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HANFORD LABORATORIES OPERATION

MONTHLY ACTIVITIES REPORT

MARCH 1958

Compiled by
Operation Managers

April 15, 1958

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

PRELIMINARY REPORT

This report was prepared only for use within General Electric Company in the course of work under Atomic Energy Commission Contract W-31-109-Eng-52. Any views or opinions expressed in the report are those of the authors only.

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TABLE I. HLO FORCE-REPORT AND PERSONNEL STATUS CHANGES

Date March 31, 1958

FORCE REPORT

	At close of Month			At beginning of Month			Additions		Separations	
	Exempt	Non-Exempt	Total	Exempt	Non-Exempt	Total	Exempt	Non-Exempt	Exempt	Non-Exempt
Chemical Research and Development	126	96	222	128	98	226	0	0	2	2
Reactor & Fuels Research & Development	153	100	253	155	102	257	2	0	4	2
Physics & Instrument Research & Development	57	25	82	57	25	82	1	0	1	0
Biology Operation	34	43	77	34	44	78	0	0	0	1
Operations Res. & Syn.	14	3	17	15	3	18	0	0	1	0
Radiation Protection	41	125	166	42	123	165	0	3	1	1
Laboratory Auxiliaries	45	181	226	45	181	226	0	2	0	2
Financial	16	34	50	16	34	50	0	1	0	1
Employee Relations	13	11	24	13	11	24	0	0	0	0
General	1	2	3	1	2	3	0	0	0	0
TOTALS	500	620	1120	506	623	1129	3	6	9	9
Totals excluding Internal Transfers	500	620	1120	506	623	1129	3	3	9	6

Composite Separation Rate - 1.339
Separation Rate (based on separations leaving G. E.) - 1.339
Controllable Separation Rate - .714

SUMMARY

BUDGETS AND COSTS

Fiscal year to-date costs are $12,680,000 at the end of March or 70% of the FY 1958 Mid-Year Budget Review as adjusted to reflect changes received from the Product Departments and HOO-AEC. Changes during March increased the HLO budget by $479,000. March costs of $1,550,000 were up $46,000 over February costs with the major increases occurring in Plutonium Recycle and CPD-Separations Research and Development.

Cost-budget relationships for all programs are in accordance with plan. Accelerated spending on Plutonium Recycle Research and Development is expected during the balance of this fiscal year due to the realization of certain off-site commitments. FPD Research and Development Programs will require continued tight control for the balance of this year and some adjustment of CPD - Separations Research and Development spending is planned in the near future.

The FY 1959 Revised Budget and the FY 1960 Annual Budget is now complete for all Level 3 components. All required schedules and data required by Contract Accounting and AEC have been supplied except for one research and development program proposal.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

Design of the Plutonium Recycle Test Reactor is 53% complete overall. Contracts have been awarded by the AEC for Phase I reactor construction and for design of the reactor fuel charge-discharge vehicle. Design of the associated Plutonium Fabrication Pilot Plant is about 30% complete.

Further generic studies of plutonium fuel cycles have been made, comparing maximum attainable exposures in reactors enriched with U-235 and with equal weights of Pu-239,241 accompanied by equilibrium amounts of Pu-240 and Pu-242. Taking into account the higher total cross-sections of the plutonium isotopes and the consequent lesser neutron leakage than in comparable U-235 systems, Pu-239,241 appears gram-for-gram to sustain longer exposures than U-235 in all cases analyzed to date. Two Pu-Al capsules (1.65 w/o Pu), irradiated in the MTR to 55-60% burnup of the plutonium atoms revealed increases in length and diameter by only about 0.2-0.3%.

Reasonably good resistance to corrosion by water is required of Pu-Al alloy fuel material to minimize loop contamination in the event of a fuel element rupture. Previous observations that Al - 6 w/o U is dramatically superior to Al - 1.5 w/o U in this respect have been confirmed by additional data. This applies to the as-cast structure; working destroys the corrosion resistance. It is here assumed that the uranium alloy is an adequate stand-in for Pu-Al.

Swaging studies of UO_2 continued during the month employing steel, Zircaloy and SAP (aluminum) tubes, with encouraging results.

High temperature studies show that UO_2 melts in a helium atmosphere whereas at reduced pressures it sublimes to cooler portions of the specimen holder. In contrast, UC melted under both conditions. These observations have relevance to the potential for very high temperature operation of oxide fuels.

Definitive tests of the effect of hydriding Zircaloy-2 on the mechanical properties of the material showed high probability that the practical upper limit of hydride tolerable in Zircaloy-2 reactor components may be higher than previously suspected.

Steel jacketed four-rod, metallic uranium cluster elements operating in the KER-3 loop at a power of 42 kw/ft have attained an integrated exposure of 1600 MWD/T.

Various fuel element fabrications in support of the NPR program are nearing completion.

Zircaloy process tube development contracts continue to show encouraging progress for application to existing reactors.

New data on the damage to graphite irradiated in the MTR at high temperatures indicate linear contractions of 0.13 and 0.5 percent at 975 C and 1050 C, respectively. These are not in good agreement with a previously reported contraction value at 975 C of 1.1 percent. Resolution of this point is highly important to IPD's ultimate potential with the production reactors, and in other graphite moderated reactor technologies.

After a year in 105-KE effluent water, samples of ASTM A7 carbon steel had corroded quite evenly to a degree representing a uniform overall rate of 0.85 to 0.88 mil per month.

Experimental heat transfer studies of the response of reactor process tube assemblies to imposed hazardous operating conditions were continued. Steady state boiling curves representative of "C" I and E fuel elements in a "K" process tube were determined for a range of tube powers between 500 and 1250 KW.

2. Chemical Research and Development

Permutit SK, the exchange resin currently in use for plutonium recovery at Purex, proved more stable to gamma radiation than other resins tested.

Confirmation of cesium recovery chemistry in a liter quantity scale has begun in the 222-S Multicurie Cell. Progress is limited by inadequacies of the test cell shielding.

Tests on the electrochemical reduction of uranium (VI) to uranium (IV) (the Flurex Process) further clarified the influence of variables such as interfering ions, cathode current densities, limiting membrane current densities, and NH_4UF_5 product washing.

A model "zebra" pulsed solvent extraction column was constructed and operated to provide specifications for a similar model at the Geneva International Conference.

[redacted]

Zirflex pilot plant studies continued to explore process variables pertinent to non-production fuels reprocessing. The Darex pilot plant titanium dissolver was completed and installation was initiated.

The potential use of an HNO_3-HF dissolver system for power reactor fuels was further enhanced by engineering studies and corrosion tests on various alloys.

Distribution of fission product elements was studied for aged irradiated UO_2 reduced in aluminum-cryolite and then contacted with molten $KAlCl_4$ at 700 C. Most Sr and Cs-Ba activity remained in the cryolite phase. Trivalent rare earths, Ru-Rh, and Zr-Nb follow through with uranium.

Another check of ground water movement using fluorescein dye tracer and well sampling showed average movement rates of 150 to 160 feet per day over a 2.5 mile distance. These data confirm previous rates in the more rapidly moving ground water in glacio-fluviatile sediments. If such channels could persist for substantially the whole path from the Separations area to the river, the HAPO ground disposal program could lose its expected safety margin.

Continuing tests show good strontium removal on calcite beds provided phosphate ion is present in the aqueous Sr containing solution. Recent tests with actual wastes showed Pu^{239} is also effectively retained on the calcite bed by a mechanism postulated to be similar to Sr retention; e.g. the formation of the apatite mineral from calcite and phosphate, Sr, or Pu ions.

3. Physics and Instruments

For the Plutonium Recycle Program, a new type experiment was conducted in the PCTR in which the reactivity was determined for a super-lattice consisting of one lattice cell fueled with plutonium-aluminum rods surrounded by six lattice cells fueled with uranium oxide. This experiment was the first attempt to use the PCTR for measurements on a region larger than a single lattice cell. Results indicate that the use of plutonium fuel in this way in the PRTR will require 20% less to achieve the same reactivity as compared with distributing the Pu-Al rods uniformly through the entire reactor. Measurements have been completed of the reactivity of Plutonium-Graphite fuel rods but doubt as to the plutonium concentration in the rods has delayed final interpretation of the results. A document giving nuclear safety requirements in the handling of Pu-Al alloys was issued.

Two experiments were performed in the PCTR to determine the reactivity temperature coefficient of existing production reactors when uncooled and containing higher exposure slugs. Analysis of the results is in progress.

In the NPR program the work was primarily in the theoretical direction this month with attention given to correlation of results of previous experiments in exponential piles with the aim of improving calculational methods. Two computer codes were adapted for local use. One additional experiment with cluster fuel elements using 0.9-inch diameter rods was performed to round out this series.

Continued work on the slightly enriched uranium dissolver problem included measurements with I and E slugs containing 1.6% U-235. These experiments involved

the highest bucklings ever measured in exponential experiments at Hanford. The amount of material involved was 60% of that required for criticality. A new dissolver design for handling E-Metal was reviewed and some changes were suggested. PCTR experiments were run to obtain data on the reactivity of Uranyl nitrate-water mixtures at three enrichments near 2% and at two water to uranium ratios. Equipment for measurements on oxide, water mixtures at 3% enrichment is being fabricated.

Advice was provided on nuclear safety problems in 234-5 Bldg. and in the Recuplex Operation.

Unsuitable weather conditions prevented experimental work on the Wahluke Slope problem but assistance was given to Radiation Protection Operation in the preparation of a report for the ACRS.

Work on the methods of forecasting 200-mile trajectories of clouds released from disasters indicates that the methods considered to date will give only mediocre accuracy.

Instrument development continued satisfactorily. Particularly gratifying was completion of a five month field test of a scintillation, transistorized alpha hand counter. During this test no down time was required for maintenance and no recalibration was necessary.

In the basic data field, work progressed on the determination of the low-energy fission cross sections of Np^{237} and Am^{241} and on standardization of our measurements with other laboratories.

4. Biology

Present findings on I^{131} metabolism in sheep show a significant depression of thyroid metabolism at a feeding level of 5 μc I^{131} per day. Slight depression occurs at 1.5 μc per day, and borderline depression at 0.5 μc per day.

Six years ago, 5 μc per day was stated to be apparently safe; 0.5 μc per day was chosen as a reasonable working limit. The permissible deposition on vegetation is based on this, with some rounding-off that gives an extra safety margin. The new data confirm that this approach was well-conceived.

Cs^{137} limits for drinking water cannot be applied to waters containing forms of life eaten by man because of marked concentration of this element by members of natural aquatic communities. This further enhances Cs^{137} as one of the main contributors to long term waste disposal problems.

Technical and Other Services

One minor case of plutonium deposition was confirmed bringing the total number of confirmed plutonium cases to date to 219. A potentially serious case of plutonium contamination occurred when an undiscovered minor injury was later found to contain about 120% of the MPL. Local excision of the affected area removed essentially all of the offending material.

The average emission of I^{131} from separations stacks was 27 curies. This excessive emission was reported to be the result of decreased aging time of metal and operating difficulties with iodine removal equipment. The average I^{131} deposition on vegetation outside the plant perimeter was below the Hanford limit of 10^{-5} μc/gm. Samples in the vicinity of the 200 Areas were as high as five times this concentration.

The fallout of nuclear materials from foreign bomb tests caused vegetation contamination levels to be 2 to 25 times higher than normal. "Normal," in the present connotation, already includes a fallout contribution greater than that caused by Hanford operations.

Agreement was reached on the formation of a task force to examine methods, based on economic ground rules, for the evaluation of long-range capital expenditure programs.

Further discussions concerning the nature and scope of a simulation model of HAPO were held during the month, and specific plans for the implementation of this work have been formulated.

Work on the CPD Control Study was concentrated primarily on the effectiveness of the Book Physical Inventory Difference as a control and accounting tool. Several of the accountability matrices completed as part of this study are being used and maintained by other groups because of their intrinsic value independent of the study.

In response to outside requests, consultations on activities relating to Operation Pool were held with three different groups during the month.

Statistical and mathematical assistance on 41 separate problems was given to other HAPO components. Of particular interest was work on a mathematical model for the prediction of the deposition of radioactive materials from Hanford sources, and additional work on the analysis of fuel element failure data and the construction of mathematical models of these phenomena.

Excluding the major Plutonium Recycle Program projects, there were 15 authorized projects at month end with total authorized funds of $3,591,000. The total estimated project cost of these authorized projects is $5,016,500. There were no projects completed during the month and no new projects authorized. Five new projects are awaiting AEC authorization; these have a total estimated project cost of $5,698,000.

All projects are proceeding substantially in accordance with the official schedules and within the authorized funds. However, many projects are behind the original project planning schedules due to delays in obtaining certain authorizations.

Radiographic Testing volume of work hit a new high for the month in total number of tests performed and feet of material examined. A method of measuring the changes in core thickness of MTR fuel plates was developed enabling for the first time scribing of the true cross-section of the core by non-destructive means.

Supporting Functions

As a result of the increased per diem allowance retroactive to January 1, 1958 a credit adjustment of $249 has been made to Hanford Laboratories Operation travel and living account.

The amount of underruns on appropriation requests continue to exceed the overruns; however, of the 72 completed requests since July 1, 1956, 47 (65%) have deviated (either over or under) by more than 10% from the original estimate. Methods are being studied to reduce these variances.

[redacted]

With the cooperation of all Level 3 HLO components, a forecast was made of the expected electronic data processing needs for the next few years. This forecast was made at the request of Relations and Utilities Operation to assist in evaluating the need for an IBM 709.

A questionnaire has been forwarded to ten large industrial laboratories to gain information on library services.

At month's end the staff of the Hanford Laboratories Operation totalled 1120, including 500 exempt and 620 nonexempt employees. Of the total exempt employees there were 434 with college degrees, including 416 technical degrees as follows: BS-217, MS-102, PhD 97.

Plans for the AEC-ASEE Summer Institute are progressing.

Interest in touring the facilities of HLO and particularly those of the Biology Operation has increased during recent months. During March, Kiona-Benton High School agriculture students toured the Biology Operation and arrangements have been made for additional tours for the month of April.

Since September 1, 1956, a total of 3,580,700 man-hours was completed with no disabling injuries. The medical treatment frequency for March dropped to 1.52 as compared with 2.42 during February.

There was one security violation during March, bringing the 1958 total to twelve.

H M Parker

Manager,
HANFORD LABORATORIES

HM Parker:kss

[redacted]

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Organic Coolant Studies. The program to determine the phase relationships in mixtures of the simple polyphenyls has continued. The binary mixtures have been previously reported. The eutectic mixtures of the ternary systems completed thus far are shown in the following table:

TERNARY EUTECTIC MIXTURES

Eutectic Composition (Mole Percent)	Eutectic Melting Point, °C
42% O-terphenyl 32% biphenyl 25% napthalene	11
59% O-terphenyl 30% napthalene 11% M-terphenyl	20
48% O-terphenyl 37% biphenyl 15% M-terphenyl	23
59.5% O-terphenyl 23.5% phenanthrene 17.0% M-terphenyl	28

The hydriding studies of uranium, zirconium, and Zircaloy-2 in monoisopropyl biphenyl (MIPB) have continued. Samples were exposed for six days at 100 psi total pressure. Tests covered the temperature range of 250 to 400 C and were run at 5 psi and 1 psi hydrogen partial pressure. The results are given in the following table:

HYDRIDING OF ZIRCONIUM AND ZIRCALOY-2 IN MIPB IN 6 DAYS UNDER CONTROLLED HYDROGEN PRESSURE

Temp.	Initial H in Metal	Final H in Metal	
		5 psi H Part. Press.	1 psi H Part. Press.
400 C	3-12 ppm	700-8700 ppm	--
350	3-12	140- 975	30-90 ppm
300	3-12	5- 38	2- 3
250	3-12	3- 5	<1 (a)

[redacted]

HYDRIDING OF URANIUM IN MIPB
IN 6 DAYS UNDER CONTROLLED HYDROGEN PRESSURE

Temp.	Weight Loss During Exposure, mg/sq cm 5 psi H Part. Press.	1 psi H Part. Press.
400 C	5.0	0.25
350	11.5	1.5 (b)
300	93.0	0.93
250	285.	2.6 (a)

(a) This test ran for only 4-1/2 days.
(b) This value is high due to excessive attack during cleaning.

A laboratory loop has been in successful operation for 775 hours recirculating MIPB through a Zircaloy-2 tube at about 370 C, 100 psi, and with hydrogen vented from the liquid at atmospheric pressure during each pass through the loop.

Chromic Acid Autoclave Films on Aluminum. Initial experiments were started to examine the high temperature water corrosion of chromic acid autoclave films on X-8001 aluminum alloy. The films were produced by autoclaving X-8001 alloy in 1% aqueous chromic acid at 170 C for 40 hours. Coupons were then autoclaved at 350 C for various times in both deionized water and deionized water plus 2 ppm $Na_2Cr_2O_7 - 2\ H_2O$. Weight gain measurements on the coupons autoclaved in deionized water indicated the chromic acid film inhibited corrosion for about one day and then reverted to the normal oxide film. The coupons autoclaved in 2 ppm dichromate indicated the chromic acid film is more stable in this medium. This experiment is still in progress. Other concentrations of dichromate will be investigated.

Radiometallurgy Laboratory Studies

Thermocouple Slug From GEH-4-H. This test consisted of one I & E thermocouple slug with UO_2 washers as fuel. The slug was discharged from the MTR after a short irradiation upon indication of a possible leak. Previous efforts to locate a leak with a bubble tester were negative. During the month the slug was heated to 275 C in a vacuum annealing furnace, and samples of the released gases were collected for analysis by the Analytical Laboratory for fission gases. No fission gases were detected.

When the furnace was opened, the collar, which surrounded the thermocouple outlet on the cap end, was found to have melted. The melted material was supposedly lead, which has a melting point of approximately 315 C. A sample of the material was removed and the melting point found to be less than 200 C. A spectrochemical analysis showed the material to be an alloy of lead, tin, and antimony, explaining the low melting point.

Basic Metallurgy Studies

Electron and Optical Microscopy. The study of the microstructure of cladding and fuel materials is a direct way of detecting radiation damage in these materials. Two techniques are being used: (1) metallographic examination of polished and etched surfaces, and (2) fractographic studies. Hardness, density, burnup, and metallography of fractured and repolished surfaces have been completed for specimens having burnup values of 0.02, 0.03, 0.07, and 0.10 a/o. The hardness and density data are as expected. Fractographic studies at all burnup levels show a transgranular and intragranular type of fracture, even for the lowest burnup value. To determine the source of cracks observed on a polished and etched surface 3 mm below the fractured surface, a fractography specimen was ground further to a depth of 4 mm below the fracture. Close examination of this surface by electron microscopy showed that cracks were still present. No conclusions have yet been reached about the source of the cracks.

A paper on metallographic studies of uranium has been written for the Geneva Conference. A motion picture of deformation in uranium as a function of stress and temperature is also being prepared for the conference.

Diffusion Studies. A knowledge of the interdiffusion of various uranium/barrier metal/clad metal combinations is essential in the design of fuel elements. Diffusion is being studied in U/Ni/Al, U/X-8001, U/Zr, and (U-Zr) alloy/Al couples. The effect of thermal cycling, during the diffusion anneal, on the U/AlSi diffusion rate is also being determined. A report entitled "An Evaluation of Various Diffusion Data Pertinent to Fuel Elements" has been issued as HW-54729.

Two U/Ni/Al couples, each consisting of a 0.001-inch thick nickel disk between a 0.005-inch thick disk of aluminum, and a 1/4-inch thick disk of uranium, have been annealed 66 hours at 533 C. The nickel compounds in these couples completely penetrated the aluminum at several points. An autoradiograph showed that the uranium had not migrated to the surface

of the aluminum in quantities exceeding 0.6 w/o, the lower limit of detection. Two other couples of this type were annealed 162 hours at 569 C to facilitate a study of the migration of uranium into the Al/Ni diffusion zone. Nickel penetrated the aluminum, and extensive reaction occurred between the Al/Ni diffusion product and the uranium at several points.

Studies have been initiated to determine whether a small percentage of uranium in aluminum can be detected by x-ray fluorescence. A 0.6 w/o uranium-aluminum alloy standard gave a strong indication. Fabrication of alloy standards containing smaller percentages of uranium has been initiated.

Capsules containing two U/Al couples which were irradiated at approximately 200 C (392 F), and two U/Al and two U/AlSi couples supposed to have been irradiated at approximately 250 C (482 F) in the MTR have been opened. Calculations based on burnup measurements to estimate the total integrated flux showed the temperature at the center of the U/AlSi diffusion interface to be about 77 C during irradiation. The data obtained thus far indicate that the diffusion rate at low temperatures may be much greater during irradiation than in its absence.

Cross sectioning of the U/AlSi couples has been completed. The points of diffusion in four planes perpendicular to the diffusion interface have been micrographically photographed at 280X. The diffusion zone is being measured directly from the micrographs, and the data thus obtained statistically analyzed to determine the maximum probable diffusion which occurred in the couple. The greatest penetration appears to be about 0.0003 inch into the AlSi. Each of the four U/Al couples have been cross sectioned once, but no micrographs are yet available for measurement.

Recrystallization and Recovery of Zirconium Alloys. 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 treat atmosphere have been selected as the independent variables.

Corrosion tests in 680 F water are being run on specimens of Zircaloy-2 and Zircaloy-3 by the Bureau of Mines, Albany, Oregon. The completed corrosion tests of specimens of Zircaloy-2 and argon melted Zircaloy-3 heat treated in air and helium from 400 C to 800 C for 10 to 1000 minutes showed some interesting weight gain trends. The corrosion rate plots showed, in general, three regions instead of the expected two. The graphs of weight gain as a function of time in test (at 680 F) were of an "S" shape. Both the Zircaloy-2 and the Zircaloy-3 showed the following three regions:

1. Weight gain increases at a uniform rate until "breakaway" is reached.
2. Weight gains increase at highly accelerated rate.
3. Weight gains show abrupt change, initial decrease and then very slow increases with time.

The Bureau of Mines, Albany, Oregon, has previously noted this phenomenon for zirconium alloys in hot pressurized water. Examination of the samples shows that the Zircaloy-2 samples have a tightly adherent black corrosion product, while the Zircaloy-3 samples have evidence of the white oxide. The white oxide in the Zircaloy-3 is superimposed preferentially on a black film indicating susceptibility to stringer corrosion.

In general, all the air and helium heat treatments of Zircaloy-2 and argon melted Zircaloy-3 from 400 C to 700 C improve the corrosion resistance as compared to that in the cold worked state. The difference in rates resulting from various heat treatments is small. The suggested treatments in air or helium, based on corrosion life (time to reach weight gain of 100 mg/dm^2) would be 600 C for 100 or 1000 minutes, or 700 C for 10 to 100 minutes. Air or helium treatments would be suggested only when use of a vacuum is impractical, since the corrosion rates produced by heat treating in vacuum seem to be the most satisfactory.

Radiation Damage in Thorium-Uranium Alloys. Alloys of thorium containing 1 w/o oralloy (93 percent U-235), 4 w/o oralloy, and 5.4 w/o oralloy have been obtained for irradiation tests. This material will permit evaluating changes in mechanical and physical properties in an isotropic lattice after relatively high atom burnups.

Microhardness measurements have been made on alloy specimens after 2-hour, 4-hour, and 8-hour anneals at 600, 700, 800, and 900 C to determine their annealing behavior after 60 percent cold work. These data indicate that the 1 w/o U alloy completely recrystallizes within two hours at temperatures above 700 C. For the 4 and 5.4 w/o U (low carbon) alloys, an anneal at 900 C is required to complete recrystallization within two hours. Finally, for the 5.4 w/o U (high carbon) alloy, a 4-hour anneal at 900 C is required.

In all the specimens, rehardening was observed during annealing at 900 C; however, the time at which rehardening occurred varied among the alloys. It is suspected that precipitation of a uranium-rich phase occurs during furnace cooling from 900 C which increases the hardness. Since the one w/o U alloy also exhibited rehardening, it follows that this may be a two-phase alloy instead of a single-phase alloy as previously assumed.

Hanford Irradiation PT-3NA. The design of advanced fuel elements depends upon some knowledge of the effects of irradiation on the significant mechanical and physical properties. A program to obtain this information is under way. An elevated temperature tensile test was performed at the Radiometallurgy facility on a specimen exposed to 0.10 a/o burnup. At the test temperature, 600 C, the specimen broke very readily, but outside of the gage length. Therefore, a duplicate test is scheduled to confirm the results. The specimen had a total elongation of less than one percent and had an ultimate strength of 4900 psi which is considerably lower than unirradiated uranium tested at 600 C. At temperatures below 600 C, the 0.10 a/o burnup specimens have exhibited higher strengths than unirradiated specimens. The yield strength was 3800 psi which is comparable to 3600 and 5000 psi for two unirradiated uranium specimens tested at 600 C.

Neutron Damage to Metals. The purpose of this program is to advance the theory of irradiation damage to metals by neutrons. A series of metals representing the common metal crystal types was irradiated at Brookhaven, Hanford, and the MTR under various exposures and temperatures. These metals include copper, nickel, titanium, zirconium, iron, molybdenum, and type 347 stainless steel. Post-irradiation measurements of mechanical and physical properties of these metals were initiated at KAPL and will be completed at HAPO. During the month the specimens were received from KAPL. Segregation and recanning of the specimens are about 50 percent complete. Transfer of the copper specimens to the tube storage facility was started. Final design of the electrical resistivity apparatus was completed.

Production of High-Purity Uranium. A study of methods of preparation of high-purity uranium is being conducted primarily to provide a supply of this material for use in fundamental physical metallurgy studies. Electrowinning from a molten KCL-LiCl-UCl_3 salt bath produces dendrites of uranium, which may be vacuum melted. The metal obtained from these operations may then be fabricated into the required specimens.

Small amounts of electrolytic uranium dioxide have been produced in the large electrolytic cell. During the "working" period, while the bath still contains moisture, the oxide deposits at the cathode. Since most electrolytic powders have good compacting properties, this material may be of use in making ceramic fuel elements. Continuous production of the oxide as the electrode deposit would depend on the feasibility of introducing added moisture to the molten salt bath. This process is currently being investigated.

Irradiation Study of Thermocouples. A knowledge of the errors in temperature measurement using thermocouples in a neutron flux is essential for the quantitative evaluation of the effects of neutron irradiation on materials. Because such information is lacking, a program of measuring thermocouple stability in-reactor is currently in progress. The quartz insulated and asbestos insulated thermocouple lead wire assemblies have received 456 hours of exposure in KW reactor. After the asbestos insulated assembly had recovered its resistance, no change has been observed in the readings. Both units are still showing a resistance between leads above the upper limit of the recording bridge (10^7 ohms). Quartz insulated thermocouple lead wires have been swaged preparatory to the insertion of the 300 C thermocouple stability test. No resistance measurements have been made, but continuity of the wire has been checked.

New Fuel Element Development

Rod Cluster Fuel. The irradiation of a four-rod cluster element is proceeding in KER loop 3 at a power of 42 kw/ft. Attained exposure is ca. 1600 MWD/T, about 75 percent of which exposure was accumulated with the maximum water temperature at 235 C. The Loop 3 fuel elements are intended to check charge-discharge problems, power generation, heat transfer, and core swelling.

Two seven-rod cluster fuel elements were fabricated for test in KER loop 1. The fuel rods are 0.630-inch diameter coextruded Zircaloy clad uranium produced by Nuclear Metals, Inc. The seven rods are assembled into triangular end spiders which provide low pressure drop and minimize stresses on the process tube wall in case of fuel rupture. The inter-rod spacing of the fuel assembly is 0.050 inch, and the fraction of the tube cross section filled with uranium is 54 percent. The test will be charged in April and operated with 270 C water coolant. One check of the safety of this test was made by examining of a fuel element of this type which was defected in 290 C water. After two hours exposure, the defected rod was split for only about one inch along the rod, and the swelling was modest. There was no difficulty in discharging the defected element.

A test of coextruded rod in two-foot and three-foot lengths was designed to determine the in-reactor bowing of long rods. Nuclear Metals Zircaloy-2 clad uranium will be employed, and the test will be charged following the discharge of the present KER loop 3 cluster test.

Cold Closure Development. Tools and components have been procured for investigating the feasibility of an annular closure on an I & E fuel element. The basic technique is to extrude a pipe from the interface of two concentric heavy walled rings which is intended to form a cold weld at the interface. Four trials have been made with varying extrusion conditions of which only one formed a reasonably sound weld.

An attempt to bond a cold canned and vacuum welded I & E element was only moderately successful. The element was made employing a standard cold closure cup into the base of which was welded a thin wall tube. The cup and tube were draw sized to the nickel plated core and the heavy wall ring of the cup upset tightly against the center tube. This interface was then vacuum welded and the assembly baked for two hours at 600 C and atmospheric pressure. Spotty diffusion occurred between the nickel, aluminum, and uranium.

Insulated Fuel Element. Insulated fuel elements are of interest on the assumption that increased uranium temperatures during operation should decrease the tendency to failure by thermal stress splitting. A deterrent is the question of the severity of a rupture incident. To investigate this matter, an operating, unbonded, insulated fuel element was intentionally ruptured at the MTR. The rupture was accomplished without difficulty and the ruptured element operated for one minute while at a maximum temperature of 500 C without displaying any distortion or unaccounted for swelling. Examination at the Radiometallurgy facility revealed a uniform increase of the fuel element diameter of 0.005-0.007 inch. This amount of swelling can be accounted for by plastic yielding of the aluminum cladding when strained by thermal expansion of the uranium fuel with no contribution from accumulated uranium corrosion products. The fuel element is being further examined to verify this point.

Aluminum Clad Rod and Tube Fuel Elements. The 20-inch long by 1.9-inch OD tubular fuel elements, jacketed in M-388 aluminum as described previously, were taken to BMI for fluid pressure bonding. One of the three tubes leaked at the weld, but the other two were successfully bonded. Both the inside jacket and the outside jacket withstood attempts to fracture the U-Ni-Al bond on the one element destructively examined. A report on this work will be issued as HW-55498.

Pressure drop characteristics of the rod and tube elements will be measured in an ELMO loop. One of the elements will be defected and allowed to rupture. Experience gained with these elements will be used in the fabrication of tubular elements for irradiation testing. The new elements will be similar except that extruded instead of cast uranium tubing is being used for the core material.

NPR Hot Pressed Fuel Elements. The second charge of NPR segmented, I & E enriched fuel elements has been completed. Uranium washers were nickel plated on all surfaces, then machined on the faces to remove the excess nickel. These washers were then enclosed in the A-2 aluminum alloy can. The third and fourth charges are now in process of completion. This series is to have the washers encased in the C-2 aluminum alloy can, a 2 w/o nickel alloy. Assembly difficulty was encountered; however, annealing the can at 450 C corrected the galling encountered.

A reactivity test was run on a single element in the 305 test reactor. This test was to determine the difference in reactivity between a fuel element with the uranium washers plated on all surfaces and one with machined surfaces. A difference of 0.043 inch was found; the machined washers showing the higher reactivity. However, this value is within the accuracy limits of the reactor; therefore, a larger number of pieces will be run to determine a statistical difference in full pile reactivity.

Fabrication of Tubular Uranium Cores. A method for production of uranium tube cores, 1.78-inch outer diameter, 1.44-inch inner diameter, up to 30 inches in length, is being developed for fabrication of tube and rod elements. Tube sections 2.00-inch OD, 1.25-inch ID, 22 inches long, are vacuum cast in graphite molds and machined to approximately 1.900-inch OD, 1.450-inch ID. The castings made thus far from scrap uranium stock have averaged 50 ppm N_2, 1340 ppm C, with a density of 18.80 g/cc. Subsequent heat treatment and swaging are being employed to break up the cast structure and perhaps increase the density. One tube section was beta heat treated three times and vacuum annealed at 600 C for two hours. The macrostructure after this treatment indicated that the large grained as-cast structure had been eliminated. The section has been partially reduced to size by swaging over a mandrel to hold the inside diameter and increase the length.

Restraint of Uranium Swelling by Zirconium Cladding. Swelling rates of unrestrained uranium irradiated in the 400-800 C temperature range have been measured, but to date no swelling data are available for unalloyed clad uranium with a 250-350 C cladding surface temperature and a maximum fuel temperature in the range 450-600 C. The above temperature conditions

and restraint conditions are similar to those of proposed NPR fuel elements; hence, a NaK capsule MTR irradiation has been designed to provide data for these conditions. Irradiation of this capsule, designated as GEH-3-31, began on March 5, and will continue to an exposure of 2500 MWD/T. At the beginning of the reactor cycle the temperature measured by a thermocouple located at the center of the uranium core was 350 C, which is approximately 250 C below that desired. A flux measurement of approximately 0.7×10^{14} nv in the reactor facility was made subsequent to the insertion of the capsule. This indicated flux is much less than the requested 1.2×10^{14} nv. This would account for the low uranium temperature. Next cycle the capsule will be raised to the reactor-core midplane in order to obtain the desired flux. A second identical capsule GEH-3-32 will be irradiated as soon as information regarding the temperatures of the first capsule are obtained.

A series of NaK capsule experiments is being designed for irradiation in Hanford reactors to obtain further information on the dependence of fuel element swelling upon cladding and uranium temperatures, cladding thickness, and exposure. The containers will be machined from rods of the aluminum alloy now used for standard Hanford canning components. In order to compare the corrosion resistance of the capsules to standard fuel elements, nine test capsules, with welded standard end caps, and several production slugs will be tested under accelerated corrosion conditions. Work is also continuing on the development of a method of AlSi brazing a cap into the capsule by induction heating.

Electron Beam Vacuum Welding. An investigation has been made to determine the advantages and characteristics of electron beam vacuum welding using alternating rather than direct current. Examination of welds on AlSi bonded fuel elements employing AC indicates there is complete mixing of the AlSi bond layer with the fusion zone and that the grain size of the welds appears to be smaller than comparable welds made with a DC power supply. Little advantage of AC over DC has been detected.

