capsule length at full reactor power and on GEH-13-2 vary from 625 C to 800 C along the capsule. However, the ETR operated very little during the month.

The ETR GEH-13-3 and 4 experiments were installed in positions H-5 and E-14, respectively, and will be run under vacuum in the same manner as GEH-13-1 and 2. It will not be known until reactor startup whether or not these installations were completely satisfactory.

GETR Graphite Irradiations. The first two of the HAPO graphite irradiation experiments in the GETR were built during the month. H-1, the experiment going into the E-5 center loop position of the GETR contains twelve sets of four samples. Six of the sets contain needle coke graphites from Great Lakes Carbon Corporation (GL-10 and GL-11) and National Carbon Company (VC), with CSF as a standard; the other six sets contain a series of samples to determine the effect of fine particle size on the contraction rate. The second experiment, H-2, will be located in the E-7 side loop position of the GETR. It contains eight sets of four samples. Four sets contain GL-10, GL-11 and VC and the other four contain graphites from Speer Carbon Company, SP-9, SP-10 and SV. All eight sets have a CSF sample as a reference standard.

IP-22A Intermediate Temperature Graphite Irradiation. The first test assembly in 1573-DR which became inoperative soon after installation on April 27 was replaced with a second unit on July 3. CSF graphite samples were again used for the test. Temperature control has been within ± 5 C of the desired settings of 200 C and 300 C.

Graphite Radiation Damage. A favored mechanism for high-temperature, radiation-induced contraction of graphite is the relief of stresses developed upon cooling from graphitization temperatures. Small angle boundaries between crystallites joined at the edges of the basal planes appear to be one of the sources for these stresses. Theoretically, it has been found that the angle of misorientation, defined as the angle between the 'c_o' axes of the two crystallites should increase by an amount:

$$\Delta\theta = 2\sin^{-1}\left[\left(\frac{\alpha\Delta T}{1-\alpha\Delta T}\right)\sin\frac{\theta_o}{2}\right]$$

where $\Delta T = T_G - T$, T_G = graphitization temperature, θ_o = angle of misorientation at T_G, α = coefficient of thermal expansion in the 'c_o' direction for single crystal graphite.

For small θ_o, (< 0.1 radian), this simplifies to:

$$\theta = \frac{\alpha\Delta T}{1-\alpha\Delta T}\,\theta_o \simeq (\alpha\Delta T)\,\theta_o$$

The value of ($\alpha\Delta T$) is approximately 0.08, if T_G = 2800 C and T = 500 C. Thus, the increase in misorientation between crystallites resulting from cooling of the graphite from graphitization temperature to 500 C is approximately eight percent of the misorientation originally present , θ_o, prior to cooling. This increase in angular orientation will produce stresses of various types and magnitudes dependent on the structural details of the

graphite model assumed. However, if the crystallites are constrained from deforming freely, as is probable, a stress field tending to cause the graphite to contract would result.

Hot Water Resistance of Elastomers. Additional work has been undertaken to determine the resistance of elastomers to long time immersion in boiling water and water at 175 C. Results on immersions for 5000 hours in boiling water indicate that there are several classes of materials that will perform satisfactorily. The best of these are the silicone rubber Silastic S2096 and the nitrile rubber Hycar 1002. Immersions for 2000 hours at 175 C show that the material least affected is Silastic S2096. Hycar 1002 gained considerable weight and was substantially swelled.

Thermal Hydraulics Studies

Equipment Projects. Acceptance tests were continued on the silicon rectifying equipment (Project CG-661) which was installed in 189-D to provide additional heat generating capacity in the Heat Transfer Laboratory. Checks on the response of the equipment to a step change in power level (100% to 0%) indicated that it took 1.24 seconds for the power level to drop to 22% of the initial power of 2700 KW. Other tests indicated the equipment had the characteristic of momentarily surging in power level when the circuit breakers were closed after an emergency shutdown performed by opening the main circuit breakers.

The project (CG-834) to modify the High Pressure Heat Transfer Apparatus for higher flow and heat generating capacities and to allow transient type experiments continued on schedule. Design efforts were concentrated on obtaining a satisfactory valving arrangement for the transient experiments to simulate conditions following a rupture of a hydraulic connector to a process tube. Present plans are to install a storage tank to supply water to the electrically heated test section after valving off the main part of the apparatus and opening the discharge of the test section to atmosphere. Procurement of equipment for other parts of the modifications proceeded with the ordering of two 150 KW electric preheaters.

Hydraulic Studies. A preliminary study was made to determine the amount of flow increase possible in a BDF type reactor process tube with enlargement of the rear fittings. The results indicated that a 5.5% increase in flow would be possible if the header adapter were reamed from its present size of 0.469 inch to 0.550 inch (the size of the rear hydraulic connector). With the installation of larger hydraulic connectors and larger adapters at the nozzle and header, a flow increase of 14% could be possible. It was realized, however, that such flow increases may not be obtainable without other possibly extensive modifications to the reactor and careful consideration of the resulting changes in the heat transfer and hydraulic characteristics of the process.

The gathering of data to indicate the increase in pressure drop for 7-rod cluster fuel elements due to the presence of wire wraps was completed for the 0.704-inch diameter rods in a 2.70-inch process tube. The data show a slightly higher pressure drop increase due to wire wrapping for the

0.704-inch rods than for the 0.780-inch rod assembly. However, the value of pressure drop for the non-wrapped 0.704-inch rod assembly is only about one-half that for the non-wrapped 0.780-inch rod assembly, so the 0.704-inch rod assembly still has less pressure drop when wire wrapped than does the larger sized 0.780-inch rod assembly.

Estimates were made for tube flow rates which would flush perfs and/or fuel elements for the old reactor process tubes. It appeared from laboratory tests that the charge would begin to move at 20 gpm. This information is of value during the procedure used for leak testing.

Miscellaneous. Modification of the Low Pressure Heat Transfer Apparatus to allow use of short test sections for special heat transfer studies of present Hanford reactor fuel elements was completed. In addition, a bus intertie to allow operation of the apparatus with either the motor generators or the silicon rectifiers as a heat generating source was 75% completed.

Plans were completed for the installation of a three-foot electrically heated test section simulating 7-rod cluster fuel element in the horizontal part of the high pressure heat transfer apparatus. Experimentation will be at flow rates prototypical of NPR conditions but at somewhat reduced pressures.

An experiment was run on the high pressure heat transfer apparatus to investigate surface temperatures when boiling conditions change from nucleate to film boiling. A horizontal test section was used which consisted of a 1.43-inch solid rod centered in a 1.690-inch stainless steel pipe arranged so that heat passed from the rod surface to water flowing through the annulus. The rod was heated over a length of 21 feet by passage of direct current from motor-generator sets and was supported in the pipe at intervals of 14-1/2 inches by sets of centering pins consisting of four pins 90° apart.

While the flow was maintained constant at 10 gpm, the heat input to the test section was increased by small steps. At a heat flux of approximately 160,000 Btu/hr-ft^2, the thermocouples at the top of the heated surface indicated a large temperature change as might be expected with a change in boiling conditions from nucleate to film boiling. Further increases in heat flux resulted in a temperature jump by the thermocouples on the heated surface at the bottom of the annulus and then slow gradual increases in temperature of both the top and bottom thermocouples. At a heat flux of approximately 400,000 Btu/hr-ft^2, the experiment was terminated due to failure of most of the thermocouples. At that point the surface temperatures were approximately 1200 F and the calculated exit steam quality was 70%.

Mechanical Equipment Development

Organic Cooling System Components. The MOTS-1 Facility operated for 736 hours during the month with temperature maintained at 300 C and pressure at 275 psig. The chempump and three mechanical seal assemblies have operated satisfactorily throughout the month.

Reactor Technology Development

Neutron and Gamma Attenuation Measurements. The second irradiations to determine the neutron and gamma attenuation properties of iron-serpentine concrete and barite concrete as a function of baking temperature were made in the 105 DR reactor test wells. The foils from the first tests on these two concretes are being counted. Iron-serpentine concrete is expected to have good neutron attenuation characteristics at elevated temperatures due to high hydrogen retention. This concrete is a candidate material for certain portions of the NPR biological shield.

Preparations have been made to place the perforated ferrophosphorus concrete test slabs in the 105 DR test wells during the next reactor shutdown. These test specimens will be used to study experimentally the effects of process tube penetrations on the shielding properties of bulk material.

Preliminary analysis of the foil counting rate data from the first loading of the NPR thermal shield test indicates an attenuation factor for thermal neutrons of about 6×10^{-3} through the one-inch boron steel plate. The second foil loading is being irradiated, and a third loading is ready for insertion at the next available reactor shutdown.

Shielding Instruments. Another leak has developed in the neutron spectrometer chamber. Negotiations are under way with Argonne National Laboratories for the purchase of another chamber of the Perlow type. Construction of the neutron collimator for use with the spectrometer in bulk shielding measurements is 90% complete.

3. FABRICATION DEVELOPMENT

Special Aluminum-Plutonium Fuel Elements

This special fabrication is now complete. A total of 181 Al - 7.4 w/o Pu fuel elements, 8001 Al alloy coextrusion clad with integral end caps have been shipped to SRP for irradiation. In addition, four Al uranium elements were shipped for ex-reactor evaluation. A total of 265 Pu-bearing rods were extruded. The yield on the last 50 rods extruded was slightly better than 80% while the over-all yield was about 65%. The principal reason for this decreased reject rate was an improved outgassing cycle. In addition, modification of the rod straightener dropped the inclusion reject rate to zero. All the transplutonic elements were machined with no radioactive contamination of the machined surface, indicating that chemical etching along was sufficient to minimize the contamination of the can wall during billet assembly.

Plutonium-Aluminum Thin Foils

Several different types of thin foils of a plutonium-aluminum alloy were fabricated. A 1.8 w/o Pu-Al rod was rolled to a thickness of 0.010-inch and 80-1/2-inch diameter discs punched to fulfill the PCTR requirements. All of the bar stock (1/4 x 1 x 6-1/2-inch) for the Oak Ridge National

Laboratories monitoring foils has been rolled to 0.010 inch thick. One of the four bars produced 155 acceptable discs. These have been cleaned, weighed and are awaiting the perfection of the canning operation.

Several pieces of foil were stack rolled with annealing heat treatments between roll passes. These pieces have been rolled to a thickness of 0.002 inch. Three-eighths inch discs containing 0.050 gram plutonium were punched from this thin foil for a USN Radiation Defense Laboratory request.

Special Palm Target Elements

Experimentation with extrusion compacting of mixed Al and oxide cores has continued. Current problems with this type coextrusion include dog-bone near the front end and fishtailing at the rear end. Shear type components are being tried to eliminate fishtails and rounded front cone to sidewall angle is being tried to eliminate dog-bone. The optimum stream line flow angle for this type extrusion is being investigated by sectioning extruded pieces. The angle appears to be approximately 65° included angle.

Sufficient Palm oxide was received from Savannah River to make seven Palm elements, and Hanford supplied enough for 22 normal elements for Campaign V. The Savannah River material was fabricated into seven acceptable elements. Six elements containing the normal quantity of Palm oxide were fabricated from the Hanford material. The remaining quantity was used to make eight elements containing double the quantity of Palm oxide. All of the elements containing the normal quantity of Palm oxide were acceptable. The elements made from the Savannah River material have three to four times as much gamma radiation as those made from the Hanford material. The Savannah River elements were also much more difficult to decontaminate at the extrusion billet stage. They also required caps welded on the rear end of the elements to cover alpha contamination. The contamination and radiation problems were not encountered with the Hanford material.

Four of the elements made with the double quantity of Palm oxide were acceptable. Three were lost at extrusion when the can wall ruptured. Except for the extruded rod and the extrusion dies, no contamination was spread. The dies were subsequently decontaminated. The remaining extrusion was badly dog-boned. The radiographs showed no detectable can wall at one point although no contamination was observed on the outside of the rod. Since there was a great desire to salvage as many of the elements as possible, approximately 25% of the core material was sawed off from this element to remove the dog-boned area. An attempt was made to weld a 1/8" aluminum cap over the exposed core but was unsuccessful.

B. WEAPONS - 3000 PROGRAM

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

C. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Fuels Development

Basic Studies. Sinterability studies on the isomorphous system UO_2-PuO_2 have continued. One-half-inch diameter x 3/8" long compacts containing physical mixtures of the two components have been heated in hydrogen. Sintered density as a function of time and temperature has been determined for times of one and eight hours up to 1600 C. In general, there seems to be a minima on isothermal plots of density versus composition in the intermediate range 20-40 w/o PuO_2. At concentrations greater than 40 w/o PuO_2, density increases rapidly with increasing PuO_2. In every case pure PuO_2 (produced by decomposing plutonium oxalate at 300 C) sintered to a greater density than ball milled PWR grade UO_2. The data, for a one hour soak time, and tabulated in percent of the theoretical crystallographic density, can be seen below:

Temp.	UO_2	PuO_2
1100	63.9	79.6
1200	68.0	82.5
1300	72.5	89.3
1400	76.6	88.6
1500	82.9	93.6
1600	86.2	96.5

These values were obtained by weights and physical dimensions and are less accurate than densities obtained by water immersion. Water immersion densities, however, do not account for the open porosity, and, consequently, the values obtained are somewhat misleading. Densities obtained by water immersion are nearly constant regardless of thermal treatment and indicate the void volume due to closed porosity to be on the order of 10%. Since the density obtained by dimensions does increase with sintering temperature, the densification must be largely due to a decrease in the open porosity during sintering.

The tungsten ribbon furnace for melting point determinations has operated satisfactorily at temperatures in excess of 2700 C. Radiation absorption corrections have been determined for the Pyrex sight glass and the lucite hood face. Uranium dioxide heated to 2400 C in flowing argon possesses a high vapor pressure and an "eruption" of the sample was observed near this temperature. A similar but more severe effect was also observed in vacuo. It is planned to commit the hood containing the furnace to plutonium oxide work during the next month.

Fabrication Studies. Thermal cycling of Zircaloy clad Al-Pu and Al cored elements fabricated by swage sizing is continuing in an effort to further understand the ratcheting mechanism which is occurring during this treatment. The elements are cycled in an autoclave under conditions which

approximate those expected in the PRTR, i.e., heating and cooling rates of about 4 F per minute and a pressure of 1300 psig. All elements have adequate end clearance for thermal expansion. Two eighteen-inch long wire wrapped elements which contain Al-Pu alloy were successfully thermally cycled 59 times between 100 and 350 C. These were spare elements from the fabrication of a 7-rod cluster for KER irradiation. Even though they had both been swage sized, the core in one of the elements was loose at the start of the test and after 59 cycles this element showed no external signs of distortion or loosening of the wire. Radiography indicated that the core had shrunk about 0.045 inch. The other element which had a tight core to start with showed no visible signs of distortion up through 19 cycles; however, the core had shrunk about 0.170 inch. After 59 cycles, this element was corkscrewed with the wire (about 0.100 inch), the surface had bumps approximately 0.005 inch high, the wire had loosened, and the core had shrunk about 0.227 inch. About 20 cycles would be expected in the aforementioned KER test.

Four three-foot long Al-Pu core swage-sized elements which were extras from the fabrication of clusters for ETR irradiation were also successfully cycled 59 times between 100 and 350 C. Three of these elements were wire wrapped. At the end of 19 cycles, the wires were beginning to loosen; however, there was very little external evidence of distortion. Radiography indicated that the cores had shrunk from 0.053 to 0.230 inch. At the end of 59 cycles, however, the elements were corkscrewed, there were 0.005 inch bumps on the surface, the wires were loose, and the cores had shrunk about 0.200 inch on the wire wrapped elements and about 0.300 inch on the element which was not wrapped. The over-all length of the Zircaloy cladding decreased slightly as a result of these tests. The 7- and 19-rod clusters would probably be cycled about fifteen times during their residence times in the ETR. It is felt that the wire loosening problem can be solved by attachment under less tension.

Ten more three-foot long Zircaloy clad elements containing Al cores were fabricated and swage sized to a lesser degree (about 0.002 to 0.003 inch on the diameter). The cores in these elements were loose before the start of the test and probably had a maximum diametral gap of about 0.006 inch. At the end of 22 cycles, five of the elements were straight and appeared unchanged while the other five were bowed. The core length remained unchanged in the straight elements and shrunk as much as 0.6 inch in the bowed ones. Reject tubing was used in this test, and one of the tubes showed longitudinal cracks starting from the inside. These are visible because necking can be seen on the external surface. This element was sectioned, galled areas were observed which are accompanied by extensive cracking of the tubing from the inside. It is felt that less reduction during swaging is desirable and that the application of a lubricant will help prevent galling between the Al and Zr and the resulting distortion of the element. These elements were further cycled to 34 times with the subsequent additional shortening of the cores. Those unchanged at the end of 22 cycles are now beginning to show signs of distortion.

Three rods from the Mark I-B 19-rod dummy cluster, which had received 1200 hours in hydraulic testing with about 100 thermal cycles, have been bisected and examined. Two of the rods were Zircaloy-2 clad and one was type 304-L stainless steel clad. Both were charged with 1/2-inch 1100 aluminum rod, resulting in a slip fit between tube and core of six to seven mils. A 1/2 inch gap was left between core and end cap. One Zircaloy clad rod had lengthened within the cluster and being restrained by the two end brackets was bowed. After disassembling the cluster, the rod was found to bow almost two inches in the center. Measuring the rod for the over-all length proved the rod had increased 1/4 inch. The other Zircaloy clad rod was in excellent shape and showed no external signs of the test. All the stainless steel clad rods were straight, and only one showed signs of lengthening. This rod measured 1/16 inch longer than the original length.

These three rods were bisected by milling two slots through the cladding the full length of the rods. The cores had increased in diameter to an extent that the now free cladding had to be forceably peeled from the core. Measurements were made of core length and inside length between end caps as shown in Table I.

More thermal cycle tests are being run on full length elements fabricated by various processes. A number of experimental pieces were assembled for cycling in the autoclave. This program outline is as follows:

1. Clearances - various clearances between core and can are being effected by swaging in one case and honing in another. A minimum clearance will be established above which ratcheting does not occur.

2. Lubrication - the core is being encouraged to slip (rather than seize) inside the can by the use of alcohol dag, also by etching and autoclaving the inside of the cans.

3. Bonding - mechanical bonding of the can to the core is being tried by heavy swaging. Metallurgical bonding by pressure casting is being investigated.

4. Mechanical relief - various core designs are being tried to minimize stress on the can walls. These include short sections separated by lugs, circumferential grooves, longitudinal grooves, and a "bell and bevel" design. Hollow cores are also being tried.

5. Alloying - various core alloys are being investigated which will have a coefficient of expansion closer to that of Zircaloy.

6. Can materials - study of alternate canning materials such as X-8001 C-810 aluminum alloys and thin-walled 304-L stainless steel, which have been in progress on a small scale for some time, are being accelerated.

TABLE I

Measurement	Core Length			Cavity Length			Over-all Rod Length		
	Original	Final	dL	Original	Final	dL	Original	Final	dL
Rod 1 (Zircaloy Clad & Bowed)	88"	85-3/4"	- 2-1/4"	88-1/2"	88-3/4"	1/4"	90-3/8"	90-5/8"	1/4"
Rod 2 (Zircaloy Clad)	88"	87-5/16"	- 11/16"	88-1/2"	88-1/2"	0	90-3/8"	90-3/8"	0
Rod 3 (Stainless Steel)	88"	87-3/16"	- 13/16"	88-1/2"	88-9/16"	1/16"	90-3/8"	90-7/16"	1/16"

Sixty-four billets were cast this month as follows: 13 Al-13 w/o Pu master alloy billets, 26 Al-7.4 w/o Pu billets, 18 Al-1.8 w/o Pu billets, concluding the fabrication of fuel rods for experimental physics, and seven Al-20 w/o U billets to be used as base material to investigate the properties of some Al-U-Pu alloys.

Analyses of Al-Pu billets produced by four reductions, using Pu oxide, were, in general, far below the nominal 1.8 w/o for which the charge was calculated. Analyses of samples of the flux have not been received; however, radiographs of the billets show no segregation.

A coextrusion, nominally 9/16-inch diameter of seven w/o Al-Pu clad in 1100 Al, was completed. The reduction in area was 20 to 1. Extrusion temperature was 525 C. Can wall variations along the rod length were noticed. Additional billets are being fabricated for coextrusions with integral ends.

Weld closure tests have been run on 0.005-inch 17-7 PH and 0.008-inch 304-L stainless tubing using a 1/2-inch thick end cap; the joint design being the same as that used to close the Zircaloy tubes for the 19-rod cluster. Good results were obtained, and the closure is not difficult.

A loading of 234 1.8 w/o Pu-Al rods was fabricated for the Physical Constants Test Reactor. The Pu used was from a single run, the isotopic content of which had been previously determined. The cores were extruded to 0.501-inch diameter, straightened, cut to length and then slipped into Zircaloy-2 cans. All of the fuel pieces, with the exception of the separable types, had a flat cap welded into one end and a tapered cap in the other. The separable types have a 0.005-inch Zircaloy-2 foil electron beam welded over one end. These pieces are made in two halves; they are assembled by means of a Zircaloy sleeve with monitoring foils held between the "thin window" ends of the rods.

Also included in this loading was the fabrication of 40 foils 0.010 inch thick punched from 1.8 w/o Pu-Al and clad with 0.005 inch of aluminum. The cores were punched from rolled foil and clad by cold welding the aluminum foil.

Fuel Evaluation. The two, high-density, UO_2-PuO_2 capsules (GEH-14-19, 20), which were charged in the MTR on June 8, 1959, were discharged at the conclusion of MTR Cycle 124 on July 20, 1959. Arrangements are being made to have the irradiated specimens returned to HAPO for radiometallurgical examination.

Of the sixteen capsules (GEH-14-5 through 12 and GEH-14-42 through 49) containing Al-5, 10, 15, and 20 w/o Pu and Al-12 w/o Si-5, 10, 15, and 20 w/o Pu alloy cores, twelve were charged into the MTR at the start of Cycle 124. The other four were placed in the reactor at the start of Cycle 125. All of the capsules are to operate at 30 kw/ft. Individual specimens will be irradiated from two to six MTR cycles.

The radiometallurgical examination of the four, high-burnup, Al-Pu, and Al-Si-Pu alloy capsules (GEH-14-23, 24, 25, 26) has been completed with the exception of the burnup analysis and evaluation of the fracture-surface replicas. No significant changes have been noted to date.

The four-rod, Al-Pu and Al-Si-Pu alloy cluster (IP-186A) irradiated in KER Loop 3 is currently being examined in the Radiometallurgy Laboratory. The work is nearly complete. Items to be finished are replica examination, burnup analysis, and x-ray examination.

The seven-rod, Al-Pu alloy cluster prepared for irradiation in the current KER Loop 1 charge (IP-250A) was not charged as scheduled. The cluster irradiation test was postponed until the next scheduled outage of Loop 3 or Loop 1. The element will be delivered to the reactor before August 1, 1959, as requested.

Two of the six PuO_2 impregnated graphite capsules sent to the MTR are now being irradiated in the reactor. These capsules were to be placed in a thermal neutron flux of 7 to 8 x 10^{13} nv for four and eight MTR cycles which will be 25 and 50 percent burnup of the plutonium atoms. At this flux, then, they will be operating with a maximum core temperature of 1432 F (780 C) and a surface heat flux of 161,500 Btu/hr-ft^2.

The three-foot long, seven-rod Zircaloy-clad Al-Pu cluster (GEH-11-1) is now being irradiated in the ETR 3x3 loop facility. Because of a water leak in one of the loop seals, it will be necessary to run the experiment at reduced power for the first eight days. At the end of this time, it is planned to repair the leak and resume full power operation. At full power, the maximum core temperature will be 738 F (394 C) at a surface heat flux of 230,000 Btu/hr-ft^2. The loop pressure will be 2000 psig with an inlet coolant temperature of 480 F and a coolant surface velocity of 12 ft/sec. This element was fabricated by slipping Al-1.3 w/o Pu rods into honed Zircaloy tubes, thereby maintaining not more than 0.004 inch diametral room temperature gap.

The nineteen-rod cluster (GEH-11-2) fabricated by inserting undersized Al-0.5 w/o Pu rods into as-received Zircaloy tubing and sizing the sealed tube onto the core by swaging is scheduled to be charged into the 6x9 ETR loop facility on August 4.

UO_2 Fuel Development

PRTR Fuel Elements. Six hundred fifty pounds of sintered UO_2 for swaging PRTR fuel rods was prepared this month by ball milling, cold pressing, sintering, crushing, screening, and outgassing. Sufficient data were obtained to reach a decision to eliminate the outgassing step. In the future, UO_2 will be held under a vacuum until it is used.

The swaged diameter of PRTR fuel rods was increased to 0.567 $^{+0.001}_{-0.002}$" during the month. The increase of 0.004" was made to produce a finished rod size of 0.560", minimum. Diameter reductions were: light etch - 0.0005";

buffing - 0.0015"; and heavy etch - 0.0020". Most fuel rods in process have been through the light etch twice and through buffing once. Some of the rods have been buffed twice.

Experiments with the newly installed Mackintosh-Hemphill rotary straightener demonstrated that the diameter increases during straightening is a function of pressure applied by the rolls to the rod. By carefully controlling the pressure, the increase in diameter can be limited to less than 0.001", as opposed to the 0.001" to 0.003" growth previously experienced.

A small burr left by counterboring rod ends, prior to end plug insertion, was found to be responsible for a welding problem. The boring procedure was modified to eliminate the burr. This problem again emphasized the necessity for very close tolerances at this step in the process.

The time spent etching end caps and rod ends has been reduced through the installation of etching facilities in the 325 Building basement. Acid disposal equipment is yet to be installed.

A small crescent-shaped corrosion defect was observed in the vicinity of the weld bead on PRTR fuel rods. Examination of this defect by microsection, spectrographic analysis and purposely defecting sample welds established this defect as an aluminum inclusion. The aluminum addition was attributed to aluminum chill blocks. A change was made to use copper chill blocks during the welding operation. Sample welds were made showing the type of defect that may appear in weld areas as a result of aluminum, tungsten, silica, and UO_2 inclusions in the weld metal.

The present PRTR fuel rod end caps are undersize for use with the new swaged rod diameter of $0.567\ ^{+0.001}_{-0.002}$. Six end caps were splined to increase the diameter providing the necessary press fit into the end of the fuel rod prior to welding. Welding of the splined cap appeared to be very satisfactory, with radiographs showing excellent penetration. Microsection examination is being performed to verify these results. The technique of splining or knurling the end cap to provide the necessary fit will be used with future elements.

Installation of a belt sander has simplified the buffing and reduced the time required for finishing swaged fuel rods. Buffing is still a two-man operation, but equipment modifications will reduce it to a one-man job.

A weakness in the design and fabrication of end hangar fittings was found and corrected during the month. The small tubes which join the fuel rods to the end fittings were found to be inadequately attached to the large ring of the top hangar. The attachment was strengthened by a design change which involved larger weldments. All previously assembled fuel elements were disassembled, and the weak end hangars were replaced.

Fabrication Development. Centrifugally cast, thick-walled (0.5") tubes of Zircaloy-2 have been fabricated from cleaned Zircaloy-2 scrap material by Oregon Metallurgical Corporation. Nested tubular PRTR fuel element

end fittings and seam weld caps can be machined rapidly from this material, with little material waste. X-ray inspection of machined end caps revealed no porosity, cracks, or inclusions.

Sintered and crushed UO_2 was compacted in 0.750" OD Zircaloy tubes by vibration and swaged in three passes to 0.563" OD. Elongation of the UO_2 column was measured after each pass, and results indicate that the powder was compacted to its maximum density during the second pass. Elongation during the third pass was greater by about five percent than that produced by the first and second passes combined. The elongation of one rod which had been vibrated prior to swaging was seven percent greater than that of an identical rod which had been tamp-packed prior to swaging.

Densities and cladding thickness are being determined, and additional experiments are being performed to confirm the above results, which indicate that vibration before swaging can reduce the amount of swaging required to compact a given powder to its maximum density, and thus permit starting with smaller diameter tubes.

In other studies, vibration of a 0.505" ID, eight-foot Zircaloy tube

into several pieces, and each piece was filled with UO_2, swaged, and sectioned. Measurements of the defects by microscopy studies before and after swaging indicate that the defects did not increase in depth during the swaging operation. Examination of these defects before and after swaging also indicate that the defects normally are deformed but not lengthened during the swaging operation.

In addition to the swaging tests made on a tube containing a continuous defect, tests were made on tubes containing pit-type defects. Two tubes each containing one pit were filled with UO_2, swaged, and sent through the normal process. When these rods were inspected by the fluorescent penetrant method, they were found to contain one pit each. Macroscopic examination failed to indicate any evidence of defect propagation.

To determine the stability of 18-inch, 7-rod clusters of UO_2 swaged in 0.030-inch wall Zircaloy-2 tubes, and assembled with unbonded wire wrapped spacing members, irradiation experiments have been conducted in KER loops. One assembly, which was discharged from a KER loop in March 1959, is now being examined. Close visual inspection of this fuel element has revealed no evidence of fretting corrosion under the wire wrap. Further examinations, including disassembly and sectioning, will be conducted. A similar 18-inch long, wire wrapped, 7-rod cluster of UO_2 swaged in 0.030-inch wall Zircaloy-2 has just been discharged from a KER loop, after an irradiation of approximately eight months. No warping, corrosion damage, or wire wrap looseness was detected during a preliminary visual inspection in the reactor storage basin. Two four-inch long capsules of 87 percent dense UO_2, hot swaged in 0.030-inch wall Zircaloy-2 cladding have been prepared for irradiation in the ETR to obtain additional data on the irradiation behavior of both the UO_2 and cladding.

A full size PRTR, swaged UO_2, 19-rod cluster fuel element is being flow tested in the out-of-reactor, PRTR mockup loop of the Reactor Engineering Operation. After it had been tested five days under pressure and temperature conditions exceeding those of PRTR operation, the fuel element was removed and examined. There was no evidence of fretting corrosion or loosening of the spacing wires. The fuel element was reinserted in the loop for additional testing.

PRTR swaged UO_2 fuel rods are normally reduced approximately 42 percent in cross sectional area during swaging. To determine the extent of cold work, diamond pyramid hardness (DPH) measurements were performed with swaged Zircaloy-2 cladding and the data compared with those obtained from Zircaloy-2 cold rolled sheet. The hardness measurements indicate that a 42 percent reduction in cross sectional area of a Zircaloy-2 clad UO_2 fuel element by swaging work hardens the Zircaloy cladding to a greater extent than a corresponding cross sectional area reduction on a rolled sheet of Zircaloy. This is not unexpected because a significant amount of elongation, as well as reduction in tube diameter, occurs during the swaging; this elongation increases rapidly during swaging as the UO_2 approaches the maximum density.

The grain structure of the Zircaloy-2 cladding after a 42 percent reduction in fuel element cross section by swaging is not deformed to the same extent as it is in rolled sheet having the same reduction. This is understandable if one considers that during swaging the initial pass essentially "sinks" the diameter of the tube, and the greatest amount of material flow, and therefore grain deformation, occurs in a direction perpendicular to the cross section of the tube after this initial reduction. Therefore, a tube swaged over UO_2 powder does not have the preferred orientation of a solid specimen reduced by rolling. Thus far, there is no reason to believe from ex-reactor and in-reactor test results that the usefulness or integrity of swaged Zircaloy-clad UO_2 fuel elements is in any way compromised by the cold work introduced into the cladding during swaging.

Equipment is being fabricated to thermally cycle sections of tubing containing various types of defects. The tubes will be filled with helium and cycled a predetermined number of times at a pressure of about 150 psi. The upper temperature of the thermal cycle can be any desired value up to 900 C. Both as-received tubing and sections of swaged rod can be cycled in this apparatus. It will not be possible to duplicate PRTR operating conditions, but test results will give some indications of crack propagation during reactor cycling.

A stainless steel clad, vibratory compacted UO_2 fuel element 1.44" OD, gave an indication of radioactivity during MTR startup. The cause of this activity has not been determined.

Swaged capsules containing natural and 2.47 w/o U-235 enriched UO_2 have attained a maximum exposure of approximately 10,000 MWD/T during irradiation in the MTR and ETR.

Basic Studies. Under a joint BMI-HAPO program, the effects of reactor irradiation on the thermal conductivity of uranium dioxide are being determined. Measurements on a UO_2 specimen (94% T.D.) irradiated to 0.005 a/o burnup have been made. Very preliminary data indicate that the low temperature reactor irradiation decreased the thermal conductivity by nearly fifty percent. Heating to 600 C appears to anneal out more than fifty percent of the radiation damage. An interim report of this work is being prepared by BMI; the preliminary data are being used at HAPO to recalculate PRTR fuel temperatures.

