DECLASSIFIED

[redacted]

HW--61702

DE93 010553

Tl ts
of [redacted]
o

HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
AUGUST, 1959

73553

DECLASSIFIED

By Authority of EG-PR-2
DS Lewis 6-29-92
By J Tarn 7-15-92
DG Kreiser 7-17-92

Received by OSTI

SEP 0 8 1992

Compiled by
Operation Managers

September 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

[redacted]

[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.

Route To:	P. R. No.	Location	Route Date	Signature and Date
[illegible]				

MASTER DECLASSIFIED [redacted]

DISTRIBUTION RESTRICTED TO U.S. ONLY

DISTRIBUTION

Copy Number	
1	W. E. Johnson
2	H. M. Parker
3	O. C. Schroeder
4	F. W. Albaugh
5	C. A. Bennett
6	J. L. Boyd
7	L. P. Bupp
8	W. E. Foust
9	P. F. Gast
10	A. R. Keene
11	H. A. Kornberg
12	T. G. Marshall
13	L. H. McEwen
14	W. Sale
15	J. W. Healy
16	H. P. Shaw - V. R. Cooper
17 - 20	Atomic Energy Commission, Hanford Operations Office, Attn: J. E. Travis
21 - 23	E. J. Bloch, Director, Division of Production, Washington 25, D. C.
24	Savannah River Operations Office, Aiken, South Carolina
25	300 Files
26	Record Center

TABLE OF CONTENTS

	Page
Staff	iv
Force Report and Personnel Status Changes	v
General Summary	vi through xiii
Reactor and Fuels Research and Development Operation	A-1 through A-51
Physics and Instrument Research and Development Operation	B-1 through B-22
Chemical Research and Development Operation	C-1 through C-27
Biology Operation	D-1 through D-7
Operations Research and Synthesis Operation	E-1 through E-6
Programming	F-1 through F-4
Radiation Protection Operation	G-1 through G-8
Laboratory Auxiliaries Operation	H-1 through H-21
Professional Placement and Relations Practices	I-1 through I-5
Financial Operation	J-1 through J-4
Invention Report	K-1

STAFF

Manager, Hanford Laboratories	H. M. Parker
Manager, Biology	H. A. Kornberg
Manager, Chemical Research and Development	L. P. Bupp
Manager, Laboratory Auxiliaries	J. L. Boyd
Manager, Operations Research and Synthesis	C. A. Bennett
Manager, Physics and Instrument Research and Development	P. F. Gast
Manager, Programming	L. H. McEwen
Manager, Radiation Protection	A. R. Keene
Manager, Reactor and Fuels Research and Development	F. W. Albaugh
Manager, Professional Placement and Relations Practices	T. G. Marshall
Manager, Financial	W. Sale

TABLE I. HLO FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE August 31, 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	137	105	242	139	101	240	1	6	3	2
Reactor & Fuels Research & Development	194	163	357	195	159	354	4	10	5	6
Physics & Instrument Research & Development	68	39	107	72	39	111	0	3	4	3
Biology Operation	38	47	85	39	47	86	0	0	1	0
Operation Res. & Syn.	16	4	20	17	4	21	0	0	1	0
Radiation Protection	34	100	134	34	102	136	0	1	0	3
Laboratory Auxiliaries	47	195	242	47	194	241	1	7	1	6
Financial	12	13	25	13	12	25	0	1	1	0
Prof. Plcmt. & Rel. Prct.	90	27	117	98	29	127	7	1	15	3
Programming	16	5	21	16	3	19	0	2	0	0
General	1	2	3	1	2	3	0	0	0	0
Totals	653	700	1353	671	692	1363	13	31	31	23
Totals excluding internal transfers	653	700	1353	671	692	1363	11	22	29	14

Composite Separation Rate ---------- 3.9911

Separation Rate (based on separations leaving G. E.) ---------- 2.2912

Controllable Separations Rate ---------- .2217

DECLASSIFIED

BUDGETS AND COSTS

Costs for August were $1,810,000, an increase of $141,000 over July. Fiscal year-to-date costs are 17% of the amounts authorized to HLO by the product departments and the financial plan.

Plutonium Recycle Program costs of $442,000 remained in the same range as July costs. This level of expenditures when annualized approximates $5.3 million compared to the present authorization of $5.0 million.

NPR Research and Development for IPD increased $13,000 in August over July costs. The present FY 1960 authorization of $650,000 for this program is now 30% spent.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

PRTR. At the end of the month construction progress on PRTR stands as follows: Overall: 37% complete versus 41% scheduled; Phase III contract: 19% versus 21%; Phase II-A contract: 90% versus 93%.

The partially fabricated PRTR calandria was delivered at White Bluffs on August 14. At month end all reflector vessel leaks had been repaired.

Revised calculations of the total energy distribution in the PRTR are reported in HW-61346.

Preliminary analysis of experiments with the full scale electrically heated mockup of the PRTR Mark I (rod cluster) fuel element indicates that no hot flow channels or hot fuel surface temperatures occur in the fuel bundle, and that the shape of the boiling curves is such that flow instability of the PRTR primary coolant seems remote.

Phase III of the PFPP project is estimated to be 80% completed versus 93% scheduled.

Pellets fabricated from micronized and sintered UO_2 have been fabricated consistently with a density of 98 per cent of the theoretical value.

Severe internal defects undetected by the Probolog eddy current apparatus were found in Zircaloy-2 sheathing tubes using an experimental ultrasonic tester.

The melting point of plutonium dioxide in a helium atmosphere was found to be 2480 C on the basis of five determinations. Uranium dioxide was found to melt at 2728 C in agreement with published data.

Aluminum-base plutonium alloys are under study in an attempt to obtain substantial corrosion resistance in a fuel core without significant loss in neutron economy. Five of nine alloys tested to date appear promising.

DECLASSIFIED

Plutonium fuel specimens currently being irradiated in the MTR, ETR or KER include 16 Pu-Al capsules, six PuO_2-impregnated graphite capsules, and two 7-rod clusters. Two high density UO_2-PuO_2 capsules are now being examined after irradiation.

The presence of 15 psia steam has prevented catastrophic hydriding of Zircaloy samples for 284 hours in 25 psia H_2 at 400 C, whereas similar samples all hydrided destructively before 80 hours in the absence of the steam. The test is continuing.

A new experimental aluminum alloy from Alcoa (1.5% Ni, 1.5% Fe, balance: 99.99% pure Al) has exhibited the lowest corrosion rate ever measured at Hanford on autoclaving in 360 C deionized water. When autoclave-pretreated and exposed for one month in a flow loop at 350 C, 19 ft/sec water velocity, this alloy corroded only 0.6 mil, compared with 1.3 mils for X-8001 alloy.

Autoclave rupture tests of pre-defected, coextruded NPR fuel rods indicate that annuli spacings substantially less than 1/8 inch (between the cladding and the process tube) may increase the severity of a rupture.

Two uranium-water reaction mechanisms have been identified which compete during the rupturing process after cladding failure: at 200 C a hydride-controlled reaction dominates, while above 300 C uranium hydride is unstable and the controlling mechanism is the uniform oxidation of uranium. The total effect becomes roughly independent of temperature over the 200-300 C range.

A draw sizing operation developed to replace or supplement swaging of NPR fuel rods looks very promising. Information obtained on the rods will be directly applicable to the sizing of coextruded tubular elements. Two copper plate coatings used as a lubricant in the drawing operation show considerable promise.

Although the hot heading of coextruded rods after beta heat treatment eliminates the necessity for a straightening step, it was found that the load required is excessively high and beyond the limits of the available tooling. Gamma phase hot heading operations were not completely successful.

Prototype NPR fuel rods exposed to 2000 MWD/T in the ETR with considerable thermal cycling revealed upon preliminary examination a density decrease of approximately two percent. Internal macrocracks in the uranium, similar to those found in material irradiated in the Hanford reactors were detected

DECLASSIFIED

Preliminary evaluation of ultrasonic welding for the application of supports to aluminum jacketed fuel elements reveals no damage to the clad, bond, or compound layer as a consequence of support attachment.

An over-all decontamination factor of approximately 200 was demonstrated in the first "hot" NPR decontamination test in new irradiated rupture prototype equipment in 242-B Building. Bicarbonate-peroxide reagent removed UO_2 from the loop system, and ammonium citrate-EDTA was employed to complete the decontamination.

A full-size CSGBF graphite block removed from a Hanford reactor after receiving a very high accumulated exposure at approximately 500 C showed linear contractions in the range 0.4 to 0.7 percent.

Eleven Geminol thermocouples are all still operating satisfactorily after three months in a Hanford reactor under conditions which have caused failures of iron-constantan couples.

2. Chemical Research and Development

Further laboratory work on an extraction column concept to "trap" neptunium continuously from the Purex 3WB source stream showed near quantitative recovery of neptunium was possible with careful control.

A programmer prototype which will automate the start-up and shut-down of the UO_3 plant continuous calciners was installed. Plant tests have shown that automated start-ups and shut-downs are superior to the best obtained with manual operation.

A fundamental study of partition equilibria with quaternary amine anion exchange resins in addition to the solubility and absorption spectra of thorium, neptunium, and plutonium hexanitrato quaternary amine salts in nitric acid media has set the stage for a much better theoretical appreciation of the heavy metal anion systems. For instance, these data allowed formation constants to be calculated and compared for plutonium and neptunium hexanitrato complexes; values were consistent with measured properties.

Demonstration runs in the Fission Product Isolation and Packaging Prototype were complicated by an unexpected problem in the hydrolysis of the cesium zinc ferrocyanide. During hydrolysis, the pilot quantities of material assumed a mastic composition which seriously affects the operation of the unit.

Technology in support of the Non-Production Fuels Reprocessing emphasized further study of cold sawing of prototype fuel pieces; additional observations of Redox feed solution stability; more dissolver pilot plant tests; and several studies of process chemistry.

DECLASSIFIED

Operation of the Radiant Heat Spray Calciner has been extended to include a final melt-down pot in which product powder may be compounded with other materials and heated to form an ultimate more dense glassy solid.

A laboratory column containing 50 grams of clinoptilolite has had 13,600 gallons of filtered Columbia River water spiked with Cs-137 (24 uc/gal) passed through it with the specific decontamination factor for cesium remaining above 500. These data dramatically illustrate the specificity of certain minerals for removal of certain cations; even when these cations are present in very low concentrations. Larger pilot-scale tests are planned.

Laboratory equipment was set up to produce kilogram quantities of UO_2 by the salt cycle process, (electrolytic precipitation of UO_2 from uranyl chloride in fused alkali halide solvent) so that product material may be evaluated as a reactor fuel source. Preliminary pilot runs were started and some physical properties of the UO_2 were determined.

Attempts to repeat work reported in the literature on separation of mercury isotopes by a photoactivation process have, to date, not been able to demonstrate high yields for Hg-202 isolation.

Implementation of a large scintillation counting crystal with a well chamber for samples has extended detection limits for most radioisotopes of interest to the range of 0.05 to 0.5 d/m per gram depending, of course, on the specific isotope involved. The device has been calibrated for some fifteen specific isotopes.

Assistance from a summer professor (G. R. Fowles) has opened the way for isotopic analyses of some elements using relatively simple modifications to an existing optical spectrometer.

The release of iodine, xenon, and tellurium from irradiated uranium at high temperatures (~1400 C) in a steam atmosphere has been shown to correlate linearly with the amount of uranium oxidized. For 100 per cent oxidation the amounts released are 90 per cent iodine, 55 per cent xenon, and 55 per cent tellurium. No explanation is apparent for the surprisingly large xenon residual found in the UO_2 phase.

3. Physics and Instrument Research and Development

An AEC-sponsored classified meeting on Criticality Alarm Instrumentation was held at Hanford on August 17 and 18 with PIRDO as host.

Good agreement between measurements on 2-per cent enriched uranium at Hanford and at Oak Ridge now permits close correlation between critical mass data determined at the two sites. As a by-product we have acquired increased confidence in the PCTR techniques because of the good agreement

DECLASSIFIED

of our results with those obtained at Oak Ridge by an entirely different method on this particular material.

In the Improved Production Reactor Program exponential measurements continue with tube-and-tube fuel assemblies in larger lattice spacings.

Work has started in cooperation with the Ceramic Fuels Operation on developing instrumentation to measure the rate of release of fission activity from a deliberately defected PRTR-type oxide fuel element during irradiation in the MTR. The rupture monitor currently installed on the test loop is unsuitable for this purpose. The new instrumentation will provide HLO with its first opportunity to get such information for uranium oxide elements.

The mass spectrometer built for a Washington-Designated Program is now performing according to design specifications and is routinely analyzing samples submitted.

The joint AEC-AF atmospheric dispersion experiments were successfully completed at month-end when the 26th field experiment was conducted.

Accumulation of background data in the Whole Body Counter continued during the month with the measurement of the activity of a number of offsite visitors, one of whom was found to have a surprisingly large burden of cesium-137.

Orderly progress was made on the many projects in the instrument field. Among these were optical methods of determining graphite temperatures, further improvements in the sensitivity of alpha air monitors, improvements in remote area monitoring systems, the use of light pipes for making measurements in difficultly accessible regions, and background studies in areas requiring the installation of criticality alarms.

In the basic data field the use of lutecium as a neutron temperature measuring device was satisfactorily demonstrated for the first time in any laboratory to our knowledge.

4. Biology

Further confirmatory evidence was obtained from work with plants that indicated that the Cs^{137}/K ratio when used for hazard predictions will lead to significant and important errors.

DTPA treatment of rats fed lethal amounts of plutonium was ineffective in decreasing the lethality.

Progress in defining the turnover of plutonium oxide in lungs of dogs is being made. It is expected that the turnover studies will significantly contribute

toward refining MPC considerations for plutonium deposited in lungs.

In gonadal studies, it was found that pancreas became the critical organ for Cs^{137} in rams fed this radioelement. To our knowledge, this is the first time that the pancreas has been so implicated. These are still preliminary results.

5. Programming

Samples of nearby uranium ore mill process streams were procured and analyzed for thorium content to provide information related to the practicality of moderate cost recovery of ionium (thorium-230) as a starting material for preparation of U-232 and Th-228 as high intensity isotope heat sources.

Substantial progress was made in the recoding of fuel cycle and economics routines to enable their use on the new IBM-709 computer. Significant progress in fuel cycle analysis awaits completion of this work.

Work was started to formulate detailed plans and schedules for the program of special physics experiments to be performed during the startup of the PRTR.

Studies were made concerning the feasibility of irradiating depleted uranium in Hanford reactors as a potential means to provide early infeed of high exposure plutonium to the Plutonium Recycle Program. Preliminary results are encouraging.

TECHNICAL AND OTHER SERVICES

A statistical analysis was completed of gold film electron diffraction patterns in order to determine the precision and accuracy of current calibration methods for powder patterns. In addition to the estimate of the calibration constant, estimates of several biasing factors including spherical aberration were obtained.

A recommendation was made and accepted that the number of analytical determinations per part to insure conformance with final product specifications be decreased from 6 to 3.

Work on 9 operations analysis programs continued during the month. In addition, statistical and mathematical assistance on 15 problems was given within HLO and to other departments and operations.

There were 23 authorized projects at month's end with total authorized funds of $8,466,100. The total estimated cost of these projects is $9,145,100 (PRTR and PFPP are considered separately). One project was completed during the month and two new projects were authorized. Five new projects are awaiting AEC approval. Seven project proposals are in preparation and one was submitted to AEC.

Construction progress continues to be delayed - last month due to the work stoppage and now due to the steel strike. Two major projects are most seriously affected. These are the 327 Building Addition, Project CGH-790 (which is delayed pending receipt of steel siding), and the Critical Mass Laboratory, Project CG-731 (on which there are procurement problems for most steel items).

Total productive time for Technical Shops for the month was 19,586 hours. This includes 14,148 hours performed in the Technical Shops, 2883 hours assigned to Minor Construction, 32 hours to other project shops, and 2,523 hours to off-site vendors. The total shop backlog is 26,798 hours, of which 50% is required in the current month, with the remainder distributed over a three-month period. Overtime worked during the month was 5.5% (1069 hours) of the total available hours.

Developments during the month relating to HAPO technical information release include (1) the review by HOO-AEC of formal Research and Development reports prior to distribution from HAPO, (2) Washington, AEC review of papers for publication on the subject of Waste Disposal, and (3) correspondence with AEC to establish a guide to be used in categorizing Atomic Weapon Data reports as requested by AEC.

No new cases of plutonium deposition were confirmed during the month. The total number of deposition cases which have occurred at Hanford remained at 232 of which 166 are currently employed..

SUPPORTING FUNCTIONS

Based on the interim financial plan, a formal request has been made to AEC for the following increases:

R&D Program	Financial Plan	Requested
Plutonium Recycle	$5,000,000	$5,729,000
Biological Research	1,000,000	1,086,000
Environmental Sciences	252,000	323,000

Commission approval was obtained for two Assistance to Hanford jobs for FY 1960. They are as follows:

ATH-HLO-2-60 Heat Transfer Corrosion Test, $24,000 assigned to APED.
ATH-HLO-3-60 Graphite Contraction Studies, $47,300 assigned to Research Services, Schenectady.

As of August 31, the staff of the Hanford Laboratories totalled 1363 employees, including 653 exempt and 700 nonexempt. There were 571 exempt employees possessing technical degrees, including 349 BS, 118 MS and 104 PhD's.

DECLASSIFIED

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Corrosion of Nickel Plated Aluminum. To simulate blistering of nickel-plated aluminum clad fuel elements in-reactor, hydrogen is evolved on the surface of the nickel plate by making it the cathode in an electrolytic cell. The effects of temperature, nickel thickness, vendor, and post-plating treatments have been investigated, with the following results:

1. Temperature - room temperature runs have been found satisfactory in simulating the blistering. Temperature variation was not found to affect the results significantly.

2. Nickel thickness - the extent of hydrogen blistering was found to be inversely proportional to the thickness of the nickel.

3. Vendors - no marked difference between the quality of Heath Plate and Industrial Plate has been found. Chemplate and Kanigen plate have shown an inferior quality compared to the previous two. All are electroless nickel plates.

Dynamic Corrosion of Aluminum - 340 C Loop Experiment. The first month of loop operation with 340 C deionized water was completed maintaining the same process variables previously employed in a 300 C test, except for the temperature increase. Average penetrations of the X-8001 aluminum samples were only slightly increased over those noted in 300 C water. After making a small linear correction to the 300 C data to compensate for small differences in exposure for the two tests, the following comparisons are obtained:

Corrosion of X-8001 Alloy After One Month of Test (mils)

Water Temperature	19 fps	38 fps
300 C	1.52 (avg. of 3)	2.35 (avg. of 3)
340 C	1.56 (avg. of 4)	2.48 (avg. of 4)

This test confirms earlier observations that temperature effects in dynamic systems are not large.

Fuel Element Rupture Studies. Rupture rates for coextruded tubular elements exposed in an autoclave at 300 C and 1500 psig have been followed by measuring the rate of release of hydrogen gas. The test

DECLASSIFIED

elements are Zircaloy clad-uranium core samples (1.46" ID, 1.84" OD, 3" long) which have been defected through the outer cladding with a 0.025-inch diameter pinhole defect. The elements are ruptured inside Zircaloy process tubing (2.09 ID, 2.41 OD) and are positioned to give a 0, 1/16, 1/8, and 1/4" annulus between the defect and the inside wall of the process tubing. They are held in position by rigid supports. The samples were exposed for two hours after they had evolved one liter of hydrogen. Samples were also exposed without the process tubing -- essentially an infinite annulus.

The rate of rupturing with a 1/4-inch annulus was about the same as with an infinite annulus. A blister formed around the defect and expanded into the annulus. After about 36 minutes the bluster ruptured and hydrogen evolution began. The element continued to blister and rupture the cladding with a slowly increasing corrosion rate of the uranium core. Two hours after rupture began, typical rates were about 0.1 to 0.3 gram of uranium per minute. In one test the rupture rate with a 1/8-inch annulus (normal) was approximately the same as for the 1/4-inch annulus.

On the other hand, samples with 1/16-inch and with zero annulus were exposed for from five to eight hours before the rupturing commenced as evidenced by the evolution of hydrogen. During this induction time, a blister grows around the defect, but, because of the restricted spacing, the blister mushrooms out over the surface of the elements doing extensive damage before the cladding ruptures. Distortion of the process tubing to 0.16 inch out-of-round actually occurred during one such test. (This distorted process tube is being checked for evidence of hydriding.) Once the cladding ruptures, the element fails rapidly with severe destruction of the inner and outer cladding, and with rupture rates approaching four grams of uranium per minute. These tests are being continued and may have an influence on the design and choice of fuel type for the NPR.

Fuel Rupture Mechanisms. Corrosion rates have been measured on open-ended samples of coextruded Zircaloy clad uranium rod. The samples were cut from coextruded rod stock, and the unclad ends were polished. These samples, along with some bare samples from which the cladding has been removed, have provided considerable insight into the mechanism of a rupturing uranium core fuel element. Two different forms of attack have been observed which occur simultaneously. One is a uniform corrosion penetration which proceeds at a constant rate with kinetics that are in good agreement with previously observed uranium oxidation rates. The rates increase with increasing temperature. The other form of attack is discontinuous and penetrates the metal deeply in the extrusion direction (perhaps along grain boundaries or stringers). This form of attack appears to increase with hydrogen pressure but becomes less important with increasing temperature. This second mode of attack is believed to be controlled by the formation of uranium hydride which is known to have a maximum stability at about 225 C and to decompose with increasing temperature above this value.

DECLASSIFIED

The integrated result of these two modes of attack in a rupturing uranium metal fuel element is a rupture process whose rate is fairly insensitive to temperature and pressure. The uniform oxidation process is dominant at 300 C, while the hydride-controlled reaction is dominant at 200 C. Ruptures at 200 C have been observed to result in greater sample distortion than at 300 C.

Radiometallurgy Laboratory Studies

Seven rod cluster fuel elements examined during the month are as follows:

Ident.	RM No.	Enrich.	Jacket	MWD/T	Comments
IP-226A	279	1.6	Zr-2	1200	Samples were removed from Rod E-1 for burnup, density & metallography.
IP-214A	295	1.6	Zr-2	1500	Metallographic examination of the uranium near the missing can wall revealed a large number of impurities & inclusions. The end of the center rod is the only rod affected.
GEH-10-2	281	Nat.	Zr-2	950	A density measurement of 18.83 g/cc was obtained on a sample from one of the peripheral rods. Metallographic examination revealed no macro or micro cracks.

A Zircaloy-2 clad, natural uranium rod, immersed in NaK and irradiated to 3500 MWD/T in a stainless steel container according to GEH-3-32, was opened (RM-250). The longitudinal crack observed in the Zircaloy-2 extended through the uranium to the thermocouple well. Foreign metallic material was observed in a small area of the crack. Another Zircaloy-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. Metallographic examination revealed macro and micro cracks in the uranium which extended within 40 mils of the jacket (RM-275). Visual examination and measurements of the samples of KER-Zircaloy-2 process tubing removed from KE Reactor have not revealed any unusual features (RM-502).

Metallography and hardness studies of two broken thorium tensile samples from GEH-3-28 and 29 were completed (RM-213). The results and conclusions from this work will be reported in connection with the respective development programs of Fuel Design and Physical Metallurgy Operations.

[redacted]

DECLASSIFIED

Basic Metallurgy Studies

Radiation Effects in Structural Materials. Information is being obtained concerning property changes in Zircaloy-2 which occur at elevated temperature in a high neutron flux. A new jig for positioning platinum strips on the Zircaloy tensile samples has been designed and fabricated. Use of the jig should remedy the frequent invalidation of results due to rotation of the platinum strips during elevated temperature tensile testing.

Metallographic studies have been completed on irradiated copper, nickel, titanium, zirconium, iron and molybdenum specimens. X-ray line broadening studies prior to annealing are complete for irradiated molybdenum, titanium, and zirconium specimens. X-ray studies on iron, copper, and nickel are in progress. Hardness measurements have been completed on irradiated molybdenum and zirconium specimens.

A metallographic study on an annealed 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 10 percent CW, 25 percent CW, 50 percent CW, and beta quenched conditions. Examination of the ten percent CW specimen was completed in July. No metallographic change has been observed in either of the specimens examined. Replicas have been prepared for three remaining specimens. Unirradiated Zircaloy-2 specimens, representing ten percent CW, 25 percent CW, and 50 percent CW, are currently being annealed at 220 C. For a time period equal to the irradiation time, cold work recovery is being followed by electrical resistivity measurements. Resistivity measurements will show what percentage of cold work recovery should occur due to in-reactor thermal annealing.

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

As reported previously, thin evaporated films of aluminum supports on copper specimen grids irradiated to various exposures up to 4.4×10^{19} nvt (thermal) showed electron diffraction evidence for: (1) the presence of Cu after an exposure to 8.4×10^{18} nvt; (2) the disappearance of Cu during additional irradiation; and (3) the appearance of $CuAl_2$ after exposures of 4.4×10^{19} nvt. A second set of irradiations, 1×10^{19} and 3.2×10^{19} nvt, has been completed: the (111) and (200) lines for copper were not observed, but an extra line with spacing of 1.392A was observed. This extra line is as yet unidentified. The (101) and (202) $CuAl_2$ lines found previously after an exposure to 4.4×10^{19} nvt were not observed.

A thin foil of high purity aluminum prepared by rolling and subsequent chemical thinning techniques has also been irradiated to an exposure of 3.2×10^{19} nvt, and has been studied in the electron microscope. When a thin film of aluminum is bombarded by the finely collimated electron beam of the electron microscope, localized thermal stresses result. These

[redacted]

stresses cause dislocations to move. Their motion can be observed with the microscope. If irradiation causes an appreciable hardening, dislocation motion should be impaired. Studies of dislocation motion in irradiated thin foils, therefore, should provide basic information on irradiated induced damage in reactor materials. Preliminary study of the motion of dislocations in the irradiated aluminum foil has shown that dislocation motion is not impaired; foils irradiated to higher exposures will, therefore, be examined.

Boron-carbide balls, irradiated in the KE Reactor have exhibited severely spalled surfaces. In order to investigate the mechanism and nature for the failure of such balls, non-irradiated control balls are being studied, and methods for conducting microscopic studies on the irradiated balls are being developed.

A report, "The Irradiation of Thin Evaporated Films of Uranium Dioxide -- Interim Report," HW-61656, has been prepared. A report, "Microscopic Studies of Damage in Irradiated Uranium Dioxide," HW-61266, coauthored with H. W. Newkirk, Ceramic Fuels, has been prepared and distributed.

X-Ray Diffraction Studies. The bond layers formed in AlSi canned fuel elements are being investigated. Bond strength and friability have been observed to vary with microstructure which in turn is a function of canning conditions. Compounds formed in the bond layer have only been partially identified. To complete this identification, standard alloys of U-Si-Al are being examined metallographically, and the structures found are being correlated with x-ray diffraction patterns. The lattice parameters of seven U-Al-Si alloys were determined along the USi_3-UAl_3 pseudo-binary. There is evidence of a two-phase region between 60-85 a/o USi_3. A number of these specimens have been polished and etched for metallographic examination.

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.

Electrical resistivity data for zirconium specimens is complete. Results show only small differences between vacuum, helium, and air annealing recovery rates at temperatures below 500 C. Electrical resistivity decreases in this temperature range. From 500-800 C resistivity increases slightly and distinct but small differences are observed between specimens annealed under the three atmospheric conditions. These differences are due to differing rates of contamination in the various atmospheres.

In-Reactor Measurements. A knowledge of errors in temperature measurement using thermocouples in a neutron flux is essential for the evaluation of the effects of neutron irradiation on materials. A thermocouple stability capsule, containing an iron constantan, a chromel-alumel, and a copper-constantan thermocouple, has been irradiated 5030 hours. The thermocouples

DECLASSIFIED

DECLASSIFIED

have been maintained at a temperature of 300 C during irradiation, except during occasional excursions to 335 C during determination of the thermal arrest temperature. An atmosphere of approximately 25% CO_2-75% He has been maintained in the capsule for the last eight weeks. A 100 percent helium atmosphere was used prior to this time. Electrical resistance between the copper-constantan couple and the metal thermocouple well in the capsule has varied between 130,000 and 50,000 ohms, indicating poor contact between the bead and the bottom of the well. Resistance between the well and the other couples does not exceed 300 ohms, and the resistance of each of the three couples does not exceed 100 ohms. Similarly, the resistance between the copper-constantan thermocouple and the bottom of the thermocouple well in an ex-reactor control capsule has increased to 2600 ohms, whereas the other two have remained in good electrical contact. Conditions in this capsule have been maintained as nearly identical to those in the in-reactor capsule as possible. The increase in electrical resistance between the copper-constantan couples and the bottoms of the wells could be due to excessive oxidation of the copper-constantan thermocouple beads. The thermocouple beads in both capsules are spring loaded against the bottoms of the wells.

Metallic Fuel Development

Cluster Fuel Elements. Post-irradiation examination of the 7-rod cluster fuel element irradiated in KER Loop 2 in 200 C coolant to an exposure of 1500 MWD/T was continued. Further examination of the center rod having a reduced section 30 mils smaller in diameter than the nominal diameter revealed the presence of inclusions and impurities in the surface of the uranium. Sections taken at the other end of this rod and from the ends of rods taken from the same extrusion as this rod and on either side of it have normal diameters and can wall thicknesses. The observed necking appears to be a local effect confined to the one end of this one rod.

Post-irradiation examination of a 7-rod cluster element irradiated to 950 MWD/T in the ETR 3x3 loop was begun. Measurements of a peripheral rod of this element showed an increase in diameter of five to seven mils (two mils ellipticity) and two to five mils increase at the other end (three mils ellipticity).

Final ex-reactor tests have been completed on the equipment that will be used for rupturing irradiated cluster fuel elements in the ETR 3x3 facility. The ex-reactor tests performed in the ELMO-4 loop at 300 C and 1450 C show that the equipment should work satisfactorily under the proposed operating conditions. At present, the schedule calls for the first in-reactor rupture tests to be performed about October 1st.

Tubular Fuel Elements. Four separate test charges of tubular fuel elements have been run. Due to lack of radiometallurgy cells large enough for 36" elements, only external dimensions measurable in reactor basins have been determined. All elements tested to date have been made from coextruded Zircaloy-2 clad uranium or uranium two percent Zircaloy alloy. Measurements made by electronic micrometer confirmed those reported last

month for the less accurate optical measurements. The only swelling observed to date has occurred in the rod of a tube and rod element exposed to 2000 MWD/T. Here the volume increased was six percent. The core temperature of this rod was about 650 C. The elements with 2000 MWD/T exposure are being shipped to BMI for radiometallurgy examination. One element was received at BMI in August.

An attempt has been made to correlate observed in-reactor growth with predicted growth of coextruded, U-2% Zircaloy tube-tube elements (1.820" OD) for low burnups at maximum temperatures less than 400 C. Comparison of post-irradiation measurements with dimensions predicted by Growth Index calculations showed good agreement between observed and predicted in-reactor growth of as-extruded elements. Growth predictions for beta-annealed tubes were not substantiated by the in-reactor test. Predicted length changes were, for the as-extruded and annealed tubes respectively, -1.65% and 0.10%. Observed growths of these elements were -1.73% and -0.63%. Predicted diametrical changes for the as-extruded and beta-annealed tubes were 1.15% and 1.60% while the diametrical growths were 1.16% and 0.20%. Both tubes were irradiated to 300 MWD/T at maximum core temperatures of from 325 C to 375 C. Large grain size might account for the disparity between observed and predicted growth of annealed elements.

Component Fabrication. A composite Zircaloy-2 uranium billet was extruded to examine Zircaloy-2 to Zircaloy-2 bonding at low extrusion ratios. The extrusion billet consisted of alternate disks of Zircaloy-2 and uranium sealed in a Zircaloy-2 jacket by electron beam fusion welding. The billet was preheated to 600 C and extruded at a ratio of 13 to 1. The bonding was very complete with the interface between the Zircaloy-2 jacket and the Zircaloy-2 disks not being detectable. Extruding at lower extrusion ratios reduces the magnitude of the extrusion end defects and would make integral end closures more feasible.

A draw sizing method is being developed to replace or supplement swaging as a rod sizing operation. Information obtained from these experiments will be applicable toward developing a draw sizing method for coextruded tubular elements. Rods have been lubricated by (1) electrolytic copper plating, (2) siliconizing, (3) phosphating followed by a sprayed lacquer-molybdenum mixture, and (4) chemical copper plating. All four coatings were covered with a rubbed "steelskin" (50% molybdenum disulfide, 50% sodium stearate) surface. The two copper plate coatings showed the most promise. The chemically deposited copper plate and "steelskin" surface was explored further because of its adaptability to production. It is possible to make four die passes without relubricating the surface for a total reduction of 0.033" on a 0.593" diameter rod. Reductions were made in steps of 0.010". About 3.5 tons of force are required to pull one reduction. The rod surface must be of good quality before plating for a successful draw. The surface finish improves in each die pass and no die pick up was noted.

DECLASSIFIED

DECLASSIFIED

Closure and Joining. Ultrasonic welding may offer some advantages for the attachment of supports to the aluminum jacketed fuel elements. A program is under way to evaluate supports attached by this process. Supports are being attached with the 4 KW ultrasonic welder recently installed in 306 Bldg. Micro sections have been prepared on twelve of these to determine whether the welding causes any damage to the clad, the bond, or the compound layer. No damage was evident. Five groups of sixty welds each have been autoclaved for 20, 40, 60, 80, and 100 hours, respectively, in 170 C steam. There were no failures and no evidence of corrosion. These are now being shear tested to determine the effects of autoclave time on weld strength. A four-tube charge for in-reactor testing is being prepared.

Contract DDR-57, Prime Contract, AT(45-1)-1350, Research Welding & Engineering Company, has been completed. The contract was to explore the feasibility of using standard welding practices to weld end caps on tubular and rod fuel element geometries. The sample welds received from the Research Welding and Engineering Company showed good possibilities for production type welding of the NPR rod and tubular elements.

Attempts were made to hot head 0.593" OD Zircaloy-2 clad coextruded fuel rods after beta heat treating. The advantage of hot heading after heat treating is that warp is minimized in the rods during the hot heading operation. All previous hot heading has been on as-extruded rods, and a separate step was necessary to straighten the rods following beta heat treatment. Beta heat treating greatly increased the force required, making it impossible to hot head the heat treated rods without exceeding the strength of existing dies. This indicates that, possibly, the uranium grain orientation in the as-extruded rods greatly aids in hot heading with the flat extrusion dies.

Hot heading was attempted on Zircaloy-2 clad 0.593" OD fuel rods with the ends of the rods heated into the uranium gamma phase (850 C). Hot heading in the gamma phase would require less force, allowing the use of much simplified hot heading tools. The Zircaloy-2 cladding did not form uniformly over the end of the rod and tended to buckle into the soft uranium core below the end of the rod. Gamma hot heading shows that the uranium core must be sufficiently stiff to resist buckling of the Zircaloy-2 cladding and force the cladding over the end of the rod under the flat extrusion die used in hot heading operation as in alpha hot heading.

Tooling is being fabricated to hot head short lengths of NPR coextruded outer tubes in the existing 400-ton press to examine the problems of tube hot heading. Also, the design is nearly complete on the tooling to be used in hot heading two-foot long inner KER coextruded tubes.

Allied Fuel Studies. In-reactor swelling experiments of Zircaloy clad rods with various uranium temperatures, cladding thickness, and exposures are being conducted. Examination of a Zircaloy-2 clad natural uranium fuel rod irradiated in NaK filled capsules at the ETR has been completed. Fuel exposure was 200 MWD/T and average central uranium temperature was

495 C. Dimensional measurements show that the diameter increased a maximum of 2.8 percent and the length decreased 0.5 percent. The average volume increase calculated with dimensional changes of the fuel is 1.6 percent while the measured density decrease is 1.96 percent. Metallographic examination reveals severe internal macrocracking of the uranium similar to that such as has been found previously in enriched uranium rods irradiated in Hanford's KER loop to an exposure of 2200 MWD/T. Cracks can be seen as near as 0.030" to the U-Zr bond, but none appear to go in or through to bond or Zircaloy-2 cladding. This fuel was subject to severe temperature cycling in the ETR.

To attempt a statistical analysis of the effect of temperature, exposure, and cladding upon fuel element swelling, a series of NaK capsule experiments has been designed for irradiation in process tubes of Hanford reactors. Fifty capsules have been assembled and are now undergoing the final examinations before charging in mid-September.

The anisotropic thermal expansion of the uranium crystals in polycrystalline uranium cause microstresses when the temperature of the uranium is changed. If the uranium is under load, these microstresses should affect the macroscopic creep rates. Constant load cyclic temperature creep studies are being initiated for uranium specimens in order to determine if the microstress distributions can alter the macroscopic creep rates by orders of magnitude. Equipment for the adaptation of present creep machines to run these tests is designed and being fabricated.

A possible mechanism for macrocracking in irradiated uranium is that the anisotropic thermal expansion of uranium crystals causes large internal strains during the cooling of fuel elements. A piece of uranium irradiated to ~1000 MWD/T was heated to 600 C and quenched in such a manner as to produce the same cooling rate as encountered in a reactor fuel element. No macrocracks were observed after a single quenching.

Equipment for in-reactor burst testing of fuel element jackets is nearing completion. Since these tests are to be made on Zircaloy-2 tubing simulating fuel element jackets, it is necessary to compare the burst behavior of this tubing with that of fuel element jackets. Actual coextruded jackets were burst tested in two conditions; one in which all the uranium was removed from the inside of the jacket and another in which a thickness of uranium equal to the jacket thickness remained bonded to the jacket. One significant difference in the behavior of the bare Zircaloy-2 jacket and the jacket bonded to uranium was the mode of failure. The bare jackets were laid wide open and one end cap was blown off when they ruptured at an average hoop stress of 50,000 psi and temperature of 370 C. The jackets containing uranium ruptured at a similar stress, but the rupture produced only a small slit in the jacket wall.

In fuel elements with bonded jackets and unbonded end caps, large displacement incompatibilities between the end cap and the fuel material occur during reactor operation. If the end cap region of the fuel element is not properly designed, these incompatibilities can cause localized strain

DECLASSIFIED

DECLASSIFIED

cycling which could fail the fuel jacketing material. An ex-reactor test for duplicating these mechanical conditions is being developed. A material with a suitably large coefficient of thermal expansion has been found (a commercial alloy, P-alloy, 72 w/o Mn-18 w/o Ni-10 w/o Cu) and formed into a rod with a bonded Zircaloy-2 jacket. The first successful bonded rod was made with the Dynapak. Further specimens for Dynapak and coextrusion fabrication have been machined in order to obtain Zircaloy-2 cladded rods of P alloy of sufficient length to test the P alloy and Zircaloy-2 bond strength during thermal cycling.

Two alloy fuel specimens of Th-2 w/o fully enriched uranium are being examined at the Radiometallurgy facility after attaining calculated exposures of 2 and 2-1/2 a/o B.U. at the MTR. Measurements of the dejacketed specimens indicate a 0.005" diameter increase (original diameter 0.388") which corresponds to about a 2-1/2 v/o expansion of the fuel material.