Beryllium Addition to AlSi. At the request of Fuels Engineering Operation studies have been initiated to determine the possible benefits to be obtained from beryllium additions to the aluminum-silicon alloy used in the canning process. The observations would include dross formation, concentration of beryllium or its compounds in the oxide skin, and fluidity and surface tension of the alloys.

Comparison is being made between standard AlSi obtained from the canning pot in the 306 Building pilot line and alloys containing 0.05 and 0.1 w/o beryllium prepared from this AlSi and a master alloy of Al - 6 w/o Be. Dross formation for beryllium-bearing alloy was less than for standard AlSi, and the oxide formed was a bright, thin film. A five-fold increase in concentration of beryllium in the oxide layer of the bath may indicate an increased health hazard in handling skimmings and possibly for working over a beryllium-containing alloy bath. No significant difference in fluidity was detected between the standard AlSi and the beryllium-containing alloys. Apparatus for measuring surface tension by the maximum bubble pressure method is being fabricated.

Thermal Contact Conductance of Fuel Element Materials. Additional contact conductance measurements were made on the system Al-U, U-U, and U-Al. The first couple differs from the last in the direction of heat flow. The uranium-uranium contact conductance data will aid in interpretation of core temperatures obtained during experimental coaxial fuel element irradiations. The recent tests with sand-blasted uranium surfaces in contact were in fair agreement with previous tests in which the contacting surfaces had a roughness of less than ten microinches rms. At thermal fluxes exceeding 100,000 BTU/hr/ft^2, the uranium-uranium contact conductance changed from 900 to 1500 BTU/hr/ft^2/°F as the pressure on the joint was increased from 150 to 1000 psi. Aluminum-uranium joints are sensitive to temperature and pressure.

Transient Temperature Calculations. The appropriate equations have been derived and an IBM 650 code written for the transient temperatures in cylinders with various surface bond conductances. The results obtained from these calculations will be used in conjunction with an experimental apparatus developed to measure the bond conductance between various jacket to fuel interfaces. The machine calculations should be completed in April.

U-Mg Matrix Fuel Material. U-Mg matrix material is being investigated as a possible high burnup fuel. There has been no post-irradiation evidence discovered to explain the observed "swelling" or dimensional instability displayed by this material. The observed "swelling" was based on fuel material measurements in the case of the KAPL powder metallurgy specimens, and on fuel element measurements in the case of the HAPO size U-Mg fuel element irradiated at the MTR. Additional measurements have been made on the fuel diameter of the HAPO size element and an observed increase verifies that most of the "swelling" is due to fuel behavior and not to the formation of a gap between the fuel material and its cladding during reactor operation. Diameter increases of the fuel clad ranged from 0.019-0.022 inch, whereas diameter increases of the fuel ranged from 0.014-0.016 inch. The observed difference of 0.005-0.006 inch could be accounted for by the formation of a gap between the fuel and clad which was obscured during sectioning and which resulted from contraction of the fuel as it cooled from operating temperature to ambient.

Tru-Line Washers. One of the methods being developed for the fabrication of Tru-Line washers is the upsetting of rod stock. The chief advantages of this method are: (1) scrapless production of washers with accompanying economy, and (2) built-in Tru-Line feature eliminating additional fabrication. An experimental die set is being used to define the material and fabrication conditions required to upset 11/16-inch diameter rod to KER size washers (1.696-inch outer diameter). Tests during the month were made with ingot uranium stock preheated to 550 C. The stock was heated in an air muffle furnace and packed in powdered graphite to prevent oxidation. The material was satisfactorily protected, and upsets were made that almost completely filled the die cavity with 175 tons force. Higher pressures will be required to form a completed washer.

Plating Development. A second lot of KER size enriched washers was plated for use in canning test elements for exposure under PT-IP-134A (Series E). After plating, these washers were stripped of nickel on the flat faces, by machining, in the same manner as was employed in preparation of the previous lot.

There is still much to be desired with respect to uniformity of nickel deposit on these washers. Several methods of racking and processing the washers have been tried; it appears that the only methods which are apt to be satisfactory will require a central anode passing through the hole in each washer. Design and procurement of suitable racks and development of procedures that will permit the employment of these principles without causing carry-over of nitrates from the etch bath to the plating bath are proving difficult. Schemes currently being tried show some promise.

One of the shortcomings of existing Plating Laboratory procedures is the lack of control tests for the various baths and solutions. During the past month, speedy control tests have been devised for nickel-ion, sulfate-ion, chloride-ion, ammonium-ion, and hydrogen-ion in the bath. Further work needs to be done in establishing norms for these ions in the plating solution, and tests must be devised for several other ions which are present as part of the makeup ingredients or as contaminants.

Steady State Deformation of Process Tubes. A method for determining the rate of deformation and stress distribution in process tubes under high internal pressure with radial temperature distributions has been formulated. The calculations assume that steady-state conditions have been reached in which secondary creep is occurring, and the stress distribution and strain rates within the tube are independent of the time. Calculations for Zircaloy-2 process tubes for the NPR will be run using this method as soon as the machine program is completed and a material model is evaluated with Zircaloy-2 creep data.

2. REACTOR PROGRAM

Coolant Systems Development

Ex-Reactor High Temperature Studies. The ELMO-1 facility is in use to determine the rate of film and scale accumulation in heat exchangers where raw water is used to cool high-temperature, high-purity water. The raw water cooled heat exchangers have not been examined yet this month as a full month's operation has not been obtained since the last inspection. Failure of the flow control valve on the cooler exchanger caused this exchanger to vary from the specified operating conditions. The valve will be replaced as soon as possible. Methods of chlorinating or otherwise treating the raw water coolant to reduce scale and algae build-up on the baffles are being examined.

Functional testing in the ELMO-2 facility at 180 C with a saturated solution of 1,5-dihydroxy-anthraquinone continued. Decomposition of the organic inhibitor became apparent after a short operating period. Since the decomposition lowered the pH of the water below the desired test

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conditions, no coupons were charged into the loop. After providing an inert atmosphere over the makeup water tank, the pH rose and the oxygen content in the water decreased to zero, apparently stopping the decomposition. Carbon steel and aluminum coupons will be charged into the loop at the next shutdown to evaluate the effectiveness of the inhibitor.

Two hot pressed Elephant slugs were tested in the ELMO-4 isothermal rupture test facility. These tests were run to confirm previous results. The first slug was bonded only on the inner and outer surfaces, hot pressed for four minutes, and had the center hole plugged with an aluminum rod. After testing for one hour at 280 C, the flow annulus in the 2.08 ID tube was not appreciably blocked. The second slug tested had bulkhead bonding of the washers and was hot pressed for 17 minutes. The rupture was slightly more severe than ruptures of slugs with only four-minute presses, but still did not plug the annulus appreciably. Even though the center hole was plugged, a pressure drop of only approximately 15 inches of water at a flow of 10 gpm was noted.

A new test to evaluate carbon steel as a possible NPR piping material was begun in the ELMO-5 facility. Carbon steel coupons of A-212, 1032 and 1051 are being exposed at 290 C and pH 10.0 w/LiOH. These coupons after exposure will be "decontaminated" with various solutions and re-exposed to determine any effects due to decontaminating. Also planned are caustic embrittlement tests, stress tests and crevice tests for A-212, 304 stainless steel and Zircaloy-2.

The ELMO-6 facility operated at 300 C, pH 4.5 w/H_3PO_4 and flow velocities of 12 fps. Two fuel elements clad in A-2 and M-388 aluminum alloys are being tested. After one week's exposure, no pitting or blistering of the cans was noted.

Thermal cycling tests of PRTR components were run during the first part of the month in the ELMO-7 facility. The 45 HP Byron Jackson pump was installed in the loop to give higher flow and available pressure drop. Heat exchangers have been installed on two manifold test sections on the loop to permit thermal cycle testing of components while the remainder of the loop is operating at a constant temperature. The most desirable cycle time to minimize loop temperature fluctuations appears to be 20 to 30 minutes according to preliminary testing from 250 to 550 F. A minimum cycle time of about 15 minutes can be obtained, however.

A-1, A-2, C-1, and C-2 type aluminum alloy clad hot-press canned and M-388 alloy clad lead dip canned Elephant fuel elements and A-1, A-2, C-1, and C-2 alloy fuel element cans have run 80 hours at 60 gpm, 580 F, 1690 psi with 4.5 pH coolant adjusted by H_3PO_4 addition. Four-rod cluster elements clad in stainless steel and coextruded Zircaloy-2 are also being tested at the same conditions. No examination has yet been made of the fuel elements.

An NPR cap and jumper connection using tapered flat gasket seals were successfully thermal cycled 136 and 143 times, respectively, between 300 and 550 F. These two test sections are now being tested at constant conditions of 580 F and 1690 psi. A bell-ring type cap seal failed on the first heating cycle and was removed from the loop.

Delivery date for the ELMO-8 carbon steel loop is scheduled for delivery from ALCO Products, Inc., on August 1, 1958. Loop operating conditions will be 370 C, 3100 psi and 100 gpm.

The test in the ELMO-9 facility at 250 C and pH 4.0 w/H_3PO_4 to determine the presence of intergranular corrosion of sensitized 304 stainless steel coupons was terminated. Metallurgical examination of the coupons is under way. The loop is being conditioned for the next test at pH 6.7, 100 to 200 ppm of 1-5 dihydroxyanthraquinone, and 250 C. Coupons of aluminum alloys and carbon steel will be charged following the conditioning period.

The prototype equipment for heated slug rupture tests was moved to the 185-D Building from the 300 Area. Reassembly of the loop and construction of trenches for the bus work and drainage system are currently being done by Construction Operation forces.

High Temperature In-Reactor Loop Tests. The KER-1 loop has been on recirculation with 4-rod stainless steel clad clusters since February 28 to evaluate the loop equipment and operation temperatures up to 275 C. The loop is currently operating at 270 C. Some leakage of the drain valves was stopped by capping the drain lines. The loop was on process water for a short time while the lines were being capped. Carbon steel coupons for decontamination studies were charged into the mock-up tubes.

The dump valve on the KER-2 loop was repaired on March 1. Repair of primary pump No. 1 was made on March 14 by installing a balanced impeller. The loop was on single pass operation with dummies during the month. As the loop has been repaired, the production test issued and the fuel elements available, it is expected that the loop will be charged during the next reactor outage. This charge will be enriched hot-pressed Elephant slugs and clad in A-2 aluminum alloy.

Following repair of the dump valve on February 28, the KER-3 loop was put on recirculation. The loop is operating at an outlet temperature of 235 C with twenty 4-rod stainless steel clad fuel elements in the process tube.

The dump valve on the KER-4 loop was repaired on March 1. At that time the loop was put on recirculation with dummies. On March 6 excessive leakage of the dump valve necessitated single pass operation. During the following reactor outage on March 14, the dump valve was again repaired by installing a new seat and plug. Ten enriched hot pressed Elephant slugs on PT-IP-134A were charged at that time. The loop has recirculated at an outlet water temperature of 240 C, pH 4.5 w/H_3PO_4 and a flow rate of 60 gpm since the reactor startup.

Organic Coolant Studies. The carbon steel (1050), aluminum (2S and M-257), magnesium (AZ-31) and Zircaloy-2 coupons were discharged from the ORA-1 ex-reactor facility after a total exposure of 1047 hours at temperatures of 700 to 750 F. Only the magnesium coupons showed any signs of corrosion. They were badly corroded and warped from the water dissolved in the

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organic. The nickel and AlSi bonded fuel elements were also discharged with the same exposure. Other than being discolored there was no apparent damage or pitting. The graphite diffusion barrier fuel element showed signs of thermal racheting. The loop was charged with three new nickel bonded, four new AlSi bonded, and one graphite diffusion barrier fuel element. Magnesium, Zircaloy-2, and aluminum (M-388 and M-257) coupons were also charged. Loop operation was excellent with only minor adjustments required.

Low Temperature Corrosion Studies. To determine the effect of pH on corrosion in present reactors (PT 105-550-E), the six central zone tubes supplied with process water at pH's 6.0, 6.5, and 7.0 from the 1706-KE Semiworks operated at an average outlet temperature of 85 to 105 C during the month. Early in the month four tubes were discharged, two that had operated at pH 6.5, one at 6.0, and one at 7.0. These tubes were recharged with weighed metal. All the data from these tubes were correlated and a report is being prepared. Work is continuing on increasing the outlet temperatures to a range of 130 to 150 C.

In a test to determine the effect of radiation on corrosion (PT 105-550-E, Supplement A), tube 2943-KE, charged with dummy slugs containing flux monitoring gold foils, was discharged. Preparations are being made to recover the gold foils. The tube was recharged with regular dummies until the data are analyzed so that appropriate conditions can be determined for further testing.

The test to evaluate the localized corrosion characteristics of M-388 aluminum under H Reactor operating conditions has operated for 110 days at 120 C and 45 gpm. The test is scheduled for 150 days exposure. The test specimens being used to compare M-388 and 1245 aluminum in process water with 1.0 ppm dichromate added were examined after four weeks exposure. There was no evidence of any accelerated corrosion on either of the alloys. The pieces were recharged and the test is continuing at 140 C and 40 gpm. The test of M-388 and 1245 aluminum in a venturi type restriction has operated for approximately seven days at 120 C and 20 gpm. The pieces will be examined at two-week intervals to determine the effects of cavitation, erosion, or local boiling.

In a test to evaluate carbon steel corrosion in reactor effluent water, samples of ASTM A7 carbon steel have corroded quite uniformly to depths of 9.7 to 10.0 mils in 11.4 months of exposure to 105-KE effluent water. This corrosion represents an overall rate of 0.85 to 0.88 mil per month. A calculated "equilibrium" corrosion rate of 0.81 mil per month for this latest 2-1/2-month period between sample removals does not compare favorably with the 0.40 mil per month calculated for the preceding three-month period. The effluent basin in which these samples are located was out of service during part of the first equilibrium corrosion period. Therefore, the 0.40 mil/month corrosion rate is too conservative. Additional data will help to establish a truly representative corrosion rate which can be used to determine useful life of the effluent basins. A second buoyant rack containing carbon steel samples was installed in the 107-H east effluent basin on March 11. Arrangements were made to install the final rack for this testing in a 107-C effluent tank during the next 105-C reactor outage.

A test of electrolytic corrosion of Zircaloy-2 in contact with wet graphite was started on March 14. A short length of B, D, F diameter process tubing was electrolytically connected to a piece of graphite tube block. This assembly is partially immersed in tap water. Temperature of the present test is nominally 95 C.

Decontamination Studies. As part of a program to study methods of decontamination for carbon steel systems, a literature search was started. This literature search is concerned principally with results of tests by Westinghouse and Babcock and Wilcox. The chemicals for the decontamination solution recommended by Westinghouse were obtained and will be tested in the ELMO-10 facility. This program has been coordinated very closely with a parallel program carried on by Chemical Development Operation. Coupons and other materials are contaminated in the loops and are supplied to the Chemical Development Operation for their studies on cleaning by chemical and electrical methods. KER removable components made of stainless steel (such as pump impellers and valve stems) were very difficult to decontaminate. This difficulty in decontamination may be tied in with the characteristic of the scale formed at these high temperatures.

A proprietary solution, Turco 4008, has been used successfully to remove heat scale from jet engines. If there is any similarity between the jet engine scale and KER scale, Turco 4008 may be useful. Samples of this chemical were ordered and will be tested as soon as possible.

Crud Studies. Carbon steel and Zircaloy-2 coupons were charged into the KER-1 Mockup Tube for a crud study. They were exposed for a seven and one-half day period. After being removed, each coupon was subjected to a gamma scan analysis. The four radioactive species discovered were Fe^{59}, Cr^{51}, Cu^{64}, and Mn^{56}. Photographs and surface replicas are being made of one of the Zircaloy-2 fuel elements that is to be charged into one of the KER loops at the next outage. The same thing will be done with one of the stainless steel fuel elements that is to be charged in the same loop. Photographs will be taken of the triangular tubular spacers also. It is hoped that this information will be useful in the study of crud deposition under irradiation.

Thermal Hydraulics

Flow Hazard Studies. Experimental heat transfer studies of the response of reactor process tube assemblies to imposed hazardous operating conditions were continued. Steady state boiling curves which are representative of "C" I & E fuel elements in a "K" process tube were determined for a range of tube powers between 500 and 1250 KW. Each curve represents data consisting of coolant temperatures, heated surface temperatures, and coolant pressures along the process tube and fittings as the coolant flow rate is reduced. Data were obtained down to flow rates sufficiently low that the cooling phenomenon changed to film boiling as indicated by sudden and large increases in the temperature of the heated surface. Such data, when combined with results from transient heat transfer experiments, are useful in establishing outlet water temperature limits for individual reactor process tubes when using I & E fuel elements.

The flow and pressure instrumentation on the experimental heat transfer facility were checked by a series of non-heated experiments wherein the system was subjected to large sudden flow reductions. As the theoretical response of the instrumentation to such occurrences is well established when using cold water, such experiments provide a method of determining instrument calibration and response time.

Calculations were made to provide a check of the numerical values of process tube outlet water temperature limits as specified by IPD in Specification A-020, HW-51659. The calculations indicated that, in general, a strict following of the calculation procedures would result in slightly higher limits than currently specified, but the difference was insignificant for practical purposes.

Hydraulic Studies. Work was completed on the rearrangement of piping in the hydraulics laboratory. The changes provide facilities for critical flow studies of steam-water mixtures and for pressure drop measurements of PRTR type fuel elements. Test sections designed to study the effect of thermodynamic unequilibrium on mass flow rates during critical flow were completed except for assembly of pressure leads.

An attempt was made to relate the temperature readings of the outlet water temperature monitors installed in process tubes at the "K" reactors with the actual temperature at the end of the fuel charge of an outlet temperature exceeding the rear header saturation temperature. Such a correlation would greatly increase the value of the monitors when the outlet temperatures were such that a steam-water mixture was leaving the end of the process tube piping. After an extensive laboratory investigation, a suitable correlation could not be established, although it was found that the maximum deviation between the actual water temperature at the end of the fuel charge and the reading of the monitor was restricted by a critical flow phenomenon. The deviation proved to be quite small for regions of practical purposes; for example, at a flow of 55 gpm and a water temperature of 150 C, the temperature monitor would indicate a temperature only 3 C lower than the actual temperature at the end of the fuel charge. The results of the study were reported in HW-55243.

Dummy section pressure drop data, as requested by IPD, were reported in HW-55269 for various combinations of pierced-solid dummy slugs in the three process tube geometries. End-of-fuel charge pressures could be increased up to 20 psi using one or two 1.438-inch OD by 0.51-inch ID by 8-inch long aluminum slugs in the support charge.

Flow tests were conducted for three different plant-fabricated models of a rear nozzle barrel purging device for a "K" reactor. The device effectively forces the entire tube flow through a hole channel in its shank to a point near the nozzle cap. The water then discharges to the annulus channel and makes a 180° return to the rear nozzle outlet. By adjustment of the shank OD and the size of the hole-to-annulus discharge holes, the device can be made to have the desired pressure-flow characteristics.

Laboratory tests and calculations were performed for Mechanical Development Operation (A), IPD, to determine the flow split with special I & E charges having various wire cables in the hole channel to adjust a special charge along the length of the process tube. Using conservative assumptions concerning the heat split between hole and annulus, and laboratory results concerning the flow split, it was calculated that the temperature rise in the hole channel would be about 1.45 times the bulk temperature rise between inlet and outlet.

Tests were conducted for IPD to determine the flow characteristics of a mixing slug which was designed especially for improved crushing strength. It was found that the use of a mixer slug of this design resulted in no detectable change of the pressure drop flow relation for thick skin I & E fuel elements in a "C" process tube.

High Pressure Heat Transfer Apparatus. The apparatus was shut down to remove and return the spare pump for ELMO-7 to the Coolant Systems Development Operation and to re-install the repaired Ingersol-Rand pump. An expansion leg was constructed in the piping on pump suction side to relieve the large forces imposed on the pump.

Project CG-661. The AEC accepted the bid by General Electric Company for the rectifier system. Delivery of this system which is rated at 2700 KW is expected about the middle of September 1958.

Heat Transfer Coefficient Studies. An analytical study was initiated to study the heat transfer characteristics of 7- and 19-rod fuel elements. A method developed by Deissler and Taylor of NACA was used to determine the variation of the heat transfer coefficient around each element. This method, which is based on the theory of a universal velocity profile, was applied to two cases of rod spacing in a 7-element cluster. The cases examined were for fuel elements of 0.63-inch diameter with (1) equal rod spacings of 0.050 inch, and (2) with the rods in contact except at the process tube wall where the clearance was 0.010 inch. The analysis indicated that the ratio of local to average film coefficient ranged from 0.71 to 1.15 and 0 to 1.15 for the respective cases. The temperature distribution within the fuel elements was also determined for the first case with equal rod spacings of 0.05 inch. The results indicated that the heat transferred to the cooling water varied less than 14 percent around the periphery of each rod while the maximum variation in film coefficient was 56 percent. This meant that as the heat transfer coefficient decreased around the rod, the surface temperature would increase in an effort to transfer the generated heat. This was in spite of the relative ease for heat to transfer through the uranium metal to a cooler surface. It is believed that final conclusions will be of more value after the cases of uranium oxide elements and elements in line contact with each other are studied.

Organic Heat Transfer Studies. Experiments were conducted to find a method to remove water from MIPB with activated alumina. This was done by circulating organic at 100 F through a dessicator made from a two-foot section of four-inch pipe filled with 4 to 8 mesh, Type F-1 activated

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alumina. The water concentration in the organic decreased from 94 ppm to 57 ppm after two hours of circulation at a rate of 3 gpm. As the results were not as good as desired, some finer mesh alumina was obtained for further tests.

Other Activities. Experiments were performed to determine safe operating conditions for the copper bus work used to convey electrical current to the heat transfer facilities. The present bus system consists of seven plates, each 1/2 x 6 inches in cross section with a 1/2 inch space between plates. When only three of the plates were used with a current density of 2010 amps per sq in., it was found that a surface temperature of 191 F was reached on the center plate, while the air temperature in the spacing was 171 F. When the bus was cooled with air by using a fan, the surface temperature dropped to 123 F in 25 minutes. It was concluded from the tests that with proper precautions the bus work could be overloaded considerably over the rated capacity.

Experiments were performed to develop an electrical insulation on metal surfaces by using an oxide coating applied by a thermospray technique. Samples have been sprayed with oxides of both aluminum and zirconium and found to have excellent characteristics of electrical resistance when dry and resistance to thermal shock. Ten samples of oxide coatings on different sized rods suffered no visible damage upon being plunged into cold water after being heated to 1000 F.

Mechanical Equipment Development

Organic Cooling System Components. The organic facility (MOTS-1) operated at 665 F during the month. A repair outage of several days was necessary when the 15 KW heater again shorted to ground. The heater jacket was shortened six inches to allow more space for packing glands, electrical insulation and electrical connections. The designs for the various basic modifications of the facility were completed and the necessary parts ordered. Design was started on a rapid thermal cycling test section to replace one of the existing test sections.

The Duraseal mechanical pump seal completed 300 hours of operation. No difficulties were experienced with the seal. An iron gasket was tested in a 3-inch flange; a torque of 200 ft-lbs was required to stop all leaks. This torque was larger than the torque required to seal smaller gaskets. No leaks developed in either the compression fitting connected or the flared fitting connected jumpers.

The testing of a soft steel gasket continued on a temperature cycle basis in the ORA-3 facility. No leaks have developed to date. The heater coked up and shorted out during the month. There was no apparent reason for the coking since the temperature had been closely controlled at about 575 F. The failure may possibly be due to a very gradual coking as the heater has been operated almost continuously for about eight months.

Shielding Studies

Attenuation Measurements. The 100 C baking of the ordinary concrete test slabs was completed. The density of the test slabs after baking was 2.29 gm/cm^3 as compared to 2.35 gm/cm^3 in the unheated condition. The fast neutron relaxation length of the ordinary concrete was found to be 12.03 cm in the unheated condition. The test slabs have been placed in the DR test well for further attenuation measurements. Attenuation measurements on ferrophosphorus concrete in the unheated condition continued. Ionization chambers were placed in the ferrophosphorus test slabs to measure gamma relaxation length. The gamma relaxation length has been found to be 8.06 cm with a ferrophosphorus concrete density of 4.83 gm/cm^3.

Thermal Shield Studies. Nearly all of the internal components for the water tank thermal shield were completed. These include the crates for containing aggregates under test, pipe-wells for foil-holders, and access ports at the back of the nose tank. The inlet and outlet water distributors are currently being installed. Calibration of the ion chambers to be used in the water tank was completed.

Neutron Spectrometer. The 100-channel pulse height analyzer for the neutron spectrometer was installed. Functional testing of the analyzer was completed. Additional scalers and programming equipment are currently being installed.

Service Work. Calculations of the volumetric rate of heat generation in the cesium shipping container and its shielding requirements were completed. These results, together with shielding requirements for the recovery process, will be incorporated in a report now under preparation.

Calculation of reflector savings and enrichment for the NPR were made for a radial reflector thickness of 125 cm using the 1 and 2-group diffusion theories. The axial reflector problem was considered, taking into account the water in the process tubes as part of the reflector. The presence of the water drastically reduces the diffusion length as compared to pure graphite, so the amount of reflector which can be advantageously used should be considerably less than for pure graphite. Reflector savings and flux distribution were calculated for this case showing that 12 inches of the graphite containing process tubes and water would give the same fraction of the infinite reflector savings as 30 inches of pure graphite. A cost analysis based on 2-group diffusion theory indicated an optimum axial reflector thickness of 16 inches. The equivalent 1-group theory result is 11 inches, so 2-group theory is significantly better for use in optimizing the reflector. The 2-group theory also appears to give a significant improvement for calculating relative power as well as for optimizing the reflector.

Nonmetallic Materials Development

High Temperature Thermal Conductivity of Graphite. The variation of thermal conductivity with temperature for unirradiated TS-GBF graphite is being measured by two independent steady state methods. In the spherical envelope method a heat source is contained in the center of a hollow sphere

[redacted]

and the temperature is measured at two different radii of the sphere. The data for a TS-GBF spherical sample indicate a room temperature conductivity of 0.25 cal/cm-sec-°C and 0.22 cal/cm-sec-°C at 175 C. Insulation of the sample should extend this method of measurement to 350 C. In the second method employing a hollow cylinder, the power input to a platinum wire heater centered in a 15-inch graphite cylinder is measured. Thermocouples are installed along isotherms parallel to the axis of the cylinder. Data to 500 C have been obtained with this method. The values from the two methods agree very well in the temperature range that has been investigated. Before extending the measurements to irradiated graphite, the temperature distribution along the length of the hollow cylinder will be measured to determine whether the assumptions for heat flow are valid.

Thermocouple Development. A laboratory test has been concluded in which several thermocouples were exposed to 100% CO_2 at 800 C for 200 days. The test included chromel-alumel and iron-constantan thermocouples with and without a 304 stainless steel sheath. Corrosion of the unsheathed couples was sufficiently rapid to cause them to fail under the test conditions. All sheaths were somewhat corroded but still retained some flexural strength. The chromel-alumel sheathed couples generally read 10 to 30 C lower than the iron-constantan which were still operating satisfactorily at the end of the test.

A test thermocouple stringer was installed in channel 1284 B (B Reactor) on February 3. This consisted of 16 thermocouples: 11 iron-constantan and 5 Geminol P-N with porcelain insulators. In order to assure similar conditions of exposure, the Geminol couples were placed adjacent to iron-constantan couples in the same block through the center portion of the reactor. Readings on March 11 for the five test blocks showed that comparable thermocouples indicated the same temperature within 10 C.

High Temperature Graphite Irradiations. Samples from the GEH-9-6 irradiation, which was terminated at cycle 100, February 10, were recovered and returned to Hanford. Changes in length and crystallite properties are shown in the following table:

RESULTS OF THE GEH-9-6 IRRADIATION IN THE MTR

Graphite Type and Density	Irrad. Temp. (°C)	Calculated Exposure(nvt x 10^{-20}) Thermal	>1 Mev	Percent Length Change	Crystallite Properties C_o, (Å)	L_C, (Å)	L_A, (Å)
TSGBF	--	Unirradiated		--	6.732	525	90
1.6 g/cc	750	11	1.0	-.32	6.740	392	58
	975	12	1.9	-.13	6.759	170	50
	1050	14	2.0	-.49	6.746	138	43
TSF	--	Unirradiated		--	6.720	480	90
1.4 g/cc	750	--	0.31	+.02	6.735	495	75

The greatest contraction, 0.49%, was found in the sample exposed at 1050 C. At 975 C the graphite contracted 0.13%. This is much less than the 1.11% contraction measured in the previous experiment at 975 C exposed to about 1-1/2 times the neutron dose. The uncertainty in length measurement is estimated to be ± 0.02%. Although a reasonable explanation has not been found to explain such a large difference in contraction rate of the 975 C samples, the three samples exposed above 750 C have shown a higher contraction rate than those exposed below 750 C.

At present the results of the MTR irradiations allow an estimate of the "Hanford equivalent damaging exposure" in MD/AT through a correlation of irradiations at 30 to 50 C. The GEH-9-6 experiment also included three integrating flux monitors at each sample position to measure the thermal flux, cadmium ratio, and fast flux. Counting of these foil monitors will be completed soon and will allow a more complete description of the flux spectrum than has been possible in earlier experiments.

Reactor Graphite Monitoring. Twenty-eight graphite samples were removed from Hanford reactor tube blocks with a core boring device for the purpose of determining stored energy and crystallite changes in the graphite. Two tube channels at each reactor were selected to provide samples representative of both filler block and tube block graphite. Graphite samples representative of filler blocks were obtained from uncooled channels which had contained graphite burnout samples for several years. Cores of cooled tube blocks were obtained from channels from which the tube had been pushed during the same outage. Four cores were removed from each channel, two in the center and two in the front fringe in the region of maximum damage as indicated by vertical height traverses. The increase in C_o, the distance between alternate layer planes, and decrease in L_c, apparent crystallite size are shown in Table I.

The C_o and L_c values are measures of the radiation damage suffered by the graphite. In unirradiated graphite C_o = 6.71 to 6.73 Å and L_c = 400 to 600 Å. Reactor irradiation results in displaced atoms which force the layer planes apart, increasing the C_o distance. L_c decreases as the crystallite becomes strained; in very highly damaged graphite the crystals may actually fracture also resulting in an apparent decrease in the average crystallite size.

It is seen in Table I that damage to the graphite is greater at the bore wall where the temperatures are lower due to contact with the water-cooled process tubes. Cores from a cooled channel have, as yet, been obtained from only one of the old reactors (2480 F). In this case a maximum C_o value of 7.46 Å was found at the bore wall 9' 6" from the reactor face, which is also

TABLE I - RADIATION DAMAGE TO REACTOR GRAPHITE

Channel and History	Distance From Van Stone Flange	Position on Tube Block	Crystallite Properties: C_o Spacing (Å)	Crystallite Properties: Crystallite Size, L_c Å
3461-B Graphite at filler block temperature	9' 5"	Bore	7.07	29
	9' 5"	Outside	6.98	50
	9' 6"	Bore	7.12	26
	9' 6"	Outside	7.01	50
	20'	Bore	6.91	77
	20'	Outside	6.75	98
	21'	Bore	6.91	80
	21'	Outside	6.78	88
1960-C Graphite at filler block temperature	9'	Bore	6.82	225
	9'	Outside	6.82	240
	9' 9"	Bore	6.78	198
	9' 9"	Outside	6.78	240
	19'	Bore	6.79	140
	19'	Outside	6.78	160
	21'	Bore	6.76	150
	21'	Outside	6.77	175
2160-C Cooled channel	9'	Bore	6.94	77
	9'	Outside	6.91	136
	9' 9"	Bore	6.85	108
	9' 9"	Outside	6.80	160
	19'	Bore	6.88	55
	19'	Outside	6.78	149
	21'	Bore	6.85	76
	21'	Outside	6.78	155
2480-F Cooled channel	9' 6"	Bore	7.46	15
	9' 6"	Outside	6.95	35
	10'	Bore	7.40	16
	10'	Outside	6.93	58
	20'	Bore	7.33	18
	20'	Outside	6.80	69
	21' 1"	Bore	7.14	24
	21' 1"	Outside	6.81	72
3580-F Graphite at filler block temperature	9' 6"	Bore	7.06	30
	9' 6"	Outside	7.00	58
	10'	Bore	7.04	32
	10'	Outside	6.96	79
	20'	Bore	6.91	75
	20'	Outside	6.78	79
	21'	Bore	6.90	76
	21'	Outside	6.78	80
1880-KW Graphite at filler block temperature	10'	Bore	6.76	370
	10'	Outside	6.77	327
	11'	Bore	6.80	262
	11'	Outside	6.78	275
	20'	Bore	6.76	245
	20'	Outside	6.73	280
	21'	Bore	6.76	171
	21'	Outside	6.77	188
4084-KW Cooled channel	10'	Bore	6.77	350
	10'	Outside	6.76	350
	11'	Bore	6.82	157
	11'	Outside	6.81	247
	20'	Bore	6.85	158
	20'	Outside	6.78	175
	21'	Bore	6.81	131
	21'	Outside	6.77	170

C_o distance, decreased from the bore wall to the outside as follows: 7.46 Å, 7.41 Å, 7.22 Å, 7.04 Å and 6.95 Å. Stored energy measurements will be determined on these cores, and estimates of the stored energy gradient will be made from the C_o values.

Much less damage was found in the new reactors (C and KW). This is because graphite temperatures in these reactors have always been relatively high. Little difference was found between cores from 4084-KW, which was cooled, and 1880-KW, which has operated at filler block temperatures since April 1957.