Corrosion Studies

Corrosion Testing PRTR Fuel Rods. The use of 48% C.P. hydrofluoric acid and 70% nitric acid in the Zircaloy etch bath was discontinued. The present etch bath uses 52% technical grade hydrofluoric acid and 60% nitric acid in the following proportion:

3.7% by volume 52% hydrofluoric acid;
46% by volume 60% nitric acid; and
49.7% by volume deionized water.

There is no detectable difference in the surface quality of Zircaloy components etched in this bath as compared to the old bath using C.P. grade chemicals.

The safety hazards associated with the etch bath makeup have been reduced with the change-over to technical grade acids. The hydrofluoric acid is presently received in ten-pound bottles, and only one bottle is required for a bath makeup rather than eight one-pound bottles previously used. The 60% nitric acid is piped directly to the etch tank from a scale tank and eliminates the handling of fifteen glass bottles of nitric acid.

The use of a cold-wet autoclave startup has eliminated the necessity for wiping the Zircaloy clad fuel elements and components dry following etching and prior to autoclaving. To date, fifty PRTR fuel elements have been processed without drying prior to autoclaving with no detectable difference from elements which had been wiped dry.

Structural Materials Development

PRTR Zircaloy-2 Process Tubes and Jacket Tubing. The first lot of six Zircaloy-2, PRTR process tubes are ready for autoclaving. These tubes successfully passed the following non-destructive tests:

1. Vidigage measurement for minimum wall thickness.
2. Immerscope ultrasonic test for metal discontinuities.
3. Zyglo fluorescent penetrant for inside and outside surface defects.
4. Eddy current for abrupt wall thickness variations and contamination of internal surface.
5. Radiography of flange and taper.

The balance of the tubes are progressing through the same series of tests. The test results on each tube are reviewed prior to pickling and autoclaving. Sufficient tubes will be processed to maintain a rate of 12 to 18 tubes per week through the autoclave.

Of the 591 Zircaloy jacket tubes segregated as exhibiting point type imperfections on their external surface when subjected to the Zyglo fluorescent penetrant test, 91 were conditioned by surface grinding. Between 0.0005 and 0.001 inch was removed from the wall thickness of the tubes. The Zyglo test revealed that 80 of the conditioned tubes were free of indications. Equipment is being modified to permit rapid processing of all of the segregated tubing. To replace the tubing being rejected by the Zyglo test, an order was negotiated with Wolverine Tube Company. Specifications for the new order include Zyglo testing of inside and outside surfaces, swage testing and flare testing to assure improved quality. The manufacturers believe this quality can be achieved.

Additional ribbed, direct extruded, Zircaloy-2 jacket tubing was received from Nuclear Metals, Inc. These samples represent the closest approach to meeting the specifications achieved by this fabricator. Fabrication

of plain tubing for the nested tubular element has begun at Wolverine and Harvey Aluminum Company. Sample tubes, extruded and cold drawn by Harvey, successfully passed the Zyglo test. The samples are being shipped to HAPO for evaluation.

Radiometallurgy Laboratory Studies

Examination of a 4-rod, 1.6 a/o enriched UO_2, Zr-2 clad cluster from KER-3 continued by obtaining samples for burnup analyses and metallography. Replicas were obtained from the fractured and polished surfaces of one sample of UO_2 that was irradiated to 160 MWD/T. Fission product gas was collected, and cathodic etching was successfully accomplished for a swaged UO_2 capsule. Diameter measurements of a high density (> 93% theoretical UO_2) sintered natural UO_2 capsule showed an increase from 0.007" to 0.064" over the original 1.440" after an irradiation of 450 MWD/T. As a part of the swelling program, electron microscope replicas were obtained from uranium, which had been irradiated to 2600 MWD/T, after annealing the sample for 100 hours at 880 C. Other samples of lower exposures were also examined after various annealing programs. The results and conclusions from this work will be reported in other sections of this report.

Thermal Hydraulics Studies

Thermal Hydraulics Studies Associated with the PRTR. Additional experiments were performed to define the heat flux at which boiling burnout could be expected for the Mark II fuel element. In an electrically heated test section identical to that described in the report last month, boiling burnout was experienced at a heat flux of 1,150,000 Btu/hr-ft^2 with a steam quality of 20% by weight. Melting of the test section upon the initiation of film boiling was prevented by a sharp reduction in heat flux. However, on an attempt to determine another burnout point at different conditions a copper to Hastelloy weld failed. Two other test sections, one of which has a built-in eccentricity of 50%, were nearly completed for further experimentation.

Experiments were run on the full scale electrically heated mockup of the Mark II fuel element to investigate flow instability and flow shifts between the three coolant channels. At tube powers of 700 and 950 kw, the flow to the test section was reduced to where the exit steam qualities were 15.5% and 18.5%, respectively. During these runs all temperatures, pressures, and flows remained normal, and initial analysis of the data indicated no gross effects of flow split or instability. The experimentation was terminated when a copper weld in the electrical lead failed during a power increase to 1200 kw.

The full scale electrically heated mockup of the Mark I fuel element was installed in the high pressure heat transfer apparatus. During initial heating runs a flow leak developed at a weld between one of the Inconel heater rods and a copper lead-in. The test section was removed to repair the leak.

Mechanical Equipment Development

Design Test PR-1 - Discharge Operation Mockup. Fabrication of test components continued during the month. Reporting will be discontinued until installation of the fueling vehicle begins.

Design Test PR-10 - Primary Loop Mockup. The primary process pump was disassembled for seal inspection after 753 hours operation (654 hours of PRTR operating conditions). The seal leakage had risen to a high of 10 gallons per hour but had decreased to five gallons per hour before the inspection. Wear on the seal faces was small, but the stellite face was heat checked. Operation was resumed with a 65 percent seal balance instead of the 70 percent balance in an attempt to prevent the extremely low leakage thought to be responsible for the over-heating. The seal leakage is 0.8 gallon per hour after 250 hours of operation.

Total leakage from the 14-inch gate valve is one gallon after 1017 hours operation and 146 open and close cycles.

The eight-inch check valve was opened for investigation of internal noises. The disc was found to be hitting the side of the valve as well as the hinge bumper. The bumper was built up 1/8 inch with weldment to remedy the trouble.

The Single Tube Prototype Mockup was operated for 525 hours during the month. The prototype pump seal was leaking less than 0.03 gallon per day after 1046 hours total operation.

Design Test PR-13 - Injection Pump Test. Combined leakage of the three plungers increased suddenly from 500 ml/hour at 520 hours operation to over 2000 ml/hour at 551 hours operation. Inspection of the Chevron type packing revealed complete failure to be imminent. Wear on the 440-C plungers was acceptable. Testing with other types of Chevron packing will be continued.

Design Test PR-20 - Calandria Characteristics. The calandria mockup level deviation was measured in relation to size of the gasometer connection. A 1-1/4 inch valve on a top gas line was opened to simulate various size connections. The worst conditions were apparent with the valve wide open.

The rate of rise of the moderator in the calandria was found to be affected by the original level in the moderator storage tank. At lower storage levels, larger gas volume required longer compressor operation to attain equivalent pressure balances.

Volume of Gas	Time to Fill Calandria
12 inches below top of storage tank, plus gas lines	8 min 20 sec
Double original volume (27 inches below)	9 " 10 "
Triple original volume (42 inches below)	10 " 30 "

PR-40 - Shim Control Mockup. The shim control drawings have been revised to incorporate improvements revealed by operation of the mockup. Revised prints and Specification Addendum No. 1 have been sent to the AEC for transmittal to the companies with bid invitations. The second prototype shim control which incorporates the latest revisions is 95 percent complete. Ball bearings, lead screws, and thermocouples have been ordered for the 24 reactor assemblies.

The planetary gear assembly coated with molybdenum disulfide failed after four days operation and a total radiation dosage of 1.25×10^8 R. Some of the binder used in application of the coating came loose and jammed the small planetary gears. The gear assembly using radiation resistant grease designed for high speeds is still operating satisfactorily.

A shim rod made of Inconel "X" has been sent to the Solar Aircraft Corporation for application of a silicon glass coating to investigate the feasibility of protecting the rod and adjacent aluminum parts from galvanic corrosion.

Two sets of ball bearings for the shim assemblies were operated without lubricant at 400 rpm in a 600 F water saturated, nitrogen atmosphere. The first set operated satisfactorily for 570 hours with a 4-pound loading during the last 250 hours. The second set failed after 240 hours using a 15-pound axial loading.

PR-50 - Reactor Piping Seal Testing. A new nozzle hold-down device is being fabricated for testing which uses the original design principles but gives increased strength and flexibility to adsorb the differential thermal expansion between the stainless steel nozzle and the chrome-molybdenum steel hold-down rods.

Leakage collection chambers were installed on the single tube mockup. Initial leakage values appear higher than expected.

PR-51 - Reactor Piping Structural Integrity. The flexure cycling facility was again modified so testing at reactor operating conditions can proceed on the new nozzle hold-down device.

PR-53 - Process Tube Thermocycling and Pressure Testing. A manifold arrangement for monitoring the pressure drop through all sections of the process tube has been fabricated and is being installed. A high pressure (2000 psi) mercury manometer has been ordered for use with the manifold. The fuel element was removed after two weeks operation, found to be in good condition, and reinstalled in the tube.

Special Tools. Designs for tools listed below are complete and fabrication begun:

1. for removal and replacement of the nozzle jumper piping;
2. for removal of the inlet flange;
3. for removing weld on the inlet end of the shroud tube for shroud tube replacement.

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A cut-off saw is being designed, using the principle of a wire blade hacksaw.

PR-60 - RTD Test. Preliminary RTD response time testing on a mockup of 1-1/2 inch outlet piping has been performed on the Single Tube Prototype Mockup test section.

PR-64 - Gas Sampling Technique. Prototype components of the gas sampling system are being fabricated with testing to be concurrent with operation of the Single Tube Prototype Mockup with helium saturated water.

PR-70 - Helium Compressor Test. The Hofer high pressure compressor has been operated 105 hours with only one mechanical failure which was a broken compensator pump return spring. Operation has been erratic and is believed to be caused by condensate injection from the interstage gas cooler to the compressor's second stage. A moisture trap on the interstage cooler is expected to improve performance.

The Corblin low pressure compressor was operated a total of 320 hours. The gas exhaust check valves have been failing after about 100 hours operation. Four stainless steel check valve disc failures so far have caused four sets of punctured diaphrams caused by metal fragments from the valves getting into the compressor cylinder head.

Replacement check valve discs are being fabricated of (1) 304-L stainless steel; (2) 416 stainless steel; and (3) spring steel. The vendor, American Instrument Company, has suggested the use of an alloy steel disc.

A Beach Sta-Dri filter has proven satisfactory for oil removal from the gas stream even while saturated with water.

PR-80 - Air Cooling Duct Test. The plenum chamber to route the air to the fuel element has been designed, and fabrication is 90 percent complete. Testing will be continued to determine pressure drop and air distribution around a fuel element.

Inconel "X" Testing. Four additional Inconel "X" test sections were tested at 1100 F and 5500 to 6000 psi. One section failed after 540 hours, but the other three failed after less than eight hours each. All failed at the bend in the tubing. Test sections have been installed successfully by welding to stainless tubing and by use of compression fittings.

Fifteen specimens of tubing were tested to determine tensile strength, using different heat treatment methods.

Gas Loop Jumper. The first jumper was destroyed when the electric heaters in the furnace failed. The second jumper failed after two hours and through 900 cycles of operation at 1200 F and 480 psig, when the bellows completely separated.

Reactor Technology Development

PRTR Process Instrumentation. Two satisfactory designs on clamp-on RTDs are available. The units supplied by the Charles Engelhard Company are the better as a result of tests to date. A connector of better design at the RTD is being specified as those under test were not satisfactory.

A flow monitor, prototypical of those to be used on each of the 85 PRTR process tubes, has received over two million full cycles at rates up to 80 cycles per minute. The maximum total error in flow is within plus or minus 0.8%. This test has been conducted by IPD in a joint program.

Equipment is being assembled to evaluate the technique of monitoring the surface temperature of irradiated fuel elements in the Fuel Examination Facility.

Preliminary laboratory tests of the calandria dump rate indicator using light refraction and appropriate electronics to achieve a signal show this system to be feasible. The capacitor probe method for detecting changes in liquid level is also being studied.

PRTR Physics Evaluation. A survey of gray shim rod materials which will provide the required maximum shim system strength of about 110 mk has been completed. Those which appear promising from the physics standpoint are Inconel-W, Inconel-X, Hastelloy-B, Monel, Duranickel, and Nickel-zirconium. Initial estimates of the shim system strength for the various alloys were based on one-group theory and neglected the effect of the reflector and enrichment ring. Modified one-group, two-group, and P-3 formulations are being utilized for a more complete analysis and comparison.

Further calculations of the effect of D_2O coolant loss on the reactivity of PRTR have been undertaken. The following results were obtained for the separate effects (cold, clean):

$$\frac{\Delta\eta}{\eta} = 0 \qquad \frac{\Delta p}{p} = -0.001$$

$$\frac{\Delta f}{f} = +0.002 \qquad \frac{\Delta \epsilon}{\epsilon} = +0.010$$

$$\frac{\Delta k_\infty}{k_\infty} = +0.011 \qquad \Delta \frac{k_{eff}}{k_{eff}} = +0.004$$

It is interesting to note that the largest effect appears to be in the fast fission factor, amounting to a gain of 10 mk. The change in k_∞ of + 11 mk is in excellent agreement with the measured PCTR value of + 12 mk for the Mark I UO_2 fuel assembly. Although an increase in k_{eff} of about 4 mk was obtained, no account was taken of streaming or of the presence of enrichment, both of which would tend to reduce this gain. This result is in general agreement with earlier predictions that D_2O coolant loss would result in only very slightly positive or perhaps negative net reactivity changes.

Tritium build-up resulting from neutron capture in the D_2O systems of the PRTR has been recalculated using the most recent design data. In general, only small changes in concentration from previous estimates were observed. Results of this study are reported in HW-61151, "Tritium Generation in D_2O Systems of PRTR."

Debugging of the Fortran version of the SNG reactor code is still in progress. Although elimination of input-output SAP subroutines appears more complex than at first believed, this approach is still being used. A 704 program deck to manufacture the program tape for the 8K-6 tape version of the two dimensional code, CURE, has been made up. It is planned to try to use this program with the 709 compatibility package initially.

Calculations indicate that several inches of iron shielding should be installed on one of the concrete walls of the fuel element examination facility. This additional shielding is needed to reduce the gamma dose rate at the wall to about 100 mr per hour.

Safeguards Analysis. Writing of the Final Safeguards Analysis of the PRTR has started. First drafts of the description of the reactor, description of the site, and reactor operation section have been completed. Supporting analyses for the safety analysis of the reactor are presently scheduled for completion by mid-August. These analyses are:

1. Thermal hydraulics studies.
2. Reactor kinetic analog studies.
3. Loss-of-coolant study.
4. Metal-water reactor study.

Hazards Analysis for Various Mechanical Failures. Calculations were made for the hazards associated with rupture in the steam drum piping taking into consideration the steam volume due to boiling. The results of these calculations indicate that the primary coolant temperature would not increase following a rupture in either the 26" vent line, or the 4" drain line. However, when the 4" drain line and the 6" feed line were assumed to rupture simultaneously, the calculations indicated that an emergency water supply must be injected into the steam drum within minutes following the ruptures. Presently, the manner in which this emergency water will be injected is not firm. Calculations will be made to aid in devising a working scheme.

Calculations were also performed on the hazards associated with process valve malfunctions. In the first case it was assumed that initially the by-pass valve on HX-1 was fully open with the reactor operating at 70 mw. The consequences of complete closure of the valve were then evaluated. In the second case the effects of completely closing the 26" vent line valve of the steam drum during full power (70 mw) operation were determined. The results of these calculations indicated that bulk boiling in the primary coolant would not occur as the result of either valve malfunction.

Design Development

Construction Status. The Phase III PRTR contract is about 10% completed versus a similar amount scheduled. Work has been seriously curtailed since July 13 because of a construction labor dispute at Hanford.

The contractor is continuing to submit detailed approval information on equipment and fabricated items. It appears that the majority of submittals have been received at least once.

The prime coat painting is 25% completed in Cells A and B. Surface preparation for painting is approximately 85% completed. Final coat painting has been demonstrated in the -11 foot level of C cell with evidence of an excessive number of pinholes. A revised surface preparation in the -21 foot level of C cell showed fewer pinholes.

The heavy water storage vessel has been placed in position and the structural steel surrounding the tank is installed. Erection of structural steel in Cell A is about 75% completed.

The helium gasholder has been moved inside the reactor building and lowered into the A cell. Installation has not been completed because the sockets for the gasholder hanger rods were not emplaced into the cell ceiling concrete. Means to properly support the hanger rods are being provided.

The Phase II-A PRTR contractor is approximately 85% complete versus 100% scheduled. The contractor resumed operations on July 16, 1959, after a high water condition subsided; however, work was subsequently curtailed because of a construction labor dispute. The pump base slab was poured, and the inside forms for the final lift of the pump structure were set.

Scope drawing and specifications for design and construction of a 150-foot ventilation stack with stack facilities (HWS-6346) were completed. It is anticipated that the stack package will be placed for bid during August.

PRTR Service Building Extension. The detail design of the service building extension for loop mockup space has commenced. Award of a contract to construct the facility is scheduled for late 1959.

Design Analysis. Contracts for performing piping stress analyses for the PRTR primary cooling system were mailed. Proposals from the three organizations being considered for this work are due on August 3.

A rough draft of a report discussing thermal convection cooling of the PRTR, with particular reference to the effects of helium dissolved in the primary coolant, was completed. Certain modifications of PRTR equipment were recommended.

Programming of the IBM-709 with flow, pressure, and temperature relationships for calculation of primary coolant transients continued. Analog computer results were obtained which indicated that the present primary

coolant system controls will handle all normal operating transients adequately. Because coolant boiling could not be taken into account with the analog computer, the results obtained for abnormal transients lack a degree of realism. However, the analog did show that the pressurizer gas cushion was lost during some power excursions and heat exchanger failures resulted within a few seconds, even if boiling were suppressed.

Reactor and Process Piping. Inspection of process tubes and preliminary runs of pickling and autoclaving are in progress at Hanford. Inspection data from ultrasonic, eddy current, dye penetrant, x-ray and visual examination are being evaluated on a continuing basis. In tubes inspected to date, inspection has revealed some surface scratches generally less than ten mils deep. The importance of these is being studied.

Alignment difficulties caused by welding procedures have been corrected in the fabrication of the process tube inlet valves. The valves have been inspected and shipped.

Core Components. Fabrication of the PRTR calandria and top and bottom primary shields ceased on July 12. All materials associated with this order in the Consolidated Western Steel plant were removed to warehouses in anticipation of a plant shutdown for the steel strike. At this time no action has been taken to attempt to complete the order in other plants.

Instrumentation and Control. Minneapolis-Honeywell has currently received all components of the PRTR automatic control and reactor radiation monitoring system. Assembly of the equipment in panels and wiring is proceeding. The system is expected to be shipped on August 31.

Purchase specifications for the rupture detection system were drafted and are currently being reviewed.

Fuel Element Examination Facility. The design of the control console was completed. The drawings have been issued for comment.

A recheck of shielding calculations has indicated the need for additional shielding at one corner of the Fuel Element Examination Facility. The additional shielding will be in the form of steel plate attached to the outside wall.

The contract for installation of the Fuel Element Examination Facility was awarded to the PRTR Phase III contractor after a negotiated price of $64,000 was agreed upon. The fair cost estimate was $54,000.

Fuel Handler. Bridge and carriage weldments are complete. Some casks have been radiographed. Final assembly drawings and test procedures were received for approval.

D_2O Recovery. Calculations indicate that the 15 psi sealing pressure on the thermal barrier inflatable seal is more than the thermal barrier structure will support. Means to reduce the necessary sealing pressure are being considered.

PRTR High Pressure Steam Loop (Project CAH-841)

All sections of the design criteria have been reviewed in rough draft or outline form; five sections (of ten) have been circulated for comment.

Based on estimates of outer can temperatures in the reference fuel element, it was decided to immerse the fuel element directly in the test section sleeve cooling water as the first approach, and to consider the "dry well" arrangements as an alternate, contingent on the use of a satisfactory high temperature can material.

Duplimat masters of the text of a document discussing the conceptual design of a supercritical pressure power reactor, and copies of the illustrations to be used in the document, were sent to Central Printing. Issuance of the document is expected by August 1.

Rupture Loop Facility

The preliminary project proposal for a rupture loop facility has received all necessary GE approvals. It has been forwarded to the AEC for their approval.

Critical Reactivity Measuring Facility (CAH-842).

Scope has begun on a Reactivity Measuring Facility which will be constructed south of the PRTR Load-Out Facility. The completed assembly will provide for reactivity measurements of irradiated PRTR fuel elements in either light or heavy water. Initial phases of the scope under consideration are the fuel transfer system, a variable lattice, and the reactor assembly details.

Scope has begun on the control and instrumentation system. Present intent is to obtain bids on a package system, containing primarily shelf stocked component units.

Plutonium Fabrication Pilot Plant

Phase II Construction. The PFPP (308 Bldg.) has been accepted, with exceptions, from the Phase II contractor, as of June 30, 1959. Progress of the Phase II contractor on correcting the exceptions was interrupted for a good portion of July, due to construction craftsmen's refusal to cross picket lines established against the Estep Construction Company. Settlement of other exceptions is in the process of negotiation by the contractor and AEC.

Phase III Construction. Completion of work under the Phase III contract is estimated at 69%, compared with 81% scheduled. The electricians' strike against Estep has seriously slowed the Phase III contractor's work. Most of the July progress has been made by crafts other than electrical or pipefitters and has not contributed very much toward the direct completion of rooms. All crafts returned to work July 27.

The Stokes factory representative arrived on July 13, the day the strike started, to check out the 30 kw vacuum melting furnace. He was unable to do so and will be rescheduled as soon as possible.

Painters have familiarized themselves with the technique of applying Phenoline 300 to the point of obtaining readily acceptable floors.

The remainder of the contractor-procured material that has delayed the completion of hood testing has been received during the strike period. Rapid progress should now be made by the contractor toward the completion of several rooms.

The remainder of the x-ray equipment has been received with the exception of the tube stand. The vendor claims to have shipped the complete order, but a thorough search of the records has shown that the tube stand has not been received on plant. Considerable effort has been expended in trying to locate this item with no results as yet. A GE liaison representative has been sent to the factory a second time in an effort to clarify the situation.

The swage facility, Room 132, was orally accepted, with exceptions, from the Phase III contractor on July 6, 1959. An attempt was made on July 2 to accept the room, but electrical corrections delayed the acceptance. Lack of the Fenwal hood fire alarm sensing elements necessitated the exceptions, but the elements are now available and should be installed soon to allow complete acceptance. Development work by operations personnel has been carried on since the acceptance, and Zircaloy clad elements with stand-in material have been swaged.

The billet lathe in Room 114 was orally accepted on July 10, on the same basis as the swage.

Procurement. The 200-ton compacting press has been received, and installation is in progress. All oxide line finishing hoods except one have been received from the Van Vetter Company. The workmanship in these hoods is excellent, and a close inspection has failed to reveal any defects.

Project Schedules. Partial occupancy of the service wing was made during July. Additional operating personnel will move in as they are required.

A new room completion schedule has not been established as yet. The electricians' strike was of nearly three weeks duration and will postpone project completion by about the same length of time.

PRTR Operations Planning

Tritium in PRTR Heavy Water. The expected concentration of tritium in the heavy water systems was reviewed with Reactor Technology Development personnel. Calculations indicate that after a few weeks of operation the concentration of tritium in the moderator and refelctor systems will be such that special radiological controls will be necessary to protect personnel exposed to D_2O from these systems. Since the rate of formation of tritium in the primary D_2O system is much lower, special protection for personnel exposed to this heavy water will not be necessary for approximately eighteen months.

It appears that transfer of D_2O from the moderator system to the primary loop should be avoided to keep the tritium concentration in the primary system to a minimum.

PRTR Handbook. The rough draft of the PRTR Handbook was reviewed and revised. The final draft is being typed at month-end. The Handbook will be issued in September.

Pre-Startup Activities. Outlines of system functional tests were written and are being circulated to interested parties for comments.

Preparation of lecture material and training aids for the PRTR Engineering Assistant training program is complete.

The recently devised valve identification system was implemented during the month to aid in identifying valves for training purposes and in operating procedures.

A revised PRTR drawing list was issued to all interested persons.

Several sections were written for the PRTR Safeguards Analysis. These include: operating program, organization for operation, training program, functional tests, operating procedures, and evaucation procedure.

An evacuation procedure, to include the PRTR, was agreed upon in meetings with the Fuels Preparation Department personnel responsible for evacuation plan revisions. The emergency communication system will utilize a new unlisted telephone in the 300 Area Patrol headquarters.

The need for nuclear incident alarm devices was reviewed with HLO Radiation Protection Operation. As a result of this review, it was recommended that three such alarms be included in the PRTR.

To insure equipment installed by the Phase I and II contractors remains in serviceable condition, the Phase III contractor must operate the equipment periodically. Procedures were written to assist the contractor in properly operating the following equipment: air compressors, water chillers, hold-up tank pumps, service area heating and ventilating system, process area heating and ventilating system, diesel generator, deep well pump, battery equipment and process water pumps.

Design liaison effort during the month included review of the rupture monitor mechanical and electronic specifications, safety and containment circuit revisions and experimental cell access port cooling system.

Bi-weekly meetings were initiated to plan the physics startup tests for PRTR. An outline of proposed tests will be completed August 15 for inclusion in the final Safeguards Analysis.

PRTR Data Processing. A report, HW-60987, "PRTR Data Listing", was prepared. This report indicates all operating data which may be recorded. It was prepared as a step in the preparation of Data Processing plans and to aid in development of operating procedures. An estimate of justification for data logging equipment was prepared. Partial justification can be derived from manpower savings; further intangible benefits were defined.

Construction and Procurement Liaison. A major portion of the Phase I and Phase II BPF data has been received and cataloged. A considerable amount of data concerning mechanical equipment is still lacking. This information has been requested since a complete blue print file is essential.

Cost control procedures have been reviewed with FPD Maintenance to insure no problems would be encountered later in obtaining cost breakdowns between repairs and new work for the various systems within the reactor.

PRTR Staffing. Ninety percent of the non-exempt Engineering Assistants have been chosen; two more remain to be picked. They will report to PRTR on October 5, 1959.

2. BASIC SWELLING STUDIES

Irradiation Program

The first completely assembled temperature monitored capsule containing natural uranium spheres is now being tested in the laboratory prior to in-reactor tests. The purpose of this test is to determine the heater capabilities and instrument response characteristics on the completely assembled capsule.

Components for seven additional temperature monitored capsules are on hand and assembly of a second capsule is under way. This capsule contains spheres of three percent enriched uranium. Information for the preparation of the in-reactor production test document is being obtained. Calculations to determine the irradiation effects on this specific capsule design are in progress.

Mechanisms and Theory

A knowledge of the mobilities of rare gas fission products through uranium is important in understanding the mechanisms of pore formation. In laboratory studies, rare gases are introduced into the uranium surface by

electrical glow discharge (sputtering). The amount of xenon deposited in a uranium surface under various experimental conditions is presently being determined.

Optical and electron microscopy are being used as a direct means for determining the size and distribution of pores in irradiated uranium. To determine the effect of cathodic vacuum etching on pore size in irradiated uranium, a sample containing pores was first replicated in the as-polished condition, etched 20 minutes, again replicated, etched for an additional 70 minutes, and replicated for a third time. No pores were found on the polished surface due to the large amount of flowed metal present. After the short etch, some of the larger pores were visible, but smeared metal was still masking the smaller ones. It was not until after the second etching operation that the worked metal was eliminated, allowing the smaller pores to also be detected. Statistical analysis by operations research will disclose the effect of etching on pore size.

The distortion associated with the replication of pores is being studied by means of pseudo specimens. Statistical analysis of micrographs prepared from 0.4 micron polystyrene spheres embedded in an epoxy resin shows the presence of a higher population of small spheres present than a random section should contain. This may be due to the extrusion of the replicating plastic as it is pulled from a pore which has its center below the cut section. This study will continue, utilizing spheres of various sizes.

A sample of uranium irradiated to a burnup of 0.4 a/o has been annealed at 700 C for 100 hours. Replicas of this specimen have been examined in the electron microscope to determine the extent of porosity. A great number of irregular shaped pores were found, thus lending credence to the low density value of 15.22 g/cc previously reported. A comparison of the observed density with density values calculated from void fractions will be difficult because of the irregular pore shape, but estimates will be made. The range of pore size is 0.2 to 10 microns. Wide bands, free of gas pores, were also observed in the electron microscope. These bands are believed to be grain boundaries because of the polarization effects noted on the optical microscope. Further studies, including autoradiography of these replicas are in progress.

An impact specimen of uranium irradiated at a temperature of less than 300 C to a burnup of 0.1 a/o has been annealed for 24 hours at 600 C. Replicas of the fractured and polished and etched surface discloses no change in the 300 Å pore size.

3. GAS COOLED POWER REACTOR PROGRAM

Graphite Studies

PRTR Pressurized Gas-Cooled Loop Facility (CAH-822). An order was placed with Struthers-Wells Company for design and fabrication of the out-of-reactor portion of the pressurized gas loop facility to be installed in the PRTR. Their bid of $385,000 compares favorably with a fair cost estimate of $420,000.

Testing of critical components of the gas loop is under way. Welding tests are being made on several different types of "super-alloy" strips under consideration for the gas loop. Two flexible connectors have failed in test; the first due to malfunction of these equipment, and the second after 1000 cycles at 500 psig and 1200 F. Two more connectors of this type remain to be tested after which alternate devices will be tried.

Graphite Oxidation Studies. Hollow cylinders of graphite, having approximately three times the surface to volume ratio of the previously utilized solid cylinders, are being used to study the surface to volume ratio effect on oxidation rates. In flowing CO_2 at temperatures between 700 C and 850 C, the hollow cylinders were found to oxidize from three to ten times faster than the solid cylinders. From these preliminary studies it appears that the oxidation rate is not uniform throughout the body even with the small 0.42" diameter cylinders that were used.

Microwaves can be used to generate oxygen atoms and ions in CO_2 and simulate the effect of radiation in making CO_2 more reactive towards graphite. In order to determine the oxygen atom concentration in the CO_2, the gas is titrated with NO_2. The fast reaction of $O + NO_2 \longrightarrow NO + O_2$ is succeeded by the slow reaction $O + NO \longrightarrow NO_2 + h\nu$, and the intensity of the emitted light is used to follow the progress of the reaction. It is necessary to measure flow rates of the NO_2 and CO_2 accurately. A simple device has been constructed which measures low flow rates by observing the volumes swept out during measured time intervals in a calibrated tube by soap films. This device is being used to calibrate rotameters for low flows.

Permeability of Graphite. The apparatus for measuring the permeability of the median range of "impermeable" graphites was calibrated for volume and leak tested. The pressure decay curves were semi-exponential as predicted from theory. Helium and CO_2 were utilized, and it was noted that the helium passed through the graphite several times faster than the CO_2. The leak rate around the graphite sample with helium is in the range of 10^{-5} cm^2/sec (permeability units). Although this is allowable for the present measurements, it will cause difficulties with the more impermeable graphites. The apparatus is being redesigned in an attempt to reach zero leak.

Surface Area and Pore Size Studies. Sixty percent of the time required for surface area determination is spent in outgassing (about three hours per sample at 350 C). Up to the present time the outgassing has been done in the surface area measurement chamber with the result that only one sample at a time could be handled. It has been found that several samples can be simultaneously outgassed in a separate chamber, cooled, and transferred (one at a time) in air to the surface area equipment without affecting the experimental results. This new procedure is expected to at least double the capacity for making these measurements.

Graphite Outgassing Studies. A study has been made to determine if significant amounts of gas are adsorbed on graphite at room temperature, since adsorbed gas can result in uncertainties in the interpretation of the high temperature irradiations. A second outgassing of graphite at 975 C for eighteen hours after exposure to room conditions for twenty-four hours yields about 46 percent of the gas volume desorbed during the first outgassing. This fact points to the importance of minimizing contact between the samples and the air after the initial outgassing. A CO to H_2 ratio of approximately one was observed during the second outgassing. These gases are probably formed by the reaction of adsorbed atmospheric water and graphite in the reaction $H_2O + C = H + CO$.

Gamma Irradiation Facility. The 15,000 curie cobalt-60 source was received and placed in the gamma irradiation facility. The stainless steel encased cobalt rods were arranged in an underwater source holder to enclose a volume five inches in diameter and eighteen inches high. Irradiation damage to plastic samples irradiated in the dry tube indicated a dose rate of 10^6 r/hr. The source is being more accurately calibrated with ferrous sulfate and ceric sulfate chemical dosimeters.