Metallurgical Development. Metallurgical examination of Zircaloy-2 clad uranium tubes bonded in the BMI pressure autoclave facility has been completed. All of the examined specimens showed nearly complete bonding on all surfaces. Even the end cap had bonded to the uranium core. Structural differences in the core on Zircaloy-2 cladding had no effect on the bonding characteristics. The unbonded areas appeared to be caused by surface contaminants on the Zircaloy or uranium. Width of the compound layer was approximately 0.005", which would indicate that either the four hours bonding time or temperature could be reduced. The pressure of 10,000 psi at the bonding temperature of 840 C was sufficient to cause flow of the Zircaloy clad into all defect areas of the uranium core. The compound layer in the cast bonded piece appeared to be improved considerably by the pressure bonding process. Final evaluation is pending micro-hardness results, tensile strength of the bond area and defect testing.

A program is under way to determine the effect of controlled additions of zirconium and carbon on the extrudibility of cast uranium. All castings have been completed for the extrusion coefficient and extrusion pressure investigation. The heat treating has been completed, samples submitted to the Analytical Laboratory for analysis and the copper billet cans and Zircaloy-2 containers have been completed. Machine work on the extrusion billets is approximately 50 percent completed. The range of carbon alloys has been reduced due to difficulty encountered in causing a reaction between uranium and carbon at concentrations greater than one w/o carbon. This reaction will occur only at temperatures in excess of 2000 C. Extrusion will begin as soon as the billet preheat furnace is installed.

Facilities and Equipment. A remotely manipulated, transducer activated measuring device, accurate to within 0.2 mil in bench testing, was used for measuring diameters of irradiated tubes. Tests designed to determine the accuracy of this instrument when operated under several feet of water are in progress.

[redacted]

2. REACTOR PROGRAM

Coolant Systems Development

Decontamination of Present Reactors. Preliminary tests have been started to compare the decontaminating efficiency and corrosion characteristics of various decontaminants. At 50 C, Wyandotte 75, a decontaminant containing bisulfate is much less corrosive to X-8001 aluminum than Turco 4306 B. Other tests are scheduled on carbon steel and stainless steel.

Two samples of Zircaloy-2 process tubes were inserted in blocks of graphite and flushed with 100 ml of Turco 4306 B (5 oz/gal). One sample was heated to 90 C and the other maintained at room temperature (25 C) for two days. These samples were then flushed twice at two-day intervals with 100 ml of water, following which the Zircaloy-2 tubes were removed from the graphite block and examined. From weight loss measurements the average penetration was 0.02 mil at 90 C and 0.10 mil at room temperature. The corrosion on the 90 C sample was fairly uniform, but the room temperature sample showed two areas of localized attack. The lower corrosion rate at 90 C is attributed to the more rapid drying of the sample.

Testing of ETR Cluster Element. A prototype cluster element as planned for ETR 3x3 loop rupture studies was tested in an out-of-reactor loop. This test element was pre-defected with a 0.025 inch pinhole through the coextruded Zircaloy-2 jacket into the uranium core, but with this defect then covered by a Zircaloy cap welded over the defect. Attached to the element was a hydraulic piston device with a guillotine blade to shear the projection. The piston is activated remotely by a hydraulic pump located outside the test section but connected to the piston by stainless steel tubing. This piston was equipped with a revised packing arrangement to minimize the leaking which was experienced with an earlier model.

The loop was operated for 72 hours at 300 C, following which the projection was successfully sheared to expose the jacket defect to the hot water. The shearing operation functioned smoothly, and the estimated leakage past the piston was 3 cc/minute at a 200 psi differential. The element was exposed to the hot water for 1-1/2 hours following the shearing. No visible swelling or distortion had occurred in the rod when it was examined after the test. The rod will be exposed for several more hours at 300 C to observe the rate and mode of rupturing.

Rupture Tests of Fuel Elements with Heat Generation. Rupture testing was continued for another hour on a coextruded U-Zircaloy-2 rod which had been isothermally beta heat treated. At the end of this test the rod had been exposed for a total time of two hours at 300 C, 1650 psi, 30 kw/ft power rate, and 20 fps water velocity. The extent of rupturing at the three 0.025-inch pinholes in the rod was definitely worse than on similar rods tested without internal power generation. Each of the defected areas had lost an average of 36 grams of uranium compared with 14 grams without power generation. Also, the ruptured areas exhibited approximately 3/4 inch diameter mounds compared with 3/8 inch diameter mounds without power.

DECLASSIFIED

DECLASSIFIED

Decontamination Studies. The first contaminated run was made in the Irradiated Rupture Prototype (242-B Building) loop following five days of pre-filming. The nine-gram irradiated uranium sample was valved into the loop and contacted with circulating 300 C water for four hours. Radiation readings indicated that most of the resulting activity centered in the two-micron micrometallic filter, while the balance of the loop remained relatively inactive. A water flush reduced the filter activity from five R/hr to 1.5 R. A peroxide-bicarbonate decontaminating solution was used to dissolve the UO_2. The dissolution was accompanied by a decrease in filter activity and an increase in activity elsewhere in the loop. This process reduced the filter activity to 150 mr/hr. The APACE decontamination process (alkaline permangante, ammonium citrate, EDTA) was then employed, following which the final loop activity including the filter was less than 10 mr/hr. Inspection of the corrosion coupons showed good film removal with the exception of the carbon steel specimens which were covered with a light-colored film which could be removed by brushing. This film evidently retained some activity as shown by low decontamination factors for the carbon steel coupons. However, the success of this first "hot" decontamination run in this new loop (IRP-1) is very promising.

S1W boiler tube sections were decontaminated in the ELMO-10 loop using the APACE process. A study was also made on the effects of this process on U.S. Graphitar No. 14 bearing material. After three complete decontamination cycles with the APACE process, no attack was apparent on the bearings.

Deoxygenating Resins. Studies to determine the capacity and efficiency of IRA-400 and S-10 deoxygenating resins are in progress. The duolite S-10 resin, regenerated with cupric sulfate, sodium hydro-sulfite, and sodium hydroxide solutions, has processed 400 bed volumes of water. It continues to remove all but 0.1 ppm O_2 from water originally containing about 6 ppm. The IRA-400 resin, regenerated with sodium sulfite and sodium hydroxide, has proved effective in processing 250 bed volumes of water. Results to date, however, indicate that the Duolite resin is definitely superior under the conditions of interest.

Metal Cleaning Procedures. A new inhibitor, 2-propyn-1-ol, is 2.5 times more effective than formaldehyde in preventing metal loss during carbon steel coupon cleaning in 50% HCl at room temperature. The cleaning takes approximately five mintues. The metal penetration by the solution in five minutes is 0.0007 mil. This is sufficiently low that corrections due to cleaning losses may be neglected. Using this inhibitor, a new process has been developed for cleaning stainless steel corrosion coupons. Cleaning can be accomplished in approximately one-fourth the time formerly required with the Turco 4501 process. The process consists of (1) immersion in 20% NaOH-3% $KMnO_4$ - 77% H_2O at 105 C for 1/2 hour, (2) rinsing in running water until the rinse water is no longer colored by $KMnO_4$ (approximately five minutes), and (3) immersion in 50% HCl - 50% H_2O inhibited with 2-propyn-1-ol for one minute. This process has also been used to remove corrosion film from Inconel-X. No attack on the base metal on 304 s/s or Inconel-X by these solutions was found after one-hour exposures. Although useful as a corrosion laboratory technique for cleaning coupons, this process is not

[redacted]

being considered for in-reactor decontamination because of the risk of chloride ion stress-cracking on stainless steel components.

A procedure has also been developed for cleaning aluminum samples exposed in high-temperature water. The standard cleaning method using phosphoric acid-acetic acid solutions and a rinse in mixed nitric-hydrofluoric acid removed only part of the film. After trying this procedure, the samples were heated in air to 500 C and quenched in boiling water, then cleaned again in the dichromate-phosphoric-acetic solution for two hours. This treatment completely cleaned the samples.

Thermocouple Design. Testing has started on a nozzle cap plug design which will permit leaking o-rings on thermocouple trains to be replaced without discharging the train. This design uses a screwed o-ring flange on the cap plug. Four solid nickel gasket designs for sealing the flange and plug joint have been evaluated by hydrostatic testing. Gaskets in the shape of a diamond and a double-edged diamond both held satisfactorily at 4400 psi, while a flat gasket failed at 100 psi and a conical gasket sealed by columnar loading failed at 4000 psi when the pressure flattened the unsupported gasket. By providing longitudinal support, it appears that this design would also be acceptable. Thermal cycle testing of both of the diamond shaped designs will be conducted in ELMO-7 test loop.

Component Testing for NPR. An NPR nozzle-tube screwed connection using "banana-ring" gaskets failed on steady-state operation at 572 F and 1900 psi in ELMO-7 loop. This joint had previously undergone about 600 thermal cycles with no observed leakage. Another screwed nozzle-tube connection using bell ring seals was noted to have begun leaking after 1200 hours steady-state operation at 572 F and 1900 psi, but testing is continuing. This section had undergone about 10 thermal cycles during loop shutdowns. An NPR cap using a Marmon-Conoseal gasket began leaking after 1300 cycles from 300 to 500 F at 1500 psi, but testing is continuing. A Canadian rolled nozzle-tube joint has completed 2000 thermal cycles from 300 to 500 F at 1400 psi with no observed leakage. Operating conditions are being increased to 550 F maximum temperature and 1800 psi pressure to approximate NPR operating conditions.

Structural Materials Development

Zircaloy-2 Process Tubes for NPR. Development of fixtures, jigs, and a dry-box for butt welding was completed at the Budd Company plant, and the nine Zircaloy extrusions, produced by Allegheny Ludlum Steel Corporation before the steel strike, were welded into three tubes ready for tube reducing to final size.

Chase Brass Company is now cutting forged ingots into extrusion billets. The first extrusions will be made in early September. Slow delivery of their new drawbench will delay the first drawing operation until about mid-November.

Harvey Aluminum has produced the first three extrusions for their NPR process tube order. The extrusions are 45 feet long and will not require butt welding to produce a finished tube 57 feet long. Examination prior to removing the

DECLASSIFIED

copper jacket revealed that the dimensions were within manufacturing tolerances and that the surfaces of the Zircaloy probably would be good. Tanks are under construction to pickle the jacketed extrusions and to apply the drawing lubricants. The first drawing operations are scheduled for early September immediately after completion of the tanks.

In-Reactor Creep Testing. An experimental strain gage has been tested to 500 C (out-of-reactor), with satisfactory performance. The strain gage under development employs an electro-mechanical system to translate linear motion into electrical signals which are recorded on an electrical pulse counter. Each electrical pulse represents a finite amount of strain. When the strain of the creep specimen causes the strain sensing contacts to open, the gage is energized causing the micrometer screw contact to advance again until the contacts close. The net result is that the strain gage arrangement causes the micrometer screw to pace the strain of the creep specimen. Strain is read out by counting the number of times each solenoid coil is energized. The strain displacement associated with each solenoid coil energization in the gage is 1×10^{-4} inch. Assembly of a complete capsule for bench testing is under way and should be completed within the next several weeks.

Nonmetallic Materials Development

GETR Graphite Irradiations. The first two graphite experiments in the GETR, H-1 and H-2, were discharged following a failure on August 18 of the reactor instrument support bracket shortly after the circulation system was started and before the reactor had gone critical. The instrument brackets were located within the pressure vessel and were part of the reactor, designed to support long instrument leads. This was the first time they had been placed in service. When they failed, the thermocouple conduits were sheared and allowed water to enter the test capsules. The capsules have been returned to Hanford, and the graphite samples recovered and reprocessed. New capsules are being built in an attempt to meet the September 1 shutdown.

MTR Controlled Temperature Graphite Irradiations. The GEH-19-2 high temperature graphite experiment, which was discharged from L-48 after mechanical trouble developed, has been repaired and recharged into the MTR. About one week's irradiation time was lost. Although temperature control cannot be maintained since good contact with three of the four thermocouples cannot be established, most of the heaters are working and temperatures can be estimated quite reliably within ± 50 C. The samples are in the 750-1000 C range. The experiment is scheduled for discharge September 21.

Hot Capsule Graphite Irradiations. MTR capsule experiments GEH-14-111 thru 114 containing graphite samples were discharged on August 10, and have been disassembled at the MTR. Aluminum wires within these capsules did not melt which indicates that the operating temperature was somewhat less than 650 C. All of the remaining capsules are evacuated, rather than He filled, and consequently will run at higher temperatures.

Twenty-two capsules containing samples of all NPR candidate graphites are being fabricated and will be charged into the MTR on September 21. These will be exposed for three cycles at a temperature calculated to be near 1000 C.

Temperature indicating paints are being evaluated to determine whether they can be utilized as temperature monitors in the capsule irradiations. Gamma ray dosages of 5×10^8 R produce no color changes in the paints. Painted graphite cylinders have been charged into the Snout Facility at KW to determine the effect of reactor radiation.

Full Bar Irradiation. A block of CSGBF graphite which was placed in the D-test hole of C Reactor before start-up has been discharged with a very high exposure. Length measurements on the 4 x 4-inch cross section, along the 24-inch length, and across a 1.8-inch diameter hole drilled down the longitudinal axis, were made before and after irradiation. The irradiation temperature of the bar was in the approximate range from 400 C to 550 C.

The percent contractions noted for each dimension are summarized as follows. Measurements in areas of the bar where visible evidence of oxidation existed have not been included.

Measurement	Contraction
Avg. for bar measurements transverse to extrusion axis	0.45%
Avg. for hole diameter measurements	0.40%
Avg. for length parallel to the extrusion axis	0.68%

Irradiation of the bar will be continued in the Y test hole at C Reactor after current irradiations of NPR candidate graphites are completed.

Low Exposure Graphite Irradiations. To provide a better understanding of the kind and number of simple defects produced during the first stages of radiation damage in graphite, a series of four short-term, low-temperature irradiations has been completed. Graphite temperatures were monitored by a thermocouple and were $15^\circ \pm 5$ C for three of the tests and $25^\circ \pm 5$ C for the fourth 100 MWD/AT irradiation. A wide range of structural types is represented in the samples. This will represent one of the most extensive surveys of physical effects of radiation on graphite; hence the exposure determinations from reactor operating power have been supplemented by foil activation and by the damage measurements in the CSF samples.

Radiation Damage to Silicone Rubbers. Preliminary studies on the combined effect of radiation and hot water on silicone rubber (Silastic S2096) indicates that at high dose rates, about 10^6 r/hr, the damage is caused almost entirely by the radiation. This is evidenced by the fact that at this dose rate the damage occurs at the same rate at 175 C as at 25 C. However, at the low dosage 10^4 r/hr at 175 C the damage rate is in excess of the small amount which results from radiation alone.

DECLASSIFIED

The damage produced by hot water in sealed systems tends to depolymerize the silicone rubber, and radiation tends to produce the opposite effect. Under certain conditions of exposure to hot water and radiation, the material should undergo minimum damage and be serviceable for an indefinite time. For example, with Silastic S2096 this combination should be attainable at 175 C when the gamma dose is between 10^4 and 10^6 r/hr. Work is continuing on these studies and will include other types of materials as well as the silicone rubber compounds.

Thermocouple Studies. On May 16, 1959, three complete stringers of eleven Geminol thermocouples were installed in D Reactor. All of these couples are still functioning perfectly. This is encouraging because on the basis of past performance with iron-constantan thermocouples in similar stringers it would be expected that half of the couples in positions nine through eleven would have failed in three months.

Thermal Hydraulics Studies

Boiling Burnout Experiments for K Reactor. Laboratory experiments were initiated to determine the heat fluxes associated with boiling burnout for the existing reactors. The test section used simulated approximately two feet of the annular flow stream for I & E fuel elements in a K process tube. At a flow rate of 50 gpm, a pressure of 25 psig, and a water temperature of 200 F, it was found that boiling burnout indications were initiated at a heat flux of 1,250,000 B/hr-ft^2. Under similar conditions except at a flow of 20 gpm, burnout was detected at 830,000 B/hr-ft^2. These values correspond to specific powers of about 250 and 150 kw/ft, respectively.

It may be noted that, although these burnout heat fluxes were evidenced by sharp rises in heater rod temperature, the temperature increases were not extreme, and stable operation could be continued even under burnout conditions. For example, while burnout conditions started at a heat flux of 830,000 Btu/hr-sq ft for the 20 gpm case, further power increases were imposed, and stable operation was established at a heat flux of 1,000,000 Btu/hr-sq ft. The maximum rod temperature at this flux was about 1100 F. The thermocouple reading this temperature was imbedded in the metal near the surface of the heater rod and probably read temperatures 200 to 300 F higher than the surface temperature. For the 50 gpm case, the rise in heater rod temperature at burnout was even less extreme, so much so that determination of the burnout point was difficult and imprecise.

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. During an overload test of the transformers, a test section similar to 32 I & E fuel elements in a K process tube was run under steady state conditions at 3840 kw. The flow rate and pressures were higher than normal during this experiment to prevent possibilities of boiling burnout. In addition, the heat generation rate was decreased from front to rear along the test section so that those portions of highest heat flux would be cooled by the coldest water.

The project (CGH-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. Orders have been placed for all major equipment items required for the steady state phase except the heat exchangers.

Hydraulic Studies. Flow characteristics were determined for a production sample of the slip-joint Y-fitting which has been procured in quantity for D and DR reactors. The assembly is shown on Drawing H-1-11734. The results were compared to the characteristics of the old type helical rear pigtail. It was found that the new slip-joint Y-fitting will result in a tube flow operating point increase of only 0.5 to 0.7 gpm, whereas tests with early models showed expected flow increases of about 1.5 gpm. However, there have been slight changes in the dimensions of the assembly which probably account for the difference. For example, the production sample has a pigtail ID of only 0.525 inch, whereas the early models had a pigtail ID of 0.555 inch. This points up the fact that small dimensional changes in the rear fittings can cause significant changes in the flow characteristics.

Flow splits were determined for a proposed tube-and-tube fuel element for charging in KER loops. The fuel element consisted of a 1.82-inch OD by 1.45-inch ID outer tube and a 1.05-inch OD by 0.50-inch ID inner tube, each supported by collapsible support rails. The tests were conducted in a 2.10-inch ID process tube. The experimental flow split was:

outer annulus - 45.8%,
inner annulus - 38.5%,
hole channel - 15.7%.

Flow tests were conducted for an improved model of the ETR 6x9 mockup which will be used for high-pressure, high-temperature tests in the 314 Building. The data obtained in the Hydraulics Laboratory allow the determination of relative flow rates for the fuel channel and the channel outside of the fuel support basket during tests in the 314 Building.

Mechanical Equipment Development

Organic Cooling System Components. The MOTS-1 facility operated for 754 hours during the month with temperature maintained at 300 C and pressure at 275 psig. All test components, including three mechanical seals, operated satisfactorily.

Reactor Technology Development

Neutron and Gamma Attenuation Measurements. A rough draft of a summary report on the shielding properties of ferrophosphorus concrete has been written. The data from the first test on iron-serpentine concrete and barite concrete are being analyzed.

DECLASSIFIED

Comparison of existing data indicates that iron-serpentine concrete of 210 lb/ft^3 density containing 40% serpentine should be suitable shield material for high temperature applications. Serpentine retains about 12% water at 300 C. Long term heating tests are under way to check water retention as a function of time at elevated temperatures.

The second foil loading was removed from the NPR thermal shield test assembly. A sulfur foil loading to measure fast neutron attenuation of the boron steel was placed in the test assembly for the next operating period.

Shielding Instruments. A subtraction unit for using the 100-channel analyzer for the two crystal Compton subtraction method for gamma spectrum analysis has been fabricated. The unit performs its subtraction function by using one phototube and crystal combination for background only and the other for background plus signal, and counting each tube for an equal length of time. Fabrication of the neutron collimator for the DR test well is complete.

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 mixtures of UO_2 and PuO_2 powders have been continued. All of the densities from previous sintering experiments have been recalculated utilizing a somewhat different water immersion technique. Since densities of pellets obtained by physical dimensions are inaccurate due to chipping, and water immersion does not account for the open porosity, the pellets were coated with clear krylon before being immersed in water. This effectively sealed the open pores. Plots of density versus composition still indicate a drastic reduction in UO_2 sinterability with even the slightest additions of PuO_2 and a rapid increase with PuO_2 contents greater than 20 weight percent. The following table compares densities of pure UO_2 and PuO_2 after an eight-hour soak time:

Temp.	UO_2	PuO_2
1100	66.0% T.D.	94.6% T.D.
1200	70.1	93.6
1300	75.7	92.1
1400	83.2	95.3
1500	86.4	90.6
1600	89.2	96.4

The differences in low temperature densification rates are rather striking.

The activation energy for self diffusion in plutonium dioxide has been calculated from experimental data as 69 k cal/mole in comparison to 75 k cal/mole reported previously for UO_2.

The melting point of plutonium dioxide has been determined as 2480 C in a helium atmosphere. This value is based on an average of five observations which varied from 2475 to 2485 C, and may be regarded as preliminary. PuO_2 melted at 2455 C in a vacuum of 10^{-4} mm Hg; however, this temperature may be low due to a condensation of oxide vapors on the furnace sight glass. Uranium dioxide was found to melt at 2728 C, which is in agreement with previous reports. The liquidus for the system UO_2-PuO_2 is being determined on samples which were transformed to a single phase by sintering at 1600 C in hydrogen. Solid solutions containing 10 and 40 w/o UO_2 "erupted" quite drastically near the melting point with the 40 w/o UO_2 sample being the most severe. The reaction is difficult to describe, but there seems to be a sponge-like growth occurring with dendritic or whisker type needles evolving

from the sponge. This effect has been observed on UO_2 but not on pure PuO_2. It is planned to investigate this phenomenon further and also to qualitatively analyze the vapors emitted from molten PuO_2.

A series of nine core alloy candidates were corrosion tested. The testing was done in a static autoclave with demineralized water at 350 C for a period of 24 hours. The following alloys were tested:

1.	Si 11% Pu 2% Al 87%	slight corrosion
2.	Si 5% Pu 2% Al 93%	failed
3.	Si 1% Pu 2% Al 97%	failed
4.	Zr 3% Pu 2% Al 95%	failed
5.	Pu 2% C2 alloy 98%	good
6.	Ni 1.5% Pu 2.0% C2 alloy 96.5%	good
7.	Pu 2% 8001 alloy 98%	failed
8.	Pu 2% Ni 2% 8001 alloy 96%	good
9.	Si 1% Pu 2% 8001 alloy 97%	good
10.	Pu 1.8 w/o Al 98.2 w/o	failed

The compositions listed are nominal. Analysis will be made for the alloys passing the 24-hour tests. The samples listed as good after 24-hour exposure were all slightly tarnished but still exhibited fabrication extrusion lines on the metallic appearing surfaces. Corrosion rates will be determined in following experiments.

Fabrication Studies. One hundred twenty-eight extrusion billets were cast this month as follows: ninety-eight Al-1.8 w/o Pu billets for PRP fuel fabrication; three Al-20 w/o U-2 w/o Pu and three Al-13 w/o U-5 w/o Pu billets for investigation of properties of Al-U-Pu alloys; four Al-3.1 w/o Pu billets for ETR cluster fabrication; and 20 Al-1.8 w/o Pu billets for investigation of direct reduction of Pu oxide to final composition. If the analyses are satisfactory, the latter billets may be used for PRP fabrication. The 98 PRP billets cast this month together with the 48 PRP billets cast in February constitute one-half the billets requirement for the first PRTR spike loading. To complete the billet requirements for the first loading, 15-20 additional working days will be required.

Experiments of the Al reduction of Pu oxide directly to a 1.8 w/o alloy continued this month. The analyses of the alloy from three reductions made last month averaged 1.2 w/o Pu; the analyses of the flux from each of the three reductions was 0.06%, 0.09% and 4.9%. Unfortunately, none of these strike a material balance; confirming analyses were obtained on extruded

rod from one of the alloy billets. Sampling, analyses, and control of reduction and alloying conditions are under investigation in the latest series of reductions.

Casting techniques are being developed for casting fuel material directly in a cladding for the purpose of making coextrusion clad fuel rods. Several important advantages may be realized if this technique is successful:

1. The decontamination and cleaning step on the cast billet is eliminated.

2. Machining may be completely eliminated (important scrap elimination step).

3. Assembly, welding, and outgassing of the billet may be completely eliminated, since it may be possible to cast not only the core material but the cap (from uncontaminated Al) as well.

Solid and hollow (I & E) Al and Al-U billets have been successfully cast into cladding material (Al) in preliminary investigation of techniques and variables. Components, compatible with existing tooling on the extrusion press, are being fabricated for a more intensive investigation of the fabrication techniques.

The extrusion of nine nominal 0.5-inch diameter Al-Pu base alloy rods for corrosion and mechanical properties testing has been completed. A 27:1 reduction in area was used. Extrusion conditions in all cases were as follows: billet temperature, 500 C; container temperature, 400 C; die temperature, 200 C; ram speed, approximately 20 inches per minute.

The billets were right circular cylinders, 2.5-inch diameter and 5.5-inch long. Extrusion constants for the various compositions were obtained.

Al base metal alloy	w/o Pu	Other alloying additions	Extrusion const. (peak) (tsi)
1. Eutectic AlSi	2	--	8.15
2. 1245	2	5 w/o Si	7.20
3. 1245	2	1 w/o Si	6.31
4. 1245	2	3 w/o Zr	7.17
5. 8001	2	0.1 w/o Ti	7.29
6. 8001	2	0.1 w/o Ti	6.89
7. 8001	2	--	6.15
8. 8001	2	2 w/o Ni	6.72
9. 8001	2	1 w/o Si	7.03

A rod was coextruded with a nominal 0.9" diameter clad in 8001 Al with an 1100 Al core as a standin for Al-Pu. Tapering of integral core ends indicate that a modification of billet end configurations will be required.

Extrusion of 1100 Al tubing as a preliminary to I & E coextrusions has been proceeding. A slightly tapered, "floating" type mandrel lubricated with oil dag(has proven satisfactory.

Several rods were coextruded to a nominal 0.9 inch diameter. The cladding was 8001 Al, and the core materials were -100 mesh, atomized Al powder and -325 mesh Al_2O_3 powder. The reduction ratio was 27 to 1. Al powders with natural oxidation films which yield Al_2O_3 contents from 0.5 to 1.5 w/o were extruded at 200, 300, 400, 450, 500, and 550 C. Densities in all cases were of the order of 99% theoretical. Al clad rods containing Al powder plus 5 w/o Al_2O_3 in -325 mesh tabular and crystal form were extruded at 500 C to approximately 98% theoretical densities.

Installation and modification of the swage hood equipment is in progress. The feeding mechanism is still being reworked. It will be adequate for sinking tubes on metallic cores, but further revision may be necessary for the heavy reductions used in ceramic swaging.

The injection rate for the prototype air pressure casting equipment was measured with an electronic timer. Aluminum at 700 C and under 70 psig air pressure filled an 89-inch long Zircaloy tube in 0.361 second.

A Zircaloy tube which had 1/8 inch wide, 1/16 inch deep circumferential rings rolled into the tube at six-inch intervals was filled with aluminum by injection casting. The restriction to longitudinal expansion provided by the reduced tubing cross sections is being evaluated in thermal cycling tests. A similar AlSi casting with no end cap clearance successfully withstood 12 thermal cycles. Additional thermal cycling tests will be performed on both the AlSi and aluminum fuel rods.

Due to an autoclave mishap which damaged the equipment and destroyed the experimental elements, there are no new thermal cycling results to report. New elements were fabricated, and cycling tests are proceeding at the present time in a four-foot long autoclave vessel.

The design has been started on a fuel element wire wrapping machine. The machine is being designed to be versatile enough to handle rod type or tube type elements with a diameter up to 3-1/4 inches. The pitch length of the wire can be accurately controlled and varied from one inch to twenty inches or any odd length between. The wire tension may be adjusted by adding or removing known weights. With these various controls, the machine will be adaptable in developing fuel elements from various materials, rod diameter, rod length, wire size, and pitch length.

A later model PRTR 19-rod cluster, the Mark I-G, has been designed. This model incorporates new end brackets especially designed for investment casting. By using "as cast" end brackets, a saving is realized by a factor of four over the Mark I-E and a factor of seven over the Mark I-F.

Fuel Evaluation. The two, high-density, UO_2-PuO_2 capsules (GEH-14-19, 20) which were irradiated at the MTR are now in the Radiometallurgy Laboratory for examination.

Sixteen capsules (GEH-14-5 thru 12 and GEH-14-42 thru 49) containing Al-Pu and Al-12 w/o Si-Pu alloy cores with 5, 10, 15, and 20 w/o Pu are currently being irradiated in the MTR.

The radiometallurgical examination of the four, high-burnup, Al-Pu and Al-Si-Pu alloy capsules (GEH-14-23, 24, 25, 26) and the four-rod, Al-Pu and Al-Si-Pu alloy cluster (IP186A) which were irradiated in the MTR and KER (Loop 3), respectively, has been completed except for burnup analysis and replica examination. Unirradiated Al-U alloy samples (6, 10, and 13 w/o U) were supplied for additional dissolution experiments in order to determine a satisfactory means of preparing burnup analysis specimens. Arrangements have been made for the examination of the replicas by the Metallurgy Laboratory in the 326 Building.

All six of the PuO_2 impregnated graphite capsules are presently being irradiated in MTR. These capsules are located in a thermal neutron flux of 7 to 8 x 10^{13} and will be irradiated for four and eight cycles which will be 25 and 50 percent burnup of the Pu atoms. Maximum core temperatures of 780 C are expected.

The 7-rod, Al-Pu alloy cluster, scheduled originally as part of the IP250A test and delivered to the reactor on August 31, 1959, is now part of the IP226A-Supp. B test and was charged into KER Loop 1 during the latter part of August 1959.

The three-foot long, 7-rod Zircaloy clad Al-Pu cluster (GEH-11-1) has been successfully irradiated for the equivalent of five days at full power. The element operated at reduced temperatures during this run because of loop difficulties. Thirty to forty days operation was requested. It is presently scheduled that the element will be reinserted into the facility on October 4 for the remainder of its irradiation time.

The three-foot long, 19-rod Zircaloy clad Al-Pu cluster (GEH-11-2) is awaiting heat exchanger repairs to the ETR 6x9 loop before it can be charged into the facility. It is presently scheduled to be charged on October 4 for a 20-day irradiation period.

UO_2 Fuel Development

PRTR Fuel Elements. Fused uranium dioxide grain is the most promising candidate fuel material for swage compacted or vibratorily compacted PRTR fuel rods containing a high density fuel core. Several vendors have been contacted as possible suppliers of fused UO_2.

Recent discussions with Spencer Chemical Co., Kansas City, Missouri, revealed that they will fuse uranium dioxide which will meet the specifications described in HW-61653, "Specifications for Fused Uranium Dioxide." Delivery time for the fused oxide is good. Spencer will agree to an O/U ratio of less than 2.010, a carbon content of less than 100 ppm and a uranium metal content of less than 0.3 percent.

Severe internal surface defects, undetected by the Probolog eddy current apparatus, were found in Zircaloy-2 tubes, with an experimental ultrasonic tester. Many of these defects were of sufficient magnitude to raise doubts concerning fuel element reliability during irradiation. The development of nondestructive tests sensitive to defects of this magnitude is imperative. At present, ultrasonic techniques appear to offer the most promise. Fabrication of prototypical testing equipment continues.

Integrally ribbed, Zircaloy-2, outer cladding tubes for the Mark II-C nested tubular fuel element were received from the vendor, Nuclear Metals, Inc. Tests showed them to be of reactor quality. Sufficient quantity of good tubing is on hand to permit fabrication of 18" or 36" long test assemblies as soon as the inner cladding tubes become available. One assembly for PRTR also is being assembled.

It has been demonstrated that PRTR 19-rod fuel element end fittings or hangers can be fabricated more quickly at HAPO and at a fraction of the cost of obtaining them off-site. End hanger assemblies for seven 19-rod cluster fuel elements were fabricated from Zircaloy-2. Each hanger was assembled from 24 pieces by the tungsten arc inert gas welding process, in a vacuum purged welding chamber. The hanger assemblies are vacuum annealed for six hours at 600 C, prior to etching and autoclaving.

Zyglo-Pentrex testing of as-received tubes has decreased the reject rate of swaged PRTR fuel rods from greater than 50% to less than 10%. Of 61 rods swaged from as-received tubes which had passed Zyglo-Pentrex inspection, only four showed defect indications.

Seven hundred eighty pounds of UO_2 destined for swaged PRTR fuel rods was prepared by sintering ball milled and cold pressued UO_2. Six hundred pounds of "micronized" UO_2 was received. Two hundred pounds were sintered. A density of 98 percent of the theoretical was obtained at 1750 C in the laboratory furnaces, and 95.5 percent in the continuous furnace at 1650 C.

Fabrication Development. Previous experiments have demonstrated that, by hot swaging at temperatures of 600-800 C, UO_2 densities can be increased 3-10% over those expected from cold swaging. Desired fuel rod temperatures for hot swaging can be obtained by resistance or by induction heating. Use of a newly designed and fabricated improved brush holder employing silver-graphite brushes is expected to eliminate any arcing resulting from the high current required in resistance heating. The brush holder is designed to automatically make and release contact with the fuel rod as it passes into the swage machine. Rate of feed, length of heating zone, position of brushes, etc., are being studied to determine the optimum heating and cooling rates, as revealed by thermocouples inserted into the UO_2.

Fuel Evaluation. The swaged UO_2, 19-rod cluster PRTR fuel element was inspected after six weeks of flow testing in the ex-reactor PRTR mockup loop of the Reactor Engineering Development Operation. This element which was operated under pressure and temperature conditions exceeding those of PRTR operation exhibited no fretting corrosion, no bowing or elongation, and no loosening of the wire wrap. The element will be reinserted in the loop for additional testing.

Maximum exposures of approximately 10,500 MWD/T have been accumulated in swaged UO_2 capsules during irradiation in MTR and ETR. Irradiation of the three capsules continues. Two natural UO_2, swaged capsules were discharged for examination after exposures of approximately 3000 MWD/T.

A thermal crack in a weld was shown to be the cause of a recent failure of a large diameter, 1.44" OD, stainless steel clad, sintered UO_2 fuel element. During reactor startup, sufficient thermal stresses were introduced to crack the weld in the region where a lack of complete penetration had occurred.

Three Zircaloy-clad UO_2 fuel elements failed in the MTR GEH-4 facility during 1958-1959 because of a Zr-2-UO_2 solid state reaction. Studies of these failures have led to the following conclusions:

1. The failures of the cladding wall occurred only at high surface heat fluxes of approximately 1,000,000 BTU/hr/ft^2.

2. End caps failed when insufficient cooling permitted coolant boiling and/or the end cap was in direct contact with molten or gaseous UO_2.

3. The failed area of the Zircaloy-2 was composed of a number of undetermined phases which may include zirconium hydride, beta-phase, zirconium, and a Zircaloy-UO_2 reaction compound. Grain growth in the Zircaloy-2 also occurred.

4. The corrosion might be enhanced by a reaction between the residual gases of CO_2, H_2, CO, and N_2 retained after fabrication.

5. The Zircaloy-2 in the region of the defect is very brittle but was deformed during a part of the irradiation.

Basic Studies. Columnar grains of UO_2 have been formed in centrally heated, unirradiated uranium dioxide fuel cores at temperatures below the melting point of UO_2. Both swaged and sintered fuel cores, 0.565" OD, were internally heated with an axial tungsten wire at 2400 C. The marked similarity between these laboratory results and the results of irradiation tests is further verification that the radially oriented columnar grains observed in some irradiated UO_2 fuel elements are formed at temperatures below the melting point of UO_2.

Electrolytic reduction of U^{VI} from a fused sodium chloride-potassium chloride eutectic (by Chemical Research & Development Operation) produces a dense, crystalline UO_2 having a crystal density of near 100% TD. This material shows promise as a swaging powder. However, it suffers from a high oxygen to uranium ratio, i.e., 2.10 or greater. A sample of the material was heated in hydrogen at two different temperatures to determine if it could be made stoichiometric. The untreated UO_2 had an O/U ratio to 2.080. Twelve hours at 1700 C reduced it to $UO_{2.001}$.

Addition of 0.1 w/o TiO_2 to untreated MCW UO_2 powder results in cold pressed compacts which sinter to 97 percent of the theoretical UO_2 density in 12 hours at 1750 C.

Corrosion Studies

The Effect of Autoclave Pretreatment on Hydriding of Zircaloy. Samples of Zircaloy-2 and Zircaloy-3 have been pretreated to form various types of ZrO_2 films to study the difference in susceptibility to hydriding with variations in the oxide film. The pretreatments for Zircaloy-2 included vapor blasting, etching, degreasing, and HF stained surfaces; and each type surface was tested both with and without subsequent autoclaving. The Zircaloy-3 was etched and tested with and without subsequent autoclaving. After preparation and weighing, all samples were exposed in dry, O_2-free, hydrogen at 400 C, 25 psia. A piece of bare uranium metal was included with the samples to insure a dry, oxygen-free atmosphere.

The pretreatments were not effective in preventing destructive hydriding indefinitely:

(a) All samples were destroyed after hydriding for 88 hours.

(b) After hydriding for 20 hours, however, the only samples destroyed were the "unautoclaved-degreased," "unautoclaved-HF stained," and "autoclaved 22-hr-HF stained" samples.

However, autoclaving appears to improve the resistance to hydriding to some extent because the three samples which failed by hydriding before 20 hours exhibited pretreatment surfaces which had thin and/or defective oxide films. No greater or lesser susceptibility to hydriding was noted

for the Zircaloy-2 under the conditions tested. At 20 hours exposure to the hydrogen, three Zircaloy-2 samples were destroyed, and all others were unaffected, showing typical go-no-go type of hydriding.

Since previous experiments have indicated that the presence of water vapor can inhibit hydriding reactions, another set of samples was prepared, as above. These samples were exposed to the same conditions of 400 C, 25 psia H_2 except that 15 psia steam was added in addition. After 284 hours exposure, no catastrophic hydriding has been observed in marked contrast to the 88-hour test above. This test is continuing.

Aluminum Alloy Development. In the past, corrosion studies have been conducted with high temperature aluminum alloys to test the effect of varying casting and fabrication techniques. However, none of these tests have shown any great dependence of the corrosion rate on these variables. Also, a number of alloys with various compositions have been tested, and these have shown little dependence of corrosion on composition as long as the amount of the alloying metals remains over a certain percentage. However, it is easier to obtain low corrosion rates consistently with certain compositions. X-8001 has been routinely fabricated and shows a parabolic corrosion rate in low flow tests regardless of the handling method. The French E_3 alloy (2.1 w/o Fe, 0.64 w/o Ni) with 0.1 w/o Ti shows a corrosion rate which is between the parabolic rate represented by X-8001 and the logarithmic rate. This has been obtained with alloys fabricated both by Hanford and Alcoa. Alloys showing logarithmic rates have not been reproducible as yet.

The emphasis in alloy development is now swinging to using higher purity base materials (99.99% or better Al) for the alloys to reduce the impurities. Corrosion rates for three alloys of this type received from Alcoa are shown below.