Structural Materials Development

B-D-F Zircaloy Tubing. Twenty-two tubes were received from Superior Tube Company under DDR-5, which is now essentially completed. On detailed inspection at Hanford these tubes showed excessive amounts of ovality. The first attempt to correct this condition by "draw sizing" was unsuccessful, but further attempts will employ an increased amount of reduction in the sizing operation. The second tube-reducing pass on DDR-6 (Allegheny Ludlum) was completed with 15 of the 20 tubes appearing good thus far. The other five showed appreciable "checking" on the ribs. Third pass tube reducing is scheduled to begin the first week of April. Bid invitations for 300 ribbed Zircaloy process tubes for the present Hanford reactors were sent to bidders the last week of March.

NPR Zircaloy Process Tubes. Mallory Sharon has drawn up a production schedule for the completion of their development contract for five NPR process tubes. Tube-reducing operations on these tubes will begin the week of April 14, and final inspection and shipment are scheduled for the week of May 17. Chase Brass & Copper Company personnel are engaged in "de-bugging" their welding device for Zircaloy NPR tubes and are nearly ready to make test welds to be used in tube drawing trials. The extrusions for the production tubes are expected to be started on April 2. Allegheny Ludlum expects to perform the tube-reducing operation on DDR-32 on March 31. Meeting this date is contingent upon successful extrusion of five more short lengths and satisfactory operation of their welding apparatus.

Zircaloy Creep Testing. A short term contract with BMI to employ five additional creep testing units to obtain short time Zircaloy-2 creep-rupture data, is now in effect and testing is under way.

Tube Burst Testing Facility. A general design has been drawn up for an improved tube bursting facility. This will consist of several units for testing short pieces of tubing. Several of these can then be bolted together end-to-end to test longer pieces. An order has been placed for the on-site fabrication of the first prototype unit test chamber.

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Advance Studies

"Multiple-Hole Internally Cooled Fuel Elements" (HW-55418, Unclassified) has been prepared for publication. This engineering evaluation tabulates calculated operating data over a wide range of variables.

"Feasibility Study of the H_2O Fluidized UO_2 Pebble Bed Reactor Concept" (HW-55546, Unclassified) has been completed in rough draft form.

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. CUSTOMER WORK

Radiometallurgical Examinations

Enriched I & E Slug Failure (RM 218). The examination of the enriched I & E fuel element which failed during irradiation under PT-IP-109-AC was completed. Metallography of a transverse wafer one inch from the male end indicated that the entire end of the slug was heated above the alpha-beta transformation temperature. The overheating apparently occurred as a result of thermal insulation of the core caused by the severe undercutting of the jacket which occurred after the failure.

Examination of Ruptured M-388 Clad Slug from IP 39-A (RM 219). Attempts to identify the particles found embedded under the cap of the M-388 clad ruptured slug from IP-39-A have met with limited success. The high level of radioactivity made identification difficult by x-ray diffraction methods; however, it has been determined that the powder coating the outside of the particles was UO_2. Attempts to identify the actual particle materials were unsuccessful. Examination of the can wall in the hot spot region has been completed. No intergranular corrosion was found.

Examination of Ruptured M-388 Clad BNTL Slug from IP 80-A (RM 222). A ruptured blunt nosed true-line M-388 clad slug from IP 80-A was sent to Radiometallurgy for examination after gassing was noted in the storage basin. Visual examination disclosed a series of longitudinal cracks in the can near the midpoint of the slug. The severity of the rupture increased as the slug was examined, as evidenced by the widening of the cracks. Slug temperature, measured by a thermocouple inserted into one of the cracks, was found to be 151 F. The slug, which was cored, was sectioned at points 2" and 4" from the base end to determine the condition of the uranium. Melting of the uranium near the core was observed

on the section cut 4" from the end. This was beneath the cracked area at the midpoint of the slug. Extensive can wall undercutting was also observed in this region, and the resulting diameter increase caused by formation of UO_2 appeared to have caused the extensive can wall cracking. Examination of can wall from the cracked region showed evidence of a corrosive attack. The exact nature of the attack has not been determined.

Metallography Service

An autoclave failure of an I & E fuel element was examined for FPD to determine the cause of rupture. A pinhole was apparent in the cap weld and subsequent metallographic examination disclosed a weld stringer which proceeded from the pinhole to a substantial void beneath the surface of the weld and thence to an area between the cap and the uranium slug which had not been wet by the AlSi. Water entry through the pinhole to the uranium led to eventual failure of the element.

Five sections of stainless steel pigtails from the rear face of "F" and "DR" reactors were examined for evidence of stress-corrosion cracking. Three of the pigtails were from welded tubing (DR Reactor) and two were from seamless tubing (F Reactor). No stress-corrosion cracking was found on any of the pigtail sections examined.

An examination of the compound layers of four fuel elements was performed for FPD. Two of the elements were produced from virgin uranium slugs and two from slugs previously canned and subsequently recovered. All elements were AlSi canned in M-388 aluminum. The compound layers of the virgin canned uranium elements appeared smoother, were more susceptible to cracking, and were less adherent to the uranium than the reclaimed uranium elements.

Samples Processed During the Month

Total samples processed:	269
Photographs:	
Micrographs	143
Macrographs	77
Total	220

The following Trips and Visits Reports apply to activities on 2000, 3000, and 4000 programs. Technical activities on the 4000 Program are reported separately in HW-55590 A2.

F. W. Albaugh

Manager, Reactor and Fuels Research
and Development Operation

FW Albaugh:kb

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VISITS TO HANFORD WORKS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
LA Patrick	3.4	F. J. Stoakes Corp., Pasadena, Calif.	Discuss specialized vacuum equipment	DC Kaulitz	No	325,326 300
J Kux F Fernholtz	3/7	Kux Press Co., Chicago, Ill.	Discuss fabricating equipment for fuel elements	JJ Cadwell EA Evans	No	325,326 300
FR Shober	3/10-12	BMI, Columbus, O.	Discuss BMI Assistance to Hanford Program	JJ Cadwell SH Bush JE Minor EA Evans JC Tobin	Yes	303,325, 326, 300
LR Weissert	3/19	Babcock & Wilcox Corp., Lynchburg, Va.	Discuss UO_2 technology	JJ Cadwell EA Evans	Yes	325,326 300
LD Schaffer GD White WC Thurber	3/27	Union Carbide Nuclear Co. Oak Ridge, Tenn.	" "	JJ Cadwell EA Evans	Yes	303,325, 326, 300
J Whealdon	3/19	Air Supply Co., Seattle, Wn.	Engineering discussions on nonmetallic materials	R Harrington	No	326, 300
W Kosiba WP Wallace WI Thompson MT Simnad SA Bernsen	3/27-28	General Atomic, San Diego, Calif.	Discuss fuel fabrication techniques & graphite applicable to Maritime Gas Cooled Reactor	RE Nightingale FW Woodfield SH Bush	Yes	303, 300; 700; 100-K; 105-DR, 100-D
MH Bartz	3/5	Phillips Pet. Co., Idaho Falls, Idaho	Discuss MTR fuel elements	OJ Wick ID Thomas TC Nelson	Yes	2704-Z, 231-Z, 200-W
MH Bartz	3/27	"	"	"	Yes	"
DR deBoisblanc		"	"	"	"	"
E Davidson		AEC, Idaho Falls, Ida.	"	"	"	"

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
OJ Wick	3/17-18 3/20-21	UCRL, Livermore, Calif. LASL, Los Alamos, N.M.	Discuss Project Whitney Discuss U-233 schedule, Pu Met & reactor fuels	WJ Ramsey RD Baker	Yes Yes
ID Thomas RW Stewart	3/17-21	UCRL, Livermore, Calif.	Discuss Project Whitney	WJ Ramsey	Yes
HR Gardner	3/17-18	Nuclear Congress, Chicago	Present paper	--	No
LC Lemon	3/24-25 3/26 3/27	North American Aircraft Los Angeles, Calif. APED, San Jose, Calif. Western Welding Brazing & Heat-Treating Conf., Menlo Park, Calif.	Observe joining of Zr, Zircaloy-titanium Fuel element fabrication Attend conference	B Nolander WR Smith --	Yes No No
ED McClanahan	3/24-26	Consolidated Electrodynamics, Rochester, N.Y.	Examine purchased equipment	W Maher	No
CH Bloomster	3/26	Clevite Research Center, Cleveland, O.	Discuss fuel element fabrication problems	EP Weber	Yes
DA Patterson	3/31	Sutton Eng. Co., Pittsburgh, Pa.	Witness operation of 1500-T press	D Russell	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JW Riches	3/24	ORNL, Oak Ridge, Tenn.	Consultation on	ML Picklesimer	Yes
	3/25	ALCOA, New Kensington, Pa.	zirconium fabrication	R Philips	No
				DD McCracken	
		Allegheny Ludlum Steel Corp., Brackenridge, Pa.	" "	TT Magel	No
	3/26	Nuclear Metals, Inc., Cambridge, Mass.	" "	P Loewenstein	No
	3/27	KAPL, Schenectady	" "	CE Weber	Yes
				CE Lacy	
				W Margulis	
	3/28	Mallory Sharon, New York City	" "	JR Chisholm	No
		New Rochelle Tool Co., New Rochelle, N.Y.	" "	WC Rudd &	No
				CA Tudbury	
	3/31	Tube Reducing Co., Wallington, N.Y.	" "	SN Randall	No
NG Wittenbrock	3/20	ANL, Lemont, Ill.	Discuss reactor safeguards	JM Harrer	Yes
	3/21	AEC, Washington, DC	Discuss safeguards analysis with DRD	A Giambusso	Yes
	3/19	Nuclear Congress, Chicago	Present paper	--	No
JF Fletcher	3/17	Nuclear Congress, Chicago	Present paper	--	No
	3/18	Atomfair, Chicago	Discuss nuclear instrumentation & control	--	No
JC Fox	3/18	Nuclear Congress, Chicago	Present paper	--	No
RM Fryar	3/19	General Mills, Minneapolis, Minn.	Discuss PRTR equipment with vendors	--	No
DJ Foley	3/18	Nuclear Congress, Chicago	Present paper	--	No
M Lewis	3/25	U. of California, Berkeley	Address Nuclear Eng. Seminar	--	No
	3/31	LASL, Los Alamos, N.M.	Observe Pu metallurgy research & liquid Pu fuels development	WH Crew	Yes

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JE Minor	3/4-5	GE Res. Lab., Schenectady	Discuss irradiation damage to materials	DW Lillie	No
	3/5-6	KAPL, Schenectady	Discuss fuel fabrication and irradiations	CE Weber	Yes
	3/6-7	Nuclear Metals, Inc., Cambridge, Mass.	Inspect uranium fabricated under NMI development contract	P Loewenstein	Yes
	3/18	ASM, Seattle, Wn.	Present talk at U. of Washington	--	No
JC Tverberg	3/24	Oregon Metallurgical Corp., Albany, Oregon	Interchange of information on melting & casting of Zr-U & their alloys	S. Shelton	No
	3/25	Bureau of Mines, Albany, Oregon	" "	H Kato	Yes
JM Davidson	3/4-5	Phillips Pet. Co., Idaho Falls, Idaho	Inspect disassembly of GEH-9-6 experiment	WS Little	Yes
C Groot	3/17-21	NACE, San Francisco	Attend 14th Annual Conf.	--	No
LD Turner CG McCormack	3/17-21 3/18-21	6th Hot Labs. & Equipment Conf., Chicago, Ill.	Chairman, Hot Lab. Comm. Present paper	RC Goertz	No
PJ Pankaskie	3/12-13	Tube Reducing Corp., Wallington, N.J.	Consultation on zirconium fabrication	RE Rohrabaugh RN Randall	No
RC Aungst	3/10	Nuclear Metals, Inc., Cambridge, Mass.	" "	P Loewenstein	No
	3/11	Chase Brass & Copper Co., Waterbury, Conn.	" "	DK Crampton	No
	3/12	New Rochelle Tool Co., New Rochelle, N.Y.	" "	WC Rudd & CA Tudbury	No
	3/13	Allegheny Ludlum Steel Corp., Watervliet, N.Y.	" "	RE Rohrabaugh	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JA Ayres LH McEwen	3/20-21	Phillips Petroleum Co., Idaho Falls, Idaho	Discuss hydraulics and heat transfer calculations for MTR experiments	RE Searnow RJ Hertney	Yes
DR deHalas	3/17-19	Nuclear Congress, Chicago, Ill.	Present paper	--	No
	3/20-21	GEL, Schenectady	Discuss organic decomposition	JA Coffman	No
RJ Lobsinger	3/17-19-20-21	NACE, San Francisco, Calif.	Attend meeting	--	No
	3/18	APED, San Jose, Calif.	Discuss tests in high pressure water systems	WI Pearl	No
KG Toyoda	3/31	GE, Schenectady	Discuss Project CG-661 order for rectifiers	TE Usher	No
EG Peterson	3/31	Corps of Eng., U.S. Army, Troutdale, Oregon	Discuss concrete testing	--	No
PM Jackson	3/17-18-20	Nuclear Congress, Chicago	Attend meeting	--	No
	3/19	ANL, Lemont, Ill.	Discuss mechanical components for reactors	TR Bump	Yes
	3/21	ALCOA, Pittsburgh, Pa.	Discuss technical details of reactor components & calandria fabrication	ME Carlisle RE Dolan	No
	3/22	Struther Wells Corp., Warren, Pa.	" "	HA Backstrum FW Emhart	No
RG Wheeler	3/3-7	BMI, Columbus, O.	Discuss clad experimental fuel element	FR Shober	Yes
WI Steinkamp	3/20-21	GE X-Ray Dept. Milwaukee, Wisc.	Observe operation with electron gun	--	No
DC Kaulitz	3/19-20	Phillips Pet. Co., Idaho Falls, Idaho	Discuss installation of ETR high pressure test loops.	Mr. Cohen	Yes
		AEC-IOO, Idaho Falls		--	Yes

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HW-55590

PLUTONIUM RECYCLE PROGRAM

MONTHLY REPORT — MARCH 1958

REACTOR & FUELS RESEARCH & DEVELOPMENT OPERATION

Plutonium Fuels Development

MTR Irradiation of Al-Pu Alloy Capsules. Examination of the Al - 1.65 w/o Pu and Al-12 w/o Si - 1.65 w/o Pu capsules which were irradiated to an estimated 55 to 60 percent burnup of Pu atoms continued. Both capsules were opened and the alloy cores were easily ejected from the Zircaloy-2 cladding. The cores appeared to be unchanged, except for a light-colored, powdery film on the surface of each. An attempt will be made to identify this film. Dimensional measurements revealed that the Al-Pu core increased 0.2% in length and diameter and the AlSi-Pu core increased 0.3%.

Further Al and AlSi capsule specimens containing 5, 10, 15 and 20 w/o Pu are being prepared for irradiation in the MTR to establish the upper limit of Pu concentration in respect to dimensional instability or swelling. Tentative plans are to irradiate four capsules of each material to high exposures, i.e., perhaps 50 to 60% burnout of the Pu atoms.

Ex-Reactor Testing of Al-Pu Alloy Cluster Elements. A Zircaloy clad, four capsule cluster, fabricated with pickled and non-pickled welds and using the electron beam welding apparatus and the tungsten inert gas evacuable welding chamber, is under test in ELMO-7 loop in 316 C coolant. To date, electron beam welding with pickling appears to be the best combination.

Accelerated corrosion testing of Zircaloy welds continued. Some specimens were exposed to flowing steam for 88 hours at 400 C and 800 psi with no evidence of breakaway corrosion. Other samples have been exposed to flowing steam for 96 hours at 800 C and 800 psi plus 65 hours at 400 C and 100 psi with no sign of white corrosion product. On the basis of these and earlier results, Al - 8 w/o Pu alloy elements are being assembled for KER irradiation.

A 19-rod stainless steel clad Al core cluster was thermal cycled 143 times in the ELMO-7 loop at temperatures up to 550 F. The cluster showed no evidence of thermal distortion, elongation or loosening of any of the spiralled spacers on the rods. This element will next be subjected to hydraulic pressure drop tests for comparison with future cluster designs.

Pyrometallurgical Techniques. An experiment was performed on 400 grams of Al - 10 w/o Pu alloy which was patterned after the Canadian experiment conducted on gram quantities of Al-Pu alloy in which Pu was extracted from molten Al-Pu alloys by molten bismuth. About 80% of the Pu was extracted by the bismuth which is similar to the Canadian results. They then further concentrated the Pu by vacuum distillation of the bismuth and the residue contained 80% of the Pu. Since distillation hood facilities were not available for separation of the Pu from the bismuth in our experiment, separation of the Pu from the bismuth was attempted by liquation. This was unsuccessful because the Pu compound has a specific

gravity which is too near that of bismuth; however, when the Pu-bismuth solidified, the last liquid to solidify was forced to the surface by the expansion of the bismuth on solidification. This metal was substantially pure bismuth, indicating that a separation of the Pu-bearing phase may be made by filtration.

Injection Casting Development

Two air pressure injection castings of aluminum into unheated, Zr tubes yielded 94.5 w/o of theoretical density. One, 96" in length, was radiographed and found to have only minor gas voids associated with some micro-shrinkage which was distributed throughout the casting. The other casting was made into a 1/2" i.d., 60" long, 20-mil wall Zircaloy tube, employing 720 C aluminum and a tube preheat to 260 C. The Al was bonded to the Zircaloy at a few isolated spots which resulted in distortion of the tubing because of the contraction of the Al.

Four 1/2" diameter by 6" long aluminum cores have been air injection cast into Zircaloy capsules using the contaminated vacuum induction melting facilities. These experiments were conducted in preparation for injection casting of Al-Pu alloys for capsule irradiations in the MTR. Radiographs of the capsules indicated some micro-shrinkage; however, there were no large voids.

In mechanical pressure injection casting studies, 2S Al was successfully cast into a 7'4" unheated evacuated tube, employing a 900 C melt, a 7/16" diameter injection inlet, and 1500 psi. Radiographs of the casting have not yet been evaluated. Contacts have been made with representatives of the Kux Machine Company in regard to the feasibility of adapting a die casting machine to the fabrication of Pu-Al fuel elements.

Corrosion Tests on Fuel Materials

It was reported previously that Al - 6 w/o U alloys in the as-cast condition showed good corrosion resistance after being subjected to saturated steam at 360 C for 24 hours, whereas, the as-cast Al - 1.7 w/o U samples were completely destroyed. Additional unclad samples of as-cast Al - 6 w/o U and an Al - 10 w/o U alloy have been tested and the original results confirmed. Working destroys the corrosion resistance. Although Al-U-Si systems show similarly good corrosion resistance at U concentrations of 1.5 w/o, the introduction of Si may introduce problems in chemical reprocessing. This somewhat surprising effect will be investigated shortly using plutonium instead of uranium stand-in.

Facilities

With the exception of the hydrogen piping system, the facilities for the plutonium oxide fuel studies are now in place.

Preliminary drawings for the hood and associated equipment required for the reduction of PuO_2 by aluminum under a cryolite flux to produce Al-Pu alloy have been modified and are currently being re-examined for safety and criticality hazards. The units are designed for a production capacity of 20 kg of Al - 1.65 w/o alloy in eight hours.

U-Pu Test Pieces for PCTR

The special 1000 MWD/T synthetic exposure slug was delivered to the Nuclear Physics Operation for irradiation. The slug was irradiated, disassembled for pin counting and returned to Plutonium Metallurgy Operation for re-assembly. After recanning, the slug was returned for re-irradiation in the PCTR. Parts for the 2000 MWD/T slugs are completed and lack only the assembly and canning operation. Four nickel plated Al-Pu foils and one unplated Al-Pu foil were delivered to Nuclear Physics Operation.

UO_2 Fuel Development

Swaging of UO_2 Powders. Variables in the swaging of UO_2 powders are being studied to determine the feasibility of this process for low cost fuel element fabrication. Stainless steel, Zircaloy, and aluminum have been employed as cladding materials. Previous results indicated that uranium dioxide density after swaging depends upon the type of powder, cladding material, and the swaging techniques used. During the past month the following studies were conducted:

1. Densities obtainable with various types of UO_2 powders swaged in 1" OD x 0.035" stainless steel were determined. The densities ranged from a low of 74 percent with untreated, "PWR grade" UO_2, to a high of 90 percent with UO_2 prepared by the Norton arc-fusion process.

2. Hot swaging experiments were conducted with sintered and ground UO_2. At 600 C this powder compacted to densities of 91 percent and 88 percent of the theoretical when swaged in 1" OD x 0.035" wall stainless steel, and 1" OD x 0.030" wall Zircaloy, respectively.

3. ASP aluminum tubing filled with sintered and ground UO_2 was swaged to determine the reduction in cross sectional area possible without rupturing the cladding. The aluminum-clad uranium dioxide powder was cold swaged to 82 percent density after a 34 percent reduction. The tubing ruptured on the next pass, at a total reduction of 42 percent in the UO_2 cross sectional area.

The Farmer-Norton swage (four-die, stationary spindle) was received and installed in the basement of the 325 Building.

Irradiation of Fuel Elements Containing Unsintered UO_2. A relatively simple, inexpensive fuel element consists of loose unsintered powder in a metal container. The two test elements of this type have been irradiated and radiometallurgical examination of one has been completed. Two Zircaloy-3 cans, 1" OD and 6" in length, were filled with 3.17 percent U-235 enriched UO_2 and irradiated to approximately 900 MWD/T in the MTR at a maximum power generation of approximately 55 watts per gram of UO_2. The fuel elements were not altered in their external dimensions. In the one element sectioned after irradiation, the UO_2 had relocated completely to one end of the can during the irradiation. Essentially all of the UO_2 powder had sintered to a density estimated to be approximately 90 percent of the theoretical. A central cavity, approximately one-third inch in diameter extended the length of the sintered oxide, with a sintered rod of smaller diameter inside this cavity and extending the length of it. Columnar

grains of UO_2 extended from the central cavity to a circumferential crack approximately 0.17" from the Zircaloy. A cylinder of relatively low density UO_2 surrounded this crack. This low density UO_2 is, in turn, separated from the Zircaloy by a 0.02" thick layer of low density UO_2 powder. The columnar grain formation has been attributed by WAPD to the crystallization of UO_2 from the molten state, in the few cases where they have observed it in irradiated, sintered UO_2 pellets. This interpretation has provided the basis for establishing limiting heat fluxes for PWR fuel elements. Back calculations of the temperatures of the UO_2 at various radial distances in the HAPO test elements lead to the conclusion that the tubular crack and the termination of the columnar grains cannot represent the limit of the molten zone, but that the molten zone is confined to the central cavity. Some mechanism other than melting, therefore, must be responsible for the formation of the columnar grains unless extreme, undetected power variations occurred in the MTR. This is the first evidence that the columnar grains do not necessarily indicate solidification from molten UO_2.

Three-rod, Stainless Steel Clad, Swaged UO_2 Fuel Element. This is the first irradiation of a swaged fuel assembly; previous tests have been confined to capsules. The fuel assembly has successfully completed one irradiation cycle in the MTR and is being returned to HAPO for radiometallurgical examination.

Continuous Ball Milling and Air Classification of Uranium Dioxide. The continuous ball mill and air classifier were modified to provide for continuous recycling of oversize particles to the ball mill for additional size reduction. This improvement makes it possible to operate this equipment for eight hours without attendance and greatly reduces the amount of ball milling required for a given weight of UO_2. Determination of the optimum operating conditions is now in progress.

Ceramic Fundamental Studies. The utilization of high temperature generating equipment for ex-reactor thermal studies is part of a program for conceiving and evaluating improved ceramic fuel elements. The Mark II carbon-arc image furnace was operated at power inputs up to 25 KW. The following results were obtained:

1. UO_2 powder was melted under a helium atmosphere. At reduced pressures ($< 10^{-2}$ mm of mercury) the UO_2 powder did not melt but sublimed onto cooler portions of the specimen holder.

2. UC powder was melted under a helium atmosphere and at reduced pressures ($< 10^{-2}$ mm of mercury).

3. Copper, Al_2O_3 and B_4C were melted in vacuo.

Steromicrographs are being taken of all specimens heated in the furnace. High speed motion pictures of the UO_2 melting phenomenon have been scheduled.

Thermal Hydraulic Studies

Experiments were initiated to evaluate the degree of mixing of the PRTR moderator as indicated in the full size calandria mockup. Results of dye injection tests indicate that a slight modification of the inlet orifices arrangement will be necessary to provide proper mixing.

PRTR Instrumentation

The study to determine requirements of instruments for detecting heavy water loss in the PRTR was continued. The requirement that the instrument be capable of detecting less than one pound per hour of heavy water evaporation due to leaks was thought to be so strict that dew point or humidity type instruments would not show any detectable change. As Advance Engineering Operation is of the opinion that the leak rate of one pound per hour is too small for a high pressure system, the present plans are to provide a chiller to condense the moisture from air passing through the areas of high leak potential. This mode of operation would reduce the sensitivity requirements of the instrumentation a considerable amount.

The design test proposals for the resistance temperature detector and for the tube flow monitors were issued (HW-55250 and HW-55251). Testing of the flow monitors is scheduled to start the first part of April. Testing of the resistance temperature detectors is awaiting arrival of prototypes from the vendors.

Coolant System Studies

The free machining qualities of 303 stainless steel provide economic advantage in fabrication of venturis for measurement of PRTR primary coolant flow. Present design requires welding of these venturis to stainless steel "jumpers". The corrosion resistance of welded 303 stainless steel is of concern in this application. Welded samples are being fabricated from short bars of 303 and 304 stainless steels. These samples will be corrosion tested in a dynamic system containing demineralized water at pH 6.0-7.0 and 235 C.

High temperature operation may cause stress corrosion of stainless steel heat exchanger components which have chloride surface contamination even though the bulk corroding medium is chloride-free. Surface contamination may result from degreasing pickling, or leak-testing operations during fabrication, or from radioactive decontamination processes during routine maintenance. Autoclave and loop tests of chloride contaminated stainless steel samples are being designed. A tentative list of 17 potential chloride contaminants was prepared.

The lucite tube for obtaining pressure drops of the PRTR elements at room temperature is being bored out to actual PRTR tube size. Addition of the new pressure taps to the tube was completed.

Mechanical Equipment Development

Design Test PR-20 - Calandria Characteristics. Preliminary runs were made on the calandria mock-up. Moderator dump tests and liquid level control tests will be run after the completion of the moderator flow distribution tests. All instrumentation for the dump and level control tests were ordered, and installation will begin immediately. An earlier shipping date of May 26 has been received for the two prototype dump valves and actuators.

Design Test PR-24 - Calandria Shroud Tube Bellows. The bellows which failed during the live steam corrosion test was sectioned and is being examined to determine the cause of failure. Another shipment of bellows was received during the month, and additional corrosion tests will be run. A development contract

is being placed with the Solar Aircraft Company for procurement of additional bellows. A new purchase requisition is being processed to attempt to locate additional suppliers. Studies were initiated to develop other means of attaching the aluminum ends to the bellows. Several mechanical and casting methods will be tried.

Design Test PR-25 - Shroud Tube Collapsing Pressures and Installation. Testing to determine collapsing pressures was approximately 80 percent complete at the end of the month. The detailed design and machining of the simulated calandria bottom tube sheet were completed. The experimental welding tests of shroud tube attachment methods were begun.

Design Test PR-50 - Reactor Piping Seal Testing. Seal No. 1 - Inlet jumper to inlet piping, Seal No. 2 - Inlet jumper to process tube connection, Seal No. 7 - Outlet jumper to outlet nozzle connection, and Seal No. 8 - Outlet jumper to outlet header connection -- All four of these seals are 1-3/4-inch flared tubing fittings. The formal test program on these flare type seals has been completed, although additional tests are being carried out. The two-inch flares on the inlet fitting assembly were replaced with flares formed on the power flaring machine. A torque of 700 ft-lbs was required to stop all leaks during a 3000 psi hydrostatic test. The inlet fitting assembly will be subjected to additional thermal cycling tests on the ELMO-7 facility. The four 1-3/4-inch flares on nozzle cap assembly "B" were cycled 581 times with no leakage. A torque of 500 ft-lbs was required to stop all leaks.

Seal No. 2 - Inlet jumper to process tube connection - a new design of this seal was received from Construction Engineering Operation. The new seal is a flanged assembly utilizing a solid steel "O" ring. A test fitting was completed and will be tested as soon as the "O" rings arrive.

Seal No. 3 - Inlet gas seal - The work on the original bellows seal has been completed. A new design utilizing a solid copper "O" ring was received from Construction Engineering Operation. The fitting assembly made for testing the new inlet jumper to process tube connection will also be used to test the new inlet gas seal.

Seal No. 4 - Process tube to nozzle - The delta gasket in End 2A was replaced with a new gasket 0.007 inch larger in diameter to provide more wedging action. The fitting was cycled 150 times from 530 F to 185 F with no leakage. It was then disassembled, the flexitallic gasket in End 1A replaced, and the fitting retorqued to 900 ft-lbs. After a total of 345 cycles, both the delta gasket and the flexitallic gasket were performing satisfactorily.

Seal No. 5 - Nozzle cap seal - After 153 cycles on the static thermal cycling tester, nozzle cap assembly "B" was removed for disassembly. The assembly did not leak, but the "Bridgman" ring and the "Dome" ring were difficult to remove from the assembly. The two rings were cleaned to a 32 RMS finish and the cap assembly replaced on the static test facility. After a total of 329 cycles with no leakage, the assembly was removed. The rings were again difficult to remove during disassembly. The fitting was reassembled without cleaning for a hydrostatic test at 2500 psi. Leakage rates were 8 ml/hr for the "Dome" seal and 4 ml/hr for the "Bridgman" seal. Leakage stopped after five additional cycles on the thermal cycling facility. A total of 581 cycles have been run to date. Nozzle

cap assembly "A" was cycled 143 times from 550 F to 300 F on the ELMO-7 facility. End 1A, designed for use with a flexitallic gasket, was not leaking. End 1B, designed for an "O" ring but using a flexitallic gasket, was leaking at a rate of about 0.05 gph.

Seal No. 6 - Outlet gas seal - A Johns Mansville packing was tested in the test assembly. This packing remained hard and did not loosen during the 600 F baking. The gas leak rate using this packing was several liters per hour. The test fitting is being redesigned to attempt to reduce the gas leak rate of the various packings being tested.

Process tube assembly "A" - Fabrication of the seals for this short prototype process tube continued during the month.

Process tube assembly "B" - A purchase requisition was written to cover the installation of "Conoflex" seals on this assembly.

The Mechanical Equipment Development Operation static cycling facility was modified by automating one of the fitting test positions. The second test position will be automated early in April. Each position will then be capable of approximately 70 cycles per 24-hour day.

Design Test PR-51 - Reactor Piping Structural Integrity. Fabrication of the jumper flexure machine was completed and the machine was installed in the 314 Building. An inlet jumper, simulated venturi housing and header jumper were fabricated for use on this machine. Testing will begin early in April.

Design Test PR-63 - Process Channel Leak Detection Facility. The construction of the control panel including flow rators, dilution chambers, connecting valves and piping, and the necessary electrical supply was completed. Fabrication of the test assembly was also completed. Construction of the entire facility is estimated as 80 percent complete. Testing will begin in late April.

Other Activities. Single tube prototype facility (PhaseI) - Construction of this phase is now approximately 45 percent complete. All valves necessary to complete this phase have been shipped. Notice of a delay in the shipment of the instrument panels was received. The panels are now expected May 1.

Single tube prototype facility (Phase II) - Construction of this phase is approximately six percent complete. All material and equipment have been ordered with delivery expected by June 1, except for some valves which will be delivered by August 1.

Full size PRTR process pump - Delivery of the pump is still expected in November 1958.

PRTR injection pump - Delivery of the pump is still expected in May 1958.

Eight-inch check valve - The apparent lower bidder was requested to modify his valve to meet all specifications. It is expected that the order will be placed shortly.

Fourteen-inch gate valve - Delivery of the valve is still expected in July 1958.

PRTR inlet piping valves - The valves have been shipped and will be prepared for testing during the next month.

Pump seal test facility - The design of the facility was completed during the month. This facility will be used to test small double seals to gain experience for the testing of the large seals on the PRTR process pump. The fabrication of the facility will begin next month.

Tube rupture facility - The design of a small facility to rupture sections of process tubes was completed during the month. Fabrication will begin during the next month.

Zircaloy Tubing

An attempt to taper three PRTR Zircaloy process tubes was made at Tube Reducing Corporation, with "cross-cracking" being experienced in the tapered section of at least one tube. It appears that the total cold reduction required in the tapering operation is too great for a single operation, and a two-step operation has been proposed.

Preliminary work at Nuclear Metals to extrude ribbed PRTR Zircaloy jacket tubing has been successful on 0.750" ID material jacketed in steel and extruded over a mandrel. Both rib bonding and corrosion resistance appear to be excellent. Problems encountered in the extrusion of the 0.578" ID tubes have been solved by using a heavier steel jacket. Two each of the 1.818" and 2.968" ID tubes will be extruded at the Detroit plant of Revere Copper and Brass the second week of April.

New Rochelle Tool Company has completed the first phase of their contract to produce a machine for welding ribs to PRTR jacket tubing employing the high-frequency "Thermatool" process. Their preliminary work on steel components indicates that the method should be practical. Work will proceed on design and fabrication of the equipment.