D. CUSTOMER WORK

Radiometallurgical Examinations

Nickel Plated Elements. Three nickel plated, C-64 jacketed, I & E, natural uranium, Hanford production fuel elements, irradiated to approximately 400 MWD/T, were selected from material irradiated under PT-IP-207-A by personnel from Reactor Engineering Operation, IPD. The slugs were transferred to the Radiometallurgy Laboratory for detailed examination to evaluate the nickel plate. The three slugs represent three types of nickel plating -- chemplated 0.0005", electroplated 0.001", and chemplated 0.001". Visual examination of the 0.0005" plated slug showed the nickel plate to be intact over the entire surface of the slug with the exception of one-fourth inch at the female end. A "hot spot" was seen which was approximately one and one-fourth inches wide and extended from one-half inch from the female end to the midpoint of the longitudinal axis. Orientation of the "hot spot" was not possible as rib marks were not visible. Detailed examination of can wall sections showed that a "side hot spot" rupture was probably averted by the presence of the nickel plate. Advanced spheroidization in the AlSi and extensive Ni-Al diffusion show that the maximum surface temperature was at least 400 C in the hot spot. The Ni-Al bond exhibited high integrity over

the slug surface with the exception of the female end. Several small mounds in the nickel, approximately the size of a pinhead, were observed near the female end. The mounds appeared to be associated with the poor bonding in that location of the slug.

Examination of Natural Uranium I & E Fuel Element. The natural uranium I & E fuel element clad in X-8001 aluminum from tube 2762-D was sectioned in the badly pitted area again, and metallographic studies were made. The pits in the can wall went through the X-8001 aluminum, AlSi, bond area and into the uranium, although the element had not been discharged as a suspected rupture.

Two pieces of can wall were removed from one transverse sample of this element for chemical analysis. One piece was taken from the corroded side and contained 1.45% nickel and 1.37% iron. A piece from the opposite side contained 1.36% nickel and 0.623% iron.

Metallography Laboratories

One complete set of Syntron vibratory lapping machines has been installed in each of the two Metallography Laboratories. All accessory equipment is now on hand and the units have been fully tested.

Samples Processed During the Month

Total samples processed: 325

Photographs

Micrographs	189
Macrographs	89
	278

F W McBaugh

Manager, Reactor and Fuels Research
and Development

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
FW Albaugh RM Fryar	7/22	GE-APED, San Jose, Calif.	Discuss APED PRTR audit.	RB Richards	No
NG Wittenbrock	7/8-9	GE-APED, San Jose, Calif.	Discuss reactor hazards problems.	RK Andersen	No
	7/10	W.A. Palmer Films, Inc., San Francisco, Calif.	Discuss technical details of PRTR movie.	HB Butler	No
DJ Foley LC Lemon	7/10	Consol. Western Steel, Los Angeles, Calif.	Discuss PRTR calandria fabrication.	DE Coates	No
MR Kreiter	7/1	Rohr Aircraft Co., Chula Vista, Calif.	Discuss PRTR bellows.	G Adams	No
	7/2-16 & 7/28-31	Consol. Western Steel, Los Angeles, Calif.	Liaison on PRTR calandria and shields.	DE Coates M Ward	No "
SH Bush EA Evans	7/6-10	GE-APED, San Jose, Calif.	Fuel Element Conference	EW O'Rorke	No
FE Young	7/10-11	AEC-IOO & Phillips Pet. Co., Idaho Falls, Ida.	Repair irradiation loop test element.	R Neidner	Yes
WL Wyman	7/21-22	Sciaky Bros., Los Angeles, Calif.	To make weld specimens.	CA Carlson	No
JE Minor DC Kaulitz	7/21	Res. Welding & Engr. Co., Compton, Calif.	Discuss welding contract.	G Garfield	No
	7/22	Sprague Engineering, Gardena, Calif.	Discuss instrumentation.	--	No
JM Davidson EM Woodruff	7/18-22	Great Lakes Carbon Co., Morgantown, N. C.	Discuss NPR graphite manufacturing quality control & inspect processing facilities.	BL Bailey	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
RL Knecht	7/7	Mallory Sharon Metals, Cincinnati, O.	Consult on fabrication of zirconium.	SN Randall	No
	7/8	Allegheny Ludlum, Watervliet, N.Y.		J Preston	"
	7/9	Tube Reducing Corp., Wallington, N.J.		H Spittler	"
	7/10	Superior Tube Co., Norristown, Pa.		H Cooper	"
	7/13	Chase Brass & Copper, Waterbury, Conn.		DK Crampton	"
	7/14	Bridgeport Brass, Bridgeport, Conn.		Mr. Cleveland	"
	7/15	Harvey Aluminum, Torrance, Calif.		GE Moudry	"
RC Aungst	7/14	Aerojet General, Los Angeles, Calif.	Consult on fabrication of zirconium.	L Zernow	"
				GE Moudry	"
RC Aungst JW Riches	7/15	Harvey Aluminum, Torrance, Calif.			
JW Riches	7/16	Bridgeport Brass Co. Riverside, Calif.		RA Quadt	"
C Groot RL Dillon	7/20-23	Gordon Conference, New London, N.H.	Attend conference.	WG Parks	No
RL Dillon	7/27	Alcoa, New Kensington, Pa.	Discuss aluminum.	M Brown	No
	7/8-11	General Atomics, San Diego, Calif.	Consult on aluminum corrosion.	Dr. Simnad	No
SH Woodcock ED McClanahan	7/7-10	LRL, Livermore, Calif.	Discuss Project Whitney problems.	J Jepson WJ Ramsey	Yes
MD Freshley	7/9	MTR, Idaho Falls, Ida.	Emergency repair GEH-11.	R Neidner	Yes
PG Pallmer	7/20-27	ANL, Lemont, Ill.	Discuss Pu alloy fabri-on.	JG Schnizlein	Yes
JH Rector	7/28-29	Bendix Aviation Corp.,	l... ct equipment.	PH Wormel	Yes

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
MJ Sinnott	7/20-26	U. of Michigan, Ann Arbor, Mich.	Consulting Agreement #199	JJ Cadwell SH Bush EA Evans OJ Wick et al	Yes	300, 326, 303, 325;
F Marrujo	7/17-21	Byron Jackson Pump Co., Los Angeles, Calif.	Consult on mechanical seals in PRTR pumps.	PA Scott	No	300, 314, PRTR; 100-D, 189
FH Trones	7/21	Byron Jackson Pump Co., Seattle, Wn.	Same as above	PA Scott	No	Same as above.
AB DeLorenzo RR Hobson	7/21	GE-APED, San Jose, Calif.	Consult on PRTR shim rods.	LT Pedersen DE Rasmussen	No	700, 760
PN Hewett	7/14	Johns Manville Co., Seattle, Wn.	Discuss PRTR seals.	PM Jackson	No	300, 314
C Vail	7/21	Minneapolis Honeywell, Richland, Wn.	Assist in problem on temp. control unit.	BS Kosut	No	300, 326
M Siegler	7/7-8	GE-APED, San Jose, Calif.	Discuss heat transfer test & view high pressure loops.	RJ Lobsinger TF Demmitt	No	100-K, 1704-K, 1706-KE
E Craig	7/13	Vallecitos Atomic Lab., Pleasanton, Calif.	Discuss HAPO contract.	JM Davidson JW Helm.	No	300, 326
GI Parker	7/21	Lepel High Freq. Labs., New York, N.Y.	Servicing engineer contract.	JL Jackson	No	300, 326, 3730
RH Michel	7/31	Allis-Chalmers Mfg. Co., Washington, D.C.	Discuss irradiation of graphite cementing materials.	EM Woodruff	No	300, 326

VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
HL Yakel, Jr. WC Ulrich RJ Gray	7/1-2	ORNL, Oak Ridge, Tenn.	Discuss hot labs & equipment.	LD Turner LA Hartcorn ID Thomas	Yes	300, 326, 327, 200-W, 2704-Z
EA Wright	7/20-	Wolverine Tube Co., Allen Park, Mich.	Consult on fabrication of Zircaloy.	HP Oakes	No	700, 703; 300, 306, 314, 325, 326; C-25 WB
S Amelinckx	7/23-24	MOL, Blegium	Discuss radiation damage to materials.	DR deHalas RE Nightingale HH Yoshikawa	No	300, 3760 PRTR
J Burtulis	7/29-30	SRL, Savannah River, Ga.	Discussions on zirconium.	JW Riches et al C Groot	Yes	300, 306, 326, PRTR
JF Willging Mr. Schornhorst	7/8-10	Dow Chemical Co., Denver, Colo.	Discuss plutonium metallurgy.	OJ Wick	Yes	200-W, 2704-Z 231-Z
Paula Naillon J Bryan	7/16	LRL, Livermore, Calif.	Discuss fabrication problems.	RW Stewart	Yes	200-W, 2704-Z, 231-Z
Messrs. Fisher, Kesser, Feder, Levenson	7/22	ANL, Lemont, Ill.	Discuss fuel fabrication.	OJ Wick	Yes	200-W, 2704-Z, 231-Z

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

JULY 1959

FISSIONABLE MATERIALS - 2000 PROGRAM

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION REACTORS

Lattice Neutron Temperature Study

Experiments to determine the feasibility of using lutecium foils to measure the effective neutron temperature have continued. Foils, 8 mg/cm^2 thick, were irradiated in a monoenergetic beam of neutrons of energy 0.14 ev. The activity produced by the 0.14 ev resonance neutrons had a half life of 7 days. Therefore, this experiment corroborated the fact (reported in BNL-325) that the resonance at 0.14 ev belongs to the cross section of Lu^{176}. It appears, then, that the Lu^{175} cross section has resonances which, in a reactor spectrum, would shield the foils more effectively than those of the Lu^{176} cross section. This fact is also evidenced in cadmium ratios obtained in the internal column of the TTR. These ratios were 4.68 ± 0.05 and (4.1 ± 1.3) x 10^2 for the Lu^{175} and Lu^{176} isotopes, respectively. Cadmium ratios of other elements were also obtained. The results of these latter measurements will be reported next month.

The branching ratio for beta decay of lutecium 176 is not known. This quantity is necessary for the determination of the activation cross section. Its determination would make possible the measurement of neutron temperatures without first running a series of calibration experiments in a heated thermal column. The calibration experiments would be required because of the various counting methods and counting efficiencies in use.

The double-focusing beta-ray spectrometer is ideally suited for the investigation of the beta decay of lutecium. For this purpose the spectrometer is being reactivated. The equipment has been assembled, and some of the instruments checked out. A few of the pieces necessary for the operation of the spectrometer could not be located. Plans are being made for the fabrication of the missing units.

Neutron Temperature Coefficients

An IBM 709 program to generate a nuclear data tape has been written and debugged. Work has begun on a program to up-date and correct the nuclear data tape.

Cross section data for approximately ten elements has been processed and is being keypunched. Subroutines to generate a file of microscopic cross sections from punched cards, and to print out the contents of the cross section tape have been completed and checked out.

The best choice of a trial function in a variational principle was investigated under the assumption that the adjoint function can be approximated by a polynomial of degree n. It was found that the parameters in the trial function are then determined by the condition that its first n moments be given correctly. This result was applied to the estimation of the effective neutron temperature in an absorbing medium. A plot has been made of the ratio of neutron to moderator temperature as a function of $\Sigma_a/\xi\Sigma_s$ for the moderator.

A thermocouple-recorder system for use in the temperature coefficient measurements has been calibrated over the range 0°C to 625°C.

Thermal Neutron Flux Spectrum Near a Temperature Discontinuity

Debugging has been completed on the modified SYZYGY program for calculating the analytical flux spectrum and the normalized 1/v reaction rate with net current flowing across the plane interface. The results of a few sample cases show the expected spatial shift of the transition region in the direction of the neutron current.

The modified FX, able to handle two thermal groups, was compiled several times and several debug runs made. The program was miscompiled (machine error) once. The other problems have been caused by interval cycling of the IBM-709. Whether this is due to programming or compilation errors is not known. The program was modified to permit more complete output of intermediate results, and debug runs are being made daily.

A summary of past work has been submitted to the ANS for inclusion in the 1959 Winter Meeting. A manuscript for publication in Nuclear Science and Engineering is in preparation.

Work is currently proceeding toward the design of cylindrical graphite, water and fuel regions in the PCTR core to investigate more complicated geometries, moderators, and fuel systems.

Instrumentation

The stack gas effluent monitor is still in operation at 100-F. In general operation, the circuitry is adjusted to count the I^{131} photopeak (364 kev). Four charts have now been run with no readings obtained over about twice "normal" or installed background. The instrument will be left in service with some coordination necessary with 100-F Area personnel to inform us when a fuel element rupture has occurred in the F reactor.

The circuitry for input logic, magnetic core drives for reading in and reading out of information (including horizontal and vertical line drives and inhibit drives) has been completed in the simple computer. These units are transistorized with the exception of a sequencing pulse string. The horizontal, vertical, and inhibit lines are driven by transistor switches rather than transformers. Considerations are being given to output logic circuits to perform the arithmetic operations for which this particular application of magnetic core storage devices was devised.

Two of Westinghouse's miniature solid-state neutron detectors (for slow neutron flux measurements) are being purchased for evaluation purposes and possible initial application in the PCTR. The expected characteristics for this detector are as follows:

1. Water tight
2. Sensitivity: 0.5×10^{-4} cps/nv (thermal)
3. Maximum diameter (except at connector end): 80 mils
4. Life: 10^{13} nvt minimum
5. Operating temperature: 75°C maximum

With this device, the flux at a given point in the PCTR versus control rod position could be measured.

The experimental investigation of optical techniques for measuring in-reactor graphite temperature continues with development of a suitable sensing head for measuring color temperature in the range 500 to 1000°C. Study of the characteristics of arsenic trisulphide indicates that it can be used in conjunction with a lead sulphide photoresistor to obtain a narrow band wavelength filter in the region between two and three microns. The response of lead sulphide cells to radiation from a tungsten filament was studied. The temperature of the tungsten filament was measured with a thermocouple. Usable responses were measured below 500°C as well as in the range 500 to 1000°C. A mockup unit is now being assembled to determine the sensitivity to color temperature variations. Indications are that the Radiation Reference standard needed for this work will not be received until the first week in August.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Exponential Pile Measurements of Large Diameter Fuel Elements

The series of material buckling measurements on lattices using 1.92-inch diameter solid fuel elements has been completed. Final buckling values not previously reported are given in Table I along with other pertinent information.

TABLE I

Lattice Spacing	Buckling (10^{-6} cm^{-2})	Side-Side λ (Inches)	Volume Ratios Al/U	H_2O/U	C/U
12 3/8 wet	+ 34	2.11	0.264	0.288	51.31
12 3/8 dry	+ 102	2.25	0.264	--	51.31
10 3/8 wet	+ 70	1.56	0.264	0.288	35.60
10 3/8 dry	+ 127	1.50	0.264	--	35.60

λ is the extrapolation length. The same front-to-rear λ of 1.03 inches was used for all lattices.

The buckling measurements on one lattice using a 2.5" x 2.0" with 1.66" x 1.1" tube and tube fuel element are complete. Final bucklings are listed in Table II.

TABLE II

Lattice Spacing	Buckling (10^{-6} cm^{-2})	Side-Side λ (Inches)	Volume Ratios Al/U	H_2O/U	C/U
14 9/16 wet	- 123	2.25	0.487	1.089	68.48
14 9/16 dry	+ 55	1.79	0.487	--	68.48

The front-to-rear λ used was 1.03 inches.

A new series of buckling measurements using a tube and rod fuel element has been started. Results of the first measurement are given in Table III.

TABLE III

Fuel Element	Lattice Spacing	Buckling (10^{-6} cm^{-2})	Volume Ratios Al/U	H_2O/U	C/U
2.5 x 2.0 with 1.17 solid	14 9/16 dry	+ 74	0.305	--	51.25

The buckling value quoted in Table III is tentative based on an estimated side-extrapolation length of 1.66 inches. The final buckling will be reported after analysis of horizontal traverse data.

A new COFIT program to analyze horizontal traverse data has been written and debugged. The program is now being routinely used for analysis of all horizontal traverses.

Further studies have been made on the problem of determining extrapolation distances. The cadmium ratio has been measured in several horizontal traverses to determine the lateral extent of the region of constant cadmium ratio. Generally only the outer points near the last process tube had a different cadmium ratio, which would indicate that these outer points should not be used in the Cosine fit to determine the extrapolation distance.

Horizontal traverses taken at different points in the cell have indicated that λ is definitely a function of the position in the cell where the traverse is taken. In one lattice the traverse at the corner of the cell was fitted by $\lambda = 1.96$", while the traverse taken directly between process tubes was fitted by $\lambda = 1.50$". This could be a significant factor in evaluating past buckling measurements, since past traverse locations were determined more by experimental convenience than consistency.

The variation of λ with the height of the horizontal traverse has been studied, but not completely analyzed.

It appears that workers in Sweden are having the same trouble with λ that we are experiencing. They use a D_2O exponential tank only 1 meter in diameter and analyze the data with a theoretical λ. Their results show the bucklings about 30 x 10^{-6} cm^{-2} high compared to critical measurements at Saclay. A difference of 1.1" in λ would account for this discrepancy. Since the theoretical λ for D_2O-U systems is about 0.5", they need a λ of 1.6" to get agreement with

critical measurements, and a λ of 1.6" would be right in the middle of the range of λ's we are measuring in the present series.

PCTR Measurements of Lattice Parameters of Large Diameter Fuel Elements

a. k_∞ and f Measurements for Selected Cluster Elements.

Preparations for the measurement of k_∞ and f for a 7-rod cluster of 0.926" natural uranium rods in a 7" graphite lattice are almost complete. This will be a negative k_{ex} measurement to test the feasibility of such measurements in the PCTR. The cluster will be enriched up to $k_\infty = 1$ with J metal placed at the edge of the cell. The J metal location has been changed from the previous plan of wrapping it around the process tube, since it was found that changes in p and ϵ due to the J metal are more easily interpreted in the new location.

The IPD survey code predictions were compared with the exponential measurement on the natural cluster and the PCTR measurement on the enriched cluster, both at 7" lattice spacing. The calculation on the exponential measurement was 3 mk high and would be expected to be 7 mk high for a PCTR measurement on a natural cluster, since k_∞ from exponentials has been typically 4 mk above PCTR measurements. The calculation on the PCTR measurement for the enriched cluster was 19 mk high, so the residual 12 mk must be a combination of experimental error and improper theoretical treatment of the enrichment. These factors are of major interest since the Survey Code is used in predictions involving enriched cluster fuel for the NPR.

b. PCTR Measurements on Solid and Tube-and-Tube Fuel Elements

Design of the lattice and fuel elements is proceeding for measurement of k_∞, f, p, and ϵ for a 2.5" diameter solid element, and a tube-and-tube element using a 1.66" x 1.1" tube inside a 2.5" x 2.0" tube, both in a 10 1/2" lattice.

Extrapolation of buckling measurements combined with theoretical predictions indicates that the tube-and-tube will have k_∞ around 0.97 with water coolant.

c. Improvement of Methods for p and ϵ Measurements

Studies on obtaining scintillation counters with uniform efficiency across the central region of the face have been extended to the 1/2" x 5" crystal and a 1" x 3" crystal. The response of the 1/2" x 5" crystal was satisfactorily flattened, but this required many absorbers. The 1" x 3" was flattened only over 1" of the face, requiring a stack of absorbers about 1" high. As a result of these studies, a 2" x 5" crystal has been ordered for future use in counting large foils whose activity is non-uniform.

An investigation of the availability of additional highly depleted foil revealed that no more is available, and that production of additional material would involve prohibitive cost. However, Oak Ridge can reclaim quantities of uranium as small as 1 gram, and they could probably reprocess our depleted foil.

Full Scale PCTR

A tentative physical layout of the Full Scale PCTR has been completed.

Critical mass calculations are in progress which include the uranium in the end reflectors as well as the drivers. The results will be normalized upon a comparison of the experimental and calculated values for the present PCTR in order to increase the accuracy of the calculations.

Effect of Absorbing Cylinder on Thermal Neutron Flux Spectrum

Investigation continues of the effect of an absorbing rod on the thermal neutron flux in an infinite, nonabsorbing moderator. The coefficients of the analytic solution are being evaluated under the assumption that the reciprocal of the rod blackness varies linearly with energy. This assumption possesses the attractive features of being reasonably realistic physically and tractable mathematically. The mathematical result is a three-term recursion relationship for the coefficients. A program for numerical solution of this recursion formula has been written and compiled and is now being debugged. Preliminary hand calculations indicate that convergence difficulties may be present, and means of surmounting them are being investigated.

Computational Programming Services

The Experiential Data program is operating satisfactorily. Input-output format changes initiated last month are working and the program is in use. Some modifications of the Cofit program have been made and it is conditionally operational. A report on this program has been written and is being prepared for publication. The incomplete gamma function subroutine is ready for use pending a decision regarding the range of arguments to be permitted each approximation. The possibility of a program to extend the effective FORTRAN memory of the 709 is being explored.

A Program for Analyzing PCTR Data

The foil data processing program is in the debug stage. A combination of programmer and IBM-709 errors has contributed to the delay. The program should be available for production use shortly.

A short program was written as an aid to reduction of data taken in temperature coefficient measurements. Temperature readings from twelve thermocouples attached to a Brown recorder are analyzed. The present program reads in temperature readings as a function of time and interpolates to prepare a table of temperatures as they would have read had they been recorded simultaneously at one minute intervals. Data for a test case are being keypunched.

Improved Methods of Reactor Parameter Calculations

Numerical comparison of methods used in the calculation of effective values of diffusion coefficient and diffusion length for a simple heterogeneous system consisting of a solid rod of natural uranium in a graphite moderator has been completed. Results will be presented in the Nuclear Physics Research Quarterly Report for April, May, and June. At present, a comparison between the lattice parameters as calculated by the IPD "IDIOT" program and the IPD Survey Code is

being made for cluster, rod-and-tube, and tube-and-tube elements.

Instrumentation

A proposed new idea for a possible fuel failure detection system for the NPR has been favorably received and is being included in the Design Criteria being prepared by CEO. This system has a primary monitor which mechanically scans the gross gamma activity of 100 samples of coolant with one detector at a rate sufficiently rapid to be the equivalent of continuous monitoring with 100 detectors. Calculations based on experimental data indicate this system would have sufficient sensitivity to detect, within 60 seconds after failure, failures which release at least 100 milligrams per minute of uranium and fission products. A secondary monitor uses methods of gamma-ray energy spectroscopy to monitor each sample at least once every forty minutes with higher sensitivity. This can be used to detect and give warning of "slow leaker" or "pinhole" type failures, for confirmation of primary monitor signals, and for identification of unusual non-fission-product activities in the coolant. A program for development of demonstration prototypes of this system is being prepared. Compared to alternate systems which use individual detectors to monitor samples from each process tube, this system offers opportunity for very substantial initial and operating cost savings, improved reliability, and reduced ambiguity of interpretation.

A report is in preparation on the principles of instrument reliability to provide a better understanding of their applicability at Hanford.

Possible application of two new types of control systems to reactors is under study. One is the sampling at discrete intervals rather than the continuous measurement of the controlled element. The other is the use of adaptive controls in which control characteristics automatically change as a function of system response.

STUDIES RELATED TO THE NEW PRODUCTION REACTOR

Gamma Production and Penetration in Borated Steel

A slow neutron source was used to measure the resultant gamma spectrum and intensity produced in beam geometry through samples of borated steel. Samples of varying thickness of steel with different types and amounts of boration were compared with mild steel for the resultant gamma radiation spectrum and intensity. In general, it was found that the addition of 1.5 percent boron to the steel reduces both the hard and soft gamma radiation from the surface by a factor of approximately six. In contrast, the addition of a boron fritt layer to mild steel had a relatively small effect. An informal report on this study is being prepared.

Mechanism of Graphite Damage

Exposures of Kendall coke graphite samples to electron beams were extended to higher values. The first sample, irradiated to a total of 5200 microampere minutes, showed no expansion within the limits of detectability of the equipment. A second exposure, to 19,000 microampere minutes, also showed no detectable expansion due to radiation damage. Both samples were cooled to

near liquid nitrogen temperatures during exposure to reduce the effect of annealing by heating in the beam.

STUDIES RELATED TO SEPARATIONS PLANTS

Analysis of a Possible Nuclear Incident

A study of the possible consequences of a maximum credible incident in the Redox dissolver has been completed.

Three types of incidents were investigated. The first type consisted of a single burst occurring in a localized region of abnormal solution concentration in the dissolver. Following the initial burst the action of radiolytical gases would mix the system thus reducing the abnormal concentration.

This type of incident would be similar to the Los Alamos incident of December 1958. The burst would involve approximately 1.6×10^{17} fissions and would last for approximately 0.45 sec.

The second type of incident considered was that resulting from a supercritical condition in the dissolver in which the excess reactivity was very small so that the period or e folding time for power increase was much longer than the e folding time for heat transfer from the fuel elements. Under these conditions the system would boil until enough moderator-reflector had been boiled away to terminate the reaction. Assuming a reduction in moderator height of 1 cm to terminate the reaction, this incident would involve approximately 2.9×10^{19} fissions and would take approximately 37 minutes to heat up and approximately 70 minutes to boil away the necessary moderator-reflector. During the boiling stage the system would operate at a power level of approximately 17 kw.

In the third type of incident the dissolver was loaded with fuel elements. Additional material was added to make the system prompt critical or near prompt critical, the important point being that the e folding time for power increase is much shorter than the e folding time for heat transfer from the fuel elements. A burst of about 10^{19} - 10^{20} fissions results, however, almost all the heat caused by the incident (89% of the energy release) is retained in the slugs. As a result the slug temperatures rise very rapidly and severe exothermic chemical reactions between uranium and water and aluminum and water result. The nuclear reaction would probably end here due to the expulsion of moderator-reflector from the system as a result of the chemical action; however, the chemical reactions would probably continue. Very little experimental data are available concerning these exothermic chemical reactions; however, there is available an energy release of 4×10^{7} kw-sec. which would be sufficient to rupture the dissolver and cause severe damage to process lines and possibly the dissolver cell.

The third type of incident is then considered to be the maximum credible incident.

Due to the uncertainties which exist in calculations of this kind and in the assumptions concerning the burst mechanism these results are only qualitative and give perhaps no more than an order of magnitude for the number of fissions in each case.

Critical Hazard Specifications

Nuclear Safety in 234-5 Building Processing

The following is a tabulation of the estimated critical masses for plutonium metal-plutonium solution systems in spherical geometry. The results are based on a two region-one group method previously used. The corresponding equivalent cylinder diameters are also given. The calculations are based on plutonium metal surrounded by "solutions" of plutonium polymer.

Sphere Diameter (Inches)	Cylinder Diameter (Inches)	Critical Mass (Metal + Solution) (Kg Pu)
4.09	2.5	5.85
4.83	3.0	4.50
5.57	3.5	3.65
6.29	4.0	3.00
7.71	5.0	2.00
9.12	6.0	1.15

The critical mass of 1.15 kg Pu in a 9.12-inch diameter sphere contains essentially no Pu metal. This critical mass is essentially equal to that derived for polymer-water systems in water-reflected spheres of this size.

Plutonium Critical Mass Facility

Construction was halted on the Plutonium Critical Mass Facility (Project CG-731) during about 60 percent of July because of the strike situation. It is reported that the normal complement of construction personnel returned to work on July 30. Despite the work stoppage the contractor is presently on schedule.

The 234-5 Development Operation of Research and Engineering, CPD, has prepared small samples of PuO_2 in polyethylene, paraffin, and methyl methacrylate, preliminary to the potential needs of the Critical Mass Facility for larger quantities of this kind of material for critical mass experiments. Data for some of these samples are given below:

	H/Pu
PuO_2 - Methyl methacrylate - 1185 gm/L	15
PuO_2 -paraffin - 1680 gm/L	15
PuO_2 -polyethylene - 1800 gm/L	15
PuO_2 -polyethylene - 2300 gm/L	10
PuO_2 -polyethylene - 3100 gm/L	5

Of particular interest in the critical mass program is the minimum critical dimensions for Pu oxide water systems in which the plutonium density in the slurry has a maximum of 2-4 gm/cm^3 with H/Pu ratios in the region of 10-25,

since the mixture of optimum moderation for a plutonium precipitate (polymer formation) is thought to occur in this region. PuO_2-CH_2 mixtures are being considered as a possible substitute for the plutonium precipitates in these experiments.

Criticality Studies in Support of Processing Power Reactor Fuels

Exponential and critical approach measurements were continued with the 0.600-inch diameter rods of 3.063 percent enriched uranium in water moderated and reflected systems. The expression which gives the critical buckling from the exponential measurement may be equated to that which gives the buckling from the critical approach measurement so as to yield values of both the extrapolation length (λ) and the buckling (B^2). The relationship which exists between the two formulas is as follows:

$$\left(\frac{2.4048}{R+\lambda}\right)^2 - \left(\frac{1}{b_{11}}\right)^2 = \left(\frac{2.4048}{R_c+\lambda}\right)^2 + \left(\frac{\pi}{H_c+2\lambda}\right)^2$$

R is the radius of the loading in the exponential pile, and b_{11} is the measured relaxation length. R_c and H_c are the critical radius and height as determined from the critical approach.

The exponential measurements were made with fuel rods 32 inches in length; these rods were encased in 1/32-inch wall lucite tubes. Relaxation lengths and radii from the exponential measurements are given in the following table:

Lattice Spacing (Inches)	H_2O/U (Volume)	R (Cm)	Relaxation Length (Cm)
1.200	3.41	13.10	35.58
1.300	4.18	13.54	35.05
1.420	5.18	14.79	41.24
1.600	6.84	17.20	37.99

As a safety precaution, prior to conducting the exponential measurements a critical approach was made for each of the lattices with the 32-inch long fuel rods. The lattices were loaded to within 96 percent of the critical number as predicted from the inverse multiplication plots. The following critical mass values were determined for the 32-inch fuel rods.

Lattice Spacing (Inches)	H_2O/U (Volume)	$N_{critical}$ (Fuel Rods)	Critical Mass (lbs.)	R_c (Cm)
1.20	3.41	79.9	495	14.30
1.30	4.18	74.1	459	14.92
1.42	5.18	73.8	457	16.27
1.60	6.84	82.4	510	19.37

The extrapolation lengths and bucklings as determined from the exponential and critical approach measurements are given in the following table:

Lattice Spacing (Inches)	H_2O/U (Volume)	With Critical Approach Data** for 16-inch Fuel Rods λ (Cm.)	With Critical Approach Data** for 16-inch Fuel Rods B^2 ($Cm^{-2} \times 10^{-6}$)	With Critical Approach Data for 32-inch Fuel Rods λ (Cm.)	With Critical Approach Data for 32-inch Fuel Rods B^2 ($Cm^{-2} \times 10^{-6}$)
* 1.000	2.06	6.30	14,656	5.96	15,225
* 1.100	2.71	6.50	14,885	6.60	14,720
1.200	3.41	5.82	15,365	5.60	15,755
1.300	4.18	6.18	14,057	5.94	14,426
1.420	5.18	5.84	13,000	5.93	12,872
1.600	6.84	5.44	10,590	5.56	10,461

* Measured the previous month.
** Critical approach data for 16-inch fuel rods were obtained previously.

The results for λ and B^2 using the critical approach data for the 32-inch fuel rods must be qualified since it was necessary to support the core directly on an aluminum plate because of lack of room. This interposed about 1/2 inch of aluminum between the core and the bottom water reflector. In addition, the critical dimensions of the lattices with the 16-inch fuel rods were more amenable to the analysis resulting in smaller errors for λ. Because of this the values for λ and B^2 as calculated with the criticality data for the 16-inch long fuel rods are considered more accurate.

The error in λ appears to result primarily from the uncertainties in the exponential measurements rather than in the uncertainties from the critical approach measurements.

Miscellaneous Experiments for Nuclear Safety Specifications

A re-evaluation of the k_∞ measurements on UO_3-H_2O mixtures of low enrichment is nearly completed. A total of 14 k_∞ measurements involving 37 different reactivity coefficients in the PCTR are involved in the re-evaluation. All experiments are being re-examined and k_∞ recalculated in view of the information obtained from the recent measurements of the adjoint ratio m_1/m_2 in a mixture of 1.006%-enriched UO_3 and H_2O with an H/U atomic ratio of 4.99.

This experiment showed that the ratio m_1/m_2 in the mixture in the PCTR was matched to the m_1/m_2 characteristic of the system UO_3 + H_2O + containers for the same conditions under which the flux ratios ϕ_1/ϕ_2 were matched. This information together with reactivity measurement data with extra poison on both the central and void cells permits the calculation of a correction to Δk_∞ due to the presence of the thick aluminum containers.

It appears that the values of Δk_∞ for these mixtures will not be significantly changed from those previously reported. However, interpretation of the uncertainties in terms of confidence intervals should now be possible.