CORROSION OF NEW ALUMINUM ALLOYS IN LOW FLOW 360 C DEIONIZED H_2O

Penetration (Mils)

Time Hours	X-8001(a)	Alloy "KH"(b) 1.42% Ni, 1.54% Fe	Alloy "KI"(b) 2.89% Ni, 0.38% Fe	Alloy "KJ"(b) 2.85% Ni, 0.37% Fe, 0.37% Cr
242	0.39	0.21	0.28	0.38
	0.42	0.20	0.33	0.33
723	0.60	0.26	0.43	0.44
	0.60	0.30	0.47	0.43
1515	1.24	0.37	0.55	0.60
	1.26	0.34	0.54	0.61

(a) Data for standard X-8001 alloy, for comparison with the new alloys.
(b) "KH," "KI," and "KJ" are local HAPO designations for these new experimental aluminum alloys received from Alcoa. These three alloys were made from high-purity (99.99%) aluminum.

Alloys with similar iron and nickel contents have been tested before without obtaining such low corrosion rates. Metallographic examination of these samples shows by far the finest and most uniform distribution of the second phase material seen in any aluminum alloy samples to date, and especially so for the KH sample. The bulk of the second phase material in KH is not visible as discrete particles at 250X. The rates shown by the KI and KJ alloys are comparable to the low, logarithmic rates obtained on some alloys previously. The corrosion rate shown by the KH alloy at 360 C is the lowest rate ever obtained for an aluminum alloy at this laboratory. Whether the low corrosion rates shown by these particular alloys are due to low impurity content, or as a result of better second phase distribution, is not known at present.

The Dynamic Corrosion of Alcoa Alloy 192597. Several alloys in addition to the Alcoa alloy 192597 (designated "KH" at HAPO), have been observed to corrode by the favorable logarithmic process in the refreshed 360 C autoclave. However, these "super alloys" have not previously been available in sufficient quantity to test in dynamic loops. Based on the corrosion model developed in the last year or two for dynamic corrosion, there has been doubt whether the favorable low corrosion rates of the "super alloys" in static systems would also be exhibited in dynamic tests. One month corrosion data for alloy KH in 340 C deionized water at 19 fps flow rate provide some preliminary information on this matter.

In comparison with X-8001 alloy run simultaneously in the same test section, etched KH is very similar in corrosion properties. After an autoclave treatment prior to the loop experiment, corrosion of KH was reduced to less than one-half that of X-8001 similarly pretreated. The results of this test are shown in the accompanying table:

DYNAMIC CORROSION OF X-8001 AND KH, 732 HRS, 340 C DEIONIZED WATER, 19 fps

	Sample Pretreatment		
	Etch Only	1 wk. 350 Deionized Water Pretreatment	1 wk. 350 pH 4.5 Phosphoric Acid
KH	1.31 mils (2)*	0.60 (2)	---
X-8001	1.56 (4)	1.30 (4)	1.36 (4)

*Number of samples tested shown in ( ).

Structural Materials Development

PRTR Jacket Tubing. A further modification of Nuclear Metals contract (DDR-29) will be negotiated to complete the work started on a final generation of extruded, externally ribbed jacket tubing. This work is expected to provide three sets of jacket tubing, and a final report outlining a process for the production of such tubing in quantity.

Discussions have been held with Allegheny Ludlum personnel on the production of formed Zircaloy wire for rib-stock to be welded to jacket tubing, with the conclusion (by Allegheny Ludlum) that this shape could

be produced and delivered about 10 weeks after the steel strike ends. The capability of the Thermatool welding machine to attach straight or spiral ribs or thin-walled Zircaloy tubing was demonstrated by New Rochelle Tool Company. The machine will be shipped to Hanford in the near future.

Burst Testing of Zircaloy Tubing. A technique to measure the water temperature within a pressure-tube burst test specimen has been devised, and measurements indicated an 85 C drop in temperature during the final minutes of tests employing annealed specimens in which large elongations occur. A reservoir of hot water inserted between the pump and the specimen reduced this temperature drop to 10 degrees C. An accumulator was added to the system to reduce the pressure fluctuations during the test. Using the new equipment, annealed Zircaloy-2, PRTR type tubing failed at calculated hoop stresses of 42,600, 46,000 and 47,200 psi at a temperature of 300 C ± 10 C. On the basis of these refinements in burst test technique, the minimum bursting pressure for a minimum walled, maximum ID, PRTR process tube is calculated to be 3700 psi (compared with 4000 psi based upon previous burst test results).

A closure for burst-testing heavy walled Zircaloy pressure tubing with more than 20% cold work has been successfully tested. The closure utilizes a 3/16-inch welded end cap to provide the pressure seal and a heavy flange bolted against the end cap to provide the strength. The assembly is held on the tube by a double split ring arrangement. Two shallow concentric grooves are machined in each end of the tube 0.5 inch from the weld zone. Split rings, which protrude above the surface of the tube, are placed in these grooves. Two heavy flanges engage the split rings. These two flanges and the flange in contact with the welded plate are bolted together with ten half-inch bolts to effect the closure.

Radiometallurgy Laboratory Studies

Metallographic examination was completed on a Zircaloy-2 clad sample from the ruptured end of a natural UO_2 fuel element and replicas obtained for electron microscopy studies (RM-300). A Zircaloy-2 clad UO_2, 4-rod cluster was photographed, disassembled, and each rod sectioned for metallography and burnup analysis samples (RM-270). Examination of a 304L stainless steel clad, sintered UO_2 fuel element with 2.33 w/o U-235 was initiated and the existence of a crack at the end cap weld was verified with a penetrating dye (RM-315).

Replicas of both the fractured and polished surfaces of high and low density UO_2 specimens were obtained (RM-308). Fission product gas was collected from three sintered UO_2 samples irradiated to 1500 MWD/T (RM-273). Fission product gas was also collected from a swaged UO_2 capsule (GEH-3-46) and a transverse section was prepared for replication (RM-293).

As part of the swelling program, X-ray diffraction studies were conducted on two uranium samples which had been irradiated to 2600 MWD/T and annealed at 880 C and 700 C, respectively for 100 hours (RM-265). No correlation

was obtained between the irradiation exposure, post-irradiation annealing treatment and the density of 22 other lower exposure uranium specimens (PT-3NA)(RM-317). The results and conclusions from this work will be reported in connection with the respective development programs of Ceramic Fuels, Plutonium Metallurgy, and Physical Metallurgy Operations.

Thermal Hydraulics Studies

Laboratory data taken from runs made with the full scale Mark II-B prototype have been studied. The observed relationship between flow rate and pressure drop at a given power level for each flow channel is as predicted by theory and indicates that instability will not occur at normal operating temperatures and pressures. Power levels up to 950 kw were realized and outlet qualities as high as 18.5%. The highest power level corresponds to a heat flux of 216,000 Btu/hr ft^2.

The full scale electrically heated mockup of the Mark I fuel element was installed in a special process tube in the high pressure heat transfer facility. The 19-rod fuel element mockup was run at prototypical temperatures and pressures at powers up to 1200 kw using the DC generators as the power source and at powers up to 2000 kw using the silicon rectifiers as the power source. Initial experiments at powers up to 1200 kw and flows low enough to yield bulk boiling at the outlet were made to determine if poor mixing or hot flow channels existed in the bundle. Water channel temperatures and fuel surface temperatures near the end of the active section, as measured by about 50 thermocouples, revealed no evidence of poor mixing or hot spots.

The second phase of experimentation consisted of obtaining boiling curves (pressure drop versus flow rate at constant power) at various powers from 750 kw to 1800 kw. The boiling curves were obtained by setting the tube power and reducing the flow until the exiting coolant was partially steam. In most cases, the flow was reduced until the exit quality was about 20 percent by weight. Results were as follows:

Power kw	Flow gpm	Outlet Quality % by wt.	Outlet Quality % by vol.	Heat Flux Btu/hr ft^2
750	35.2	13.9	74	130,200
1250	50.2	18.9	81	217,000
1500	60.2	19.7	82	260,000
1800	69.5	21.4	83	312,000
2000	153.2	0.55	9	346,000

The surface temperatures were not completely analyzed but seemed consistent with expectation for power and flow variations. As an example, at 1250 kw the maximum surface temperature measured was 623 F with the majority of the surface temperatures very close to 600 F.

The preliminary analysis of the experimental results indicate that no hot flow channels or hot fuel surface temperatures occur in the fuel bundle

and that the shape of the boiling curves is such that flow instability of the PRTR primary coolant seems remote.

The Mark II-B fuel element has been repaired and two pressure taps installed in the fuel element near the outlet end. It is hoped these additional pressure points will permit the collection of more useful pressure drop data. The fuel element has been installed in the process tube and insulation obtained. The next step is pressure testing followed by connecting to the proper instrumentation.

Mechanical Equipment Development

PR-1 - Discharge Operation Mockup. A Work Review is being processed prior to start of installation work.

PR-10 - Primary Loop Mockup. Testing of primary loop components has been discontinued with the exception of the spare primary process pump. Planned tests on the three PRTR primary process pumps were cancelled when the pumps were assembled and delivered to the PRTR Phase III contractor on August 11, 1959.

The 14-inch Gate Valve and the eight-inch Check Valve were removed from the loop on August 24, 1959, in order to meet the contractor's schedule. They had been operated for a total of 1471 hours at 480 F and 1050-1150 psig. Total leakage from the lantern collection ring of the 14-inch valve was 1.42 gallons for the entire period. Leakage through the closed valve seats, both gate valve and check valve, was not measurable during a three-hour test at 1050 psig pressure. The eight-inch check valve closed with a backflow of 118 gpm and would not re-open until all pressure was off and water was drained from the downstream side of the valve.

The primary process pump was disassembled on July 31 to investigate the complete failure of the low pressure water mechanical seal after 250 hours of operation. It was thought that excessive clearance (0.005") in the thrust bearings had allowed the friction ring (L-ring on the shaft) to ride up on the shaft since the full speed thrust of the pump is upwards. This movement after several startups completely separated the seal faces.

The primary pump seal leakage during the month varied from two to five gphr. The pump was disassembled again during the loop outage on August 24, 1959, after 719 hours operation on the high pressure seal. The seal faces were in excellent condition but were replaced with the original seal balance of 70 percent in an attempt to reduce the leakage rate.

The Single Tube Prototype Mockup was operated for 546 hours during the month. The prototype process pump was disassembled during the August 24, 1959, component removal outage. The primary seal faces were in excellent condition after 1581 hours of operation (1387 hours at PRTR operating conditions). The leak rate during the last month's operation varied from 0.01 to 0.001 gphr, and there was no sign of overheating on the seal faces.

The new mechanical seal assembly was placed on order August 19, to evaluate for possible use in the PRTR primary process pumps. The assembly consists of a Byron Jackson double self-adjusting seal to replace the high pressure mechanical seal and a balanced type U mechanical seal to replace the L-ring low-pressure seal. The high pressure seal change is expected to give more consistent leakage and longer life. The low pressure seal change will incorporate a more dependable seal along with the strength to take full system pressure under emergency conditions.

PR-13 - Injection Pump Test. Pump operation during the month has been for Single Tube Prototype Mockup support. Johns Manville packing Style 413 Unepac rings have been received and will be life tested.

PR-20 - Calandria Characteristics. Tests have been completed on the Claandria Mockup in 189-D. Data are being processed, and the final report is being written.

PR-40 - Shim Control Mockup. The first bids on shim control were opened August 10, and all were considered non-responsive because of various discrepancies in each bid. The invitations were re-submitted, and a new bid opening date has been set as September 4. Bids ranged from $80,000 to $147,000 at the first opening.

The second prototype shim control was completed and was successfully operated for about 650 cycles which represents about 65 hours of continuous operation. Failure of the chain drives occurred at this point. New chain and sprockets have been ordered and will be dry-lubed (baked on molybdenum disulfide) prior to installation to evaluate results of this application.

The planetary gear arrangement using Standard Oil Company of California Nuclear Radiation Resistant Grease #335 is still operable and is still undergoing radiation test after exposure of $> 8.4 \times 10^8$ R.

All material to be furnished to the vendor is now being procured.

PR-50 - Reactor Piping Seal Testing. The new nozzle hold-downs were received and are being evaluated. With the exception of a spring arrangement to absorb the high stresses caused by the differential thermal expansion between the nozzle and the hold-down, all problems appear solved. Stainless hold-downs were evaluated versus a high strength chrome-molybdenum hold-down. The significant difference lies in the coefficient expansion of the materials. A leaf spring arrangement is being developed for evaluation.

PR-51 - Reactor Piping Structural Integrity. The flexure cycling facility has been operating to evaluate the hold-down devices. The pump is currently being repaired after the thrust bearing failed.

PR-53 - Process Tube Thermal Cycling and Pressure Testing. The Mark I fuel element was removed and inspected following approximately 800 hours testing at reactor conditions. There was no evidence found of any difficulties, and the unit was returned to service. Seal leakage during this period has averaged: nozzle cap - 0.65 ml/hr; nozzle-to-process tube - 1.3 ml/hr; inlet assembly - 0.26 ml/hr. New seals were installed in the nozzle cap and the nozzle-to-process tube joints.

Special Tools. Construction of a tool for removing nozzle caps is completed but not tested. Redesign is in progress on the tool for the jumper-to-nozzle connection in order to decrease the size of the geared nut. A cut-off saw was tested but was not satisfactory due to the slow cutting speed. Other tools are still being fabricated.

PR-64 - Gas Sampling Technique. The mockup for testing the gas sampling system is essentially complete, and testing will proceed as soon as the Single Tube Prototype Mockup is operated with helium saturated water.

PR-70 - Helium Compressors Test. After 125 hours total operation, it became impossible to maintain oil pressure on the second stage of the Hofer high pressure compressor. The second stage oil compensating pump was badly worn and would no longer supply adequate oil flow. This pump was rebuilt by Technical Shops and operation resumed. The repaired pump works satisfactorily; however, these pumps are undersized and felt to be inadequate.

Oil contamination was detected in the high pressure receiver tank at 140 hours; after another 70 hours, the oil leakage had increased until it interfered with compressor operation. The diaphragms from the second stage were found punctured and severely dented. The first stage diaphragms were intact but were quite dented, apparently from metal particles. It was found that the check valves from the first stage were badly worn, and pieces of the pins used for assembly of these valves were missing. Apparently these broken pins were the cause of the diaphrgam failure. Autoclave engineers are being contacted regarding the inadequacies of the oil compensating pumps and gas check valves for the Hofer machines. These two items must be corrected before we can consider these machines as adequate for our reactor installation.

An item of interest concerns procurement of spare parts for these Hofer compressors. Five weeks ago a number of spare parts were ordered on an emergency basis. These parts have not yet been received, apparently because Autoclave engineers must send to Germany for these parts.

During the past month, 545 hours of operation have been accumulated on the Corblin compressor for a total of 865 hours. Two gas outlet check valve discs and four diaphragms failed during this period. Three of the diaphragms were punctured by metal particles from the broken check valve disc, and one, an original type Corblin alloy steel diaphragm, failed from apparent metal fatigue after nearly 300 hours of operation.

Two carbon steel discs supplied by American Instrument Company have been tried in the gas outlet check valves. One of these discs failed after 200 hours of operation, and the second disc is still intact after 510 operating hours. A 304-L disc fabricated on plant failed after 107 hours. A 416 disc has now operated 175 hours without failing. Discs are now being inspected by x-ray and Zyglo before installation in an attempt to eliminate erratic failures.

General operation of the Corblin compressor has been quite satisfactory, and it is believed that this machine will provide good operating service in the PRTR reactor.

Correspondence and conversation with the Mine Safety Appliance Company indicates that infrared analysis will be the most satisfactory method of detecting oil contamination in the helium gas stream. Infrared analyzers are being used for this purpose at the Cape Canaveral missile launching sites. Leads & Northrup Company are also being consulted regarding the use of their infrared analyzers for this service.

The two helium compressors which were being stored in the PRTR warehouse have been moved into the 300 Area by Minor Construction forces. These compressors will be assembled and modified as necessary for reactor installation.

PR-80 - Air Cooling Duct Test. The plenum chamber to route air to the fuel element has been completed. The air distribution around the fuel element is not yet satisfactory, and modifications are continuing.

PRTR In-Reactor Gas Loop. First prints for comment on the in-reactor loop are 25 percent complete. Hastelloy "X" tube and material have been requisitioned.

Weld samples of Multimet, Inconel, Hastelloy "X" and Hastelloy "F" have been prepared and tested. Strict adherence to welding procedures with the Hastelloys is necessary if weld efficiencies are to be above 50 percent in strength.

The gas loop nozzle was tested with a flexitallic gasket through two cycles at 1300 F and 500 psi with very little leakage. A solid stainless steel gasket was found to relieve at certain pressures and then reseal at a lower pressure.

Inconel "X" Testing. Stress-rupture testing of Inconel "X" tubing continued with no failures for 480 hours of operation at 1150 F and 5500 to 6000 psi.

Leak Detection. A water vapor leak detection unit was received during the month. Work was begun on a calibration system for the instrument.

Calandria Fabrication. The calandria was unloaded at White Bluffs on August 14, upon receipt from Consolidated Western Steel. Upon pressurizing of the reflector vessel, nine leaks were detected. Three

sensing lines and four top coolant lines were removed because of weld burn-through. One leaky flux chamber was removed and a manhole cut in the inner shell to permit access to one gas line leak.

At month-end all leaks have been repaired, and the manhole cover is being replaced.

Reactor Technology Development

PRTR Process Instrumentation. Testing of resistance temperature detectors continued on a high-pressure, high-temperature loop in the 314 Building. Thin (0.002 inch) silver foils placed between the sensing window of the RTD and the pipe reduced response times significantly. The units supplied by Ruge responded twice as fast and those by Engelhard in 15% less time. Using foils, both types of detectors met response time specifications. Representatives from Daystrom Systems and from Ramo-Woolridge visited to discuss data handling system requirements.

An evacuated sleeve has been fabricated to slip over the thermistor temperature probe to eliminate the effects of circulating air currents. Spacings of 1/8 to three inches between the thermistor and the heat source are being investigated. A heat source has been fabricated from stainless steel and its surface milled and oxidized to approximate that of the fuel element.

PRTR Physics Evaluation. A further refinement in calculation of the reactivity worth of the shim system for various alloys was completed utilizing a two-group model. In addition, a first order perturbation theory formulation was used to examine the effect of partial rod insertion. It was found that the ratio of reactivity effect in a configuration of maximum effectiveness to that of an equivalent fully inserted single rod at the same radial location is of the order of 1.6. Results of the two-group calculations compared to earlier estimates based on P-3 analyses are as follows:

MAXIMUM TOTAL SHIM SYSTEM STRENGTH

Material	P-3 Estimate	2-Group Calc.
Inconel W	137.4 milli-k	135.2 milli-k
Inconel X	132.0 "	133.0 "
Hastelloy B	151.3 "	137.5 "
Monel	145.3 "	137.1 "
Duranickel	144.8 "	138.1 "
Nickel - Zr	152.6 "	141.7 "

Although the effect of the reactor reflector, self-shadowing and enrichment have not been included in the above results, it appears that Inconel or any of the alloys shown will provide the required shim strength. Also, the worth of an individual three-foot rod will be of the order of three mk in its most reactive position. This value is well below 80 cents even for pessimistic loading assumptions.

A calculation was performed to determine the activity from gaseous fission products swept out of the high-pressure test loop. These gases are carried to ex-reactor loop piping in the helium stream which serves as carrier for moisture that is monitored to estimate coolant leakage. The dose rate at the pipe wall was obtained as a function of the diffusivity of the gases from the loop fuel, the mass flow rate of helium and the piping size. This result is

$$D = 3.91 \times 10^{10} \frac{r\rho}{R} \text{ in Roentgens/hr}$$

where r = radius of pipe in cm,

ρ = gas diffusion constant in sec^{-1},

R = helium flow rate in cm^3/sec at S.T.P.

PRTR Total Energy Distribution. Calculations were made to determine the total energy distribution in the PRTR. These calculations are a revision of the work performed previously by Triplett (HW-52347). The results of the present analysis are contained in document HW-61346. The results of this heat transfer and physics analysis indicate that the primary coolant removes 94.8 percent or 66.4 MW of the 70 MW nominal total power. The reflector energy is 0.92 percent or 0.606 MW. The total heat load on the top and bottom primary shield coolant is 0.78 percent or 0.545 MW, while 0.36 percent or 0.251 MW are removed in the radial cast iron shield; therefore, the total energy removed by all the shields is 1.14 percent or 0.796 MW. Then, by difference, the moderator heat load is 3.14 percent or 2.2 MW.

CO_2 Gas Cooled Loop. A heat transfer analysis was performed for the CO_2 gas cooled loop. A document (HW-61393) was issued containing the results of these calculations.

Transient temperature calculations performed for a 500 kw fuel element indicated that emergency back-up water must be injected into the process channel if fuel meltdown is to be prevented following loss of CO_2 flow. Also, water injection is necessary following loss of helium if 600 F shroud tube temperatures are to be averted.

Startup and shutdown loop piping temperature transients have been programmed for solution on the IBM-709. Two cases of startup and two cases of shutdown are to be examined.

PRTR Safeguards Analysis. Writing of the text and preparation of figures for the PRTR Safeguards Analysis Report continued during the month.

Analog computer studies of power transients resulting from various reactivity accidents were completed. Calculation of fuel temperature transients, based on these power transients, is in progress.

An analysis of hazards resulting from various mechanical failures in the primary and secondary cooling systems was completed. Results of this analysis were incorporated in the Safeguards Analysis Report. It is expected that a rough draft of the final report will be completed early in September.

Design Development

Overall PRTR Contract. The overall PRTR contract is 37% completed versus 41% scheduled based on the official PRTR schedule. The drop in schedule is attributable to delay in procurement of major process equipment such as the calandria, shields, and steam generator.

Phase III PRTR Contract. The Phase III PRTR contract is estimated to be about 19% complete versus a scheduled 21%. The labor dispute, which had seriously curtailed the construction progress for about 21 days, was settled on July 30. A few contractor procured items are being delayed due to the steel strike and a teamsters' strike in the San Francisco area.

Concrete preparation and prime coating for the finish painting is estimated to be about 45% complete. The contractor is installing the outer steel forms for the outer biological shields. Present plans call for starting the heavy aggregate shield placements the latter part of September with completion in October.

The mechanical subcontractor is building facilities for pipe cleaning at the site. He was requested to start providing x-rays of 10% of the piping welds in accordance with the specifications.

Phase II-A PRTR Contract. The Phase II-A PRTR contractor is approximately 90% complete versus 93% scheduled. He has completed concrete pouring for the pump structure and the piles have been driven in the north wing wall. Upon completion of the south wing wall, the river excavation on the intake channel, which will complete the work under this contract, will be started.

PRTR Stack Addition. The contract bid package for the 150-foot PRTR stack and stack sample facilities was mailed to prospective bidders August 26. The bid opening date is September 16. Contract construction time is 90 calendar days. Estimated cost of the stack addition is $50,000.

PRTR Service Building Extension. The detail design of the service building extension for loop mockup space is estimated to be about 42% complete versus a scheduled 42%. Award of a contract to construct the facility is scheduled for late 1959. The contract will include the building addition for the Critical Reactivity Measuring Facility and the stack filters.

Design Analysis. Subroutines have been written for all calculation steps in the IBM-709 computer program being written for the PRTR primary coolant transient analysis. These subroutines are currently being fitted into the main program. Program checkout is expected to begin in September.

Reactor and Process Piping. Design data and information relating to primary pump isolation valves, moderator reflector pumps check valves, motor-operated steam generator cooling water control valve, and the steam generator, reflector and shield coolant heat exchangers were reviewed during the month.

The steam generator is in the final stages of assembly, testing and cleaning, and an early September shipment is expected. Arrangements were made to have photographs taken of the internal portions of the unit to assist in future maintenance.

Review of inspection data and pickling and autoclaving of the Zircaloy process tubes is continuing. The specifications for procurement of the spare tubes were revised to incorporate the results of tube inspection to date. A purchase requisition has been issued for 30 spare tubes.

Reactor Core Components. Because the strike in the steel industry had interrupted the work at Consolidated Western Steel on the PRTR calandria and top and bottom primary shields, the core components were shipped to other fabricators for completion. The calandria was shipped to the HAPO Minor Construction facilities at White Bluffs, arriving on August 14. Fabrication work on it since that time has been concentrated on repairing leaking components and welds.

The top and bottom primary shields were moved from storage to the National Supply Company where fabrication of these items will be completed under Consolidated Western Steel supervision.

Additional pressure relief area from the moderator system in the form of rupture diaphragms on the large lines between the calandria and heavy water storage tank was provided to cope with the case where a process tube failure ruptured the surrounding shroud tube and released large quantities of steam and water into the moderator vessel. The eight rupture diaphragms can handle the worst credible break in the process channels.

Shielding. The installation of the biological shield inner and outer steel liners has started. Review of the proposed procedure for placing the heavy aggregate concrete indicated that a satisfactory procedure has not been developed by the contractor and that he has little experience in the specialized process of heavy aggregate concreting. A series of questions were submitted to the contractor to aid in developing an adequate procedure.

The thermal shield blocks have all been poured. Most of the blocks shrank to the extent that they are shorter than the drawing tolerances allow. A procedure for repair has been submitted to the fabricator.

Instrumentation and Control. Minneapolis-Honeywell has scheduled inspection and acceptance testing of the automatic controller for September 3. Assuming the equipment proves acceptable, a September shipping date appears likely.

A purchase order has been issued for 150 photomultiplier tubes for the PRTR rupture monitor system. These tubes will be put through a number of tests designed to reject those which have characteristics too different from the norm and to run the tubes through a number of fatigue cycles before their installation in the rupture monitor system. This procedure is necessary to obtain a set of tubes whose outputs can be properly matched when used in the rupture monitor system.

Design is continuing on changes to the PRTR safety and containment system to bring it into accord with ACRS and APED recommendations. Drawings are expected to be issued for comment in early September.

Design changes were initiated to provide for (1) automatic start of the D_2O injection pumps when the level of D_2O in the pressurizer falls to abnormally low levels, and (2) to provide automatic shutoff of the flow of primary coolant to HX-1 whenever temperature of this flow at the outlet of HX-5 exceeds allowable limits.

Fuel Element Examination Facility. The drawings of the control console for the fuel element examination facility have been approved, and a requisition is being processed.

Mosler Safe Company has submitted shop drawings of the cast iron shieldings for approval. The drawings did not incorporate the changes in the wall blocks required to fit the as-built concrete dimensions and were returned for revision unapproved. The drawings of the top blocks and certain of the filler blocks were approved for construction. Since the required changes can be incorporated during machining, the Mosler Safe Company is proceeding with the casting of the blocks in order to meet the required delivery date. Drawings will be submitted for approval prior to final machining.

The design of the primary manipulator has been completed by the W. F. & John Barnes Company. Detailing of components remains to be completed. A trip was made to their plant to review the design prior to submission of the drawings for approval.

The design of the additional shielding required on one corner of the Fuel Element Examination Facility has been completed and the drawing issued for comment.

Load Out Cask. Bid assemblies for the 25-ton cask which will be used to ship irradiated fuel elements to the radiometallurgy facility and separations facilities have been sent to prospective bidders.

PRTR High Pressure Steam Loop (Project CAH-841)

The design criteria document for the loop is being assembled for comment issue. Seven new scope drawings were issued during the month. Three in-reactor test sections are now included in the design criteria. Two are for internally cooled fuel elements; the third is a pressure tube

design. Arrangement of the cleanup system has been revised to permit greater flexibility in handling fuel element ruptures, or for semi-continuous operation with a defected fuel element. Sizing of equipment and general arrangement of the loop and controls are now sufficiently firm to enable transient analyses to be made.

Study of the operating characteristics of the regenerative heat exchanger indicates that a considerably smaller unit will suffice if the maximum fuel element inlet temperature is desired. An electrical heater for this service condition appears feasible and will be the most compact type of unit.

PRP Critical Facility (CAH-842)

Scope has continued throughout the report period. The scope description document for the Critical Reactivity Measuring Facility is essentially completed. The reactor assembly design requirements for structural rigidity and test lattice variation have dictated a design with replaceable inner test lattices rather than a variable lattice. The facility will be scoped with a reactor tank that is capable of receiving an outer ring of "driver" elements and control rods and an inner test lattice, each removable.

The PRTR addition which will house the facility will consist of a shielded well-type structure 10x12x25 feet deep containing the reactor and the fuel element transfer equipment. A control room and work area near the reactor well will be provided on the ground floor addition. Architectural style will be similar to the PRTR Service Building.

Rough draft scoping of the instrumentation and control system of CRMF has been completed. Design criteria for this section is due September 17. Inquiries for an expression of interest has been sent to potential vendors. Possibilities of making a preliminary systems analysis are being examined.

Plutonium Fabrication Pilot Plant

Phase III Construction. Completion of work under the Phase III contract is estimated at 80%, compared with 93% scheduled. Good progress was made during the month with the result that the following rooms have been accepted with a few very minor exceptions:

Room 132	Swage and hood
Room 114	Billet lathe and hood
Rooms 104-106	30 kw vacuum melting furnace
Room 101	Welding shop
Rooms 103-105	Radiography rooms

The ground floor corridors No. 2 and 3 have also been taken over. The corridor doors of Rooms 113, 125, 131, 102, 112, 126 and 138, in which the installation contractor is still working, have been locked and taped. Air balancing and installation of filters in these rooms is in progress.

Room 119, Autoclave system, which was to have been accepted with this group, is being delayed three days because of minor design and fabrication errors. The rupture diaphragm unions were placed in the pipeline in the reverse direction to the actual direction of flow, the flat face asbestos gaskets did not hold (one of them blowing out at 1350 psig), and the pressure recorder controllers were faulty in minor respects. These defects are being rectified rapidly by the contractor. The unions have been cut out of the lines and rewelded, and code tests of the piping have been performed. Flexitallic gaskets have been ordered to replace the flat asbestos gaskets. Corrective work on the pressure recorders has placed one of them in service. No difficulty is expected in obtaining acceptance of Room 119 by September 2.

Room 113 is scheduled for acceptance September 15; Room 138, September 25; and Rooms 125-131, November 1.

Procurement. The sintering furnaces are promised for shipment by truck from Salem, Ohio, on September 11. The control panels will follow in about two weeks. Fabrication of the control panels was delayed by a design change recommended by the vendor and concurred in by project and design personnel here. The contractor can make his schedule provided these dates are closely kept. If further delays occur, the proposed November 1 closing date for the Phase III contract cannot be met.

PRTR Operations

Reactor Functional Tests. Arrangements were completed with CE&U for consultation and review services during the preparation of the design and functional tests for PRTR, scheduled for completion by October 1, 1959. Rough drafts of four tests were completed by month end.

PRTR Handbook. The PRTR Handbook, which includes basic operating and construction data for PRTR, is being printed. It will be issued in early September.

SS Accountability. Accountability requirements for SS materials stored in the PRTR building have been determined, and preparation of procedures has been initiated. Accountability procedures will include control of D_2O as well as the usual SS materials. GE Security has approved a plan to store the initial heavy water shipment in the Central Stores building.

Pre-Startup Activities. Post-criticality startup tests for PRTR were prepared and issued after review for inclusion in the Final Safeguards Analysis. Assistance was rendered Programming Operation in planning Physics Startup Tests. The valve identification system has been applied to 12 PRTR systems. The valves in the remaining four systems will be assigned identification code numbers during the coming month.

Operating procedures for the primary and moderator coolant systems and associated equipment have been prepared for review.

Design liaison continued during the month with review of a number of electrical, mechanical, and instrumentation system drawings.

PRTR Data Processing. A proposed outline of specifications for the Automatic Data System and a description of the desired features of the system were prepared and forwarded to design personnel. Basically, the system as envisioned will consist of 350 points of input, scanning speeds of 200 to 300 points per second, and 20 to 30 points per second readout on punched tape and flexowriter with magnetic tape as an option. Principal functions of the system include data logging, computation, loop control, and off-normal alarm. Also to be included are control features for 20 process variables, 200 alarm comparisons and a computer capable of calculating tube powers and xenon transients.

PRTR Staffing. Staffing plans were completed this month. Five PRTR Technicians reported for training on August 31 for a five-week accelerated training course. Present plans call for the remaining twenty engineering assistants to report for an 11-week training course beginning October 5, 1959.

2. BASIC SWELLING STUDIES

Irradiation Program

Four capsules each containing a precharacterized uranium pellet immersed in NaK have been received for post-irradiation examinations. These non-instrumented capsules with their specimens, GEH-14, 33, 34, 35, 36, were irradiated to gain insight into the effect of irradiation temperature and exposure on the swelling characteristics of unrestrained uranium.

The first temperature controlled capsule containing natural uranium spheres did not perform satisfactorily during bench testing due to a faulty outer seal. The capsule has been modified slightly to avoid future difficulties with the seal and the new components are presently being assembled. The thermocouples and heater, as well as the instrumentation, behaved as expected. Certain improvements for future capsules made themselves obvious during this test, but it is felt that the present design will be satisfactory, for the initial irradiations at the lower temperatures.

Temescal Metallurgical Corporation electron beam melted a five-pound ingot of three percent enriched uranium in an attempt at purification. Spectrochemical analysis of the ingot indicated that considerable improvement was realized with regard to the metallic impurities, but chemical analysis and metallographic examination revealed that the carbon content was about 300 parts per million, which is much higher than desired. It appears, therefore, that this method of purifying uranium is not suitable for purposes of producing high integrity specimens for the swelling program. An alternate scheme presently being examined is to alloy high purity depleted uranium with oralloy by melting in vacuum using extreme care to avoid contamination.

Mechanisms and Theory

Optical and electron microscopy are being used as a direct means for determining the size and distribution of pores in irradiated uranium. Replicas of a wafer section from the specimen irradiated to a burnup of 0.2 a/o and then annealed 100 hours at 880 C has been restudied. Representative micrographs from the center and edge sections have been evaluated by statistical methods. From plots of the percentage of bubbles having various S/d ratios, and from plots of numbers of bubbles versus apparent bubble diameters, the conclusions derived from earlier studies have been verified. Namely, bubbles are smaller in regions of the specimen where irradiation temperatures are lowest; (2) post-irradiation annealing causes bubbles to increase in size, the greatest increase being in regions where the temperature of irradiation was the lowest; (3) the number and size of bubbles varies appreciably within regions as small as 0.1 mm. S is the shadow length of the shadowing material on the negative replica and d is the apparent maximum diameter of the bubble measured on the negative replica at right angles to the shadow.

After annealing 100 hours at 880 C and subsequent cooling at 50 C/hr, the specimen with a burnup of 0.2 a/o appears to have either a second phase or band with a different concentration of fission products associated with the gamma grain boundaries. These regions were characterized by relatively few but very large bubbles, six microns in diameter. The specimen was polished and re-etched several times to establish whether or not these regions were polishing artifacts; in all cases the bands persisted. Similar observations have been made on uranium irradiated to 0.4 a/o which had been annealed at only 700 C for 100 hours. Since the replicas of these specimens may have picked up or extracted enough solid contamination from the regions in which the bands occurred to permit qualitative identification by microautoradiographic techniques, a replica was autoradiographed. Results, however, were inconclusive, in that only general background contamination was present on the replica.

Since distortion of bubbles must occur as a consequence of etching and replication, a specimen with 0.2 a/o burnup annealed at 880 C for 100 hours is being prepared for replication after 10, 20, 40, and 80 minutes of etching. Similar areas in the center and edge will be photographed in the electron microscope and the results will be analyzed statistically.

Investigation of the formation mechanisms of fission gas pores in irradiated uranium has brought about a need for solid surface tension values of uranium in the presence of inert gases at swelling temperatures. The solid surface tension data is to be obtained experimentally by balancing the forces pulling down on a series of fine wires of uranium with the forces of surface tension pulling upward.

High purity three percent enriched uranium was drawn to 0.00105" diameter wire. Short lengths of the wire (approximately one inch) will be suspended in a 600° furnace with weights attached. The weights will be selected to bracket the point at which there will be no extension or

contraction of the wires. The Zirconium II sample holder will contain five wires with uranium weights - one sample at the balance point of surface tension versus weight and others at -10 and -20 percent of this value. Calculations indicate that measurable extensions or contractions of the gage length of the wires should be obtained in 280 hours. The system will be filled with krypton at approximately 20 mm Hg pressure.

The furnace was modified to place two light bulbs inside the system to illuminate the samples when measuring the extension or contraction with an external X-Y micrometer telescope.

A knowledge of the mobilities of rare gas fission products through uranium is important in understanding the mechanisms of pore formation. A literature search on the escape of xenon and krypton from irradiated uranium indicates that inert gas release is a highly surface dependent process, making measurements of the apparent diffusion coefficient very difficult to reproduce from one experiment to the next. At the present time, there is no reliable information on how fast Xe or Kr will migrate into a void or cavity in uranium. A report summarizing the existing data is nearing completion and will be issued shortly.

Diffusion of rare gases in uranium is being studied. In these studies, rare gases are introduced into the uranium surface by electrical flow discharge (sputtering). The amount of xenon deposited in a uranium surface under various experimental conditions is presently being determined. A 3/16" ID x 2" long uranium cylinder was outgassed for one day at 620 C. The inner surface was then subjected to an electrical glow discharge of approximately 4 ma/cm^2, in xenon at a pressure of one millimeter of mercury, for three days at 640 C, and an additional three days at 160 C. Electron and optical microscopy have shown that voids were formed in the redeposited layer on the inner surface of the uranium tube. This layer is presumed to be uranium metal but could conceivably be oxide or some other uranium compound.

3. GAS COOLED POWER REACTOR PROGRAM

Graphite Studies

PRTR Pressurized Gas-Cooled Loop Facility (CAH-822). Design of the Phase "A" (out-of-reactor equipment) portion of the loop by Struthers-Wells Corporation is proceeding according to schedule. Processing of Struthers-Wells questions and approvals continues. Engineering approval and comments have been returned on the valves, heat-exchangers, vacuum pump, and diaphragm compressor. Being reviewed currently is a proposal for the main and emergency motor-generator sets plus auxiliaries. Approval drawings of the primary gas blowers have been received from Bristol-Siddeley Engines, Ltd., of Coventry, England.

Purchasing Operation was requested to secure the services of International General Electric Company for liaison on the Bristol-Siddeley order. Design of the in-reactor test section of the loop was undertaken by the

Mechanical Equipment Development Operation. Some difficulties are being encountered in obtaining the in-reactor tubing to the required dimensions and tolerances, particularly in regard to wall thickness. The connecting components to the in-reactor section are on order.

Graphite Oxidation Studies. The effects of sample geometry on the kinetics of the CO_2-graphite reaction are being studied. The rate of oxidation of hollow cylindrical samples has been compared with solid samples of the same outside dimensions. Surface to volume ratios of the hollow samples is three times that of the solid samples. Linear weight losses on CSF graphite of 1.83×10^{-5} gm/gm-hr and 5.68×10^{-5} gm/gm-hr were determined at 700 C and 750 C, respectively. The rates are greater than those for solid samples by a factor of three. The activation energy is approximately 43 kcal/mole, which is the same as that found for solid cylinders above 750 C. Below 750 C Arrhenius plots of rates on the solid samples showed some curvature.