Corrosion Studies

Tensile Testing of Hydrogenated Zircaloy-2. Tensile testing of 50 hydrogenated Zircaloy-2 specimens has been completed. Tests were performed in duplicate at five temperatures (room, 100, 200, 300, and 400 C), and five hydrogen concentrations (less than 10, 50, 100, 200 and 500 ppm). The specimens were machined from cold-rolled strip approximately 60 mils thick to have a one inch gage length and 0.250" gage width. The long dimension of the sample was oriented transverse to the rolling direction. All specimens were in fully annealed condition and were pulled at the same strain rate of 0.002"/min in a helium protective atmosphere. The hydrogen additions at each level were uniform from sample-to-sample, end-to-end, and surface-to-center as shown by individual weight gains and a visual appraisal of the distribution of hydrides in a mounted, polished, and anodized metallographic specimen at each concentration. Results of the tests are reported below in terms of the six mechanical properties observed.

EFFECT OF HYDROGEN ON THE MECHANICAL PROPERTIES OF ZIRCALOY-2

Mechanical Property	Test Results
Ultimate Tensile Strength	No apparent effect of hydrogen; decreased from ca. 75,000 psi at room temperature to 25,000 psi at 400 C.
Yield Strength (0.2% Offset)	Essentially insensitive to hydrogen concentration; decreased from ca. 65,000 psi at room temperature to 15,000 psi at 400 C.
Proportional Elastic Limit	No apparent sensitivity to hydrogen concentration; 43,000 psi at room temperature, decreasing to 11,000 psi at 400 C.
Percent Elongation	Hydrogen concentration significantly affects this property at temperatures up to and including 200 C. Fifty ppm H caused no detectable change, but concentrations from 100 to 500 ppm H caused progressive reduction in elongation at the lower temperatures. At room temperature, values ranged from 29% (vacuum annealed) to 19% (500 ppm). Maximum values occurred near 200 C: 53% (50 ppm) to 43% (500 ppm). However, at 400 C elongation values were relatively stable at 33% ± 3%, irrespective of hydrogen content.
Percent Reduction in Area	As in the case of total elongation, the effect of hydrogen diminishes with increasing temperature. From room temperature to 200 C the effect of hydrogen is significant and increases with increasing hydrogen content, being most pronounced at the lower temperatures. Sensitivity to 50 ppm hydrogen is marginal but at 100 ppm it is definite. At room temperature the values ranged from approximately 51% (vacuum-annealed) to 26% (500 ppm); at 100 C, 53% to 44%; and at 200 C, 61% to 53%. At 300 and 400 C the percent reductions in area were approximately 68 and 71%, respectively, regardless of hydrogen concentration, presumably due to dissolution of the hydride platelets in alpha zirconium at these temperatures.
Modulus of Elasticity	Modulus of elasticity values obtained from the slope of the initial straight portions of the load-strain curves were too scattered to reflect either the effect of the temperature of testing or the hydrogen concentration. However, this property is of lesser importance in most applications.

As indicated in the tabulation above, none of the six properties were significantly affected by the presence of 50 ppm of hydrogen. In the range from 100 to 500 ppm H only the percents elongation and reduction in area showed appreciable changes due to hydriding. The minimum percent elongation of 19% and the minimum reduction of area of 26% (both at room temperature and 500 ppm H) still represent a ductile material and do not appear alarmingly low, although it is expected that this material would show definite embrittlement in an impact test.

Aluminum Alloy Testing - Miscellaneous Observations. Samples of X-8001 failed after a few days in 300 and 350 C water. Sample stock is probably from the same lot as the samples discussed in January's Monthly Report which failed at 290 C. Spectrographic analysis has not indicated anything off-standard in the composition of these samples.

Alcoa powder metallurgy product M-457 after short exposure at 360 C has shown somewhat higher corrosion rates than wrought comparison material.

Alcoa alloy 192263 (1.4% Ni, 1.4% Fe) which has shown better resistance to intergranular corrosion than X-8001 or M-400 is also well recommended from Alcoa tests.

Solubility of Aluminum Corrosion Product in Deionized Water. Recent laboratory data indicate that the solubility of aluminum corrosion product can be somewhat sensitive to water quality. Delineation of this effect, which may relate to differences in water pH caused by impurities, will require further experimentation. While the solubility versus temperature data for aluminum corrosion products in deionized water are therefore still subject to revision, some calculations have been made based on the preliminary solubility data. In the following tabulation observed corrosion rates are compared with predicted values in 250 C deionized water. The table demonstrates the degree to which the solubility mechanism may be employed to predict corrosion losses in-reactor or in test loops within the usual accuracy of corrosion measurements.

COMPARISON OF OBSERVED AND PREDICTED CORROSION RATES FOR ALUMINUM
Temperature = 250 C For All Cases

Facility	Flow Ft/Sec	Refreshment Rate, Gal/Hr	Sample Area	Mils/Year Obs.	Mils/Year Calc.
Autoclave	0	2	3000 cm^2 (Approx.)	0.82	--
Autoclave	25	2	1200 cm^2 (Approx.)	3.2	1.2
Elmo-6	20	0.2	130 cm^2	22	30
Elmo-6	20	0.2	40 cm^2	60	95
	Flow Gal/Min				
Elmo-9 ΔT = 75 C	0.2	--	80 cm^2	19	27
H Loop (in-reactor) ΔT = 10 C	12	--	44 in^2	70	70
KER (in-reactor) ΔT = 3 C	60	--	44 in^2	50	100

Corrosion Testing Facilities. Two new one-liter autoclaves designed to be used for zirconium testing have been installed and pressure tested. These autoclaves were designed to be operated at 400 C with a pressure of 500 psi in one and 1500 psi in the other. Tests now in progress indicate that these operating conditions can be met, although it may be desirable to use a preheater for ease of operation and temperature distribution inside the autoclave.

Installation of the 12-in. ID x 12-ft long PRTR uranium fuel testing autoclave is nearly completed. The electrical circuits have been checked and accepted. The piping should be completed and performance tests are expected to be started about the first of April.

A test was started on March 11, 1958, on a semi-quantitative basis, to determine the corrosion characteristics of five different types of steel shot in hot softened water. It is expected that some of the PRTR shielding will contain shot similar to those being tested.

PRTR Design - Construction

General. Overall design is 53% completed.

Phase I - Containment Shell and Concrete. The John P. Hopkins Company was awarded the Phase I construction contract at $1,025,000. Construction of this phase is scheduled to start this month and to be completed by June 1959.

Phase II - Service Area. Design of this phase is 70% completed and is scheduled to be finished by May 2.

Phase III - Reactor. Design is 40% completed on this phase of the reactor.

A contract for design of the reactor fueling vehicle by General Mills Corporation was signed by the AEC. The completion date estimate is four months. A contract for design of the shim controls is expected to be awarded early in April. A combined development and procurement contract will be requested for the automatic controller.

Tests have indicated that a flanged process tube nozzle is desirable for maintenance reasons. The feasibility of incorporating this in the design is being investigated.

A survey of potential leakage points and possible leakage rates in the primary system has indicated that detection and location of very small leaks and recovery of D_2O from some of the ventilating air is necessary. A report has been prepared and will be supplemented with a compilation of the equipment and instrumentation which is required.

The bottom shield design was altered to include a thermal insulating sleeve around the process channel shield tube.

Design Development

Instrumentation and Control. Calculations of the tritium build-up, by the D(n, γ) T reaction, in the heavy water coolant and moderator of PRTR show that up to 0.75 megacuries will be present after ten years. A final equilibrium concentration of 1.75 megacuries is possible. The actual concentration will be influenced strongly by D_2O leakage from the system.

Open loop control characteristics of the PRTR are being investigated with the analog computer. This information is required as a basis for the controller design.

Coolant Systems. Primary coolant system flow pressure losses were investigated to establish a normal operating liquid level for the pressurizer. The present system will permit an 1800 gpm shutdown coolant flow with one pump operating at one-third speed. Total system pressure drop will be 10 psig under these conditions.

A probable maximum required pressurizer liquid level of -7 feet was established for a flow rate of 1400 gpm to compensate for additional flow restrictions which may be incorporated prior to reactor startup.

The operating volume of heavy water in the pressurizer was established at 109 cu ft (at 478 F).

A possible method for detection of heat exchanger tube leaks is based on radioactivity measurement in the cooling water. Use of this method would require raising the moderator and reflector pump discharge pressures to 100 psig, to ensure that any leakage will result in movement of D_2O into the cooling water.

Reactor Physics. A preliminary result of $K_\infty = 1.126$ from PCTR spike fuel loading experiments is in excellent agreement with calculations, so detailed planning of PRTR loading arrangements may be undertaken with some degree of confidence. Specification of the isotopic composition and concentration in the fuel elements to achieve 30 ± 5 plutonium tubes will be established by a coordinated physics, heat transfer, and hazards study.

Preliminary studies of PRTR shim rod materials indicated that large rods of low cross-section material are preferable to small, high cross-section rods. The following relationship was found between diameter and poison value for 0.5 to 1.5-inch diameter stainless steel rods.

$$P = -11.3 + 46.8\ d$$

where P = reactivity worth of the entire system, in milli-k
d = diameter, in inches.

PRTR Safeguards Analysis. The PRTR Preliminary Safeguards Analysis is being revised to reflect design changes, better defined lattice physics constants, and further knowledge of metal-water and hydrogen combustion reactions.

The following analyses were started to clarify the metal-water reaction hazards:

1. Calculation of the weight-rate of primary coolant discharge because of ruptured bottom tube or top tube jumper, or ruptured bottom or top 14-inch header.

2. Calculation of temperature transients to jacket melting points, for UO_2 and Pu-Al fuel elements, for a loss of coolant incident.

3. Experimental determination of the size of zirconium droplets from melting fuel element jackets.

Plutonium Fuel Cycle Analyses

In previous studies it has been concluded that uranium-235 is generally more "valuable" as enrichment in thermal reactors than an equal weight of plutonium-239, -241, i.e., would sustain a longer period of fuel exposure. These studies had as a limitation for the comparison either (1) identical heat rates (for spike enriched cases), or (2) identical loss factors (number of neutrons lost by leakage, absorption in non-fuel materials, etc.) in a reactor. In a more detailed comprehensive study now under way, it appears that plutonium may have a greater relative value as uniform enrichment in thermal reactors than does U-235. The change in viewpoint is the result of a critical evaluation of the limits expressed above. For the more recent work, calculations were made for uniformly enriched fuel elements of Pu or U-235 at various burnouts, mixed with U-238. For uniform enrichment the heat limitation can be met by lowering the flux in the Pu-fueled reactor, and comparisons may be made on a gram-for-gram basis. The loss factor limitation is lowered in favor of plutonium when it replaces U-235 in a reactor. Plutonium's greater competition for neutrons in a reactor flux due to its higher cross-section results in fewer neutrons lost to extraneous reactor materials, as compared with U-235. The net effect is a longer exposure for U-238 uniformly enriched with plutonium because fewer neutrons are lost.

An increase in exposure was found possible in all cases studied, where U-235 enrichment was replaced by an equal weight of Pu-239 + Pu-241, together with equilibrium amounts of Pu-240 + Pu-242. In addition, where Pu-239 was replaced by an equal weight of Pu-239 + Pu-241 with the accompanying Pu-240 and Pu-242, it appears that maximum possible fuel exposures increase with increase in percent Pu-241 in efficient reactors (k_∞/ϵ values above about 1.07).

It should be pointed out that this comparison would not apply to fuel substitution in a given reactor, where the neutron spectrum would change as the result of the substitution. The effects of such a spectrum change are being investigated.

Studies intended to lead to the formulation of a generalized diffusion theory have covered six currently used forms of diffusion theory. Two (the Richards approximation and the ordinary diffusion equation with the exact asymptotic diffusion length) were found to be of inadequate accuracy. One (the modified P_2 approximation) was substantially better than the others.

"A Generalized Calculation of Material and Reactivity Balance in Recycle Plutonium Reactors" (HW-54074, Unclassified) was completed in rough draft form.

Plutonium Fabrication Pilot Plant Design - Construction

Phase I - Outside Utilities. Construction was started March 12, and is scheduled for completion by June. Temporary construction office buildings have been placed, and excavations have been started.

Phase II - Building and Services. A re-estimate of the building cost after 50% design completion indicates that costs should be within scope estimates. All building equipment requisitions are expected to be submitted during April.

Phase III - Process Equipment. The standard detail concept is being applied to design wherever possible to reduce design costs and time requirements.

The most recent cost estimates of process equipment indicate that the present scope can be designed and constructed within the funds available.

Equipment procurement requisitions totaling about $158,000 have been submitted.

The present equipment design based on glove boxes will be retained in order to meet the scheduled ready-for-use date, even though recent information indicates that a hot cell facility may be required to handle multi-cycle plutonium. The glove box facility is expected to be adequate for earlier development phases and probably for a large part of eventual work with multi-cycle material.

Scope information for fuel element test autoclaves has been prepared. A scope revision will be submitted when vendor information drawings and specifications are completed.

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

MARCH 1958

FISSIONABLE MATERIALS - 2000 PROGRAM

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION PILES

Dry 7½-inch Lattice Temperature Coefficient Measurements

During the past month the PCTR experiments necessary for the determination of the 1000 MWD/T Pu enriched natural uranium total and metal temperature coefficients have been completed. In addition, the metal temperature coefficient experiments for the natural uranium case were completed. Analysis of these data is incomplete.

The new oven cover mentioned in the February 1958 Monthly Report has proven successful. Its use has resulted in significant savings in reactor time.

Two minor α-contamination incidents occurred in these experiments. The first was on a double slug for the 1000 MWD metal temperature coefficient experiment. Two slugs were welded end to end and drilled (at the weld) for the insertion of thermocouples. Prior to the heating experiments no contamination was observed. The α-counting rate on smears taken around the thermocouple hole and on the slug surface after the experiment was finished was 4000 C/M. The second contamination incident occurred with a special slug for pin irradiations after an irradiation at 400° C. Unfortunately only surface smears were taken because of the necessity of cleaning the slug immediately to obtain the irradiated pins. The RMO estimate of the α-count on the smear was 5000 C/M. No smear analysis was made to determine whether the α-count was actually Pu or whether it was only uranium. It is, however, quite reasonable to expect Pu contamination.

Thermal Neutron Flux in a Medium with a Temperature Discontinuity

Work on the network method of solving the partial differential equation was continued. It has been interrupted, however, to write a formal report on the analytical solution of the problem.

STUDIES RELATED TO FUTURE PRODUCTION PILES

Exponential Pile Buckling Measurements

The material buckling of a seven-rod cluster of 0.926-inch-diameter uranium rods has been measured in a 14-inch lattice. The value obtained with air in the coolant volume was $85 \times 10^{-6} cm^{-2}$. The aluminum sheaths of the individual rods were separated by 70 mils. The carbon-to-uranium atom ratio was 71.3. This measurement completes the exponential pile work with these cluster fuel

assemblies.

Machine Computational Programs

A program for evaluation of an integral encountered in cosine weighting has been written in OMNICODE and is awaiting assembly. This integration is expected to be incorporated into a program of broader scope.

Considerable effort was expended in trouble shooting the 650 version of the P-3 program, which developed operational difficulties. The source of these difficulties has apparently been traced to the improper function of an output punch in the machine.

Additional P_3 Program

A program deck and instructions for the 650 Nuclear Code called "Pop" was obtained from the APED of the General Electric Company. Output from the code consists of absorption cross sections, transport cross sections, and diffusion coefficients averaged over the flux and volume. Diffusion lengths and the thermal utilization are included in the output. A neutron balance is computed for the over-all cell. The output also includes volume fractions, advantage factors, weighting factors, and regional neutron balances for each region in the cell. Computing time for a 15-region problem is 45 seconds. Copies of the program deck and instructions have been prepared and given to interested members of the Nuclear Physics Research Operation (HLO) as well as to the Advanced Engineering Operation (HLO), and the Process and Reactor Development Operation (IPD).

Plutonium Isotopic Concentrations at High Neutron Temperatures

The effect of a cosine weighting correction to the previously calculated Pu isotopic concentrations is being investigated. Numerical evaluation of these corrections for the particular case of kT = 0.06 ev and approximately 3000 MWD/T exposure indicates an appreciable correction ($\gtrsim$20%) is involved for chopped cosine fluxes with $2\,\theta/\pi \gtrsim 0.8$.

As the calculations involved are rather cumbersome when done by hand, the isotope buildup equations and the corrections are being written in a form suitable for programming for the 650 or 702 computers. A set of graphs suitable for approximate evaluation of the correction factors is also being prepared.

Correlation of Exponential Pile Data with Theory

A uranium rod within an infinite moderating medium will always capture in resonance a fraction of the neutrons that are born within the rod. If there is no competition between adjacent fuel elements for the capture of neutrons of resonance energy, then the resonance escape probability can be expressed as a product of two escape probabilities, say P' and P_o, where P_o denotes the probability of escaping resonance capture in the source rod and P' denotes probability of escaping resonance capture in any other rod.

Let P' be represented by the simplified expression given in Glasstone and Edlund

and let P_o be represented by (1).

$$1 - P_o = (1 - P_{o\,\infty})\,\tau_\infty / \tau_L,$$

where $P_{o\,\infty}$ is the probability of escaping resonance capture in the source rod within an infinite moderator, τ_L denotes the Fermi age in the lattice and τ_∞ denotes the Fermi age with an infinitely large lattice spacing.

The above assumptions were used to correlate theory with experiment for 1.66-inch O.D. fuel elements. Thermal utilizations were calculated by the present P_3 methods. In these calculations, the variation in the effective neutron temperature with lattice spacing was accounted for, and η was computed from Westcott's cross sections. An η value of 1.328 was obtained for a room temperature Maxwellian distribution. Fast effects were calculated by the method outlined in HW-52834 and HW-54667.

The values of $P_{o\,\infty}$, resulting from the correlation, range from 0.965 to 0.971, in good agreement with the 0.970 value given by Campbell and Carter in BNL-433 for a 1.2" fuel element. The resultant effective resonance integrals may be expressed by

$$\left(\int \sigma_u \frac{dE}{E}\right)_{eff} = 8.978 \left(\frac{1}{F} + 0.159 \frac{S}{M}\right) \times 10^{-24}\ cm^2.$$

where F denotes the resonance disadvantage factor.

By using the above expression for the effective resonance integral in computing P' and letting $P_o = 0.970$, the resonance escape probability for a 1.679" O.D. natural uranium fuel element in a 7 1/2-inch lattice is 0.780, which is in fair agreement with the experimental value(2) of 0.769. In the past, correlation of exponential bucklings have resulted in resonance escape probabilities that were three to four percent higher than experimental results.

Instrumentation

Study and investigation was continued concerning information storage devices. Methods utilized by various manufacturers for such information storage were investigated with the emphasis on ferrite core storage.

The developed period meter circuitry was tested in conjunction with input signals other than of the exponential type. The output was the logarithmic value for such various input signals.

Development work was continued on the three-color pyrometer system. Tests were instigated using both a Cd S photocell detector and a multiplier phototube. Both tests were successful; however, the photocell response is much slower than that of the phototube system. Accuracies of temperature measurements to ± 1.0% were noted. The response time of the phototube system is

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(1) CRRP-655, E. Critoph

(2) HW-54667, Roy Nilson

[redacted]

limited only by the speed of rotation of the color wheel. The net response time for the phototube system was found to be 0.02 seconds.

A modification of the arc furnace cooling system permitted operation without mirror damage with 20 KW input power to the electrodes. The radiant flux focused by the mirror is sufficient to melt boron carbide (2350° C) and melt UO_2 (2800° C).

STUDIES RELATED TO SEPARATIONS PLANTS

Measurement of k_{oo} for Uranyl Nitrate H_2O Mixtures

Experimental work was continued on the measurement of k_{oo} for enriched uranyl nitrate water mixtures. Data were obtained in the PCTR for determining k_{oo} of 2.1%, 2.2%, and 2.3% enriched uranium with an H/U atomic ratio of 16. In order to obtain a more uniform mixture at this H/U ratio some polyethylene was used as a replacement for water; the chemical form of the mixture was: $UO_2(NO_3)_2 \cdot 2CH_2 \cdot 6H_2O$. Data were also obtained with enrichments of 2.1% and 2.3% at an H/U ratio of 14. For the 2.1% enrichment, the H/U ratio of 14 was obtained in two different ways; in one case the uranyl nitrate mixture contained 7 H_2O, and in the other, 4 $H_2O \cdot 3CH_2$. These latter measurements will show the feasibility of using polyethylene as a replacement for water in achieving H/U ratios for which it is difficult to maintain homogeneity in the water density. These data have not been analyzed.

Nuclear Safety Specifications for Enriched Uranium in the 1.25% - 2% Range

In reference to critical mass studies for nuclear safety specifications, the first buckling measurements were taken with 1.6% enriched uranium in water moderated lattices. The fuel elements were of the I and E type with dimensions of 1.39-inches O.D., 0.464-inch I.D. and were contained in type 3S aluminum tubing which was 1.50 inches in O.D. with 0.049-inch wall thickness. The buckling was measured for the cases with the slug core dry and wet. The measurements which have been completed are listed as follows:

Buckling for 1.6% Enriched Hollow Fuel Elements

Separation Between Rods	H_2O/U (by volume)		Buckling (10^{-6} cm^{-2})
2.1 inches	1.51	Core Dry	6483
2.2 inches	1.79	Core Dry	6587
2.0 inches	1.38	Core Wet	6605
2.1 inches	1.64	Core Wet	6941
2.2 inches	1.91	Core Wet	7000
2.4 inches	2.50	Core Wet	6450
2.6 inches	3.14	Core Wet	5125

The above assemblies consisted of 43 rods (each 40 inches in length) positioned in a hexagonal pattern. The assemblies contained about six tenths of the critical mass for the fuel elements in the cylindrical array. These are the highest material bucklings which have been measured in the exponential experiments at Hanford. Previous measurements were taken with fuel elements of

the same dimensions but with the smaller enrichment of 1.466%. The present measurements, therefore, can be used to show directly the effect of enrichment on the material buckling.

Criticality Studies in Support of Processing Power Reactor Fuels

Equipment for the k_{∞} measurements of 3% enriched UO_3-H_2O mixtures has been designed, and shop fabrication is being initiated.

Additional calculations have been made of the maximum expected k_{∞} and of the safe concentration limit (H/U ratio for which k_{∞} equals unity) for those mixtures which are to be measured. A summary of these values appears below:

Chemical Form	Enrichment	H/U	k_{∞}
UO_3 + x H_2O	3%	51	1.00
UO_3 + x H_2O	3%	8.0	1.39
$UO_2(NO_3)_2$ + x H_2O	3%	38	1.00
$UO_2(NO_3)_2$ + x H_2O	3%	9.5	1.19

Nuclear Safety, Critical Mass Consultations

1. Nuclear Safety in 234-5 Building Processing

   A. A review of a CPD rough draft document on Nuclear Safety of Hoods 1 - 4 (Batch Task I - II Hoods) in the 234-5 Building was made. This document is based on recommendations made to Research and Engineering (CPD) in February on methods of increasing the capacity of Hoods 1 - 4.

   B. A discussion was held with Research and Engineering - CPD on methods of handling an oversized batch of DBP product in vessels K-1, K-2, K-9, and 6-58 of the Recuplex Operation. Although this batch was larger than the allowable operational limit, it was below that required for criticality. The problem involved methods for safe transfer of this solution to vessels where criticality could be attained under the proper conditions.

2. E-Metal Dissolver Design

   A new E-metal dissolver design was reviewed for nuclear safety. The chief difference between this design and previous annular tank designs was that air rather than water or uranyl nitrate solution existed inside the annulus for a large portion of the dissolver. It was recommended that this air gap be filled with masonite surrounded by a 20 mil cadmium liner. The masonite is required to insure thermalization of neutrons leaving the annulus and the cadmium serves to capture these neutrons and thus minimize interaction across the annulus.

Neutron Age Measurements

The monoenergetic age measurements for water and kerosene have each been run

with both large and small neutron sources. The data have been reduced and corrected for geometric effects. Values of neutron age to indium resonance have been obtained for each case but an extensive error analysis has not been completed.

REACTOR DEVELOPMENT - 4000 PROGRAM

STUDIES RELATED TO THE PLUTONIUM RECYCLE PROGRAM

Plutonium Spike Measurements

The infinite medium, thermal neutron multiplication factor, k_{∞}, has been obtained for a heavy water moderated unit cell (supercell) which is actually a configuration of 7 cells having an 8-inch spacing. The central cell of the supercell contains a 19-rod cluster of plutonium-aluminum fuel elements surrounded by 6 nearest neighbors of 19-rod clusters of UO_2 fuel elements. The fuel elements are those used in the previous 19-rod cluster measurements. This k_{∞} result yields information concerning the effect of uniformly distributed enrichment columns on the multiplication constant of a lattice and is furnished in support of the design studies for the PRTR. The value obtained for k_{∞} of the supercell was 1.126 with a minimum standard deviation of 5 mk and an estimated maximum error of 10 mk. This result may be compared to the k_{∞} of 19-rod clusters in which the Pu-Al elements are mixed with UO_2 fuel elements. The reactivity advantage in separating the plutonium from the uranium results in about a 20% savings in fuel for the same k_{∞}.

Plutonium-Graphite Fuel Rod Measurements

The analysis of k_{∞} and f for the three plutonium-graphite fuel rods intermixed with 16 UO_2 fuel rods in an 8-inch lattice has been completed. However, it is apparent from supplementary reactivity measurements that the concentration of plutonium in these rods, compared to that in the Pu-Al rods, is uncertain by about 10 to 20%. Until a better figure for the plutonium concentration is obtained, the k_{∞} and f determinations can only be preliminary.

Heavy-Water Analyses

The results of isotopic analyses of the D_2O being used in the PRP experiments have been received from Savannah River. The heavy water has been degraded slightly during the past year in which the D_2O has been used in the PCTR. The D_2O is now about 99.68% of the total whereas the analyses before shipment to HLO was 99.75%. This change in purity is negligible insofar as the PCTR experiments are concerned.

Nuclear Safety, Critical Mass Consultations

A document, HW-55173, on "Plutonium-Aluminum Alloy Criticality" was issued, in which the nuclear safety in the handling of both moderated and unmoderated systems of plutonium-aluminum alloys was discussed.

Resonance Escape Theory

The value of the resonance integral for the narrow resonance approximation reported last month has been found in error. The corrected value is now

$$\sigma_a \text{ (eff)} = 0.625 + 0.496 \sqrt{\frac{S}{M}} + 1.712 \frac{S}{M}$$

With the new value of σ_a (eff) for the narrow resonances, it is noticed that the total σ_a (eff) is no longer negative for $\frac{S}{M} = 0$.

Instrumentation

Characteristics of various slug-rupture detection systems were summarized and compiled in a report forwarded to the Advance Engineering Operation.

Descriptive material is being gathered concerning noble gas monitoring systems. This information will be studied and compiled.

CROSS SECTION MEASUREMENTS PROGRAM

Subthreshold Fission - Np^{237}

Six fission foils of purified Np^{237} have been prepared and mounted in a fission chamber on the crystal spectrometer. About 5 mg/cm^2 of Np^{237} is being used. The spectrometer has been used with poor resolution to obtain fission cross section measurements from about 0.1 to 1 ev at present. The fission cross section measured from 0.1 to 0.2 ev is approximately 1/v and extrapolates to a 2200 m/s value of (15 ± 2) mb in reasonably good agreement with the pile neutron value of 19 ± 3 mb given in BNL-325. The fission cross section appears to be similar to the total cross section in that the thermal cross section is much larger than that contributed by the observable low lying resonances. Fission has been observed in the resonance at 0.49 ev. The measured peak cross section for fission is about 75 mb which corresponds to a fission width of about 10^{-6} ev. Measurements are in progress to attempt to determine the resonance fission in the 1 to 7 ev energy region. Preliminary results indicate a fission width of about 5×10^{-6} ev for the 1.34 ev resonance. Both of these widths are much smaller than predicted theoretically.

Subthreshold Fission - Am^{241}

A single foil of Am^{241} of about 0.01 mg/cm^2 has been used for fission cross section measurements in the same fission chamber with the Np^{237}. Am^{241} has a large resonance in total cross section at 0.3 ev and fission has been observed in this resonance. The observed fission resonance has a larger total width than that observed in the total cross section measurements which indicates the possibility of a Pu^{239} contamination in this foil. The measurements should be repeated with a sample of high purity. Nevertheless the 0.3 ev resonance which is observed can be analyzed to define the peak cross section of the Am^{241} resonance within the limits of about 20 to 30 barns. This gives a fission width of about 0.16 mv for the resonance. Preliminary results give fission widths of approximately 0.06 mv, 0.06 mv, and 0.55 mv for the 0.53, 0.58, and 1.26 ev resonances. The observed distribution of fission widths is very large as would be expected. The magnitude of the average fission width is the order of the maximum expected theoretically as opposed to the results obtained for Pu^{240} and Np^{237}. The observed fission cross section in the region 0.1 to 0.2 ev is not 1/v and is larger than would be calculated from the 0.3 ev resonance parameters. The curve can be extrapolated as 1/v from the lowest measured

energy to give what is probably an upper limit for the value of the 2200 m/s fission cross section of 7 barns. The reported value for pile neutrons is 2.9 barns.

U^{235} Fission Cross Section

Equipment has now been installed at the TTR to facilitate a comparison of fission rates in a spatially flat thermal neutron flux. Measurements have been initiated to compare the relative U^{235} weights of the fission foils which were used for absolute measurements at Hanford and at Harwell.

Three Crystal Spectrometer

Consultation was continued with CEO on spectrometer installation and specification. Difficulty has been encountered with the operation of the outer shutter assembly which may postpone the anticipated early completion date of the project.

Time-of-Flight

Two new high transconductance electron tubes have been received from Western Electric. Tests to date indicate that they may be desirable substitutes for the EFP60 tubes used in the loop amplifiers of the time analyzer vernier chronotron. Development of a new time analyzer has proceeded satisfactorily.

A larger plastic scintillator has been mounted on a 5-inch-diameter RCA7170 photomultiplier tube which is being tried as a high efficiency detector for the time-of-flight measurements.

TEST REACTORS OPERATION

Operation of the PCTR continued on a two- or three-shift basis during the month. There were four unscheduled shutdowns, one resulting from an electronic failure, one from a power failure, and two from faulty bypassing techniques.

Measurements were completed on the first group of simulated high exposure slugs (1000 MWD). One series of measurements was completed using slightly enriched UN hydrate.

Two improved design control rods were installed making a total of four rods replaced. An O-ring sealed entry port was designed and fabricated for the core heater assembly. This permits removing the test cell without unbolting the entire heater cover. New electrical outlets were provided to the assembly rooms to correct unsatisfactory near-overload conditions.

The expansion of the 305-B Building, Project No. CA-778, is proceeding satisfactorily. The firm of Carson and Moe of Kennewick has architect-engineer responsibility and preliminary scoping work is under way.

There was one unscheduled shutdown during the month caused by an improper trip setting.

Work continued on normalizing the fission foils that are to be used in the lattice neutron temperature experiment.

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Several reactor runs were made for the fission foil chamber, multichannel analyzer work being done by Experimental Nuclear Physics personnel.

An experimental test device for checking the performance of log diode tubes used in reactor control instruments was completed. Calibration work is in process.

BIOLOGY AND MEDICINE - 6000 PROGRAM

BIOPHYSICS RESEARCH

Atmospheric Physics

A lack of suitable meteorological conditions prevented further exploration of the transport and diffusion of materials which emanate from the 100 Areas and then traverse the Wahluke Slope. Analyses of available experimental data were continued as part of an interim report, which is scheduled for completion by June 1, 1958.

With this temporary cessation of Slope activities, attention was directed to the completion of other studies. Development of statistically derived forecasts of 200-mile cloud trajectories progressed to the point where comparison of this method with independently derived forecasts using only the current synoptic situation was possible. The objective statistical method proved to be the somewhat more reliable method; however, neither method was foolproof. The forecast trajectory was within $\pm 38^{\circ}$ of the true trajectory 65% of the time. Improvement over this rather mediocre accuracy will require a considerably more elaborate model than has been used to date.

After prolonged delays, analyses of data from the wind station network were received from the Computing Center and a five-year summary of wind information neared completion.

Considerable time was spent with Radiological Protection personnel deriving answers to specific questions regarding environmental hazards in the vicinity of the 100 Areas and with particular reference to the Wahluke Slope. Best estimates of atmospheric transport and dilutions and historical wind records were supplied for the "routine" emission case and for nonroutine emissions. These estimates were strongly influenced by the results of our experiments on the Slope but were not restricted to these incomplete data.

DOSIMETRY

A few more facts about the rock-shield low-background facility became available. Consistent with the expectation of an excess of low energy rays in a low atomic number shield, a 1/16-inch sheet of lead around a counter inside the shield materially reduced its background. The relative backgrounds in rock and lead shields are consistent with about half as much radium per gram of rock as there is per gram of lead.

The coincidence scintillation counter for plutonium detection was studied once more. The previous difficulty was the interference of Cerenkov light pulses from the light pipe with light pulses from X-rays. It was found possible to discriminate against the Cerenkov pulses by reason of their very fast rise time.

The proportional counter previously used for plutonium was also put in service again. It was modified and found to work well up to five atmospheres pressure of the counting gas. A larger proportional counter is being built.

Some magnets needed for the electron calorimetry work were partly completed. A comprehensive literature review of w measurements was made for inclusion in our reports on the subject.

The ion source on the Van de Graaff essentially "wore out" and had to be replaced. Otherwise the accelerator operated satisfactorily during the month.

One week of accelerator time was used by Nuclear Physics in exploratory time-of-flight studies of Be(d,n) and Li(d,n). Part of one week (interrupted by the ion source replacement) was used by Radiological Development in an energy sensitivity study of the neutron film badge.

The energy calibration of the Van de Graaff system was extended to the highest energies available from the machine. The same nuclear reactions used for the low-energy calibration were used for the high energies by using a beam of singly ionized hydrogen molecules rather than a beam of protons.

Initial tests were made of a Hurst Dosimeter (for neutrons) borrowed from Oak Ridge.

Measurements of w were made for protons in CO_2, air, and tissue-equivalent gas.