A preliminary analysis has been made of the data obtained in the PCTR during June for determining k_∞ of a homogeneous mixture of 1.006 percent enriched UO_3 and H_2O with an H/U atomic ratio of 4.99. The value of k_∞ is 0.986 ± 0.005.

This result is significant in that previous measurements had indicated a value of 1.02 ± 0.02 w/o as the measured U-235 enrichment for which homogeneous mixtures of pure UO_3 and H_2O would have $k_\infty < 1$ unity, with the highest value of k_∞ occurring for an H/U atomic ratio of about 5. The latest measurement is in agreement with the previous results and gives further credence to the earlier analysis.

Critical Mass Theory

The program for integration of the reactor kinetics equations with N groups of delayed neutrons and time dependent reactivity has been modified to reduce significantly the number of time increments needed. The modified program has been compiled and is being debugged.

Mass Spectrometry

The mass spectrometer for heavy element analysis was put into operation for the first time following the successful assembly of the kovar-to-glass seal of the ion source. A beam of potassium ions originating from impurities in the sample filament was analyzed and detected using only a vibrating reed electrometer at the collector. The various faults of the instrument components are presently being discovered and repaired and alignment of the spectrometer is in progress.

NEUTRON CROSS SECTION PROGRAM

Absolute Fission Cross Sections

A parallel plate BF_3 chamber was fabricated and tested. A pulse height distribution has been observed which is not adequate to allow a precise measure of counting efficiency. The cause of the poor pulse spectrum is not known at present.

No fission foils have been received from off-site for intercomparison fission counting.

Slow Neutron Scattering Cross Sections

Early in the month a gas leak developed in a thermocouple hole which is partially covered by the three axis crystal spectrometer shielding. The resultant gas activity required the use of fresh air masks for the operation of the spectrometer and greatly restricted the work on scattering cross sections. The gas leak was fixed at the expense of unstacking the spectrometer shielding. Since so much time was lost in the realignment necessary after unstacking the shielding it was decided to spend a somewhat longer time and re-evaluate the alignment of the whole system. Two disturbing features have been uncovered to date: 1) the first (fixed) axis of the spectrometer was apparently installed about 1/16 inch off of the beam hole center line, and 2) the second collimator holder which was always difficult to adjust can no longer be moved and is frozen in a misaligned position. These faults prohibit the use of the spectrometer for high resolution work.

Considerable evidence now exists that it is possible to obtain a practical monochromating crystal which will yield up to ten times the intensity previously used in neutron differential scattering measurements. All of the present effort is consequently directed toward finding the proper crystals. As part of this effort a new crystal growing furnace has been put into operation for the production of single crystals of lead and aluminum for investigation of their reflecting properties.

Slow Neutron Fission Cross Sections

A final tabulation of Pu^{241} fission cross-section data from 0.1 ev to 20 ev has been prepared. A re-analysis of the fission cross-section curve has led to some revisions in the resonance parameters reported earlier. The present best values of the parameters obtained for the resonances above 2 ev are given below.

Pu^{241} Fission Cross Section
Resonance Parameters

E_o(ev)	$\sigma_{f,o}$ (b-ev)	Percent Resolution
4.3	1190	3.8
4.65	560	
5.9*	170	
6.94	220	4.8
8.6	130	5.4
9.6*	150	
15.1*	87	7.1

* These resonances show evidence of being unresolved multiple levels.

Work is continuing on the study of a gas scintillation fission counter for fission cross-section measurements.

Subthreshold Fission

The fission component of the 1.056 ev resonance in Pu^{240} has been remeasured using a plutonium sample of 99.75 percent Pu^{240}. The statistical precision of the data through the resonance is about ± 10 percent. The resonance was observed with a calculated resolution width of about 30 mv which is only about 1/3 of the width used in previous measurements. The peak value of the fission cross section at resonance was observed to be 19 barns uncorrected for resolution or doppler broadening. The agreement with the results of previous measurements with less pure samples and poorer resolution verifies the original assignment of the resonance to Pu^{240} and confirms the peak cross-section value to a precision of about 20 percent. The usual discrepancy occurred between the mass of the fission foil obtained from the reported alpha count and that deduced from the fission rate. The effective masses of the foils were assigned from the measured spontaneous fission rate. This procedure automatically corrects for fission counting efficiency.

Fast Neutron Reactions

A study has been made of methods of measurement of fast neutron counter efficiency. The stability of the plastic scintillator fast neutron detector systems is being studied.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Lattice Parameters for Low Exposure Plutonium

Component fabrication is complete for the first phase of the 1.8 w/o Pu-Al experiments. Plutonium Metallurgy advises that the fuel fabrication is finished with delivery expected momentarily. Some difficulty has been encountered in fabrication of the monitor foils and these may be delayed a few weeks.

Lattice Parameters for High Exposure Pu-Al Fuels

Programming Operation has been asked to make the necessary arrangements with AEC and Phillips (Arco) to extend the irradiation of the MTR Pu-Al elements to provide the required 35-40% Pu-240 material for the high exposure plutonium lattice.

The Reactivity Measurement Facility (RMF)

A letter formulating the experiments which could be done in the RMF has been prepared and forwarded to the scope designer. The main purpose of the letter is to point out the flexibility required to use the facility to the best advantage for the Plutonium Recycle Program.

Subcritical Experiments with Plutonium

In reference to critical mass studies for processing plutonium bearing fuel (PRTR), the final delivery was made of the specially prepared Al-5 w/o Pu fuel rods by the Plutonium Metallurgy Operation. The total number of rods which have been received includes 200 Zircaloy-2 clad rods 2 feet in length and 20 rods of 1 foot length; the diameter of the clad rods is 0.576 inch.

Instrumentation

An analysis of errors due to the effects of non-linearity in the warp and diameter units of the Profilometer for the PRTR viewing basin has been completed. A detailed discussion of this analysis is being written. The main findings were:

1. The accuracy of the diameter unit is improved by repositioning the measuring screw.

2. The diameter unit requires compensation for thermal expansion. Temperature changes of ± 10 degrees will affect the measurements.

3. The warp unit appears to be linear in response and accurate as designed.

The sine wave response of several lenses has been determined using patterns and equipment assembled during the last month. A more compact unit has been designed for testing wide angle viewer and Profilometer components. This unit will be fabricated during August.

Comments were prepared on the preliminary design criteria for the PRTR Fuel Rupture Monitor. Plans are being made for evaluating and selecting the photomultiplier tubes to be used with the scintillation detectors for this monitor.

GAS COOLED REACTOR PROGRAM

Lattice Parameter Measurements

The experimental phases of the GCR program have been completed for the first enrichment fuel. Final analysis of the data from the first measurement (K_∞, p, f, ϵ) is under way. Preliminary analysis of the data from the second (control rod) and third (fuel temperature coefficient) measurements is also under way.

Variation of Doppler Coefficient with S/M Ratio

The Lepel 7 1/2 KW induction heater has arrived and been put into operation. A Lepel field engineer conducted the startup tests and gave instruction in operation and maintenance. Safe operating procedures and a hazards breakdown are being prepared.

Theoretical PCTR Studies

The small source theory formulation of the critical condition for an infinite lattice of super-cells has been extended to include two energy groups of neutrons. The result, in a simplified form, has been applied to the GCR lattice and predicted a change in f of approximately 29% upon insertion of control rods as opposed to the 12.5% quoted earlier based on the one group calculation. The simplifying assumption in the present calculation is that the epithermal blackness of the fuel rods is zero; therefore, the Δf quoted here should serve as an upper bound to the actual change.

Evaluation of the lattice sums encountered in the small source theory treatment of superlattices in square arrays has been programmed for the 709. The program is now being debugged.

A technique has been developed for treating the more general case in which the control rod is replaced by a reproducing rod (such as enrichment, for example) which does not increase the complexity of the calculation to any great extent.

TEST REACTOR OPERATIONS

Operation of the PCTR continued routinely during the month except for a scheduled maintenance outage starting July 20, 1959. There were two unscheduled shutdowns due to electronic failure.

The fuel temperature experiment for the gas cooled reactor was completed during the month.

During the maintenance outage, a charging port was put through the moving face. This will allow insertion of heated fuel elements into the reactor or the removal of test cells up to 10 1/2 inches square without moving the face. A safety railing around the top of the reactor is being fabricated and will be installed at a later date.

Experiments to find the optimum arrangement and the H to U^{235} ratio for the TTR fuel disks were conducted during the first week of the month.

Critical mass experiments were conducted in the TTR reactor room for 2 1/2 weeks.

The remainder of the month was used to make preliminary calibrations on Lu_2O_3 foils for the Neutron Temperature Experiment.

Instruments to maintain the oven temperature at preset levels and to turn the heating power off if the temperature exceeds a preset value were received and installed.

Three unscheduled shutdowns occurred during the month, two caused by noise in the channel 3 circuit, and one by incorrect bypassing technique.

BIOLOGY AND MEDICINE - 6000 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

Routine full-scale operation of the joint AEC-AF dispersion experiments was achieved when favorable meteorological conditions became persistent during early July. As of July 31, fifteen experiments had been completed.

Analyses of the data were restricted to semiquantitative surveys of the trajectories of the tracer material over the 25-6 km course and the vertical distribution of this material within 3200 meters of the source. These data were used to realign the horizontal sampler distribution near the source. Vertical distributions have been clearly defined by the sampler arrays on the vertical masts. Earlier difficulties with inadequate gasoline supply were overcome.

The most serious difficulty encountered was a frequently heavy dust loading of the filters used to collect the tracer on the 12-8 and 25-6 km arcs. These arcs were originally oiled in the vicinity of each sampling station. However, dust was carried by servicing vehicles from unoiled portions of the road to the sampling points. Steps were taken to have the entire lengths of these arcs oiled in order to overcome this problem. This work was partially completed by month's end; in the meantime some relief was obtained by restricting traffic on these arcs to an absolute minimum. This action prevented full operation of all samplers, but did materially reduce the dust problem.

Calibration of the source was successfully accomplished following revision of the stirring system and the automatic counters operated satisfactorily. All other equipment operated according to design specifications, also, except

Investigations of concepts related to alpha air monitoring continued with an evaluation of the technique of comparing the gamma caused by natural background with the naturally occurring alpha. Calculations from measurements indicated that the sensitivity improvement over the High-Level Alpha Air Monitor could be about a factor of ten. The High-Level Alpha Air Monitor alarm sounds before a man inhales an amount of insoluble plutonium to cause a retention of about one percent of the lifetime maximum permissible amount. Hence, a system utilizing this technique with an improvement factor of ten alarms before a man inhales an amount of insoluble plutonium to cause a retention of about 0.1 percent of the lifetime maximum permissible amount as specified in the NBS Handbook 52. Other concepts which were investigated and utilized include the instrument with the alarm circuits sensitive to rate-of-change and the Dual Alpha Air Monitor. The system which compares the naturally occurring gamma to the alpha might be more useful than the other systems because it is a monitor for fission product contamination as well as for plutonium contamination. An application is foreseen in integrated environmental monitoring systems.

Further circuitry investigation work was carried out with transistors resulting in an excellent "inhibit gate" or pulse-cancelling circuit, a new count-rate meter circuit with excellent pulse-width pulse-height control, and a 1.0 KC, fedback, chopper-amplifier (transistorized) within ± 5% gain limits from 0°C to 50°C. The other circuits mentioned work satisfactorily from -5°F to +150°F. The chopper-amplifier has a fedback gain of 1000 with an input signal minimum of about one millivolt. This is dictated by chopper noise. The new count-rate circuit drives a 0.5 milliamp meter and has the usual ranges of 1000, 10,000 and 100,000 c/m. This can be extended to 1,000,000 c/m if desired. Linearity is ±5% over each range. The duty cycle at full-scale each range is about 15%. Two other transistor circuits were also developed and tested, one for a pulse-level discriminator and one for a pass gate or pulse-passing enabling circuit. Further tests will be done on these two to determine circuit operation limits.

All final work was completed on the design for the 300 Area criticality or nuclear incident alarm instruments. All components have been tested for five continuous months with actual source tests each day. The alarm limits, set on 20 mr/hr for testing purposes, have varied by ±3% maximum in the five months by actual source test. The two units tested were the same ones sent to Los Alamos for testing with the Godiva assembly. The units can be operated in parallel, back-to-back, multiple detector heads, and both gamma and neutron triggering as desired by the particular application. The alarm device itself, whether siren, bell, or horn, will be decided upon by the 300 Area Safety Committee.

Fabrication continues on the experimental, completely transistorized, aurally indicating, alpha-beta-gamma detecting and indicating instrument. A count-rate meter is included for high-level indications. The aural indication for alpha particles is a speaker "pop" and the indication for beta-gamma contamination is a speaker "chirp" comprising a 1.0 KC distinct note. The CRM indication is for alpha only or alpha-beta-gamma combined as desired.

The gamma dose-rate analysis of the background in Purex is being continued. The background is now being checked in the P and O gallery near the nuclear incident alarm systems.

A miniature G-M tube of about one millimeter in diameter by one inch long which was obtained from Western Radiation Laboratory on a recent trip was demonstrated to the personnel in Biology. The tube, which is filled with helium and quenched with iodine, was tested in a 12 mr/hr field from a Cs^{137} source with good results. After relationship between dose rate and counting rate is established, the tube will be used to measure dose rates in the various organs of an animal.

Calibration of two of the new Zinc-Sulfide Particle Counters for Atmospheric Physics Research is nearly complete.

The experimental dust detector was tested in a chamber in which dust could be circulated. Presently, dust is being impacted on a lucite disc over the face of a photomultiplier tube. The pulses from the phototube are used to drive a count-rate meter and recorder. The minimum particle size to which the detector responds is calculated to be 25 μ. The efficiency of the detector for particles of 25 μ or larger was calculated to be 0.2%.

A 200-channel analyzer is being used in a study of background conditions at various plant locations. The analyzer is used to collect data for approximately one week at each location. One location checked so far is in the P and O gallery at Purex in 200 East. Data are being gathered at present in 222-S at 200 West.

WASHINGTON DESIGNATED PROGRAM

Studies were continued to determine the characteristics of the mass spectrometer for this program which affect the accuracy and precision of isotope analyses.

The output pulse height distribution of the electron multipliers originally purchased for use in this mass spectrometer is being studied. Ultraviolet light is used for a source in order to obtain single electron events at the first dynode of the multiplier structure. The electron gain of the multiplier is determined from a measurement of the output current and output pulse rate of the multipliers with ultraviolet light incident on the first dynode of the multiplier structure. The electron gain of the multiplier can be used to determine the average secondary electron yield per incident ion. The possible procedures for obtaining dynode reactivation of multipliers to increase the multiplier gain are also under investigation.

No analyses were performed this month. Some instrument modifications are in progress for this spectrometer.

CUSTOMER WORK

Analog Computation

A set of solutions has been obtained for the PRTR primary coolant transient analysis problem. A report covering this problem will be issued within the next sixty days.

A set of solutions to the PRTR Hazards Analysis problem is presently being obtained on the computer. Faulty equipment and drift in the equipment due to high ambient temperatures has caused considerable delay in solving the problem.

A formal report, HW-59932, "The Simulation of the Plutonium Recycle Test Reactor on an Analog Computer," by W. D. Cameron, has been issued.

Preliminary runs on the frequency response of the NPR heat exchanger were completed this month. It was discovered that the equations used lacked consistent time-dependent terms and the results were in error.

The primary loop frequency response study for the NPR was completed this month. Analog runs were made with an initial assumed temperature coefficient for both full equilibrium power level and one-half equilibrium power level. A further set of runs was made using a temperature coefficient of one-half the initial value at full equilibrium power level. Compilation of results from the recordings obtained has not been completed.

The analog runs for the Separations Waste Tank Heat Transfer study were based on a one-dimensional analysis. These runs have been completed satisfactorily. A representative run was chosen for a digital solution in the IBM-709 computer. The digital program was completed and is scheduled to be put on the 709 this week. The remaining funds from this work order will be used for writing a digital program for a more extensive two-dimensional analysis of the temperature profile of a representative waste tank, since the analog computer facility is not large enough for a two-dimensional heat transfer analysis of this magnitude. The one-dimensional run on the digital computer is being made for the purpose of familiarization with the technique of using the Thermal Analyzer program developed by the SHARE organization.

Weather Forecasting and Meteorology Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	93	87.4
24-Hour General	62	88.5
Special	114	88.6

Although average temperatures prevailed during July, two very cool periods held the over-all monthly average to 77.7. This was 1.4 degrees above normal, but was well below the record-breaking 81.2 average of July 1958.

Instrumentation

The dual beta-gamma probe for the Fission Product Chemistry Operation is complete and calibrated. The low-level probe has a dose-rate of 50 mr/hr to 1.9 r/hr. The high-level probe has a dose-rate range of 2.0 r/hr to 100 r/hr. The calibrations were made with a 0.75 mev gamma (Ra) source, and the electron accelerator whose average gamma energy was 0.75 mev.

The class in electronics for instrument maintenance personnel is about one-half completed and is progressing smoothly.

Fabrication continued in the 328 Building Electronics Shop on a G-M tube detector beta-gamma alarming monitor for Redox. A meter relay is incorporated and all circuitry is transistorized. Approximate alarming levels available will be from 0.1 mr/hr to 5.0 mr/hr. These levels correspond, approximately,

to 200 c/m to 10,000 c/m from the G-M tube detector.

Fabrication continued in the 328 Building Electronics Shop on a completely transistorized loudspeaker count-rate meter alpha, 110 VAC-operated, semi-portable monitor for use with either alpha scintillation probes or alpha air-proportional probes as desired. The unit is being fabricated for the Calibrations Operation, HLO.

Evaluations were completed on the rebuilt and adjusted Victoreen Remote-Area Monitoring System and on the scintillation portable battery-operated neutron detector and dose-rate meter (fast and slow). Two loudspeaker G-M's were sent out for field tests and evaluation continued on the scintillation alpha, beta, and gamma detector.

Optical Work

Design and estimate has been completed for modifying the Variable Power Microscope at 105-C for scratch depth measurement.

Assistance has been given to IPD in devising a suitable optical scanning mechanism for a TV camera to be used in the access holes of the shield on the rear face of the reactors.

A scanning mechanism is being designed for use with a zoom lens and TV camera to be inserted in a 10-inch diameter pipe. This system is to be used for remote viewing in the cells of the chemical separation buildings.

Optical shop work included:

1. Fabrication of water level indicators for PRTR use.
2. Fabrication of parts for the PRTR Wide Angle Viewer.
3. Servicing T Building periscopes.
4. Fabrication of bioplastic well crystal.
5. Servicing two crane periscope heads for Redox.
6. Fabrication of 12 glass bearings.

John E. Faulkner for Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
O. J. Judd	7/1-2	Rush Drake Associates Seattle, Wash.	Discuss Analog Computer techniques.	HH Burley WD Cameron GR Taylor	No	300: 326
J. A. Berberet	7/1-7	Technical Military Planning Operation General Electric Santa Barbara, Calif.	Discuss cross section and critical mass experiments.	JE Faulkner	No	300: 326
H. L. Hallinger	7/9	Booz-Allen Applied Research Bethesda, Md.	Discuss and witness dispersion experiments.	GR Hilst	No	200-W: 622
N. Islitzer	7/16	U. S. Weather Bureau Idaho Falls, Idaho	Discuss and witness dispersion experiments.	GR Hilst	No	200-W: 622
D. O. Staley	7/16	Univ. of Wisconsin Madison, Wis.	" " "	GR Hilst	No	200-W: 622
Robert Ralston	7/21-23	Univ. of California Radiation Laboratory Livermore, Calif.	Discuss critical mass experiments, administrative and technical procedures for criticality control in Pu processing plants.	ED Clayton CL Brown	Yes	300: 326 305-B 231-Z,2704-Z 234-5,105-K 105-KE
A. H. Blackadar	7/22	Penn. State Univ. University Park, Pa.	Discuss and witness dispersion experiments.	GR Hilst	No	200-W: 622
Wayne E. Duffy	7/31	Vallecitos Atomic Lab. General Electric Pleasanton, Calif.	Discuss technical problems in mass spectrometry.	CR Lagergren	No	300: 326 325

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
H. L. Henry	7/13	Gonzaga University Spokane, Wash.	Present talk on nuclear reactors to High School Teachers Summer Institute.	A. L. McNeil	No
W. C. Roesch	7/20-30	IXth International Congress of Radiology Munich, Germany	Attend meetings of the International Commission on Radiological Units Committee on Quantities and Units.	Members of the Congress	No

Chemical Research & Development

RESEARCH AND ENGINEERING

FISSIONABLE MATERIAL - 2000 PROGRAM

IRRADIATION PROCESSES

Decontamination of Reactor Components

A two-step (APACE-type) process involving treatment with alkaline permanganate followed by treatment with an acidic reducing solution still appears to be the most effective and economic decontamination process available. Inorganic and organic acid solutions containing various corrosion inhibitors were tested as possible replacements for the more expensive ammonium citrate-EDTA solution used in the second step of the APACE process. Corrosion rates of carbon steel were excessively high in all of the formulations tested. More encouraging results were obtained with Turco 3291, a proprietary compound containing sodium bisulfate. Further testing of this latter reagent and other proprietary compounds of a similar type is in progress.

The effects on fission product decontamination of mixing solutions from the two steps of APACE-type decontamination processes were investigated. Mixing could occur because of inadequate rinsing between decontamination steps. Decontamination factors for stainless and carbon steel were decreased by factors of about 30 and 4, respectively, when one part of alkaline permanganate solution was added to 9 parts by volume of either ammonium citrate solution or to Turco 4512 solution. Partial destruction of the corrosion inhibitor in Turco 4512 solution was observed also. Precipitation of MnO_2 was noted at higher concentrations of the permanganate solution.

Automatic Analyzing Monitor

The energy distribution of the gamma background was measured in the 107-K retention basins sampling building. This was done to establish the feasibility of installing the analyzing monitor at this location. The low energy portion of the spectrum, near 0.1 Mev, showed high intensity even with four inches of lead shielding. The location was considered undesirable for measurement of emitters such as Np^{239}.

Uranium Oxidation and Fission Product Volatilization Studies

Six additional fission product release experiments in steam atmosphere were completed for a total of sixteen to date. Complete analytical results became available for the first eleven runs.

A procedure was developed for separation of the oxide and residual metal produced during the uranium-steam experiments. Separate analyses of the oxide and metal are now being made to determine the distribution of fission products. Xenon measurements showed that a considerable amount of rare gas remains in the oxide produced in a 150 minute run at 1100 C.

Unirradiated uranium-steam experiments were made to characterize the oxide formed. X-ray diffraction patterns showed UO_2 to be the only compound formed in the range 990 to 1215 C.

Pigtails from 100-H Area

Spectrographic and chemical analyses confirmed that the off-site pigtail mentioned in last month's report was fabricated from type 304 stainless steel. Three additional pigtails obtained from stores also proved to be 304 stainless steel. Huey tests on these latter pigtails gave corrosion rates on the order of 50 mils/month, much higher than would be expected for the specified heat treatment (one-half hour at 1800 F and quench to less than 800 F in less than three minutes).

One of the latter three pigtails was solution annealed at 1975 F and water quenched to eliminate the effects of previous heat treatments. Sections of the specimen were then subjected to various heat treatments and corrosion rates determined by the Huey test. Corrosion rates approximately equal to those noted with the as-received pigtails were observed for a specimen which was deliberately sensitized by heating one hour at 1250 F and then water quenching. This treatment produces maximum precipitation of carbides and a minimum resistance to intergranular attack by nitric acid. Corrosion rates for all other heat treated specimens were in the range 1-3 mils/month. These observations suggest that the off-site pigtail received from 100-H Area and those obtained from stores were improperly heat treated.

Analytical Services

A method for the preparation of uniform, adherent foils supporting more than one milligram of uranium per square centimeter has been obtained. The foils are needed for cross-section measurements. A modification of Cohen and Hall's electrodeposition method permitted depositing 100 per cent of 2.5 mg of uranium on a 1.44 cm^2 disc, 98 per cent of 7.5 mg on a 7.1 cm^2 disc, and 86 per cent of 10 mg on a 7.1 cm^2 disc. Uranium loss must be minimal because of the high value of the isotopically pure uranium being used for the cross-section studies.

The Port Orford, Oregon, "Contaminated Waste" barrel was found to contain no alpha, beta, and gamma activities above detectable limits.

Use of Analytical Chemistry's nine-inch well crystal simplified analysis of gamma emitters in various well and river waters. Eight-liter samples were concentrated 16-fold and counted. Previously, eight-liter samples had been taken to dryness and plated on one-inch steel dishes.

SEPARATION PROCESSES

Recovery of Neptunium and Plutonium from Purex 1WW

Analytical work is now complete on the runs that were made on the anion exchange recovery of neptunium and plutonium from Purex plant 1WW. The results are summarized in a report, "Recovery of Plutonium and Neptunium from Purex 1WW by Anion Exchange," HW-61145, July 16, 1959, by H. H. Van Tuyl. Simultaneous adsorption of neptunium and plutonium was demonstrated, and radiation induced decomposition of the resin was found to be negligible.

Neptunium Recovery from Purex 3WB

The present procedure for recovering neptunium in the Purex plant suffers from the disadvantage that purification of neptunium for load-out employs equipment (2A and 2B columns) routinely used for plutonium processing so that neptunium can be processed only at the expense of interrupting normal uranium and plutonium processing. Processing of neptunium simultaneously with plutonium and uranium will require installation of additional equipment so an experimental study has been undertaken of a concept which is believed to represent a minimum capital cost approach. This concept would require installation of a single column of critically safe design which would process Purex 3WB (the Purex plant's most concentrated neptunium stream) on an intermittent basis. Neptunium would be accumulated in the plant 3WB circuit as at present. When a sufficient inventory of neptunium is accumulated, all or a portion of the 3WB would be diverted to the feed point of the new column. The extraction section of this column would be operated under conditions such that neptunium, uranium and plutonium would be extracted quantitatively. The aqueous effluent from this column, if chemically compatible, would be recycled to the normal 3WB addition point of the HA column; otherwise, it would be recycled to the 3WB concentrator and thence to the HA column.

The scrub section of the new 3WB processing column would be operated under conditions such that uranium and plutonium would be retained in the organic phase but neptunium would be forced to transfer nearly quantitatively to the aqueous phase. The neptunium would then reflux within this column. The uranium and plutonium bearing organic effluent from this column would, if chemically compatible, be recycled to the HAO addition point on the HA column, otherwise to the 1BXF tank.

When a sufficient inventory of neptunium had been "bottled" within this column, the 3WB flow would be restored to its normal route and non-radioactive nitric acid would be substituted as feed to the 3WB processing column. An operation analogous to the established 2A-2B "spin" flow sheet would thus be applied in this column to effect the fission product decontamination necessary to permit the neptunium to be transferred to an anion exchange facility (either at Purex or the Hot Semiworks) for final purification.

Miniature mixer-settler tests indicate such an approach to be chemically feasible. Addition of about 0.1 molar nitrous acid to synthetic 3WB containing 9 to 10 $\underline{M}$ HNO_3, 0.25 $\underline{M}$ U, 0.15 $\underline{M}$ $SO_4^{=}$, and 0.075 $\underline{M}$ Fe(III) renders neptunium sufficient by extractable. Use of a 0.2 to 0.5 $\underline{M}$ HNO_3 scrub solution containing 0.03 to 0.05 $\underline{M}$ Fe(III) yields efficient selective stripping of neptunium in the scrub section. Depending on the flow ratios chosen, neptunium can be forced to reflux to a maximum concentration in the range of 300 to 1000 times that in either effluent. On the basis of the runs made to date, it appears that an adequate job of "bottling" the neptunium could be done over a range of at least 30 per cent variation in flow ratios.

Application of a "spin" decontamination flow sheet has not been thoroughly tested but preliminary results indicate no difficulty.

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It is estimated that about 300 grams of neptunium could be "bottled" in the aqueous phase of a typical critically-safe aqueous-continuous column and that the product could be withdrawn at an average concentration of between one and two g/l, quite appropriate for feeding to an anion exchange step.

Chemistry of Actinide Elements

Spectrophotometric studies have proven useful in elucidating the nature of complex ions of plutonium(IV) and neptunium(IV) present in high nitrate solutions. In these studies the hexanitrate complexes are isolated by precipitation from aqueous solution as the anhydrous tetraethylammonium or tetrabutylammonium salts, i.e., $[(C_2H_5)_4N]_2\ M(NO_3)_6$ or $[(C_4H_9)_4N]_2\ M(NO_3)_6$. These salts are soluble in a variety of organic solvents and exhibit identical absorption spectra in acetone, acetonitrile, acetic anhydride, and hexone. Since the Lambert-Beer law is obeyed and, further, the spectrum in these solvents is identical with that for the tetravalent actinide in 13 M HNO_3, it is presumed to be the characteristic spectrum of the hexanitrate complex. On this assumption the fraction of the plutonium(IV) present as the hexanitrate complex has been evaluated and found to range from about four per cent at 5 M HNO_3, to about 50 per cent at 8 M HNO_3, to essentially 100 per cent at 12 M and higher concentrations.

Formation of the hexanitrate complex in metal nitrate solutions is less readily accomplished. For example, only 26 per cent of the Pu(IV) was present as the hexanitrate complex in 5.75 M $Ca(NO_3)_2$, 0.5 M HNO_3 and only 19 per cent in 2.6 M $Al(NO_3)_3$, 0.25 M HNO_3. Only 91 per cent of the plutonium was present as the hexanitrate complex in 9 M $Ca(NO_3)_2$, 0.25 M HNO_3 (which represents a melt of approximate composition $Ca(NO_3)_2$-2.5 H_2O).

Subtracting the contribution of the hexanitrato species from the absorption spectrum of Pu(IV) in 9 M HNO_3 gave no evidence for species between the mono-nitrato and hexanitrato complexes. Similarly, the nitrate ion dependence for conversion of lower species to the hexanitrato complex allows no stable intermediate higher than the dinitrato complex.

The absorption spectrum of a hexone solution formed by extracting Pu(IV) from 1.5 M $Al(NO_3)_3$, 0.5 M HNO_3 is distinctly different from the hexanitrato complex obtained by dissolving $[(C_4H_9)_4N]_2\ Pu(NO_3)_6$ in dry hexone, and is likewise distinctly different from the spectrum in aqueous nitrate solutions. The stability of the hexanitrato spectrum in dry hexone indicates no complexing of Pu(IV) by hexone. Thus, the Pu(IV) extract from aqueous solution is presumably the neutral species $Pu(NO_3)_4(H_2O)_2$.

The solubility of the compound $[(C_2H_5)_4N]_2\ Np(NO_3)_6$ has been measured over a range of nitrate concentrations in nitric acid and $Ca(NO_3)_2$, 0.5 M HNO_3. The solubility curves are very similar to those obtained for Pu(IV). In nitric acid, the minimum solubility (with 0.4 M $(C_2H_5)_4N\ NO_3$) is 0.0045 g Np/l, and occurs at 7.5 M nitrate, about the point of the maximum in the anion exchange distribution coefficient. In calcium nitrate solutions the solubility is lower than in nitric acid solutions of the same total nitrate concentration and continues to decrease as the nitrate concentration is increased. This is again quite similar to the behavior observed for Pu(IV).

Spectrophotometric studies of neptunium systems showed Np(IV) to be the stable oxidation state in concentrated nitric acid solutions, and the hexanitrate complex to be the sole species present at 12 M HNO_3 or higher concentrations.

Tritium Processes

Continued examination of Linde Molecular Sieve 5-A (30 - 100 mesh) for removal of hydrogen from hydrogen-deuterium mixtures in chromatographic separation runs has disclosed no large dependence of the separation effect on flow velocity and column length. No more than 20 per cent of a representative hydrogen-deuterium feed sample has been separated as hydrogen with an acceptably low deuterium content in any single run.

The use of 0.01 per cent palladium with the Molecular Sieve 5-A has been ineffective in increasing the separation by causing equilibration of the hydrogen species. A run at - 78 C showed almost no separation.

Analysis of Plant Streams

Recent decontamination difficulties in the Purex plant prompted examination and analysis of samples of suspect plant streams. The most significant findings were that all organic samples tested (100, 2BW, and 1CW) contained suspended, fission product bearing solid matter, as did the plutonium product (2BP). Further, the fission product level in the waste from the 2A column (2AW) was higher than in the feed to this column, strongly suggesting the existence of a "crud problem" in the 2A and 2B columns.

This diagnosis proved correct as indicated by the fact that a thorough flush of the 2A and 2B columns and exhaustive flushing of the No. 1 solvent system has restored decontamination performance for plutonium in the Purex plant.

Solvent Treatment with "Mistron 28"

Very brief laboratory tests indicated that "Mistron 28" (a commercially available, finely divided talc), which was recommended and proved beneficial for increasing column throughout in the Recuplex plant, is beneficial also in removing solids from Purex plant solvent. A dilute nitric acid suspension of talc was ineffectual but a suspension in dilute caustic caused the solid to be transferred to the aqueous phase and removed about two-thirds of the gamma activity from solids-bearing solvent recently encountered in the Purex plant. Such a batch treatment might be profitably considered in the event such solids-bearing solvents are again encountered in the Purex plants.