Four graphite samples in quartz capsules loaded with CO_2 at 200, 300, 400, and 500 psi pressures, respectively, have been prepared and will be maintained at 550 C out of the reactor for six to eight months. Oxidation, dimensional, surface area, and structure changes will be compared with similar in-reactor experiments.

Gamma-Induced Gas-Graphite Studies. Calibration of the 15,000 curie cobalt-60 source was continued, and construction of a closed recirculating glass loop was started. The source intensity is $1.18 \pm 0.03 \times 10^6$ r/hr for a distance of four inches above and below the center line. The intensity decreases to 8.1×10^5 r/hr at nine inches below the center line and eight inches above the center line. All measurements were made with ceric sulfate chemical dosimeters.

The effect of gamma radiation on the CO_2-graphite reaction will be determined in a glass recirculating loop contained in one of the four sample tubes. An all-glass gas pump is being constructed, and a sample heater is being designed.

Microwave Studies. A number of graphite samples have been placed within or downstream from a microwave glow discharge established in either CO_2 at a pressure in the order of 0.1 mm Hg or in helium at a few mm Hg. In all cases the samples lost in the range of 0.1 to 0.3 percent weight after a few hours. At the same time, a sooty deposit, probably amorphous carbon, accumulated on all samples, heaviest on those in the CO_2 glow and much lighter on those exposed in a helium glow. Deposits of carbon suboxide were found on the quartz reactor tube walls downstream from the flow in samples exposed to CO_2.

D. CUSTOMER WORK

Radiometallurgical Examinations

Nickel Plated Elements from PT-IP-207-A (RM-306). Examination of the 0.0005-inch thick nickel plated, C-64 aluminum alloy jacketed, I & E, natural uranium production fuel element which was irradiated to 400 MWD/T as part of PT-IP-207-A, was completed this month. A can wall section from the female end of the slug, where the nickel plate appeared to be sloughing off, showed that the nickel was poorly bonded to the aluminum over approximately one-third of the surface. Intergranular corrosion of the C-64 aluminum alloy jacket, originating at breaks or "pores" in the nickel, was observed in several locations. The maximum penetration noted was 0.025 inch.

Examination of a uranium wafer from the hot spot area showed no effect on the uranium structure. Maximum surface temperatures of the slug probably did not exceed 350 C, but must have persisted for at least 300 to 400 hours to produce the Ni-Al diffusion and AlSi spheroidization observed in the can wall. Based on less data available last month, the maximum surface temperature was stated as 400 C in the previous monthly report.

RM-318 - Direct Cast Core Fuel Elements. Two sections were removed from the badly distorted direct cast core fuel element and examined metallographically. Large grain uranium was found across the entire piece. No obvious cause of the uneven growth pattern has yet been found.

Examination of Internally Ruptured Natural Uranium I & E Fuel Element Clad in X-8001 from Tube 3665 KW (RM-305). Examination work was started on an internally ruptured, natural uranium, X-8001 aluminum clad, I & E fuel element with a 320 MWD/T exposure. The fuel element was visually examined and photographed in the as-received condition. The ruptured area, about 1/6 of the total external area, was missing from the slug. Both ends were cleaned in a 10% nitric acid solution and optically examined for cracks in the weld zone. The male end had one possible suspect area which was checked with penetrating dye. No entry point into the uranium was found.

Metallography Laboratories

Samples Processed During the Month

Total samples processed: 380

Photographs	
Micrographs	398
Macrographs	85
Total	483

F. W. Albaugh

Manager, Reactor and Fuels Research and Development

FW Albaugh:kb

[redacted]

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JE Minor GA Last WE Roake	8/4-5	GE - KAPL, Schenectady	Attend Hi Temp Fuels Committee Meeting	CE Lacy	Yes
JE Minor GA Last	8/6-7	NMI, Concord, Mass.	Consult on Fabrication problems.	HF Sawyer	Yes
GT Geering	8/6	AEC-IOO & Phillips Pet. Co., Idaho Falls, Ida.	Inspect element over-heated in 6x9 loop.	R Neidner	Yes
TK Bierlein	8/6-10	U. of Washington, Seattle, Wn.	Guest interviewee on TV show.	EC Lingafelter	No
AL Bement JC Tobin	8/6	United Electrodynamics, Pasadena, Calif.	Discuss contract.	FB Coker	No
	8/7	Technical Industries, Pasadena, Calif.	Discuss creep capsule.	JC Kyle	No
RE Olson HP Oakes	8/10	Bridgeport Brass Co., Bridgeport, Conn.	Fabrication of zirconium.	J Estes	No
	8/11	Superior Tube Co., Norristown, Pa.	"	H Cooper	No
	8/12	Tube Reducing Corp., Wallington, N. J.	"	H Spittler	No
	8/13	Damascus Tube, Greenville, Pa.	"	B Burd	No
	8/14	Wolverine Tube Co., Allen Park, Mich.	"	E Wright	No
RE Olson	8/17	Spencer Chemical Co., Kansas City, Mo.	Discuss fused uranium oxide.	H Lambertus	No
WV Cummings	8/12-14	Denver Research Inst., U. of Denver, Estes Park, Colo.	Present paper at 8th Annual Conf.-Applications of X-Ray Analysis.	WM Mueller	No
KR Merckx	8/13	UCRL, Livermore, Calif.	Discuss mechanical properties tubing program.	WJ Ramsey	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
RJ Anicetti	8/17	Spencer Chemical Co., Kansas City, Mo.	Discuss fused uranium oxide.	H Lambertus	No
LE Mills	8/17	GE - KAPL, Schenectady	Consult on resistance bonding methods.	J Mylroie J Gerken	Yes
	8/17	GEL, Schenectady	Consult on welding problems.	WI Johnson	No
	8/17	RERL, Schenectady	Discuss welding electrodes.	JD Cobine	No
	8/18	New Rochelle Tool Co., New Rochelle, N.Y.	Discuss rib welding machine.	Mr. Tutburry	No
	8/19	Precision Welder & Flexo-press Co., Cincinnati, O.	Discuss proposal for magnetic force welder.	AW Schueler	No
JC Tobin DC Kaulitz	8/27	AEC-IOO & Phillips Pet. Co., Idaho Falls, Ida.	Discuss installation of irradiation capsules in ETR core.	R Neidner	Yes
CH Bloomster	8/9-16	BMI, Columbus, O.	Discuss fuel element fabrication .	Mr. Dickerson	Yes
		NMI, Boston, Mass.		Mr. Sawyer	"
		Investment Casting, Jersey City, N.J.		Mr. Parris	No
		Arwood Co., New York, N.Y.		Sales Manager	No
HR Gardner	8/12-13	LRL, Livermore, Calif.	Discuss mechanical properties testing program.	WJ Ramsey	Yes
RK Koler	8/27-28	Fernholtz Machinery Co., Los Angeles, Calif.	Observe die casting machine operation.	FW Fernholtz	No
RW Stewart WS Hartnett	8/31-9/3	LASL, Los Alamos, N.M.	Discuss new Pu casting techniques.	J Anderson	Yes
RE Dunn	8/31-9/4	Panellit Inc., Skokie, Ill.	Discuss computers - data processing.	--	No
		GE-ANP, Cincinnati, O.		MC Leverett	"
		Minneapolis-Honneywell, Philadelphia, Pa.		--	"

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JW Helm	8/2-8	GE - APED, San Jose, Calif.	Install H-1 & H-2 experiments in GETR.	ER Craig	No
DR deHalas FD Hobbs	8/19-20	GE - APED, San Jose, Calif.	Salvage H-1 & H-2 experiments in GETR.	ER Craig	No
RL Dillon	8/6-8	US-AEC, Washington, DC	Consult on overseas corrosion meeting.	--	No
HP Oakes	8/25	Wolverine Tube, Decatur, Ala.	Fabrication of zirconium.	EA Wright	No
	8/27	Wolverine Tube, Allen Park, Mich.	"	EA Wright	No
RC Aungst	8/17	Allegheny Ludlum, Dunkirk, N.Y.	"	J Cummings	No
	8/18	Budd Co., Philadelphia, Pa.	"	W Dickhurt	"
	8/19	Chase Brass & Copper, Waterbury, Conn.	"	DK Crampton	"
	8/20	Aerojet General, Azusa, Calif.	"	L Zernow	"
	8/21	Harvey Aluminum, Torrance, Calif.	"	W Rotsell	"
WK Winegardner	8/17-19	Willamette Iron & Steel, Portland, Ore.	Fabrication of PRTR fueling vehicle.	L Hallmark A Kitchen	No
DJ Foley	8/10	Olympic Welding Co., Pacific Car & Foundry, Seattle, Wn.	Fabrication of PRTR rotating shield & B shield liner.	W Rehmke R LeBlanc	No "
DP Schively JF Fletcher	8/3	Struthers-Wells, Warren, Pa.	Discuss gas loop procurement.	AM Mitchell	No
		Union Carbide, Oak Ridge, Tenn.	"	J Zasler	Yes
WS Kelly	8/24-25	W.F. & John Barnes Co., Rockford, Ill.	Review fuel exam. facility manipulator design.	J Ross	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JM Batch ME Shockley	8/17-18	Bingham Pump Co., Portland, Ore.	Consult on high pressure pump	Mr. Rayner	No
KG Toyoda	8/8-15	Struthers-Wells, Warren, Pa. Hammel-Dahl, Providence, R.I. Fisher-Governor, Marshalltown, Iowa Annin Valve, Los Angeles, Calif.	Discuss valve fabrication, pressure vessels & pre-heaters.	J Fanaritis J Curran RA Engel D Annin	No " " "
RM Fryar	8/7-12	Consolidated Western Steel, Los Angeles, Calif.	Vendor discussions on PRTR	L Klein	No
MR Kreiter	8/4-12	"	Liaison on PRTR calandria and shields.	M Ward	No

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
LR Weissert EJ Silk	8/26-27	Babcock & Wilcox Lynchburg, Va.	Discuss techniques for handling & fabricating Pu oxide & swaging of ceramic fuels and results of irradiation tests.	FW Albaugh OJ Wick WE Roake RJ Anicetti DR Stenquist	Yes	300; 328,326, 325
LA Sundquist J Zorn	8/6	The Martin Co., Baltimore, Md.	Fabrication & irradiation testing of PRTR fuel elements.	JJ Cadwell EA Evans	No	300; 326,325
RH Anderson	8/7	ARVA, Seattle, Wn.	Discuss installation of datex analog to digital translator.	LJ Chockie	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
B Murtha	8/14	Combustion Eng'g. Corp., Hartford, Conn.	Discuss UO_2 fuel program.	JJ Cadwell EA Evans	No	300;326,325
DS Billington	8/28	ORNL, Oak Ridge, Tenn.	Discuss fuel element development.	JJ Cadwell	Yes	300, 326
RE Burian JE Gates	8/31	BMI, Columbus, O.	Discuss examination of irradiated fuel elements.	JJ Cadwell JE Minor	Yes	300, 326
B Weidenbaum T Slozack J Cleveland	8/31	Vallecitos Atomic Lab., Pleasanton, Calif.	Fuel element discussions.	JJ Cadwell EA Evans	No	300, 326
JC Kyle H Potter	8/31	Tech. Industries, Inc., Pasadena, Calif.	Discuss in-reactor creep programs.	JJ Cadwell JE Minor JC Tobin	No	300, 326
J Bryan J Bowerbank O Mohl P Naillon J Bell	8/3-6 8/3-4 8/12-14 8/25-31 8/25-28	LRL, Livermore, Calif.	Discuss fabrication problems.	RW Stewart OJ Wick	Yes	200W; 2704Z, 231Z
CC Wagoner WA Webb	8/20-21 "	Carolinas-Virginia Power, Pittsburgh, Pa. Westinghouse, Pittsburgh, Pa.	Inspect component testing facilities.	WK Winegardner WA Burns H Harty et al	No	300; 314, 309
ARF Day EE Lindros	8/3-4, 25-26 8/25-26	Byron Jackson Pump Co., Los Angeles, Calif.	Engineering consultation & pump repair.	PA Scott	No	300, 314
JC Griess	8/17-18	ORNL, Oak Ridge, Tenn.	Discuss Al corrosion.	JA Ayres et al	Yes	100K, 1704; 300, 328
G Oxx	8/25	GERL, Schenectady	"	FW Woodfield JW Riches PJ Pankaskie	Yes	300, 328

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

AUGUST 1959

FISSIONABLE MATERIALS - 2000 PROGRAM

FUELS

Nuclear Safety for Fuels Preparation Department

Ten "J" slugs (U^{235}-Al alloy fuel elements) have been rolled into flat sheets 8" x 5" x 1/8" for test purposes. The nuclear safety of these sheets in the vapor blasting hood was considered. Since the ten sheets contained less than 400 g. U^{235}, criticality was not a problem.

The FPD nuclear safety specification(1) requiring that 0.96 percent enriched fuel elements be encased in 1/8" (minimum) iron tubes in order to be considered critically safe in all arrays was revised to permit the use of 12 gauge (0.109") iron tubes. According to the original evaluation of the use of iron cladding for poisoning fuel element arrays(2), which is a correlation of theoretical calculations supported by experimental data, the criticality parameters in question compare as follows:

Iron Clad Thickness	k_∞	B^2
0.125" (present limit)	0.875	-4000×10^{-6} cm^{-2}
0.100" (proposed limit)	0.92	-2200×10^{-6} cm^{-2}
0.060" (critical)*	1.00	-0-

* Maximum thickness that could permit criticality (water reflected system at optimum H/U ratio)

On the basis of this information, approval was given for the "all-safe" iron cladding limit to be changed to 0.100" (minimum).

---

(1) "Nuclear Safety Specifications - Fuel Element Manufacturing Processes," HW-47013, Dec. 10, 1956.

(2) N. Ketzlach, "Nuclear Safety of Iron-Encased Fuel Elements," HW-56423, June 17, 1958.

DECLASSIFIED

[redacted]

DECLASSIFIED

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION REACTORS

Neutron Temperature Study

The data obtained from cadmium-ratio measurements of several elements have been analyzed. The irradiations were carried out on the foil rotator of the internal thermal column of the TTR. These ratios are summarized in Table I.

TABLE I

Cadmium Ratios

Element	Thickness (mg/cm^2)	Ratio[a]	r Value
Au	47	3.52	0.056
Mn	40	16.4	0.059
Cu	225	19.6	0.064
U^{235}	0.40	31.6	0.058
Pu^{239}	0.40	45.2	0.011
Lu^{175}	5.4	2.7[b]	-----
Lu^{176}	0.14	214 ± 70[b]	-----

[a] All ratios are ± 5 percent unless otherwise specified.

[b] These values include a correction for differences in the power level of the TTR. This difference was not known to be present when the values were reported last month.

Also included in Table 1 are the r parameters calculated from the observed cadmium ratios. This parameter is defined by C. H. Westcott[1] and is proportional to the ratio of epithermal to thermal neutrons. It should be independent of the foils used to measure it. This is true for all but the plutonium measurements. No explanation for this discrepancy can be given at this time. Values are not listed for the lutecium foils since the available parameters[1] necessary for the calculations assume all the resonances to be in Lu^{176}. The cadmium ratios for the lutecium isotopes indicate that this assumption is not valid.

Ratios of the activity of Lu^{177} to that of Lu^{176m} have been obtained in the thermal column of the TTR. They have been measured as a function of the temperature of the thermal column for temperatures between 23°C and 581°C. The ratios were compared to the plutonium-uranium ratios at the same temperatures. For this comparison the curve obtained with the lutecium foils has been normalized to the curve for the plutonium and uranium foils at 20°C. The "lutecium thermometer" is about 6 times as sensitive as the Pu^{239}-U^{235} thermometer at room temperature and remains more sensitive up to about 400°C.

[1] C. H. Westcott, CRRP-787.

[redacted]

Copper foils were irradiated along with the Lu foils. A comparison of the activities resulting from Lu^{175} and the copper activities indicates that the thermal cross section of Lu^{175} varies in the same manner as the thermal cross section of copper, i.e., Lu^{175} has a 1/v cross section in the thermal region.

The missing units necessary for reactivation of the beta spectrometer are being fabricated and should be ready next month for investigating the beta decay of lutecium. Checking of the instrumentation has continued through the month and is about finished.

Neutron Temperature Coefficients

A nuclear data tape containing cross-section information for 17 isotopes has been generated. Coding of the up-dating and correcting program is about 50 percent completed. The up-dating program will generate up to 10 macroscopic cross-section records from microscopic cross sections with just one reading of the nuclear data tape.

The effect of energy-independent absorption on the neutron temperature was studied by the variational procedure described in the July monthly report. It was found that the ratio of neutron to moderator temperature is nearly the same as in the case of 1/v absorption, provided $\Sigma_a(kT)/\xi\Sigma_s \lesssim 0.2$. This indicates that, to a first approximation, the effective neutron temperature can be found by replacing Σ_a by $\Sigma_a + DB^2$, where B^2 is the local buckling when the flux is position dependent, and D is the constant diffusion coefficient.

Thermal Neutron Flux Spectrum Near a Temperature Discontinuity

The objectives and some features of the general layout of future experiments on graphite and H_2O rethermalization cross sections have been discussed and written down. The succeeding phases would entail neutron absorbing cylinders also.

The modified version of the F_3 code is still running improperly. Calculated reactivities are about 3 mk below those given by the unmodified program. Some changes have been made in the program and another debug run will be made shortly.

A comparison at one temperature ratio has previously been made between the exact solution to the temperature discontinuity problem in the plane case and two approximations to this solution: a) the effective neutron temperature approximation, and b) the Selengut two-thermal-group method. To facilitate further comparisons, a program has been written to evaluate these approximations at arbitrary temperature ratios. This program has just been tested successfully.

Neutron Thermalization Theory

Effect of Absorbing Cylinder on Thermal Neutron Flux Spectrum

Investigation still continues on the effect of an absorbing rod on the thermal neutron flux in an infinite, nonabsorbing moderator. A 709 subroutine has been completed which evaluates the coefficients of the analytic solution under the assumption that the reciprocal of the rod blackness varies linearly with energy. The main program for calculating the flux, effective temperature, and neutron density is being debugged. Preliminary hand calculations of flux and effective

DECLASSIFIED

temperature have been made for a rod with thermal absorption approximating that of a standard Hanford slug. Results for this case show that, at the surface of the rod, the effective temperature of the outgoing current is about 45°C higher than the 300°C temperature of the incoming Maxwellian current. Further calculations will be made as soon as the main program is operating.

Instrumentation

The stack gas effluent monitor at 100-F remains in good stable operation. The instrument remains adjusted to count, by pulse-height analysis, the I^{131} photopeak of 364 Kev. If desired, the photopeak contribution of other radioisotopes can be obtained by instrument adjustment. Instrument technicians at the 105-F Building are now changing charts, checking instrument operation twice daily, and will inform us if general repairs seem required or if a fuel element rupture has occurred.

Two-color temperature measurement in the range 500°C to 1000°C is being studied for possible application to reactor graphite temperature measurement. Lead sulphide cells are being used to provide a signal which can be analyzed by the Shawmeter. The Shawmeter provides two-color temperature measurement above 1000°C. A slight modification of its circuit is being tested which will permit insertion of a signal from the lead sulphide cell. The Radiation Reference Standard was received and is being used as a source for this work.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Exponential Pile Measurements of Large Diameter Fuel Elements

Material buckling measurements have been completed on several lattices using tube and tube, and tube and rod fuel elements. Final buckling values along with other pertinent information are given in Table I:

TABLE I

Fuel Element	Lattice Spacing	Buckling ($10^{-6}cm^{-2}$)	Side-Side λ (inches)	Volume Ratios A/U	H_2O/U	C/U
2.5 x 2.0 with 1.66x1.1	12 3/8 wet	-72	1.47	0.493	1.102	49.31
2.5 x 2.0 with 1.66 x 1.1	12 3/8 dry	+104	1.50	0.493	-	49.31
2.5 x 2.0 with 1.66x 1.1	10 3/8 dry	+76	1.85	0.493	-	33.86
2.5 x 1.6 with 1.17 solid	14 9/16 dry	+65	2.22	0.305	-	51.25

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

[redacted]

Two new series of buckling measurements have been started. One series uses a 2.5" x 1.6" tube as an I and E fuel element; the other uses a 2.5" x 1.6" tube with a 0.5" rod. Preliminary results are available for the I and E fuel element and are shown in Table II:

TABLE II

Fuel Element	Lattice Spacing	Buckling (10^{-6} cm^{-2})	Volume Ratios A/U	H_2O/U	C/U
2.5 x 1.6	14 9/16 dry	+ 71	0.373	-	70.44

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

There was an error in the Monthly Report for July in Table III. The fuel element listed should have been the 2.5 x 1.6 solid tube with a 1.17 rod instead of the 2.5 x 2.0 with 1.17 solid tube and rod.

Study is continuing on the problem of determining the correct extrapolation length. Measurements of the thermal and epi-thermal extrapolation distances have been made in two exponential piles, and these horizontal traverses are now being analyzed.

Full Scale PCTR

Further work was done during the month on the critical mass estimate for the Full Scale PCTR. The work will be completed as soon as authorization for the Full Scale PCTR is obtained from Washington.

Computational Programming Services

The scheme for expanding the 709 memory for FORTRAN programs by utilizing tape units for storage of instructions has operated successfully with a moderately complex test program. A report on this scheme is being written. The BKL and COFIT programs are operating properly and are in the process of being turned over to Data Processing for routine handling. A program has been written for Critical Mass Physics for use in the analysis of results obtained in recent approach-to-critical experiments. This program appears to operate satisfactorily, though in some cases it yields non-unique results. The reason for this deficiency is being sought.

Instrumentation

A proposal was submitted, at the request of the Instrument Design Operation of CE and UO, for a proposal to develop demonstration prototypes of radiation protection instrumentation for the 105-N Building. Most of this work consists of adaptation of previous development-prototype instruments to the specific needs of the NPR project. Some consists of new development studies. Included in the proposal are area monitors, underwater monitors, airborne particulate matter monitors, and effluent gas and water monitors.

DECLASSIFIED

Verbal agreement has been received from representatives of the IPD NPR Project Operation and Research and Engineering Operation to finance development of the proposed dual system Fuel Failure Monitor for possible NPR application. This system consists of a fast-scan gross-gamma activity monitor and a higher sensitivity slow-scan gamma-energy monitor. Analytical investigations are underway preparatory to development of the prototype system hardware.

Discussions were carried on with members of IPD to review the present thinking concerning the need for automatic reactor controllers. There appears to be support in favor of investigating the characteristics which a controller must have in order to perform adequately.

Mechanism of Graphite Damage

Two runs out of four yielded fruitful results in measuring the expansion of Kendall coke graphite irradiated with 80 microamperes of 1.5-Mev electrons from the Van de Graaff accelerator. The good runs which lasted 242 minutes and 1235 minutes showed approximate linearity between expansion and exposure and gave an expansion coefficient of about $1.3 \times 10^{-6}\%$ per microampere minute.

The drift of the calorimetric system was measured to be 36.6 microvolts per milliwatt power input. At present the possible causes of existing drifts of the order of one microvolt are being investigated to try to work down toward a few millimicrovolts, the actual noise level of the detection system. For Co^{60} the present detectability is 2 millicuries.

STUDIES RELATED TO SEPARATIONS PLANTS

Criticality Instrumentation Meeting

An AEC-sponsored classified meeting on criticality instrumentation was held at Hanford on August 17 and 18. PIRDO was the host for this meeting. The purposes of the meeting were:

a. To review types of criticality control and/or alarm instrumentation at each site, their problems, shortcomings and potential obsolescence;

b. To discuss instrumentation in the area of approaching criticality; and

c. To consider for material balance purposes, the feasibility of devising instruments to detect the buildup of plutonium and enriched uranium bearing residues in process systems.

A total of twenty-one persons attended this meeting from off-site; attendance was divided between criticality experts and instrumentation specialists from the various sites.

[redacted]

Critical Hazards Specifications

Nuclear Safety for Hanford Laboratories

An inquiry was received from the Plutonium Metallurgy Operation concerning a casting operation involving 3.2 Kg of plutonium; an array of ten 250 gm rods were to be cast in a graphite mold. This operation was deemed critically safe on the basis that a) the system was isolated from other plutonium, b) water flooding would not occur, and c) the carbon to plutonium molar ratio in the mold would be less than 500.

The handling of 4% U^{235} fuel elements in an autoclave was reviewed for the Corrosion and Coatings Operation. The amount of U^{235} in the elements to be processed was less than 400 g., so the system is critically safe.

Nuclear Safety in 234-5 Building Processing

At the request of CPD, the nuclear safety of two sizes of plutonium hemispherical shells in arrays of 2, 4, 6, and 44 were evaluated to provide a basis for designing plutonium shell processing and storage hoods for the RMC line. The sizes of the shells being considered for fabrication are:

	Maximum O.D. (in.)	Maximum Wall Thickness (in.)	Maximum Mass (kg.)
Hemi-Shell A	7.6	0.14	4.5
Hemi-Shell B	9.5	0.10	6.6

These shells would be cast in graphite molds 0.3" thick on the inside and 1-1/8" thick on the outside.

From this evaluation it was found that the following arrays of shells A or B are critically safe:

a) Two hemi-shells on 14" centers (bare or in graphite molds)
b) Four hemi-shells on 21" centers (bare or in graphite molds)
c) Six hemi-shells on 24" centers (bare or in graphite molds)
d) Forty-four hemi-shells on 30" centers (bare)

The main stipulations on these arrays are that no reflector or moderator be inside the shells other than the 0.3" of graphite in the mold and that the size and shape of the shells be as specified above.

Plutonium Critical Mass Facility

The construction schedule calls for 16 percent completion of the Critical Mass Facility as of this time; actual construction is now 24 percent complete. The contractor has been having difficulty in obtaining corrosion tested stainless steel. Because of this, the AEC has made available to the contractor stainless steel through G-E or J. A. Jones stock.

DECLASSIFIED

Design is continuing on the reactor components for the critical experiments.

Criticality Studies in Support of Processing Power Reactor Fuels

Heterogeneous Systems

The smallest fuel rods which were used in the criticality studies in support of processing power reactor fuels were 0.300 inch in diameter. In order to determine the minimal critical mass for the 3 percent enriched uranium and to establish the maximum buckling, measurements were required with a smaller rod diameter. Smaller fuel rods were obtained by swaging the 0.300-inch rods. This work was accomplished by personnel of Critical Mass Physics using the swaging machine of Physical Metallurgy. The swaging was completed this month. Before swaging, each rod was 0.300 inch in diameter and 8 inches in length; after swaging, the diameter was 0.175 inch, and the length 23 1/2 inches. A total of 1,000 of the smaller fuel rods were obtained; the time required to swage this number was about 50 hours.

The critical approach experiments with the 0.175 inch diameter rods are being delayed because an off-site vendor has experienced difficulties in placing end caps in the lucite tubes for the fuel rods.

Exponential experiments were conducted with 3 percent enriched 0.600-inch diameter rods. The buckling was remeasured for three lattices with fuel rod configurations which differed from those previously used in an effort to reduce the error in the buckling from the exponential experiments. The measurements were done in connection with the evaluation of extrapolation lengths by equating critical bucklings from the exponential pile measurements with those obtained from critical approach measurements. The 1.0, 1.2, and 1.6 inch lattices were chosen since these showed the most variation in the calculation of extrapolation lengths. The values of the bucklings from these re-runs are compared with previous measurements in the following table:

Lattice Spacing (inches)	H_2O/U (Vol)	λ(BNL) (cm)	B^2(rerun) ($cm^{-2} \times 10^{-6}$)	B^2(previous) ($cm^{-2} \times 10^{-6}$)
1.0	2.06	7.08	13,293	13,453
1.2	3.41	6.62	14,251	14,033
1.6	6.84	6.50	9,496	9,507

The current measurements do not show a consistent variation from previous measurements and thus do not result in improved values for the extrapolation lengths.

The calculations of extrapolation lengths, λ , by equating the buckling from the critical approach measurements for the 16 and 32 inch cylinder heights and the exponential measurements were completed for the 0.300 and 0.600 inch diameter rods. Errors were estimated for each calculation of the extrapolation length and a weighted average of λ obtained. The values of the extrapolation lengths are summarized in the following tables.

[redacted]

0.300" Dia. - 3.1% Enriched Uranium

Lattice Spacing (inches)	H_2O/U (Vol)	λ $B_{16CA}=B_{exp}$	λ $B_{32CA}=B_{exp}$	$B_{16CA}=B_{32CA}$	λ	λ weighted	BNL λ
0.6	3.41	6.50 cm	6.50 cm	6.61 cm	6.54 cm	6.51 cm	6.62 cm
0.7	5.00	6.07	6.30	5.54	5.97	6.05	--
0.8	6.84	6.20	5.85	6.78	6.27	6.17	--
0.9	8.92	5.93	5.89	6.10	5.97	5.94	--
0.600" Dia. - 3.1% Enriched Uranium							
1.00	2.06	6.30 cm	5.96 cm	7.11 cm	6.46 cm	6.16 cm	7.08 cm
1.10	2.71	6.50	6.60	6.28	6.46	6.52	6.76
1.20	3.41	5.82	5.60	6.31	5.91	5.77	6.62
1.30	4.18	6.18	5.94	6.63	6.25	6.13	6.54
1.42	5.18	5.84	5.93	5.54	5.77	5.86	--
1.60	6.84	5.44	5.56	4.80	5.27	5.46	--

The error in the weighted average is about ± 0.2 cm.

Values of the extrapolation length obtained from the above type analysis are slightly less than those predicted from the BNL data in which the uranium enrichments were in the range of 1-1.3 percent.

Homogeneous Systems

Preparations have been made for k_∞ measurements at H/U atomic ratios of 30, 35, and 40. From calculations, the value of k_∞ is expected to become unity in the range of H/U = 35 - 50. Two sets of experiments will be conducted (H/U = 30, 35, 40, and H/U = 45, 50, 55) to determine the "cross over" point.

Preparations have been made to conduct exponential measurements in 3% enriched UO_3 polyethylene moderated systems at H/U atomic ratios of 6, 12, and 18. A lucite cylinder (12" diameter by 32" high) will be used for containment.

Miscellaneous Experiments for Nuclear Safety Specifications

Values of k_∞ have been obtained at the ORNL Critical Experiments Facility for 2 percent enriched UF_4 paraffin moderated at an H/U-235 atomic ratio of 195.

Using a one-group model for the critical equation, the value of k_∞ was 1.200 ± 0.011; when based on a two-group model, the value of k_∞ was 1.202 ± 0.012.

These values are to be compared with k_∞ measurements conducted in the PCTR in January 1959 with this same material. The value of k_∞ from the PCTR experiments is 1.208 ± 0.013 if 2200 meter/second cross-section values are used; and 1.216 ± 0.013 if "effective" cross-section values, obtained by averaging the cross sections over the Wigner-Wilkens spectrum for a similar mixture, are used. Both the latter numbers contain an error of ± 0.008 which was added because of a discrepancy between the two methods.

DECLASSIFIED

DECLASSIFIED

The PCTR results are thus in good agreement with the value of k_∞ obtained from critical experiments. This is perhaps the best check on the PCTR results to date. The intercomparison is particularly gratifying since further credence may be placed in both the method and reliability of the PCTR measurements.

Criticality Calculations for Correlating Theory with Experimental Data

A preliminary basis has been established for evaluating critical mass problems associated with the fabrication of plutonium shells in HLO and CPD. An expression has been derived for determining the critical buckling of a spherical shell. Using the boundary conditions that the flux is zero at the outer shell boundary and that the derivative is zero at the inner boundary, we have:

$$\tan Ka = \frac{Ka + \tan Kb}{1 - Ka \tan Kb}$$

where K = square root of buckling

a = inside radius of sphere

b = outside radius of sphere

(including the extrapolation length)

From this expression, the critical mass versus shell diameter relationship was calculated for uranium. This curve is confirmed reasonably well by an experimental point from UCRL at Livermore (for a 7.1-inch diameter oralloy shell)(1). Consequently, the formula will be used as a preliminary basis for critical mass problems involving plutonium shells.

The following variational estimates were made for the geometrical buckling of spherical and cylindrical shells:

$$B^2_{\text{spherical shell}} = \frac{1}{t^2} \frac{84 + 210 \left(\frac{a}{t}\right) + 140 \left(\frac{a}{t}\right)^2}{8 + 35 \left(\frac{a}{t}\right) + 56 \left(\frac{a}{t}\right)^2}$$

$$B^2_{\text{cylindrical shell}} = \frac{1}{t^2} \frac{30 + 40 \left(\frac{a}{t}\right)}{5 + 16 \left(\frac{a}{t}\right)}$$

where a is the inner radius and t is the shell thickness. Comparison with the exact solution, which can be calculated directly for $a \rightarrow o$ and $a \rightarrow \infty$, show an error in B^2 of slightly over 6% and 1% for the sphere, and 4% and 1% for the cylindrical shell.

---

(1) James Carothers, private communication.

A two-group, two-region analysis of the 3 percent heterogeneous uranium and water systems has been started in order to correlate experiment and theory. The calculated critical radius of the systems will be compared to the experimental critical approach values. The critical equation has been programmed for IBM-709 and is in the process of being debugged.

Mass Spectrometry

The testing and alignment of the mass spectrometer has proceeded satisfactorily. Several fabrication errors have been corrected and the machine is now being operated at the designed magnetic field and accelerating potential. An electron multiplier for increased ion detection sensitivity has now been installed and a beam of uranium ions has been detected. The alignment of the ion beam is in progress and the characteristics of single filament source operation are being studied.

Critical Mass Theory

Debugging continues of the program for integration of the reactor kinetics equations with N groups of delayed neutrons and time dependent reactivity. Although several errors have been located and corrected, the program continues to give divergent results. The locations of the remaining difficulties are still being sought.

NEUTRON CROSS SECTION PROGRAM

Three Axis Spectrometer

A technique for investigating the neutron reflectivity of single crystals has been developed and applied to several crystal samples. Two nearly perfect calcite crystals are being used in anti-parallel reflection to obtain a high resolution monochromatic neutron beam which has a very small angular divergence. For most of the crystals to be examined this beam serves effectively as a delta function in neutron energy and angle thereby making it possible to determine in detail the neutron reflectivity of the crystal being tested as a function of neutron angle and energy.

Using 0.09 ev energy incident neutrons, preliminary measurements have been made of the characteristics of the beryllium and lead crystals which were used for monochromators in the previously reported water scattering measurements. Both crystals were found to have multiple crystal structure. However, the high intensity lattice planes in the beryllium and lead crystals can be approximately characterized by peak reflectivities of about 15 percent and 10 percent efficiencies and mosaic half widths of about 0.75° and 0.08° respectively. The reflectivities of six sodium chloride crystals were also measured at 0.09 ev. All of these crystals were multiple and seemed to consist of two or more crystallites separated by angles of 0.05° to 5.0°. Generally these crystallites were observed to have mosaic half widths of about 0.05° and maximum reflectivities of about 5 percent.

Measurements are presently in progress on some aluminum single crystals. Crystal reflectivities have been obtained on one aluminum sample at several incident neutron energies. In a Laue diffraction this sample has a peak reflectivity of

DECLASSIFIED

about 30 percent with a crystal angular half width of about 0.14° at 0.035 ev and 0.09 ev incident neutron energy. This crystal width is not a measure of mosaic because the crystal shows evidence of being multiple. At 0.3 ev incident energy the peak reflectivity drops to about 15 percent. The results of these measurements on aluminum are encouraging as evidence that the neutron intensity of the three axis spectrometer can be significantly improved by proper selection of monochromating crystals.

Subthreshold Fission

Measurements have been made on the Pu^{240} fission cross section at low neutron energies using the 99.75 percent Pu^{240} sample. Measurements were made at the energies of the peaks of the low energy fission resonances of Pu^{239} and Pu^{241}. These measurements were used to evaluate the isotopic content of Pu^{239} and Pu^{241} in the sample. The measured isotopic contents are significantly different from the reported values. Two extended measurements at a neutron energy of 0.1 ev were internally inconsistent and must be repeated.

Pu^{241} Fission Cross Section

The data obtained on the Pu^{241} fission cross section from 0.1 ev to 20 ev have been compiled and tabulated and are available for distribution.

Fast Neutron Cross Sections

The gain stability of a 6810 photomultiplier has been studied under conditions appropriate to its use with the chronotron. Side-channel selection will be essential if the gain needs to be stable to better than 5 percent.

Neutrons from a Be target in the Van de Graaff were used to evaluate the current status of the fast time-of-flight system. The accelerator is severely misaligned and rather unstable. This misalignment is a major cause of the high background observed, which occurs principally as photons. The chronotron-analyzer combination is working marginally, and needs additional work to improve reliability. In its present form it appears to be usable down to a bias of about 1/4 Mev without cooling of the photomultiplier, but a neutron group near threshold undergoes a time-displacement of the order of 10 millimicroseconds. Plans for attacking these problems are not yet completed.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Lattice Parameters for Low Exposure Plutonium

The 1.8 w/o Pu-Al fuel has been received from Plutonium Metallurgy, together with the monitor foils of the same material. The first set of experiments, k_∞ and f in graphite, is awaiting reactor time.

Lattice Parameters for High Exposure Pu-Al Fuels

Three batches of plutonium nitrate, 425 gms ± 25 gms each batch, having an isotopic content of 21.7% Pu^{240}, will be shipped to Hanford from Oak Ridge for

fabrication into fuel elements for PCTR measurements. Arrival date has not been established as yet.

PRTR Startup Experiments

A rough draft of a letter which would be a guide to further planning efforts and to the evaluation of safeguard procedures for the startup of the PRTR was prepared.

Discussions of experiments pertaining to post-startup tests were held. From these discussions a list of post-startup tests for the PRTR was developed.

The Reactivity Measurement Facility

The scope design of the RMF has continued through the month with more attention being paid to the details. As the design progresses the facility appears to be a more versatile instrument than an RMF. For this reason the facility will henceforth be known as the Critical Facility of the Plutonium Recycle Program.

Instrumentation

Fabrication of a unit for determining the sine wave response of lenses was completed. The unit was used to determine the quality of five lenses of the type to be used in the wide angle viewer. There is still some difficulty with noise. Noise signals interfere with getting accurate measurements on the higher frequency patterns where the lens response is low. It is believed that the noise signals originate in the light source.

The analysis of the non-linearity of the Profilometer diameter measuring unit was continued. It was found that the unit will operate with less than 0.001 inch deviation from linearity by proper positioning of the components, even when allowance is made for standard machine shop tolerances.

Plans proceeded on an extensive evaluation project concerning 150 multiplier phototubes and associated NaI crystals to be used for fuel element rupture detection for the PRTR. Eighty-seven phototubes are to be selected on the basis of low-noise, high-gain, stability, and good resolution. Because of exceedingly stringent time requirements, only tests considered to be absolutely essential to correct operation will be performed.

Investigation was made and instrumentation recommended for detecting and measuring the rate of release of fission activity from a deliberately defected PRTR type oxide fuel element during irradiation in the MTR GEH-4 loop. The installed rupture monitor was designed for high sensitivity to detect unintended failures. In the series of defected element tests planned by the Ceramic Fuels Operation it would go off-scale and not yield the desired information. A simple, but reliable method of current-meter monitoring of the gross d-c phototube anode signal current was recommended. Previous experience with this type of monitoring has proved its reliability and linearity over the expected range of radiation intensities. This addition can be made to the installed high sensitivity gamma spectrometer monitor without jeopardizing its operation.