A literature review was made of data on ranges and stopping powers of charged particles. This study will provide the data needed in addition to our w measurements for fundamental neutron dosimetry measurements. The study revealed that when certain relative measurements are renormalized to agree with the best available absolute measurements then there is a difference in stopping power between gases and the same compounds in liquid or solid form. Such a difference was expected theoretically but was difficult to predict quantitatively. The difference found in the study was in reasonable agreement with the theory. The difference is of importance in dosimetry because one tries to make ion chambers that have gas and walls of identical atomic composition and must allow for this difference in stopping power between them.

INSTRUMENTATION

Development work was continued on an experimental all-transistor, scintillation combined alpha, beta, gamma Hand and Shoe Counter. One complete beta-gamma channel has been completed and is being tested. The 154 Kev beta from C^{14} is detectable. The geometry for detection of Sr^{90}-Y^{90} betas was found to be approximately 25%. One of the combined detector scintillation probes using

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The vacuum-tube Model II alpha, beta, gamma Hand and Shoe Counter, which also has external cabled probes for clothing checking, has now operated successfully for six continuous weeks. Total down-time in six weeks was 10 minutes for recalibration adjustments. This instrument can replace the 4-fold and 5-fold instruments and is the size of a 5-fold.

The experimental transistorized scintillation neutron count-rate-meters have been partially tested, using thin Zn S and B^{10} crystals, on fast neutrons from an Ra-Be source. Net neutron sensitivity is approximately 150 c/m per $n/cm^2/sec$ after biasing the gamma contribution from a 500 mr/hr field to less than five c/m. The ten-inch-diameter aluminum sphere for a fast neutron moderator has been fabricated. The sphere will be paraffine filled and will be used with a phototube and LiI crystal for dose-rate investigations.

One of the two experimental transistorized scintillation neutron count-rate meters was shipped to UCRL for field testing and usage.

Two prototype scintillation transistorized gamma-energy analyzers are being fabricated for field testing and evaluation.

All Radiotelemetering development has now been completed. Testing and assembly of components remains to be done.

An experimental circuit was developed using a non-isotropic magnetic coupling for proximity sensing for the robot monitor and gave usable sensitivity to a distance of 60 cm from large metallic objects. Previous circuitry using an isotropic electrostatic field sensing device was found to be sensitive to non-metallic objects at a 50 cm distance.

The pyrobeliometer averaging circuits were tested. Errors of less than two percent were obtained.

Investigations were continued on the sensitive alpha air monitoring system. The experiments have shown that the alarm level for airborne plutonium is approximately 60 mpc in 20 minutes or 120 mpc in 10 minutes, etc. The original alpha scintillation air monitor required 60 minutes to alarm with an airborne alpha concentration of 500 mpc.

The machine work is completed on the zinc sulfide particle detector for the Atmospheric Physics Operation. Assembly and testing will follow.

All machine work for the Dog Counter for Biology was completed and the shield was assembled. Complete system testing will now be undertaken. A very complete operation and instruction manual will be prepared before the counter is sent to Biology.

In conjunction with the scintillation Fish Scanner Counter for Biology, it was decided to use a NaI crystal well-counter for the gross counting of the tiny minnow-size fish. The larger fish will be counted head-down with the body of the fish dry to eliminate water-shielding problems. Only the head and gills of the large fish will be immersed in a fresh water supply.

Evaluation tests were completed on a commercial 110 VAC input, ± 900 VDC

output transistorized power supply.

Evaluation tests were successfully completed on the scintillation beta-gamma dose-rate meters, and the two test instruments are now being rebuilt for field usage. The instruments are gamma energy independent within about ± 10% from 50 Kev to 5.0 Mev. First range of the instrument is 0 - 0.5 mr/hr. This is a 100 times improvement over the standard ion-chamber type C-P.

WASHINGTON DESIGNATED PROGRAMS

The construction of the mass spectrometer for this program is proceeding satisfactorily simultaneously with the construction of the mass spectrometer for the critical mass program.

CUSTOMER WORK

Analog Computing

Computer performance continues to be satisfactory. Problems encountered have not exceeded that expected for normal operation.

Purchase requisitions were placed for: Additional simulation patch cords and resistors, a remote read-out system for the digital voltmeter and for miscellaneous electronic parts. In addition the AEC was requested to secure from the Goodyear Aircraft Corporation, two additional electronic multipliers under the terms agreed upon through recent correspondence. The purchase of the two additional electronic multipliers will be under the original purchase order for the computer.

Two representatives of the General Electric, General Engineering Laboratory visited Hanford to initiate the feasibility study on process simulation. Through discussions, the first steps in defining the problem and listing the expected results were agreed upon. GEL will issue progress reports to Hanford bi-weekly and a tentative completion date for the feasibility study is July 1, 1958.

The computer runs for the Chemical Waste Tank Temperature Study have been completed. The data has been delivered to the customer and will constitute the basis for a formal report. A check is now being made of the computer solution and of the equations used. A report on the computer phase of the program will be available shortly.

Various computer runs are being made to support the NPR program in respect to establishing operating and performance specifications. At the present time no definite physical configuration or system has been established.

The study of Californium build-up in the PRTR has been completed and the data delivered to the customer. A report on the computer phase of the program is on file in the computer lab.

The gas and water dynamics of the PRTR, as well as the reactor kinetics, are now operating together on the computer. Various runs, as requested by the Advance Engineering Unit, are being made. It is becoming evident that a comp-

lete study in the detail desired is not possible with the present computer, due to lack of equipment. In order to meet the requests of the customer, it will be necessary to break the problem into parts or to agree upon simplifications which will not seriously affect the desired end results.

Weather Forecasting and Meteorology Service

As part of a continuing program of expanding useful meteorological services to plant operating forces, routine advisories as to the likely areas affected by anomalous iodine emissions were initiated. Records of iodine emissions from Separations facilities are provided daily by Radiological Protection and, in the event of anomalous emissions, the probable trajectory and dilution of this material is derived from meteorological records. RPO is then advised as to likely areas affected by each such emission. In addition, consultation services were provided to Operations Research personnel on the meteorological factors important to the over-all problem of environmental sampling in the Radiation Monitoring and Radioecology programs.

Type of Forecast	Number Made	% Reliability
8-Hour Production	93	82.2
24-Hour General	62	88.8
Special	136	90.6

March brought an end to the much above normal temperatures which had prevailed during the previous three months. The average of 43.5° F was 1.0 degree lower than normal for February and was 2.2 degrees below the normal for March. Although wind speeds averaged below normal for the month, gusts to 55 mph were observed on the 5th. A thunderstorm, only the third for March in 14 years of record, was observed on the 24th.

Instrumentation

Two of the three alpha, beta, gamma fixed filter counters for 4" x 8" air filters were converted from a crushed anthracene to terphenyl loaded bioplastic for beta-gamma counting. The resulting geometries were approximately doubled over a beta energy range from 150 Kev to 2.2 Mev. Operation has been quite successful.

Optical Service

Nine glass bearings were fabricated for the 200-W shops, and nine more bearings were partially completed for the Chemical Processing Department.

Fabrication was started on an access hole periscope for 105-F Area, and fabrication was completed on an underwater borescope for 105-C Area.

The crane periscope head from Redox was repaired.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
None						

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. G. Foster	3/11	Argonne Nat'l Lab. Lemont, Illinois	Discuss Age Experiments.	FH Martens	Yes
	3/12	Bureau of Standards Washington, D. C.	" " "	RS Caswell	No
	3/13-14	Nuclear Dev. of Am. White Plains, N.Y.	Discuss Geneva Conference Paper.	H. Golstein	Yes
	3/17	Brookhaven Nat. Lab. Upton, New York	Discuss Time-of-Flight Experiments.	GN Glasoe	No
G. R. Hilst	3/13-14	Dept. of Meteorology and Climatology Univ. of Washington Seattle, Wash.	Confer with Consultants Church and Badgley.	PE Church FI Badgley	No
D. S. Selengut	3/17	Argonne Nat'l Lab. Lemont, Ill.	Discuss Computing and Reactor Theory Program at ANL.	BI Spinrad	Yes
	3/18-19	1958 Nuclear Congress Chicago, Ill.	Present Paper.	--	No
N. Ketzlach	3/17	1958 Nuclear Congress Chicago, Ill.	Present Paper.	--	No
	3/18	Argonne Nat'l Lab. Lemont, Ill.	Discuss Criticality Experiments.	WC Redman	Yes
	3/24-26	Industrial Nuclear Safety Group Mtg. Oak Ridge, Tenn.	Present Paper.	--	Yes

VISITS TO OTHER INSTALLATIONS (Continued)

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. A. Harvey	3/17-23	Nuclear Congress Chicago, Ill.	Attend Congress.	--	No
	3/21	Argonne Nat'l Lab. Lemont, Ill.	Discuss Instruments.	T. Brill	Yes
	3/24-25	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Discuss Instruments.	John Landry	Yes
	3/26-27	Savannah River Plant Aiken, S. C.	Discuss Instruments.	Jack N. Wilson	Yes
L. V. Zuerner	3/18-19	Univ. of Colorado Boulder, Colo.	Give Talk to AIEE and IRE Groups.	Students	No
J. E. Faulkner E. D. Clayton	3/24-26	Industrial Nuclear Safety Group Meeting Oak Ridge, Tenn.	Attend Meeting. Present Paper.	--	Yes
D. D. Matsumoto	3/21	Washington State Coll. Pullman, Wash.	Check IBM-650 Computations.	Dr. Richart	No

Chemical Research and Development

ORGANIZATION AND PERSONNEL

Effective March 17, 1958, the following organization components, positions, and individuals are responsible to the Manager, Analytical Laboratories.

Organization Component	Position	Individual
Chemical & Spectral Analysis Operation	Supervisor, Chemical & Spectral Analysis	H. J. Anderson
Radiochemical Analysis Operation	Supervisor, Radiochemical Analysis	D. L. Reid
Radiological Chemical Analysis Operation	Supervisor, Radiological Chemical Analysis	F. E. Holt
Special Analysis Operation	Supervisor, Special Analysis	D. M. Robertson

P. O. Jackson, Chemist II, transferred out of Analytical Laboratories to Chemical Processing Department.

Roy K. Uenishi, Chemist I-H, Chemical Research, terminated.

RESEARCH AND DEVELOPMENT

FISSIONABLE MATERIALS - 2000 PROGRAM

IRRADIATION PROCESSES

Analytical Service

Pile coolant radioanalysis was transferred to the Purex Operation. The six previously associated personnel are being absorbed in other programs.

F^{18} was observed in reactor effluent water. Formation by O^{18} (p, n) F^{18} is probable. An analytical procedure was formulated including cation removal on Dowex-50, fluoride precipitation with $La(NO_3)_3$, and counting in coincidence the 0.51 gamma rays from positron annihilation. Sample counting rate was compared to the counting rate of a standard Na^{22} positron source. Observed F^{18} half-life was 1.83 hours compared to the 1.87 hour literature value. Observed positron energy agreed with the literature value.

Automatic Analyzing Monitor

Shakedown of the monitor was essentially completed. Over 170 cycles (seven days operation) without any malfunction were attained. The principal area remaining for improvement is in the gamma scintillation counting system which is not yet sufficiently stable to give the long periods of unattended operation required. Provisions were made for obtaining the necessary pure isotopes for improved calibration of the

instrument. Component amplifier performance was sub-optimum and calibration of the Na^{24} channel was not satisfactory. The 100-channel analyzer results on samples from the 107 Basin are being compared with those from the automatic analyzer.

Uranium Oxidation Experiments

Good progress was made toward gathering base-line data for the uranium oxidation experiments. Under an argon atmosphere, the reaction of uranium with a variety of combustion boats was qualitatively evaluated. No material was found that would be satisfactory for experimental work above the melting point of uranium. However, at lower temperatures several combustion boats were found to be satisfactory. Consequently, experiments are now being run under air atmospheres, and satisfactory results are being obtained below the melting point of uranium.

SEPARATIONS PROCESSES

Purex

Exhaustive batch scrubbing studies employing aqueous waste (HAW) from a Mini run disclosed that efficiently-extracted, difficulty-scrubbed zirconium-niobium species are present in the aqueous waste (or were generated in the extraction operation). Typical increasing distribution coefficients were seen for both zirconium-niobium and ruthenium through seven successive scrubs. Addition of uranium yielded improved ruthenium decontamination in both the extraction and scrubbing operations, repressed zirconium-niobium extraction but did not significantly alter zirconium-niobium scrubbing.

The fact that addition of uranium improved decontamination performance of zirconium-niobium only in the initial extraction step suggests that efforts at improving decontamination from zirconium-niobium should be directed primarily at limiting the initial extraction of these species. In particular, these results suggest that operation of the 2D column at increased solvent saturation should be one of the first measures attempted in the event fission product decontamination is inadequate with the proposed two-cycle flowsheet. Higher solvent saturation should be permissible with the two-cycle flowsheet since uranium lost to the 2DW will be backcycled.

Samples derived from batch studies performed in December and January with Purex HCW, IBXF, IAF, and II00 were recently re-analyzed to correct for the masking effect of iodine-131 activity in the organic samples.

In general, application of a batch scrubbing operation simulating the proposed Purex HS column yielded improved decontamination for both a synthetic "HAP" prepared from Purex HCW and a synthetic "IBU" prepared from Purex IBXF. Addition of 0.01 molar oxalic acid to the scrub did not improve decontamination of synthetic "IBU." However, addition of 0.01 molar oxalic acid to Purex IAF improved gamma decontamination by a factor of about 1.5 in a batch counter-current run simulating the 2D-2E cycle and employing Purex II00 as solvent. Addition of oxalate reduced distribution coefficients for gamma activity in the extraction section by factors of 2 to 4 but did not adversely affect uranium loss.

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Anion Exchange Processes

Recovery of Plutonium from Purex 1WW. Permutit SK, the resin currently in use in the Purex continuous anion exchange concentration unit, proved more stable to cobalt-60 gamma radiation than other resins previously tested. At a dose of 3.4×10^8 R this resin still possessed excellent mechanical properties and had lost only ten per cent of its initial plutonium absorption capacity. Irradiation to 5×10^8 R destroyed completely the utility of the resin. However, the damage suffered in this prolonged exposure may well be due to nitrous acid-catalyzed chemical attack by the static 7 M HNO_3 solution which covered the resin during the irradiation. Formation of nitrous acid is known to have occurred since oxides of nitrogen were detected when the sample vial was uncapped.

The absorption capacity of Permutit SK for plutonium out of a synthetic Purex 1WW solution containing 10 mg/l Pu was determined at 25 and 60 C. The capacity proved to be virtually identical to that of Amberlite IRA-401. At 30 per cent breakthrough (corresponding to recovery of 89 to 91 per cent of the plutonium charged) the capacity was 3.24 g Pu/l resin at 25 C and 1.73 g Pu/l resin at 60 C.

Purex Concentration Step. Laboratory tests disclosed no change in properties of a sample of Permutit SK removed from the Purex continuous anion exchange unit after 16 days operation.

Kinetics Studies. Studies of plutonium absorption and elution kinetics aimed at the screening of commercially available anion exchange resins have been completed. Of eleven resins tested, Dowex-1, X-4 (50 to 100 mesh) exhibited the optimum combination of absorption and elution rates. Of 20 - 50 mesh resins tested, Permutit SK proved far superior, with Amberlite IRA-401 and Dowex-1, X-4 (20 - 50 mesh) as second and third choices, respectively.

Increased radiation stability makes Permutit SK and Amberlite IRA-401 first and second choices, respectively, for processing highly radioactive feeds.

Pyrochemical Processing

Continued pyrochemical process studies have been directed to the accurate determination of the uranium distribution between potassium aluminum chloride and aluminum metal. Considerable difficulty in this measurement has been encountered apparently because of side reactions involving the container material, silica. On the basis of recent experiments, it is believed that the extent of reduction of uranium in this system may be greater than previously thought and may approach 90 to 100 per cent.

Cesium Recovery

The installation of equipment in the 222-S Multicurie Cell for liter scale cesium recovery studies was completed, and cold shake-down runs have commenced. These will be followed by intermediate level runs to test adequacy of shielding and then by full level experiments.

"Acid side" cesium recovery flowsheets, employing zinc ferricyanide or zinc cobalticyanide vice zinc ferrocyanide, have been developed through the cesium precipitation

step and have the advantage that they eliminate the need of handling a ferric hydroxide precipitate. A process for converting a cesium bearing zinc cobalticyanide precipitate to a cesium chloride product has now been scouted at tracer level and shows great promise. The cesium zinc cobalticyanide precipitate is metathesized with silver carbonate to give a precipitate of silver cobalticyanide, zinc carbonate, and silver carbonate with the supernate containing only cesium carbonate. The latter is acidified with hydrochloric acid and evaporated to dryness. Cesium recovery has averaged about 90 per cent, with less than five per cent of the cesium lost to the metathesis precipitate.

Neptunium Recovery

Very little neptunium is currently reaching the 1BP (plutonium) stream, and it appears impractical to alter the 1B acidity and flow ratios to insure routing with the plutonium by this means alone. However, two flowsheets have been demonstrated in batch experiments which achieve the desired partitioning through the use of complexing agents. In one, oxalate is added in the 1BS. This is destroyed and the neptunium (and plutonium) oxidized with cerium(IV) and extracted in the 2A column. Stripping with nitrite in 2B reduces the neptunium to the (V) and plutonium to the (IV) state for easy separation in the resin cycle. Neptunium would then be recovered from the XAW after reduction with ferrous sulfamate. Alternately, fluoride can be used in 1B followed by addition of aluminum or zirconium in 2A.

Coulometric Titration of Plutonium

Twenty elements which were considered possible interferences in the controlled potential coulometric titration of plutonium were studied. Each element was tested for possible electrode reactions under the coulometric titration conditions used for plutonium in each of the three titration media used: citrate buffer, nitric acid and hydrochloric acid. The reduction potentials of the eleven elements which underwent electrode reactions in the vicinity of the plutonium reduction potential were measured, and the possible extent of interference was then calculated for each case. The interference was tested experimentally with a plutonium sample in the cases of iron, mercury and gold. The calculations were confirmed in the cases of iron and mercury, but gold reduced in the plutonium reduction span to a lesser extent than predicted.

It was found that the interference of every element tested except iron was negligible in at least one of the titrating media. At equal concentrations of iron and plutonium, a one per cent bias is introduced in the plutonium titration in HCl and that a ratio of Fe/Pu as high as ten is tolerable if a correction is made.

Counting Instrumentation

A simple coincidence system having no active elements such as vacuum tubes (a passive coincidence system) was designed in order to have a low cost, low maintenance system available for laboratory work. The system is usable on the output signals of the more common pulse discriminators used at Hanford. This subject is discussed in the report, HW-55290.

Feed Preparation

Dissolution of Dingot Metal. The effect of chemical additives on the dissolution of uranium in nitric acid is being studied in an attempt to shorten dissolution time cycles for dingot uranium fuels. Dissolution rates for dingot uranium in 6 M HNO_3 - 1 M UNH were not appreciably affected by the addition of sulfuric acid in concentrations up to 0.05 M. At 0.1 M H_2SO_4 the rate was increased by factors from 1.3 to 1.8 over that without sulfuric acid. However, these latter rates are still only about half those observed for ingot metal in the absence of sulfuric acid.

Attempts to relate dissolution rate of dingot uranium to grain size and impurity content were continued. Dissolution rates in 8 M HNO_3 were not significantly different for samples of dingot metal having a macroscopic grain size difference of about five. A series of centrifugally cast uranium base-carbon-silicon alloys prepared from dingot uranium showed dissolution rates in 8 M HNO_3 ranging from one to seven times that of production dingot uranium. Dissolution rate could not be related to silicon content, carbon content, or the silicon/carbon ratio.

Continuous Dissolution. Five runs have been completed in the 5-inch-diameter continuous dissolver. Dissolution rates of the order of 13-19 lb./hr./ft.^{3} (i.e., about 0.8 ton/day/ton heel) of dissolver were achieved with a product acidity as low as 0.05 mole HNO_3 per mole of uranium. During the studies, it was noted that the dissolution rate of the depleted uranium slugs used for these studies was up to 50 per cent greater than the dissolution rate of normal uranium slugs. The information available indicated the depleted slugs had been reduced with a commercial grade of magnesium rather than with the highly purified magnesium used for the normal uranium slugs.

Annular Dissolver. Fabrication of an "E" metal dissolver mock-up based on SK-2-7180 was completed at month's end. Test charging of the mock-up will be initiated in the near future.

Solvent Extraction

Purex 1C Columns. Efficiency studies comparing the performance of a plant-type Purex 1C Column cartridge with cartridge 10 (4 stainless steel plates alternated with one plastic plate) indicated essentially identical performance at 90 per cent of flooding. However, as previously reported (HW-52859 C), the latter cartridge permits stable operation over a wider range of pulse frequencies than that of the standard plant cartridge. Efficiency studies are in progress over the whole frequency range.

Coated Plates. The relative dispersion coalescence of sieve plates coated with linear polyethylene by a Kopper's Company "improved" method was found slightly inferior to that of solid linear polyethylene sieve plates.

New Processes

Fluidized Bed Studies. A preliminary design for a pilot plant fluid bed unit has been completed. The basic unit consists of an 8-inch diameter pipe 16 inches tall surmounted by a 12-inch diameter pipe 20 inches tall and finally a 20-inch diameter deentrainment section. External heating is provided by tubular heaters around the

full length of the 8- and 12-inch-diameter sections, and is augmented by internal gas burners at the convergence of the two pipe sections. Feed injections points are located slightly below the burner nozzles.

Flurex Development. Flurex Process development studies during the month may be summarized as follows:

1. Product yield is not significantly affected by the presence of nitrate ion, in concentrations up to 0.1 M, in an all-fluoride catholyte. However, in a fluoride-sulfate catholyte nitrate ion present in concentrations from 0.01 to 0.1 M, significantly reduces product yield. This latter effect is as yet unexplained.

2. Product yield appears to be independent of the width of a trench-type mercury cathode. Thus, the use of relatively wide trenches to reduce current density on the cathode and, consequently, improve current efficiency for uranium reduction is feasible.

3. The limiting current density (under Flurex operating conditions) for Nepton CR 61 cation membrane is not appreciably greater at 60 C than at 30 C. Permutit 3142 remains the only available cation membrane which can be used satisfactorily at one amp/in.^{2} under Flurex operating conditions.

4. Studies on the washing of Flurex product (NH_4UF_5) have been initiated. Preliminary tests indicate satisfactory removal of sulfate from NH_4UF_5 (precipitated in a fluoride-sulfate catholyte) by moderate water washing.

WASTE TREATMENT, FISSION PRODUCT RECOVERY

Cesium Isolation and Packaging

The leach concentrator has been eliminated from the Cesium Isolation and Packaging Facility. Studies and laboratory tests showed that excessive foaming could be expected if the leach liquor containing cesium hydroxide were concentrated by boiling. This foaming could result in unsatisfactory operating conditions and possible high product losses. The neutralization by gaseous hydrogen chloride will now be done in the leach receiver and the resultant cesium chloride solution will be transferred to the crystallizer for concentration and further processing. This simplification eliminates one piece of equipment together with its associated piping.

In a cooperative effort with Facilities Engineering Operation of the Chemical Processing Department the packaging facility equipment arrangement has been completed. This permits firm jumper and nozzle assignment.

A method was found to eliminate the need for accurate positioning of the cesium shipping container with respect to an ion chamber for measuring the curies of Cesium 137 present. Two ion chambers spaced on opposite sides of the shipping container will reduce the tolerance to ± 1/8 inch instead of the ± 0.006 inch required with a single chamber.

Observation Wells

Additional scintillation probe logs of monitoring wells were prepared in a study of the distribution of radioactive material beneath disposal sites. A total of 68 wells have been probed in this study to date. The data obtained reveal significant variations of probe readings, which are being correlated with the geologic stratigraphy. No completely satisfactory way of calibrating these probe readings is yet available.

Recently drilled wells east of the 200 East Area within three miles of the river indicated the presence of a residual ground water mound in the relatively impermeable consolidated Ringold formation. The low mound is believed to be the residue of recharged water from the river, annually replenished during high river stages.

Disposal to Ground

Laboratory soil column tests indicated that at least 10 column volumes of Redox D-2 wastes may be discharged to a soil column before breakthrough of long-lived isotopes would require abandonment of the disposal facility. Four column volumes of this waste have been discharged to the 216-S-7 crib. Tests with a sample of waste resulting from an equipment flush in the Redox plant produced a Sr^{90} breakthrough after the passage of less than one column volume of the solution. About 0.1 column volume of this material has also been discharged to the 216-S-7 crib.

Similar laboratory tests with a sample of process condensate waste from Purex revealed very poor retention of radiostrontium by the soil. The probability of early breakthrough of strontium from this crib is not great because of the very low initial concentration of radiostrontium in these wastes ($1\text{-}3 \times 10^{-7}$ uc/ml).

On the basis of laboratory data, calculations showed that Sr^{90} may enter the regional ground water beneath the 216-A-8 crib within the next few months. Consequently, a recommendation was made to Purex Operation to abandon this crib and to activate the 216-A-24 replacement crib on or about May 1, 1958.

Ninety per cent of the Sr^{90} discharged to the abandoned 216-S-1 and 2 cribs was accounted for in a cylinder of soil of about 120 to 140 feet in diameter and 30 feet deep. The audit of Sr^{90} was calculated using the radioanalysis of soil samples taken from wells located near the circumference of the cylinder. In nearly all these same soil samples, Cs^{137} was not detectable which prohibited making a Cs^{137} audit. The absence of Cs^{137} is evidence that it was removed by the soil before the waste reached the wells. The material balance of long half-life isotopes or "positive" approach method of auditing of wastes discharged to the ground appears to be a feasible reinforcement to the present monitoring method. However, it would be very expensive, requiring a large number of isotopic analyses of the influent to a crib and possibly tripling the number of wells required with the crib.

PROCESS CONTROL DEVELOPMENT

Process Control Instrumentation

Two fluorothene gamma monitor sample cells molded around a brass pattern have been laboratory tested for fission product retention using Purex (organic) 1BXF solution. After one week exposure each cell exhibited a full cell to empty cell gamma ratio of 50 or greater. A cell of this type is in use on HSP monitor.

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Laboratory tests indicate that ultrasonic techniques will be practical for detecting the resin level in the Purex 1WW plutonium recovery ion exchange unit. Specifications were written and submitted for bid on equipment similar to commercial marine type fathometers.

Instrument Development

Purex HA Column Densitometer. The prototype dual diameter float (designed for 1-1/2 inch travel) for use with the Purex HA Column densitometer exhibits float movement due to column pulsing. This movement produces a maximum error of ±4 per cent from the calibration curve. Float sticking problems have been eliminated, and tests are underway with the system pressurized to simulate conditions at the column feed point.

Contact Alpha Counter. Data obtained with the contact alpha counter on the Task I supernate transfer line have been ambiguous. In 150 transfers with plutonium concentrations ranging from 0.03 to 6 grams per liter, the counter measured the plutonium concentration above 0.5 gram per liter to ±0.25 gram per liter. Subsequent to installing a new multiplier phototube, data on 100 transfers revealed little if any correlation between monitor readings and plutonium concentration. A new phosphor is being installed and calibration data again accumulated.

Neutron Detector. The neutron detector on the same Task I transfer line (see above) has performed unsatisfactorily due primarily to high neutron background activity. Minor modifications to geometry and shielding have improved this condition somewhat but major changes appear necessary to assure useful performance.

Remote Instrument Probe. Design drawings (SK-3-7825, SK-3-7830) were completed on a remotable pH sensing unit for use in the F-16 (neutralized waste) tank at Purex. The basic design of this remotable unit for in-canyon tank and line installations is adaptable to many type detectors.

Materials Development

Non-Metallic Materials. On the basis of its demonstrated chemical resistance to process solutions (discussed in last month's report), Pro-Fax, a polypropylene manufactured by Hercules Powder Company, has been submitted to gamma radiation tests. These tests indicated that the material became brittle (fractured when flexed less than 1000 times at a fiber stress of approximately 5000 psi) when irradiated to 10^8 Roentgen. However, when irradiated to 10^9 Roentgen some of the material's flexibility was regained.

Corrosion of Titanium and Tantalum in Recuplex Task I Filtrate. Corrosion rates for A-55 titanium and commercially pure tantalum in boiling simulated Recuplex Task I filtrate (2.0 M HNO_3, 0.41 M K^+, 0.42 M Mn^{++}) and in the same solution concentrated four-fold were determined. Rates for tantalum were less than 0.01 mil/mo. penetration in both solutions. In the dilute solution, titanium corrosion rates decreased from about 0.2 to 0.01 mil/mo. during a 240 hour test; in the concentrated solution, rates increased from <0.3 to about one mil/mo. in the same period. Details of this study have been transmitted by letter to Finished Products Technology, Chemical Processing Department.

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Redox Product Concentrator Failures. The presence of a concentration cell is postulated as a possible cause of frequent failures near the feed inlet of the Redox product concentrator. A laboratory cell which permits simultaneous exposure of different parts of a metal specimen to two solutions of different concentrations is being operated to test the hypothesis. With nitric acid only as the corrodent, little if any difference in rates of attack on 347 stainless steel in the two cell compartments has been observed. If the results continue negative with nitric acid, solutions containing nitric acid and uranyl nitrate or plutonium nitrate will be tried.

Crevice Corrosion in Atmospheric Heat Transfer Test Devices. Crevice corrosion, adjacent to gaskets in the atmospheric pressure heat transfer test units, has caused considerable difficulty in determining corrosion rates in saltless nitric acid solutions. A significant decrease in the severity of the crevice corrosion was obtained using either modified Teflon* or Fluoroglas (glass fiber reinforced Teflon) gaskets. Use of these materials will be explored further.

SEPARATIONS PROCESSES

Analytical Services

Assay of metals in $Cs_2ZnFe(CN)_6$ was simplified with preliminary sodium hydroxide fusion in nickel or porcelain crucibles. The resulting cake was soluble in acid with no ferrocyanide complex remaining. Standard cesium, zinc, and iron methods worked. Most time-consuming was the dithizone method for zinc.

Elapsed time was reduced for UO_2 particle size measurement with the Andreasen sedimentation pipet. Previously, suspended UO_2 was assayed by drying, burning, and finally weighing U_3O_8. Now, suspended UO_2 is dissolved in nitric acid to allow uranium assay directly by x-ray absorption.

Residual formaldehyde in synthetic IWW was measured by acid titration of sodium hydroxide produced by formaldehyde - sodium sulfite reaction at pH >10.45. A suitable precision of 10-20 per cent was readily obtained at the 0.05 molar level of formaldehyde. When needed, much better precision is possible with refinements like lower reaction temperature.

Geneva Exhibit Column

A model of a pulsed solvent extraction column was developed which will produce a "zebra" emulsion satisfactory for display purposes. The 2-inch-diameter column employs a stagnant organic (Soltrol) phase, a circulating aqueous phase containing 2 g/l. citric acid and 0.8 cc/l. green cake coloring. The cartridge consists of alternately three linear polyethylene sieve plates and seven stainless steel plates, all on 1/2-inch spacing. Pulse amplitude and frequency are 0.3 inch and 120 cycles/minute, respectively.

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*duPont trademark

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NON-PRODUCTION FUELS REPROCESSING

Fuel Processing Chemistry

Continued study of the stability of Nb(V), Al(III), U(VI), NO_3^-, F^- systems indicates that processing such feeds in the Redox process would require an acid flowsheet (at least 0.5 M HNO_3 in the feed and about 0.2 to 0.5 M HNO_3 in the solvent). The limited solubility of niobium in aluminum-containing systems would require omission of the scrub section in the first extraction column.

A workable feed for processing in a Purex process has the composition 1 M HNO_3, 0.05 M Nb(V), 0.5 M F^-, 0.2 M UO_2^{++}, 0.7 M $Al(NO_3)_3$. A scrub stream in the range 1 to 3 M HNO_3 would be acceptable.

Mechanical Processing

The first tests on the cutting of simulated fuel elements (ceramic-filled stainless steel tube bundles and carbon-steel stacked plate assemblies) show that both circular sawing (with friction and diamond blades) and shearing (by alligator and both mechanical and air-operated guillotines) are mechanically feasible. A test is planned in April at the Williams Patent Crusher Company in St. Louis on a third method of chopping up fuel elements. It involves the use of a "hog mill" (a king-size hammer mill) designed primarily for chopping up steel scrap into "bite-size" pieces.

Dissolution Processes

Zirflex. Continued pilot plant studies of the dissolution of Zircaloy-2 by ammonium fluoride-nitrate solutions have indicated that positive steps must be taken to remove the ammonium hydroxide reaction product if a reaction inhibiting effect is to be avoided. Removal was accomplished by air sparging the dissolver pot and diversion of condenser reflux to an auxiliary receiver.

It was also noted that the apparent reaction rate was first order in free fluoride. Confirmation of this mechanism will simplify the experimental program.

Evolution of Iodine during Zirflex Dissolution. No detectable evolution of iodine occurred during simulated Zirflex dissolution of Zircaloy-2 with ammonium fluoride only or with ammonium fluoride-ammonium nitrate solutions. Uranium metal was present during the dissolutions. Inert iodine was added as potassium iodide and the dissolver solutions were air sparged throughout the runs.

Conductivity Instrument - Zirflex. Conductivity measurements appear to be related to the fluoride ion concentration in solutions and mixture of ammonium fluoride and zirconium ammonium fluoride. A 1000 cycle per second A.C. conductivity bridge and a cell with platinum electrodes were used for the measurements. This technique could readily be made into a continuous readout device for use on a Zirflex dissolver.