Interfacial Transfer Studies

The work on the transfer of uranyl nitrate across the water - TBP interface has been concluded with several experiments at low concentration using U-237 tracer. A report has been written covering this work. Some of the conclusions of interest are:

[redacted]

1. The transfer rate for both uranyl nitrate and nitric acid from aqueous to organic is second order with respect to the transferring solute, first order with respect to TPB and highly dependent on the stirring rate in each phase.

2. The transfer rate is much more sensitive to stirring at high solute concentrations than at low concentrations.

3. Transfer from organic to aqueous is first order with respect to solute, independent of TBP concentration and independent of aqueous phase stirring.

4. Surfactants (especially hydrophilic types) greatly retard the transfer.

5. Aqueous to organic transfer is characterized by a very marked decrease in rate after 50 to 70 per cent of equilibrium is reached. This is not due to surfactants or other impurities or to depletion of the solvent but represents a change in mechanism.

6. It is postulated that the initial, very rapid second order transfer reaction is due to interfacial turbulence caused by the transfer reaction itself and that the later slow reaction is the "normal" one.

7. Activation energies of ca. 3 kcal for either direction suggest that a physical process rather than a chemical reaction is the rate-limiting step.

Dissolution of Nickel Clad Fuel Elements

Several procedures for dissolving the nickel coating, proposed for aluminum clad production elements to increase corrosion resistance, are being tested. Boiling nitric acid dissolved the coating at penetration rates (assuming a density of 7.9 g/cc for the coating) which increased exponentially from ca. 0.05 mil/hour at 0.05 M HNO_3 to ca. 35 mils/hour at 3 M HNO_3. Penetration rates in boiling 1.5 M UNH - HNO_3 solutions were factors of 10 to 20 higher than in nitric acid alone. Removal of nickel cladding with UNH-HNO_3 dissolver solutions would be feasible therefore if introduction of small amounts of nickel into the Purex process is not considered objectionable.

In the dissolution of nickel cladding in 3 M HNO_3 about 2.4 moles of HNO_3 are used per mole of nickel dissolved. Off-gas from dissolution of nickel cladding in 3 M HNO_3 is principally oxides of nitrogen with only traces (0.1 to 0.3 volume per cent) of hydrogen. Dichromate ion inhibits nitric acid dissolution of both nickel cladding and ingot uranium metal. Dissolution rates of nickel cladding and ingot uranium in boiling 3 M HNO_3 are decreased by factors of about 450 and 6, respectively, by the presence of as little as 0.01 M $Na_2Cr_2O_7$.

Analytical Services

I^{131} analysis was improved through use of a nine-inch well crystal. Time for analysis of farm produce samples was reduced six-fold and detection limit was reduced 50-fold to 2×10^{-8} uc/g.

The Parr sulfur bomb was used to obtain a carbon analysis on a uranium carbitol compound or mixture prepared by Chemical Research. A half gram sample was required since sugar or other fuel could not be added, as normally needed for sulfur determination. (A micro carbon train though more appropriate would have been much more costly.)

Pu^{238} analysis was simplified by eliminating the need for chemical separation of Am^{241}. The 60 Kev Am^{241} X-ray was counted directly using a NaI(Tl) crystal. The method required one plate of approximately 1×10^4 d/m for alpha energy counting and a second plate of approximately 1×10^4 d/m of Am^{241}. Pu^{238} was determined by subtraction of the Am^{241} d/m from the $Pu^{238} + Am^{241}$ d/m value obtained from alpha energy measurement. A unit saving of approximately two hours was realized.

The determination of nitrate by controlled potential coulometry as reported in June was used to determine the per cent nitrate in plutonium oxide. The finely ground powder was cold-leached with 0.1 N perchloric acid prior to titration. Nitrate concentrations were comparable to the water content of the samples.

Some 0.0006 per cent cobalt in aluminum was measured colorimetrically with about ten per cent error. Tetraphenylarsonium cobaltothiocyanate was extracted in chloroform and transmittance of the complex was observed at 615 mu. Iron interference was removed by fluoride complexing and copper, by its reduction with iodide. Nickel did not interfere. Samples were dissolved in nitric and hydrochloric acids. Published methods for cobalt in aluminum are not apparent.

X-Ray spectrometry is being used to measure uranium at the 1 to 2 g/l range. Precision is about one-fifth that of refined ceric sulfate titration.

WASTE TREATMENT

Waste Solidification

The formation of glassy products from Redox first cycle waste by the addition of borate or of borate plus silicate followed by calcination was reported last month. Melting points ranged from 800 to 1200 C. The solubility of these materials have now been measured as a function of moles of additive per equivalent of metallic cation in the waste. Melts obtained by adding borax or boric oxide alone melted below 1000 C but disintegrated or dissolved completely in boiling water. (This implies that the solid would require storage in some sort of impermeable container.) Melts containing borax and sodium silicate exhibited a melting point as low as 850 C and had a minimum solubility of 1.3 per cent at an equivalence ratio of 2:1. Boric oxide with silica (SiO_2) addition gave the lowest solubility, only 0.06 per cent, at the same ratio but a higher melting point of 1200 C.

The boric oxide-silica type additions were also tried on Purex type waste but did not give clear glassy melts such as were obtained with the Redox waste. Apparently the presence of aluminum and chromium in the Redox waste plays an important role in melt formation with these particular additives. The phosphate and phosphate-borate systems continue to appear more attractive for use with Purex waste.

Radiant Heat Spray Calciner

Analytical results have been obtained on the effect of phosphate and of phosphate plus sugar addition on loss of sulfate and on product particle size in the calcination of formaldehyde treated Purex waste. No sulfate was lost when the waste was calcined without additives, 24 per cent was lost with phosphate alone, and 72 to 89 per cent with phosphate plus sugar. Corresponding average particle sizes were about 2, 4, and 9 microns, respectively.

Chemical analyses and Millipore filter studies show that de-entrainment of the spray calciner off-gases from solids and non-volatile is excellent. The de-entrainment factor across the Micrometallic knock-down filters at the bottom of the column was 2×10^4, and the over all factor from feed to noncondensable off-gases was in excess of 1.5×10^6.

Further details of this program are included in the first and second Quarterly Progress Reports - Research and Development Activities - Radioactive Waste, edited by D. W. Pearce. The first (report for January - March) is HW-60584.

Semiworks Waste Calciner Prototype

Over all job completion of the waste calciner prototype is approximately 90 per cent. Equipment-connecting piping and service lines installation is 95 per cent complete. Electrical and instrument installations are 80 per cent complete. Equipment insulation has been started. Functional testing of all equipment is in progress.

ANL Fluid Bed Calcination Studies

Exploratory studies at ANL on fluid-bed calcination of simulated Purex "formaldehyde-killed" and three-fold concentrated acid waste have continued.

Recent efforts have been directed toward reducing feed nozzle pluggage (and resultant agglomerate formation) by improvements in nozzle design. A conical nozzle was tested with some improvement. At report time, another feed nozzle with an extended tip on the liquid nozzle is being tested.

Special Geological Studies

The caliche zone capping the Ringold formation beneath 200 West Area and the Palouse soil overlying it there were traced through all the wells along the north-east side of Cold Creek Valley about half way to the Yakima Horn. Silts and sands of the upper part of the Ringold formation were similarly traced through a narrower and shorter area through many of the same wells. The high $CaCO_3$ content, fine-grained texture and exchange capacity of the combined stratigraphic units recommend this area, particularly immediately southeast of 200 West Area, for future waste disposal. This was also indicated in HW-60450, "The Rate of Land Usage at Hanford for Waste Disposal - A Guide for Future Disposal Plans," by R. E. Brown, issued during the month.

Observation Wells

While testing two new deep sampling devices it was possible to obtain samples of the ground water 400 feet below the surface of the water table in well 699-28-52, located one mile south of the 200 East Area in the center of the Cold Creek Syncline. This is the first time a representative water sample has been collected from such a depth. Analytical results show concentrations of gross beta activity in the bottom of this well up to 4.7×10^{-7} uc/cc and nitrate ion concentrations up to 13 ppm. No background data are available for these ions at this depth but it is believed the concentrations reported are above normal. No detectable concentrations of beta emitters have ever been reported at the water table in this well. The nitrate ion concentration at the water table is less than 1 ppm. Many more data are needed before any conclusion can be made as to the mode of travel of this contaminated ground water to this structural low in the basalt.

Disposal to Ground

Recent probing of wells near the unused 216-T-27 and 28 cribs revealed significant concentrations of radioisotopes from 30 to 80 feet beneath the site. Undoubtedly this contamination resulted from the spreading of T Plant scavenged waste discharged to the 216-T-26 crib, the northernmost crib in the series.

Uncertainties relative to the remaining life of the unused parts of multiple cribs resulted in a recommendation to CPD that the facility be used for the disposal of relatively small volumes of T Plant decontamination facility waste. It was also recommended that UO_3 plant process condensate be routed to a new crib instead of to the 216-T-27 and 28 site. Neutralization of this waste should not be necessary if the Sr^{90} concentration is maintained below 8×10^{-8} uc/cc as has been the case for the past five months.

Laboratory experiments were performed to study the effect of $CaCO_3$ neutralization of CAW type waste. Measurements of CO_2 gas evolution and pH were made. Gelation of the high aluminum waste prevented neutralization to a pH greater than 3.9. On the basis of these experiments it was concluded that the $CaCO_3$ contained in one cubic foot of soil would gel 5.8 liters of CAW type waste and suggests the possibility of immobilizing this waste by naturally occurring carbonates in the soil.

On the basis of laboratory soil column experiments and well probings, recommendations were made to build a new crib for the UO_3 plant condensate.

TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Cerium and Promethium Recovery

A peroxide-acetate precipitation process is under development for the separation of cerium from the trivalent rare earths. The process is adaptable to campaign operation in existing Purex plant equipment and has the advantage over previous processes that ruthenium volatilization is eliminated and that only non-corrosive reagents are used. The rare earth double sulfate precipitate serves as starting

material. This is dissolved, a hydrogen peroxide-sodium acetate solution added, digested at 50 C, and the cerium peroxy acetate precipitate separated by centrifugation. This precipitate is readily redissolved in nitric acid. The peroxide serves as oxidant to oxidize the cerium to the (IV) state, and the acetate serves both as precipitant and buffer. Minimum pH is in the range 4.5 to 4.7 for cerium recoveries ranging from 99 to 99.9 per cent. Since the trivalent rare earths begin to precipitate at a somewhat higher pH (5.4 to 5.6), accurate pH control is essential. However, achievement of this is greatly facilitated by the buffer action of the acetate and should not present a serious plant operating problem. A reprecipitation may be required to free the cerium of all traces of trivalent rare earths.

Solvent Extraction of Fission Products

The extraction of fission product strontium and rare earths with tall oil was further explored using purified fractions. These included a fatty acid (Indusoil L-5) and a rosin acid fraction. Strontium extraction from a partially neutralized (pH 8 to 10) 1WW slurry was greatest with the fatty acid fraction. From sodium nitrate solutions, rather than synthetic 1WW, there was essentially no extraction of tracer strontium (< 0.4 per cent extracted) implying that other components in the 1WW may play a role in the extraction, perhaps through complex formation, or that the pH may be altered during extraction from the unbuffered sodium nitrate system. In other experiments, a naphthenic acid - xylene solution was found to extract cerium, but not strontium, from partially neutralized sodium nitrate or 1WW solutions. The naphthenic acids may prove valuable in the recovery and/or separation of the rare earths.

Fission Product Isolation and Packaging Prototype

The capper, the last component to be fabricated, was completed and installed. Operational "cold" testing of the prototype equipment continued. Operation of the hydrolyzer has been complicated by the persistence of a mastic stage in the continuous conversion of the $Cs_2ZnFe(CN)_6$ slurry to the reacted oxides. Variations in operational procedures and possible equipment modifications are being considered to alleviate this difficulty.

Purex Crude Rare Earth Recovery

Filtration Studies. An SMX* filter cartridge was tested using a synthetic crude rare earth sulfate slurry. The cartridge resembled a three-foot long bellows three-inches in diameter, is made of grade D (65 micron pores) sintered stainless and contained ten square feet of filtering area. This cartridge was installed in a four-inch diameter glass container for tests. A 200 liter batch of the slurry containing 16 grams/liter of rare earth sulfate was successfully filtered in a two hour operation (190 liters filtered in one hour) using vacuum filtration. The tested batch was one-twelfth of the contemplated Purex batch (600 gallons) and completely filled the container (0.19 cubic foot) with rare earth sulfate. Approximately 99 per cent of the rare earth precipitate was recovered.

* Trademark of the Micro Metallic Division, Pall Corporation

Heat Transfer Studies. A small apparatus was made for determining thermal conductivities of granular solids. The device requires only 60 cc of sample and may be used with moist or electrically conducting materials. Two materials have been tested to date, with results summarized below:

1. Fluid bed calcined Purex 1WW (HCHO killed) (from Argonne): K = 0.17 at 424 F

2. Sodium Rare Earth Sulfate: K = 0.107 at 244 F
   K = 0.118 at 435 F

where K is in Btu/(hr)(ft^2)(°F)(ft). The sodium rare earth sulfate slurry was dried in the test apparatus to simulate a cake deposited on a filter.

Heat transfer characteristics of a sodium rare earth sulfate cake deposited on a bellows-shaped filter element were investigated. No attempt was made to simulate uniform heat generation, instead, the "worst case" with all heat entering along the axis of the cylinder, was tested. Comparative data tabulated below show that for this configuration, substituting a helium atmosphere for air improves the thermal conductivity by about 1.75 as indicated by the relative temperature differences.

Heat Generation Rate, Btu/(hr)(ft^3)	Atmosphere	Cake Temperature, °F* Inside	Outside
11,720	Air	654	257
11,720	Helium	504	278
18,000	Helium	702	367

* Distance between inside and outside about 1-5/8 inches.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

X-Ray Analysis

An X-ray spectrographic method was developed for the determination of gallium in mixtures of gallium oxide and uranium oxide having a sensitivity of 0.05 per cent Ga_2O_3. The $U_{L\beta 2}$ line at a 2θ value of 21.60 degrees (with a lithium fluoride analyzing crystal) was used as the reference line for the $Ga_{K\alpha}$ line at 38.92 degrees. Scattered background was measured at 40.0 degrees. It was necessary to grind the samples very finely (300 mesh) in order to obtain uniform mixing and true fluorescent intensities from the gallium.

EQUIPMENT AND MATERIALS

Purex F-6 De-mister Pad

Samples of 5 mil Ta and Zr wire; 6, 11, and 62 mil Ti wire; and 6 and 11 mil stainless steel wire were exposed as de-mister pads to the vapor over a boiling

solution of the composition 6.2 M HNO_3, 0.4 M H_2SO_4, 0.4 M $NaNO_3$, 0.4 M $Fe_2(SO_4)_3$, 0.01 M H_3PO_4. Corrosion rates of the Ta and Zr wires were less than 0.01 mil/month. The Ti and stainless steel wires corroded at rates of about 0.3 and 0.1 mil/month, respectively. Extreme care should be taken if Zr or Ti is used in the fabrication of this pad. Both the 5 mil Zr and the 6 mil Ti wire could be ignited with the flame from a match. The 11 mil Ti wire required the flame from a laboratory glass working torch for ignition.

234-5 Fluorinator Off-Gas Filters and Powder Transfer

Using a bank of three porous carbon filters, the equivalent of thirteen filter cycles was achieved in filtering a dust (cerium fluoride) laden air stream. Restoration of the filters after each cycle was accomplished by equilizing the pressure across the filters while vibrating the filters and housings at 8650 cycles per minute and an amplitude of 1/32 inch. Greater than 95 per cent of the accumulated cake was removed each time. The initial pressure drop increased by a factor of two (from 8 to 16 inches of water) after the first cycle; thereafter, little increases in initial pressure drop were observed.

A three hundred gram batch of 20 mesh cerium fluoride powder was pneumatically transferred successfully twelve times with a 2-inch diameter reverse cyclone device. Five SCFM of air were required to lift and transfer the powder to and through a 1/2-inch I.D. tangential outlet containing a 10-foot run and 3-foot rise. In comparison, twenty SCFM, or more, would normally be required to fluidize the 20 mesh cerium fluoride powder in an equivalent diameter pipe. Modifications are now being made to permit the transfer of up to 4 mesh cerium powder using 5 to 6 SCFM of air.

PROCESS CONTROL DEVELOPMENT

UO_3 Plant Automation

The three servo systems which will be used in the plant test of the Calciner Programmer were accepted from Technical Shops on July 16. The two variable speed servos were calibrated to ascertain the output shaft speed vs. the panel dial gear ratio. These shaft speeds determine the rate of: 1) the initial fast furnace power increase, and 2) the following slow increase of furnace power during start-up. This completes the necessary bench testing of the Calciner Programmer and readies it for plant installation.

All the necessary mechanical and schematic drawings for offsite construction of the Calciner Programmer have been completed, checked, and approved.

C Column Instrumentation Studies

On the completion of the Purex 2B Column studies a number of changes were made to the 3-inch glass pulse column to improve its usefulness as a research tool. The major changes are as follows:

1. The column was lowered 51 inches. This places the greater portion of the column in an area more readily accessible for sampling and observation and makes greater use of the existing fluorescent lighting. In addition, the column is now in a position to run concatenated with an A-type column at some future date.

2. The feed inlet distributors were redesigned to discharge directly onto the end plates of the cartridge. This eliminated the "spray column" effect that accompanies distributors discharging some distance from the cartridge.

3. Two of the three 3-foot sections of the column were drilled with eleven 1/8-inch holes and fitted with quick disconnect type sampler connections. This permits a single sensing unit to be alternately connected to these sampling points, which allow incremental observations of uranium concentrations to be made throughout the length of the cartridge under operating conditions.

4. The cartridge tie rod was extended out the top of the column and secured to an externally mounted bracket. This enables the cartridge to be moved up and down in relation to each specific sampling connection which in turn permits a uranium concentration scan to be made from a specific plate-to-plate section while the column is in operation.

The uranium photometer for analysis of the aqueous phase of the samples removed through the mid-column sampler connections was calibrated in the laboratory. The accuracy of the instrument was increased from the standard 3 per cent to something less than 1 per cent, by immobilizing the light source and operating it at 5.3 volts instead of 6.3 volts, by changing the standardization cutoff filter from a 3060 to a 3385, and by connecting the phototube directly to a 90 v power supply (eliminating one set of cable connectors).

A programmer was designed which will automatically scan the readings of all column instrumentation in use at present. A digital voltmeter and printer will be connected to the programmer switching circuits in such a way that each instrument reading will be printed and identified with a code number. Each sample port on the column also has a code number. Six readings and standardization will be made over a period of 2 minutes for each sample port after which the other instrumentation will be scanned as rapidly as nulls are obtained on the digital voltmeter. Construction of the programmer unit has begun.

An extensive literature survey has been completed to collect all available equilibrium distribution data on the uranium-nitric acid-water, tributyl phosphate-kerosene system at temperatures from 0 to 60 C. A composite of this data and any new data which may be necessary for these studies will be documented for general use. The data are needed in the present study to determine either HTU's or mass transfer coefficients in the column. In most cases heretofore, the equilibrium data given for 25 C in KAPL-602 have been used arbitrarily for all temperature whenever HTU's have been calculated.

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NON-PRODUCTION FUELS REPROCESSING

Mechanical Processes

Shear Studies. Shear studies continued with tests of a combination consisting of a 17-7 PH stainless steel male Vee moving blade and a semicircular stationary blade. Preliminary results show this combination cuts with lower forces than any other tried to date, and that rod bundles disintegrate more thoroughly. Life tests are required to demonstrate that wear of the blade point will not markedly alter cutting characteristics.

Coldsaw Studies. Initial operation of a Motch and Merryweather Model 3 coldsaw, being tested for power fuels end-fitting cutoff, showed that the blades may be expected to process at least 50 tons of fuels if proper work clamping can be employed. About 1500 sq. in. of stainless steel have been cut without detectable dulling of the blade. Blade speed, pitch, and feed rate for the test were 17 surf ft./min., 0.41 inch, and 3/4 inch/min., respectively. The resultant chips (about 3/32 inch x 3/8 inch) have a bulk density of 75 to 100 lb./cu.ft. Detailed clamping studies will be made after initial life testing is completed.

Feed Preparation

Flooded Tray Dissolver. Investigations of the "flooded" tray dissolver concept have been initiated by modifying the Darex pilot plant dissolver. Modifications include installation of a glass lined pump to transport dissolvent from the bottom of the original Darex dissolver (250 liters) into two Zircaloy-2 troughs (40 liters) suspended inside the Darex dissolver but above the solution level. The dissolvent flows longitudinally through the trough and over a weir and returns to the solution reservoir.

Two runs have been made in this equipment to determine the effect of recirculation rate on the dissolution rate of Hanford slugs of depleted, metallic uranium in boiling 13 M HNO_3. At recirculation rates of 4, and 70 liters per minute, side penetration of the slugs averaged 27.3 and 38.4 mils per hour, respectively, over an 8-12 hour period. These rates compare favorably with 27.3 mils per hour attained in a conventional batch dissolver under the same dissolution conditions.

Recirculating Dissolver. Installation of an "outrigger" dissolver barrel on the Hastelloy F dissolver has been completed and studies initiated on the dissolution of Hanford slugs of depleted, metallic uranium. A recirculation rate of 20 gpm with a four-foot lift was easily obtained by sparging 10 scfm of air at a submergence of eight feet. Equipment operation was satisfactory and uranium dissolution normal. Quantitative data are not available at report time.

Sulfex Pilot Plant. The first series of pilot plant runs involving the dissolution of 304-L stainless steel by the Sulfex process was completed. Decladding solution concentrations were varied from 3.1-5.7 M H_2SO_4, with dissolution rates from 12-47 mils/hour. In 4 M H_2SO_4 the average penetration rates varied from 14-25 mils/hour. The dissolution rates were markedly uniform throughout the course of each run.

The dissolution reaction was initiated by the addition of cold concentrated sulfuric acid to boiling water in the dissolver vessel containing the stainless steel. The acid addition rates were varied from 0.008-0.16 gallon/minute per square foot of stainless steel. Dissolution of the stainless steel (in contact with mild steel) began when the acid concentration reached 2.5 M - 3.1 M H_2SO_4. On the other hand, in the absence of mild steel, even at high acid addition rates the stainless steel failed to dissolve in 7.2 M H_2SO_4.

Air bleed rates required to maintain the hydrogen concentration in the off-gas below two per cent averaged 2.5 scfm per square foot of stainless steel.

Dissolver Foaming Studies. Experiments have been initiated to determine if the sparging of air or the passage of gaseous reaction products through Zirflex or Sulfex dissolver solutions would form troublesome stable foams. The passage of either air or mixtures of air and hydrogen through Sulfex dissolver liquors produced very unstable foams. Similarly, unstable foams also resulted when either air or mixtures of air, hydrogen, and ammonia were sparged through Zirflex liquor. At room temperature, both the Sulfex and Zirflex foams decayed completely within one minute after the solutions were removed from direct contact with the gas streams. The Sulfex foam becomes increasingly unstable as the solution temperature is increased.

Sodium-Nitric Acid Reactions. Scouting studies were re-initiated to measure the pressures developed when metallic sodium reacts with nitric acid. The sodium, encapsulated in copper tubing, was submerged in eight feet of 60 per cent nitric acid in an eight-inch pipe, at the ambient temperature. With 11 and 22 grams of sodium, the peak pressures recorded with a ballistic transducer and an oscilliscope, were 375 and 850 psi, respectively. The reaction with the larger sodium charge ejected some acid from the open top of the 15-foot dissolver and displaced the 700-pound unit one foot.

U-Mo Alloy Dissolution. Laboratory studies of the applicability of the Darex process for dissolution of U-Mo alloys were completed. Solutions typical of those resulting from Darex dissolution of U-3 weight per cent Mo alloy and subsequent boildown to remove chloride ion are being stored at room temperature to check longterm stability. Thus far (9 weeks) no solids have formed. Redox-type, batch extraction studies were made with Darex process U-Mo alloy dissolver solutions containing 0.0 to 0.5 M chloride ion. Molybdenum extraction was negligible in all cases, and no significant effects on uranium extraction were observed. Chloride distribution coefficients were in the range 0.01 to 0.015.

Observations of long-term stability of solutions produced by dissolution of both U-3 weight per cent and U-10 weight per cent Mo alloys in nitric acid - ferric nitrate dissolvents were continued. In some cases stability has been checked for as long as 18 weeks. In all cases solutions are more stable at room temperature than at 50 C. Stability is greater also at higher acidities. Present indications are that solutions at room temperature are completely stable with respect to solids formation after the first week or two of storage. Small amounts of solids deposited during the initial storage period may represent finely divided material produced during dissolution and not removed by centrifugation prior to

storage. Experiments were performed also to define satisfactory conditions for the dissolution of 10 weight per cent alloy at 0.5 - 0.75 M $Fe(NO_3)_3$. Stability of U-Mo alloy dissolver solutions during the plutonium oxidation step was determined also.

Zirconium Dissolution vs. Electrical Conductivity. Additional Zirflex dissolution runs have been carried out to firm up earlier data on ionic conductance as an index of completeness of zirconium dissolution. The data summarized herein were obtained with an industrial type conductivity bridge whereas the earlier data were obtained with laboratory type equipment. In eight dissolution runs the electrical resistance increased 15 ± 1 ohms from the beginning of dissolution to complete or nearly complete dissolution. In four of the eight runs dissolution was complete, while two runs left 0.2 - 0.3 per cent of the zirconium undissolved, and two others left 2 - 3 per cent of the zirconium undissolved. The 15 ohm increase is independent of the initial resistance and agrees with the increase observed with the laboratory type bridge.

On the basis of these and previous data, the ionic conductance can serve as an empirical index of the completeness of zirconium dissolution in the Zirflex process.

Waste Treatment Studies

Experiments to determine physical and chemical properties of various neutralized NPF wastes were initiated. Neutralization of synthetic Sulfex process waste with 50 per cent caustic was followed with a pH meter. Appproximately 40 ml of caustic were required to neutralize 100 ml of waste of the composition 0.54 M stainless steel, 6.5 M H^+, 3.86 M $SO_4^=$ to pH 10.5. Neutralized waste slurries contained 54 to 80 volume per cent solids after long term standing. Oxidation of iron(II) to iron(III) was not observed during the settling period.

Recovery from Off-Standard Sulfex Wastes

Techniques for recovery of uranium and plutonium from off-standard Sulfex decladding solutions are under study. Precipitation of uranium as the peroxide and as the phosphate has been investigated. Uranium recoveries by peroxide precipitation are unsatisfactorily low presumably because of interference from iron(II) and sulfate ion. Recovery was not improved by changes in temperature (25 to 60 C), oxidation of iron to iron(III), or by the presence of peroxide stabilizers. Adequate uranium recovery is obtained by precipitation as the phosphate, but the precipitate is contaminated badly with iron, chromium and nickel. Separation and recovery of uranium by precipitation as the diuranate or hydroxide at a controlled pH was studied briefly. Further studies of this latter technique are in progress.

Materials of Construction

Sulfex process wastes may be contained safely in 304-L stainless steel equipment provided a small concentration of iron(III) is present. Corrosion rates at 60 C in the presence of as little as 0.001 to 0.004 M $Fe(NO_3)_3$ or $Fe_2(SO_4)_3$ were

negligible. Oxidation of a portion of the iron(II) already present in the waste with 0.001 M $Na_2Cr_2O_7$ also served to reduce corrosion rates to acceptable values. In some instances synthetic Sulfex process wastes containing no added iron(III) were found to be non-corrosive to 304-L stainless steel. This effect may be due to air oxidation of iron(II) to iron(III). An air sparge of the spent decladding solution may be sufficient to produce a solution which may be stored in 304-L stainless steel.

A small amount of a heat of modified, vacuum melted Hastelloy F was received from the Haynes Stellite Company. The composition of this alloy corresponds to that of the standard alloy except that Mo and Cu contents are three and two weight per cent, respectively (instead of six and zero weight per cent, respectively) and niobium is not present. Short term corrosion tests indicate corrosion rates in Zirflex process solution to be comparable to those for standard alloy. Corrosion rates in Sulfex process solutions are comparable to those for Ni-o-nel alloy. In Niflex process solutions corrosion rates are comparable to those obtained for the Hastelloy F heat used in construction of the 321 Building dissolver.

Weldments of the new material were simulated by drawing an arc across coupons to produce a bead of weld metal. Exposure of these coupons to Zirflex and Niflex process solutions showed no preferential weld metal attack. A few small occlusions were present in both the base and weld metal which were rapidly attacked by the Niflex process solution (1 M HNO_3 - 2 M HF). Appreciable end-grain attack occurred also in this latter solution.

Samples of a Cr-Ni-W and a 60 Ni-40 W alloy were exposed to boiling 65 weight per cent HNO_3, 1 M HNO_3 - 2 M HF, and 4 M H_2SO_4 solutions. Corrosion rates of the Ni-W alloy in these solutions were 300, 1, and 0.2 - 0.3 mil/month, respectively. The Cr-Ni-W alloy corroded at rates of 50, 2, and 300 mils/month in these solutions.

Precision Level Measurements

Two final water calibrations utilizing a standard dip tube system were completed this month. One calibration was performed weighing water into the vessel, and the other weighing water back out. This will allow determination of both a filling and emptying curve. Data were taken to determine the calibration curve from zero to 2-1/2 inches by adding water in twelve 30 pound increments. The empty vessel was filled to 0.3 inch ten times to determine the accuracy of estimating the zero intercept of the tank calibration curve. The data from all the calibrations are now being programmed for statistical analysis on the 709 computer.

[redacted]

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Salt Cycle Process

The conversion of uranium oxides to uranyl chloride by the action of chlorine in fused halide systems and subsequent recovery as UO_2 by reduction has been termed the "Salt Cycle Process." The process has two principal potential applications, (1) processing of reactor fuels, and (2) preparation of reactor fuel material.

Continued studies showed that both UO_3 and U_3O_8 chlorinate more readily than ceramic grade UO_2. Chlorination at 900 C reduced the reaction time considerably as compared to 800 C and resulted in less residue. Black residues from the preparation of UO_2Cl_2 by passage of chlorine through KCl-NaCl melts containing oxides of uranium were found to react with HCl to yield, apparently, UO_2Cl_2 as evidenced by its color.

The reduction of UO_2Cl_2 from halide melts was accomplished electrolytically, and by bismuth, lead, ammonia (hydrogen) and also by electrode grade graphite. The electrolytic approach seems of greatest potential for fuel material preparation. In preliminary experiments UO_2 with bulk and aggregate densities as high as 4.8 and 10.5, respectively, have been obtained.

Thermodynamics of Halide Systems

Preliminary analysis of effusion experiments with the KCl-UCl_3 system indicates a changing composition of both starting material and condensate which suggests an enhanced volatility of uranium due to compound formation.

High Temperature Spectrophotometry

The previously reported difference in the absorption spectrum of UCl_3 obtained by use of the hydrogen and tungsten lamps has been resolved as due to light scattering rather than molecular effects. Because of the low intensity of tungsten radiation in the near ultraviolet scattered light becomes appreciable resulting in spurious transmission effects. The lower limit of use for the tungsten lamp with the modified Beckman DU spectrophotometer has been set at 320 mu.

Procedures have been established for preparing pure, dry samples of $AlCl_3$, KCl, UCl_4, UCl_3, and mixtures of these salts.

Liquid N_2O_4 System

Kinetic experiments on the reaction of UO_2 with anydrous nitrogen dioxide at 105 C have shown that the reaction apparently proceeds through formation of an intermediate, possibly $UO_{2.25}$. After 164 hours, 77 per cent of the original UO_2 had disappeared, 61 per cent having converted to uranyl nitrate and 16 per cent to another uranium oxide phase having a UO_2 structure but lattice parameter $A_o = 5.40$ Å.

Continuous Ion-Exchange Contactor Development

Preliminary studies in the three-inch diameter by four-foot long Weiss contactor indicated satisfactory resin flow and retention on each plate with various pulsing conditions and no fluid flow. The four-plate unit was then replaced by a three-inch diameter column three-feet long containing 15 resin support plates spaced 2.5 inches apart. The plates were equipped with one-half inch downcomers extending one inch above and two inches below each plate. Shakedown runs with both water and 7 M HNO_3 indicate satisfactory resin retention at flow rates up to 3.5 gal/min./sq.ft. Although the resin was partially fluidized at the maximum flow rate, the settled height remained constant at one inch on each plate (the distance the downcomers protruded above the plate). A uranium feed will be used in future runs to study the exchanging efficiency of the contactor.