DECLASSIFIED

GAS COOLED REACTOR PROGRAM

Lattice Parameter Measurements

The analysis of the metal temperature coefficient data obtained in the Allis Chalmers-Kaiser Engineers, 8-inch, graphite lattice is about 50 percent complete. One heating run with a 5/16-inch thick, cylindrical layer of lampblack insulation surrounding the 7-rod enriched uranium oxide cluster yields a PCTR reactivity loss of 2.206 cents for a maximum fuel temperature change of 466° C. Nevertheless at this point in the data analysis the reactivity loss does not appear to be truly a linear function of the change in fuel temperature. If we tentatively neglect this nonlinearity a straight line fit to the data yields a value of

$$\frac{1}{P}\frac{\Delta P}{\Delta T} = \frac{1}{k_\infty}\frac{\Delta k_\infty}{\Delta T} = -2.9 \times 10^{-5}/^\circ C$$

over the temperature range 50° to 516°C. An 18 to 20 percent uncertainty on this quoted coefficient is dictated by the results of a second heating run with all the insulation removed. A value of $-3.4 \times 10^{-5}/^\circ C$, over the temperate range 31° to 421° C, is obtained from a linear fit to this data. Even though there is ultimately a very pronounced increase ($\sim$23° C) in the adjacent moderator temperature when the insulation is removed, it is difficult to assign more than a small portion of the difference between the two values to moderator heating effects since the major change in reactivity occurs before the surrounding graphite is appreciably heated.

In order to resolve this large difference in resulting coefficients, additional heating runs must be analyzed and, if possible, an evaluation must be made of the spectral change, if any, due to moderator removal when the insulating graphite is taken out.

Variation of Doppler Coefficient with S/M Ratio

In-reactor measurements for determining k_∞ and f for a 1.92" diameter solid natural uranium fuel rod in a square 8 3/8" graphite lattice have just been completed. These measurements were made with air coolant and H_2O coolant. No analysis has been done on these data yet.

Several interesting and useful experimental techniques were inaugurated during these measurements.

a. Simultaneous BF_3 cadmium ratio measurements along the core axis. Two traversing assemblies were installed, one in the "one-up" hole and one in the "one-down" hole. An enriched and a normal BF_3 tube were intercalibrated and the enriched tube covered with a 0.040" thick cadmium sleeve. No shadowing effects were discernible from interaction between the cadmium sleeve and the bare BF_3 tube. With an enrichment factor of $\sim$5, simultaneous CdR's could be obtained at points along the core, to establish the effects of leveling ring position on longitudinal flux flattening. Complete traverses could be obtained in about one hour.

b. Unloading the central cell pieces through the large access hole in the moving face. This approach allowed more immediate removal of irradiated foils following high level irradiations (~1 - 2000 wattminutes), with greatly reduced radiation exposures to personnel. The radiation exposure reduction is conservatively estimated at a factor of ten. Some coordination among experiments in designing equipment will be necessary to best utilize this facility.

Theoretical PCTR Studies

The off-site lattice sum of K_0 functions required for the small source theory formulation of a critical condition for an infinite array of superlattices has been evaluated for a rectangular lattice. Extension to the hexagonal array is currently being accomplished.

Efficient methods of programming the general formulation on the 709 are being studied. Subroutines for evaluating on-site and off-site lattice sums for a square lattice are being debugged.

TEST REACTOR OPERATIONS

Operation of the PCTR continued routinely during the month. There were four unscheduled shutdowns caused by electronic failure.

K_∞ measurements were completed on 1.92 inch diameter natural uranium slugs in an 8 3/8-inch lattice.

The extended outage for providing a test cell charging port was completed on schedule. Before the experimental work was begun, a series of reproducibility check runs was made because it had been necessary to unstack and then rebuild the entire moving face graphite. The standard deviation in a series of 6 runs was 0.012 cents. Each run was initiated by a rod scram and the face was then run out its full distance. Based on this somewhat limited test, an improvement by a factor of about 3 appears to have been made. The improved reproducibility is believed to be the result primarily of the recent reinforcing of the floor under the rails.

The new charging port has been used to unload the central cell after high level irradiations. This new facility reduces personnel exposure levels by at least a factor of 10.

Critical mass experiments were conducted in the TTR reactor room during the first 1-1/2 weeks.

Two days were used to irradiate fission foils for calibration purposes.

The remainder of the month was used to calibrate lutecium and copper foils for use as a neutron thermometer.

A technical radiation overexposure occurred caused by handling irradiated J metal foil without the use of tongs. The overexposure was to one hand and amounted to one-third the yearly maximum.

There were no unscheduled shutdowns during the month.

DECLASSIFIED

BIOLOGY AND MEDICINE - 6000 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

The joint AEC-AF dispersion experiments were successfully completed on August 28, 1959, when the twenty-sixth field experiment was conducted. A tentative classification of these twenty-six experiments showed twenty-three of them to be complete, one was classified as providing little or no useful information, and two were partially successful, but did not provide distribution parameters on one or more sampling arcs. Intensive analyses of these experiments were scheduled to begin in September with the release of available manpower from the field program.

DOSIMETRY

During the month 30 people were counted in the whole body counter. This brings the grand total to 100 people counted in the iron room. Of the 30 subjects counted this month, 6 were routine measurements of Hanford personnel, 18 were routine measurements of AEC fellows, 4 were Pu wound measurements and 2 were fission product contamination cases. A visitor from the Olympic Peninsula was counted and found to have about 8 times the usual Cs^{137} burden which is by a factor of 3 the highest we have seen. Peculiar conditions which affect his food supply may possibly explain the high Cs^{137} burden.

The construction work on the positive ion accelerator building was essentially completed and experimental work was resumed. A polyethylene double moderator was calibrated in the neutron energy range 182 - 1192 kev. In contrast to the paraffin double moderator which employs a non-standard size BF_3 tube the polyethylene double moderator has a slightly larger central hole in which a commercial BF_3 tube is located. Further advantages of the polyethylene arrangement over the paraffin arrangement are lower cost and better reproducibility in the density of the moderating material.

The reproducibility in setting the bias level for accepting low-energy neutrons in the time-of-flight system is being investigated.

INSTRUMENTATION

The scintillation, transistorized combined alpha-beta-gamma hand and shoe counter has now operated satisfactorily for six months in general use in the 329 Building. Total downtime required (in six months) has been three hours. One miniature commercial transistorized power supply failed and was replaced to permit continued instrument operation. The power supply was repaired.

Various types of airborne radioactive particulate matter monitoring investigations continued. Development work concerned the detection by scintillation methods of alpha-air contamination in the presence of high background conditions caused by radon-thoron concentrations. The instrument will use an anticoincident circuit and a discriminator to provide pulses to a coincidence circuit having a resolving time of 300 microseconds. The coincidence rate will be proportional to the natural activity. If assumptions are correct, the ratio between the co-

incidences and the total alpha count of a natural activity-background filter counter count will be a constant. Calculated sensitivity is about 20 MPC in three minutes. This will be a factor of three improvement over the developed and tested Dual Alpha Air Monitor.

Further investigations were made to determine if natural radon-thoron background activity can be absorbed by activated charcoal.

Circuit and mechanical drawings were completed for the prototype, transistorized High-Level Alpha Air Monitor and for the Dual Beta-Gamma Alpha Air Monitor. The dual system will alarm for 10,000 MPC of Pu^{239} in one minute.

Further refinements to improve sensitivity include possible anticoincident circuits to prevent the large alpha-caused pulses from counting in both channels. Part of the dual system will be transistorized at a later date. The present vacuum tube dual system has operated satisfactorily, in experimental form, for three weeks.

Further sulfide particle counter experiment arrangements were made with the Atmospheric Physics Unit. Both zinc and calcium sulfide particles will be dispersed and filter-collected. Previous experiments have shown the two pigments to produce different phototube output pulse heights when irradiated with a Pu^{239} source. Both electronic and visual counts will be made and the results correlated.

Experiments continued concerning a scintillation remote area monitoring system of a logarithmic readout type. The phototube and two-inch by two-inch terphenyl-in-polyvinyltoluene detector is essentially gamma energy independent above 90 Kev. The obtained logarithmic response, using only a simple silicon diode resistor and 20 microampere meter circuit, extends over about a two and one-half decade range to an accuracy of ±5 percent. The present accurate range is from 10 mr/hr to three r/hr. Some saturation effects occur above four r/hr. Further tests will be made to improve the upper-end response. A higher dynode resistor divider current is necessary.

Various outer-area background studies continued. The 200-Channel Analyzer was in continued operation in various 200-Area Buildings to obtain data concerning gamma energy distributions. Present emphasis is on data gathering. Later, extensive correlation and data reduction will be undertaken. Buildings investigated thus far are Purex, Redox, 222-S, and 234-5. Several locations in each building were checked and where requested, sample data were given to respective building radiation analysts. Other background study work concerned gamma dose-rate analysis at Purex.

Light pipe and scintillation detector technique investigations continued. A light pipe three inches long and three millimeters in diameter was fabricated and tested. The use of the unit was demonstrated at Biology. A beta scintillator of terphenyl-in-polyvinyltoluene was employed with the light pipe to check a kidney and testicle from an animal. The results were quite satisfactory. Proper dose-rate to count-rate relationship was established. Using the detector will permit measurement, in sections of various organs, of Cs^{137} in terms of μc/gm. An experimental alpha-detecting probe using a wedge-shaped light pipe and zinc-

DECLASSIFIED

sulfide detector was fabricated. The probe counting efficiency (geometry) was 12 percent at any point on the two by four-inch detecting area. The forward end of the detector wedge is only one-fourth inch thick thereby permitting easy monitoring usage. The probe was evaluated using the basic scintillation transistorized combined loudspeaker and count-rate meter SCINTRAN instrument of which some 30 are being fabricated at present for plant installations. Tests using a Ra-gamma source showed that the probe had a background counting rate of less than one count/minute in a three r/hr field while having the stated 12 percent geometry at any probe point for Pu^{239}. Such a probe will prove to be exceedingly useful in several 200-Area buildings. The probe is nonmicrophonic, unaffected by temperature humidity variations, and is light-tight. The simple additions of a capacitor and large voltage dropping resistor to the probe will permit its use with the old standard Hanford Cart-Poppy instrument if desired. Direct application will be to the SCINTRAN completely transistorized instrument. The wedge-shaped probe is six inches long. It is one and one-half inches thick at the phototube end tapering to one-fourth inch thick at the forward end. The effective probe detecting area is, as was stated, two inches by four inches or eight square inches.

Fabrication, delayed by other more pressing work, continued on an experimental, completely transistorized, aurally-indicating alpha-beta-gamma detecting instrument. A count-rate meter is included for high-level determinations. The loudspeaker indicating output is completely different for alpha versus beta-gamma-caused pulses, thereby permitting easy ear separation. The CRM indication can be selected for alpha-only or alpha-beta-gamma combined.

The two experimental prototype scintillation transistorized slow and fast neutron count-rate and dose-rate portable instruments were modified to permit use of a standard aluminum wall BF_3 tube detector as an alternate to the scintillation probe. Either detector may be used without instrument modification at the option of the monitoring personnel. The scintillation probe can be used with the 17-pound spherical polythene moderator or the BF_3 probe can be used with the 35-pound cylindrical wax moderator to obtain fast neutron dose-rate information. Either probe (without moderator) can be used for slow-neutron detection and counting. The complete instrument, excluding the probes, weighs only four pounds. Tests have been quite satisfactory with both probe types.

Debugging continued on the radiotelemetering system and the operation is such that the system is almost ready to be turned over to plant maintenance forces.

Notification was received that a patent application is being prepared on the Invention Disclosure, "Medium-Level Alpha Air Monitor by M. O. Rankin."

WASHINGTON DESIGNATED PROGRAM

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

Other analyses done to test the performance of the instrument indicate that the designed characteristics of (a) sample sensitivity, (b) mass resolution, and (c) abundance sensitivity have been achieved, i. e.

[redacted]

(a) 5×10^{-13} grams minor isotope in uranium
(b) 1 part in 1000
(c) 10^5 at the mass 237 mass position

Studies of the pulse characteristics of the electron multipliers used in ion detection were continued.

CUSTOMER WORK

Analog Computation

An attempt was made to restudy the pump coastdown characteristics of the NPR, but a computer failure prevented results from being obtained. This program will be placed on the computer again early in September.

The compilation of results from the NPR primary loop frequency response analog study was completed. The results are being transcribed into graphical form.

The original equations for the NPR heat exchanger analog computer study have been modified to include time dependence of all variables. Satisfactory results should be obtained with the modified equations. The problem will be programmed on the Goodyear computer as soon as sufficient computer time is available.

A set of solutions for the PRTR hazards analysis computer study was obtained and a report is being prepared.

Several runs for the one-dimensional representation of heat transfer for a waste tank were made on the IBM 709 computer for comparison with analog computer runs, but the results were not satisfactory. Further checking of the input data is necessary.

Weather Forecasting and Meteorology Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	93	86.8
General	62	88.5
Special	114	91.2

August was cool and dry. The average temperature (71.8) was 2.3 degrees below normal and 7.6 degrees below the average for the hot August of 1958. Precipitation totaled only 0.03 inch and this is all that occurred at the station since June 11.

Instrumentation

The beta-gamma gross count instrument using a scintillation detector, well-shielded, was completed and delivered to Coolant Systems Development, HLO. All circuitry is transistorized with available count-rate meter full-scale ranges of 10,000, 100,000 and 1,000,000 counts/minute. The unit will be used to determine decontamination factors for "coupon" samples from an experimental fuel rupture loop.

A Fast Neutron Beam Scanner was completed and was delivered to and used satisfactorily by IPD personnel in two 100 Areas. The instrument uses a mechanical

DECLASSIFIED

scanning device to move a fast neutron detector phototube probe across a neutron beam. Measurement of the beam intensity at various cross-section points was required.

Consultation and advice was rendered to Instrument Technician personnel at 100-C concerning conversion of another mica-window GM shielded counter to a simple, reliable, inexpensive, more sensitive scintillation detector. Previous conversion work has proved to be quite satisfactory.

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

Fabrication continued in the 328 Building Shop on a completely transistorized loudspeaker count-rate meter, alpha-only, 110 VAC-operated monitor for use with both scintillation or air-proportional alpha-detecting probes. The unit is being fabricated for the Calibrations Unit, HLO.

A complete set of specifications for the Automatic Data Recording System (PCTR Mark I) was written and forwarded to the Reactor Lattice Physics Operation.

The electronics course for instrument maintenance personnel and the AEC Radiological Physics Fellowship Program were completed.

Evaluation tests were completed on: (a) The two prototype combination alpha-beta-gamma transistorized scintillation portable survey instruments, (b) commercial PANDUX self-reading pencil-size dosimeters, and (c) the two prototype transistorized portable loudspeaker and count-rate-meter GM survey instruments.

Evaluation tests were started on the Ohmart Remote Area Monitoring System for IPD and the PRTR Fuel Failure Monitor photomultiplier tubes.

Optical Work

The 440 manhours of optics shop work for the period July 19 to August 16 consisted of 1 percent for FPD, 22 percent for IPD, 36 percent for CPD, 33 percent for HLO, and 8 percent for CEcUO. This work included:

1. Removal of the Discharge Area Periscope from 105 DR to the Optical Shop.
2. Repair of three periscope heads for Redox.
3. Fabrication of ten glass bearings.
4. Fabrication of a sine wave response test unit.
5. Repair of one large Lenox borescope.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

[redacted]

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
Randulv Os	8/4	Stanford Research Inst. Menlo Park, Calif.	Discuss wind dispersion experiments.	GR Hilst	No	200-W: 622
Harry Moses	8/10-12	Radiological Physics Argonne National Lab. Lemont, Ill.	" " "	GR Hilst	No	200-W: 622
G. C. Gill	8/10-12	Univ. of Michigan Ann Arbor, Mich.	" "	GR Hilst	No	200-W: 622
E. R. Wagner	8/12-14	Allis Chalmers Washington, D. C.	Discuss PCTR experiments on the Gas Cooled Reactor Program.	RE Heineman TJ Oakes	No	300: 326 305-B
D. M Papke	8/18	Union Carbide Nuclear Corp. Oak Ridge, Tenn.	Discuss instrument development.	WG Spear	No	300: 329
H. Steinhauer	8/18	Goodyear Atomic Corp. Portsmouth, Ohio	" "	WG Spear	No	300: 329
John N. Wilson	8/19	E.I. duPont de Nemours Savannah River, Ga.	Discuss instrumentation.	RS Paul	No	300: 3760
Lowell Anderson	8/19	Argonne National Lab. Lemont, Ill.	Discuss health instrumentation.	LV Zuerner	No	300: 329
[illegible]. Maras	8/19	Dow Chemical Plant Rocky Flats Boulder, Colo.	Discuss instrument development.	WG Spear	No	300: 329
A. D. Callihan	8/19	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Discuss critical mass programs.	ED Clayton	Yes	300: 326 205-B 105-KE,100-K 202-A,200-E

DECLASSIFIED

DECLASSIFIED

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
J. L. Powell	8/31	Univ. of Oregon Eugene, Oreg.	Consulting.	JE Faulkner	Yes	300: 326 100-K 105-KE

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. E. Heineman	8/6-7	Idaho Test Station Idaho Falls, Idaho	Discuss RMF and ETR Mockup.	D. R. DeBoisblanc	Yes
P. F. Gast	8/12	G-E Vallecitos Lab. Pleasanton, Calif.	Discuss physics of thermal heterogeneous reactors.	T. Snyder	Yes
	8/13	Atomic Power Equipment Dept., G-E San Jose, Calif.	" "	John Weil	Yes
	8/14	Aircraft Nuclear Propulsion Dept., GE Cincinnati, Ohio	" "	F.A. Aschenbrenner	Yes

Chemical Research & Development

RESEARCH AND ENGINEERING

IRRADIATION PROCESSES

Decontamination of Reactor Components

Acid sulfate solutions, when used following an alkaline permanganate pretreatment, are promising low-cost decontaminants. Wyandotte 1112 was the best of three proprietary compounds evaluated; carbon steel decontamination was superior to that obtained with the APACE process, but stainless steel decontamination was lower by a factor of about five. Sodium acid sulfate alone was prohibitively corrosive and a relatively poor decontaminant. However, satisfactory corrosion rates and good decontamination were obtained with a solution containing sodium acid sulfate, oxalic acid, thiourea as a corrosion inhibitor, and Tween 21 as a wetting agent.

Further APACE process studies evaluated the effect of citrate concentration in Step II. Decontamination was reduced significantly when citrate concentrations below 0.5 M were used. Corrosion of carbon steel was increased during Step II when the citrate solution contained small amounts of the Step I solution (alkaline permanganate) indicating the need for flushing between the two steps of the APACE process.

Automatic Analyzing Monitor

A telemetering device was designed and is being assembled to permit checking via installed telephone lines the operating status of the instrument. On dialing the telephone number to which the device is connected, a tone signal is returned indicative of the proper functioning of the monitor. The device will permit remote checking of the instrument's performance without requiring direct observation.

Uranium Oxidation and Fission Product Volatilization

Fission product release experiments in steam atmosphere were continued. A linear relationship was found to exist between the amount of uranium oxidized and the release of volatile isotopes I, Xe and Te. For 100 per cent oxidation the percentages released are 90 per cent I, 55 per cent Xe, 55 per cent Te.

Retention of radioisotopes by the residual specimen following steam oxidation was followed through radiochemical analyses of the separated oxide and residual uranium. Preliminary results indicated that at 1440 C, I^{131} diffuses more rapidly from the unoxidized molten uranium than does Xe^{133}.

Work progressed on the development of a furnace for induction heating of highly irradiated uranium specimens that will be used in fission product release studies. The effect of air flow rate and distribution on the oxidation rate and particulate emission of unirradiated uranium was investigated. Methods for temperature measurement were established and calibrated against known melting points.

[redacted]
DECLASSIFIED

A prototype furnace was designed and tested; it appeared to be suitable for the high exposure specimens.

Special Geological Studies

The Yellowstone earthquake of August 17 and subsequent apparent aftershocks were detected by numerous devices at Hanford. High sensitivity seismoscopes in all reactor areas responded to the initial shock, galvanometers in all reactor areas oscillated at varying times recording a total of seven subsequent apparent aftershocks up to 7:40 a.m. August 18. US Coast and Geodetic Survey records note only the initial shock, the about 7:40 a.m. aftershock and a later one on the 19th. Galvanometer oscillations at other times thus might be due to Yellowstone aftershocks not recorded by the USCGS or might be secondary quakes of very minor nature occurring elsewhere (even in the Hanford area) and triggered by the initial Yellowstone quake.

The Chelan quake of August 5 was not felt in the Pasco Basin area, although it was felt in the immediately surrounding area (Walla Walla, Yakima, etc.). This suggested that Hanford lay in a seismic "safety island" for that shock. The Yellowstone earthquake however, clearly affirmed this was not a general situation.

Observation Wells

Analytical results from wells 699-34-39A, 699-31-30, and 699-24-33, located southeast of the 200 East Area, have shown slight increases in radioactive material concentrations during recent months. The average concentration in wells 699-31-30 and 699-24-33 increased from less than 1.5×10^{-7} uc/cc in December, 1958 to more than 2×10^{-6} uc/cc. The nitrate concentration in these two wells averaged 20 ppm during this period. Well 699-34-39A has shown a gradual increase in average radioactive material concentrations of from less than 1.5×10^{-7} uc/cc in June, 1957 to more than 4×10^{-6} uc/cc. The nitrate ion concentration in this well averaged 15 ppm. Because of the complex hydrological conditions which exist southeast of the 200 East Area it is difficult to determine the source of this radioactive material and the mechanics of its movement into these wells. The concentrations of salt ions and of radioactive materials in the cooling water sent to the B-swamp are below those detected in the wells and are therefore not the source of this contamination. Depth sampling of these wells was completed and the results may give some indication as to the source.

Special 2 gallon, larger-volume, samples were taken from wells 699-34-39, 299-E25-1, 699-31-65, 699-36-61, 299-W22-20, 299-W19-2, and 699-25-55; analysis showed that the activity can be attributed to Ru^{106} with one exception, well 299-W19-2 showed a Sr^{90}-Y^{90} concentration of 2.2×10^{-8} uc/cc versus a detection limit of 5.7×10^{-9}. Neutralization of the original waste with limestone rather than with caustic may be related to this Sr movement.

Disposal to Ground

Core samples of the underlying soil were taken from four locations in the 216-Z-9 crib. The soil cores are being sectioned and extracted with nitric acid in the

Earth Sciences Laboratory; plutonium analyses will be made at the 234-5 Laboratory; the results will be used to determine the variation of plutonium present with depth.

Soil column tests indicated that the useful life remaining to the 216-S-6 crib, which receives 202-S process vessel cooling water, is in excess of seven years at the present rate of use.

Analytical results of a special ground water sample from well W-19-2 monitoring the UO_3 Plant process condensate crib showed Sr^{90} to be present at a concentration of 2.2×10^{-8} uc/cc. This confirmed earlier indications of Sr^{90} breakthrough at the 216-WR facility and resulted in a recommendation to the Chemical Processing Department that construction of the planned replacement crib be expedited. The present recommended limit for Sr^{90} contamination in ground water is 8×10^{-8} uc/cc.

Analytical Services

Autoclaved Zircaloy slugs were examined for surface uranium contamination down to 5×10^{-9} g/cm^2. Such examination was needed as an irradiation specification. Exposure of the slugs to nuclear emulsion film for one week gave enough alpha tracts to be observed upon developing the film. The method is an application of standard bioassay.

Decontaminating solutions such as Turco, alkaline permanganate, and others are being subjected to viscosity, density, and thermal conductivity testing at 25 and 95°. Other properties to be measured are heat capacity, vapor pressure and freezing point.

SEPARATION PROCESSES

Dissolution of Dingot Uranium

Dissolution rates in nitric acid were determined for samples of a special lot of dingot uranium to which silicon had been added (by Mallinckrodt Chemical Works) to increase grain size. Silicon content was about 100 ppm. No significant difference in dissolution rates for this special lot and for normal dingot uranium (silicon content ca. one ppm) were observed. Metallographic analysis of the special lot samples to determine the manner in which silicon is present has been requested.

Analysis of Purex Plant Streams

In a further attempt to elucidate the origin of the minor decontamination difficulty encountered in the Purex plant during the current run period, samples of all streams in the plant partition cycle were submitted to Analytical Laboratories for zirconium and niobium analyses. The data obtained on samples collected on August 6 and 8 indicate that while niobium is behaving in a normal fashion in the 1BX column, zirconium is tending to follow uranium to a much larger extent than usual, resulting in the observed very good decontamination for plutonium but sub-standard decontamination for uranium. The material balance for zirconium was poor across the 1B system also, suggesting the existence of a "crud problem" in the 1B system.

DECLASSIFIED

Neptunium Recovery in Purex

The feasibility of recovering neptunium in parallel with normal uranium processing by "bottling" the neptunium in a single column fed by Purex 3WB and operated with total internal reflux of neptunium, was outlined in the July report.

Further studies indicate this flow sheet is most vulnerable to "loss" of neptunium to the organic stream and measures taken to protect against this lead to increased internal reflux of plutonium. Low acidity is favorable for the iron(III) oxidation by which it is proposed to convert neptunium(IV) to (V) in the scrub section and force it to reflux. For example, the ratio of the steady state concentration of neptunium in the organic at the feed plate to that at the organic exit point decreased from 1430 to 50 as the scrub acidity was increased from 0.01 M to 0.5 M HNO_3. However, the ratio of plutonium concentrations in the organic at the feed plate to the organic effluent was 20 with 0.01 M HNO_3 scrub versus 2 with 0.5 M HNO_3 scrub.

This tendency for plutonium to reflux represents the most severe control problem in this flow sheet. However, the above data indicate that satisfactory "bottling" of neptunium could be accomplished without severe reflux of plutonium by employing a 0.01 M HNO_3 scrub but at a lower flow ratio than the L/V of 0.6 used in these runs. Near-quantitative extraction of neptunium appears easily possible. The neptunium "loss" to the aqueous effluent in these runs represents only about 0.01 per cent of the neptunium present in the organic phase at the feed plate.

Chemistry of Actinide Elements

Partition equilibria with quaternary amine anion exchange resins and solubilities of the salts $[(C_2H_5)_4N]_2 M(NO_3)_6$ show the expected trends for thorium, neptunium, and plutonium. Anion exchange equilibria for neptunium have been measured at 5 per cent resin loadings to make them directly comparable to earlier measurements with plutonium and thorium. The anion exchange partition coefficient

$(K_D = \frac{g^{Np}/g \text{ resin}}{g^{Np}/l \text{ solution}})$ for neptunium attains a maximum value at 7.8 M HNO_3, very close to the point at which the maximum occurs for plutonium anion exchange. The maximum K_D measured for neptunium under conditions of 5 per cent resin loading is 2800, virtually identical with that measured by Sheppard and Becker (HW-49825) with neptunium-239 tracer and Dowex 1, X-10 resin. Comparing the anion exchange and solubility data for plutonium(IV) and neptunium(IV) reveals the expected trend. The maximum K_D for plutonium is some 40 per cent greater than that for neptunium while the minimum solubility for the salt $[(C_2H_5)_4N]_2 M(NO_3)_6$ is about 30 per cent greater for neptunium than for plutonium.

This trend continues with thorium. Measurements of the solubility of the salt $[(N_2H_5)_4 N]_2 Th(NO_3)_6$ in nitric acid yielded a minimum solubility, again at 7.8 M HNO_3, and the thorium solubility at this point is greater than that of plutonium by a factor of about 65.

Measurements of the absorption spectra of neptunium(IV) in HNO_3 - 0.2 M semicarbazide have been extended to cover the range 14 M to 15.5 M HNO_3. No change in the absorption spectrum occurs over this range and the spectrum is identical

with that of the salt $[(C_2H_5)_4N]_2Np(NO_3)_6$ in acetone or acetonitrile. The presence of isobestic points at 866 and 892 mu indicates that in the range 5 M to 15.5 M HNO_3 only two spectral entities are present. Thus, the fraction of the neptunium present as hexanitrato species in nitric acid solutions could be calculated from the absorbance at 877 mu, a peak which disappears entirely at 5 M HNO_3. Analysis of the neptunium absorption spectrum in this fashion yields a hexanitrato complex growth curve very similar in shape to that obtained for plutonium but displaced in the direction of higher nitric acid concentration. The fraction of the neptunium present as hexanitrato complexes is negligible at 5 M HNO_3, increases to 50 per cent at about 9 M HNO_3, and attains 100 per cent at 14 M and higher nitric acid levels. From these data and the assumption that only one species other than the hexanitrato complex exists over the range 6 M to 15 M HNO_3 and the further assumption that the stable lower complexes involve the same number of nitrate ligands, it is possible to calculate the ratio of the formation constants for the hexanitrato complexes for plutonium and neptunium. Over the range 6 M to 11 M HNO_3 the formation constant for hexanitrato complexes of plutonium was calculated to be greater than that for neptunium by a factor of 3.4 ± 0.4. The fact that a relatively constant ratio is obtained is in itself indicative of the correctness of the initial assumptions.

In the course of this work, a useful preparative technique was developed. Higher molecular weight quaternary amines available commercially only as the iodide salt can be readily converted to the nitrate salt by anion exchange with a nitrate form quaternary amine resin. In the case of water-insoluble salts this process can be satisfactorily applied in another suitable solvent, such as acetone.

A study of the nitrate complexes of neptunium(IV) has just been completed and is being prepared for journal publication. Complimentary solvent extraction and spectrophotometric methods were employed with good agreement in those regions of nitrate concentration where both were applicable. Average values of the first and second formation constants were about 1.9 and 3.7, respectively.

Analytical Services

Carbon in UO_3 was measured by evolving carbon dioxide from the oxide at white heat. Induction heating of the sample with no added flux gave a carbon dioxide evolution about one-third as rapid as the rate for stainless steel. While not ideal, the analytical method permitted giving timely support to UO_3 reactivity improvement studies.

More sensitive analyses of Sr^{90} in test well water were reported. The previous threshold of 7×10^{-8} uc/cc was reduced to 2×10^{-8} uc/cc.

A quality control program for test well water and stack gas analyses was instituted. Test solutions containing $Sr\text{-}Y^{90}$, Cs^{137}, Co^{60}, $Ru\text{-}Rh^{106}$, and I^{131} were prepared and are run with each group of samples, semi-weekly.

Application of X-ray spectrometry to the analysis of potassium was accomplished using a procedure developed by Chemical Research. One gram per liter of potassium is the lower limit (flame photometric lower limit is about 0.0001 g/l). Also, rapid zirconium determination down to the 0.1 g/l range is possible with less than 3 per cent error.

DECLASSIFIED

Various impurity hydrocarbons were measured in n-butane purchased in quantity for plant needs. The gas chromatograph and a mass spectrometer simplified the analytical effort.

Analysis of Pm^{147} in plant waste is being perfected. Rare earth fluorides were converted to hydroxides which were dissolved in minimal hydrochloric acid. The rare earths were transferred to Dowex-50 cation exchange resin and eluted with molar lactic acid at pH 3.25. Separation of Pm^{147} from yttrium was not always complete, but differential beta counting gave adequa e resolution.

Molybdenum analysis in plant dissolver solution promises an improvement in measuring fuel burn-up. Accordingly, the controlled potential coulometer was calibrated for Mo analysis in the 0.07 to 1.0 ug range using the mercury electrode cell and a 3 M $HClO_4$ - 1 M H_2SO_4 electrolyte. The observed deviation of ± 6 per cent was apparently due to problems associated with liquid electrodes. Solid electrodes of gold, platinum, lead, carbon and silver were unsatisfactory due to either the production of hydrogen or dissolution in the electrolyte.

WASTE TREATMENT

Semiworks Waste Calciner Prototype

Installation of all equipment and piping is essentially complete. Functional testing of all equipment is in progress. Operation is expected within the next month.

ANL Fluid-Bed Calcination Studies

Exploratory studies at ANL on fluid-bed calcination of simulated Purex "formaldehyde-killed" and threefold concentrated acid waste have continued. Recent work has been at a bed temperature of 500 C, the highest and most successful temperature tested to date.

Feed nozzle pluggage, the major problem to date, has been nearly eliminated by the use of a modified feed nozzle in which the liquid nozzle tip is extended slightly into the calcine bed. The use of this modified nozzle (plus an attrition air jet to maintain adequately small particle sizes) has permitted a voluntarily terminated run of 30 hours duration. Although the bed particle sizes had grown considerably from those in the starting bed (the final bed contained 60 per cent of plus 20 mesh particles), conditions had stabilized with no additional particle size growth after about 20 hours of operation.

Two short (5-1/2 hours each) runs were made with the modified nozzle and 250 g/l sugar in the feed solution to determine calciner performance and heat requirements. Growth of the particles appeared to be less than previously obtained; in fact, the use of attrition air jet reduced the average particle size during the second run. The powder from these runs is lighter in color (tan), has a lower bulk specific gravity (1.05 untapped), and is more easily crumbled than that from runs made without sugar. Essentially no difference in the nitric acid solubility of the two types of powder was noted. Heating requirements were reduced about 20 per cent with the sugar addition.

One run of 12 hours duration was made using a standard pressure type of pneumatic atomizing nozzle. Although no difficulties were indicated during the operation, inspection of the final bed revealed the start of a small amount of caking around the nozzle. This caking would probably have led eventually to nozzle pluggage. However, improvements in operation with this type of nozzle might be made with several design modifications.

Batch Calcination

One additional run using unagitated batch calcination techniques has been made. The calciner vessel size was increased to a 12-inch-length of 4-inch-diameter stainless steel pipe. (Previous studies have been made using a 3-inch-diameter by 5-inch-tall vessel.) The formaldehyde-killed, threefold concentrated acidic waste was calcined to a volume equivalent to 2.1 gal/ton U and a bulk density of 1.9 g/cc.

Storage Tanks for Acidic Purex 1WW

Corrosion studies on 304-L, 316-L, and 309-L stainless steels and A-55 titanium are in progress pertinent to selection of a material for construction of tanks for interim storage of acidic Purex 1WW. In boiling synthetic waste containing 6 M HNO_3, the stainless steels corroded at rates increasing from about one mil/mo to three mil/mo (on a weight loss basis) as sulfuric acid concentration was increased from 0.8 to 1.6 M. Both 304-L and 316-L showed severe intergranular attack and actual penetration rates are several fold higher than the weight loss rates. Intergranular attack was not evident on the 309-L within the duration of the test. Corrosion rates for A-55 titanium were from 0.01 to 0.2 mils/mo over the same sulfuric acid concentration range. Tests to determine corrosion rates as a function of nitric acid concentration are now in progress.

TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Fission Product Isolation and Packaging Prototype

"Shakedown" studies have continued on the fission product packaging prototype. Although the basic operability of most of the equipment has been demonstrated, problems have been encountered in the hydrolyzer, the cesium chloride hopper-dryer and the conveyor positioning devices. The problems associated with the dryer and the conveyor should be solved by relatively simple changes in equipment design and by using modified processing conditions. In the hydrolyzer, operations have been complicated by the formation of an "asphaltic" mastic compound which presumably results from both polymerization of the cesium zinc ferrocyanide salt during conversion and frequent dampening of the partially reacted salt. During the coming month, a series of hydrolyzer runs are planned at operating conditions specified to either prevent formation of the asphaltic compound (batch operation) or to flash convert small increments of ferrocyanide.

Purex Crude Rare Earth Recovery

Studies have been made in the pilot plant in an effort to determine technical criteria to be used as a basis for design of filter elements to be used for the recovery of a crude fission product rare earth sulfate from the Purex plant waste.

[redacted]
DECLASSIFIED

DECLASSIFIED

In addition to the previously reported tests to determine the filtration effectiveness of a typical production filtration media, pilot plant tests have been performed to determine the heat transfer properties of the dried precipitate and to develop suitable methods for leaching calcined (to 600 F) precipitates from the filter element.

In the pilot plant tests a 3-foot-long, 3-inch-diameter, bellows-type, sintered stainless steel filter element was used. This element was mounted in a 4-inch-diameter glass tube and rare earth sulfate precipitate was collected and dried in the annulus. At the completion of the filtration efficiency studies, a calrod unit was installed inside the filter element and the thermal effects in the powder were determined at various heat generation rates between 12,000 and 33,500 Btu/(hr)(cuft) with air and helium atmosphere. Comparison at a heat flux of 21,000 Btu/(hr)(cuft) indicates that the effective thermal conductivity of the cake is increased by a factor of 1.7 when a helium atmosphere is substituted for air in the filter.

Following the heat transfer studies, the calcined cake was dissolved by repeatedly passing a 180-liter batch of hot (120 to 150 F) 6 M HNO_3 - 0.05 M HF through the filter. After 6 hours approximately 95 per cent of the cake had been dissolved.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

Microspark Apparatus for the Study of Inclusions in Metals

An informal report, HW-61187, having the above title has been issued describing the design and performance of a spectrographic microspark unit. The spark stand contains a microscope and a sample holder with a transport mechanism to provide both horizontal and vertical motion. A motorized drive is used to provide scanning at each of several speeds across the horizontal surface of the sample. The power supply can deliver up to 110 microamperes and 6000 volts. The source is mounted on a medium-quartz Hilger spectrograph equipped with a motor-driven, plate-racking mechanism. Using a counter electrode of number 30 aluminum wire in a capillary tube with a five mil opening at the tip, a sparking path width of about six mils on a metal sample is obtained. It was found that a boundary less than one mil wide of copper in an aluminum specimen can be detected in a microspark scan.

EQUIPMENT AND MATERIALS

Non-Metallic Materials Testing

Teslar, a polyvinylfluoride film manufactured by duPont, was tested by static immersion at room temperature. This material was unaffected by 60 per cent nitric acid, 50 per cent caustic soda, Recuplex CAX, Purex HAX, carbon tetrachloride, perchlorethylene, trichlorethylene, 48 per cent HF, 1 M HF - 2 M HNO_3, 1 M HCl - 2 M HNO_3, and 1 M HCl - 12 M HNO_3. It swelled approximately 3 per cent in hexone. The test duration was 28 days.

Teslar is reported to be the most radiation tolerant fluorine bearing polymer ever tested by the Reactor & Fuels Research & Development Operation. The maximum tolerance limit is approximately 5×10^8 r gamma.

Plutonium Oxide Chlorinator

Further tests of possible materials of construction for use in a phosgene-air-water atmosphere at 500-600 C have not disclosed materials superior to Hastelloy B and C, nickel and Chlorimet-2. Corrosion rates for these materials were less than one mil/mo at 500 C, from four to seven mils/mo at 600 C, and ca. 10 mils/mo in the condensed off-gas phase at 95 C.