Darex Pilot Plant. During the past month, fabrication of the Darex pilot plant equipment was continued and installation has begun. Fabrication of the dissolver is 95

per cent complete. The titanium for the condenser and acid tank was received and fabrication has begun. The overall Darex installation is about 20 per cent complete.

Corrosion Studies

The corrosion of low-carbon (0.01 per cent) Hastelloy F weld metal in 1 M HNO_3 - 2 M HF is considerably more rapid (approaching a factor of 10) than corrosion of the base metal. While some preferential attack of the weld metal occurs in nitric acid solutions, it is much less than when hydrofluoric acid is present. Reducing the attack on weld metal by nitric-hydrofluoric acid solutions by heat treatment and altered weld metal composition is being explored. Stressed Hastelloy F specimens have shown no preferential attack after 450 hours exposure (liquid and interface) to 1 M HNO_3-HF solutions.

Maximum corrosion rate observed for Hastelloy F exposed to simulated Zirflex dissolver solutions under heat-transfer conditions (bulk metal temperature 125 C) was 0.6 mil/mo. No pitting or other preferential attack occurred during the one-month exposures.

Corrosion of 1020 mild steel in synthetic Zirflex process waste solutions at 25 and 40 C is, qualitatively, very low at pH 8.5 and above. Reliable quantitative measurement of the corrosion rates will require several months exposure. Similar studies are underway on the corrosion of 1020 steel in synthetic neutralized wastes expected to result from reprocessing stainless steel clad fuels dissolved in nitric-hydrofluoric acid solutions.

Dissolution of 304-L stainless steel in nitric-hydrofluoric acid solutions at temperatures below boiling has been investigated briefly. Optimum nitric acid concentration appears to be between 0.5 and 1.0 M regardless of the temperature. At hydrofluoric acid concentrations of 2 M or less, the dissolution rate increases approximately four-fold as the temperature is increased from 72 C to boiling. The dissolution rate of uranium metal in boiling nitric-hydrofluoric acid solutions increased from 2.2 to 35 $mg/cm^2/hr$. as nitric acid concentration was increased from 1 M to 4 M with hydrofluoric acid concentration held constant at 2 M.

Criticality Studies - Homogeneous UNH System

The preparation and delivery of the enriched homogeneous uranyl nitrate for the second part of the full-scale phase of the PCTR criticality experiment have been completed. The material consisted of two 500 lb. batches of uranyl nitrate with a 16 hydrogen to uranium atom ratio at 2.10 per cent and 2.30 per cent U-235, respectively, and one 40 lb. batch with a 16 hydrogen to uranium atom ratio at 2.20 per cent U-235. Powdered polyethylene was blended into crystalline UNH to provide the extra hydrogen. (UNH plus two extra waters of hydration does not remain homogeneous.)

Power and Propulsion Reactor Fuel Processing

Flowsheet development and economic study of the "single dissolver" proposal for power reactor fuel processing was continued. For the types of fuel and cladding likely to be processed at Hanford, a dissolver of Hastelloy "F" is expected to accommodate

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zirconium dissolution by Zirflex; stainless steel by nitric acid, hydrofluoric acid and aluminum by the conventional caustic-sodium to nitrate techniques. Unless more resistant claddings are proposed for Hanford processing, these studies will continue to be directed along the lines of the single dissolver process.

Ultimate Disposal of High Level Wastes

Study was initiated on the volume and heat release factors related to the packaging and dry storage of calcined, Purex, high level wastes. Preliminary results indicate that interim storage of the liquid for radioactive decay over a period of two to four years may be required to maintain the solid wastes at less than the calcining temperatures in simplest containers.

REACTOR DEVELOPMENT - 4000 PROGRAM

Pyrochemical Processing

Aged irradiated UO_2 was reduced in aluminum and cryolite and the fission product distribution determined. Almost all the uranium, plutonium and trivalent rare earths, 60 per cent of the Zr-Nb, and 20 per cent of the Ce-Pr and Ru-Rh activities were found in the metal phase. Less than 0.1 per cent of the Cs-Ba and 0.2 per cent of the Sr were present.

After this metal phase was contacted with molten potassium-aluminum chloride at 700 C, there remained 0.04 per cent of the Sr, 33 per cent of the Zr-Nb, and 86 per cent of the Ru-Rh activities. Previous studies have shown that plutonium seeks the salt phase in this step. Although not demonstrated in this experiment, it is believed that the plutonium and aluminum (in the separated salt phase) can be reduced essentially quantitatively by use of calcium or magnesium thus yielding an alloy suitable for recycle as a plutonium fuel material.

This experiment exemplifies the large separation of Sr and Cs-Ba attained in the cryolite contacting. It also shows the reversed behavior of the trivalent rare earths in the fluoride and chloride systems, thus offering possibility of controlled transfer.

In these two cycles a gross gamma decontamination of 100 for the uranium was obtained; however, it must be remembered that the starting material was cooled 30 months, hence not typical of process fuels.

Reprocessing of PRP Fuels by Amine Extraction

The extraction of plutonium by trilaurylamine was studied as a function of nitric acid and uranyl nitrate concentration to better define the effect of these variables and the range of practical feed solution compositions. Although the plutonium extraction coefficient decreases at high (1-1.5 M) uranium concentrations, it is still large enough to insure good plutonium recovery.

It has been found difficult to decontaminate used amine extractant from extracted fission products by simple carbonate washing. Steam distillation of trilaurylamine was accordingly tried as an alternate method of repurifying used solvent. The results were unsatisfactory with only a trace of amine distilling and with evidence of some amine decomposition in the still.

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BIOLOGY AND MEDICINE - 6000 PROGRAM

A study was begun of the effect of pH of the reactor coolant water on the concentrations of radioisotopes produced in the effluent water. Preliminary results on samples obtained from process tubes using water with pH controlled at 6.0, 6.5, and 7.0 show that the Cu^{64} concentration is reduced to about one-third when the pH is reduced from 7.0 to 6.0. Na^{24} remains essentially constant over this pH range. Additional measurements on about ten more radioisotopes will be made.

A cooperative study with the Biology Operation was made on the uptake of short-lived radioisotopes by rats following a single feeding of concentrated reactor effluent water. The animals were sacrificed 24 hours after the feeding, and the radioisotope uptake of the various organs was measured. The data from this study will provide information for planning longer term, more precise experiments.

Studies of the protective effects of compounds on preventing change in a chemical dosimeter were continued to further elucidate the influence of chemical structure of the protective compound. Results obtained showed that compounds containing strong electron-withdrawing atoms have low protective indices; the number of carbon-hydrogen bonds strongly affects the protective indices of the three-carbon alcohols; the protective indices of compounds containing amino groups appear to be related to the amount of free amine released to the solution.

Geology and Hydrology

The Standard Oil Company of California passed the 9400-foot depth, still in basalt, in the Rattlesnake Hills stratigraphic test well. The disposal of wastes beneath the basalts is becoming progressively less feasible owing to the increasing expense and difficulty in monitoring which would be required.

A study was started to identify the geologic origin of an aeolian deposit underlying the 200 West Area. The mineralogic composition of the high density fraction of samples was determined microscopically and compared with that of adjacent formations. The deposit appears to be correlative with the Palouse soil of eastern Washington and is apparently derived from the upper Ringold formation.

A fluorescein tracer test was used to time the underground movement of ground water over a distance of 2.5 miles. The movement of ground water through glaciofluviatile sediments southeast of 200 East Area occurred at an average rate of 150 to 160 feet per day. The fluorescein concentration in observation wells continues to increase indicating the possibility of estimating the diffusion rates in the ground water.

Soil Chemistry and Geochemistry

Further tests of the removal of strontium from phosphate solutions were made with samples of actual wastes. The calcite bed was shown to remove greater than 99 per cent of the strontium from these wastes and about 44 per cent of the other radioactive material. It was found that Pu^{239} is removed from solution by the calcite-phosphate mechanism in the same manner as strontium and calcium. It is believed that all "bone-seeker" radioisotopes may be removed from solution by this mechanism since the chemical reaction by which bone is formed is similar to this apatite replacement reaction.

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Work continued on the removal of Cs^{137} from solution by means of the mineral pollucite. The degree of removal was shown to be independent of mineral grain size. Thus, the pollucite appears to behave as a true zeolite. Potassium and rubidium were shown to influence the removal of cesium to a greater extent than does sodium. Sodium concentrations less than 0.01 M were found to have no measurable influence on Cs^{137} removal. A wash with 1 M amonium nitrate removed 82 per cent of the cesium retained on a pollucite bed.

Ground Waste Investigations

Work continued on the study of soil column variables and their interpretation with regard to the breakthrough of specific ions. It was found that the adsorption of cesium in the presence of other cations is most efficient at low temperatures, probably because cesium ion is less hydrated in solution than other cations. Tests were initiated to study the influence of column length on the breakthrough data. Preliminary data from 10 and 20 cm columns indicated a possible linear relationship between breakthrough volumes and column length.

A possible new technique for high precision control of very low flows was studied for application to soil columns; gases generated by electrolysis are used to slowly force samples through the column. Rapid adjustment of flow to any desired rate is possible but the method is sensitive to atmospheric pressure changes.

Field Apparatus Development

Thermistor probes in several configurations were tested to determine optimum arrangement for measuring ground water velocity. The smaller, more sensitive probes responded tc local eddy currents resulting in erratic readings. Increased stability was achieved with some loss in sensitivity by increasing the thermal capacity and size of the probe.

An El-tronics humidity cell was investigated for use in soil moisture measurements. The usable range of humidity measurement for Ringold soil was from below 3 per cent to 20 per cent moisture content. Very small, sensitive moisture indicators are required for research in unsaturated flow.

Tests of a water deaeration system designed and recently completed for soil permeability measurements showed that the water processed contained about 3 ppm oxygen. This is believed to be entirely adequate for the requirements.

L P Bupp

Manager
Chemical Research & Development

LP Bupp:bp

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
E. G. Kendall D. I. Sinizer	3/6-7/	NAA-Atomics Internat'l. Canoga Park, Calif.	Discuss UO_2 processing & fabrication, UNH calcination, and remote operations.	LP Bupp RL Moore EE Voiland BM Johnson WR DeHollander WH Reas	Yes
	3/7/		Discussions on waste disposal.	CA Rohrmann	No
	3/6/		Discuss remote emission spectrograph operation.	HJ Anderson	No
J. C. Bresee F. R. Bruce	3/6/	Oak Ridge National Laboratory Oak Ridge, Tennessee	Discuss current waste disposal practices and Geneva Exhibit.	LP Bupp CE Linderoth LC Schwendiman	No
	3/7/		Non-Production fuels reprocessing; ion-exchange, cesium recovery, Zirflex.	OF Hill RJ Sloat AM Platt	Yes
	3/7/		Discuss technical activities in new solvents, anion exchange, Zirflex process, & waste treatment.	MT Walling RL Moore WH Reas	Yes
Dr. A.R. Gopal-Ayengar	3/7/	India's Department of Atomic Energy	Discussed thorium bioassay procedure and instrumental methods of analysis for waste stream radioisotopes.	JM Nielsen	No
J. Hershey R. L. Folger M. W. Davis	3/11/	DuPont, Savannah River Plant Augusta, Georgia	Discussions on developments in in-line instruments, equipment, materials of construction and feed preparation.	OF Hill GJ Alkire RJ Sloat RE Burns AM Platt	Yes
M. W. Davis R. L. Folger	3/12/		General separation matters.	AS Wilson LL Burger RL Moore MT Walling WH Reas	Yes

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
P. Turner R. E. Latta	3/12/	G.E. - A.N.P. Cincinnati, Ohio	Discuss special plutonium reactor materials and fabrication processes of interest.	WH Reas	Yes
R. F. Bracelin R. H. Gedney	3/14/	Corps of Engineers Seattle District	Discuss foundation conditions at Ben Franklin dam site.	RE Brown	No
W. N. Parker	3/17/	Radio Corporation of America Lancaster, Pa.	High vacuum technology.	LP Bupp RJ Brouns WH Reas HJ Anderson LP Bupp	No
J. A. Consiglio P. Troutman	2/17-18/	GEL Schenectady, N.Y.	Discuss the analog scintillation of a solvent extraction column.	ET Merrill CA Rohrmann	Yes
M. B. LeBoeuf	3/25/	KAPL Schenectady, N.Y.	Analytical procedures.	LP Bupp DL Reid DM Robertson EW Christopherson	Yes
	3/24-25/		Discuss advances in radiochemistry and nuclear instrumentation.	RE Connally RJ Brouns WH Reas	Yes
J. T. Byrnes	3/25/	Dow Chemical Rocky Flats, Colo.	Pu analysis discussion.	R Ko	No
	3/25-27/		Discussed analytical methods for plutonium.	FM Smith FA Scott RM Peekema FP Brauer RJ Brouns MC Lambert AS Wilson WL Lyon MT Walling K Koyama WH Reas	No

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
George Hazzard	3/31/	Research Laboratory Schenectady, N.Y.	To acquire Hanford background to aid in the recruitment of technical personnel.	WH Reas LP Bupp	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. G. Bradley	3/2-5/	Phillips Petroleum Co. Idaho Falls, Idaho	Inspect mechanical processing facilities.	JA Buckam	Yes
		ANP Idaho Falls, Idaho	Inspect ANP hot shop facilities.	RE Drexler	Yes
V. P. Kelly	3/3-4/	ANP Shop and Phillips Petroleum Company Idaho Falls, Idaho	Inspect ANP Hot Shop; inspect remote mechanical processing facilities.	DC Durill JA Buckam	Yes
K. H. Hammill	3/4/	Penberthy Instrument Seattle, Wash.	Inspect lead shield window and discuss shielding installation around window.	J Gifford	No
R. Ko	3/7/	Pittsburgh Conference	Present Paper	---	No
	3/10/	Union Carbide Nuclear Company Paducah, Kentucky	Discuss uranium isotopic analysis.	RF Smith	Yes
E. W. Christopherson	3/7/	University of Missouri Missouri School of Mines Washington University	Recruiting	Placement Departments, et al	No
A. C. Leaf	3/14/	Phillips Petroelum Co. Idaho Falls, Idaho	Analytical discussions.	RC Shank	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
F. A. Scott	3/3-5/	Pittsburgh Conference Pittsburgh, Pa.	Attend Conference.	---	No
	3/13-14/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss analytical instrumentation techniques.	M Kelley	Yes
W. H. Bierschenk	3/8-9/	US Bureau of Mines Bartlesville, Okla.	To study fluid flow through porous media & techniques of waste disposal.	JW Watkins FE Fleming	No
		Phillips Petroleum Bartlesville, Okla.	" " "	R Piety B Wiley	No
	3/10/	Magnolia Petroleum Co. Dallas, Texas	" " "	CE Alexander W Skinner J Breneman R Sandburg P Lawrence	No
	3/11/	Jet Research Center Arlington, Texas	" " "	EL Gillingham B Wiley	No
J. R. Raymond	3/10/	US Bureau of Mines Bartlesville, Okla.	To obtain information on ground water phenomena.	JW Watkins FE Armstrong	No
		Phillips Petroleum Co. Bartlesville, Okla.	" " "	R Piety B Wiley	No
	3/11/	Magnolia Petroleum Co. Dallas, Texas	" " "	CI Alexander W Skinner J Breneman R Sandburg P Lawrence	No
	3/11/	Jet Research Center Arlington, Texas	To discuss well perforation equipment.	E Gillingham	No
R. J. Brouns	3/13-14/	Phillips Petroleum Co. Idaho Falls, Idaho	Discuss analytical methods for fuel processing.	RC Shank	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
C. L. Pleasance	3/17-18/	DuPont Company SRL Augusta, Georgia	Discuss plant instrumentation programs; particularly continuous chemical analyzers and close-coupled analyses that may be applicable for process control in the HAPO separations processes.	CH Ice JD Ross	Yes
	3/19-20/	Nuclear Congress Chicago, Illinois	To attend conference and present paper.	---	No
W. R. DeHollander	3/17/	Nuclear Congress Chicago, Illinois	Present paper.	---	No
	3/17-18/	Argonne National Lab. Lemont, Illinois	Discuss metal pyrophoricity.	R Vogel G Schnitzlein H Porte	Yes
J. Dunn	3/17/	Hill-Acme Company Cleveland, Ohio	Alligator shear demonstration.	---	No
	3/17/	Lewis Flight Propulsion Center Cleveland, Ohio	Calciner seal materials.	---	No
	3/18/	Penberthy Injector Co. Detroit, Michigan	Jets	---	No
	3/18/	Cadillac Gage Co. Detroit, Michigan	Control Valves	---	No
	3/19-20/	Nuclear Congress Chicago, Illinois	Attend meeting and present paper.	---	No
	3/20/	Process Equipment Co. Dayton, Ohio	Canned Motor Pumps.	---	No
	3/21/	Easy Industries Chicago, Illinois	Canned Motor Pumps.	---	No
R. E. Brown	3/17-21/	Nuclear Congress Chicago, Illinois	Present Paper.	---	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. E. Brown D. J. Brown	3/26-29/	Geological Society of America Cordilleran Section Eugene, Oregon	Present Papers.	---	No
D. W. Pearce	3/27/	Colorado School of Mines Golden, Colorado	Speak at student seminar on Radioactive Waste Disposal at Hanford.	RA Baxter	No

A. Organization and Personnel

No major or significant items relating to personnel changes or activities occurred during March 1958.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Atmospheric Contamination

Concentrations of I^{131} in thyroid glands of jack rabbits were about three times those observed one year ago. Values were as follow:

Collection Site	µc/g Thyroid Average	µc/g Thyroid Maximum	Trend Factor
Prosser Barricade	3×10^{-3}	4×10^{-3}	-
Four miles SW of Redox	2×10^{-3}	5×10^{-3}	-2
Wahluke Slope	6×10^{-4}	1×10^{-3}	-

Concentrations of fission products in rabbits were approximately the same as observed one year ago. Values were as follow:

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

Columbia River Contamination

The concentrations of beta emitters in minnows were about twice the values observed one year ago. Values were as follow:

Sample Type	Collection Site	µc/g wet wt. tissue Average	µc/g wet wt. tissue Maximum	Monthly Trend
Minnows (entire)	Hanford	1×10^{-3}	2×10^{-3}	-
Minnows "	Ringold	1×10^{-3}	3×10^{-3}	-

Effect of Reactor Effluent on Aquatic Organisms

Reactor effluent was changed in concentrations from 3 to 6.2 per cent to simulate the magnitude of fluctuations which may result from power production at Priest Rapids Dam. It caused a very slight and probably non-significant increase in the mortality of young salmon. This result is different than that obtained with whitefish and will be checked by continued exposure.

Monitoring of the effluent from the KE reactor with comparison of the toxicity of the gross effluent with that from special Tube No. 4963 was re-established with young salmon. This test was wiped out last month as a result of difficulty with the river water supply.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Phosphorus

One week after administration of P^{32} to trout was stopped, the concentration in the hard tissues had declined at a rate approximating the physical decay of the isotope. The decline in the soft tissues was 1.5 times faster. Blood data from the high level group (fed 0.6 μc P^{32}/g body weight/day) showed a significant decline in leucocyte count, erythrocyte count, hemoglobin and hematocrit level. No statistically significant decline in these blood components was found among fish administered P^{32} at rates of 0.06 or 0.006 μc/g).

Zinc

To determine optimum concentrations of Zn^{65} for tagging aquatic communities, several aquaria containing aquatic plants and animals were spiked with several concentrations of Zn^{65}. After seven weeks nearly all the Zn was transferred to the biota. Concentration factors were 10,000 to 80,000 for phytoplankton and 1,000 to 4,000 for fish.

Three-hundred days following intraperitoneal injection of rats, measurable amounts of Zn^{65} were present only in bone and pelt. The retention curve for pelt is irregular, due, no doubt, to periodic shedding of hair. Retention in bone is reasonably well-described by a single exponential function indicating a biological half-life of 245 days. Approximately 4 per cent of the Zn^{65} originally injected remained in the animals after 300 days.

Strontium

Early results are available from the second experiment on the effects of dietary calcium on chronic deposition and retention in rats of Sr^{90} and Ca^{45}. Data are, thus far, available for the first 13 days of a planned 100-day experiment. Results are similar to those obtained in the earlier preliminary experiment except that absolute amounts deposited are lower by a factor of about two, probably due to the older age of the animals in the present experiment.

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Results relative to the concentration of Sr^{90} in the blood at various times following oral dosing are available for the first adult miniature pig. The results indicate an appreciable uptake within 30 minutes after dosing, with a maximum concentration at three and one-half hours following administration. The concentration in the blood remained relatively constant between the 6th and 15th days at approximately 30-fold less than the peak.

Cinebar and Ephrata soil samples uniformly contaminated with Sr^{90} were treated with $(NH_4)_2SO_4$, gypsum, and $Ca(NO_3)_2$. Nitrogen additions were equalized through adding appropriate amounts of ammonium and nitrate ions. Barley was grown in two successive croppings by the Neubauer method and radishes were grown in pots in the greenhouse. In the first crop of barley, sulfate depressed Sr^{90} concentration in plants grown on Cinebar soil by 25 per cent and calcium increased Sr^{90} concentration slightly over that in plants from untreated soil. Concentration of Sr^{90} was three to four times higher in plants grown on the acid cinebar than on basic Ephrata soil. No effects of soil treatment were noted with Ephrata soil. In the second crop no effect of treatment was observed with either soil and concentration of Sr^{90} in plants from both soils was the same.

Radishes grown in pots had almost 10 times more Sr^{90} when grown on Cinebar as compared to Ephrata soil. None of the treatments of either soil affected the concentration of Sr^{90} in the radish tops. This soil is being re-cropped with barley. In all cases yields were markedly greater from Ephrata than from Cinebar soil.

Tests with nutrient solution containing low concentrations of calcium showed depression of Sr^{90} concentration in plants with increasing concentrations of calcium in the nutrient. The depression was slight, however, with about a threefold drop in Sr^{90} with a tenfold increase in calcium. Presence of small amounts (relative to calcium) of stable strontium with the lowest calcium concentrations increased Sr^{90} concentration in leaves but not in stems.

Iodine

Q/D values (quantity of I^{131} in the thyroid divided by the daily quantity of I^{131} fed) are definitely depressed in sheep fed 5 μc I^{131}/day, somewhat depressed in sheep fed 1.5 μc I^{131}/day, and very slightly depressed in sheep fed 0.5 μc/day, as compared to sheep fed 0.15 μc/day. It is interesting to note that we once stated that 5 μc I^{131}/day was safe for sheep, and that 0.5 μc/day would be a reasonable working limit.

In pigs fed 5 μc I^{131}/day, Q/D values are about 20 per cent lower in animals which receive 30 per cent less food than others.

Cesium

Frogs from the pond spiked with cesium-137 last June were sampled before they had fed after emerging from winter hibernation. The concentration

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of Cs^{137} in muscle was about one-half the value observed before the animals hibernated and about 6,000 times the concentration in water.

Concentration in tissues from fish, which were in the winter semiquiescent state, were only slightly less than those observed in specimens sampled during the fall when the fish were actively feeding. Fish maintained without food in water containing 4.5×10^{-2} μc Cs^{137}/ml accumulated the radioisotope to 20 per cent of the concentration in the water.

Plutonium

Results are available from an experiment in which DTPA was administered to rats over a period of four weeks commencing 38 days after intravenous injection of plutonium. The DTPA treated rats retained 49 per cent of the administered plutonium in their skeleton as compared with a 64 per cent retention in control animals. Retention in the liver was reduced from 3.7 per cent in the controls to 0.5 per cent in the DTPA treated animals. Total excretion of plutonium during the DTPA treatment period was 14 per cent of administered dose as compared with 5.5 per cent excretion during the same period in control animals. The control animals in this experiment received calcium gluconate injections which in themselves may have had an appreciable affect in increasing plutonium excretion.

Radioactive Particles

A dog, surgically prepared with an externalized trachea, was exposed to an aerosol of $Sr^{90}SO_4$ to study the translocation of particles from the lower respiratory tract. Blood, urine, and feces were collected and assayed for Sr^{90} at intervals for one week after exposure when the animal was killed for assay of the tissues. The skeleton contained the largest fraction of the total Sr^{90}. A smaller fraction was present in the lungs and only trace quantities in other tissues.

Gastrointestinal Radiation Injury

The decrease in DNA in the irradiated intestine might conceivably be due to an increased activity of enzymes capable of destroying DNA. In experiments to evaluate this hypothesis it was found that the extracellular enzyme, DNAase I, was decreased by about 50 per cent in both the plasma and intestine, following whole-body or intestinal tract X-irradiation (700 to 1,500 r). The intracellular enzyme, DNAase II, increased slightly in the plasma and decreased slightly in the intestine. These changes were observed one day following X-irradiation.

Shielding of a portion of the intestine during irradiation has been shown by others to increase survival. Results of preliminary experiments employing this technique indicate that following 1,500 r total body exposure synthesis of DNA in unshielded portions of the intestine recovers faster than does the synthesis of DNA in the intestine of animals similarly exposed without shielding.

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Relative Biological Effectiveness

Further experiments were performed to establish phosphate leakage as an indicator of radiation damage for RBE studies. Potassium in the suspending medium did not effect phosphate leakage unless glucose was also present. With both glucose and potassium, phosphate leakage from irradiated cells was twice as great as in non-irradiated control cultures. Glucose and potassium had no effect on phosphate leakage from control cells. These results indicate a metabolic relationship in phosphate loss.

A second experiment comparing effects on viability and mutation resulting from metabolized high specific activity P^{32} verified the previous finding of a more rapid loss of viability from metabolized P^{32} as compared with radiation applied from outside the cell. Data on mutation were inconclusive.

HA Kornberg
Manager
BIOLOGY OPERATION

HA Kornberg:es

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C. On-Site Visits and HLO Visitors

Name	Dates of Visit	Company or Organization Represented and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
VISITORS TO HAPO						
25 students	3/13/58	Kiona-Benton City Agricultural class	Tour facilities	RF Foster WJ Clarke	No	146-FR, 141-M, 100F
JA Morbacher and George Morby	3/26/58	Lockheed Aircraft, Georgia	Tour facilities	RF Foster JJ Davis WJ Clarke	No	146-FR, 141-M, 100F
L. K. Bustad	3/26/58	Univ. of Washington	Discuss current research at Animal Farm	HA Kornberg and staff	No	141-M, 108-F 100-F
A. J. Martinis, L. M. Nyhus R. E. DeVito	3/27/58	Univ. of Washington Medical School, Seattle	Tour facilities and discuss research.	HA Kornberg and staff	No	146-FR, 141-M 108-F, 100-F
L. F. Maranville, G. R. Quimby J. E. Jeffery	3/31/58	Rayonier, Inc., Olympic Research Division, Shelton, Washington	Tour facilities	DE Warner RF Foster WJ Clarke	No	108-F, 146-FR 141-M, 100-F
VISITS TO OTHER INSTALLATIONS						
W. J. Bair and H. A. Kornberg	3/18-22/58	Stanford Research Institute, Menlo Park, Calif.	Attend meeting of Sub-Committee on Inhalation Hazards for NAS	Other members of Sub-Committee	No	-
D. G. Watson	3/27-29/58	Harrison Hot Springs, B.C., Canada	Attend meeting of Pacific Fishery Biologists	-	No	-

D. Lectures

a. Papers presented at meetings

None

b. Seminars

March 12, 1958 - Dr. Eugene P.Odum, "The Trend in Radioecology".

E. Publications

Bair, W. J., L. A. Temple, D. H. Willard, J. L. Terry and A. Graybeal, "Deposition and retention of Ru^{106} following administration of $Ru^{106}O_2$ to mice by inhalation and intratracheal injection," Document HW-52285 (UNCLASSIFIED).

(Internal Distribution)

Olson, P. A. and R.F. Foster, "Effect of Separan on Rainbow Trout," Document HW-55292 (UNCLASSIFIED) March 11, 1958.

Foster, R. F., "The Effect on Fish of Increasing the Temperature of the Columbia River," Document HW-54858 (SECRET) March 14, 1958.

The following papers were prepared and submitted for publication in the Proceedings of the International Conference on the Peaceful Uses of Atomic Energy (Conference to be held in Geneva, Switzerland, September 1958):

Davis, J.J., R. W. Perkins, R. F. Palmer, W. C. Hanson and J. F. Cline, "Radioactive Materials in Aquatic and Terrestrial Organisms Exposed to Reactor Effluent Water".

Pendleton, R.C. and W.C. Hanson, "Absorption of Cesium-137 by Components of an Aquatic Community".

Thompson, R. C., W. J. Bair, S. Marks, and M. F. Sullivan, "Evaluation of Internal Exposure Hazards for Several Radioisotopes Encountered in Reactor Operations".

Kornberg, H.A., "Radiation Biology as a Supporting Function for Atomic Energy Installations".

Kornberg, H.A., "Radiostrontium-Calcium Relations in Plants and Animals".

Open Literature:

Kawin, B. and R. F. Palmer, "Absorption and Distribution in Rats of Radioactive Phosphorus Biologically Incorporated in Food," Nature 181, 127-128, Jan. 11, 1958.

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RADIATION PROTECTION OPERATION MONTHLY REPORT-MARCH, 1958

A. ORGANIZATION AND PERSONNEL

Organization

Katherine M. Niessner, Secretary, transferred into Radiation Protection Operation March 24, 1958. Carolyn B. Sullivan, Secretary, Radiation Monitoring, transferred to Facilities Engineering March 31, 1958. Luese W. Powers, Secretary, transferred into Radiation Monitoring March 24, 1958. K. R. Holtzinger terminated March 28, 1958. D. E. Rickaby returned from military leave March 24, 1958.

Force Summary	2-28-58	3-31-58
Exempt	42	41
Nonexempt	123	125
Total	165	166

B. ACTIVITIES

Radiation Monitoring

Experiments in Biology involving exposures of animals to Sr^{90} aerosol and the use of significant quantities of Cs^{137} and Y^{91} were accomplished with good control of contamination and personnel exposure. Misinterpretation of a radioactive shipment record permitted uncontrolled shipment of contaminated piping from the 224-U Building, 200-W, to the 321 Building. Some uranium contamination was spread enroute. A special study was started in the 200-W process laundry to determine the degree of contamination spread, if any, from washing nonregulated items in a regulated washer. The normal release surveys were made for excess materials available for public sale. Routine surveys of Relations & Utilities facilities revealed no contamination.

An over-all Civil Defense budget review and forecast for Technical Defense was made and submitted to AEC-HOO. This budget reflected the needs of the Biology, Chemical, and Radiological Defense Sections. An information meeting on Technical Defense was held. Twenty-three attending members of the Technical Defense staff and AEC representatives reviewed progress and plans.

A detailed report of Radiation Monitoring is contained in HW-55537.

Regional Monitoring

The average weekly emission of I^{131} from separations stacks was 27 curies. This represented a 2.5-fold increase over the working limit of 10 curies/week. This excessive emission in March caused the average weekly emission rate for the last year to increase from 7.0 curies for the 12-month period ending in February to 8.4 curies for the 12-month period ending in March. The increased emission in March was the result of several events including decreased aging time and difficulty with iodine removal equipment. The average I^{131} deposition on vegetation outside of the plant perimeter was below the Hanford limit of 1×10^{-5} μc/gm. Vegetation on the project was as high as five times this concentration.

OPERATIONS RESEARCH AND SYNTHESIS OPERATION
MONTHLY REPORT

March, 1958

ORGANIZATION AND PERSONNEL

Mr. P. M. Thompson resigned effective March 4, 1958 to accept another position.

OPERATIONS RESEARCH ACTIVITY

Economic Studies

Following the General Manager's meeting of March 12, it was agreed that a task force would be formed to develop long-range programs for the evaluation of capital expenditures. The first meeting of this task force will be held early in April.

The investigation of the nature and scope of a simulation model of Hanford was culminated with a visit by Dr. Martin Shubik of the OR & S Consulting Service. Data collection and detailed planning for the study continued throughout the month. In anticipation of requirements of the model, some work on the development of new theory has been started.

CPD Control Study

The tabulation of accountability matrices was completed for the period July to December, 1957. The detailed matrix for the 234-5 Building is being maintained to date by SS Accountability. Although these matrices were developed primarily as analytical and investigative tools, they may have value in themselves for use by other groups.

Estimates of the imprecision in receipts, removals and inventory of plutonium in the Redox plant was made for the period July - December, 1957. This detailed synthesis of the BPID variance was supplemented by an analysis of the variation in monthly BPID's in Redox and Purex plants in calendar years 1956 and 1957. The primary purpose of this work is to gain a better understanding of the effectiveness of the BPID as a control and accounting tool.

Other

In connection with the investigation of the problem of operator coverage at electrical substations in the outer areas, considerable effort was directed toward obtaining a value for lost production in the event of inadequate electrical power supply to the reactors. Work to date indicates that obtaining a realistic value may require a detailed study. Alternative approaches are being examined.

Consultations in the area covered by the Operation Pool report were held with two different groups during the month. In addition, a memorandum commenting on an AEC document in this area was prepared.

STATISTICAL AND MATHEMATICAL ACTIVITY IN SUPPORT OF THE RESEARCH PROGRAM

2000 Program - Metallurgy

Further discussions were held with the Coating and Corrosion Operation concerning the derivation of a new mathematical model to predict uniform corrosion of aluminum alloys in an in-reactor production climate. Assistance was also given in developing an iterative scheme, suitable for a digital computer, for the solution of a three-dimensional set of non-linear equations expressing equilibrium conditions between vapor and fluid states in an organic coolant system.

A method of treating data from experiments to determine the diffusion of uranium through aluminum-silicon eutectic alloys was suggested to the Physical Metallurgy Operation. In addition, methods for simplifying and numerically tabulating three definite integrals, each involving a parameter and hence defining transcendental function were developed. These integrals arise in the theoretical interpretation of the intensity of X-radiation after its defraction by irradiation damaged metallic crystals.