Boiling Metal Characteristics

The equipment for this study was described in last month's report (HW-60846 C, page 18). This equipment has now been operated with lead-bismuth eutectics containing 5, 10, and 20 per cent mercury. With the thermosyphon in operation, boiling occurred in the top one-third of the column. As the power level was raised, the amalgam flowed faster around the thermosyphon, maintaining the same boiling region. This region was relatively independent of the metal composition. Traverses along the column showed that the temperature rose linearly from the bottom of the column to the point at which boiling initiated and then decreased gradually through the two phase region. The normal boiling points for 5, 10, and 20 per cent mercury were 530, 480, and 420 C, respectively, with the maximum temperature in the column being as much as 30 degrees above these values, presumably because of hydrostatic effects.

WASTE FIXATION

Mineral Reactions

Eighty-three hundred column volumes of a synthetic waste simulated to contain 24 uc/liter of Cs^{137} were decontaminated with a decontamination factor greater than 500 by passage through a 50 g column of clinoptilolite at a flow rate of 2.8 gal/ft^2/min. The adsorption of Cs by clinoptilolite is not significantly reduced by decreasing the pH from 12 to 1. Results of equilibrium type experiments indicated that Sr decontamination by clinoptilolite drops sharply as the pH is reduced below 3. A search is presently being conducted to find selective ion exchangers suitable for long-term storage of radioactive wastes.

Laboratory experiments are in progress to investigate the effect of neutralization on simulated high-level waste solutions. Purex and Darex type wastes are being studied both chemically in non-radioactive systems and in Sr^{85} and Cs^{137} traced systems.

A request to determine the availability of the CR In-Farm Scavenging Facility in 200 East Area studying mineral reactions on a pilot-plant scale was transmitted to CPD.

Calculations were made to estimate the temperatures that might be experienced in a dry limestone bed exhausted through utilization of the calcite-phosphate reaction. Temperatures only several degrees higher than that of the surrounding earth would be reached in a twenty-foot diameter column of apatite if the influent waste stream contained 0.01 uc Sr^{90}/cc. A hundred-fold increase in the Sr^{90} concentration in the waste stream should not result in severe limitations on mineral bed (calcite) dimensions due to temperature considerations. Similar studies were started to evaluate temperature problems that may be associated with beds of clinoptilolite.

BIOLOGY AND MEDICINE - 6000 PROGRAM

Radicisotopes in Farm Products

A survey of the radioisotopes in farm produce samples from land irrigated with Columbia River water is in progress. By counting 500 gram samples of whole produce in the new large crystal spectrometer, sensitivities of 10^{-8} to 10^{-7} uc/g are obtained for most gamma emitters without any chemical separation or sample preparation other than packing into a plastic bottle. The major radioisotope is Zn^{65}, in representative amounts tabulated below:

Type of Produce	Method of Irrigation	Activity d/m/g
Pasture grass	Flooding	80
Wheat (grain)	Flooding	12
Mint plant	Ditch	6
Beans	Sprinkler	3
Carrots	Sprinkler	2
Corn	Ditch	2

In addition to these investigations the large crystal spectrometer is being used by the Radiological Chemical Analysis Operation for routine crop sampling measurements. Sensitivity increases by a factor of three or better are possible if desired by increasing the sample size to five gallons or larger.

Radicisotopes in Reactor Effluent

The concentrations of Eu^{152} (13 y.) and Tb^{160} (72 d.) in reactor effluent water were measured in three composite samples and averaged 0.3 and 0.6 d/m/ml, respectively. Although present only in these small concentrations, these isotopes are strongly adsorbed on reactor piping and are important contributors to the rear face dose.

Liquid Scintillation Counting

A liquid scintillation counting procedure was developed for determining the Pu^{241} present in plutonium samples. The plutonium is removed from the metal disks used in alpha counting with 1N HCl and extracted into a mixture of dibutylphosphate and liquid scintillator. After counting, the plutonium can be easily recovered for further measurements.

Geology and Hydrology

Two separate erosion surfaces were identified on the top of the Ringold formation. The older, Pleistocene in age, evidently sloped gently southeastward from 200 West Area toward the Columbia River; a remnant area lies along the northeast side of Cold Creek Valley, including 200 West Area. It is characterized by a thick caliche bed and is overlain by Palouse soil. The second and later erosion surface, about 10,000 years old, was incised into the earlier surface as a network of anastamosing river channels, immediately preceding the deposition of the recent fluviatile deposits. Recognition of the two erosion surfaces will permit better differentiation of the Ringold and fluviatile sediments and hence, better define problem areas where the fluviatile sediments lie beneath the water table. There they at least potentially transmit large quantities of ground water at high flow rates toward the Columbia River.

A map was prepared showing the elevation contours of the ground water as of June 1959. Eleven wells situated between the eastern and western ground water mounds showed an average rise in water level during the past six months of almost 0.6 foot. At the present rate of change the water table will be everywhere above 400 feet in this region by the end of 1959.

A less complicated derivation of the proposed unsaturated flow equation

$$Q = -KA(\rho')e_i$$

has been developed. This new derivation employs a set of substitutions which is much simpler to follow. It also gives a much stronger argument for its validity. The equation will be used in evaluating present and future disposal sites.

Preperforated pipe is being used in the construction of ten hydrological test wells at the Gable Mountain test site. This is the first time casing of this type has been used at Hanford. While attempting to drive this pipe in the first of these ten wells, the contractor collapsed the casing which indicates that some other method of installing the preperforated casing may be needed.

Soil Chemistry and Geochemistry

Laboratory experiments were designed to study the replacement of Cs on clinoptilolite by other ions. This research studies the effect of ionic charge and radii on the relative ease of replacement. The early results show three distinct replacement series, exclusive of tetravalent cations. Only for sodium, of the ions studied, was the relative replacement ability significantly affected by temperature.

Two of the replacement series are associated with alkali metals and alkaline earth metals, and the third with trivalent ions. The alkali metal replacement series is $Cs^+ > Rb^+ > K^+ > Na^+ > Li^+$ while that for the alkaline earth metals is $Ba^{++} > Sr^{++} > Ca^{++} > Mg^+$. Ammonium ion does not appear to fit properly into either of these two series, but is intermediate between them.

Laboratory experiments with samples of Conasauga shale from Oak Ridge, Tennessee, showed that in a 1M sodium system at a pH of 2.8 and at 25 C this material has about one-tenth of the cesium removal capacity and about one-tenth the cesium removal efficiency of clinoptilolite.

Turbidimetrically analyzed supernatant solution from centrifuged Ce equilibrium systems indicated that the pH range of soil colloid peptization corresponds to that of apparent low Ce removal. The formation of a peptized colloidal hydroxide of Ce, singly or in association with a soil colloid, is the most apparent explanation of these results.

Experiments with a pH 10.3 system indicated that non-centrifugable Ce is 60 per cent adsorbed on Dowex 21K anion exchange resin. Negligible adsorption by Dowex-50W cation exchange resin was found. A physical filtration of particulate cerium was indicated in a soil column experiment with a cerium influent at pH 10.3 and < 0.35 mm calcareous soil; this resulted in greater than 90 per cent cerium removal.

Ground Waste Investigations

Soil column experiments were continued to study the effect of Sr concentration on Sr breakthrough. In the presence of 1,000 ppm Mg ion, Sr concentrations of 0.1 ppm and lower had no effect on Sr breakthrough. The change in slope of the Sr breakthrough curves with column length is consistently greater in Mg-Sr than in Ca-Sr systems. On the basis of ionic competition, it is postulated that Na-Sr systems will yield an even greater slope change.

Laboratory soil column experiments were performed with soil and influent representative of that from the model crib experiment in progress near Gable Mountain. These experiments resulted in a 1 per cent radiostrontium breakthrough at 0.5 column volume, 5 per cent breakthrough at 0.8 column volume, 50 per cent breakthrough at 2.0 column volumes, and ultimate effluent concentrations approaching 90 per cent of the influent. A laboratory soil column of the same length as the soil column beneath the model crib is being studied.

Elution of Sr^{85} from the soil at the test site was concluded after leaching with 12,300 gallons of Ca solution and washing with 3900 gallons of water. After flushing, the concentration of Sr^{85} in the ground water beneath the site ranged from detectable to 3 per cent of the original influent concentration.

On the basis of the experimentally-determined porosity of 31 per cent for the test site soil and the nitrate ion breakthrough volume it was calculated that the effective volume of soil beneath the 2-foot x 2-foot crib is equivalent to a column 8-foot in diameter.

New wells were driven and a 6-inch x 6-inch crib installed in preparation for a new experiment soon to be initiated.

Field Apparatus Development

An airborne magnetometer used by the U.S. Geological Survey in local flights was studied in a survey flight over the Hanford Project. The objective was to determine whether magnetic response of the airborne total field instrument would correlate with ground instrument surveys made last summer with a vertical field instrument. From the few lines surveyed it appeared that good correlation will be obtained; strong response was recorded over known basalt features. Permission was requested to acquire and study all the magnetic data collected by the USGS.

Methods and equipment for sampling at depth in wells were reviewed. A solenoid valve sampler was assembled and tested under 400-feet water head. Leakage occurred at a rate of 10 cc per hour which is minor unless the sampler must remain at these depths for long periods before admitting the sample. Leakage can be eliminated through proper valve selection. The valves available were not rated for the pressure at 400-feet. Other sampling concepts were developed for trial.

Micromeritics

The literature relating to particle interaction with surfaces was reviewed in detail to establish a base for extending the research study. There appears to be a great need for experimental work to verify theories relating to deposition and retention of particles on surfaces, which is the area of work anticipated.

The issuance of the document HW-61082, "Radioactive Particles in 234-5 Building Ventilation Exhaust," concluded the work of characterizing particles in the 234-5 Building stack.

L. P. Bupp

Manager,
Chemical Research & Development

LP Bupp:bp

L. S. Kellogg, Chemist II, was hired and assigned to the Analytical Laboratories Operation.

J. C. Langford, Chemist II, was transferred in from the Chemical Processing Department and assigned to the Analytical Laboratories Operation.

E. C. Martin, Chemist I - H, was hired and assigned to the Chemical Research Operation.

J. E. Poelman, Chemist II, was transferred in from Professional Placement and assigned to the Chemical Development Operation.

P. F. Raney, Junior Scientist, was hired and assigned to the Analytical Laboratories Operation.

P. W. Smith, Engineer II, was transferred in from Professional Placement and assigned to the Chemical Development Operation.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
W.W.T. Crane	7/1/	The Martin Company Baltimore, Md.	Discuss cerium recovery program.	WH Reas RL Moore LP Bupp	Yes
A. Giambusso	7/7/	Division of Reactor Development - AEC Washington, D.C.	Division interest in chemical processing.	OF Hill LP Bupp	Yes
W. B. Tarpley	7/9/	Aeroprojects, Inc. West Chester, Pa.	Temperature dispersion in use of ultrasonics as agglomerator.	OF Hill	Yes
F. M. Empson	7/14/	ORNL Oak Ridge, Tenn.	Discuss radioactive waste.	CE Linderoth WA Haney DW Pearce	Yes

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
B. L. Legler	7/20/	ICPP Idaho Falls, Idaho	Observe Cesium Packaging Facility	RJ Sloat	No
J. I. Stevens	7/23/	ICPP Idaho Falls, Idaho	Waste Disposal Practices and the Waste Calcination Process	AM Platt	No
E. S. Simpson A. E. Peckham	7/21-24/	USGS Washington, D.C.	Discuss waste disposal research at Hanford pertaining to geology and hydrology.	RE Brown JF Honstead DW Pearce LC Schwendiman JR Raymond	No
T. J. Ward	7/27-31/	Clarkson College Potsdam, New York	Study waste disposal and other major activities at Hanford	JF Honstead	No
W. F. Semmett	7/27-31/	Air Tech. Intelligence Wright-Patterson AFB Dayton, Ohio	Study waste disposal and other major activities at Hanford	JF Honstead	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
A. J. Scott	7/7-9/	NRTS Idaho Falls, Idaho	Attend 6th AEC Air Cleaning Seminar	J Horan	Yes
W. B. Silker	7/10/	Dugway Proving Grounds Dugway, Utah	Participation in reactor fuel burndown experiments.	Maj. JL Terry	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. L. Burger	7/13-14/	University of Washington Seattle, Washington	Present Seminar to Chem. Engrg. Dept.	AL Babb	No
A. S. Wilson	7/14/	Gonzaga University Spokane, Washington	Present talk to Institute for High School Chemistry Teachers.		No
P. P. Rowe	7/13-14/	State College of Wash. Pullman, Wash.	Discuss problems relating to Soil Physics research	WH Gardner	No
W. H. Bierschenk	7/13-15/	USGS, Water Resources Albuquerque, N. M.	Discuss subject relating to ground water hydrology research	CV Theis	No
G. J. Alkire	7/16/	Gonzago University Spokane, Wash.	Present talk on "Chemical Instrumentation" at the Summer Institute for High School Teachers.		No
R. E. Brown L. C. Schwendiman J. R. Raymond W. H. Bierschenk	7/24/	Washington State College Pullman, Washington	Discuss geophysical seismic studies planned by group, also model studies of hydrologic problems.	ER Tinney EW Greenfield HW Barlow D Adams JW Crosby	No
R. J. Brouns	7/22-24/	AEC Washington, D.C.	Committee Meeting on Wash. Designated Prog.	W Singlevich	Yes
R. E. Ewing	7/27-28/	G.E. Diamond Section Detroit, Mich.	Technical Discussions	NA Mathews	No

BIOLOGY OPERATION

A. ORGANIZATION AND PERSONNEL

Dr. Howard E. Erdman joined the Radioecology Operation on July 27 and Dr. Richard A. Hennacy joined the Pharmacology Operation on July 30.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Radioiodine Contamination

Concentrations of I^{131} in thyroid glands of jack rabbits were approximately six times less than those observed one year ago. Values follow:

Location	μc/g Wet Wt. Average	μc/g Wet Wt. Maximum	Trend Factor
Prosser Barricade	4×10^{-4}	7×10^{-4}	+ 2
4 Miles SW of Redox	2×10^{-4}	1×10^{-3}	-
Wahluke Slope	2×10^{-4}	7×10^{-4}	- 2

Columbia River Contamination

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

Sample Type	μc/g Wet Weight Average	μc/g Wet Weight Maximum	Trend Factor
Minnows (entire)	2×10^{-3}	3×10^{-3}	+ 2

Of several antibiotics tested, Distrycin appears to be most favorable for studying mutation of C. columnaris to drug resistance. Work is continuing to obtain conditions suitable to evaluate the dose-mutation rate relationship.

Fallout Contamination

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

Sample Type	μc/g Wet Materials Average	Trend Factor
Bone	7×10^{-5}	+ 2
Feces	4×10^{-5}	-
Muscle	3×10^{-5}	+ 3
Liver	1×10^{-5}	-

Effect of Reactor Effluent on Aquatic Organisms

Monitoring of the effluent from the 100-KE reactor was continued with young rainbow trout. After two months there was no appreciable difference in the size of the fish exposed to 1, 2, or 3 per cent strength effluent. There was, however, a somewhat higher mortality among the fish in the 2 and 3 per cent effluent. Survival in all lots has been affected by bacterial disease which has accompanied high water temperatures.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Phosphorus

A cursory test on the uptake of P^{32} by cichlids indicated that appropriate body burdens would build up by merely adding the isotope to the water. Preparations are being made to use this method on the aquarium fish in a test to determine radiation damage to sex products.

Strontium

Yearling rainbow trout have received intramuscular injections of Sr^{90}-Y^{90} at levels of 6×10^{-4}, 3×10^{-3}, or 1.5×10^{-2} μc/gram of fish twice each week for ten weeks. No effect on growth or mortality is yet evident but the variation in size of the fish within the median and high level groups has become appreciably greater than that in the control group.

Daily force feeding of gelatin capsules to anesthetized trout had no apparent effect on the fish and was discontinued after ten weeks. Weekly phlebotomies were also discontinued after ten weeks since the erythrocyte count was well-stabilized and leucocyte count did not increase after the sixth week.

Significant improvements were made in the gill perfusion technique and initial runs with Sr^{85} indicate that the method and equipment will furnish satisfactory data on the transport of radioisotopes across the gill membranes.

Pigs farrowed by one miniature sow fed 5 μc of Sr^{90} for over four months and 90-day-old fetuses from a miniature sow fed 25 μc/day seemed normal in size and appearance.

Uptake of Sr^{90} from soil contaminated with chemical forms of Sr^{90} of varying solubility is little changed after three successive croppings with beans. A slightly reduced uptake was observed from all treatments on acid soil indicating some fixation of the Sr^{90}. Uptake of the soluble forms, $SrCl_2$ and $Sr(NO_3)_2$ was slightly lower from basic soils that had been observed in previous croppings. This suggests a possible move toward an equilibrium of the Sr^{90} in these soils.

Iodine

Radish and lettuce plants are being exposed to fission products released by melting a fuel element. The melt-down is being arranged by the Air Force. After plants are exposed, they will be decontaminated with a variety of reagents to evaluate the feasibility of decontaminating plant foods for human consumption.

Cesium

Plants were grown in soils containing the same amount of Cs^{137}/g under three water conditions: soil at field capacity, saturated soil, and saturated soil with 2 1/2" of standing water. Plants from soils moistened to field capacity had no increase over background, and those from saturated soils were only double this, but samples from saturated soil and standing water contained 70 times as much Cs^{137} as those grown in field capacity conditions.

Internal measurements of the gamma dose rate using ionization pencils in two rams fed 1.25 and 0.50 mc Cs^{137} daily for five and twenty days, respectively, are shown in the following table:

Location	Amount of Cs^{137} fed daily	
	1.25 mc (5 days)	0.5 mc (20 days)
Liver	35 mr/hr	15 mr/hr
Kidney	31	23
Muscle	23	16
Brain	19	16
Testes	26	11
(Testes removed from body)	15	5
(Scrotum with testes removed)	8	7

(Earlier measurements indicated that no appreciable beta irradiation from Cs^{137} would penetrate the walls of the ionization pencils.)

A small beta scintillation probe was utilized for scanning one testicle and one kidney of a ram fed Cs^{137} for five days. It was found that the Cs^{137} concentration in the medulla of the kidney was about 80 per cent of that observed in the cortex. (French workers some time ago reported a similar relationship for radiopotassium in the kidney.)

Fifteen per cent of the administered dose of Cs^{137} was excreted in the urine of a ram fed 0.5 mc/day for 20 days, while 19 per cent of the administered dose was excreted in the urine of another ram 20 days after receiving a single 2 mc dose.

Plutonium

Rats injected with 1 μc of plutonium have been irradiated with weekly doses of 100 r to an accumulative total of 2200 r. Four of twelve rats survived this treatment. Ten of twelve rats subjected to the X-ray treatment only have survived.

The effectiveness of DTPA in preventing plutonium deposition was not improved by its administration as magnesium or zinc salts. Reduced glutathione administered immediately following $CaNa_3DTPA$ significantly improved the effectiveness of DTPA treatment. This effect will require further study.

The initial two swine for an experiment designed to study the effects of intradermally deposited plutonium were injected with a 0.2 N $Pu(NO_3)_4$ solution. The levels injected ranged from 0.0016 to 1.0 μc and were duplicated on both sides of the animal. The rate and extent of plutonium disappearance from the site of injection are being followed by a scintillation probe.

Three pigs were injected with Pu^{239} citrate suspension, pH 5.5. At intervals ranging from minutes to hours, over a five-day period, blood samples were taken for radioanalysis. On the sixth day the animals were sacrificed for tissue radioanalysis. Similar groups of animals will be similarly dosed when they reach the age of these animals. However, DTPA, EDTA, and zirconium citrate will be administered to them to test their effectiveness in removing plutonium.

Two mature male Pitman-Moore pigs were administered plutonium in the first phase of the study designed to establish the comparative toxicity of Sr^{90}, Ra^{226}, and Pu^{239} following single intravenous administration. Pu^{239} citrate suspension, pH 5, was injected in an amount calculated to give a body burden of 1 μc/kg body weight. Routine blood sampling, clinical and X-ray examinations will be followed in these animals during their lifetime.

Radioactive Particles

Twenty-four dogs were exposed to plutonium oxide aerosols to complete a study of the effect of particle size and concentration on deposition, distribution, and excretion. Two dogs were killed at about nine months after exposure to see if excretion and lung burden of plutonium could be correlated.

Gastrointestinal Radiation Injury

Studies are continuing on the effect of intestinal tract irradiation on glucose absorption. A sublethal exposure of the tract to 900 r appears to have as large an effect on glucose absorption as 1500 r. The correlation of blood sugar levels with the inhibition of absorption is being investigated as a possible method of estimating radiation dose to the intestinal tract.

Experimental Techniques

A new technique has been developed for the positive identification of radioactive particles collected on millipore filters. Heretofore absolute distinction between radioactive and non-radioactive contaminant dust particles (in the range of 0.8 μ to 2 μ) was impossible and posed a constant and harassing problem in the difficult but highly important lung inhalation studies.

The new method involves the application of a very thin layer of Eastman Kodak NTA nuclear emulsion on an electron microscope grid upon which a sample of millipore filter has previously been dissolved. After several days the exposed grid, covered by the thin layer of emulsion, is developed in a routine manner and subsequently examined and photographed in the electron microscope.

A new approach to the indwelling catheterization of the femoral vein in swine was established. The catheter is introduced into the recurrent tarsal vein and passed along this vessel into the femoral vein. This method provides a quick and relatively simple procedure by which frequent blood sampling may be accomplished.

Whole-Body Monitor

Direct background measurements were made with a 128-Channel Analyzer equipped with a 2 x 2 inch NaI-crystal detector in the site chosen for the subject facility. Readings made both above and below ground indicated that there may be an advantage to utilizing an earthen barrier. This is, however, being further investigated. Additional measurements will be made in one month, when the reactor is shut down and when it is in operation, using the type of shielding planned for the new facility.

H. A. Kornberg
BIOLOGY OPERATION

HAK:es

C. OFF-SITE VISITS AND HAPO VISITORS

Names	Dates of Visits	Company or Organization Represented/Visited	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas and Bldgs.
VISITS TO HANFORD WORKS						
Dr. Asher White & Douglas White	7/1	Minneapolis, Minn. (private practice)	Tour	(KL Englund) Foster, Bustad	No	100-F, Biol.
Dr. Ensminger	7/7	WSC, Pullman	Consultation	Bustad	No	" "
Mr. Olson	7/8	Self-employed.	Tour	(Englund) Clarke, Foster		" "
30 High school teachers	7/17	Gonzaga Univ., Spokane	Tour	Bustad, Foster	no	" "
Dr. E. Sanger	7/21	Radiology Dept., U. of Cincinnati.	Tour	(Norwood) Kornberg	No	" "
Adm. Watkins	7/24	U.S. Navy	Tour	RL Persing	No	" "
10 Members of summer institute of nuclear Eng.	7/24	AEC, NSF	Tour	Bustad, Foster	No	" "
Maj. G. Farmer	7/23	Las Vegas Field Office, AEC	Tour	Bustad, Bair, Thompson	No	" "
Dr. C. M. Weiss	7/28	Univ. of N. Carolina	Tour	Foster	No	" "
Dr. Geldiay, Messrs. Joyner and Kimmel	7/30	U. of Washington	Tour	Foster	No	" "
VISITS TO OTHER INSTALLATIONS						
FP Hungate	7/9-11	Dugway Proving Grounds, Utah	Set up experiments	Capt. Rawers	No	
FP Hungate	7/12-14	U. of Washington	Address summer institute.	Welander	No	
FP Hungate	7/15	Gonzaga Univ., Spokane	" " "	"		
JF Cline and JD Stewart	7/27 -	Dugway Proving Grounds, Utah	Expose plants to fallout.	Capt. Rawers	No	
RT O'Brien	7/17-22	Gordon Research Conf., Meriden, N.H. and Rockefeller Inst., NY	Attend conference and discuss research.	Drs. Peachy and Rasmussen		
JJ Davis, WC Hanson, DG Watson	7/17-	Seattle, Kotzebue, Alaska	Conduct ecological research at site of Project Chariot.	AEC personnel	No	
RC Pendleton	7/29-31	Flathead Lake, Mont.	Address summer institute	-	No	
WJ Clarke	7/22-24	Seattle, U. of Wash.	" " "	Welander	No	
VH Smith	7/23-24	Seattle, U. of Wash.	" " "	"	No	
DE Warner	7/29-30	Eastern Oregon College, La Grande, Oregon	Present lecture.	Drs. Quaintance and Badgley	No	
DG Watson	7/7-8	Seattle	Check on fish shocker.	-	No	

D. Lectures

a. Papers presented at Meetings

None

b. Off-Site Seminars

FP Hungate, 7/13/59, "Biological Effects of Radiation on Cells," University of Washington Summer Institute, Seattle, Washington.

OPERATIONS RESEARCH AND SYNTHESIS OPERATION MONTHLY REPORT

July, 1959

ORGANIZATION AND PERSONNEL

W. F. Stevenson transferred to the Quality Control Operation, FPD, effective July 1. A Technologist R & D was transferred into Operations Research and Synthesis from Reactor and Fuels Research and Development effective July 13.

OPERATIONS RESEARCH ACTIVITIES

Input-Output Simulation Model

Work on the computer program continued.

Other

In connection with the study of business systems, work is being done with personnel of the computing operation to examine the basic characteristics of that operation from the point of view of effective control. In particular, the desirability of standard billings as opposed to a control based on cash flow -- available machine time -- output relationships is being examined.

OPERATIONS ANALYSIS STUDIES

Redox Dissolver Study

Principal component analysis of the data was completed and supplied considerable information as to possible variants of the basic model. Work on a computer program for determining the parameters of an empirical relationship between specific gravity and time was completed.

Z Plant Information Study

This study is essentially in a standby status while awaiting receipt of specifications for process equipment modifications. Data describing physical plant layout and conduit routings have been sent to the IBM equipment design engineer.

FPD Process Control and Experimentation

The cleaning process is being thoroughly investigated as a means of eliminating "non-wet" rejects. Data from a preliminary experiment, in which one step at a time was eliminated in the cleaning process were helpful in designing a subsequent experiment which will permit estimation of the effects of eliminating any combination of steps in the present process. In this same experiment, the effect of changing the concentration of one of the agents will also

be investigated. Assistance was provided in the design of other experiments in which various substitutions and additional steps are to be considered. The protection afforded by the existing sampling plan for "non-wet" rejects was evaluated, and suggestions were made for employing a sequential plan giving the same protection.

Data were analyzed to evaluate the effects of several variables on dimensional distortion during heat treatment in the co-extrusion process. It was pointed out in discussing the results of the analysis that failure to replicate may lead to misleading conclusions in evaluating the reduction ratio effect, which is of primary interest.

Quality Certification Program

In response to a rough draft of proposed product specifications prepared by IPD personnel, data requirements to implement such a product specification system were listed. To illustrate how these data could be reported and interpreted, a thorough review was made of one measurement, total count. It was shown that total count data could easily be routinely reported and interpreted, and criteria were drawn up for reporting additional data to IPD when "out-of-control" situations occur.

Some misunderstanding of the need for transforming raw total count data to logarithms has existed. Since total count is such a widely used measurement tool, a document (HW-61394) was prepared discussing in detail the reasons for requiring this transformation. Illustrations with actual data were included.

Process Tube Leaks

A report has been issued outlining in some detail the next step to follow in an effort to better predict which tubes are likely to leak because of external corrosion. Work will begin on the analysis during August.

In connection with the general problem of external corrosion, assistance was given IPD personnel engaged in determining the "seizure" effect of tube corrosion, where "seizure" on a fuel element due to a tube's collapsing from corrosion product build-up may lead to a stuck charge. Available leak data, indicating the frequency of pits of a given depth, are being interpreted along with visual pit distribution data to calculate the probability of "seizure."

Aluminum Corrosion

Discussions were held with IPD and HLO personnel relative to the comparison of two aluminum corrosion models as regards their effectiveness in describing reactor data. Both models considered lead to a non-random error distribution. and are quite comparable when data of less practical importance are deleted. Calculations have been made for two additional models utilizing these same data, but comparisons with the other models have not as yet been made.

Reactor Calculations

A preliminary document is being prepared in connection with this study which will: (1) describe aspects of the problem in mathematical language; (2) present the results of analyses pertaining to the handling of reactor power data and the frequency of temperature map making; and (3) list the information necessary to have before the accuracy of reactor power level calculations can be assessed in the light of accountability needs.

CPD Control

A rough draft report was issued in connection with the study of material control in the Recuplex dissolvers. It is planned to document this report because of the potential usefulness of this type of mathematical model in explaining the data, and consequently, in formulating optimum operating procedures.

Radiation Protection Studies

Work continued on the analysis of data from a Calibration Operation experiment to test the validity of the inverse square law as it applies to radium gamma film badge calibration. A pilot study experiment to test the effect of exposure angle upon the film badge was analyzed, and the information obtained was used to design a more complete experiment to further investigate the effect.

At the request of Radiation Protection Operation personnel, preliminary precision estimates for the annual 3r. dose limit were provided. Improved estimates must await the completion of all experiments in progress and a study of the manner in which the various sources of error interact to provide the total error in dose estimation.

Systems Reliability

A general digital computer program has been written which is capable of handling logical descriptions of systems of any degree of complexity. It is felt that the use of this program to complete detailed studies of the K Plant water system must serve as the basis for more general studies.

STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program - Electron Diffraction

A statistical analysis was initiated of a gold film electron diffraction pattern for Physical Metallurgy Operation to determine the precision and accuracy of their current calibration formula for powder patterns. The analysis should provide information on the importance of spherical aberration as a biasing factor in the calibration, on the number of rings that should be used in the calibration, and on the biasing characteristics of individual rings. Any consistent bias pattern in the reading of ring diameters as one progresses outward from the center of the configuration should be discernible, as well as the relative importance in measuring ring diameters of replicating a given orientation and reading several orientations.

4000 Program - Swelling Studies

Analysis was completed on a distribution of known diameter balls in a "Scotch" medium, processed and photographed similarly to the uranium samples, in an effort to determine the nature of the distortion introduced in the processing. Work continues in this area.

4000 Program - Fission Gas Release

An unclassified document commenting on the fraction of fission gas released from a spherical source was written and will be issued shortly. The document considers the numerical evaluation of a familiar but computationally complex infinite series expansion expressing the fraction of fission gas released from a spacially homogeneous spherical source in uniform continuous production. Included is a general discussion of the calculation of the infinite series with a bound for the error arising from truncation after a specified number of terms, and in addition, approximations to the fraction released for extreme values of the parameter Dt/a^2 where D is the diffusion coefficient of the spherical source, t is the length of the production time interval, and a is the radius of the spherical source.

4000 Program - Waste Disposal

Consultation was held with members of the Chemical Effluents Technology Operation concerning the design of a proposed experiment to measure the effects of several factors occurring in a waste disposal study.

6000 Program - Biology and Medicine

Work continued on statistical analysis of data from a radiostrontium-calcium uptake and retention experiment involving acute and chronic administration of these isotopes to groups of mature and growing rats. A modified power function, derived from a mathematical model of the experimental situation, has been fitted to the data from the acute administration experiment. Preliminary results seem to indicate that the modified power law is in excellent agreement with the data.

Work was initiated on a statistical analysis of data from a daily Sr^{90} SO_4 inhalation experiment. The same mathematical power law is applicable in this situation, with the necessary modification for chronic rather than acute administration.

General

Mathematical assistance is being given in a study of the elastic solutions for the thermal stresses in finite solid cylindrical fuel elements under various assumptions on the thermal distributions.

Analysis of several tank calibrations associated with volume measurements of non-production fuel element solutions was completed. Two more calibrations with water are being run, in one of which the calibration is being performed by emptying rather than filling the tank. Two experiments will also be run in which the precision of the heel at zero manometer reading will be evaluated.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Irradiation Processing Department

A reliability analysis was made of a proposed scram system which is designed to distinguish between spurious and real scram situations. Conservative estimates of individual component reliabilities were used in this analysis. Also, a sampling plan proposed to use in connection with the acceptance of parts for this system was evaluated.

Chemical Processing Department

A series of meetings were held to discuss the applicability of the Gorton lathe to the precision machining of free form weapons components. The serious restrictions to machining due to this lathe's peculiar coordinate system were demonstrated and thoroughly discussed. It was agreed upon that for certain uncomplicated shapes, the Gorton should be tested. As a consequence, a mathematical program for the IBM 709 is nearing completion which will convert device specifications into the appropriate cam specifications.

Construction Eng. and Utilities Operation

The results of a review of the present measuring system used to evaluate fair cost estimates made by Estimating Operation were presented to responsible management during the month. It was pointed out that the present system leads to difficulties in setting realistic and objective estimates. Suggestions for improving the situation were given and a report is being prepared.