234-5 Powder Transfer Cyclone

Cyclone-type powder transfer devices are being investigated for fluidizing and transporting heavy plutonium powders in the 234-5 Building. Air enters tangentially near the vortex of the cyclone and eventually carries the powder out the tangential upper outlet tube. Using a 2-1/4-inch-diameter cyclone and approximately 4 cubic feet of fluidization air per minute, it has been possible to fluidize various heavy powders and carry them through a 10-foot run of 1/2-inch tubing including a 3-foot rise at a 5 to 10 kg/hour rate. In addition to course and fine cerium fluoride powders, it was possible to fluidize 1/4-inch diameter stainless steel balls. When mixtures of cerium fluoride powders and stainless steel balls were fluidized, some internal scaling of the cyclone walls was noted. On the basis of these encouraging runs, a Teflon cyclone is being fabricated. This unit will include a star valve feeder which should provide more uniform feed rates to the cyclone.

PROCESS CONTROL DEVELOPMENT

UO_3 Plant Automation

The Programmer prototype for automating the UO_3 Plant K-calciner was installed this month. Several automatic startups and shutdowns of the calciner have been made since installation. All the startups have been as good or better than the best that have been obtained manually in the past. However, observation of the rapid shell temperature decreases during the shutdowns indicated that an additional intermediate step in power level was needed after the feed was cut off. Originally at shutdown, the power dropped immediately from 50 per cent of full load capacity to 5 per cent. At present, it appears that dropping the power from 50 per cent to 30 per cent and holding at this level for 20 minutes, then dropping to 5 per cent will give a satisfactory rate of shell temperature decrease. A timer, delay relay, and a 3-pole double-throw relay have been incorporated in the Programmer to give this intermediate step.

The first section of the Programmer Manual has been completed. This section describes the function of all the controls and indicators on the Programmer. The other two main sections of the manual will describe in detail (1) the operation of the Programmer and other calciner controls under normal and emergency conditions and (2) the electrical circuitry.

C-Column Instrumentation Studies

The uranium photometer for the analysis of the aqueous phase of samples removed through the mid-column sampler connections was put into operation. The operation of the photometer unit was satisfactory with the exception of the Snap-Tite quick

DECLASSIFIED

DECLASSIFIED

disconnect fittings. Here the seals had swollen so badly that complete mating with some of the fittings was not possible. Special Viton-A seals for these fittings are expected to alleviate this problem.

The interface recorder controller system was moved from the canyon to the operating gallery panel board to reduce the instrument maintenance created by the attack of the canyon atmosphere on the instrument.

The circuitry of the Data Scanning Programmer was revised to allow measurement of more voltages and to allow making undergrounded measurements with the Digital Voltmeter on such instruments as the pH amplifier. Construction of the unit has begun and it should be completed this month.

A Plugboard was designed for use in the 321 Building operating gallery instrument racks. The Plugboard panel will allow better utilization of the existing instruments and rapid substitution of spare instruments in case of instrument failure.

Purex Sampler Jet Runs

The Purex-type steam motivated sampler jet used during Palm recovery runs to transfer the 2BP stream to the 2AF tank via the 2BP sampler line fails to operate in continuous operation. This failure appears to be due to the high temperature (50 C) of the process solution. Tests carried out in the 321 Building with this type jet, demonstrated that adequate flows (0.5 gal/min) could be maintained by operating the jet in a cyclic manner thereby eliminating the excess temperature rise at the jet even at a solution temperature of 65 C. Automatic cyclic operation of the jet, one minute out of five, provided adequate flows during a 3-day period.

NON-PRODUCTION FUELS REPROCESSING

Mechanical Head-End - Coldsaw Studies

Continued operation of a milling-cutter coldsaw, being tested for power fuels hardware cutoff, confirmed the feasibility of the saw for massive hardware removal. If, instead of massive hardware cuts, cuts through the rods of a multirod bundle are desired, rigid clamping is required for successful sawing. By shimming between rods of a multitube bundle the bundle is "firmed up" enough to permit cutting through the rod portion of the bundle.

In the life test stainless steel cutting, about 2700 square inches of material was cut. This is roughly equivalent to the presently scheduled annual processing load for HAPO. No significant blade wear, saw horsepower increase, or gross change in chip appearance occurred.

With the blade life test completed, future studies will include: (1) water-lubricated sawing (without cutting oil additive), (2) extra-thin wall tubing cuts, (3) simulated Dresden-type hardware (with spring-loaded rods) cuts, and (4) cuts on rod bundles with interiors inaccessible for shimming.

Feed Preparation

Nitric Acid-Hydrofluoric Acid Dissolution of Zircaloy-2. A survey of dissolution rates of Zircaloy-2 in HNO_3-HF solutions was made. For hydrofluoric acid concentrations ranging from 0.5 to 2.0 M, dissolution rates were high (2 to 9 g/cm^2-hr) and essentially unaffected by nitric acid in concentrations from zero to 5 M. Dissolution rates were greatly reduced by the presence of aluminum nitrate and approached zero as the Al/F mole ratio approached one.

Depassivation of Stainless Steel in Sulfex Systems. A study aimed at finding better methods of avoiding passivation or insuring depassivation of stainless steel in sulfuric acid was initiated. Difficulty was experienced in obtaining surfaces on 304-L stainless steel which were passive to boiling 4 M H_2SO_4. Of the methods tried, which included pickling in boiling 12 M HNO_3 alone, with chromic ion present and with dichromate present; anodizing; and pickling in 4 M HNO_3 - 0.5 M HCl, only the HNO_3-HCl procedure was successful. In attempts to depassivate passive 304-L surfaces in boiling 4 M H_2SO_4, reducing agents, such as hydrazine and bisulfate at 0.01 M were not successful. Hydrofluoric acid at 0.1 M was successful. When the passive stainless steel was coupled to platinum, passivity was retained; depassivation was induced when the stainless steel was coupled to carbon steel. Electrolytic depassivation in which the stainless steel was made cathodic with respect to an electrode immersed in the dissolvent was successful.

U-Mo Dissolution. Observations on the stability during prolonged storage of dissolver solutions prepared through dissolution of U-Mo alloys in HNO_3-$Fe(NO_3)_3$ dissolvents were continued. Stability of solutions stored at room temperature is very good; some solid formation has occurred in those stored at 50 C. Addition of dichromate to the solutions appeared to enhance their stability and also served to oxidize plutonium to the hexavalent state during storage.

Flooded Tray Dissolver. Three additional runs were made to dissolve Hanford slugs of depleted, metallic uranium in 13 M nitric acid. The experimental information secured, combined with earlier data on the same system follows:

Recirculation Rate gph/ft^2 chg.	Dissolution Rate[a] mils/hr	HNO_3 Consumption Moles/Mole U	Air Bleed Rate Moles O_2/Mole U
440	27.3	2.5	5.0
108	31.3	---	2.1
29.5	36.0	4.1	1.9
27.0	33.0	6.0	2.0
14.5	38.4	5.7	1.8
0[b]	27.3[b]		

(a) End penetration rates were 3.5-fold higher than side penetration rates.
(b) Estimated for a batch system.

DECLASSIFIED

DECLASSIFIED

These data indicate an apparent inverse relationship between recirculation rate and dissolution rates, although all the rates are within a modest ± 20 per cent deviation from the mean. The exact reason for this behavior is not certain, but might involve a dissolution reaction mechanism where a reaction by-product (perhaps nitrous acid) is also an active reactant. Thus, higher recirculation rates, which quickly remove the reaction by-products from the uranium surface, would slow the dissolution.

Two additional runs were made to dissolve sintered uranium dioxide in 13 M nitric acid employing recirculation rates of three liters per minute (18.8 gph/ft^2 charge). Dissolution rates were greater than 120 mils per hour as compared to 100 mils per hour predicted for a batch system for dissolving the sintered oxide.

The Gould-Pfaulder glass lined recirculating pump failed after 50 hours service apparently because of a chip or crack in the glass on the impeller shaft. An air lift has replaced the pump.

Recirculating Tube Dissolver. Operation of the recirculating tube dissolver was continued during the month to define the hydraulics and operability of the system for dissolution of spent nuclear power fuels. All tests were conducted with an 8-foot liquid level and gas motivated circulation through a 7.5-inch-diameter tube to four feet above the reservoir level.

Dissolution rates of Hanford slugs of depleted, metallic uranium in the circulating systems of 12 M HNO_3 were typical of batch rates, i.e., 28 mils per hour. Unsintered uranium dioxide rates averaged 240 mils per hour. (This dissolution rate is about twice that for sintered uranium dioxide and is consistent with that expected.)

Air rates required to maintain a circulation rate of 20 gpm ranged from 7 scfm to 50 scfm. Only 7 to 15 scfm of air was required to circulate hot solutions through a 20-inch depth of 1/2-inch uranium dioxide pellets and fines; but near 50 scfm of air was required to circulate cold solutions under the high lift to submergence (0.50) employed.

In dissolving zirconium with water boil-off removal of ammonia, the solution was over-concentrated and, as one would expect, zirconium precipitated; circulation stopped; and the dissolver temperature dropped. With this "plugged" condition the dissolver circulation was started by diluting with water and using a steam sparge instead of air for motivating circulation. After readjustment of conditions dissolution appeared normal.

To date, foaming has not been a problem in the circulating system; but the gases generally produced a volume expansion of 30 per cent where the reservoir volume was 1.5 times the dissolver-tube volume.

Sulfex Pilot Plant. Evaluation of the data from the first series of pilot plant runs involving the dissolution of 304-L stainless steel by the Sulfex process indicates that the quantity of hydrogen observed in the off-gas was somewhat lower than the stoichiometric quantities. The relative quantities of hydrogen in the off-gas very closely followed the course of the reaction and were used to determine the start and the end of the dissolution.

In use of decladding solutions containing 2.9-4.1 M H_2SO_4, no precipitation was experienced up to 1.1 M stainless steel concentration. With concentrations of 1.3 M stainless steel, a heavy precipitate occurred when the decladding solution was cooled to room temperature.

Document HW-61482, "Rates of Reaction of Irradiated UO_2 and Uranium Metal with Sulfuric Acid," by J. L. Swanson, has been issued.

Zirflex Process Chemistry. A point of some concern in the Zirflex process is the fact that uranium(VI) is relatively soluble in the terminal solution resulting from a Zirflex decladding operation. In particular, concern was felt that any uranyl nitrate solution left as a heel in a dissolver might be lost to the cladding waste in a subsequent Zirflex decladding step. Fortunately, however, laboratory studies in both glass and stainless steel equipment indicate that dissolution of Zircaloy-2 by either NH_4F or NH_4F - NH_4NO solutions containing uranium(VI) results in rapid and near-complete reduction of uranium to the less-soluble uranium(IV) for all conditions of practical interest. The situation is more favorable in stainless steel equipment where corrosion of the vessel apparently results in some reduction of uranium(VI).

In glass equipment the rate of reduction of uranium(VI) is apparently related to the rate of dissolution of zirconium by the expression

$$\frac{d\left[U(VI)\right]}{dt} = \frac{k\left[H^+\right]^{1/4}\left[U(VI)\right]\frac{d\left[Zr^{+4}\right]}{dt}}{\left[F^-\right]_f}$$

where the terms in brackets denote molar concentrations, the subscript "f" denotes "free" fluoride (defined as fluoride in excess of a six to one mole ratio with zirconium in solution) and k has a value of ca. 3000. From these data it is estimated that a typical Zirflex decladding operation would result in reduction of greater than 99.9 per cent of the initial uranium(VI) to uranium(IV).

Thus, the only point of concern is the possibility that re-oxidation of uranium(IV) may occur after decladding has been completed. A soluble reducing agent which could be added to the cooled cladding waste which would reduce and precipitate uranium(IV) would guarantee low losses of uranium to the cladding waste. One such reductant appears to be hyposulfite. The rate of reduction of uranium(VI) by hyposulfite in synthetic Zirflex cladding waste was found to obey the equation:

$$-d\frac{\left[U(VI)\right]}{dt} = K\left[U(VI)\right]\left[S_2O_4^{=}\right]\left[H^+\right]^{1/2}$$

where the terms in brackets denote molar concentrations and K has a value of 10^4 at 25 C for time in minutes. Assuming formation of uranium(VI) in cooled cladding waste at a rate of 10^{-3} miles/liter,hour (more than ten-fold greater than the expected rate via radiolysis), a concentration of 0.01 M hyposulfite at a pH of 8 would hold the uranium(VI) concentration to less than 1.7×10^{-3} M. A major question, as yet unanswered, is whether hyposulfite is sufficiently stable for such an application.

DECLASSIFIED

Dissolver Foaming Studies. The rate and volume of foam generated during both Zirflex and Sulfex dissolution processes were studied in the laboratory. Zirflex solutions were found to foam vigorously during the early stages of the dissolution process causing significant increases in solution volume. Sulfex solutions were observed to foam vigorously as long as any pieces of stainless steel remained undissolved. The volume increase due to foam was also found to be dependent on the volume of solution and the liquid depth; as the volume and liquid depth increased, the ratio of foam volume to initial solution volume decreased.

The effect of gas sparging on the rate and volume of foam generated during dissolution was studied by passing air through both the Zirflex and Sulfex dissolver solutions. As soon as the air was introduced, significant reductions in the volume of foam were noted.

Solvent Extraction

A minimixer settler run simulating first and second cycle Redox solvent extraction conditions was made using a feed solution prepared by dissolution of unirradiated U-3 per cent Mo alloy dissolved in HNO_3-$Fe(NO_3)_3$ solution.

Plutonium and fission products were spiked into the feed. Gross beta and gamma decontamination through the two cycles were factors of two and four, respectively, lower than obtained in a control run simulating current Redox operation. Ruthenium was the principle radio-contaminant in the product from the U-Mo feed run. Molybdenum contamination of the product was negligible.

Waste Treatment

Further exploration of methods for recovering uranium and plutonium from off-standard Sulfex decladding wastes have disclosed no promising precipitation methods. Precipitation of uranyl peroxide and selective precipitation of uranyl hydroxide by pH control could not be made quantitive for uranium. Total precipitation of heavy metal cations by phosphate or hydroxide is quantitative for uranium and plutonium but produced large (ca. 100 per cent of solution volume) quantities of solids. Sulfate ion washed readily from the hydroxide precipitate by dilution.

The pH of neutralized Zirflex process decladding solutions decreases on standing at elevated temperature due to loss of ammonia. To ensure a constant high pH (ca. 10) in neutralized wastes, an amount of base equivalent to the total ammonium ion present plus that needed to precipitate Zirconium hydroxide is required. Direct-strike neutralization of simulated decladding wastes (0.6 M Zr) produced 20 to 30 volume per cent of fast-settling solids which are difficult to suspend after standing. Reverse strike neutralization produced 50 volume per cent of slow-settling solids.

Materials of Construction

A sample of 304-L stainless steel obtained from Carpenter Steel Company (Ht. #40446), which contained greater than usual copper and molybdenum as impurities, dissolved about fivefold more slowly than "standard" 304-L under Sulfex decladding conditions. Corrosion rates obtained for this heat in Huey tests and under Zirflex decladding conditions were normal for 304-L.

Examination of the microstructure of copper-bearing Hastelloy F weld metal (reported last month to show no preferential attack in HNO_3-HF solution) disclosed no segregated phase in the weld metal or in the adjacent heat sensitized area.

Process Control Development

Boron Monitor. Development work on the Redox boron monitor was completed this month. The unit was calibrated in the laboratory with solutions containing from zero to two grams per liter boron in water, 50 per cent sodium hydroxide, 38 per cent sodium nitrate, 40 per cent nitric acid, and 60 per cent nitric acid. The recorder range was altered to make full scale correspond to water containing no boron and zero correspond to two grams per liter boron in 60 per cent nitric acid. The instrument has been delivered to the Redox plant.

Transient Pressure Measurement. Accurate pressure measurements were made to determine the transient pressure waves produced in the liquid phase when metallic sodium reacts with nitric acid. The observations were carried out using a Norwood Controls pressure transducer and a Hughes Memoscope. Liquid pressures were measured at the bottom of a vertical column of 60 per cent nitric acid contained in an 8-inch-diameter pipe. The metallic sodium was submerged to a depth of eight feet. Photographs of the transient pressure waves indicate a peak pressure of 850 psig and a frequency of 700 cycles/second for 20 grams of sodium and 700 psig at 1,000 cycles/second for 11 grams of sodium under the test conditions.

Criticality Studies - Feed Materials Preparation

A core material for the fifth PCTR criticality experiment (H/U atomic ratio of 35) using three per cent U-235 enriched uranium trioxide was prepared and delivered. The shipment consisted of approximately 220 pounds of polyethylene-moderated uranium trioxide.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Plutonium-Aluminum Alloy Processing

The concentration of plutonium in solution has been measured in a simulated decladding operation in which 1.5 w/o plutonium-aluminum alloy and Zircaloy-2 were simultaneously exposed to boiling 6 M NH_4F - 0.5 M NH_4NO_3. Measured plutonium concentrations were 2.5 mg/l in the initial solution, 2.6 mg/l after zirconium had dissolved to 0.47 molar (corresponding to 3.2 M "free" fluoride) and 3.3 mg/l after zirconium had dissolved to 0.81 molar (corresponding to 1.2 M "free" fluoride). Aluminum concentrations measured at the same time were, respectively, 1 g/l, 2 g/l, and 2 g/l.

Dissolver Off-Gas Analysis

A thermal conductivity cell for use on Redox dissolver off gases during Zirflex decladding of PRTR fuels has a greater response to background gases such as

DECLASSIFIED

DECLASSIFIED

ammonia and nitric oxide than tabulated thermal conductivity values would indicate. This is probably due to thermal convection effects within the conductivity cell. Two methods are being investigated to minimize this problem.

A method for calculating the percentage of hydrogen and ammonia in mixtures of hydrogen, ammonia, and air has been worked out. The method is based on sensitivity differences of these gases in a combustible gas analyzer (catalytic oxidation) and a thermal conductivity analyzer for compensating thermal conductivity cell readings for thermal convection effects is also being studied. A cell block originally fabricated for a combustible gas analyzer is being adapted for use with a thermal conductivity cell to determine the effectiveness of this approach to nulling out background gas sensitivities.

Continuous Ion-Exchange Contactor Development

Weis Contactor. Studies are continuing in the 3-inch-diameter by 4-foot-long Weis contactor to define the optimum plate spacing and downcomer protrusion (upwards) and overlap (downwards). A protrusion of at least one inch and an overlap of approximately one inch appears to give good hydraulic operation. Although it is also desirable to minimize the resin-free volume of the contactor, a plate spacing of three inches appears to be a minimum, with five or six inches preferred. The large plate spacings result in a few number of contacting stages and over all efficiency per unit length of column.

Conversion from the present intermittent air pulser to a continuous mechanical pulser is under way to permit operation under a greater variety of pulse amplitudes and frequencies.

Jiggler Contactor. The extraction section of a pilot, jigged, continuous countercurrent ion exchanger has been designed and 90 per cent installed. The 5-foot by 4-inch glass column employs the same principle as the Australian unit described in the 1958 "Geneva" proceedings. The fluidized bed will be pulsed directly with air to keep the resin bed from plugging by the solid-bearing feed. Equipment shakedown tests will start soon.

Fluidized-Bed Ion-Exchange Development

Fluidized-bed studies were continued in the 4-inch-diameter by 6-foot-long fixed-bed column using 0.01 M UNH in 7 M HNO_3 and Permutit 20 to 50 mesh anion resin. The flow rates varied from 0.6 to 1.5 gpm/sq ft downflow and from 0.3 to 1.5 gpm/sq ft upflow. The calculated values for HETP were 30 and 300 per cent higher for upflow rates of 0.3 and 0.6 gpm/sq ft, respectively, than for the corresponding downflow rates, indicating excessive channeling and mixing in high-density solutions, even at relatively low flow rates.

Boiling Metal Characteristics

Experimental work on the boiling metal system was concluded this month. Analysis of the data is in progress. Preliminary results indicate a loop with a very low hydraulic resistance will be necessary to satisfactorily absorb power inputs of

1 to 5 kw per foot of length. The key to stable operations appears to require fluid circulation at high enough rates so that boiling occurs only in the upper part of the heated column.

Salt Cycle Process

Because of current interest in the evaluation of electrolytically produced UO_2 as a fuel element material, a set of preparation conditions was fixed and a scaled up laboratory process was put into operation with a goal of producing about five kilograms to serve as a pilot batch of material for fuel element fabrication evaluations. Using a 3500 gram batch of NaCl-KCl eutectic charged with sufficient UO_3 to yield a 0.35 molal solution of UO_2Cl_2 after chlorination for three hours at 800 C and a reduction period of two hours at 30 amperes a production rate of about 300 grams/run results. Conditions are not particularly optimum and the product represents from 65 to 75 per cent of the total reduced - that not retained on the electrode is not recovered and is re-dissolved in the subsequent chlorination cycle.

A typical product from this process has a tap density of 5.8 g/cm^3 an aggregate density, as measured by fluid displacement, of 10.7 g/cm^3.

The weight change occurring when the electrolytic product is converted to U_3O_8 is less than that calculated for UO_2. Either the product has an O/U ratio of about 2.2 (which is questionable) or is contaminated with some material which volatilizes on heating and, therefore, offsets some of the weight gain due to oxidation. A sample held in hydrogen for six hours at 650 C had an apparent O/U ratio of 2.08; after 12 hours at 1700 C the ratio was 2.001. Currently, efforts are being made to ascertain what is responsible for this behavior.

Two noteworthy items were learned from this series of runs, (1) UCl_4 produced on depletion of the dissolved uranium to low concentrations can readily be reconverted to UO_2Cl_2 by sparging with air at 750 C, and (2) attrition on the graphite electrodes at the interface is markedly reduced by retention of a chlorine atmosphere. This is accomplished by merely blanketing the cell with glass wool.

Mercury Isotope Separation

A number of runs have been made to confirm the enrichment of mercury-202 as reported by H. E. Gunning and co-workers. The most noteworthy result of this series has been the very low yields of Hg_2Cl_2 obtained. This has two consequences; (1) the small sample size makes analysis by the gas source mass spectrometer difficult because of the "memory" effect and large background correction, and (2) low yield is a problem which must be solved in any practical separation scheme.

The reason for the low yield (which is not discussed by Gunning) has not been firmly established. It may, however, be due to a build-up of a butadiene dimer layer on the reaction vessel surface which absorbs or destroys the quality of the radiation. If so, a change to a less polymerizable organic reactant for free radicals suggests itself.

[redacted]
DECLASSIFIED

DECLASSIFIED

Spectrographic Determination of Mercury Isotopes

A scanning spectrometer modified to take photographs of spectra is being applied to the determination of mercury isotopes using the 3984A and 6123A lines and an electrodeless discharge. The isotope shifts for adjacent even isotopes in the case of these two lines are 0.08A and 0.085A, respectively. The photographic method is required because of the low intensity obtained from small samples, but a new grating blazed for the 16,000A region will increase the sensitivity by permitting the much more intense 2536A line to be used (in the 6th or 7th order). Some changes in the direct reading optics are expected to permit photomultiplier read-out for most samples, resulting in better precision.

WASTE FIXATION

Radiant Heat Spray Calciner Studies

Two long duration runs were made during the month, one for 18 and the other for 21 hours. The feed was formaldehyde killed synthetic, Purex 1WW. Build-up of solids on the walls of the column was no greater in the long duration runs than in one hour runs, and increase in pressure drop across the off-gas filter was slight in the first run and negligible in the second (larger filter - blow-back lines were installed before the second run). Although operation of the radiant heat spray calciner itself was uneventful, difficulty was encountered in the melt-down pot which was used to sinter the product. Faulty design and inadequate heating rate lead to bridging with a plug of partially sintered powder. Although not related to the spray calciner proper, this caused powder to back up and eventually shut down the first run.

The addition of borate to Redox and TBP-25 type wastes has been previously shown to result in glassy melts. This was tried in the spray calciner with good results. Using TBP-25 waste and one mole of borate per metal equivalent, a dense nitrious glass was obtained. The density of the product was about 2 g/cc.

Better values than those previously reported have been obtained for off-gas de-entrainment. The de-entrainment factor from feed to non-condensible off-gas was 1.8×10^8, and the factor from feed to condensate was 1.5×10^4, both satisfactorily high.

Mineral Reactions

Operation of the 50g clinoptilolite column was temporarily interruped to place heavier shielding around the column and to install a new feed pump to raise the flow rate from 2.7 gal/ft^2/day to about 6 gal/ft^2/day. Up to this time 13,600 gallons of filtered river water traced with Cs^{137} (24 uc/gal.) had passed through the column with a decontamination factor greater than 500 illustrating the ability of clinoptilolite to remove Cs in the presence of the relatively much larger amounts of other cations present in the river water.

As a part of the program to determine the ability of clinoptilolite to remove Cs from Purex boiling tank waste condensate, some synthetic 1WW Purex waste was

prepared and neutralized. The hydrated ferric oxide formed scavenged most of the fission products except Cs which remained in solution and thus would become the most important constituent in the condensate.

A study of the neutralization of representative simulated high level wastes continued. Gels were formed upon the addition of caustic to Darex, TBP-25 and STR wastes, which became slurries upon further addition of NaOH. All precipitates dissolved readily in HCl except those from TBP-25 and STR. The precipitates carried essentially all the radiostrontium in all cases. They contained 25-55 per cent of the Cs^{137} except in TBP-25 where 70 per cent was found in the solids.

BIOLOGY AND MEDICINE - 6000 PROGRAM

Detection of Low-level Radioisotopes

Detection limits were determined for 15 radioisotopes as measured in 500 gram samples in a large well scintillation counter. The NaI(Tl) crystal is 9-3/8-inch in diameter, 8-1/2-inch-thick, and has a 3-1/4-inch-diameter well 5-inches-deep. Using a 50-minute sample count and 1000-minute (overnight) background the detection limits (99 per cent confidence level) for Na^{24}, Sc^{46}, Mn^{56}, Co^{60}, Zr-Nb^{95}, I^{131}, Cs^{137}, and Np^{239} are 0.033 - 0.052 d/m per gram; for Zn^{65} is 0.067 d/m per gram; for As^{76} is 0.1 d/m per gram; for Cr^{51}, Cu^{64}, and Ru^{106} are 0.24 - 0.29 d/m per gram; for Ce-Pr^{144} is 0.34 d/m per gram; and for K^{40} is 0.46 d/m per gram. These limits will be somewhat higher if other interfering radioisotopes are present. Because of these low detection limit values, this apparatus is specially suitable for analyses of samples from low-level radiological studies.

Greater precision of standardization of radioisotopes is obtainable by the liquid scintillation beta-gamma coincidence counting and X-ray-gamma coincidence counting techniques recently developed. I^{131}, Ag^{110m} and Se^{75} were standardized by one of these methods and efficiencies determined for 4π or gamma scintillation counting methods so that these isotopes may be accurately standardized by these simpler and more routine methods.

Aluminum Isotope Scavenging Beds

Operation was discontinued this month of columns containing aluminum turnings for removing radioisotopes from reactor effluent water. The studies included tests of the effect of column length, effluent flow rate and temperature, aluminum turning surface area, and changing effectiveness with time. Preliminary evaluation of data from these tests indicate that this method may have application to treatment of wastes from present reactor operations. Studies of the biological and engineering factors of such application are being made by the Biology and the Chemical Effluents Technology Operations.

Geology and Hydrology

Comparison of exchange capacity profile data from well samples with recently completed geologic cross sections further confirmed the geologic interpretations. Variations in the exchange capacity up to 25-fold, however, were noted in individual beds, particularly in the Ringold formation. This reflects the known

DECLASSIFIED

DECLASSIFIED

heterogeneity and anisotropism even of these beds, but provides a measure of the degree of variance. Similarly, although the tendency was noted for the exchange capacity to increase downward through the series to the basalt, numerous exceptions and local reversals to the rule make such generalizations hazardous. The variations in exchange capacity appear due to variations in grain size (with consequent greater surface area per unit weight), to the degree of sorting, and to variations in the mineral content.

Construction of a thirteen-well test site north of Gable Mountain was initiated to study the movement and dispersal of various radioisotopes in the ground water. Three of these wells were completed in 1954 and four more were completed this month. From the hydrological data obtained from these seven wells, the remaining six well sites were selected.

Scale transformations were found which allowed solution of the differential equations describing flow through isotropic but non-homogeneous soils. These solutions require testing, however, by laboratory models and field trials. If these mathematical relationships show an acceptable degree of agreement with experimental results, the solutions of many soil physics problems at Hanford involving flow of wastes through stratified soils can be facilitated.

Soil Chemistry and Geochemistry

The incremental effects of Na concentration on the Cs capacity of clinoptilolite decreases rapidly with increasing Na concentrations. For example, with a common Cs^+ concentration of 0.01M and no $NaNO_3$, Cs capacity is 135 meq Cs/100g clinoptilolite; at 3M $NaNO_3$ it is 34 and at 6M it is 29 meq Cs/100g clinoptilolite. These data indicate a possible application of clinoptilolite for Cs removal from high-salt wastes.

The addition of competing Na as nitrate, chloride or sulfate did not change the effect of the Na on clinoptilolite Cs capacity.

The "mass-action" relationship between Cs concentration in solution and corresponding clinoptilolite Cs capacity yields a straight line when the above data are plotted on log scales. This information allows prediction of Cs capacities at tracer Cs concentrations by extrapolations utilizing line slopes. Obtaining clinoptilolite Cs breakthrough data experimentally at tracer Cs concentrations would be exceedingly tedious because of the large volume of throughput required to reach breakthrough.

Degree of peptization as measured by light transmittance was less in a centrifuged soil-Ce equilibrium system when the system had been neutralized by CsOH than when neutralized by NaOH. This tends to support a previously advanced theory that the cerium occurs as a negatively charged colloid resulting from association with hydroxyl ions.

When the centrifuged supernatant solution of a Ce system dispersed with NaOH was passed through Hanford surface soil an immediate breakthrough of activity was noted. The first 10 per cent of the effluent solution had an active concentration 80 per cent of that in the influent. Effluent turbidity decreased with decreasing Ce content indicating an association of the Ce with the mobilized clay fraction of the soil.

Ground Waste Investigation

Soil columns studied at different infiltration rates showed that at rates below 4 $ml/cm^2/hr$ the characteristics of the Sr breakthrough were not affected by flow rate, indicating that the column is near equilibrium at all points. At flow rates greater than this, the volume to breakthrough becomes less as the flow rate increases. At 40 $ml/cm^2/hr$ the capacity of the column for Sr is about one-half of that at 4 $ml/cm^2/hr$. Most waste disposal sites are estimated to have flow rates no greater than about 2 $ml/cm^2/hr$, indicating maximum utilization of the soil capacity.

A column 9.3-feet-long using dry soil from the test crib site was studied to detect possible nitrate hold-up. The first 20 ml of effluent (ca. 2 per cent of a column volume) contained essentially the same quantity of NO_3^- as the influent, indicating no NO_3^- hold-up.

Flow of Sr^{85} spiked $Ca(NO_3)_2$ was started into the 0.25 ft^2 crib on August 3. This second experiment using smaller crib and increased Sr^{85} concentration is to study the scaling factor on underground spreading. By August 26, 600 gallons had been put to ground.

Soil experiments with Recuplex Process waste going to 216-Z-9 crib indicated that much of the contained Pu may be concentrated near the bottom of the crib. Plans were made to obtain 4 soil core samples to determine Pu distribution so that criticality calculations may be made.

Field Apparatus Development

A commercial twelve-channel seismic refraction instrument was demonstrated by a sales engineer of the Electro-Technical Labs, Houston, Texas, in the project area. Seismic lines were run at three locations near wells drilled to basalt. Data from these tests permitted depth to ground water and basalt to be determined at one site, and the Ringold conglomerate at a second site. The presence of a fault or channel in the Ringold conglomerate near well 42-12 (south of Hanford townsite) was strongly indicated. The reconnaissance-type surveys were performed in a short time and did not permit full exploitation of the method but further application of seismic methods holds considerable promise in obtaining geologic data with speed and accuracy.

The in-well television development was reported in Document HW-61323, "A Closed Circuit Television System for In-Well Use - Interim Report," by C. A. Ratcliffe, August 5, 1959, Unclassified.

A soil moisture measurement technique for laboratory use was studied which would permit removal, weighing and replacement in the model of a core of the unsaturated soil.

DECLASSIFIED

DECLASSIFIED

[redacted]

Rupture Monitoring and Rupture Debris Characterization

A document, HW-61325, "Significance of Rupture Debris in the Columbia River," summarized the relationships of ruptures to river concentrations. The need is pointed out for considerably more data to achieve better measurement of rupture monitor sensitivity, river clean-up of rupture debris and characterization of rupture debris.

Micromeritics

The USPHS course in Atmospheric and Source Sampling at the University of Massachusetts was completed.

Experiment and equipment design was underway for measuring particle deposition parameters in tubes, ducts, and pipes.

L. P. Bupp
Manager,
Chemical Research & Development

LP Bupp:bp

[redacted]

ORGANIZATION AND PERSONNEL

L. A. Bray, Engineer I, was transferred in from Chemical Processing Department and assigned to the Chemical Research Operation.

W. R. DeHollander, Senior Scientist, transferred to APED, San Jose, California.

J. W. George, Chemist I - H, terminated to return to his teaching position.

T. Harris, Junior Scientist, terminated to return to school.

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. Wilhelmson	8/10	Atomic Energy Commission Idaho Falls, Idaho	Discuss instruments and instrumentation.	WH Bierschenk PP Rowe LC Schwendiman	No
D. Verhagen J. S. Burns	8/10/	Van Waters & Rogers Inc. Seattle, Wash.	Industrial chemicals and minerals for waste disposal.	LL Ames JL Nelson	No
M. Savery	8/10/	National Geographic Magazine Washington, D.C.	Tour 325 Building for future story to be published in the magazine.	EE Voiland	No
C. S. Schlea	8/11-12/	Savannah River Lab. Aiken, South Carolina	Discuss fission product recovery.	RL Moore	Yes
C. Schlea	8/11/	duPont - SAP Aiken, South Carolina	Discuss fission product packaging.	RJ Sloat	No
J. Humberstone A. Muller J. Don Rauth E. Zuckart	8/12/	Air Reduction Sales New York, N.Y. Martin Company Baltimore, Md. Consultant for Air Reduction Sales and Martin Company.	Discuss fission product packaging.	RJ Sloat LP Bupp	No

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
D. R. DeBoisblanc R. B. Lemon	8/17-18/	Phillips Petroleum Idaho Falls, Idaho	Discuss waste processing technology.	RL Moore BM Johnson	Yes
R. D. Walton	8/17-19/	Idaho Operations Office - AEC Idaho Falls, Idaho	Discuss waste processing technology, waste treatment & Non-Production Fuels	RL Moore BM Johnson OF Hill RJ Sloat CE Linderoth	Yes
C. Huntington W. Burkhardt	8/17/	Fernald Cincinnati, Ohio	Discuss spray calcination.	BM Johnson	No
G. H. Whipple	8/18/	Univ. of Michigan Ann Arbor, Mich.	Discuss earth sciences.	DW Pearce	No
Mr. Coleman	8/19/	Argonne National Lab. Lemont, Illinois	View hot cells.	HH Van Tuyl	No
J. R. Prince	8/27/	Univ. of Washington Seattle, Washington	Discuss research in waste disposal at Hanford	LL Ames PP Rowe	No
G. W. Watt	8/24-28/	Univ. of Texas Austin, Texas	Technical Consultant	LP Bupp RK Hilliard AJ Scott WH Reas MT Walling OF Hill RE Burns	Yes
C. R. Naeser	8/31/	USGS Washington, D.C.	Discuss mineralogic research as related to decontamination of wastes.	DW Pearce JF Honstead	No
R. J. McNamee A. D. Ryon	8/31/	ORNL Oak Ridge, Tenn.	Discuss solvent extraction technology including work on Non-Production Fuels.	AM Platt	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
E. E. Voiland	8/3-4/	Union Carbide Nuclear Paducah, Kentucky	Discuss UO_3 problems.	V Katzel C Powell R Levin	Yes
	8/5/	Mallinckrodt Chemical St. Louis, Mo.	Discuss UO_3 reactions.	AE Ruehle JA Kennelley	No
A. K. Postma	8/3-14/	Univ. of Massachusetts Amherst, Mass.	Attend USPHS Atomospheric & Source Sampling Course.	HP Kramer	No
	8/17-18/	KAPL and GEL Schenectady, NY	Discuss small particle technology.	RJ Feinberg WH Truran TA Rich SB Dunham	No
B. W. Fry	8/5-14/	Idaho Operations Office Idaho Falls, Idaho	Perform analytical chemistry work.	C Sill D Walker	Yes
L. P. Bupp	8/12/	Walla Walla College College Place, Wash.	Present talk to summer students.	RH Brown	No
K. J. Schneider G. L. Richardson	8/10/	Brookhaven Nat. Lab. Upton, New York	Discuss Non-Production Fuels, Non-aqueous reprocessing and waste calcination.	C Williams	Yes
	8/11-12/	Argonne National Lab. Lemont, Illinois		Mr. Munecke	Yes
	8/13/	Phillips Petroleum Idaho Falls, Idaho		CM Slansky	Yes
R. R. Robertson P. F. Raney	8/17-28/	Idaho Operations Office Idaho Falls, Idaho	Perform analytical chemistry work.	C Sill D Walker	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
M. C. Lambert	8/10/	Pratt & Whitney Aircraft Livermore, Calif.	Discuss X-ray equipment and special shielding.	VG Scotti	No
		University of Calif. Davis, Calif.	Discuss X-ray methods.	J Buchanan	No
	8/12-14/	Estes Park, Colo.	Attend Conference.	W Mueller	No
M. T. Walling G. E. Benedict	8/18-19/	Savannah River Lab. Aiken, South Carolina	Discuss Palmolive Program	JW Morris	Yes
	8/20/	ORNL Oak Ridge, Tenn.	Discuss power reactor fuel processing.	FL Culler	Yes
F. P. Brauer	8/17-18/	Vallecitos Atomic Lab. Pleasanton, Calif.	Discuss mutual problems in radiochemical analysis.	HW Alter	Yes
	8/19/	San Francisco, Calif.	Attend Wescon Instrument show.		No
G. Rey	8/21/	Argonne National Lab. Lemont, Illinois	Discuss fluidization and volatility pilot plant problems & liquid smoke waste disposal.	S Lawroski JR Humphreys F Smith	Yes
	8/24/	Pratt & Whitney Aircraft Div. Middletown, Conn.	Off-Gas deentrainment studies.	HK Lemar	Yes
R. L. Moore W. H. Reas	8/17/	AEC Washington, D.C.	Discuss current & future fission product needs.	WH McVey DR Miller	Yes
	8/18-19/	Martin Company Baltimore, Md.	Discuss SNAP Program	WWT Crane	Yes
	8/20-21/	ORNL Oak Ridge, Tenn.	Discuss fission product recovery and waste treatment.	FL Culler	Yes
W. H. Reas	8/19/	Savannah River Lab. Aiken, South Carolina	Discuss Palmolive Program.	JW Morris	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. W. Pearce J. L. Nelson J. F. Honstead W. H. Bierschenk C. E. Linderoth	8/25-27/	Univ. of California Berkeley, California	Attend AEC-sponsored Seminar and present papers.	WJ Kaufman	No
H. H. Van Tuyl	8/27-9/3/	ORNL Oak Ridge, Tennessee	Observe and consult on fission product recovery.	E Lamb FL Culler	Yes

BIOLOGY OPERATION

A. ORGANIZATION AND PERSONNEL

No significant changes occurred during August.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Radioiodine Contamination

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

Location	μc/g Wet Wt. Average	μc/g Wet Wt. Maximum	Trend Factor
4 Miles SW of Redox	2×10^{-4}	4×10^{-4}	-
Prosser Barricade	1×10^{-4}	2×10^{-4}	- 4
Wahluke Slope	7×10^{-5}	8×10^{-5}	- 3

Columbia River Contamination

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

Sample Type	μc/g Wet Wt. Average	μc/g Wet Wt. Maximum	Trend Factor
Minnows (entire)	1×10^{-3}	1×10^{-2}	- 2

Young trout appear to be killed more slowly following exposure to C. columnaris than were young salmon. Two large trout were each injected in the dorsal aorta with 5000 columnaris organisms. One of the two died in two weeks with typical symptoms of infection. The other showed no symptoms and was discarded.