2000 Program - Separations

A statistical design was constructed for the Heavy Element Chemistry Operation which permits the simultaneous investigation of five pertinent variables affecting particle size control in a fluidized bed denitration unit.

In connection with a heat transfer problem pertaining to an evaporative concentrator being developed by the Process Equipment Development Operation, the appropriate partial differential equation boundary value problem was formulated and the solution obtained.

4000 Program - PRP

Assistance was given the Ceramic Fuels Development Operation in designing an experimental program for investigating the properties of irradiated swaged capsules as a function of the type of uranium oxide powder, swaging conditions, residual atmosphere, and certain reactor variables.

Mathematical assistance on the theoretical deductions that can be made about the rate of growth of a function from a knowledge of properties of its Fourier transform was given to a member of the Advanced Engineering Operation.

[redacted]

6000 Program - Biology

Work was continued on the generalized migration model of the transfer of radioactive particles from region to region within a biological system. Attempts are currently being made to discover ways of estimating the parameter which occurs in the model.

Data from miscellaneous fish tests completed by the Aquatic Biology Operation and from a recent Pharmocology Operation experiment on the inhalation turnover of Ru and Pu in mice were analyzed.

STATISTICAL AND MATHEMATICAL ACTIVITY FOR THE PRODUCT DEPARTMENTS

Process Control - Fuels Preparation Department

Discussions with interested Quality Control personnel on the effect of various canning line variables on reject rates were continued. This investigation is designed to assist process operators to determine what corrective action is needed when out-of-control situations occur.

A proposal for conducting a process capability study on certain quality characteristics of fuel elements was submitted to Quality Control personnel. Suggestions were also tendered for developing an automatic quality control system which will provide necessary information rapidly enough to enable the immediate correction of situations causing an excessive number of rejects.

Tolerance statements on the proportion of fuel elements rejected by the penetration tester which had residual can wall thicknesses greater than a given value were prepared from data on a sample which had been caustically stripped.

General - Fuels Preparation Department

Statistical evaluations were made of (1) an experiment conducted to study improvement in yields resulting from the removal of carbonaceous material from the canning baths, (2) an experiment designed to compare the reactivities of normal uranium fuel elements with various histories and geometries, and (3) minor injury data from 1957.

Production Tests - Fuels Prep. Dept. and Irrad. Proc. Dept.

Data from the first 15-tube discharge under production test IP-19A were analyzed to estimate the warp and diameter growth experienced by I and E fuel elements. Exposure effects appeared to be strongly confounded with date of discharge.

Data from production test 105-601-53MT were analyzed to determine the effects of slug heat treatments involving different delay times prior to quenching on the dimensional distortion of fuel elements. The original design and the subsequent analysis were not as effective as they might have been due to the fact that almost one-third of the observations were missing.

Rupture Studies - Fuels Prep. Dept. and Irrad. Proc. Dept.

Rupture data from 1956 and 1957 were submitted in order to obtain an objective estimate of the best curve relating rupture rate to exposure and power. It was emphasized that the resulting graphs were only descriptive in nature since the variables involved had been averaged over all other conditions in each instance.

A statistical analysis of rupture data for calendar years 1956 and 1957 has demonstrated that both tube power and outlet water temperature affect side rupture rates. An appropriate mathematical model of this phenomenon has been constructed and will be contained in a complete report on the present rupture situation being prepared by IPD personnel. Comparisons were also made of the rupture experience for fuel elements canned with M-388 components and those canned with 1245 components.

[redacted]

General - Irradiation Processing Department

An operating characteristic curve for a multiple sampling plan for the acceptance or rejection of lots of panellit gages was computed for personnel of the Components Testing Operation.

Estimates were made of the wearing rates of brushes for different electric motors and of the motor running times when the brushes would be expected to have a specified length.

The coefficients of a Fourier series expansion were evaluated in terms of modified Bessel functions.

Final Product Specifications - Chemical Proc. Dept.

A method of programming the calculation of final product specifications for the 702 computer has been tentatively agreed upon. The feasibility of using control limits for Pu content such that deviation from the nominal Pu content of shapes will be instantly noted and appropriate action taken was discussed with Analytical Control Laboratory personnel.

General - Chemical Processing Department

Statistical consultation and analysis included (1) work on the calibration of the C-2 tank and (2) comparison of alpha-Simpson proportional with alpha-scintillation counters, (3) the derivation of the least squares fit for estimating the constants in a transcendental equation, and (4) methods of fitting a linear regression model to production vs. cost data.

OTHER STATISTICAL AND MATHEMATICAL ACTIVITIES

Activities for other Operations

Statistical consultation with the task force concerned with the evaluation of conversion ratios for Pu was continued. Activity at this time is primarily concerned with the design of the experimentation to be performed, and in particular with the statistical effectiveness of the proposed work as opposed to its cost.

Activities within HLO

A mathematical model for the prediction of the deposition of radioactive materials from Hanford sources on the Wahluke Slope was constructed for the Radiation Protection Operation. Other work for the Radiation Protection Operation included (1) analysis of the properties of different brands of monitoring film as a function of developer time, depth in developer, and developer temperature, (2) further discussions on the problem of scheduling bioassay samplings, and (3) an evaluation of data from an experiment to measure the leakage characteristics of pencil dosimeters.

[redacted]

Work for the Chemical Effluents Operation included preliminary discussions of the current method of calculating Purex A-8 crib capacity, and mathematical assistance on the interpretation and use of several higher transcendental functions and the evaluations of two improper definite integrals.

Statistical consultation was provided to the Technical Information Operation in regard to an evaluation of error rates in the key punch operation.

OFFSITE VISITS AND VISITORS

Julius F. Hudson of the Union Carbide Nuclear Corporation, Oak Ridge, Tennessee, visited on March 4 for discussions associated with Operation Pool.

W. H. Bloodworth and Martin Shubik of the OR & S Consulting Service, Management Consultation Services visited on March 11 to 14 for discussions of proposed work on an input-output simulation response model.

M. N. Hudson of the Division of Nuclear Materials Management, AEC, Washington, D.C. visited on March 13 for discussions relating to Operation Pool.

Leon Chajson of Westinghouse Atomic Power Division, Pittsburgh, Pennsylvania consulted with members of the OR & SO on March 28 and again on April 1 relative to activity connected with Operation Pool.

At the request of Communications and Personnel Development Operation, L. G. Waters presented a paper on the "Application of Statistical Techniques at HAPO" to the Oregon Council of Teachers of Mathematics at Portland, Oregon on March 20.

Carl A. Bennett

Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

CAB:jbk

The fallout of nuclear materials from foreign bomb tests caused contamination levels on vegetation to be 2 to 25 times higher than normal.

Analyses of Columbia River water at 100-F and Pasco showed 4.8% and 1.8%, respectively, of the continuous occupational MPC_{GI}. Sanitary water samples at 100-F, Pasco, and Kennewick indicated 0.7%, 0.4%, and 0.7%, respectively, of the same maximum permissible concentration.

Work was started in preparation of the Hanford contribution to the Public Hearings on Radioactive Waste Disposal to be held April 28-May 6, 1958.

A detailed report of waste disposal monitoring is contained in HW-55550.

Exposure Evaluation and Records

One case of minor plutonium deposition apparently not exceeding one per cent of the MPL was confirmed bringing the total of confirmed plutonium cases to date to 219.

Another more serious case of plutonium contamination occurred when skin contamination on the thumb of an employee in the 234-5 Building was associated with an injury so minor that it could not be recognized as such by medical personnel. Surface surveys indicated that all skin contamination had been removed. A subsequent examination three days later revealed a tiny black speck at the sight of the previous skin contamination. The black speck was removed and shown to contain about 5000 d/m Pu. Further checking with the shielded monitoring facility survey equipment indicated that ~120 per cent (.05 μc) of MPL still remained in the thumb. Local excision removed essentially all of the plutonium.

A local overexposure to the skin occurred to an employee in the Redox plant when his coveralls became contaminated. The total dose to the skin was estimated to be 1.80 rads including 0.63 r.

The annual review and updating of bioassay schedules was completed. This critical review including direct contact with CEO and R & U managers will probably result in reduced sampling of employees who have essentially no potential for exposure.

Ground was broken on March 11 for construction of the shielded monitoring facility adjacent to the bioassay laboratory in the 700 Area. Rough plumbing, foundation walls, and installation of service lines to the building were completed. The preliminary phase of electronic data processing of bioassay records was initiated. This system is currently in parallel with the manual record system which it will eventually replace.

Radiological Development

The fabrication of the prototype badge reloading machine was completed and the machine placed into experimental use for the shakedown tests. The evaluation of Eastman Type II personnel meter film was completed with valuable results. The study indicates operational advantages over the film in current use. The primary advantages include a lower detection limit, improved accuracy and dose measurements, and the convenience of processing one piece of film rather than the present

two pieces of film to provide high and low dose ranges. Parallel field testing of this new film with the current film is planned for about a three-month period.

A study of alternate techniques was started for the measurement of thermal neutrons. If successful, this study will result in a neutron badge containing NTA film for fast neutrons and a cadmium shielded beta-gamma film to measure the thermal neutron dose.

Work on the low-level pencil reading device and techniques continued. Leakage tests were conducted on pencils at various potentials. Leakage equivalent to about 1.2 μr/hr at 20 volts was determined. Plans were made to provide a pencil reading device and suitable pencils for field testing and application of this technique to low-level environmental measurements.

Calculations were completed for the estimated dose rate, at the element and through 10-1/2 inches of cast iron, for 5, 10, and 50 per cent burnup of plutonium-aluminum alloy for various decay times. Other calculations were also made for the evaluation of potential air hazard associated with this material.

Calibrations

One of the Ra-Be sources was returned after being calibrated at the National Bureau of Standards. The NBS calibration results should be available in April. Our supply and control of radium was checked by the HLO auditor. Everything was found to be in good order. Progress was made toward obtaining the new PuF_4 neutron source. The construction of the source container and storage cask was essentially completed. Procedures are being prepared to ensure adequate control of this neutron source.

Drawings and specifications of a number of Hanford portable instruments were forwarded to Technical Information Service, Oak Ridge and to APED.

Radiological Consultation

Comments were forwarded to Dr. L. S. Taylor, Chairman of the NCRP, on Communication Number 48. Comments were also forwarded to the Secretary of the NCRP on the final draft of the addendum to the National Bureau of Standards Handbook Number 54. Explanation for interpreting urinary excretion rates for plutonium and uranium was forwarded to the Radiological Health Officer, U. S. Naval Radiological Defense Laboratory.

In reply to a query from the AEC-HOO probabilities and warning time data associated with the radiological status of the Wahluke Slope were calculated and submitted.

J. W. Healy served as a member of the Atoms for Peace mission in New Zealand from March 24 through April 3, 1958.

Radiological Standards

A review was made of some of the considerations involved in limiting external radiation to individuals who have a body deposition of plutonium. The study is still in progress.

A discussion of release limits of I^{131} from the separations stacks was forwarded to the Chemical Processing Department. It was indicated that there were no reasons which appear to justify modification of the current working limit of 10 curies I^{131} per week from separations stacks.

Significant Reports

Four manuscripts and one abstract were completed for publication in the proceedings of the Geneva Conference of 1958. These included:

"A Sensitive Analytical Method for the Determination of Plutonium in Humans"

"Radiation Exposure to People in the Environs of a Major Atomic Energy Plant"

"Wind Pickup of Radioactive Particles from the Ground"

"Radiation Protection Records at a Major Atomic Energy Facility"

"Measurement of Body Deposition of Plutonium" (Abstract)

Safety and Security

There were three medical treatment injuries for a frequency of 1.12. No security violations occurred during the month.

Suggestions

Three suggestions were submitted by RPO personnel. Three suggestions were also received in RPO for evaluation. Two evaluations were completed leaving a backlog of four suggestions yet to be evaluated. No suggestion awards were made to RPO personnel in March.

Relations

Negotiations with the regional monitors continued without noticeable progress. The Company's most recent offer in these negotiations included the combination of the Radiation Monitoring and the Regional Monitoring classifications into one classification and maintenance of dual senority lists for ROF purposes only for a six-month period starting with the execution of the agreement. No reply had been received from the HAMTC at month end.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings
J.A. Mohrbacker G.M. Morby	3/27 - 28/58	Lockheed Aircraft Corp., Georgia Div., Marietta, Georgia	Inspect facility Discuss environmental monitoring	KR Holtzinger RW Meisinger LL Crawford RH Wilson BV Andersen JM Selby	NO	329, 3706 3745:300
Dr. A.R. Gopal-Iyengar	3/7/58	Indian Department of Atomic Energy	Discuss waste disposal	JW Healy	NO	108-F: 100-F

VISITS TO OTHER INSTALLATIONS

J.W. Healy	3/12/58	Lumberman Mutual Casualty Co., Chicago, Illinois	Present paper to Nuclear Energy Training Course	HT Halworth and others	NO
R.L. Junkins	3/12 - 13/58	Eberline Inst. Corp. Santa Fe, New Mexico	To attend symposium on film badge dosimetry	FS Smith, Jr.	NO
J.W. Healy	3/13 - 14/58	Division of International Affairs, AEC	Attend briefing for Atoms for Peace mission	RL Kirk	YES
L.J. Defferding	3/19 - 20/58	Hot Lab Conference Chicago, Illinois	To attend conference		NO
L.J. Defferding	3/21/58	Argonne Nat'l. Lab. Lemont, Illinois	To discuss radiation hazards in conjunction with examining irradiated Pu fuel elements	Pete Tedeschi JR Novack	YES
J.W. Vanderbeek	3/24 - 27/58	President's Conference on Occupational Safety	Attendance at conference		NO
J.W. Vanderbeek	3/28/58	General Electric Co., New York, New York	Discuss proposed study	JN Dupuy	NO
J.W. Healy	3/24/58 - 4/3/58	New Zealand Gov't.	Participate in Atoms for Peace mission	RL Kirk Carol Zabel Arthur Rupp	YES

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REGIONAL MONITORING

The general findings are summarized in the following:

Sample Type and Location	Activity Type	Average Activity Density µc/cc	Trend* Factor
Drinking Water and Related Materials			
Benton City Water Co. Well	alpha	1.0×10^{-8}	--
100 Areas	beta	$(0.1 \text{ to } 8.6) \times 10^{-6}$	-2
200 Areas	beta	$(0.8 \text{ to } 2.5) \times 10^{-6}$	-2
Pasco, Kennewick, McNary Dam	beta	$(0.1 \text{ to } 2.7) \times 10^{-6}$	--
Backwash Solids - Pasco Filter Plant	beta	0.15 µc/gm	-3
Backwash Liquids - Pasco Filter Plant	beta	3.1×10^{-6}	--
Anthracite, Sand Filter - Pasco Filter Plant	beta	2.7×10^{-4}	-5
Other Waters and Related Materials			
200 West Wells	beta	$< 2 \times 10^{-7}$ to 2.5×10^{-3}	--
200 East Wells	beta	$< 2 \times 10^{-7}$ to 3.9×10^{-2}	--
Wells Near 200 Areas	beta	$< 2 \times 10^{-7}$ to 2.1×10^{-6}	--
Outlying Wells	beta	$(< 2.0 \text{ to } 4.2) \times 10^{-7}$	-2
Columbia River - Hanford Ferry	beta	4.4×10^{-5}	--
Columbia River - Below Reactors	beta	3.8×10^{-5}	--
Columbia River - Paterson to McNary	beta	1.2×10^{-6}	--
Columbia River - Mud	beta	$(0.2 \text{ to } 1.9) \times 10^{-4}$	-2
Raw Water - Operating Areas	beta	$(0.005 \text{ to } 3.0) \times 10^{-5}$	--
Reactor Effluent Retention Basins to River	beta	20,000 to 39,000 µc/sec/reactor	--
		$(3.6 \text{ to } 7.8) \times 10^{-3}$	--
Reactor Effluent Retention Basins to River	alpha	< 0.04 µc/sec/reactor	--
		$< 5 \times 10^{-9}$	--
I-131 in Farm Wastes to River	I-131	1.4×10^{-7}	--
I-131 in Columbia River - Hanford	I-131	9.0×10^{-8}	--

* The trend factor shows the n-fold increase (+) or decrease (-) from last month, where the values of n less than 2 will not be noted.

Sample Type and Location	Activity Type	Average Activity Density μc/cc	Trend* Factor
Atmospheric Pollution			
Gross Alpha Emitters	alpha	$(0.8 \text{ to } 5.8) \times 10^{-15}$	+2
Gross Dose Rate - Separations Areas	beta-gamma	0.6 to 5.7 mrad/day	+3
Gross Dose Rate - Residential Areas	beta-gamma	0.4 to 2.8 mrad/day	+2
Active Particles - Separations Areas	beta	$(2.9 \text{ to } 8.1) \times 10^{-13}$	+2
I-131 Separations Areas	I-131	$(0.2 \text{ to } 3.4) \times 10^{-12}$	+9
I-131 Separations Stacks	I-131	3.8 curies/day	+2
Ruthenium - Separations Stacks	Ru-103-106	0.01 curie/day	--
Active Particles - Wash., Idaho, Ore., Mont.	--	0.002 to 0.021 ptle/m^3	-2
Active Particles - Project	--	0.002 to 0.018 ptle/m^3	-5
Vegetation			
Environs of Separations Areas	I-131	1.0×10^{-5} μc/gm	--
Residential Areas	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	5.6×10^{-5} μc/gm	--
Alpha Emitters - Separations Areas	alpha	$(0.2 \text{ to } 1.1) \times 10^{-6}$ μc/gm	--

* The trend factor shows the n-fold increase (+) or decrease (-) from last month, where the values of n less than 2 will not be noted.

[redacted]

RADIATION MONITORING	Hanford Laboratories	Minor & Major Construction	Others	March	Year to Date
Special Work Permits	1373	2	440	1815	5927
Routine and Special Surveys	1351	29	117	1497	4524
Air Samples	2219	0	188	2407	6859
Skin Contamination	8	0	1	9	13
*Class II Radiation Incidents	0	0	0	0	0
**Class II Radiation Incidents	0	0	0	0	4

EXPOSURE EVALUATION AND RECORDS

Gamma Pencils	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
March	38,694	36	7	3
1958 to Date	150,252	118	21	11

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)
March	20,296	667	24	4	50	3.12	9.10
1958 to Date	65,830	2,594	84	28	133	3.29	9.69

Slow Neutron Pencils

	Pencils Processed	Paired Readings 4-12 mrem	Paired Readings Over 12 mrem	Lost Readings
March	3,462	49	31	3
1958 to Date	12,162	139	44	6

Fast Neutron Film Badges

	Badges Processed	Readings Above 50 mrem	Lost Readings
March	1,080	0	1
1958 to Date	3,691	8	4

Bioassay	March	1958 to Date
Plutonium: Samples Assayed	1,306	3,957
Results above 2.2×10^{-8} µc/sample	20	124
Fission Product: Samples Assayed	1,382	4,131
Results above 3.1×10^{-5} µc FP/sample	3	9
Uranium: Samples Assayed	301	974

*HLO Radiation Monitoring Customers
**Other Plant Components

[redacted]

Uranium Analyses	Following Exposure Units of 10^{-9} µc U/cc			Following Period of No Exposure Units of 10^{-9} µc U/cc		
Sample Description	Maximum	Average	Number Samples	Maximum	Average	Number Samples
Fuels Preparation	10.9	6.78	20	8.68	4.10	18
Hanford Laboratories	35.4	9.76	20	17.2	5.22	19
Chemical Processing	45.3	6.37	73	29.1	4.54	75
Chemical Processing*	74.1	8.61	33	53.7	10.3	16
Special Incidents	1.76	1.22	4	-	-	-
Random	2.64	1.22	23	-	-	-

*Samples taken prior to and after a specific job during work week.

Tritium Analyses	March	1958 to Date
Samples Assayed	0	0
Thyroid Checks		
Checks Taken	0	5
Checks Indicating .01 µc	0	0
Hand Checks		
Checks Taken - Alpha	47,413	141,352
- Beta-Gamma	37,151	116,436

CALIBRATIONS

Portable Instruments	Number of Units Calibrated March	1958 to Date
CP Meter	873	2,812
Juno	297	938
GM	1,168	3,813
Other	213	641
Total	2,551	8,204
Personnel Meters		
Badge Film	1,164	3,384
Pencils	8,355	11,587
Other	281	971
Total	9,800	15,942
Miscellaneous Special Services	1,625	3,612
Total Number of Calibrations	13,976	27,758

A. R. Keene, Manager
RADIATION PROTECTION

[redacted]

ARK:kc

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LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - MARCH, 1958

GENERAL

Safety performance of the Operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 2.98 per cent.

The absenteeism rate was 2.68 per cent, which is about average experience and is within expected limits.

There were no security violations charged to the Operation for the eighth consecutive month.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 12,987 hours. The total shop work backlog is 23,457 hours of which 40% is required in the current month, with the remainder distributed over a six month period. Overtime worked during the month was 3.7% (664 hours) of the total available hours.

Distribution of time was as follows:

	Man Hours	% of Total
Fuels Preparation Department	2457	18.9
Irradiation Processing Department	1370	10.6
Chemical Processing Department	1123	8.6
Hanford Laboratories Operation	7842	60.4
Construction Engineering Operation	68	.5
Miscellaneous	127	1.0

Customer demands for service remained firm with the total backlog of work slightly below the previous month. However, demands for emergency service increased substantially resulting in a higher than normal overtime rate.

The Nuclear Science and Engineering Congress held in Chicago was attended by the Manager of the Technical Shops. In conjunction with this trip shop management personnel were contacted at Argonne National Laboratory and the Hotpoint Co. to discuss mutual shop problems. Property management personnel in the General Services Administration, and the Chicago Ordnance District of the U. S. Army were contacted in reference to the procurement of excess machine tools for the Technical Shops.

RADIOGRAPHIC TESTING OPERATION

The activity of the Radiographic Testing Operation shows a steady growth as reflected by the number of tests performed. For the current month a new high was reached in the total number of tests performed. A total of 4,279 tests were made of which 348 were radiographic exposures (including x-ray and gamma-ray) and 3931 were supplementary tests. The supplementary test work included penetrant, ultrasonic (thickness measurements and flaw detection), eddy current, densitometry, and dimensional measurements (micrometric and air gauge). The other indicator of the amount of work accomplished, the feet of material examined, also showed a high for this

onth of 14,528. This footage represented 1,764 pieces examined. Work was done for 13 different organizational components representing all of the operating departments and service operations with the exception of Fuels Preparation Department. A total of 40 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on nine different occasions for advice and information regarding general testing theory and applications for other than the jobs tabulated in Part II.

One of the highlights of the past month's activities was the achievement of density scans of MTR fuel plates. A method has been developed for measuring the density of the core section of radiographs made of the MTR fuel plates. Assuming uniform alloy composition, the density traces represent changes in core thickness and for the first time present the true cross-section of the core by a nondestructive means.

Testing Statistics

Component	No. of Tests	Ft. of Weld or Material	No. of Pieces	Description
A. Chemical Processing Department	6	3	6	Carbon steel weld coupons.
B. Construction Engineering Operation	55	96.5	21	Carbon steel pressure vessels and weld samples.
C. Hanford Laboratories Operation	4162	13,464.5	1498	Zr tubing, UO_2, thorium, and MTR fuel elements. C.S. pressure vessels and aluminum weld samples.
D. Irradiation Processing	20	20	14	C.S. pressure vessel. S.S. valve.
E. Relations & Utilities Operation	36	944	45	S.S. welded pipe and tubing Electrical pole climbers.
Total	4279	14,528	1764	

FACILITIES ENGINEERING OPERATION

Projects

There were 15 authorized projects at month end with total authorized funds of $3,591,000. The total estimated project cost of these authorized projects is $5,016,500. There were no projects completed during the month and no new projects authorized. Five new projects are awaiting AEC authorization; these have a total estimated project cost of $5,698,000. One project proposal was returned by AEC without approval. Proposals for five new projects are in preparation including modification of the one which was returned.

A detailed report of project activity and status is attached.

Engineering Services

Approximately 2.3 man months engineering was devoted to service work. The following list shows active jobs and status:

Title	Status
Breathing Air Installation, 141-FS Building	Job completed.
Preliminary Study - Acid System and Acid Dispenser Hood in the Bioassay Laboratory	Estimate for new hood received. Estimate for structure and installation and request for Work Determination being prepared.
Prepare Analysis and Recommendations to Lessen Sound Level and Improve Ventilation, Keypunch Room 3760 Building	Work Order has been written to extend partition, add a door and rearrange equipment.
Prepare Analysis and Recommendations for Air Filter on Vacuum System, 325 Building	Work progressing.
Install Intercom System, 326 Building	Purchase Order #H8E-888-57982, dated 3-14-58 issued for intercom equipment.
Construct Barn and Pasture 100-F	Completed 3-25-58; accepted 3-27-58.
Alterations to the 3705 Building	Complete except for acceptance.
Provide Engineering Assistance for Seam Welder Installation Basement 325 Building	Supplemental authorization for engineering assistance issued 3-10-58. Seam Welder has been moved into place and is being assembled by C. O.
Repair Damaged 100-KW Water Heater, 189-D Building	Work Order A-57818 has been issued to C. O. for repair of vessel. Scheduled completion date is 4-10-58.
Extend 440 Service Line - Basement 325 Building	Purchase Order #H8C-888-57928, dated 3-11-58 issued for Air Circuit Breaker. Work Order A-57819 issued to C. O. for installation work on sub-panel.
Install a Hot Water Heater in 327 Building	Purchase specification for tank and equipment being prepared.
Clean Up the West End of 314 Building	Investigation work has been started.
Increase Electrical Service and Install Outlets - 141-H Building	Plant Forces Work Review approved 3-13-58. Estimate for installation will be requested of 100-F Maintenance.
Provide Ventilation Exhaust from Room 8-2A 325 Building and Block Off Existing Supply	Plant Force Work Determination approval has been received. Work Order is being issued.
Greenhouse - Roof of 108-F Building	Work progressing.
Development Plan for Biology Facilities from 100-F Limited Area	Work progressing.

Title	Status
Installation of New Hood, Room 14-A, 329 Building	Plant Forces Work Review will be submitted following preliminary scoping.

Design and Drafting Services

Total drawings produced during the month total approximately 210 including revision work.

Approximately 12,700 square feet of Ozalid prints were reproduced for comment, check and work sheet purposes.

The work load in our central drafting room is very heavy even though six employees are "on loan" in our drafting room from other departments. Also, an additional four "on loan" draftsmen are supplying HLO's needs to R&D components in the field.

Major work being produced includes the following:

Cesium Recovery - Engineering Flow diagrams approved 2-27-58. Scope drawings complete. Detail design drawings scheduled to start 3-26-58. Scope drawings 100% complete. Design information 50% complete. Design drawings (50-60) scheduled for completion 7-1-58. Prototype scheduled for operation 12-31-58.

'pectrometer Drive Assembly - design power drive for spectrometer. Drive arm 10° per minute - drive motor table at 5° per minute which is geared to drive a counter at .002° per revolution of main drive shaft. 60% complete.

25° Conversion Analyzer Chamber. This design to modify existing equipment. 100% complete.

Constant Temperature Bath - constant temperature bath for hot tensile specimen. 60% complete.

Removable pH Probe Unit. 100% complete.

Cobalt Source Gamma Absorptometer. This design to provide a means of determining the density of Uranium Oxide rings by exposing the rings to a 1 curie cobalt source.

Vacuum Welding - Design for a small vacuum welding unit - small rotating chuck in a bell jar. Exclusively for welding fuel elements. This design for Development and Fuel Fabrication - 306 Building. This unit will be able to handle all sizes of fuel elements. Attachments for welding of full length process tubes of all diameters.

Temporary Cut-off Facility - This cut-off facility designed for use while "A" cell is down on project #682. The temporary cut-off will be located on the north side of "B" cell. It will operate remotely by an old Hanford Slave manipulator. It is scheduled to be in operation by 4-15-58.

Ionization Chamber for Building 305-B.

Table for Medium Level Cell - 325 Building. Table to be used as a support for 16 Ton Medium Level Cell.

Detector Box - designed for use on spectrometer.

High Temperature Impact Sample Breaker - To provide a means of breaking an irradiated sample after it has been brought up to a high thermal temperature in a vacuum furnace. To be used in "B" cell, 327 Building.

321 "As-Builts" - Outside lines SK-3-7367; 100% complete. Plumbing Drainage Piping Basement Plan, H-3-5609; 100% complete. Plumbing and service piping first floor plan, H-3-5610; 95% complete. Plumbing and drainage first floor plan H-3-5611; 95% complete. Arrangement first floor, H-3-5612 sheet 1, 100% complete. Arrangement, H-3-5612 sheet 2, 60% complete. Additional vent. piping and drainage, H-3-4228, 50% complete. Electrical drawings 5% complete. Proposed 300 Area plot plan, H-3-7306, 100% complete as of 3-12-58.

Engineering Survey of Liquid Helium requirements for HLO and HAPO is currently in the data gathering stage.

Maintenance and Building Engineering Services

Interior painting of the 108-F Building was started on 3-21-58. Estimated completion date is 4-4-58. A work order has been issued to paint the change room - locker room in the 141-M Building.

Interior and exterior painting of all 622 Buildings was completed on 3-19-58.

Interior painting of the hallway, 222-U Building was completed on 3-14-58.

A physical inspection of the Finished Products Development Laboratory, 231-Z Building, was made. An analysis is being made of the feasibility of assuming landlord functions.

A survey of office furniture and equipment in all HLO buildings was commenced for inventory and utilization purposes.

Completion of propane tank installation has been delayed because of faulty pressure regulators. Service has been maintained using one of the old regulators.

Modification of 3707-C is progressing on schedule using minor construction forces.

Revised building procedures for 329 Building are being circulated for signature approvals.

Cards for each building occupied by HLO showing space occupancy by level three HLO components were prepared.

Survey and Inspection of Pressure Vessels is 78% complete.

Wall Thickness Measurements of HLO Pressure Vessels is 50% complete.

TECHNICAL INFORMATION OPERATION

A number of matters related to the always troublesome problem of releasing reports for offsite use arose during the month. A memorandum was sent to all Level 3 Managers reviewing some of the Commission's general policies on release of reports, particularly reports on environs contamination.

The newly appointed Liaison Officer for Hanford, Mr. Bram Feldman of the Division of Classification, Washington, visited Hanford to become acquainted with the Hanford activities and hold discussions with HAPO personnel on the proposed Hanford Classification Guide. The discussions were chiefly concerned with the basic classification policies and procedures, and hence quite general.

On March 28, Mr. Feldman met with the HOO Classification Committee. He reviewed the results of his visit, and reiterated the points made in local discussions. He agreed to review the proposed Guide within two or three weeks and to indicate promptly those topics which are acceptable to the Division of Classification. Others will require further justification. The changes recommended for HAPO to the Supplement to OC-DOC-44 and to OC-DOC-47 and OC-DOC-48 are unlikely to be made. According to Mr. Feldman, it is not necessary that they be made before the new Guide can be accepted.

The Technical Information Procedures Specialist and the Supervisor of Acquisitions and Cataloging are investigating the possibility of converting the library's subscription records to an IBM control system.

The library's file of vendors' catalogs will be transferred on April 21, unless a request not to do so is received from the Level 2 Managers informed of the decision. The file will be incorporated into CEO's vendor catalog file in the 760 Building.

The second month's updating of the HAPO accountability tape took place on schedule. Two minor difficulties arose which are being studied: (1) the input tally was 13 less than last month's output tally, and (2) one document was out of sequence. Of the 16,541 document accountability changes submitted, 113 were rejected. Most of these dealt with classification changes and the reason for the "bounces" has been determined. Total accountable documents on the tape for the month was 212,207.

Three items of office equipment were ordered during the month:

1. A metal cabinet with sliding glass doors to store the Issue books.

2. A Diebold elevator file, electrically operated. This will hold the file record cards. It will greatly improve efficiency by (a) centralizing the record posting operation and providing a streamlined piece of equipment for this purpose, and (b) improving control over the withdrawal and return of file record cards.

3. A new addressograph to replace one that is ten years old, badly worn and not well adapted to the job.

Work Volume Statistics

Library -	February	March
Titles Added	88	152
Volumes Added	297	291
Books Circulated	2,168	1,630
Periodicals Circulated	3,345	4,393
Reference Questions	229	208

		February	March
Classified Files -			
	Documents routed and discharged	18,644	16,868
	Documents issued	13,276	8,431
	Documents sent offsite	4,529	6,224
	Documents filed	7,945	8,653
Report Reference and Publication -			
	Abstracts	206	168
	Literature Searches	26	29
	Formal Reports issued	12	7
	Reports released to CAP	27	37

LABORATORIES ADMINISTRATION AND TECHNICAL LIAISON

One new Organization and Policy Guide No. 04.9, Work Review Determination and Work Assignment, was issued. Timely revisions were issued on specific sections of seven existing guides including No. 04.6, Authorization and Performance of Work, and No. 02.3.1, Approval Authorizations.

Two letters of delegation of authority for work authorization were issued as well as specific delegations covered by OPG No. 02.3.1, Approval Authorizations.

An extension of Consultant Agreement No. CA-159 with Dr. M. E. Ensminger was requested.

An Assistance-to-Hanford authorization, No. ATH-HLO-1-58-C, was issued to General Engineering Laboratory assigning $1500 for a bearing analysis study.

Manager
LABORATORY AUXILIARIES

JL Boyd:jcw

UNCLASSIFIED

MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-55590
March, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	Directive Comp. Date Design / Const.	Estimated COMP. DATE DESIGN / CONST.
General AEC-2-23X-56-L-2	Plant Projects - FY 1956	Reactor & Fuels	$ 135,000	$ 140,000* / 4-4-57	100 / 100	95 / 97	5-23-56 / 12-7-56	- - - / 5-1-58	9-28-56 / 5-1-58
CG-664	350° Flow Loop - 314 Building								
	Engineer: R. W. Dascenzo								

REMARKS: The pump installation, pressure testing of the loop at White Bluffs, and delivery of the loop to the 314 Building were completed satisfactorily. The installation of the loop and instrument panel have been initiated. Electrical and instrumentation installation is complete. Preliminary tests of instrumentation have been made.