Relations Operation

Data from the returned questionnaires used in the recently completed GE News readership survey were analyzed. Comparisons were made between major components and between different employee groups with respect to the percentages of favorable responses to the various questions. Several significant differences were detected.

At the request of the Health Operation a statistical analysis is being performed on data from several human cases of accidental Pu deposition to determine the effectiveness of different dosage schedules of a DTPA treatment.

Empirical data are also being statistically analyzed to determine the functional relationship relating microparticle size to terminal falling velocity in a viscous medium.

Carl A. Bennett Manager
OPERATIONS RESEARCH & SYNTHESIS

1240111

CAB:blp

PROGRAMMING OPERATION
JULY 1959

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. Radioisotopes for Heat Sources

Study of Th-228 preparation via Th-230 irradiation and decay of the resulting U-232 was continued. The Litton computer was utilized to provide data on the progress of irradiation (with 2.16 x 10^{13} neutron flux) of a mixture of Th-232 and Th-230 (11 per cent Th-230). The resulting curves showed that such a mixture (representative of material which may be recovered from the most desirable ore sources) containing one kilogram of Th-230 would yield about 20 grams of the desired intermediate product, Pa-231, in 100 days. After aging, about an equal amount of by-product U-233 containing about 0.5 gram of U-232 was also produced. These results support expectations for a reasonable yield of Pa-231 which could then be recovered and further irradiated for an annual production of kilogram quantities of U-232.

2. Hanford Loops

Jointly with Reactor and Fuels Research and Development Operation a comprehensive synopsis of all Hanford in-reactor and out-of-reactor loop facilities was prepared for the 2000 Program budget review. Each loop was described according to its purpose, physical dimensions, materials, operating conditions, location, and cost. A total of 27 out-of-reactor loops and 13 in-reactor loops were described and categorized.

B. REACTOR DEVELOPMENT - 4000 PROGRAM

1. Plutonium Recycle Program

RBU Computer Code

Collection of nuclear constants from the readily available literature for the isotopes in the RBU cross-section library proceeded to the point where about one-third of the total required data are compiled. Testing, debugging, and input coding for RBU continued.

Plutonium Value Study

The compilation of information to facilitate reporting a year's study of the apparent value of plutonium to reactor operators using self-sustaining plutonium recycle and a uranium enrichment cascade is continuing and some cases will be run to fill out the data. The concurrent revision of the IBM-650 codes used for this work into an integrated single IBM-709 code has progressed to complete debugging of the recycle portion which is now being applied. The portion using uranium once-through operation may be usable within a month.

PRTR Planning

The effects on supporting facilities of PRTR physics experiments planned for reactor startup were investigated. Equipment and manpower requirements and radiation hazards were analyzed for those experiments studied to date.

C. BIOLOGY AND MEDICINE - 6000 PROGRAM

1. Radiological Consultation

A request was received to assist in certain sections of the forthcoming revision of the U. S. Weather Bureau's pamphlet, "Meteorology and Atomic Energy". Comments were forwarded on the outline and agreement given to provide assistance.

A lecture on "Maximum Permissible Radiation Dose" was given to the Radiological Physics Fellows.

2. Programs

A request was prepared for Chemical Effluents Technology to review the fate of radioactive materials used in the Rattlesnake Springs projects of Radioecology.

Two meetings of the Radiological Evaluation Task Force were held during the month. The appendices to the report being prepared by the Task Force were discussed in detail and returned to the authors for revision.

D. OTHER ACTIVITIES

With the completion of arrangements for off-site speakers the final schedule for the 1959 - SINE program was issued. Through July, forty-four lectures and twenty-one tours were completed in accordance with the schedule. Eleven of these lectures were given by off-site personnel including individuals from Phillips Petroleum facilities at Idaho Falls, and the Oak Ridge and Argonne National Laboratories. Programming Operation personnel completed six lecture assignments and assisted in several tours and also in the problem assignments.

Assistance was provided in planning and carrying out the Hanford Laboratories portion of the General Advisory Committee visit. Tours and visits were coordinated for several groups of students and teachers during the month.

Participation in the activities of the Task Force on Plant Improvement Analysis continued. A system of categorizing plant improvement programs was developed by the group.

Milton Lewis

for Manager, Programming

M Lewis:dl

VISITS TO HANFORD:

Name	Dates of Visit	Company or Organization Represented and Address	Reason for Visit	HAPO Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
E.L. Saenger, M.D.	7/21/59	U. of Cincinnati, Cincinnati General Hospital Cincinnati, Ohio	Review problems connected with their handbook on medical aspects of radiation accidents.	J.W. Healy	No	300 - 328
D. J. Crouse	7/14	ORNL, Oak Ridge, Tennessee	Give talks to Summer Institute of Nuclear Energy - Chemical Processing Program participants.	C.A. Rohrmann	No	300 - 325
T. Butler	7/14			"	"	" "
K. L. Rohde	7/16	ICPP, Phillips Petroleum Co., Idaho Falls, Idaho				
F. M. Warzel	7/16-17					
B. L. Legler	7/20					
J. I. Stevens	7/23					
J. L. Fischer	7/21	ANL, Lemont, Ill.	" "	"	"	" "
Robert Kessie	7/21					
H. M. Feder	7/22					
M. Levenson	7/22					
John Valance	7/27/59	AEC, Division of Reactor Development Washington, D.C.	To discuss status of HLO Pu fuel cycle analysis and future planning.	E. A. Eschbach	No	300 - 328

VISITS TO OTHER INSTALLATIONS:

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
E. A. Eschbach	7/6-17	Mass. Institute of Tech. Cambridge, Mass.	To attend MIT Special Program 2.158 "Direct Conversion of Heat to Electricity".	J. Austin	No
	7/20-21	GEL Schenectady, N.Y.	To discuss thermionic conversion devices and mercury cooling.	J.L. Michaelson H. Schmidt	No
	7/21	GERL Schenectady, N.Y.	Discuss Eschbach's high vacuum work at GERL request.	V. Wilson	No
J. W. Healy	7/15-16	GE, Schenectady, N.Y.	Meeting of Marine Subcouncil of GE Reactor Safeguards Council.	E.J. Schmidt	Yes
	7/23-24	GE, San Francisco, Calif.	Meeting of GE Reactor Safeguards Council.	K.P. Cohen	Yes

RADIATION PROTECTION OPERATION MONTHLY REPORT - JULY 1959

A. ORGANIZATION AND PERSONNEL

I. Holtzman (Specialist, Radiation Monitoring) and Maryann Long (Secretary) were added to the rolls of Radiation Protection Operation on July 14 and July 27, respectively. The force of the Radiation Protection Operation now totals 135.

B. ACTIVITIES

Three new cases of plutonium deposition were confirmed during the month. One case was the result of a contaminated minor injury and two cases were detected through the routine sampling program. The total number of deposition cases which have occurred at Hanford is 232 of which 164 are currently employed.

The contaminated minor injury occurred during routine maintenance work in the Recuplex recycling and blending hoods. Initial contamination levels in the vicinity of the wound area on the finger were > 40,000 d/m Pu. Normal decontamination efforts were relatively unsuccessful. Measurement of the contamination in or near the wound in the Shielded Personnel Monitoring Station indicated ~ 0.016 μc Pu in the wound site. Excision of tissue at the wound site reduced the contamination level to ~ 0.001 μc. The initial estimate of the internal deposition is < 10 per cent of the maximum permissible limit (0.04 μc Pu).

An improved method for evaluation of NTA film exposed to fast neutrons was initiated. This method involves a sequential analysis technique for reading films which have received a significant gamma exposure as measured by the gamma film in the neutron badge. This procedure will result in reading fewer negative films. Those films which are read will have an improved sensitivity.

The film badge processing machine is being utilized routinely for processing of badges. Several safety features have been added. The film exit chute was equipped with a specialfilm catching magazine which orderly stacks film removed from the badges.

A comprehensive study was initiated on the variation of expected neutron and gamma exposures during separation and fabrication of plutonium as a function of the concentration of plutonium isotopes 240 and 241. This study will be helpful in forecasting expected exposure resulting from longer reactor exposure of uranium metal.

A study of finger ring dosimeter results obtained from working with plutonium was initiated during the month. The study is aimed at confirming the adequacy of present Calibrations procedures in the light of increased shielding of processing hood enclosures.

Higher than acceptable backgrounds continued to trouble the testing of the reduced area plutonium electrodeposition procedure. All new laboratory equipment was tried in an attempt to determine the source of these high backgrounds. Information on the process used at the Savannah River Plant is being secured by

Analytical Chemistry. Their process involves use of an ion exchange resin on a 250 ml sample.

Six urine samples were spiked with plutonium-240 and 239 and were electroplated. This work is related to the development of procedures for determination of Pu^{241} by liquid scintillation counting.

Pressure vessels in the Bioassay laboratory were inspected by a State inspector.

Body dose rates of 6 r/hr were encountered for a short period during the disposal of a waste carton containing irradiated zirconium tubing from the 327 Building. The surface dose rate of the carton was 110 r/hr.

A Kennewick residential survey was performed following the disclosure that a 300 Area maintenance employee had personal clothing spattered by acidic solution, potentially contaminated with uranium. No contamination was found.

Monitoring service was furnished at the request of AEC-HOO Licensee Inspection Division in connection with an allegedly dangerous and highly publicized "waste drum" washing ashore on an Oregon beach. Radiation surveys of the drum upon its arrival at the Richland AEC airport and analytical samples of its content indicated that no radioactive materials were involved. The drum appeared to contain sea water and oil.

The scoping and the coordination phases of establishing criticality alarms in the 300 Area were completed. Construction work orders were initiated covering the fabrication of the alarming equipment for all locations at which significant potential for criticality accidents exists.

Three aerial surveys of the Hanford area were made using the USGS plane and two surveys were completed from Hanford to the Pacific Ocean with the AEC plane during the month. These surveys are in conjunction with refining the use of aerial surveys for environmental monitoring and correlating our surveys with the USGS program.

Very preliminary and sparse data indicate there may be an upward trend in the radiation background in the Columbia River water above the Hanford plant. Additional data are being gathered with particular emphasis on the trend of uranium concentration. Any increased natural uranium in the Columbia River water could result in increased total radioactive content of the water after exposure in the Hanford production reactors.

The concentration of I^{131} in vegetation samples was less than 1.5×10^{-6} μc/gm in all of the 27 zones sampled. Fission products other than I^{131} were less than 1.0×10^{-5} μc/gm at all locations except separations areas, on-project, and Wahluke Slope vegetation sample groups. These locations averaged $1 - 2 \times 10^{-5}$ μc/gm. In all vegetation samples Zr^{95}-Nb^{95} was consistently found at an average of 4.5×10^{-6} μc/gm.

The Radiological Chemical Analysis laboratory began using a nine-inch NaI (Tl) well crystal. The larger crystal reduces the detection limit for I^{131} in raw produce samples to about 2×10^{-8} μc/gm. Apparently, adequate sensitivity can

be achieved for other radioisotopes in produce without ashing. This assumption is being tested. If this is true, the capacity of the laboratory for processing produce samples will be substantially increased.

The usual seasonal decrease in isotopic concentrations and GI tract exposure estimates were observed with the increased flow of the Columbia River. The average river flow for July, 1959, was 349,000 cfs, against 331,000 cfs for June, 1959. It is interesting to note, as a comparison, that during July, 1958, the average river flow was 194,000 cfs.

A special ionization chamber suitable for measuring the concentration of tritium in air has been designed. The chamber will be used in conjunction with the pulse pencil reader to determine tritium concentrations. The Technical Shops have scheduled delivery of the chamber early in August. Calculations indicate that this system should be capable of detecting tritium concentration down to 2×10^{-5} μc/cc, which is the occupational MPC for tritium in air.

Preliminary investigations of the new Eastman Type 3 personnel monitoring film indicated that doses of a few mr of radium gamma can be detected. The film sensitivity appears to be about twice that of the Eastman Type 2 film. This is achieved through a double emulsion of the sensitive film. As presently available, the Type 3 film packet consists of two films: a sensitive film and an insensitive film. Further investigation is planned.

The mechanized film badge processing system to be used in the darkroom arrived on site. Plans were made to install this unit in August.

Work continued on the design of the automatic densitometer. A fifteen-sided selector ring was designed for perforating on the data processing card, the proposed payroll number coding system. Work on the automatic densitometer centered about studies of a stable light source. The use of a trickle battery charger and battery in series has resulted in the most stable light source to date. The total commitments for Request for Appropriation 59-HL8-101, An Automatic Film Processing System, now stand at $35,084; actual expenditures total $27,535.

Phosphate glass and cobalt glass for use as dosimeters were obtained for testing. A Bausch & Lomb spectroscopic 20 instrument was also obtained to evaluate these dosimeters. The small phosphate glass dosimeters measure 1 mm in diameter by 6 mm in length and may prove useful for evaluating high gamma doses.

Assistance was provided to the Biology Operation in making internal and external dose measurements on two rams that had been given Cs^{137}. The pulse pencil reader and special ionization chambers were used successfully for these measurements.

C. EMPLOYEE RELATIONS

Several RPO personnel have taken advantage of the PRTR tours which are conducted on a weekly basis.

Preliminary information was received on the tentative award of the arbitrator in the Maki Arbitration Case.

There were three medical treatment injuries for an estimated frequency of 1.47. No security violations occurred during the month.

No suggestions were received for evaluation. No suggestion evaluations were made during the month. One suggestion is pending in RPO for evaluation. No awards were made.

D. SIGNIFICANT REPORTS

HW-60896 "Waste Disposal Monitoring Activities Summary - June 1959" by K. F. Baldridge.

HW-60954 "Analysis of Radiological Data for the Month of June, 1959" by R. L. Junkins.

HW-61008 "A Review of the NTA (Fast Neutron) Film Program" by E. C. Watson.

HW-61029 "Hanford Mid-Year Report to Columbia River Advisory Group Through June, 1959" by R. L. Junkins and M. W. McConiga.

HW-61354 "Monthly Report - July 1959, Radiation Monitoring Operation" by A. J. Stevens.

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

Con.Undoc. "Unconfined Underground Radioactive Waste and Contamination in the 200 Areas" by K. F. Baldridge.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings
Howard Perry	7-9-59	GE-ANP Evandale, Ohio	Obtain information relative to bio-assay program	HA Meloeny	None	3705:300 747 & 747A 700
Jack Meuschke Phil Philbin	7-10-59	U.S. Geological Survey, Washington, D.C.	Survey HAPO from the air	IC Nelson	None	-
Dr. Eugene Saenger	7-21-59	Univ. of Cincinnati Cincinnati General Hospital, Cincinnati, Ohio	Discuss treatment of emergency cases and the radiological hazards of plutonium	AR Keene RH Wilson	None	3705, 328, 300
Claire Palmiter	7/22 - 24/59	Washington AEC Div. of Licensing and Inspection Washington, D. C.	Discuss film badge program	AR Keene HA Meloeny RH Wilson LL Crawford	None	3705, 3746 300
J. J. McMahon	7/24/59	National Industrial Conference Board, New York, New York	Discuss radiation protection methods	AR Keene	None	703:700

VISITS TO OTHER INSTALLATIONS

None

ENVIRONMENTAL MONITORING - RESULTS (June 22, 1959 - July 26, 1959)

Sample Type and Location	Activity Type	Monthly Average	Units*	Trend** Factor
Drinking Water				
100-F Area	Isotopic	0.4	% MPC_{GI}	--
Separations Areas	Gross Beta	3.0×10^{-7}	µc/cc	--
Pasco	Isotopic	0.1	% MPC_{GI}	--
Kennewick	Isotopic	0.1	% MPC_{GI}	--
Richland	Gross Beta	$< 3.0 \times 10^{-8}$	µc/cc	--
Columbia River Water				
Above 100-B Area	Gross Beta	1.8×10^{-8}	µc/cc	--
100-F Area	Isotopic	1.6	% MPC_{GI}	--
Hanford Ferry	Gross Beta	1.5×10^{-5}	µc/cc	--
Pasco	Isotopic	0.4	% MPC_{GI}	--
McNary Dam	Gross Beta	8.9×10^{-7}	µc/cc	--
Vancouver, Washington	Gross Beta	No Sample	µc/cc	
Waste Water				
Outlying Test Wells	Gross Beta	4.5×10^{-6} (Max.)	µc/cc	--
Atmosphere				
Gross Dose Rate -				
Project	Gamma	1.0	mrad/day	--
Environs	Gamma	0.7	mrad/day	--
I-131 Separations Areas	I-131	1.7×10^{-13}	µc/cc	-
I-131 Separations Stacks	I-131	1.8	curies/week	--
Active Particles - Project	--	4.1	ptle/100 m^3	--
Active Particles - Environs	--	3.7	ptle/100 m^3	-3
Vegetation				
Separations	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Residential	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Eastern Washington and Oregon	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Fission Products less I-131 - Wash. and Ore.	Beta	$< 1.0 \times 10^{-5}$	µc/gm	-2

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

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

EXPOSURE EVALUATION AND RECORDS

Exposure Incidents Above Permissible Limits

	Whole Body	Localized
July	0	0
1959 to Date	6	6

Gamma Pencils

	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
July	17,980	86	7	1
1959 to Date	192,232	676	30	9

Beta-Gamma Film Badges

	Badges Processed	Readings 100-300 mrads	Readings 300-500 mrads	Readings Over 500 mrads	Lost Readings	Average Dose Per Film Packet mrad(ow)	mr(s)
July	9,869	639	47	26	23	9.08	11.27
1959 to Date	75,385	6,064	621	130	315	6.45	17.20

Neutron Film Badges

	Film Processed	Readings 50-100 mrem	Readings 100-300 mrem	Readings Over 300 mrem	Lost Readings
Slow Neutron					
July	676	0	0	0	4
1959 to Date	8,171	19	2	0	42
Fast Neutron					
July	41	0	0	0	4
1959 to Date	508	3	13	0	41

Bioassay

	July	1959 to Date
Plutonium: Samples Assayed	545	5,248
Results above 2.2×10^{-8} µc/sample	25	233
Fission Products: Samples Assayed	571	5,128
Results above 3.1×10^{-5} µc FP/sample	5	29
Uranium: Samples Assayed	299	1,959
Confirmed Plutonium Deposition Cases	3	8*

*This brings the total number of plutonium deposition cases which have occurred at Hanford to 232.

Uranium Analyses

Sample Description	Following Exposure Units of 10^{-9} µc U/cc Maximum	Average	Number Samples	Following Period of No Exposure Units of 10^{-9} µc U/cc Maximum	Average	Number Samples
Fuels Preparation	15	4.0	58	14	2.8	59
Hanford Laboratories	6.0	2.0	20	31	4.0	17
Chemical Processing	28	6.1	64	22	3.8	56
Chemical Processing*	164	31	10	8.8	5.8	6
Special Incidents	22	13	3	1.7	1.7	1
Random	-	-	-	-		-

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

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

Hand Checks		
Checks Taken - Alpha	35,246	249,886
- Beta-gamma	26,051	169,964

Skin Contamination		
Plutonium	43	161
Fission Products	26	293
Uranium	13	77

CALIBRATIONS

	Number of Units Calibrated July	1959 to Date
Portable Instruments		
CP Meter	969	6,729
Juno	313	2,098
GM	1,431	9,621
Other	186	1,393
Total	2,899	19,841
Personnel Meters		
Badge Film	612	5,911
Pencils	1,657	6,905
Other	364	3,016
Total	2,633	15,832
Miscellaneous Special Services	379	3,066
Total Number of Calibrations	5,911	38,739

AR Keene

Manager
Radiation Protection

AR Keene:ko 1240124

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - JULY 1959

GENERAL

Safety performance of the operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 4.78 which is considered above average experience.

One security violation was charged to the operation.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 20,300 hours. This includes 13,969 hours performed in the Technical Shops, 1,702 hours assigned to Minor Construction, 52 hours to other project shops, and 4,577 to off-site vendors. The total shop backlog is 30,439 hours of which 50% is required in the current month, with the remainder distributed over a three-month period. Overtime for this period totaled 7.0% of the total available hours. This high ratio was necessary to meet customer requests for emergency service. Aggravating the situation was the construction work stoppage which closed down the Construction Operation Machine Shop. During the previous month 3,235 man-hours were assigned to the Construction Shop versus 1,702 man-hours in the current month.

Distribution of time was as follows:

	Man-hours	% of Total
Fuels Preparation Department	6246	30.8
Irradiation Processing Department	886	4.4
Chemical Processing Department	445	2.2
Hanford Laboratories Operation	11478	56.5
Construction Engineering & Utilities	1165	5.7
Miscellaneous	80	.4

Two machinists and one sheet metal man were added to the Technical Shops' roll during the month with one more machinist scheduled to report on August 3. These additions will bring the shop complement to full authorized strength.

New equipment received included two Hendey tool room lathes. This equipment will replace two lathes which have been on loan from the 2101 Building.

Security performance was considered satisfactory with no violations. Safety performance was considered satisfactory with no major injuries; however, the number of medical treatment injuries (16) was higher than normal. Statistics are being studied to determine if any correlation exists between the season of the year and minor injury rate. All personnel are being urged to give special attention to safety on the job now when the mind is apt to be distracted by outside activities of the summer season.

RADIOGRAPHIC TESTING OPERATION

Activity for the Radiographic Testing Operation leveled out satisfactorily this month. Operations are becoming smoother and more efficient following the two month move of the field facilities from 200-E Area to White Bluffs. A total of 4,012 tests were made, of which 601 were radiographic (including x-ray and gamma-ray) and 3,411 were supplementary tests. Out of a total of 1,750 manhours, 783 (44.7%) were used in connection with Radiographic tests, and 567 (55.3%) were used on supplementary tests. The supplementary work included: autoclave; borescope; eddy current; penetrant (O.D. and I.D.); pickling; stress analysis and ultrasonic (flaw detection and thickness measurements).

The number of pieces handled this month totaled some 3,347 items. The feet of material represented by the foregoing amounted to 29,407 feet. Both of these figures represent considerable gains and are indicative of the increased automation and supplementary testing being done in the Radiographic Testing Operation. Work was done for 15 different organizational components representing most of the operating departments and service organizations. A total of 49 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 19 different occasions for advice and information relating to general testing theory for other than the jobs tabulated in part II - Testing Statistics.

In an effort to reduce the activity of the Radiographic Testing Operation to an easily understood figure for comparison purposes a new concept has been developed called a "Productivity Factor". This factor combines all of the foregoing statistics in the following manner:

$$\frac{\text{No. of Tests} \times \text{Ft of Mat'l} \times \text{No. of Pieces}}{\text{Manhours} \times 10^6} = \text{PF}$$

It is believed that this factor can conveniently represent month to month conditions and will reflect advances in productivity as they are made. The factor for this month is 224 as compared to a factor of 213 for the past year and a half. The principle reasons for the increase in the factor, and hence productivity, has been the successful automation of a number of tests and the increased use made of less time consuming supplementary tests.

Scheduled testing and treating of PRTR process tubes has been seriously delayed as a result of the current work stoppage by contractor personnel. Despite these setbacks, trial pickling and autoclave tests have been made indicating that the installed facilities will operate as designed. Pickling and autoclave procedures are still under development and R.T.O. has not yet been given the process to be used. Testing of the tubes has been continuing. The most recent successful test application has been the use of a black light borescope for the fluorescent penetrant examination of the process tube inside surfaces. Directions as to allowable conditioning have not been forwarded, though a number of candidates are available for pickling and autoclaving. A general picture of tube quality to date indicates that the tubes appear to be of good integrity.

Continuation and follow-up of the zirconium sheath program indicates that a large number of the cladding tubes held in the "pit" category as established by fluorescent penetrant testing can be salvaged. Surface conditioning of these tubes by abrasive belt grinding and retesting has shown that in the majority of cases the objectionable pits can be removed. At month end another expedited program was started on these tubes to evaluate the internal surfaces using the fluroescent penetrant tests.

An extensive stress analysis (using brittle lacquers and electric resistance strain gages) was successfully made on the K-West reactor front face during a recent outage. Measurements were made on a series of connections between the cross-headers and the risers.

The indicated stresses generally confirmed the stress patterns thought to exist. It was found that the twisting moments in the piping were greater than those caused by bending. At no locations tested were stresses found to be of a serious magnitude.

Testing Statistics

Component	No.of Tests	Ft.of Weld or Material	No.of Pieces	Description
CPD	112	110	26	Purex fac. - H.S. Col EH-3; Nichol base alloy weld coupons; Purex fac. concentrator; titanium tube assembly.
CEC	20	18	20	Al - S.S. Inconel - titanium.
HLO	3772	28634-1/2	3235	4", 11", 8' long x 9/16" O.D., zr-2 clad UO_2 fuel rods; cast zr-2 seam well closures, 2" O.D. x 36-1/2" long al tube; .505" and .680" I.D. x 10 and 7' long zr-2 tubes; external ribbed zr-2 tube for nested tubular fuel elements; PRTR - zr-2 process tube; transplutonic fuel element prog; 3rd Palm Fab Program; Pu-Al Billets, zirc clad fuel elements; Titanium tube assembly; S.S. clad fuel element welds; Penetrant tests of pigtails.
IPD	84	137-1/2		Expansion joint S.S.; Welds on tube positioner; gas storage vessel; stress analysis strain gage meas. on front face.

Component	No. of Tests	Ft. of Weld or Material	No. of Pieces	Description
RUC	24	507	34	Longitudinal welds on S.S. pipe.
GRAND TOTALS	4012	29407	3347	

FACILITIES ENGINEERING OPERATION

There were 22 authorized projects at month's end with total authorized funds of $8,529,700. The total estimated cost of these projects is $8,658,100.

Four new project proposals are being prepared. Five new project proposals; Physical and Mechanical Properties Testing Cell, High Level Utility Cell, 327 Building Modifications, Access for PRTR Fuel Elements, 327 Building and Shielded Analytical Laboratory, 325 Building were submitted to AEC for approval.
The attached projects report details the status of individual projects.

Engineering Services

Title	Status
Clean Air Ducts - 326 Building	Work completed by Lump Sum Contract.
Design and Install Fire Alarm System 314 Building	Construction cost estimate is being prepared.
Air Balance - 108-F Building	Field work is essentially complete.
Gamma Irradiation Facility 3730 Building	Work is essentially complete.
Isolate Crane Conductors, 314 Building	Field work is dependent upon availability of electricians.
326 Building Retention Waste Sump Modifications	Engineering work in progress.
Temperature Control for Fish Troughs Biology Operation	Field work will be performed by plant forces. Work order is being issued.
Graphite Storage Building	Field work is 75% complete. Beneficial use has been delayed because of lack of construction crafts because of picket lines.
HLO Plan	Preliminary work is progressing on development of plant layout of HLO structures, utilities and grounds including future plant additions. Review of preliminary work will be made during week of August 3.

Title	Status
Improve Process Ventilation, Laboratories 204 & 206 - 3706 Bldg.	The work involves additional air flow and equipment to provide a high degree of clean air to the laboratories. Engineering study and cost estimate is complete.
Hood Ventilation in 183-KE Building	Procurement schedule indicates system will be ready for use the latter part of September.
Sound Proof Enclosure for Sonic & Vibratory Compacting Equipment 325 Building Basement	Preliminary design work has been prepared. Details are being developed for fabrication and installation.
Graphite Storage Racks - 326 Building	Design work complete. Fabrication work proceeding.
Accelerator Target Area Temperature Control 3745-A Building	Preliminary design with suggested solution to problem has been presented to customer; awaiting approval to proceed with formal drawings.
Increased 440 Volt Electrical Service - 325 Building Basement	Construction Operation is proceeding with procurement and installation.
Heating and Air Conditioning 141-M Building	Design work on the heating system has been started for this building. It is planned to replace the existing steam heating system with electric heaters.
326 Building Retention Waste Sump Modifications in Basement	Work is underway to replace existing sump pump because of unreliability with more positive sump pump. Flooding conditions in basement will be minimized.
Supplemental Cooling Unit Rooms 4-A and 17-B - 326 Building	Refrigerant type cooling equipment is being installed to supplement building system in order to create proper conditions for function of R&D equipment located in these rooms.
Glycol Heat Exchanger Study 325 Building Main Air Supply Units	Repair work in accordance with ASME Code was planned for one unit that was out of service. The 3rd party Code Inspector would not approve an expansion joint designed by Ross Heat Exchanger Company the vendor of original equipment. Present plans are to replace the heat exchangers with Code approved and more reliable units.
Sound Enclosure for Kux Press Pump Unit - 325 Building Basement	Preliminary design complete. Customer is reviewing proposal.

Title	Status
Drain System - 327 Building Basement	Preliminary work is in progress to provide basement drainage system.
Air Conditioning Problem - 747-A Building	This building was designed by an off-site A-E. Shortly after occupancy, deficiencies were noted in the cooling capacity of this structure and the electronic equipment could not function properly. This problem is being solved by the addition of an adequately sized refrigeration type air conditioner.
Cooling Problem - Positive Ion Accelerator - 3745-B Building	Refrigerant type cooling units are being procured for installation in this building.
Cooling problem - Counting Room 329 Building	The installation of additional electronic equipment in this room requires the addition of supplemental refrigerant type air conditioning equipment.
329 Building Cooling Problem	This building has had increasing difficulty in maintaining comfort conditions during summer months. The apparent problem area is within the "cold" section of the building; i.e., other than laboratory process area. A plan is being developed which by utilization of the majority of existing duct work and using supplemental equipment presently on hand and the installation of corridor doors for isolation purposes, sufficient supplemental cooling capacity can be added at minor cost to provide satisfactory working conditions.
Alterations to Door Mechanism Shielded Personnel Monitoring Cell 747-A Building	The design produced by an offsite A-E has proved to be cumbersome and possibly unsafe. An engineering study is being initiated towards remedial work and positive operation and elimination of safety hazards.
Compressed Air System 231-Z Building	Work is progressing on the compressed air system in 231-Z Building. The work includes relocation of the existing compressor and the addition of a new compressor of same size and manufacturer.
Study of HLO Waste System	Work has been initiated to review HLO waste handling procedures, requirements, and future planned expansions.

Title	Status
Unfired Pressure Vessel Survey and Inspection	Records on vessel inspection in 300 Area are up to date. Engineering data compilation and evaluation continues. Considerable consultation work with users regarding Code compliance, material specifications, and safe practices is a continuing work load.

Drafting & Design Services

A branch office of the Drafting unit was established in the 306 Building. This branch consists of 4 employees including a design leader.

Design and drafting work in progress includes the following:

PRTR prototype loop - "As-Built" - 314 Building.
Mechanism for moving samples through Gamma recording instrumentation.
Fuel element X-ray photometer.
Test set-up design - fuel, fuel and foil holders, and graphite - 305-B Building
Tube filling machine - machine delivers specified amount of oxide to each tube during compacting process.
Ceramic Fuels development work - miscellaneous designs as required.
Ultrasonic test device - for use in determining density of ceramic filled fuel assemblies.
Manipulator Model II "As-Builts".
Inert atmosphere welding box.
Mobile cask for handling 250 gallons of radioactive solutions - complete with refrigerant type cooling system, agitator, pump unit and accessories for vehicular transport.
Special mounting of TV camera for visual investigation of radioactive material.
Modify existing PRTR shim control drawings.
"As-Built" - Metallograph Assembly and Details - 327 Building.
Modifications to vacuum welding box - 325 Building Basement.
Calciner Control Programmer - 224-U Building.

Also, work is being performed for layout and details on projects CGH-834, Modifications and Additions to High Pressure Loop, 189-D Building and CGH-838, Fission Product Volatilization Studies Test Facility - 292-T Building.

Maintenance & Building Engineering - Landlord Functions

Costs - June - $ 105,381
May - $ 112,211

Fiscal year 1959 expenditures totaled $ 1,234,840 which was 99% of budget. Expenditure forecast was $ 1,245,000 or 100% of budget.

Analysis of Costs - At year end, the liquidations were adjusted downward to balance the costs, otherwise we would have overliquidated $10,160. Relative to the forecast maintenance was $12,200 below, utilities were $25,600 above, janitors $9,900 below, power operators $13,600 below, engineering services $3,300 above, general $3,300 below and administrative showed no variance.

Summary of FY-1959 Unusual Maintenance Items and Costs:

Paint	$ 37,593
Relocation & Alteration (moves & space)	27,996
Electrical changes & replamping	4,302
Piping	10,296
Heat and ventilation corrections	21,715
Filters CWS fireproof type	2,592
Noise Reduction	978
Reroofing	11,095
Floors	5,563
Shade Screens & storm windows	12,776
Miscellaneous	1,428
	$ 136,334

Miscellaneous

Approximately 130 drawings including sketches, work sheets, and formal drawings were completed by the Drafting Component during the month.

Approximately 11,600 square feet of prints were reproduced during the month.

The total estimated value of the 18 requisitions issued during the month was $100,000. Material procurement and control is being performed for HLO projects and plant operation.