Autopsy of fingerling trout shows the dermal portion of the skin as the tissue most affected by columnaris. Blister-like structures filled with microcysts characteristically appear in the dermal layer. The larger trout is currently being checked for sites of pathologic damage.

Fallout Contamination

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

Sample Type	µc/g Wet Materials Average	Trend Factor
Bone	4×10^{-5}	- 2
Feces	3×10^{-5}	-
Liver	8×10^{-6}	-
Muscle	7×10^{-6}	- 4

Effect of Reactor Effluent on Aquatic Organisms

Routine monitoring of effluent from the 100-KE reactor continues to show a slight deleterious effect on young rainbow trout at the 3 per cent strength level. Results at the 2 per cent level are inconclusive.

Equipment fabrication and placement was begun for a test to determine the effectiveness in reducing contamination in fish of passing effluent through a bed of aluminum turnings.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Zinc

Pregnant female rats were placed on a Zn^{65} drinking water regimen. Animals will be sacrificed at intervals to determine relative deposition of Zn^{65} in the dam and fetus.

Strontium

Yearling rainbow trout have received intramuscular injections of Sr^{90}-Y^{90} for thirteen weeks. No gross evidence of radiation damage has appeared even in the high level group (1.5×10^{-2} µc/g of fish twice each week) except for a greater variance in size.

Several successful measurements of the movement of Sr^{85} across the gill membranes of trout were made with the perfusion technique. Reproducible results are being obtained and the rate coefficients appear to fall within the anticipated range.

Initial harvest data from plots initially contaminated in 1954 with Sr^{90} show no significant change in Sr^{90} concentration in plants compared with that observed in past years.

Following weaning, miniature swine of the F-1 generation were started on a daily Sr^{90} feeding of 1 or 5 µc/day in the long-term toxicity study.

No changes in the cellular components of the blood have yet been observed in the miniature swine fed 25 µc/day for five months, but there is a suggestion of a change in the blood-enzyme component.

Iodine

Six young adult Pitman-Moore swine utilized in a study of various anesthetic regimens were given a tracer dose of I^{131} prior to sacrifice. Preliminary observations indicate that peak I^{131} concentrations in the thyroid averaging 30 per cent of the administered dose were realized at 24 hours and the effective half-life of I^{131} in the thyroid gland was about 6.5 days.

From two attempts to expose vegetation to volatile fuel element melt-down products, only two groups of plants were appreciably contaminated. Leaves from these plants were washed in water, KI, dilute HCl, $Na_2S_2O_5$, dilute NH_4OH, and Pluronics. In all cases about 50 per cent of the I^{131} was removed from the leaves. Data were quite variable and a further attempt is being made to obtain more contaminated plants.

Cesium

Carrier cesium reduced yields when included with potassium in nutrient solution at K/Cs ratio of 1/1, very toxic at 1/10, but no effects were observed 100/1. All cesium concentrations were kept below 0.2 meq Cs/L.

O.R. values increased as potassium was increased in nutrient solutions. These values are similar to previously reported data from experiments where no carrier cesium was added to nutrients. This further shows Cs^{137} is a poor tracer for potassium, because OR values increased by a factor of 40 with 1000 fold change in potassium concentration in the substrate.

Experiments in which plants were grown in soils containing the same amount of Cs^{137} but different amounts of water were continued. The ratios of Cs^{137} concentrations in plants grown in soil containing water at field capacity, saturation, and saturation with 2½ inches of standing water were 1, 4.5, and 110, respectively.

Plutonium

Rats with a body burden of 1 μc deposited plutonium accumulated 2600 r of total body X-irradiation in 100 r per week doses. Only one of 12 rats has survived while seven of 12 rats receiving the X-irradiation but having no plutonium survived. Rats with plutonium deposition of 2.4 and 6.4 μc are being similarly irradiated. All have survived a total dose of 700 r.

Preliminary results are available from the experiment designed to demonstrate the survival value of DTPA treatment for plutonium contaminated rats. Six out of seven rats receiving 200 μc/kg Pu^{239} died on the sixth day. Five of seven rats receiving the same dose of plutonium but subsequently treated with 1.5 millimols/kg DTPA died on the seventh day. DTPA treatment at this extremely high plutonium level was therefore relatively ineffective. Animals treated with DTPA showed smaller weight losses than untreated animals. A similar experiment was performed at a 40 μc/kg Pu^{239} injection level. Again the DTPA treated animals showed a smaller weight loss. All of these animals are still alive; the plutonium injected should cause death in approximately four months. No data from these experiments are yet available with regard to plutonium concentrations in the animal or in the excreta.

In the study of the therapeutic effectiveness of DTPA in miniature swine, analyses of the tissues and excreta from three control animals given plutonium but no DTPA are virtually complete. Treatment of plutonium injected miniature swine with DTPA will be accomplished next month.

The two swine previously injected intradermally with plutonium nitrate are being periodically monitored with scintillation probes. Monitoring results recorded since last month's report indicate very little removal of the injected substance.

Radioactive Particles

An estimate of the acute lethal dose of inhaled $Pu^{239}O_2$ in dogs was obtained. Five dogs died within four months after deposition of 50 to 100 μc.

Two dogs were killed 40 weeks after inhalation of about two μc $Pu^{239}O_2$. During this period one dog excreted 55 per cent of the deposited dose in feces, retained 21 per cent in lung, and 22 per cent in tracheobronchial lymph nodes. The other dog excreted 38 per cent in feces, retained 53 per cent in lung, and seven per cent in tracheobronchial lymph nodes. The daily variation in excretion of Pu^{239} was often more than 100 fold. The half-time for fecal excretion of Pu^{239} was 1400 and 1600 days for the period four to 40 weeks after exposure. The data showed greater retention of Pu^{239} in dogs than in mice where the maximum half-life observed for lung clearance was 460 days.

The mean total fecal excretion of Pu^{239} by 14 dogs the first two weeks after pulmonary deposition of $Pu^{239}O_2$ was 52 per cent of the deposited dose with a standard deviation of $\pm$ 18 per cent. Excretion in urine was 0.36 $\pm$ 0.25 per cent. Total fecal excretion over a two week period after exposure may provide a reasonable estimate of the deposited dose of $Pu^{239}O_2$.

Dogs are being trained for single and weekly exposure to $Pu^{239}O_2$ for long-term study of the behavior and biological effects of Pu^{239}.

It is planned to use rats to screen a variety of agents for hastening the pulmonary clearance of Pu^{239}.

Gastro-intestinal Radiation Injury

In the experiment designed to study the effects of chronic beta irradiation of the GI tract in which 0.5 mc/day of Y^{90} were fed over a two month period, the first animal has died since cessation of the Y^{90} feeding. This animal died approximately 300 days after the initial treatment and showed gross evidence of carcinoma of the colon, as yet unconfirmed histologically.

Attempts to use glucose absorption as a measure of radiation dose to the intestine by determining glucose levels in the blood are unreliable due to extreme variability in blood sugar levels following irradiation. Preliminary indications are that absorption from the intestine is inhibited by X-ray doses as low as 300 r and that the duration of the inhibition is dose dependent.

Radiation Protective Agents

Recent efforts to measure more adequately the protective effect of erioglaucine in both mice and rats have indicated a very slight protective effect much less impressive than that originally noted. It is possible that this may be due to a relatively impure preparation of erioglaucine which was used in recent tests.

Microbiological Studies

Haploid yeast appears to utilize EDTA as a carbon source. To determine whether the utilization was complete, it was tested by the Warburg technique. It appeared that oxygen utilization with EDTA as a substrate was about 25 per cent of that with an acetate substrate. Substantial amounts of CO_2 were liberated from the acetate but not from the EDTA. Thus it is still uncertain whether this yeast utilizes EDTA or not.

Respiratory deficient strains of yeast known to contain reduced cytochrome and catalase were compared with the parent non-deficient strain regarding degree of radiation killing in a N_2 and O_2 atmosphere, expression of post-irradiation damage, and respiration response in a Warburg. No consistent results were obtained which related to known mechanisms of radiation damage.

Gonad Dose

In a continuation of the study on gonadal dose in rams from beta- and gamma-emitting isotopes, the gastrointestinal absorption and biological turnover of Zn^{65} and Cs^{137} was determined from whole-body measurements. These data indicate that the gastrointestinal absorption of Cs^{137} was 40 to 60 per cent. Four days after I.V. administration, 50 per cent of the administered dose was excreted. The approximate biological half-life of the Cs^{137} remaining in the body at that time was 20 days.

Gastrointestinal absorption of Zn^{65} was 15 to 20 per cent, excretion of 50 per cent of an I.V. dose requiring 24 days. It was estimated that more than 50 days would be required for excretion of 50 per cent of the Zn^{65} remaining in the body after 10 days. These estimates may be revised when all excretion data have been analyzed.

Analysis of the tissues from the rams fed Cs^{137} for 5, 10 or 20 days showed highest concentrations in this order: pancreas, kidneys, pituitary, adrenals, testicles, muscle (including heart and tongue) and bulbo-urethral glands. Whereas most of these tissues appeared to be approaching their maximum concentrations of Cs^{137} by the tenth day (~ 4 x blood plasma levels), muscle continued to increase throughout the 20-day period.

HA Kornberg
Manager
BIOLOGY OPERATION

HA Kornberg:es

C. OFF-SITE VISITORS AND TRIPS

Name	Dates of Visits	Company or Organization Represented	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
VISITS TO HANFORD WORKS						
40 U. of Wash. Summer Institute Fellows	8/3-6	High school and college science teachers.	Training program.	FP Hungate and Biology staff.	No	100-F, Biology
Merle Severy	8/10	National Geographic Magazine	Tour Biology.	LA George	No	"
Dr. Shubek	8/4	Consultant to C. Bennett	Tour	LK Bustad	No	"
5 Naval officers	8/10	Nuclear Submarine Savannah	Tour	PA Olson	No	"
29 USAF Officers	8/21	Larson AFB	Tour	Capt. Persing	No	"
Col. Tessmer	8/28	Armed Forces Institute of Pathology, Wash.DC	Tour and discuss research.	LK Bustad	No	"
VISITS TO OTHER INSTALLATIONS						
JJ Davis, WC Hanson, DG Watson	7/17-8/15	Kotzebue, Alaska-Project Chariot	Biological survey	-	-	
RL Uhler, JE Stewart	8/17-9/	Dugway, Utah	Participate in fuel element burn-down experiments.	-	-	
WJ Clarke	8/20-28	Ames, Iowa; Kansas.City	Discuss research at U. of Iowa - Dr. Jensen Attend AMVA Convention			
AC Case	8/16-30	AEC, Idaho Office, Idaho Falls	Analysis of samples.	C. Gills	-	

D. Lectures

a. Papers presented at Meetings

None

b. Off-Site Seminars

University of Washington Summer Institute Program at Hanford:

August 3 - RC Thompson, "Evaluation of hazards from internal emitters"
RF Palmer, "Ion competition in animals"
NL Dockum, "Autoradiography"

August 4 - MF Sullivan, "Effects of gut irradiation"
RL Uhler, "Ion uptake by plants"
LA George, "Effects of skin irradiation"

August 5 - LK Bustad, "Large animal studies in radiation biology"
WJ Bair, "Hazards from inhaled isotopes"
RC Pendleton, "Isotope transfer through food chains"

c. Biology Seminars

None

E. Publications

a. HW Publications (external distribution)

None

b. HW Publications (internal distribution)

None

c. Open Literature

None

OPERATIONS RESEARCH AND SYNTHESIS OPERATION
MONTHLY REPORT

August, 1959

ORGANIZATION AND PERSONNEL

There were no changes in personnel during the month of August.

OPERATIONS RESEARCH ACTIVITIES

Input-Output Simulation Model

Work on the computer program continued. A comprehensive test case for the program has been formulated. During the visit of Dr. Martin Shubik to Hanford, technical details of the statistical program were discussed in terms of the possibility of integrating this material with his over-all simulation program in order to facilitate the simulation program at Hanford.

Other

In connection with the study of business systems, work on an examination of the Data Processing Operation continued. Information for this work has been collected and a method of analysis outlined, and the study should be completed during September.

Some generalized remarks on the behavior of the "worth" of plutonium were prepared and presented to the task force on profitability measurement.

OPERATIONS ANALYSIS STUDIES

Redox Dissolver Study

Based on chemical kinetic theory, the hypothesis that the specific gravity time relationships in the Redox dissolvers are primitives of a general class of differential equations was tested extensively using Redox operating data. In addition, six sub-analyses of the general data have been made by hand calculation, and two large scale models were formulated for computation when the machine program is complete.

Z Plant Information Study

Due to delays within the Data Processing Operation, work on logic flow diagramming for the IBM processing portion of the information system has been started internally. In addition to accelerating the programming, this work will provide valuable training in and experience with the generalized routines involved.

DECLASSIFIED

 DECLASSIFIED [redacted]

FPD Process Control and Experimentation

Data from an experiment designed primarily to estimate the effects of increased concentration of Diversey were analyzed. The experiment was also designed to permit estimation of the effects on incidence of non-wets of all possible cleaning combinations.

An additional experiment was conducted to determine the effects of core size on fuel element quality. In addition to data on rejects, variables measurements were taken to evaluate the integrity of the bonding layer (total count) and the can wall thickness (caustic penetration and optical comparator). A seeming discrepancy between results based on attributes and those based on variables was due to insufficient sample sizes.

A test was run to determine whether or not trepanning around the base of the stud was necessary prior to the stud pulling test of bond strength. The results of this test were also used to estimate required sample sizes if the test is to be included in the Quality Certification Program.

Data were analyzed from two experiments conducted to determine the effects of welding on bond integrity as measured by total count. Single-pass welding and double-pass welding were both investigated, and repeat measurements on the fuel elements, both successively and after a period of time, gave valuable information about the reproducibility of the 306 tester. The effects on bond integrity of using various cleaning techniques on the bare uranium cores were also investigated.

A number of uranium cores were subjected to a different transformation treatment at Fernald in anticipation of reducing the hydrogen content, and hence, improving bond integrity. These were then canned in the pilot plant, and the resulting quality was compared with control material canned at the same time.

Tubes for the NPR prepared by the extrusion process have fairly rigid specifications with regard to wall thickness. Data from a number of tubes extruded in the developmental stage are being analyzed in order to determine whether or not these specifications can be met. Of prime interest is the variation in wall thickness observed in a given portion of the tube.

Quality Certification Program

As part of the mechanics of initiating the Quality Certification Program, dimensional and weight data for several lots of different type fuel elements are being analyzed. These data will be used to determine specifications for the various measurements.

Process Tube Leaks

Data are currently being collected in an attempt to determine a leak severity index which would be useful in predicting when a given tube is likely to leak due to external corrosion. The initial analysis will be completed during the next few weeks.

[redacted]

Reactor Calculations

The report on the accuracy of reactor power level calculations is nearing completion. In line with this, a rather complete study was made of the power recording system across all reactors to determine whether or not areas for improvement exist. There appears to be little promise of improvement in this area. In general, it appears that the long term relative error in the product yield estimate is dominated by systematic errors which may exist in the system. As will be discussed in the report, there are logical reasons why these systematic errors cannot be completely assessed or eliminated.

Final Product Specifications

A recommendation has been made and accepted that the number of analytical determinations per part be decreased from six to three. This will ease the work load of the laboratory, and should lead to no difficulty in demonstrating that parts meet current specifications.

An apparent discrepancy in magnitude of analytical errors between different AEC sites has been noted by LASL personnel. A meeting to discuss this situation and to consider other statistical aspects of final product specifications has been arranged. Preparations are currently being made to attend this meeting.

Radiation Protection Studies

Data from an experiment to investigate the effect of exposure angle upon the gamma film badge response were analyzed. Based upon the assumption that all exposure angles are equally likely to occur, average value factors were calculated which can be used to correct field film to 90° exposure for comparison with calibration curves. A detailed report of the experiment and its analysis will be issued in the near future.

The data analysis of the experiment to test the validity of the inverse square law as it applies to radium gamma film badge calibration is still in progress.

Systems Reliability

The revised logic diagram of the K plant water system has been completed and estimates have been obtained of the required failure frequencies. Based on this work, preliminary evaluations can now be computed using the generalized computer program previously developed.

STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program - Electron Diffraction

A statistical analysis was completed of gold film electron diffraction patterns for Physical Metallurgy Operation in order to determine the

DECLASSIFIED

DECLASSIFIED

precision and accuracy of their current calibration formula for powder patterns. Estimates of several biasing factors, including spherical aberration, asymmetric characteristics of individual rings, and diameter measurements, were supplied as well as the over-all precision of the K calibration constant estimate.

4000 Program - Swelling Studies

Micrographs of pre- and post-anneal uranium samples were further analyzed and the distributions of pore diameters appearing on the micrographs were compared. The data permitted a detailed study of these diameter distributions and gave an indication of pore growth distinguishable from any distortion introduced in the processing. Void fraction estimates will be compared with given density changes.

4000 Program - Plutonium Recycle

Further statistical analysis was done on data from the recent PRTR containment vessel pressure test in an attempt to determine more precisely the leakage rate during the test.

6000 Program - Biology and Medicine

Statistical analysis was initiated of data from a Pharmacology Operation experiment involving plutonium inhalation by dogs. A three compartment excretion model has been derived, and current efforts are directed toward estimation of the parameters of the model.

General

Investigations are continuing on methods of obtaining exact and approximate solutions to the problem of determining the thermal stresses in solid cylindrical fuel elements under conditions of non-uniform heat generation.

A series of mathematical analyses concerned with the time variation of concentrate in both recirculating and cascading dissolver tanks were completed.

Paired quantitative analyses for several effluent water samples, using a single channel instrument and also a 256 channel instrument, were submitted for statistical analysis by Analytical Chemistry Operation. The data are being processed to investigate the relative bias and precisions of the two instruments for routine isotopic evaluation of effluent water. An experimental design was suggested for further comparison of the instruments in order to determine more precisely their relative characteristics.

Data from the last two tank calibrations runs in connection with the non-production fuels reprocessing measurements have been analyzed, and preliminary estimates of calibration precision have been found. It was found that precise control over the temperature of the manometer fluid is necessary.

[redacted]

Adjustments made to estimates of the slopes of the calibration curves due to changes in recorded manometer fluid temperature were substantial in magnitude. A fair amount of the significant between calibration variance has been removed by means of these corrections. Formulas were developed for estimating the intercept, the within calibration variance associated with the intercept, and the covariance between the slope and intercept estimate for the cumulative model.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Irradiation Processing Department

Assistance was provided in the design of an experiment concerned with assessing the extent of charge damage on bond integrity. Selection of the sample was made such that fuel elements subjected to different degrees of impact in the experiment were homogeneous with respect to pre-impact total bond count and bond strength.

Chemical Processing Department

Estimates were made of the accuracy and precision of the amounts of uranium and plutonium present in a given dissolver tank in connection with HAPO's future role in dissolving power reactor fuels from other sites. A discussion of random and systematic errors was included in the report on this problem. This was closely associated with recent work in the area of tank calibrations.

Construction Engineering and Utilities Operation

A report presenting the results of a review of the measuring system used to evaluate fair cost estimates was issued during the month.

Relations Operation

Departmental average percentages of favorable results were computed in connection with the recent GE News readership survey. It was pointed out in discussing these results with personnel involved that these percentages as they stand can be misleading, and that they should be interpreted only in light of the observed differences between employee groups noted in the previous analysis of these data.

A preliminary consultation has been held with personnel of the Data Processing Operation concerning a study of machine failure rate.

Statistical analysis of data from several cases of accidental plutonium deposition in humans has been completed, and the results reported to interested persons.

Carl C. Bennett
Manager
OPERATIONS RESEARCH & SYNTHESIS

CA BENNETT:jbk

DECLASSIFIED

[redacted]

DECLASSIFIED

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
George Garrett	8-4-59	Union Carbide & Carbon Oak Ridge, Tenn.	Consulting	CA Bennett	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
Carl A. Bennett	8-24 to 8-28-59	Gordon Res. Conf. New Hampton, N.H.	Discussion Leader	-	No
"	8-31-59	GE Reactor Safeguards Council Chicago, Ill.	Consultation	J. W. Healy et al	No

PROGRAMMING OPERATION
AUGUST 1959

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. Radioisotopes for Heat Sources

Study of the potentials for ionium (thorium-230) recovery from uranium ore mill waste streams continued. Samples of liquid streams were obtained and chemical analysis to characterize thorium content was started. If the ore leaching process solubilizes the ionium in the ore, a relatively simple recovery process may be effected by merely adding an ion exchange treatment to present waste streams.

Study of alternate irradiation schemes indicated that it should be possible to produce good yields of pure protactinium (Pa-231) by irradiating ionium highly contaminated with thorium-232, with no need for any isotope separations process. Studies on the Pa-231 indicate that combinations of irradiation and separation processes which provide rapid throughput and lowest inventory (to achieve minimum losses of neutrons in side reactions) would be best for producing large amounts of uranium-232. The uranium-232 may itself have distinctive properties as a heat source or it may be stored for routine periodic recovery of its thorium-228 daughter product. Thorium-228 may be of unusual interest as a heat source because of its high heat potential of 156 watts per gram.

B. REACTOR DEVELOPMENT - 4000 PROGRAM

1. Plutonium Recycle Program

Cycle Analysis

Computer Code Development. The self-sustaining plutonium recycle portion of the IBM-709 plutonium value analysis program was tested and checked against the former nine separate IBM-650 programs which it supplants. With testing and checking now complete it is an operable program now being applied to supply needed data. Progress was also made in checking and testing the equivalent program dealing with once-through reactor cycles. To further expedite the computer work and to capitalize on the large memory and high speed of the IBM-709, preliminary analysis was made of coding procedures necessary to use this machine to eliminate almost all hand processing of fuel cycle economic data. Considerable hand processing of such data was required during the period of use of the IBM-650 machine.

The Meleager fuel cycle analysis code is now set-up for the IBM-709 computer and was checked against some available data relating to a single channel experiment in a production reactor. Thus far, approximately 20 separate check cases have been run, with parameters of neutron temperature and epithermal ratio. The agreement between calculated and observed

isotopic compositions of the plutonium produced was excellent (within 0.12% for Pu-239). The calculated values of reactivity turned out to be lower than observed, and analysis is being made to understand the discrepancy. Evidentally, it is attributed to the use of an incorrect self-shielding factor for uranium fuel rods.

Improvements were made in utilizing the Meleager code on the IBM-709 machine and resulted in a reduction of actual machine time to about two minutes per case (considering 16 isotopes and exposures of up to 2000 MWD/T). In addition, a new and more extensive cross-section library was completed which will permit the application of the code to thorium fuel cycles.

Further progress was made in rounding-out certain codes and procedures peripheral to the use of the RBU code. The cross-section library is now about 50 per cent complete and the input routine is about 70 per cent complete and some headway was made in its debugging.

Advance Fuel Concept Analysis. Analytical studies were made concerning temperature and heat transfer problems associated with the potential use of Hg-204 coolant in plutonium recycle reactors. Moderators other than graphite were surveyed and found generally to be less well-suited for expected service conditions.

PRTR Plans and Schedules

Analysis and determination of the types of physics experiments to be performed during the start-up of the PRTR was completed. Work started to translate these into detailed plans and schedules. An analysis was also made of the buildup of transplutonic isotopes during successive recycling of plutonium through the PRTR.

Further studies were made to refine the schedule for high exposure plutonium use in the Plutonium Recycle Program. Detailed studies were performed, in conjunction with personnel from other departments, concerning the feasibility, costs, and timing involved in manufacturing the necessary quantity by irradiating depleted uranium in a Hanford reactor. Preliminary results indicate the method to be feasible and the costs roughly competitive with other methods.

A first draft of the Plutonium Recycle Program annual report covering fiscal year 1959 was completed.

PRTR Hazards Analysis

Calculations on the consequences of a potential accident in the PRTR were started in preparation for inclusion in the final hazards report. It was necessary to re-evaluate the accident at this time because of increased information now available on the fractions of the available fission products released as a result of overheating the fuel. A retabulation

of the gamma energies of the fission products was completed and the post-accident dose rates around the containment vessel were calculated.

C. BIOLOGY AND MEDICINE - 6000 PROGRAM

1. Radiological Consultation

Advice and counsel were provided concerning proposed revisions of Radiation Protection Standards, and waste disposal and industrial hygiene publications. Review was made of criteria to be used for the diagnosis of radiation injury. Drafts of Handbooks 42 and 60 were critically reviewed and recommendations forwarded to the National Committee on Radiation Protection and Measurements. An analysis was made of potential problems associated with the construction and operation of a novel radioecological facility, and means to improve the effectiveness of gonad dose measurement studies were developed. The quarterly report of Radiological Sciences activities was compiled and edited, and proposals made to increase coverage and decrease frequency of issuance.

Further progress was made by the Radiological Evaluation Task Force and a draft of the final report was completed.

D. OTHER ACTIVITIES

The Summer Institute on Nuclear Energy - Chemical Processing was concluded on August 14. The eight participants represented seven institutions. Including this group, the programs conducted during the last three summers had representation from a total of twenty-four colleges and universities and involved twenty-eight individuals. The 1959 program was the first to utilize a number of off-site speakers who covered sixteen topics. The time for these additional speakers required a corresponding reduction in time allowed for special problem assignments, but the program was regarded as highly satisfactory by the participants. The 1959 program comprised a total of fifty-three lectures and twenty-five tours which required the active participation of seventy-six G.E. people and fifteen off-site personnel.

Assistance was rendered in arranging for nine tours (involving approximately 200 people) through HLO and HAPO facilities.

L H McEwen

Manager, Programming

LH McEwen:dl

VISITS TO HANFORD:

Name	Dates of Visit	Company or Organization Represented and Address	Reason for Visit	HAPO Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
George Garrett	8/4/59	ORNL, Oak Ridge, Tennessee	Give lecture to SINE participants.	C.A. Rohrmann	No	300, 325
Bill Burch	8/4/59	" "	" " "			
C. E. Guthrie	8/5/59		" " "			
J. J. Colvin	8/11/59	duPont, Savannah River, Ga.				
J. M. Smith, Jr. (ACCESS PERMIT)	8/17-18	GE - APED San Jose, Calif.	Discuss radiological data.	J.W. Healy	No	300, 328
G. Hoyt Whipple	8/17-19	U. of Michigan Ann Arbor, Mich.	Discuss radiological data.	J.W. Healy	No	300, 328
T. A. Prater	8/25-26	GE Research Lab. Schenectady, N.Y.	Discuss nuclear materials research.	L.H. McEwen	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. Coppinger C. A. Rohrmann	8/26/59	Dawn Mining Company Ford, Washington	To obtain information on uranium mill waste.	W. H. Darlington	No
J. W. Healy	8/30-31	General Electric Chicago, Ill.	Attend meeting of the GE Reactor Safeguards Council.	K. Cohen	No

D. SIGNIFICANT REPORTS

HW-61731 "Monthly Report - August 1959, Radiation Monitoring Operation," by A. J. Stevens.

HW-61441 "Analysis of Radiological Data for the Month of July, 1959" by R. L. Junkins.

HW-61137 "Waste Disposal Monitoring Activities Summary - July, 1959" by K. F. Baldridge.

Conf.Un. "Inventory of Radioactive Liquid Wastes to Active Disposal Sites - June, 1959" 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	Area and Buildings
R. M. Baltzo E. I. Shaw	8/17 - 8/20/59	Univ. of Washington, Seattle, Washington Univ. of Kansas, Lawrence, Kansas	Discuss AEC Radiological Physics Fellowship Program.	AJ Stevens	NO	105-KE 100-F 200-E 300
G. H. Whipple		Univ. of Michigan, Ann Arbor, Michigan	Gain information on monitoring of wastes from the plant.	JW Healy RL Junkins		
L. S. O'Rourke	8/19/59	Union Carbide Nuclear Company, Paducah, Kentucky	Discuss radiation protection.	AJ Stevens	NO	300
R. G. Maras	8/19/59	Dow-Chemical Company, Rocky Flats Plant, Denver, Colorado	Discuss radiation protection and toured Calibrations to gather data on our IBM system for record keeping.	AJ Stevens FH Sanders EC Watson	NO No	300 3745, 3706, 3171 B, 747A,700
Bill Simmett	8/11/59	Air Technical Intelligence Center, Dayton, Ohio	Attend SINE - discuss Environmental Monitoring program.	RL Junkins	YES	3746:300
J. Smith	8/17 - 8/18/59	APED, San Jose, California	Discuss radiation protection methods.	HA Meloeny GD Brown RH Wilson RL Rising FH Sanders	NO	3705, 3706, 3746:300 747:700
M. Wilhelmson	8/20/59	AEC - Idaho Falls, Idaho	Discuss radiation protection methods.	HA Meloeny WV Baumgartner FH Sanders	NO	3705, 3706, 3745, 3171B:300

ENVIRONMENTAL MONITORING - RESULTS (July 27, 1959 - August 23, 1959)

Sample Type and Location	Activity Type	Monthly Average	Units*	Trend** Factor
Drinking Water				
100-F Area	Isotopic	0.7	% MPC_{GI}	--
Separations Areas	Gross Beta	3.4×10^{-7}	μc/cc	--
Pasco	Isotopic	0.2	% MPC_{GI}	+2
Kennewick	Isotopic	0.2	% MPC_{GI}	+2
Richland	Gross Beta	$< 3.0 \times 10^{-8}$	μc/cc	--
Columbia River Water				
Above 100-B Area	Gross Beta	1.6×10^{-8}	μc/cc	--
100-F Area	Isotopic	2.2	% MPC_{GI}	+2
Hanford Ferry	Gross Beta	3.1×10^{-5}	μc/cc	--
Pasco	Isotopic	0.6	% MPC_{GI}	--
McNary Dam	Gross Beta	1.2×10^{-6}	μc/cc	--
Vancouver, Washington	Gross Beta	1.8×10^{-7}	μc/cc	--
Waste Water				
Outlying Test Wells	Gross Beta	7.6×10^{-6} (Max.)	μc/cc	--
Atmosphere				
Gross Dose Rate -				
Project	Gamma	1.1	mrad/day	--
Environs	Gamma	0.7	mrad/day	--
I-131 Separations Areas	I-131	3.1×10^{-13}	μc/cc	--
I-131 Separations Stacks	I-131	2.7	curies/week	--
Active Particles - Project	--	3.2	ptle/100 m^3	--
Active Particles - Environs	--	2.2	ptle/100 m^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	1.6×10^{-5}	μc/gm	--

* The % MPC_{GI} is the percent of the maximum permissible limit for continuous occupational exposure to the gastrointestinal tract calculated from drinking water limits.

** The trend factor shows the n-fold increase (+) or decrease (-) from last month, where values of n less than 2 will not be noted.

ENVIRONMENTAL MONITORING - RESULTS (July 27, 1959 - August 23, 1959)

Sample Type and Location	Activity Type	Monthly Average	Units*	Trend** Factor
Drinking Water				
100-F Area	Isotopic	0.7	% MPC_{GI}	--
Separations Areas	Gross Beta	3.4×10^{-7}	μc/cc	--
Pasco	Isotopic	0.2	% MPC_{GI}	+2
Kennewick	Isotopic	0.2	% MPC_{GI}	+2
Richland	Gross Beta	$< 3.0 \times 10^{-8}$	μc/cc	--
Columbia River Water				
Above 100-B Area	Gross Beta	1.6×10^{-8}	μc/cc	--
100-F Area	Isotopic	2.2	% MPC_{GI}	+2
Hanford Ferry	Gross Beta	3.1×10^{-5}	μc/cc	--
Pasco	Isotopic	0.6	% MPC_{GI}	--
McNary Dam	Gross Beta	1.2×10^{-6}	μc/cc	--
Vancouver, Washington	Gross Beta	1.8×10^{-7}	μc/cc	--
Waste Water				
Outlying Test Wells	Gross Beta	7.6×10^{-6} (Max.)	μc/cc	--
Atmosphere				
Gross Dose Rate -				
Project	Gamma	1.1	mrad/day	--
Environs	Gamma	0.7	mrad/day	--
I-131 Separations Areas	I-131	3.1×10^{-13}	μc/cc	--
I-131 Separations Stacks	I-131	2.7	curies/week	--
Active Particles - Project	--	3.2	ptle/100 m^3	--
Active Particles - Environs	--	2.2	ptle/100 m^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	1.6×10^{-5}	μc/gm	--

* The % MPC_{GI} is the percent of the maximum permissible limit for continuous occupational exposure to the gastrointestinal tract calculated from drinking water limits.

** The trend factor shows the n-fold increase (+) or decrease (-) from last month, where values of n less than 2 will not be noted.

EXPOSURE EVALUATION AND RECORDS

Exposure Incidents Above Permissible Limits

	Whole Body	Localized
August	1	2
1959 to Date	7	8

Gamma Pencils

	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
August	20,291	110	5	1
1959 to Date	212,523	786	35	10

Beta-Gamma Film Badges

	Badges Processed	Readings 100-300 mrads	Readings 300-500 mrads	Readings Over 500 mrads	Lost Readings	Average Dose Per Film Packet mrad(ow)	Average Dose Per Film Packet mr(s)
August	11,140	706	47	17	24	7.31	12.04
1959 to Date	86,525	6,770	668	147	339	6.55	16.60

Neutron Film Badges

	Film Processed	Readings 50-100 mrem	Readings 100-300 mrem	Readings Over 300 mrem	Lost Readings
Slow Neutron					
August	1,391	0	0	0	11
1959 to Date	9,562	19	2	0	53
Fast Neutron					
August	299	8	0	0	10
1959 to Date	807	11	13	0	51

Bioassay

		August	1959 to Date
Plutonium:	Samples Assayed	781	6,029
	Results above 2.2×10^{-8} μc/sample	54	287
Fission Products:	Samples Assayed	809	5,937
	Results above 3.1×10^{-5} μc FP/sample	1	30
Uranium:	Samples Assayed	237	2,196
Confirmed Plutonium Deposition Cases		0	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	34	4.4	48	139	3.1**	42
Hanford Laboratories	43	5.6	18	4.0	2.1	16
Chemical Processing	72	8.4	60	26	5.0	47
Chemical Processing*	7.1	7.1	1	6.8	5.9	2
Special Incidents	14	14	1	0	0	0
Random	1.8	1.5	2	0	0	0

*Samples taken prior to and after a specific job during work week.
**Exclusing maximum sample value.

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

Hand Checks		
Checks Taken - Alpha	35,056	284,942
- Beta-gamma	62,484	232,448

Skin Contamination		
Plutonium	22	183
Fission Products	27	320
Uranium	13	90

CALIBRATIONS

	Number of Units Calibrated August	1959 to Date
Portable Instruments		
CP Meter	942	7,671
Juno	306	2,404
GM	1,394	11,015
Other	211	1,604
Total	2,853	22,694
Personnel Meters		
Badge Film	924	6,835
Pencils	2,134	9,039
Other	285	3,301
Total	3,343	19,175
Miscellaneous Special Services	152	3,218
Total Number of Calibrations	6,348	45,087

R L Jenkins
for the Manager
Radiation Protection

AR Keene:RLJ:kc

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - AUGUST 1959

GENERAL

Safety performance of the operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 3.25 which is considered about average experience.

There were no security violations charged to the Operation.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 19,586 hours. This includes 14,148 hours performed in the Technical Shops, 2,883 hours assigned to Minor Construction, 32 hours to other project shops, and 2,523 hours to off-site vendors. The total shop backlog is 26,798 hours of which 50% is required in the current month, with the remainder distributed over a three-month period. Overtime worked during the month was 5.5% (1069 hours) of the total available hours.

Distribution of time was as follows:

	Man Hours	% of Total
Fuels Preparation Department	2825	14.4
Irradiation Processing Department	1135	5.8
Chemical Processing Department	328	1.7
Hanford Laboratories Operation	13027	66.5
Construction Engineering & Utilities	2180	11.1
Miscellaneous	91	.5

One machinist was added to the Technical Shops' roll and a requisition was filed to replace a machinist who is resigning in September.

New equipment received included a wood-working planer which will be used to machine graphite. This equipment is replacing other equipment which has been on loan from the 2101 Building.

Security performance was considered satisfactory with no violations. Safety performance was considered satisfactory with 11 medical treatment injuries. This is a 33% decrease from the previous month.

RADIOGRAPHIC TESTING OPERATION

The index of activity for the Radiographic Testing Operation introduced last month - the Productivity Factor - was 131 for August. This figure can be compared to that for July, 224, and the Radiographic Testing Operation average of 213. A large part of the drop is attributable to vacations and is customarily observed at this time of the year.

Radiographic Testing Operation made a total of 4,467 tests, of which 602 were radiographic (including x-ray and gamma-ray) and 3,865 were supplementary tests. Out of a total of 1,789 man-hours, 657 (36.8%) were used in connection with radiographic tests, and 1,132 (63.2%) 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 2,256 items. The feet of material represented by the foregoing amounted to 23,205.6 feet. Both of these figures are high, representing work on tubular components. A total of 55 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 27 different occasions for advice and information to general testing theory for other than the jobs tabulated in Part II - Testing Statistics.

Testing of the PRTR process tubes has been essentially completed. Work still remaining to be done includes some inside surface fluorescent penetrant testing and radiography. After numerous process and equipment modifications, some success in pickling and autoclaving of the process tubes has been demonstrated on reject material but has not been reproducible. No pickling or autoclaving of acceptable tubes has been done pending the development of a satisfactory process. As part of the development of the pickling and autoclaving process it has been necessary to provide for complete vapor blasting of the inside and outside surfaces of the process tubes. The small number of reject tubes available for evaluating the pickling and autoclaving process required that they be cleaned up after autoclaving for re-evaluation. Perhaps the biggest contributing factor in overcoming some of the difficulties was the provision of proper circulation of the acid and stop solutions. With the size of tanks being used stratification was a serious problem and had to be eliminated. If full production can now be established and maintained it should be possible to have 85 tubes completed by October 15.

Work has started on the radiographic inspection of the PRTR calandria assembly. Inspection of both vendor and on-site welding is being made. Radiographic Testing Operation is advising Reactor Engineering personnel as to weld quality and acceptability within the specifications. Final acceptance of weld areas is being made by the customer based on weld evaluation, criticality of service and other factors. Close liaison with the construction forces is being maintained and a 24 hour, 7 day week coverage has been made available.