*Includes $350 transferred equipment

General AEC-23-57-N-2	Plant Projects - FY 1957	Radiation Protection	$ 140,000	$ 150,000 / 2-4-57	100 / 100	N.S. / 5	2-18-57 / 3-11-58	- - - / 12-31-58	12-19-57* / 10-31-58
CG-658	Shielded Personnel Monitoring Station - 747 Building								
	Engineer: D. S. Jackson								

REMARKS: Notice to proceed was issued to the contractor, Lewis Hopkins Company, Pasco, Washington on March 5, 1958. The contractor has placed an order for the 3 inch steel plate with the Bethelem Steel Company, Sparrow Point, Maryland plant. Plate is scheduled for delivery to the job site by 9-15-58. The Roberts Machine Company of Boise, Idaho is rough cutting the 7¼ inch steel plate, and the Todd Machine Company of Seattle, Washington, will fabricate all plate ready for assembly at the job site. The contractor completed excavating and and forming for the footings and foundation walls of the building addition. He expects to pour concrete on April 1, 1958. Excavation for utilities has started. A revised Work Authority increased the General Electric Company funds from $6,000 to $9,000 for management services and technical assistance during fabrication and erection of the monitoring cell and for project unitization. *Actual Date.

CG-680	Corrosion Testing Facility - 314 Building	Reactor & Fuels	$ 111,765	$ 135,000 / 5-2-57	100 / 100	100 / 100	10-3-56 / 5-2-57	- - - / 3-15-58	1-24-57* / 2-28-58*
	Engineer: R. W. Dascenzo								

REMARKS: A Physical Completion Notice was issued on March 10, 1958 indicating Using Operation Acceptance on February 28, 1958 and an underrun of $23,235. This project will no longer be carried in this report.

*Actual Dates.

CA-700	Geological and Hydrological Wells - FY 1957	Chemical Research	$ 128,000	$ 122,000 / 6-27-57	100 / 100	100 / 100	11-8-56* / 10-24-56*	- - - / 2-1-58	1-15-57* / 1-31-58*

REMARKS: All work has been completed on this project. The Physical Completion Notice for the General Electric Company portion was prepared March 31, 1958. This project will no longer be carried in this report.

*Actual Dates.

MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	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 / Constr.	Estimated COMP. DATE DESIGN / CONST.
CG-729	Ventilation System Improvements - 222-U Building Engineer: A. W. Hervin	Chemical Research	$ 77,500	$ 73,000 3-12-57	100 100	98 98	4-23-57 9-15-57	6-12-57* 9-15-58	5-28-57** 5-1-58
CG-733	Plutonium Metallurgy Facility Engineer: J. T. Lloyd	Reactor & Fuels	$ 295,000	$ 295,000 5-10-57	100 100	92 98	5-14-57 6-10-57	9-25-57* 6-15-58	10-1-57** 5-1-58
General Plant Projects - FY 1958 AEC-2-23-58-L CG-760	Expansion of the 3745-B Facility Engineer: R. C. Ingersoll	Physics & Instr.	$ 193,000	None to Date None	To be est 0	To be est 0	1* 9*	To be est To be est	6* 16*
CA-765	Additions to the 314 Building Engineer: A. W. Hervin	Reactor & Fuels	$ 46,000	$ 46,000* 11-15-57	100 100	To be est 0	10-14-57 4-20-58	- - - 11-15-58	3-7-58 11-15-58

REMARKS: The fixed price contractor completed his portion of the work on February 28, 1958. A meeting with the contractor was held on March 13, 1958 to discuss the contractor's four claims for extras which amounted to over $2,000. Three of the claims were considered valid and an equitable adjustment of $1,045 is being made. The other claim was rejected. A Work Release has been issued to the CPFF Construction Contractor to do necessary additional work. Work has been started on the removal of the obsolete exhaust fans and supply ductwork. The balancing of the ventilation system and their controls will be done by plant forces when the new grills for the ventilation system have been received and the obsolete ductwork has been removed. It is anticipated that this work will be completed during April or the first part of May.

*Scheduled Date. **Actual Date.

REMARKS: The following items remain to be completed by C.O. - 1) 2 removable doors cannot be replaced until hoods are brought through the openings; 2) Room 38 is now available so plastering will be done; 3) Operations has requested that the small hood now considered unnecessary in Cell I be removed along with it's piping and exhaust duct. Additional work of changing ventilation in rooms 16 and 17 will be done if funds permit. As Built work has been started. *Scheduled **Actual Dates.

REMARKS: The project proposal was resubmitted to the AEC-HOO on March 13, 1958.

*Months after authorization.

REMARKS: The special conditions for the construction contract have been forwarded to the Commission. It is anticipated that invitations to the prospective bidders will be issued the first part of April. The Commission has issued a work order to the CPFF Construction Contractor to remove the existing machinery platform and barricade the underground concrete duct, both of which are contaminated. It is felt that by doing this the contractor will not need to perform work under SWP conditions.

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-55590
March, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT: CONST. SCHED / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	Directive Comp. Date: Design / Constr.	Estimated COMP. DATE: DESIGN / CONST.

REMARKS: (CA-765 Cont.) This will eliminate a costly item and a job problem when the Fixed Price Contractor's work starts.
*$6,140 is the General Electric Company portion of total authorized funds.

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT: CONST. SCHED / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	Directive Comp. Date: Design / Constr.	Estimated COMP. DATE: DESIGN / CONST.
CA-778	Expansion of the 305-B Building Engineer: R. C. Ingersoll	Physics & Instr.	$ 55,000	$ 55,000 12-11-57	To be est To be est	To be est To be est	4-4-58* 7-1-58**	5-15-58** 10-15-58	5-15-58** 10-15-58

REMARKS: Carson & Moe, Architect-Engineers, have been engaged for Title I, II & III services on this project. No schedules have been set up as yet.
*Tentative starting date submitted by the A-E.
**Scheduled Dates.

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT: CONST. SCHED / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	Directive Comp. Date: Design / Constr.	Estimated COMP. DATE: DESIGN / CONST.
CG-779	Alterations to the 321 Building Engineer: J. T. Lloyd	Chemical Research	$ 63,000	None to date None	0 0	0 0	None None	None None	None None

REMARKS: The project proposal was returned unapproved by the AEC-Washington. It is being revised and will be resubmitted.

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT: CONST. SCHED / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	Directive Comp. Date: Design / Constr.	Estimated COMP. DATE: DESIGN / CONST.
IR-236	321 Building Test Pit Enclosure Engineer: A. W. Hervin	Chemical R & D	$ 19,000	$ 19,000 2-28-58	Not Sched 20	0 0	3-3-58 To be est*	- - - To be est*	To be est To be est*

REMARKS: A comment drawing was issued the first part of March. However, no further work will be done until the hutment has been released to the Commission by the Army.
*Dates cannot be established until release of the hutment.

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT: CONST. SCHED / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	Directive Comp. Date: Design / Constr.	Estimated COMP. DATE: DESIGN / CONST.
	Geological and Hydrological Wells - FY 1958 Engineer: D. S. Jackson	Chemical Research	$ 49,000	None to date 4-17-58*	0 0	0 0	4-7-58* 6-23-58*	To be est To be est	5-12-58* 12-31-58*

REMARKS: The project proposal has been prepared and routing for HLO approvals was started on March 31, 1958.
*Estimated approval, start, and completion dates based upon submission to the AEC before April 11, 1958.

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-55590 G

March, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	Directive Comp. Date DESIGN / Const.	Estimated COMP. DATE DESIGN / CONST.
CA-769	Additions to the 622 Building Engineer: J. T. Lloyd	Physics & Instr.	$ 80,000	None to date None	0 0	0 0	None None	None None	None None
		REMARKS: The General Electric Company will request return of the project proposal.							
	Laboratory Alterations - 231-Z Building Engineer: J. T. Lloyd	Reactor & Fuels	$ 49,600	None to date None	0 0	0 0	To be est To be est	None None	None None
		REMARKS: The Project Estimate has been prepared. Rough Draft of the project proposal has been given to Plutonium Metallurgy Operation for comment.							
Equipment Not Included in Construction Projects - Program Class 2900		Reactor & Fuels	$ 135,555	$ 135,000 6-29-56	100 100	100 100	3-27-56* 5-14-57*	3-29-57** 3-15-58	4-1-57* 2-28-58*
CG-660	Modifications and Additions to the Metallographic Cell - 327 Building Engineer: D. S. Jackson	REMARKS: Minor start-up work is continuing on the project. All accounts have been closed and the Physical Completion Notice was issued 3-10-58. This project will no longer be carried in this report. *Actual **Scheduled Dates.							
CG-661	Additional Heat Generation Facility - 189-D Building Engineer: A. W. Hervin	Reactor & Fuels	$ 664,000	$ 664,000 9-18-57	31 44	0 0	12-6-56 1-15-59	10-1-58* 8-31-59*	11-1-58 8-31-59
		REMARKS: The vendor for the heat exchanger is working on the tubing, it appears that the scheduled shipping date of May 12, 1958 will be met. The order for the steam condensor has been placed, Because of code stamp requirements a shipment date at least one month later than the scheduled date of May 1, 1958 is indicated. This will have no effect on overall completion of the project. Design work has been resumed on both the mechanical and electrical phases of the project. *Scheduled Dates.							
CG-672	Monochromatic Neutron Beam Facility - 105-KE Building Engineer: H. Radow	Physics & Instr.	$ 187,000	$ 195,000 3-7-57	100 100	83 90	5-21-56 11-1-57	- - - 5-1-58	11-1-56* 4-15-58
		REMARKS: Final completion is being held up pending manual operation of existing inner shutter in Beam Hole. This will be done at the next outage which is expected in the near future. *Actual date.							

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-55590 G
March, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	Directive Comp. Date Design / Const.	Estimated COMP. DATE DESIGN / CONST.
CA-681	Hanford Equipment in the ETR Engineer: H. Radow	Reactor & Fuels	$1,200,000	$1,200,000 8-12-57	100 100	0 0	9-17-56* 4-15-58	4-57 12-15-58	5-29-57* 12-15-58
		REMARKS: Indicated starting date for construction is still April 15, 1958. Modification of the 9 x 9 Loop to accommodate PRTR and NPR fuel elements has been requested. Funds currently remaining in contingencies will cover extra costs involved. *Actual Dates.							
CG-682	High Level Cut-Off and Examination Cell - 327 Building Engineer: A. W. Hervin	Reactor & Fuels	$ 430,000	$ 430,000 8-20-57	100 100	0 0	7-18-56* 4-15-58	- - - 10-1-58	6-26-57* 10-1-58
		REMARKS: The vendor on the cut-off saw has completed approximately 95% of the detailed parts and approximately 50% of the assemblies and sub-assemblies. It is anticipated that this item may be shipped sometime in April. The vendor of the shipping cask poured the lead for the cask shielding on 3-17-58. Indications are that the cask will be shipped 4-17-58 as promised. The vendor for the manipulators has received approximately 90% of his materials and 30% of the assemblies are in fabrication. The vendor of the meehanite cell has completed the basic planing on all castings. Boring of the plug holes has been started on all but one casting and is approximately 55% complete. The boring operation is time consuming, an average of 9 hours per hole, as a result the vendor is behind schedule. It now appears doubtful that the revised shipping date of 4-15-58 can be met. An effort is being made to expedite this order so that it will not seriously impair the completion of the project as scheduled. The CPFF Construction Contractor has moved a TC Building to north side of the 327 Building, this will be used as a change house for the crafts, particularly during the removal of the contaminated lead cell. The contractor will do miscellaneous preparatory work before 4-15-58 which is the date established for the start on dismantling the existing cell. A construction schedule will be issued the first part of April. *Actual Dates.							
CA-695	Radio Telemetering Network Engineer: J. T. Lloyd	Physics & Instr.	$ 98,000	$ 89,000 1-10-57	100 100	Not Sched " "	2-22-57 7-25-57	4-15-57* 5-15-58	5-27-57** 1-1-59
		REMARKS: It has been agreed by both the AEC and the General Electric Company that there will be no reduction in scope at the present time. The repeater station will be contracted for in the near future. The contractor will ship the prototype model without the switch shortly after 4-1-58, the switch will be supplied later. *Scheduled Date **Actual Date							

BM-7300-005 (11-56) AEC-GE RICHLAND, WASH.

1248973

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / SCHED DATE / ACTUAL DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	Directive Comp. Date Design / Const.	Estimated COMP. DATE DESIGN / CONST.
CG-758	Ceramic Fuels Development Press and Furnace Additions	Reactor & Fuels	$200,000	$ 200,000 / 8-1-57	100 / 100	Not Sched* / 20	8-22-57 / 1-20-58	2-1-58** / 10-1-58	2-28-58# / 10-1-58
	Engineer: R. C. Ingersoll	REMARKS: Bid package for installation of the press was issued 3-25-58. Bid opening is scheduled for 4-10-58. Furnace has been assembled and hood is in place. *Overall construction schedule has not been established because the second phase construction (press installation) has not been scheduled. **Scheduled Date. #Actual Date.							
CG-785	In-Reactor Studies Equipment - 105-KW Building	Reactor & Fuels	$400,000	$ 15,000* / 2-12-58	5 / 5	0 / 0	3-10-58 / To be est	- - - / To be est	6-13-58 / None est
	Engineer: H. Radow	REMARKS: A schedule of preliminary drawings has been issued and scope information is being developed. *For preliminary design and necessary services to submit a revised project proposal for procurement and construction funds.							
IR-231	Badgehouse Alterations for Self-Service - 100 and 200 Areas	Radiation Protection	$ 13,168*	$ 18,500 / 8-29-57	100 / 100	100 / 100	7-1-57 / 12-2-57	- - - / 2-14-58	9-15-57* / 2-17-58*
	Engineer: D. S. Jackson	REMARKS: The Physical Completion was issued and unitization is underway. This project will no longer be carried in this report. *Actual							
New Construction - FY 1958									
CG-731	Critical Mass Laboratory	Physics & Instr.	$1,800,000	None to date / None	To be est / 0	To be est / 0	None est / " "	None / None	None / None
	Engineer: R. W. Dascenzo	REMARKS: To date the AEC has not authorized funds on the project proposal request of $175,000 for total design.							
CA-744	Metallurgical Development Facility	Reactor & Fuels	$3,290,000	None to date / None	To be est / 0	To be est / 0	None est / " "	None / None	None / None
	Engineer: R. W. Dascenzo	REMARKS: A revised project proposal is being prepared. The AEC has not approved the first project proposal for partial design funds.							

BM-7300-005 (11-56) AEC-GE RICHLAND, WASH.

UNCLASSIFIED

MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-55590
March, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	Directive Comp. Date Design / Const.	Estimated COMP. DATE DESIGN / CONST.
CA-749	High Level Radiochemistry Facility Engineer: R. W. Dascenzo	Chemical Research	$1,070,000	$ 20,000* 9-27-57	100** 100**	To be est 0	7-11-57 None est	None None	8-1-58 8-1-59
		REMARKS: Authorization for total project funds has not been received to date. *Interim Authority **Scoping and Preliminary Design.							
	X-Ray Diffraction Cell - 327 Building	Research & Fuels	$120,000	None to date None	None 0	None 0	None est " "	None None	None None
		REMARKS: A project proposal is being prepared for partial design money only on this project.							
	High Temperature Tensile Testing Cell - 327 Building Engineer: R. W. Dascenzo	Research & Fuels	$140,000	None to date None	None 0	None 0	None est " "	None None	None None
		REMARKS: A project proposal is being prepared for partial design money only on this project.							
CGH-790	High Level Radioactive Receiving and Storage Addition Engineer: A. W. Hervin	Reactor & Fuels	$325,000	None to date None	None None	None None	1* 8*	None None	6* 19*
		REMARKS: The project proposal has been approved by the local AEC Review Board. The Construction Project Data Sheet is being prepared. It is anticipated that the project proposal and data sheet will be forwarded to the AEC-Washington for approval the first part of April. *Months after approval.							
	Facilities for Long Term Isotopic Experiments Engineer: J. T. Lloyd	Biology	$ 49,800	None to date None	None 0	None 0	To be est To be est	None None	None None
		REMARKS: Project Proposal with estimate is being routed for approvals.							

BM-7300-005 (11-56) AEC-GE RICHLAND, WASH.

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H.W. Personnel Contacted	Access to Restricted Data	Areas & Buildings Visited
NONE						

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
P.F.X. Dunigan	3-17-58	1958 Nuclear Congress Chicago, Illinois	Big Shielding Window Conference	Representatives of Penberthy Glass, Corning Glass & Pittsburgh Glass. Representatives of AEC sites & Atomic International.	No
	3-18-58 3-21-58	" "	Hot Laboratory Committee Meeting 3-18 and 3-21-58	Hot Laboratory Committee	No
			6th Hot Laboratory & Equipment Meeting	Public	No
L. J. Lucas	3-17-58 thru 3-21-58	Argonne Lab. GSA Chicago Ord. Dist. Hotpoint Chicago, Illinois	To discuss mutual shop problems and attend the Nuclear Science Congress.	H. Ross L. A. Mapes G. F. Shanahan G. F. Lenartson	Yes
R. W. Benoliel	3-17-58 thru 3-21-58	1958 Nuclear Congress Chicago, Illinois	Attend Atomic Energy Management Conference; Nuclear Engineering & Science Conference; Atomfair		No
	3-24-58	AEC Office of International Conferences Washington, D. C.	Discuss Geneva Conference exhibits.	R. Pahler S. W. Davis	No

1248976

EMPLOYEE RELATIONS OPERATION MONTHLY REPORT

GENERAL

At month's end the staff of the Hanford Laboratories operation totalled 1120, including 500 exempt and 620 nonexempt employees. Of the total exempt employees there were 434 with college degrees, including 416 technical degrees as follows: BS - 217, MS - 102 - PhD - 97. There were 37 nonexempt employees with degrees.

AEC SPONSORED TRAINING PROGRAMS

Plans for the AEC-ASEE Summer Institute are progressing. The ten candidates selected for the Institute have indicated their intention of participating in the summer program. The Institute is scheduled to commence on June 22 and will be conducted over an eight-week period ending August 15.

The 1958-1959 AEC Radiological Physics Fellowship Program will invite fourteen candidates to participate at the University of Washington and sixteen to participate at the University of Kansas. The Commission's facilities at Arco will probably be used for the summer field training for University of Kansas participants and there will be no significant increase in the total spending the summer of 1959 at Hanford.

TOURS OF LABORATORIES FACILITIES

Interest in touring the facilities of HLO and particularly those of the Biology Operation has increased during recent months. During March, Kiona-Benton High School agriculture students toured the Biology Operation and arrangements have been made for additional tours for the month of April.

ORGANIZATION

Formal approvals were obtained to establish a new level 3 component, Programming Operation, within HLO to be effective April 1, 1958. Concurrently several minor organizational changes within Reactor & Fuels R&D were approved. Effective March 17, an organizational restructuring was approved and implemented within the Analytical Laboratories.

HEALTH, SAFETY AND SECURITY

Laboratories personnel worked 191,000 hours during the month with no disabling injuries. Since September 1, 1956, a total of 3,580,700 man-hours have been completed with no disabling injuries. The medical treatment frequency for March dropped to 1.52 as compared with 2.42 during February.

There was one security violation during March, bringing the 1958 total to twelve.

EMPLOYMENT

Employment of nonexempt personnel continues at a very limited pace with openings being filled from within the Laboratories or from other HAPO departments. There were no force reductions within the Laboratories during the month.

TECHNICAL PERSONNEL PLACEMENT

Seventeen PhD candidates visited Richland for interviews during the month and acceptances were received from three candidates. For the recruiting year, September 1, 1957 to date, there have been twelve PhD acceptances received. The recruiting of experienced BS/MS personnel continues at a minimum level.

UNION RELATIONS

Negotiations are continuing with the Regional Monitors and the Company is currently awaiting a reply of the HAMTC following the Company's agreement to maintain separate seniority for Field Inspectors and Radiation Monitors for six months following the execution of the Modification Agreement.

Three grievances were received during the month, two of which were bargaining unit grievances which have been discussed at Step II. The non-unit grievance was answered satisfactorily at Step I. There have been a total of twelve grievances, including two non-unit grievances in HLO since January 1.

ATTITUDE SURVEY

A detailed report of the attitude survey study within Laboratories Auxiliaries was submitted to their management. Reactions to date have indicated that this study was a successful one and profitable.

BENEFIT PLANS

The Laboratories participation in the Employee Benefit Plans is as follows:

	Jan	Feb	Mar
Insurance	99.6	99.7	99.7
Pension Plan	98.4	98.5	98.6
Stock Bonus	60.6	61.3	61.9
Savings Plan	7.5	8.2	8.7

T G Marshall

Manager
Employee Relations

TG Marshall:tr

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VISITORS TO HAPO

Name	Date of Visit	Company or Organization Represented	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
H. H. Hutchinson	3/19, 3/20	General Electric Co. Employee Compensation Service	Exempt and Non-exempt Pay Practices	H.A. Paulsen W.E. Foust R.D. Tillson	None	700 - 703
J. A. Reid	3/20	General Electric Co. Union Relations Service	Union organizing and union relations	T.G. Marshall A.P. Hudspeth	None	700 - 703

VISITS TO OTHER INSTALLATIONS

Name	Date of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
T.G. Marshall D.C. Fleckenstein	3/31	General Electric Research Lab. Schenectady	Personnel Development	G.W. Giddings	None

TABLE III. EMPLOYMENT - TECHNICAL PERSONNEL STATUS

I. Employment

Non-Exempt Employment Status	Feb.	Mar.
Requisitions		
At end of month	7	11
Cancelled	0	0
Received during month	5	10
Filled during month	9	6
Candidates Considered		
Total applications	24	18
Total transfer requests from other at HAPO	0	2
Total interviewed	0	0

Non-Exempt Transfer Requests	Feb.	Mar.
Transfer Requests		
Active cases at end of month	46	46
Cancelled	1	2
New during month	5	2
Transfers effected	1	0
Planned transfers		
Effective during month	0	3

II. Technical Personnel Placement

Ph.D. Recruiting - HLO - 9/1/57 to date

	Cases Considered	VISITS TO RICHLAND				OFFERS*			On The Roll
		Extended	Visited	To Visit	Open Invite.	Extended	Accepted	Open	
Engineering:									
Chemical	53	21	6	5	-	7	3	1	-
Electrical	21	4	1	1	1	2	-	-	-
Mechanical	30	9	2	4	-	2	-	-	-
Met-Ceramics	47	24	7	4	2	5	-	2	1
Other	6	3	-	3	-	-	-	-	-
Science:									
Chemistry	229	35	15	7	3	10	5	1	4
Physics	221	84	19	17	15	10	2	2	3
Math-Statistic	33	3	-	1	-	-	-	-	1
Other	33	7	3	2	-	2	2	-	2
TOTAL	673	190	53	44	21	38	12	6	11

*Offer totals include 14 Ph.D. open offers as of 9/1/57.

BS/MS Experienced Recruiting - HLO - 9/1/57 to date

	Cases Considered	VISITS TO RICHLAND				OFFERS			On The Roll
		Extended	Visited	To Visit	Open Invite.	Extended	Accepted	Open	
Engineering:									
Chemical	6	2	1	-	-	1	-	1	-
Electrical	8	2	2	-	-	-	-	-	-
Mechanical	11	4	3	-	-	2	-	-	-
Met-Ceramics	6	1	1	-	-	1	1	-	1
Other	14	-	-	-	-	1	1	-	1
Science:									
Chemistry	10	-	-	-	-	-	-	-	2
Physics	5	-	-	-	-	2	-	-	-
Math-Stat.	3	1	1	-	-	1	1	-	-
Other	15	-	-	-	-	-	-	-	-
TOTALS	78	10	8	0	0	8	3	1	4

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TABLE IV. Exempt Transfer Cases

			March	February	Total
Active cases at beginning of month			30	28	
New cases:	Initiated by employee		2	1	5
	Initiated by management*		3	3	11
Cases reactivated					
			35	32	
Cases closed:	Transfers:	Within HLO		2	2
		Within HAPO			0
		Other G.E.			0
	Withdrawn		1		0
	Terminated		3		4
			31	30	8
Active cases at end of month			31		31
Total cases - January 1, 1958 to date (includes 23 cases initiated prior to and active on 1/1/58)					39

Initiated by employee 15
Initiated by management* 24

*Includes ROF's, transfers proposed by employee's management, and requests from other G. E. departments.

TABLE V. Union Relations

Grievances Processed - January 1, 1958 to date

Total processed	12	(includes 2 non-unit grievances)
Step I		
Answered satisfactorily*	5	(includes 1 non-unit grievance)
Step II		
Pending Step II discussion	1	(includes 1 non-unit grievance)
Pending Step II answer	1	
Answered		
Satisfactorily	4	
Pending time limit	1	
Applied for arbitration	1	

* Step I grievances which Council indicated a desire to discuss at Step II not scheduled for discussion within three months are considered settled at Step I.

** Step II grievances in which the Council formally applied for arbitration but for which no further action is taken within three months are considered settled at Step II.

FINANCIAL OPERATION MONTHLY REPORT

Personnel

There were no personnel changes in the Financial Operation during March.

General Accounting Operation

Level 3 Managers were advised of the amount allocated each of them for Charges Against the Contract Fee during calendar year 1958. Subsequently we received advice that the per diem allowance had been increased from $10 to $11 per day, however, no change was made in the amount previously allocated.

It has been known for some time that SS Materials inventories on the books of HLO were overstated significantly. Previous attempts to secure permission of the Commission to write these inventories down to a more realistic figure have failed, however we are again negotiating with the Commission and hope to adjust our book figures by June 30, 1958.

At the suggestion of the FPD-HLO SS Accountability representative a substantial quantity of depleted uranium 0.15% U-235 having no recorded value is being used in a dissolution study conducted by the Chemical Development Operation rather than using normal uranium scrap having a per pound value of $13.40. Substantial savings are expected as a result of this suggestion plus the intangible value of not diverting normal uranium from production channels.

Continuity of service which is accrued at a standard rate of 10% of salaries was over-accrued during 1957 by approximately $102,000. This over-accrual is being disposed of as follows:

Minimum balance in accrual for Workmen's Accident Compensation		$ 10,000
Additional inventory reserve equipment		2,000
Credits to Cost -		
January	$15,000	
February	15,000	
March	50,000	80,000
Remainder to be transferred to Cost in April		10,000
		$102,000

A running analysis was initiated during the month to determine the degree of accuracy experienced in estimating the value of equipment required on appropriation requests. The results of this analysis based on FY 1957 and FY 1958 closed Appropriation Requests are shown below.

	Number of AR's	Auth. Funds	Actual Cost	(Over)-Under	Percentage
Over Run					
By more than 10% (Supplement required)	18	85,138	111,836	(26,698)	31.4%
By less than 10%	9	75,775	79,633	(3,858)	5.1%

	Number of AR's	Auth. Funds	Actual Cost	(Over)-Under	Percentage
Under Runs					
By more than 10%	29	135,975	102,137	33,838	24.9%
By less than 10%	16	111,644	109,158	2,486	2.2
Total Appropriation Requests	72	408,532	402,764	5,768	1.4%

As a result of the increased per diem allowance retroactive to January 1, 1958, a credit adjustment of $249 has been made to Hanford Laboratories Operation travel and living variation incurred during January and February, 1958. The calendar year to-date variation through March for Hanford Laboratories Operation is a credit of $128. March reports for travel and living and charges against the fee reflect the adjustment.

A meeting was held with IPD and HLO Financial management to discuss the transfer of zirconium currently booked in HLO Inventory Account. As a result of this meeting, it was agreed that HLO Property Accounting will transfer to IPD material and fabrication cost booked in HLO inventory account which was for IPD use. In the future, zirconium cost, if applicable to IPD, will be transferred when ingots are shipped off-site for fabrication. Zirconium costs transferred to IPD in March were $120,959 which included material and fabrication costs on DDR-5 and DDR-6 and material shipped off-site on DDR-34.

Cost Accounting

Funds allocated to Hanford Laboratories Operation have been adjusted during March as follows:

	Increase (Decrease)
Increase in Plutonium Recycle R&D from $3,300,000 to $3,425,000 (new authorization is $138,000 less than Mid-Year Review)	$125,000
Increase in FPD Research & Development	
Category I	10,000
Category II	10,000
Switch in IPD Research & Development	
Category I	34,000
Category II	(34,000)
Diversion of Washington Designated Program operating cost to capital equipment (Test Program on Irradiated Metals)	(6,000)
Increase in Pu Al Fuel Plates for MTR from $250,000 included in Mid-Year Review to $284,000 (excluding 10% contingency)	34,000
New work requested by AEC to fabricate and assemble U-233 Fuel Plates for MTR (current estimate excluding 10% contingency)	186,000

	Increase (Decrease)
New authorization from CPD to manage the fabrication of a hood (capital equipment), Work Order #80430	$ 70,000
New authorization from CPD to perform Weapons Research and Development work, Work Order #80489 (not authorized as CPD-234-5 Weapons R & D but as Other Services to CPD) (includes General Overhead)	50,000
Total Increase	$ 479,000

The revised authorization for Plutonium Recycle Program received from AEC for FY 1958 totals $3,870,000; $3,425,000 for Research and Development and $445,000 for capital equipment. Level three and four operating budgets will be adjusted for April reporting; however, March reports were footnoted to call attention to the new authorization.

The FY 1959 Revised Budget and the FY 1960 Annual Budget is now complete for all Level three components. All the required schedules associated with operating budgets and inventories have been submitted to Contract Accounting. All proposals for Research and Development with the exception of the Advance Studies proposal have been submitted. The Advance Studies proposal which is classified is in process. The supplementary information on HLO maintenance for FY 1959 that was requested in connection with the budget preparation has also been submitted.

Personnel Accounting Operation

228 HLO employees, who left their 1952 bonds on deposit for the required 5 year holding period, received their bonds and a check for the income due under the terms of the Plan on March 13, 1958.

During the first calendar quarter 590 insurance claims were received and processed. This compares with 512 for the same period in 1957, or an increase of 78 claims. However, the increase in the amount of benefits paid was only $2,400.

Procedures

A coordination study was completed in which forecasts were made of expected electronic data processing needs of HLO for the next few years. Conferences were held with representatives of each level 3 component in order to compile the most realistic and objective appraisal of our future needs of this equipment. A general, long-range upward trend in the demand for electronic data processing is expected from nearly every organization in the Laboratories. Moreover, special interest was found in the potential acquisition of newer computer equipment geared to handled scientific problems; it is here that the largest planned area of growth appears.

Auditing

The General Electric Travelling Auditors arrived at the end of March. It is expected they will be at HAPO for about three months. HLO Financial is providing one man full time in assisting in the audit.

Measurements

A questionnaire was developed in cooperation with members of Technical Information to gain information on library services. This was forwarded to ten large industrial laboratories throughout the United States on March 18.

A narrative on the use of measurements in managing was prepared for use in PBM. This is being reviewed currently by PBM leaders.

A rough draft comparison of HLO statistics with other industrial laboratory statistics was completed.

Payroll Statistics

Number of HLO Employees Changes During Month	Total	Exempt	Exempt
Employees on Payroll at Beginning of Month	1 129	506	623
Additions and Transfers In	6	3	3
Removals and Transfers Out	(15)	(9)	(6)
Employees on Payroll at End of Month	1 120	500	620

Overtime Payments During Month	March	February
Exempt	$ 6 786	$1 820
Non-Exempt	8 222	7 678
	$15 008	$9 498

Gross Payroll Paid During Month		
Exempt	$397 715	$386 609
Non-Exempt	266 366	262 478
	$664 081	$649 087

Participation in Employee Benefit Plans at Month End	No. Participating March	No. Participating February	% Participating March	% Participating February
Pension Plan	1 124	1 127	98.6%	98.5%
Insurance Plan				
Personal Coverage	1 164	1 173	99.7	99.7
Dependent Coverage	732	740	-	-
U.S. Savings Bonds				
Stock Bonus Plan	693	693	61.9	61.3
Savings Plan	97	92	8.7	8.2

Insurance Claims Employee Benefits	March Number	 Amount	February Number	 Amount
Life Insurance	0	$ 0	0	$ 0
Weekly Sickness & Accident	10	1 020	17	1 197
Comprehensive Medical	56	5 897	54	4 005
Dependent Benefits				
Comprehensive Medical	106	7 403	105	7 186
Total	172	$14 320	176	$12 388

Good Neighbor Fund	March	February
Number participating	714	725
Percent participating	64.1	64.2

W. Sale/bk
April 10, 1958

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
W. L. Wyman	The Field of Welding Vessels Which are Evacuated to a Low Internal Pressure
R. A. Curd and W. C. Roberts	The Art of Conveying Washers or Disk-like Members for the Purpose of Visual Inspection
C. G. McCormack, R. L. Brandt, and W. R. DeHollander	A Process for Impregnating Powdered or Ceramic Material with Gelatin or Plastic to Permit Sectioning and Investigation of the Material
W. F. Stevenson	Process Simulator
L. C. Amos	"A Combination Crystallizer and Heater Conveyor"
T. R. Cartmell	"An Instrument for Measurement of Micro Quantities of Water Vapor in Gases" HW-55325
A. S. Wilson	"The Production of Uranium Dioxide by the Self-Reduction of Ammonium Diurante" HW-55201
W. L. Lyon	"The Reconstitution of Partially Depleted Plutonium-Aluminum Reactor Fuel Alloys by Electrolysis" HW-55499

H M Parker