TECHNICAL INFORMATION OPERATION

Procedures for the clearance of papers and speeches prior to publication was reviewed and revised by Technical Information. The OPG divides information released to the public into two general categories.

A. That originated by the Education, Communication and Community Relations Operation for release to the press, mass circulation periodicals, radio and television.

B. That originated by individual employees writing about HAPO activities for publication or oral presentation to public groups.

Release of information in category A is the responsibility of the Manager, Relations Operation. Clearance of materialunder category B is the responsibility of the Manager, HLO with the Manager, Education, Communication and Community Relations Operation approving it from the Public Relations viewpoint.

The Hanford Operations Office has asked to review all classified formal Research and Development reports prior to distribution from Hanford. The purpose of the review is to make certain that production data, or information from which production data can be deduced, is not being distributed offsite in other than the production categories C-66, C-67, and C-68. We have agreed to comply with this request. In a further effort to control production data, a memorandum was sent to all Departments reminding them that the possibility of inadvertent release of production information to unauthorized recipients also exists in technical reports prepared primarily for internal use, since many of these receive quite extensive offsite distribution. The memorandum also included Commission views on the interpretation of the term "production data" for the guidance of technical personnel writing reports.

The Hanford Operations Office has proposed a major revision of the procedures for the local control of access to documents in the Classified Files. Under the HOO proposal, all documents in the 300 Area Files would be marked with an appropriate category designation. Personnel on the Plant would be authorized for specific categories of information and File Clerks would determine from an individual's pass and the category markings on the documents whether or not the individual has a "need to know" for the report. Several alternative systems are possible, each involving considerable interaction between all HAPO Departments, Technical Information personnel, and Security personnel. The Commission has been requested to allow time for a detailed study of these alternatives by a Task Force to be composed of Department representatives, and a representative from the local AEC.

A letter from the AEC Patent Branch, Washington, complained that the release of HW-58000, an unclassified Research and Development report entitled "Annual Report - Plutonium Recycle Program - FY 1958" prevented the Commission from filing a patent application on isostatically formed UO_2 fuel elements in certain foreign countries. A summary of the case was prepared for Plant Counsel.

The memorandum, HW-60872 entitled "Classification Policy: Production Reactor Technology and Photographs" was distributed to the field during the month.

The proposed revisions for the Hanford Classification Guide reflecting the recent downgrading of Hanford production data were submitted to the HAPO members of the HOO Classification Committee for comment. After their approval is received the revisions will be submitted to the AEC for the appropriate approvals prior to inserting the topics in the Guide.

Work continued on expanding the NPR classification instructions received from the Commission into topics which will be useful to HAPO classifying authorities. Many of the problems encountered with the initial use of the Hanford Classification Guide are prominent in the NPR Guide which was received from the Commission. Design construction and procurement, the critical phases of the NPR at this time, are not adequately covered. The approach used in the Proposed Hanford Guide (HW-55000) appears to offer the best solution. Topics will be drafted along these lines and sent to the personnel working on NPR for their comments. Unfortunately, complete drafting of all topics, arranging the necessary HAPO reviews, and obtaining AEC approvals can not be accomplished in time to provide the assistance on design and procurement which is needed now.

The program to reduce paperwork in the Library's procurement activity continued. On June 1, the preparation of receiving reports for periodical subscriptions was discontinued, with Accounts Payable accepting the Library's receiving records instead. Representatives of Technical Information also met with the management of the Purchasing Operation to study the possibility of using the IBM printed subscription renewal form (when this is available early in August) in lieu of the present purchase [illegible]

Library Collection:

	Main Library	W-10 Library	108-F Library	Ind. Med.	Total
No. of books	26,813	8,212	1,452	1,956	38,433
No. of bound periodicals	12,359	1	1,431	96	13,887
	39,172	8,213	2,883	2,052	52,320

Classification and Declassification

	June	July
Documents, including drawings and photographs reviewed for downgrading or declassification	98	10
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification	33	25
Documents submitted to Declassification Branch, Oak Ridge	9	6

J L Boyd

Manager
LABORATORY AUXILIARIES

JL Boyd:jcw

BUDGET CLASSIFICATION Improvements to Production and Supporting Installations - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 61274
MONTH July, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED (or Actual) COMP. DATE DESIGN / CONST.
CG-731	Critical Mass Laboratory		$1,000,000	100	5	5-22-58	- - -	2-24-59
		$1,000,000	3-23-59	100	5	6-4-59	6-30-60	6-30-60
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: D. S. Jackson		

REMARKS:

A work stoppage resulted from picketing of all HOO-AEC Contractors by the electrical workers. The stoppage began on July 13, 1959 and continued till July 30 when picketing stopped. No appreciable amount of construction occurred during this period; however, procurement and off-site fabrication continued to progress.

CA-744	Metallurgical Development Facility - 306 Building		$2,685,000	96	87	6-30-58	- - -	9-1-59
		$2,623,000	11-5-58	95	8	3-20-59	9-1-60	9-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. T. Lloyd		

REMARKS:

The work stoppage on July 13, 1959 effectively halted all progress on the construction except for some ventilation ductwork for the bag filter relocation. All crafts reported back to work on July 30, 1959. The contractor is planning to start a two shift operation. A request was received from the Commission to revise our purchase order for the salt bath and quench tank; this is being done by clarifying the specifications. New bids will be called for on these items.

CA-749	High Level Radiochemistry Facility		$960,000	100	97*	6-15-58	- - -	11-21-58
		$960,000	10-31-58	100	94*	8-14-58	1-1-60	9-30-59
* FP schedule; total schedule 85% complete.		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: R. W. Dascenzo		

REMARKS: The electician's work stoppage of July 13, 1959 has delayed the electrical and pipefitting work at least 3 weeks and the other work about 9 days. The following construction work was completed and material received this month: (1) Roofing and sheet metal complete. (2) Outside painting complete; inside painting progressing. (3) Hauserman partitions 97% complete. (4) Main shielding doors were hung; awaiting electrical work. (5) Welding of cell liners to door frames is 90% complete. (6) Plugs, under the windows, have been delivered. (7) Electrical work on cell face has started. (8) Vertical rising doors lifting mechanism partially in place. (9) Piping at cell face started. (10) Sprinkler system 99% complete. (11) Interior of cells stripped of blocking and shoring. (12) Bridge crane erected. (13) Liquid transfer hood and instrument lines tested. (14) Gunite cleanup inside the building completed. (15) Finishing and roving on cell roof slab was completed.

UNCLASSIFIED LE10421

BUDGET CLASSIFICATION Improvements to Production and S[illegible] Installations - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - [illegible]374
MONTH July, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT CONST. SCHED.	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CGH-7[illegible]	High Level Radioactive Receiving and Storage Addition - 327 Building	$350,000	$345,000	4-23-59	100	55	6-23-58	10-9-58	- - -	2-1-60	12-31-58	2-1-60
					100	50						

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: J. J. Peterson

REMARKS:
Work stopped on July 13, 1959 because of the labor dispute. Five ironworkers returned to work on July 23, 1959. Work is progressing on the structural steel which is approximately 75% complete. Shop fabrication of the decontamination chamber was started by Monarch Machine Company. There was no work by the CPFF forces this period.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT CONST. SCHED.	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CGH-819	Increased Laboratory Waste Facilities - 300 Area	$300,000	$30,000	11-24-58	100	0	3-30-59	11-1-59	- - -	- - -	9-1-59	12-30-60
					98	0						

USING COMPONENT: Chemical Research & Development
FEO ENGINEER: J. J. Peterson

REMARKS:
All drawings and specifications are at the approval stage.

General Plant Projects - FY 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT CONST. SCHED.	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CAH-827	Automatic Columbia River Monitoring Station	$39,000	$39,000	6-30-59	100	0	4-3-59	9-15-59	- - -	12-31-59	6-18-59	12-31-59
					100	0						

USING COMPONENT: Radiation Protection
FEO ENGINEER: D. S. Jackson

REMARKS:
The Commission prepared and approved a project proposal revising total project cost to $39,000 and authorized an additional $12,000 to the AEC. No change was requested or made in funds authorized to the General Electric Company. Construction by the fixed price contractor cannot proceed until the contractor on the PRTR river pump structure has completed his backfill. Progress on the backfilling has been delayed by the work stoppage against all HOO-AEC contractors. The D.C. amplifiers were received on July 24, 1959. All other engineered items are on order or are being fabricated.

UNCLASSIFIED

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - MONTH: July, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CAH-828	Central Storage Facility - 300 Area	$40,000	$40,000 / 7-31-59	N.S. / 100	0 / 0	4-2-59 / 7-15-59	- - - / 12-31-59	6-8-59 / 10-15-59
		USING COMPONENT: Finance				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

Contract No. AT(45-1)-1278 was awarded to Raymond J. Britton June 30, 1959 for construction of the storage facility. Notice to proceed was issued July 15, 1959. Project proposal revision No. 1, requesting additional funds to establish a contingency for construction was approved July 31, 1959.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-829	Building 325 Basement Improvements	$70,000	$70,000 / 2-13-59	N.S. / 100	95 / 70	2-13-59 / 3-2-59	- - - / 12-31-59	9-27-59 / 12-31-59
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

The revised project proposal which included mezzanine partition work was approved July 27, 1959 by AEC Directive No. 481, Modification 1. Fixed price portion of the work including ramp and sprinkler system is complete. CPFF portion of the work is scheduled 96% complete and is actually 39% complete based on the revised scope of work. New design and construction schedules are being prepared.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-837	Animal Pens, Isolation and Examination Facilities	$80,000	$80,000 / 3-17-59	100 / 100	N.S. / 18	3-30-59 / 7-10-59	- - - / 4-1-60	6-3-59 / 12-1-59
		USING COMPONENT: Biology				FEO ENGINEER: J. T. Lloyd		

REMARKS:

Rough excavation for the sewer line and septic tank is complete. The concrete has been poured for footings and walls. Channels for facing ends of dog pen partitions are being installed.

UNCLASSIFIED

HW-

BUDGET CLASSIFICATION: General Plant Projects FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

MONTH: July, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-840	Sheet Metal Shop Addition - 328 Building	$40,000	$40,000 / 6-18-59*	N.S. / 80	N.S. / 10	6-22-59 / 6-25-59	- - - / 5-1-60	9-1-59 / 12-1-59

USING COMPONENT: Laboratory Auxiliaries

FEO ENGINEER: J. J. Peterson

REMARKS:

The construction progress schedule was transmitted to AEC-HOO for approval on July 15, 1959. Footings have been poured and forming for foundation wall is in progress. Some electrical conduit for fire alarm and power has been installed in the 328 Building. Work stopped on July 13, 1959 because of the labor dispute.

* Directive dated April 30, 1959; accepted by the General Electric Company June 18, 1959.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CAH-848	Geological and Hydrological Wells - FY 1959	$56,600	$56,600 / 6-24-59	N.S. / 100	2 / 2	5-12-59 / 7-16-59	- - - / 5-31-60	7-6-59 / 3-30-60

USING COMPONENT: Chemical Research & Development

FEO ENGINEER: H. E. Ralph

REMARKS:

Two drilling rigs are in operation and all materials are on site. Wells 699-62-43 A, B, C, and D have been redeveloped. Forty feet of new hole has been completed on well 699-62-43 E.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-860	Access for PRTR Fuel Elements - 327 Building	$81,000	None / None	0 / 0	0 / 0	1/2* / 2 1/2*	- - - / - - -	3* / 10*

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. Radow

REMARKS:

The project proposal was submitted to the AEC for approval on July 6, 1959; it is on the agenda for the review board meeting of August 6, 1959.

* Months after authorization.

0410421

UNCLASSIFIED

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - MONTH: July, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
				DESIGN	CONST.			
			AMOUNT	SCHED.	SCHED.	DESIGN	DESIGN	DESIGN
			DATE	ACTUAL	ACTUAL	CONST.	CONST.	CONST.
CGH-264	Shielded Animal Monitoring Station 100-F		None	0	0	1*	- - -	3*
		$46,000	None	0	0	2*	-	7*
		USING COMPONENT: Biology				FEO ENGINEER: J. T. Lloyd		

REMARKS:

Word was received informally that the AEC had approved this project on the basis that the following changes be made in the work performance: (1) AEC to manage the project. (2) Architect-Engineer do the design. (3) A lump sum contractor do the work. General Electric Company has not received a directive to date.

*Months after authorization.

IR-243	Relocation of the 200-E Testing Equipment		$18,000	100	100	3-12-59	- - -	5-22-59
		$18,000	3-11-59	100	99	3-16-59	4-22-59	8-15-59
		USING COMPONENT: Laboratory Auxiliaries				FEO ENGINEER: H. Radow		

REMARKS:

A work order has been issued for the rehabilitation of 221-B and 224-B Buildings (the former location of the radiographic testing cab) and the installation of the heating plant in C-25 Building. However, there has been little progress due to the work stoppage caused by picketing on another project.

IR-246	Alterations to the Positive Ion Accelerator Facility 3745-B Building		$19,000	N. S.	60	4-21-59	- -	5-1-59
		$19,000	4-20-59	100	85	5-7-59	10-20-59	10-20-59
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

Structural work has been completed. Electrical and pipefitting work remain on the air conditioner installation. Job progress stopped on July 13, 1959 because these crafts refused to cross picket lines.

UNCLASSIFIED

UNCLASSIFIED 1410421

BUDGET CLASSIFICATION
General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - MONTH July, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
HR-247	Permit Electrical Service - Experimental Animal Farm - 100-F	$12,500	$12,500 / 4-28-59	N.S. / 100	80 / 93	4-29-59 / 6-5-59	- - - / 9-28-59	5-12-59 / 8-15-59

USING COMPONENT: Biology

FEO ENGINEER: R. C. Ingersoll

REMARKS:

The Lump Sum Contractor's portion of the distribution line work was inspected and accepted July 2, 1959. Modification work performed by Plant Forces inside the 141-H and 141-F Buildings is approximately 95% complete. Tie-in work on the 2.4 KV line by Plant Forces will be done as soon as the line work of Project CAI-831 "Badge House and Fence Relocation - 100-F Area" has been completed. In this way only one scheduled power outage will be necessary for the Experimental Animal Farm.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
0084 (AEC-167)	Pickling and Autoclaving Facility for Zirconium Tubes - C-25 Building, White Bluffs	$120,000	$120,000 / 5-25-59	100 / 100	100 / 100	3-2-59 / 3-19-59	- - - / - - -	5-15-59 / 8-15-59

USING COMPONENT: Laboratory Auxiliaries

FEO ENGINEER: H. Radow

REMARKS:

Construction completion with exceptions has been attained. Startup modifications are being done by work order, but progress has been curtailed due to the work stoppage caused by picketing of the electrical crafts on another project. The process equipment is being beneficially used.

Improvements to Production and and Supporting Facilities - 60-a-1

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-832	Full Scale Physical Constants Testing Reactor	$915,000	None / None	0 / 0	0 / 0	- - - / - - -	- - - / - - -	- - - / - - -

USING COMPONENT: Physics & Instruments R & D

FEO ENGINEER: R. W. Dascenzo

REMARKS:

To date the project proposal requesting $30,000 preliminary design money has not been approved by the AEC-Washington.

UNCLASSIFIED

HW-7h0h2

BUDGET CLASSIFICATION Improvements to Production and Supporting Facilities - 60 a-1

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - MONTH July, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-859	327 Building Modifications	$350,000	None / None	0 / 0	0 / 0	1 * / - - -	- - - / - - -	- - - / - - -

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: J. J. Peterson

REMARKS:

The project proposal was signed by the General Manager and transmitted to the AEC on July 6, 1959; it is on the agenda for the review board meeting of August 6, 1959.

Equipment Not Included in Construction Projects - Program Class 2900

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CG-661	Additional Heat Generation Facility - 189-D Building	$419,000	$664,000 / 9-18-57	100 / 100	100 / 97	12-6-56 / 12-3-58	- - - / 8-31-59	10-15-58 / 8-31-59

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: J. J. Peterson

REMARKS:

Trouble is being experienced in getting the saturable reactors to respond as rapidly as desired. This trouble has not been pin pointed as yet, but it is anticipated that it will be resolved soon. Construction forces will start the first part of August on cleanup items.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CA-681	Hanford Equipment in the ETR	$1,140,000	$1,140,000 / 4-1-59	98 / 98	90 * / 89 *	9-17-56 / 4-1-58	- - - / 3-1-60	7-15-59 / 3-1-60

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. Radow

REMARKS:

Construction progress has been curtailed because of a strike of pipefitter and electrical crafts. Procurement progress on the remaining items continues favorably.

* Based on field completion only.

AM-7300-019 (5-58)

UNCLASSIFIED

UNCLASSIFIED

HW 74013

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

BUDGET CLASSIFICATION: Equipment Not Included in Construction Projects - Program Class 2900

MONTH: July, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
				DESIGN SCHED.	CONST. SCHED.	DESIGN	DESIGN	DESIGN
			AMOUNT					
			DATE	ACTUAL	ACTUAL	CONST.	CONST.	CONST.
CG-785	In-Reactor Studies Equipment - 105-KW Building	$276,000	$276,000	46 *	0	1-5-59	- - -	- - -
			12-8-58	46	0	N.S.	12-31-60	12-31-60

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. Radow

REMARKS:

* Based on revised design schedule submitted for approval. This revision reflects a curtailment of design progress pending the placement of the major instrumentation order and resolving the details of the special equipment to be furnished.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
				DESIGN SCHED.	CONST. SCHED.	DESIGN	DESIGN	DESIGN
			AMOUNT					
			DATE	ACTUAL	ACTUAL	CONST.	CONST.	CONST.
CGH-801	X-Ray Diffraction Cell - 327 Building	$170,000	$10,000	40	0	6-10-58	- - -	11-1-59
			6-7-58	40	0	N.S.	- - -	7-1-60

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: R. W. Dascenzo

REMARKS:

Approval of the project proposal for the remainder of design and total construction funds, submitted to the AEC-HOO November 19, 1958, has not been received.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
				DESIGN SCHED.	CONST. SCHED.	DESIGN	DESIGN	DESIGN
			AMOUNT					
			DATE	ACTUAL	ACTUAL	CONST.	CONST.	CONST.
CGH-805	High Temperature Tensile Testing Cell - 327 Building	$150,000	$150,000	100	0	8-26-58	- - -	6-15-59
			2-25-59	100	0	1-2-60	3-31-60	3-31-60

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: R. W. Dascenzo

REMARKS:

Quotations have been received on the test cell assembly and a viewing window, but the orders have not been placed as yet. Quotations have been requested on the plugs for the test cell.

UNCLASSIFIED

AM-7300-019 (5-58)

July, 1959

DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
DESIGN	DESIGN
CONST.	CONST.
- - -	2-9-60
10-15-60	10-15-60

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ppage is resolved.

- - -	8-20-59
11-30-59	11-30-59

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ll shortly be given

- - -	14 *
- - -	- - -

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BUDGET CLASSIFICATION Equipment Not Included in Construction Projects -- Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - MONTH July, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CGH-858	High Level Utility Cell -- 327 Building	$500,000	None	None	0	0	0	0	1 *	- - -	- - -	- - -	12 *	- - -

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: R. W. Dascenzo

REMARKS:

The project proposal requesting design funds in the amount of $70,000 has been awaiting AEC approval since July 6, 1959.

* Months after approval.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CGH-866	Shielded Analytical Laboratory - 325 Building	$480,000	None	None	0	0	0	0	1 *	- - -	- - -	- - -	5 *	- - -

USING COMPONENT: Chemical Research & Development

FEO ENGINEER: R. W. Dascenzo

REMARKS:

The project proposal requesting $30,000 design funds has been awaiting AEC approval since July 15, 1959.

* Months after approval.

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

USING COMPONENT

FEO ENGINEER

REMARKS:

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H.W. Personnel Contacted	Access to Restricted Data	Areas & Buildings Visited
James R. Mohondro	7-21 & 7-22-59	Hallidie Machinery Co. Spokane, Washington	Inspect a Heald grinding machine	L. J. Lucas	No	300-328
Carl Foulk	7-21 & 7-22-59	Heald Machine Co. Los Angeles, Calif.	" "	L. J. Lucas	No	300-328

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. E. Berwick	7-1-59	Star Machinery Co. Seattle, Washington	To attend Electro-force Electrostatic Chucking Demonstration	Paul Berner	No
R. B. Socky	7-31-59	G.E. X-Ray Dept. & Puget Sound Naval Shipyard Seattle, Washington	Supervise repair of x-ray unit at G.E. X-ray. Disscussion of installation details on 2 mev. Van DeGraaff for 306.	F. Robinson G.E. X-Ray Wm. Hanna PSNY	No

PROFESSIONAL PLACEMENT AND RELATIONS PRACTICES OPERATION MONTHLY REPORT

GENERAL

As of July 31st, the staff of Hanford Laboratories totalled 1363 employees, including 671 exempt and 692 nonexempt. There were 585 employees possessing technical degrees, including 355 BS, 118 MS, and 112 PhD.

COMMUNICATIONS

Thirty high school teachers studying at Gonzaga University under National Science Foundation grants toured Hanford Laboratories during the month.

HEALTH & SAFETY

Hanford Laboratories' first disabling injury was sustained by an employee while stepping onto a stool, resulting in a torn cartilage in his knee. This injury terminated a period of 1059 injury-free days. The medical treatment frequency for July was 1.86 as compared with 2.02 last month.

There were 4 security violations during the month of July, bringing the total for the year to date to 26.

PROFESSIONAL PLACEMENT

Three PhD candidates visited HAPO during the month. Six offers were extended and one acceptance was received from an experienced PhD physicist. Five PhD's reported on roll during July, including an experienced metallurgist, 1 experienced physiologist, and 3 new graduates.

Eight acceptances were received from experienced BS/MS candidates and 4 acceptances from new technical graduates. For the recruiting year to date there have been 79 new technical graduates, 74 experienced BS/MS and 14 PhD's employed.

There were 14 additions to the Training Program rolls during July, including 12 Technical Graduates, 1 member of the Western Circuit - Engineering Training Program, and 1 College Junior. The total force on the Training Programs, including summer employees, is now 107.

EMPLOYEE COMPENSATION

The HLO organization directory, functional organization charts, and position relationship charts were revised, effective July 1st.

The 1959 Suggestion Fund allocation for HLO has been increased from $3300 to $5,000. There is currently a balance of $3590 in this fund.

EMPLOYMENT

Twenty-one requisitions were filled during July. With receipt of 26 new requisitions and 3 cancellations, there are currently 35 nonexempt openings, for which 16 candidates are in process and 10 transfers are pending, leaving 9 candidates

yet to be procured.

Manager
Professional Placement and
Relations Practices

TG Marshall:dhg

TABLE III. PROFESSIONAL PERSONNEL PLACEMENT

A - Technical Recruiting Activity - HAPO - September 1, 1958 to Date

	Cases Considered	Visits to Richland: Invited	Visited	To Visit	Offers*: Extended	Accepted	Open	On the Roll
Ph.D.	670	200	88	28	61	13	7	14
Exp. BS/MS	544	109	80	3	111	74	6	68
Prog. BS/MS	395	-	-	-	207	79	4	68

*Offer totals include offers open on 9/1/58

Ph.D.	3
Exp. BS/MS	3
Prog. BS/MS	3

B - Technical Recruiting Activity - HLO - September 1, 1958 to Date

	Cases Considered	Visits to Richland: Invited	Visited	To Visit	Offers**: Extended	Accepted	Open	On the Roll
Ph.D.	670	200	88	28	46	9	6	10
Exp. BS/MS	426	80	54	2	47	28	2	27

**Offer totals include offers open on 9/1/58

Exp. BS/MS	2
Ph.D.	2

In addition to the above activity, 26 exempt employees have transferred into HLO from other HAPO departments and 28 technical graduates have accepted off-Program placement in HLO to date.

C - Technical Graduate and Technician Training Program
Month ending July 31, 1959

	TG Program	TT Program
Number Personnel on assignment	83	9
(HAPO Tech Grad Program.....68		
(West. District E.P.....15		
Summer Juniors	10	
High School Teachers	5	
	98	9
Distribution of assignments by Depts.		
HLO	39	4
CE&UO	2	0
FPD	12	0
IPD	33	5
CPD	12	0
Distribution of assignments by function		
R&D or Engineering	68	9
Other	30	0

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TABLE II NONEXEMPT EMPLOYMENT

Nonexempt Employment Status	June	July
Requistions		
At end of month	33	35
Cancelled	5	1
Received during month	33	26
Filled during month	39	21
Candidates Considered		
Applications	73	65

Nonexempt Transfer Request	June	July
Transfer Request		
Active cases at end of Mo.	77	87
Cancelled	5	2
New	9	12
Transfers effected	1	0

FINANCIAL OPERATION MONTHLY REPORT
JULY 1959

Personnel

The Specialist - Procedures was transferred to Construction Engineering and Utilities Operation on a promotional basis.

Activities

GENERAL ACCOUNTING OPERATION

Hanford Laboratories has been allocated $28,000 for Attendance at Meetings of Professional Societies and $3,300 for Attendance at Off-Site Courses during FY 1960. An allocation of this money to HLO Sections is currently under study.

The new Prime Contract which became effective July 14, 1959 had some delaying effect on Approval and Agreement letters then in process. Most of this delay has been overcome. Two requests for approval covering Assistance to Hanford work during FY 1960 have met with considerable delay and do not yet have Commission approvals. However, informal contacts between Hanford Laboratories operating managers and the Commission indicate that authorization will be forthcoming in the near future.

A draft of a manual on travel for HLO has been reviewed with Financial personnel of other HAPO components. We expect to issue the manual in final form shortly after September 1.

A new procedure was placed in effect as of August 1 for reporting pending travel of HLO personnel and showing expected visitations to Hanford Laboratories. It is hoped that the new procedure will have some benefits in increasing the utilization of the services of personnel traveling on Company business.

A new procedure was inaugurated in the dispensing of cash advances to Hanford Laboratories personnel. Third parties accepting cash for the account of others are required to secure the signature of the person to whose account the cash advance will be charged and to deliver the signed receipt to General Accounting. This procedure was adopted by the Manager - Finance to overcome a known weakness in our cash control procedures.

Quarterly inventory reports for the quarter ending June 30, 1959 were received from all HLO custodians of special materials and reconciled with Property Accounting stock control records. All reports were found in agreement with Property Accounting records. A comparison of the June 30, 1959 balance ($196,072) with that of March 31, 1959 ($189,618) shows an increase of $6,454 principally due to the purchase of platinum and gold.

Preparations were completed and a procedure distributed for the FY 1960 physical inventory of uninstalled cataloged equipment in the custody of Radiation Protection Operation. The inventory which began July 20th has an anticipated completion date of August 12, 1959 for all field work. A 100 percent verification of equipment is being made by Property Accounting with the exception of portable radiation monitoring instruments. The inventory

of these instruments will be accomplished by Calibrations Operation furnishing us with a detailed IBM listing certified by the custodian that all instruments listed were inventoried. This listing will be spot-checked by Financial personnel.

A physical inventory of shop stock material in the custody of Technical Shop Operation was taken July 11, 1959. The count was taken and recorded on IBM-type physical inventory tags pre-written by custodial personnel and witnessed by Property Accounting personnel. The physical inventory tags are currently being extended for inventory value and upon completion of the reconciliation a report of results will be prepared.

In response to a request of SS Accountability, material custodians were requested to submit forecasts for inside diversions of SS Materials covering the second and third quarters of FY 1960. Upon receipt the information will be consolidated and forwarded to SS Accountability.

Chapter 16 of the Property Management Manual was prepared and distributed to holders of the manual. This chapter was prepared to set forth procedures and controls required for the control of source and special nuclear materials needed for the operation of Laboratories.

During the fiscal year 1959, over 17,000 separate IBM input data sheets were prepared and submitted to Data Processing for updating and/or to add new items to HLO uninstalled cataloged equipment records. This required approximately 52,000 key punch cards to be prepared and verified by Data Processing in order to process the data on the 702 machine.

A notice to proceed was furnished the contractor, dated July 15, 1959 on the Central Storage Facility with a completion date of October 1959. Revision No. 1 requesting additional funds, to establish a contingency for construction was approved by the AEC. The total authorized fund has been increased from $37,400 to $40,000.

An equipment expenditure forecast was prepared based on equipment requirements as submitted by the field and engineering estimates for equipment projects. A summary of this forecast is shown below:

(amounts in thousands)	6-30-59 Outstanding Commitments	Estimated FY 1960 Expenditures	Estimated Commitments 6-30-60
2000 Program			
Projects	$ 956	$ 943	$1 866
Equipment	366	1 477	400
Total	1 322	2 420	2 266
3000 Program			
Equipment	3	85	-
4000 Program			
Projects	869	885	154
Equipment	61	514	100
Total	930	1 399	254
6000 Program			
Equipment	11	150	25
Total All Programs	$2 266	$4 054	$2 545

COST ACCOUNTING OPERATION

The Hanford Laboratories FY 1960 Revised Budget as submitted last Spring was used as the control budget during July except for the changes shown below. Inasmuch as program amounts for research and development agreed with the HOO-AEC submission to Washington-AEC, with a minor exception in the 6000 Program, this approach appears realistic.

Sponsored Programs

IPD Metallurgy I	increased $13,000
IPD Metallurgy II	increased 6,000
IPD Reactor I	increased 7,000
IPD Reactor II	increased 15,000
CPD Separations	decreased 75,000

Hanford Laboratories Programs

Environmental Science Research	decreased $28,000
Project Whitney	decreased 10,000
Service Assessments	decreased 40,000
Special Requests (off-site)	reduced to amounts currently authorized.

Data for preparing the annual report of representative economy measures have been received from HLO components and compiled for submission to Contract and Accounting Operation. Four items will be submitted by Hanford Laboratories as follows:

1. Reduction of radiation monitors through improved procedures and equipment.

2. Reduction of Plant Library and Classified Files cost through improved procedures.

3. Lower costs due to a change in procurement of special equipment, i.e., HAPO predetermined design versus flexibility in vendor design to meet HAPO specifications.

4. Reduction of building maintenance costs through improved equipment and innovations.

An audit of store order withdrawals for the month of May 1959 was conducted during the month by Cost Accounting to determine the validity of approval signatures. Analysis of the results of this audit indicates about the same general magnitude of findings as in the two preceeding audits.

PERSONNEL ACCOUNTING

College graduates engaged in research and development activities were categorized according to instructions received from Employee Compensation Services in connection with the Los Alamos Annual Survey of Professional Scientific Salaries. The following summary data were contained in the report which was forwarded on July 20, 1959:

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	Number of Employees		
	Non-Supervisory	Supervisory	Total
Bachelors and Masters Degrees	401	34	435
Doctors Degrees	59	46	105
	460	80	540

Engineers	200
Chemists	149
Physicists	75
Metallurgists	46
Mathematicians	16
Geologists	7
Biologists	4
Other	43
	540

Recent Bureau of Labor figures indicating a further rise in the cost of living resulted in a .59% wage increase for HLO salaried employees, effective July 27, 1959. This increase was reflected in salary checks for week ending August 2, delivered to employees on August 7. As a result of this increase isolation pay was increased from $2.09 daily and $10.43 weekly to $2.10 daily and $10.49 weekly. Area differential will be increased from $45.00 per month to $45.22, effective August 1, 1959. This increase will be reflected in the August salary payments.

An article was issued in the Management News Bulletin requesting a speed-up of the completion and availability for pick up of weekly time cards. This article also indicated that time card pick up schedules would be distributed to supervisors on August 7, 1959.

GENERAL

Instructions concerning the revised system for Hanford Laboratories OPGs have been issued along with three plant-wide OPGs modified for Hanford Laboratories' use.

L L Rodig
for Manager - Finance

W. Sale:bk

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INVENTIONS OR DISCOVERIES

All persons engaged in work that might reasonably be expected to result in inventions or discoveries advise that, to the best of their knowledge and belief, no inventions or discoveries were made in the course of their work during the period covered by this report except as listed below. Such persons further advise that, for the period therein covered by this report, notebook records, if any, kept in the course of their work have been examined for possible inventions or discoveries.

INVENTOR	TITLE OF INVENTION OR DISCOVERY
R. W. McKee	Trough-tray Dissolver (6-26-59)
L. C. Schmid W. P. Stinson	Neutron Thermometer
D. E. Wood	Mercury Switch
R. J. Sloat R. W. McKee	A critically safe dissolver for processing power reactor fuels that have been enriched with fissionable material (U-233, U-235, Pu-239, or Pu-241) above the enrichment level of natural uranium
F. B. Quinlan	The Art of Forming Externally Ribbed Rods and Tubes.
G. S. Allison P. A. Ard W. L. Wyman	A Process for Nuclear Fuel Element End Closures
P. M. Jackson D. E. Rasmussen	Dome Seal
P. M. Jackson D. E. Rasmussen W. K. Winegardner	Banana Seal
E. D. Waters F. R. Zaloudek	A Device for Determining the Vapor Quality in Flowing Stream

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