Work is continuing on further evaluation of zircaloy sheath tubes. A testing scheme has been evolved which will assure the highest integrity and will allow salvage of many tubes. Four principal tests have been proposed including: fluorescent penetrant testing of the I.D. and O.D. surfaces, eddy current testing using an I.D. probe, immersed ultrasonic testing, and a new test for structural anomalies consisting of measurement of the dampening capacity.

Testing Statistics

Component	No.of Tests	Ft. of Weld or Material	No.of Pieces	Description
CPD	1,378.0	1,291.5	65	Radiography 3" sch. 40 (304-L) s.s. pipe; radiograph titanium tubes assembly; H.S. column TH-3; X-ray girth seams, on shell box, boot and pipe welds; ultrasonic tests (304-L) s.s plates.
CE&UO	91.0	81.5	103	Radiograph weld qualification coupons for PRTR; radiograph welds.
HLO	2,968.0	21,407.6	2,077	Zr-2 clad UO_2 fuel rods; radiograph fuel elements to determine NaK level 2.44xO.D.x 10-1/2" long; transplutonic fuel element program; 3rd plan fabrication program; PRTR process tubes; zr-2 tubes 680" I.D. x .035" wall x 7' long; 9/16 O.D. x 8' long zr-2, clad UO_2 fuel rods; .505" I.D. x 9' long, zr-2 tubes; 3.070" O.D. external ribbed zr-2 tubes .680" I.D. x .035" wall x 7' long, zr-2 tubes; .700" O.D. x .015" wall x 8' long Inconel tubing; 700" O.D. x .020" wall x 8' long 17-7 s.s tubing.
IPD	30.0	425.0	11	Radiograph saddle weld on NPR PCE loop 189-D Building 3" sch. 160; KER zirc tubes; penetrant test pump shaft.
Total	4,467.0	23,205.6	2,256	

FACILITIES ENGINEERING OPERATION

Projects

There were 23 authorized projects at month's end with total authorized funds of $8,466,000. The total estimated cost of these projects is $9,145,000. Two projects were authorized (CAH-864, Shielded Animal Monitoring Station - 100-F and CGH-866, Shielded Analytical Laboratory - 325 Building) and one (0084, AEC-167, Pickling & Autoclaving Facility for Zirconium Tubes - C-25 Bldg., WB) was completed during the month. Seven project proposals are in preparation. One new project was submitted to the AEC, CAH-870, Facilities for Recovery of Radioactive Cerium - 325 Building.

The attached project report details the status of individual projects.

Engineering Services

Title	Status
326 Building Retention Waste Sump Modifications	Engineering work complete. Field work initiated.
Temperature Control for Fish troughs Biology Operation	Field work in progress.
Graphite Storage Building	Partial beneficial use of this structure is being made. Remaining work includes fire detection system, electrical tie-in installation of access door and clean-up items.
HLO Plan	Preliminary development work of a plant layout of HLO structures, utilities and grounds including future plant additions is being reviewed.
Improve Process Ventilation, Labs 204 & 206 - 3706 Building	The work involves additional air flow and equipment to provide a high degree of clean air to the laboratories. The field work will be performed by J.A. Jones.
Hood Ventilation in 183-KE Building	System will be ready for use the latter part of September.
Sound Proof Enclosure For Sonic & Vibratory Compacting Equipment 325 Building Basement	Design work has been completed. Installation has been made on vibrating machine. The results are satisfactory.
Air Conditioning Alteration - Room 40-C - 326 Building	Preliminary design and sketches are in progress.

Title	Status
Graphite Storage Racks - 326 Bldg.	Design work complete. Fabrication work and installation is complete.
Increased 440 Volt Electrical Service - 325 Building Basement	Construction Operation is proceeding with installation.
Heating & Air Conditioning 141-M Building	Design work on the heating system is progressing for this building.
Glycol Heat Exchanger Study 325 Building Main Air Supply Units	Exchangers are on order.
Sound Enclosure for Kux Press Pump Unit - 325 Building Basement	Design complete.
Drain System - 327 Building Basement	Preliminary work is complete and cost estimate is being made.
Cooling Problem - Positive Ion Accelerator - 3745-B Building	Work essentially complete.
Cooling Problem - Counting Room 329 Building	Work essentially complete.
Space Utilization - Second Floor 325 Building	Plans are complete. Construction to start in September.
329 Building Cooling Problem	Preliminary design complete.
Alterations to Door Mechanism Shielded Personnel Monitoring Cell 747-A Building	Design is nearing completion.
Compressed Air System, 231-Z Bldg.	Installation work has started.
Shielded Housing for Test Equipment 326 Building	Design complete. Nine drawings produced.
Air Conditioning Room 4 141-H Building	Preliminary design complete. Appropriation request is being processed.
Fuel Extraction Facility for PRTR	Tube splitting test complete. Cutter design complete. Ram design is in drafting.
Ventilation - 314 Building	Air flows are being checked by air balance personnel. Estimate is being prepared on opening monitor. Evaporative coolers have been obtained to be used as exhausters or coolers depending on result of engineering study.

Drafting & Design Services

Design and drafting work in progress includes the following:

PRTR prototype loop - "As-Built" - 314 Building.
Fuel element X-ray photometer.
Test set-up design - fuel, fuel and foil holders, and graphite - 305-B Bldg.
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 and redesign PRTR shim control drawings.
Modifications to vacuum welding box - 325 Building Basement.
Calciner Control Programmer - 224-U Building.
Control rod redesign for experimental control rod in MTR.
Remote operated dissolver and gas sampler. Complete with encapsulating equipment, 327 Building.
Calandria revisions during fabrication - PRTR.
In addition, miscellaneous small design drafting orders are in progress.

Work is being performed on layout and details of projects CGH-834 - Modifications and Additions to High Pressure Loop - 189-D Building, and CGH-838, Fission Product Volatilization Studies Test Facility - 292-T Building.

Maintenance and Building Engineering - Landlord Functions

Costs - June - $ 105,381
July - $ 81,810

Analysis of Costs - The total costs for the month were $1,900 below forecast. Unusual maintenance was less than expected because of the construction strike and because of the full schedule of plant forces. The landlord budget was raised from $1,445,000 to $1,572,700. This $127,700 increase represented the expenses of Hanford Laboratories personnel in non-HLO space which were not assumed by the respective landlords. These costs are limited, however, to the type of expenditures which the HLO landlord assumes for tenants of HLO space. These include process utilities and space rearrangement.

TECHNICAL INFORMATION OPERATION

As indicated last month, HOO is now reviewing all 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 in non-production categories. The first report submitted for review (HW-59130 "Fabrication of NPR Segmented Fuel Elements by Hot Pressing") has been returned with a statement that it contains production information and hence may not be distributed in the Metallurgy and Ceramics category. HOO has requested that all papers intended for publication on the subject of Waste Disposal, and all Formal Research and Development reports on this subject, be cleared through the Washington Office of the Atomic Energy Commission. The first report on the subject (HW-60601, Aquifer Characteristics and Ground Water Movement at Hanford) had been submitted for review at month's end.

The Commission has replied to our letter of July 7 regarding procedures for preparation and marking of documents containing Atomic Weapon Data. However, revision of the procedures is being delayed pending clarification of such technical problems as: (1) what is the meaning of the Sigma categories as they apply to Hanford technology, and (2) what information at Hanford is properly categorized as Production and Stockpile Information (3) what information at Hanford is Atomic Weapon Data.

The Specialist, Classification-Declassification attended a meeting of the Coordinating Organization Directors at the Lawrence Radiation Laboratory in Berkeley August 13 and 14. The purpose of the meeting was to discuss ways of streamlining the declassification procedures so that declassification can be accomplished more quickly. The procedure recommended by the group would establish declassification as an action independent of other reviews or release approvals such as patent or public information. With respect to the Unclassified Fields of Research, a revised version is currently being prepared. A proposal was made to incorporate in the unclassified fields certain unclassified topics from local guides and Category 1 topics from OC-DOC-44 "Declassification Guide for Responsible Reviewers". Incorporating such topics in the unclassified fields presents some special problems in that topics must be very definitive and can in no way infringe upon a classified area. A supplement to the Unclassified Fields Guide containing these additional topics for limited use will be considered by the Division of Classification.

A considerable amount of time was spent during the month reviewing all the documents created by Washington State College in connection with work under a Design, Development and Reseach Contract. The contract and work were initially handled on an unclassified basis. It was later determined that the contract should be classified. The work was stopped, all documents were returned to HAPO and clearances were obtained. Several hundred pieces of paper were reviewed, assigned an appropriate classification and returned to WSC.

A considerable backlog of reports (20-25) exists in Technical Publications and the time to get out reports is therefore increasing. So far the customers have not complained, but the attempt to get along with three typists in the group, rather than the four used in the past, may not prove out.

The Task Force to study a possible revision of the document access system in the Classified Files has been appointed. Representatives are J. S. Stoakes, IPD; V. R. Chapman, CPD; L. C. Clossey, FPD; R. E. Jaynes, CE&U; V. D. Donihee, C&A; and C. G. Stevenson, HLO, Chairman. The AEC representatives have not yet been officially named. The group has held two meetings, but is not yet ready to make specific recommendations.

The HAPO microfilming proposal (which includes Technical Information's plan to microfilm its document holdings) was formally transmitted to HOO during the month. Subsequently, a meeting was called by the AEC at which the proposal was reviewed in detail and Commission questions answered.

The conversion of the Files records from the 702 to the 709 machine continues to be troublesome. There were 854 bounces or unmatched entries which would not process on the monthly update. These "errors" were tracked down to a program weakness and the work will be re-run after corrective action has been taken. Excluding this month's bounces, the average number of bounces since conversion to the modified system is 66 per month.

All the preliminary work needed to put the ordering and renewal of periodical subscriptions on IBM has been completed. The names and addresses of some 300 vendors of periodicals has been put on IBM cards to permit automatic printing of vendor information on renewal order forms. Data Processing has approved the order form for use by the machines and all that remains to be done is to obtain 709 machine time to set the job up.

The transfer of books from HAPO to the City of Richland was completed in August. The books fell into two categories: (1) those that had been assigned to employees who transferred with their jobs to the City, and (2) those books which were transferred from the Industrial Medical Library to the Bi-County Health Department. A total of 476 volumes having a value of $2065.24 was involved. All of these volumes were inventoried prior to the transfer by Doris Roberts, Librarian of the Richland Public Library.

J. William Young, Chief of the Atomic Energy Commission's Technical Book Section, visited Technical Information on August 12, 13, 14. During this time he talked to about a dozen Hanford scientists and managers who might be interested in doing a book for the Atomic Energy Commission Book Publishing Program.

Peter R. Stromer, of the General Electric Light Military Electronics Department in Schenectady, has accepted the position of Supervisor, Reference and Publication. He is expected to assume his new duties on October 15, 1959.

Work Volume Statistics

	July	August
Document Distribution and Files		
Documents routed and discharged (copies)	17,086	16,882
Documents issued (copies)	7,683	9,748
Documents sent offsite (copies)	2,233	3,934
Document reserves filled (copies)	512	636
Documents picked up and delivered	18,462	19,968
Document Accountability		
Holders of classified documents whose files were inventoried	579	305
Documents inventoried in Files (copies)	8,497	11,479
Documents destroyed or retired (copies)	773	3,359
Documents revised (copies)	719	1,109
Documents pulled and documents filed (copies)	10,776	10,451
Documents reclassified	219	262
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents onsite.	206,008	208,972
Reference and Publication		
Books cataloged (new titles)	50	247
Books added to the collection (volumes)	164	469
Ready reference questions answered by professional staff	149	159
Literature searches by professional staff	78	101
Reports abstracted (titles)	207	240
Formal reports prepared (titles)	8	12
Offsite requests for HAPO reports (copies)	226	217
Reports released to CAP (titles)	12	23
Library Acquisitions and Circulation		
Books ordered (volumes)	297	264
Periodicals ordered	102	81
Books circulated (volumes)	1,887	1,204
Periodicals circulated (issues)	3,218	2,824
Inter-Library loans	77	72
Films borrowed or rented	5	23
Industrial film showings	67	37
Bound periodicals added to the collection	241	*

Library collection:

	Main Library	W-10 Library	108-F Library	Ind. Med.	Total
No.of books	27,226	8,240	1,463	1,973	38,902
No.of bound periodicals	12,359	1	1,431	96	13,887
	40,585	8,241	2,894	2,069	52,789

* Due to vacation of bindery clerk, August binding statistics will be combined with September statistics.

Classification and Declassification

	July	August
Documents, including drawings and photographs reviewed for downgrading or declassification.	10	9
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification.	25	26
Documents submitted to Declassification Branch, Oak Ridge	6	5

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 - 60712
MONTH August, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CG-731	Critical Mass Laboratory		$1,000,000	100	16	5-22-58	- - -	2-24-59
		$1,000,000	3-23-59	100	24	6-4-59	6-30-60	6-30-60
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: D. S. Jackson		

REMARKS:

The contractor is having difficulty obtaining corrosion passed stainless steel. The AEC is furnishing some badly needed items from Hanford stocks. The walls of the service building were poured and the contractor is preparing to pour the floor slab. The control building floor slab has been poured. Framing is underway on the interior partitions and roof. The transite ductwork for the process exhaust system beneath the reactor building was placed.

CA-744	Metallurgical Development Facility - 306 Building		$2,685,000	100	11* 18**	6-15-58	- - -	9-1-59
		$2,623,000	11-5-58	98	11* 18**	3-30-59	9-1-60	9-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. T. Lloyd		

REMARKS:

The contractor has increased the tempo of construction by going on two shifts. The steel work is expected to start on September 1, 1959 and beneficial use of the fourth bay is anticipated by October 15, 1959. Equipment procurement is proceeding satisfactorily. Concrete walls, footings and foundations are expected to be complete by September 1, 1959. At a meeting with the AEC on August 25, 1959 contract modifications due the work stoppage in July were considered.

* Overall project. ** Contractor's portion.

CA-749	Hilg Level Radiochemistry Facility		$960,000	100	100*	6-15-58	- - -	11-21-58
		$960,000	10-31-58	100	99*	8-14-58	1-1-60	10-30-59
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: R. W. Dascenzo		

REMARKS: The following work has been completed this month: Door hardware, partition trimmings and glazing; operational test of transfer hood and installation of lead shielding; lead doors installed on transfer ducts; sprinkler completed, chlorinated and pressure tested; heating and ventilating controls partially installed; electrical work for monitoring system, instrumentation and mechanical equipment progressing but remains the principal bottleneck as neither the main or emergency breakers are on site; the main breaker was shipped August 4 and only one out of four pieces arrived. The outside of the building has been painted and 95% of the interior building is painted, but only 50% of the Amercoat painting is completed. A 20' x 20' outside concrete slab has been completed. Five viewing windows were installed. Several pipe tests were completed and only

(Continued on page 2)

BUDGET CLASSIFICATION Improvements to Production and Supporting Installations - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 69711
MONTH August, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
		USING COMPONENT				FEO ENGINEER		

REMARKS:

(CA-749 Continued) - 5% of the pipes remain to be tested. Ventilation and sheet metal work were completed. The AEC extended the completion date for the fixed price contract from August 3, 1959 to August 28, 1959; it appears the contractor will not complete his work until September 23, 1959. Installation of the General Electric Company procured equipment cannot be started until the fixed price contractor finishes his work.

* FP schedule; total schedule 87% complete.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CGH-790	High Level Radioactive Receiving and Storage Addition - 327 Building		$345,000	100	78	6-23-58	- - -	12-31-58
		$350,000	4-23-59	100	73	10-9-58	2-1-60	2-1-60
		USING COMPONENT				FEO ENGINEER		
		Reactor & Fuels R & D				J. J. Peterson		

REMARKS:

All crafts returned to work on July 30, 1959 ending the labor dispute. The steel strike is holding up delivery of siding and roof deck with latest promised shipping date four weeks after resumption of fabrication by H. H. Robertson Company. All piping, heating and ventilating equipment that can be installed, will be installed and temporarily protected. No work this period by CPFF forces.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CGH-819	Increased Laboratory Waste Facilities - 300 Area		$ 30,000	100	0	3-30-59	- - -	9-1-59
		$300,000	11-24-58	99	0	11-1-59	- - -	12-30-60
		USING COMPONENT				FEO ENGINEER		
		Chemical Research & Development				J. J. Peterson		

REMARKS:

Drawings and specifications are essentially complete. Because of the low priority of this project with respect to the budget it was decided to request only the load-out portion of the project. However, it appears that this will be too costly; more economical means are being investigated in an effort to accomplish the same end results.

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60712

MONTH: August, 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.
CAH-827	Automatic Columbia River Monitoring Station	$39,000	$39,000	100	0	4-3-59	- - -	6-18-59
			6-30-59	100	0	9-15-59	12-31-59	12-31-59
		USING COMPONENT: Radiation Protection				FEO ENGINEER: D. S. Jackson		

REMARKS:

Construction is still being delayed pending completion of backfilling around the PRTR river pump structure.

CAH-828	Central Storage Facility - 300 Area	$40,000	$40,000	N.S.	23	4-2-59	- - -	6-8-59
			7-30-59	100	13 *	7-15-59	12-31-59	10-15-59
		USING COMPONENT: Finance				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

The north and east footings and walls were poured August 28, 1959. Form work for the remaining walls is proceeding.

* Construction work was delayed by the recent work stoppage by construction crafts.

CAH-837	Animal Pens, Isolation and Examination Facilities	$80,000	$80,000	100	60	3-30-59	- - -	6-5-59
			3-17-59	100	22	7-10-59	4-1-60	
		USING COMPONENT: Biology				FEO ENGINEER: J. T. Lloyd		

REMARKS:

Concrete slabs in outside dog runs have been poured. Water lines for the new building were connected to area service on August 7, 1959. Concrete block walls were started on August 7, 1959. The sewer line to the present drainage system was completed and tied-in.

UNCLASSIFIED

BUDGET CLASSIFICATION
General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60712
MONTH August, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CGH-829	Building 325 Basement Improvements	$70,000	$70,000	N.S.	74.5	2-13-59	- - -	8-11-59
			2-13-59	100	72	3-2-59	12-31-59	12-31-59
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

The bid package for exit stairs and partition work on the mezzanine of the 325 Building basement will be issued to bidders September 1, 1959. Bid opening is scheduled for September 10, 1959.

CGH-840	Sheet Metal Shop Addition - 328 Building	$40,000	$40,000	N.S.	56	6-22-59	- - -	9-1-59
			6-18-59*	100	18	6-25-59	5-1-60	12-1-59
		USING COMPONENT: Laboratory Auxiliaries				FEO ENGINEER: J. J. Peterson		

REMARKS:

The Construction Schedule was approved July 23, 1959. Concrete block walls have been erected and one half of the floor slab has been poured. This job is being delayed because of the steel strike holding up delivery of metal roof deck.

CAH-848	Geological and Hydrological Wells - FY 1959	$56,600	$56,600	N.S.	15	5-12-59	- - -	7-6-59
			6-24-59	100	15	7-16-59	5-31-60	3-30-60
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: H. E. Ralph		

REMARKS:

Test well site 699-62-43 (14 wells) - Four existing wells have been redeveloped. Five new wells have been developed for a total 400 feet of new hole. Construction work is on schedule.

AM-7300-019 (5-58)

UNCLASSIFIED

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60712
MONTH: August, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	DIRECTIVE COMP. DATE: DESIGN / CONST.	ESTIMATED or Actual COMP. DATE: DESIGN / CONST.
IR-243	Relocation of the 200-E Testing Equipment	$18,000	$18,000 / 3-11-59	100 / 100	100 / 99	3-12-59 / 3-16-59	- - / 4-22-59	5-22-59 / 9-15-59
		USING COMPONENT: Laboratory Auxiliaries				FEO ENGINEER: H. Radow		

REMARKS:

Rehabilation of the 221-B and 224-B Buildings (where test equipment had formerly been located) is complete. Installation of the heating in the C-25 Building is yet to be done.

IR-246	Alterations to the Positive Ion Accelerator Facility - 3745-B Building	$19,000	$19,000 / 4-20-59	N.S. / 100	100 / 95*	4-21-59 / 5-7-59	- - - / 10-20-59	5-1-59 / 10-20-59
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

Work by construction forces has been completed except for installation of a unit heater and grading around the building site. Relocation of control equipment remains to be done by Plant Forces.

* Construction work was delayed by the recent work stoppage by construction crafts.

IR-247	Normal Electrical Service - Experimental Animal Farm - 100-F	$12,500	$12,500 / 4-28-59	N.S. / 100	100 / 93	4-22-59 / 6-5-59	- - - / 9-28-59	5-214-59 / 9-15-59
		USING COMPONENT: Biology				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

Modification work performed by Plant Forces inside the 141-H and 141-F Building is complete. Tie-in work on the 2.4 KV line by Plant Forces will be done as soon as the line work on 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.

UNCLASSIFIED

BUDGET CLASSIFICATION
General Plant Projects - FY 1960

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60712
MONTH August, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CGH-860	Access for PRTR Fuel Elements - 327 Building		None	0	0	1/2*	- - -	3*
		$81,000	None	0	0	2 1/2*	- - -	10*
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: H. Radow		

REMARKS:

The project proposal was approved at the AEC Review Board meeting of August 27, 1959; to date a directive has not been issued.

* Months after authorization.

CAH-864	Shielded Animal Monitoring Station - 100-F		$46,000	0	0	N.S.	- - -	12-1-59
		$46,000	8-6-59	0	0	N.S.	4-1-60	4-1-60
		USING COMPONENT: Biology				FEO ENGINEER: J. T. Lloyd		

REMARKS:

The project was authorized by Directive No. AEC-164, dated August 6, 1959. Work Authority CAH-864(1), dated August 11, 1959 authorized $15,500 to the General Electric Company for their portion of the work. Design will be by an Architect-Engineer.

Improvements to Production and Supporting Facilities - 60-a-1

CGH-832	Full Scale Physical Constants Testing Reactor		None	0	0	- - -	- - -	- - -
		$915,000	None	0	0	- - -	- - -	- - -
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

The project proposal requesting $30,000 preliminary design money has not been approved by the AEC-Washington.

AM-7300-019 (5-58)

UNCLASSIFIED

BUDGET CLASSIFICATION Improvements to Production and Supporting Facilities - 60-a-1

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60712
MONTH August, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH 859	327 Building Modifications	$350,000	None / None	0 / 0	0 / 0	- - - / - - -	- - - / - - -	- - - / - - -
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. J. Peterson		

REMARKS:

The project proposal is being returned unapproved for lack of funds.

CAH-870	Facilities for Recovery of Radioactive Cerium - 325 Building	$350,000*	None / None	0 / 0	0 / 0	** / - - -	- - - / - - -	5*** / - - -
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER:		

REMARKS:

The preliminary project proposal was approved by the AEC Review Board on August 27, 1959, but as of the end of the month a directive has not been issued. The preliminary project proposal requests only preliminary and detail design funds in the amount of $35,000; of which $28,000 is for A-E services and $7,000 is for General Electric Company project management services.

* Indicated total project cost. ** Immediately upon authorization. *** Months after authorization.

Equipment Not Included in Construction Projects - Program Class 2900

CG-661	Additional Heat Generation Facility - 189-D Building	$500,000	$664,000 / 9-18-57	100 / 100	100 / 98	12-6-56 / 12-3-58	- - - / 8-31-59	10-15-58 / 4-30-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. J. Peterson		

REMARKS:

The past two weeks have been spent conducting tests to ascertain system characteristics and operability. A representative from General Electric Company, Schenectady was here for three days to supervise and make recommendations on equipment adjustment. It appears that an extension of time will be required as the equipment as specified does not meet the present research and development needs.

AM-7300-019 (5-58)

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60712
MONTH August, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CA-681	Hanford Equipment in the ETR	$1,140,000	$1,140,000	99	90	9-17-56	- - -	7-15-59
			4-1-59	99	90	4-1-58	3-1-60	3-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: H. Radow		

REMARKS: The spare tube bundle for the 6 x 9 heat exhanger has been sent to the manufacturer for modifications to correct the leaking problem. The change consists of replacing the bolted flange head with a welded head. Return delivery is expected in early September. Based on scheduled shutdown of September 14 to 30; unit could be installed and in operation by October 1. However, shutdown will not occur as scheduled so installation date is uncertain. Request for "B" priority for 3 x 3 modifications was not granted; however, Phillips agreed to run two shifts promising completion by September 18 which would permit start-up by October 1. Hold-up here will be Hanford furnished relays for which vendor promised 8 weeks delivery; premium pay has been authorized to improve this and expediting efforts to permit installation by September 18 are underway.

CG-785	In-Reactor Studies Equipment - 105-KW Building	$276,000	$276,000	55	0	1-5-59	- - -	- - -
			12-8-58	55	0	N.S.	12-31-60	12-31-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: H. Radow		

REMARKS:

Bid deadline for the major instrumentation order has been extended to August 31, 1959. Design of the capsule removal facility is progressing.

CGH-801	X-Ray Diffraction Cell - 327 Building	$170,000	$10,000	40	0	6-10-58	- - -	12-1-59
			6-7-58	40	0	1-15-60	- - -	4-15-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

Project proposal submitted to the AEC on November 19, 1958 for total project funds was approved by the AEC Review Board on August 27, 1959. A directive has not yet been issued.

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60712
MONTH August, 1959

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

Procurement continued this month. Quotations were received for the second time for the test cell assembly and the low bid from Washington Iron Works was approximately $15,000 over the estimated amount. Purchase orders have been placed on the cell assembly, lead glass viewing window and manipulator. Quotations have been received, but orders have not been placed, on the special plugs, cell plugs and viewing plugs.

CGH-834	Modifications and Additions to High Pressure Heat Transfer Apparatus - 189-D Building	$700,000	$700,000	33	20*	4-20-59	- - -	2-9-60
			4-8-59	33	20	4-22-59	10-15-60	10-15-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: H. Radow		

REMARKS:

Procurement is progressing favorably. However, some construction delays have already been encountered due to material shortages caused by the steel strike.

* Per official construction schedule which has been submitted to the Commission for approval.

CGH-838	Fission Product Volatilization Studies Test Facility - 292-T Building	$75,000	$75,000	100	50	4-9-59	- - -	9-15-59
			3-26-59	95	50	4-16-59	11-30-59	11-30-59
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: O. M. Lyso		

REMARKS:

Design of a burning capsule is nearly complete. Fabrication of the junior cave sample train is in progress. Delivery of the induction heating unit has been delayed due to the steel strike; the latest shipping date is now September 7, 1959 from Youngstown, Ohio.

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60712
MONTH August, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-857	Physical and Mechanical Properties Testing Cell - 327 Building	$400,000	None / None	0 / 0	0 / 0	1* / - - -	- - - / - - -	14* / - - -
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

The HOO-AEC Review Board approved a project proposal requesting design funds in the amount of $75,000 on August 27, 1959, but a directive has not yet been received.

* Months after authorization.

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 HOO-AEC Review Board approved a project proposal requesting design funds in the amount of $70,000 on August 27, 1959; however, a directive was not issued in August.

* Months after authorization.

CGH-866	Shielded Analytical Laboratory - 325 Building	$480,000	$10,000 / 8-12-59	0 / 0	0 / 0	1* / - - -	- - - / - - -	5* / - - -
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

Directive No. HW-495 was issued on August 12, 1959 authorizing $10,000 for preliminary design instead of the $30,000 for total design as requested in the project proposal.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	H.W. Personnel Contacted	Access to Restricted Data	Areas & Buildings Visited
K. H. James	8- 4-59	Metallizing Engr., Inc. Seattle, Wash.	Inspect & demonstrate equipment	J. H. Kelly	No	328 - 300
J. M. Smith	8-11-59	General Electric Co. Cleveland, Ohio	Illumination Consultation	P.F.X. Dunigan R. C. Ingersoll	No	329,3760, 326, 325, 327, 300
R. E. Reynolds	8-12-59	Eastman Kodak Co. San Francisco, Calif.	Discuss radiography	R. B. Socky	No	328, 300
J. William Young	8-12 & 8-13-59	AEC Tech.Information Service, Washington, D.C.	Discuss the AEC's book Publishing Program with prospective authors	C. G. Stevenson	No	3760, 300

VISITS TO OTHER INSTALLATIONS

None

PROFESSIONAL PLACEMENT AND RELATIONS PRACTICES OPERATION MONTHLY REPORT

GENERAL

As of August 31st the staff of the Hanford Laboratories totaled 1,353 employees, including 653 exempt and 700 nonexempt. There were 571 employees possessing technical degrees, including 349 BS, 118 MS, and 104 PhD.

COMMUNICATIONS

Approximately 58% of available HLO employees donated blood during the 300 Area blood drawing on August 11.

HEALTH AND SAFETY

The medical treatment frequency for August was 1.60 as compared with 2.02 for July and 1.63 for the year to date. Hanford Laboratories has now worked a total of 239,150 manhours since its first disabling injury on July 27.

There were 5 security violations during August, bringing the total for the year to date to 31.

PROFESSIONAL PLACEMENT

During August three PhD offers were extended and six offer rejections were received. One experienced PhD physicist reported on the roll during the month. For the recruiting year ending August 31, fourteen PhD acceptances were received including 3 in chemical engineering and 2 each in mechanical engineering, metallurical engineering, chemistry and physics. During the 1957 - 1958 season a total of 17 PhD acceptances were obtained.

Eight new technical graduates and nine experienced candidates reported on the roll during August. Nine additional acceptances were received from experienced technical candidates.

EMPLOYEE COMPENSATION

The nonexempt compensation study has been completed by Relations Operation and has been submitted to the Hanford General Manager for review.

Pre-retirement group meetings were commenced for six HLO employees who are in the 59 - 60 age bracket.

EMPLOYMENT

Thirty-one nonexempt requisitions were filled during August. With the receipt of 29 new requisitions and 4 cancellations, there are currently 29 nonexempt openings for which candidates are in process and 10 transfers are pending, leaving 8 candidates to be procured.

Four employees were slated for lay off as a result of the completion of their temporary assignments in Atmospheric Physics. They have been placed in other jobs.

Manager,
Professional Placement
and Relations Practices

TG Marshall:bk

C - Technical Graduate and Technician Training Program
Month ending August 31, 1959

	TG Program	TT Program
Number Personnel on assignment	81	9
(HAPO Tech Grad Program.....70		
(West. District E.P.....11		
Summer Juniors	8	
High School Teachers	1	
	90	9
Distribution of assignments by Depts.		
HLO	35	4
CE&UO	2	0
FPD	11	0
IPD	31	5
CPD	11	0
Distribution of assignments by function		
R&D or Engineering	62	9
Other	28	0

TABLE II NONEXEMPT EMPLOYMENT

Nonexempt Employment Status	July	Aug.
Requisitions		
At end of month.	35	29
Cancelled	1	4
Received	26	29
Filled during the mo.	21	31
Candidates Considered		
Applications	65	72

NonExempt Transfer Request	July	Aug.
Transfer Request		
Active cases at end of mo.	87	85
Cancelled	2	0
New	12	3
Transfers effected	0	5

TABLE III. PROFESSIONAL PERSONNEL PLACEMENT

A - Technical Recruiting Activity - HAPO - September 1, 1958 to Date

	Case Considered	Visits to Richland: Invited	Visited	To Visit	Offers*: Extended	Accepted	Open	On the Roll
Ph.D.	686	202	92	26	64	14	3	16
Exp. BS/MS	567	123	90	8	124	83	6	77
Prog. BS/MS	395	-	-	-	207	79	-	76

*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

	Case Considered	Visits to Richland: Invited	Visited	To Visit	Offers**: Extended	Accepted	Open	On the Roll
Ph.D.	686	202	92	26	49	10	3	7
Exp. BS/MS	433	85	60	3	55	33	3	28

**Offer totals include offers open on 9/1/58

Exp. BS/MS	2
Ph.D.	2

In addition to the above activity, 27 exempt employees have transferred into HLO from other HAPO departments and 32 technical graduates have accepted off-Program placement in HLO to date.

FINANCIAL OPERATION MONTHLY REPORT
AUGUST 1959

Personnel

One non-exempt employee was added to the roll to serve the stenographic needs of the Specialist - Auditing and Procedures, Specialist - Measurements, and the OPG function.

Activities

GENERAL ACCOUNTING OPERATION

Commission approval was obtained for two Assistance to Hanford jobs for FY 1960. These are as follows:

ATH-HLO-2-60 - Heat Transfer Corrosion Test, $24,000, assigned to APED.

ATH-HLO-3-60 - Graphite Contraction Studies, $47,300, assigned to Research Services, Schenectady, New York.

In addition, Commission approval was obtained for an arrangement whereby HLO will irradiate coupons for APED on a no-cost basis. APED will, in turn, provide Hanford with information learned in decontamination processes.

An allocation of the $28,000 provided HLO for Attendance at Professional Meetings during FY 1960 was approved by the Manager - Hanford Laboratories and each Section Manager has been advised of his allocation.

The volume of HLO travel is following the same general trend as established during the last two fiscal years but at a slightly higher level - the current travel is considerably below that established during the spring quarter, however.

Reactor and Other Special Material's ledgers, files and current source documents were transferred to Contract and Accounting Operation during the month of August for accumulation and reporting, effective August 1, 1959. HLO Property Accounting will continue to (1) receive and review all source documents (2) provide liaison work between Laboratories personnel and Contract and Accounting personnel (3) be responsible for preparation of budgets and (4) assist in preparatory work for the annual witnessed physical inventory and arrange for quarterly inventories by custodial personnel.

Arrangements were completed for the regular quarterly inventory of other special materials as of September 30, 1959 to be conducted by custodial personnel. The annual witnessed physical inventory of Reactor and Other Special Material originally scheduled for September 30th was rescheduled to December 31 due to conflicting dates with the annual General Supplies inventory.

In response to a request of SS Accountability, material custodians were requested to submit forecasts for outside diversions of SS Materials covering the third and fourth quarters of FY 1960 and the first and second quarters of FY 1961. Upon receipt of the information a consolidated report will be prepared and forwarded to SS Accountability.

Effective October 1, 1959 HLO Property Accounting will assume the responsibility of issuing Extended Property Passes. The Extended Property Pass will be strictly limited to those operations which require the routine and repetitive movement of clear and specific categories of property within the plant areas.

A sharp increase in the issuance of One Trip Material Passes is expected resulting from the closing of the Richland barricade, which put the 300 Area outside the plant's property control check point. In connection with the One Trip Material Pass a new form designated as the "One Trip Property Pass" will be issued in the near future to replace the form currently in use. Upon receipt of the forms Property Accounting will distribute them to custodians and recall the unused forms currently in their possession.

In connection with the physical inventory of shop stock material in the custody of Technical Shop Operation the extension of inventory tags is complete and a report of results is being prepared. A comparison of the material inventory balance ($23,534) with the book balance ($23,377) disclosed an overage of $157.

All field work in connection with the physical inventory of movable cataloged equipment in the custody of Radiation Protection Operation is complete and the reconciliation of equipment inventoried which was not on record is in progress. All of the equipment on record at the time of inventory was physically located. Upon completion of the reconciliation by Contract and Accounting a formal report of findings will be issued.

Preparations were completed and a procedure distributed for the physical inventory of movable cataloged equipment in the custody of Laboratory Auxiliaries Operation. The inventory will begin September 1, 1959 with an anticipated completion date of September 18, 1959.

Equipment funds allocation was made based on the initial financial plan. A comparison of HLO's budget, the revision as submitted to the AEC and our allocation are shown below:

(Amounts in Thousands)

Program	FY 1960 Budget	Submittal to AEC	Allocation
2000	$3,079	$2,406	$1,555
4000	1,814	1,739	1,338
6000	217	150	90
Totals	$5,110	$4,295	$2,983

Acquisition activity in the 2000 Program has been virtually halted because of the extreme shortage of funds.

Recent changes in general ledger coding and revision of EDPM procedures has forced us to abandon our dummy codes and revise our coding structure to provide information previously supplied by the dummy codes. These coding changes must be made on approximately 4000 detail records and supporting documents during the current month in addition to providing listings of these changes to Accounts Payable, Purchasing, and the servicing cost groups on work orders.

COST ACCOUNTING OPERATION

An interim financial plan for FY 1960 was received from the AEC, which for the most part provides funds for HLO programs in amounts requested in our FY 1960 Revised Budget. Significant exceptions to this are the Plutonium Recycle Program ($5,000,000 as compared to $5,729,000 budgeted), the 6000 Program - Biological Research ($1,000,000 as compared to $1,086,000 budgeted) and 6000 Program - Environmental Sciences Research ($252,000 as compared to $323,000 budgeted). In addition, no funds were provided for Project Chariot which was undertaken at the request of the AEC subsequent to preparation of our budget last Spring.

Plans have been completed for conversion of all HLO work order servicing components to separate time distribution reports. Effective October 26th, the distribution of employees time to work orders will be submitted to Data Processing on a form separate from time cards, (the back side of the time card will no longer be used for any purpose). The cost distribution week will be from Saturday through Friday, but the payroll week will remain unchanged, covering Monday through Sunday. The resulting variances between salaries paid and salaries distributed will be analyzed each month and should not create any problems in accounting treatment. The earlier distribution cut-off and the separate time distribution will result in Monday, rather than Thursday, issuance of work order runs by Data Processing due to utilization of available machine time during weekends. Benefits resulting from this change will be a reduction in clearical records presently kept by field components, better cost control by field components and possible improvements in the HAPO cost closing schedule.

As a corollary to the above conversion of work order servicing groups, we have requested an HLO-wide, machine issued, time distribution report from Data Processing. This will entail machine accumulation of hours worked and the calculation of applicable salaries and indirect laboratory expenses for each program code. If they can provide such a report by Monday of each week in complete cost coding detail, C&AO would be able to replace the manual TDR pegboard system with considerable savings in clerical time. C&AO Procedures personnel have indicated probable acceptance of our suggestion.

New codes established during the month were as follows:

Organization Codes	
Instrument Research & Development - General	7450
Nucleonic Instrument Operation	7451
Systems Research Operation	7452
Physical Measurements Operation	7453
Program Codes	
CPD 234-5 Plutonium	.61
Project Whitney - Research & Development	.91
Project Whitney - Fabrications	.92

At the request of Accounting Operations Department located at Schenectady, New York, data concerning the number of personnel by function responsible to the Manager - Finance, Hanford Laboratories and related costs were submitted to Schenectady. The periods covered were personnel numbers at 6-28-59, 6-27-59 and 6-25-60. Cost data were submitted for the six months ended 6-30-58, 6-30-59 and 6-30-60. This information was requested of all financial components of the Company by the Accounting Operations Department.

GENERAL

Ten HAPO OPG's have been received to date with five of these coming in August. Those received prior to August have all been issued along with instructions for the new OPG system. Those received (5) during August are being reviewed or duplicated.

Direct ordering of forms by users has reduced time spent on Forms Control considerably. No negative results from the reduced control have been noted.

A procedural study to revise the Fuel Fabrication Development Operation's SS Material inventory recording procedures is in progress. Some increase in custodians and a considerable increase in transactions, types of material and AEC quotas has made the present system inadequate.

No audit is presently in progress.

W. Sale, Manager - Finance
September 11, 1959

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	Spray-Tray Dissolver for Enriched Power Reactor Fuels

END

DATE FILMED

5/28/93