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By Authority of *CG-PR-2*

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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
FEBRUARY 1958

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Compiled by
Operation Managers

March 15, 1958

CLASSIFICATION REVIEW FOR
DECLASSIFICATION BUT
UNCHANGED

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

15/1/83
Date
U.S. AEC Division

PRELIMINARY REPORT

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TABLE OF CONTENTS

Staff	iv
Force Report and Personnel Status Changes	v
Promotions and Transfers	vi
General Summary	vii through xii
Reactor and Fuels Research and Development Operation . . .	A1-1 through A1-33
Plutonium Recycle Program	A2-1 through A2-16
Physics and Instrument Research and Development Operation	B-1 through B-15
Chemical Research and Development Operation	C-1 through C-22
Biology Operation	D-1 through D-6
Operations Research and Synthesis Operation	E-1 through E-6
Radiation Protection Operation	F-1 through F-9
Laboratory Auxiliaries Operation	G-1 through G-22
Employee Relations Operation	H-1 through H-10
Financial Operation	I-1 through I-9
Invention Report	J-1

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PERSONNEL STATUS CHANGES
TABLE II. PROMOTIONS AND TRANSFERS (1)

Date February 28, 1958

Component	PROMOTIONS		EXEMPT TRANSFERS (2)						NON-EXEMPT TRANSFERS	
	Exempt	To	Non-Exempt	From	To HLO		To	From	To	From
					Other	HAPO		Other	HAPO	Other
Chemical	0	0	5	0	0	0	0	0	0	0
Reactor & Fuels	1	0	2	0	0	0	0	0	0	0
Physics & Instrument	1	0	0	1	0	0	0	0	0	0
Biology Operation	0	0	1	0	0	0	0	0	1	0
Operations Res. & Syn.	0	0	0	0	0	0	0	0	0	0
Radiation Protection	0	0	0	0	0	0	0	0	0	0
Laboratory Auxiliaries	0	0	8	0	0	0	0	0	4	1(3)
Financial	0	0	3	0	0	0	0	0	1	1
Employee Relations	0	0	0	0	0	0	0	0	0	0
TOTALS	2	0	19	1	0	0	0	0	6	2

- (1) Data through 2/28/58
 (2) Transfers within HLO not included
 (3) F. E. Simmons transferred to Sacramento Sales District

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SUMMARYBUDGETS AND COSTS

Fiscal year to-date costs are \$11,130,000 at the end of February or 63% of the FY 1958 Mid-Year Budget Review as adjusted to reflect changes received from the Product Departments and the reduction of \$363,000 in Plutonium Recycle Program Research and Development funds as required by the recent Financial Plan revision. February costs of \$1,504,000 were up \$86,000 over January costs with significant increases occurring in Plutonium Recycle Program and IPD-Category II Research and Development.

Cost-budget relationships for most programs are in order with two-thirds of the fiscal year complete, however, some adjustment is still required in order to respect the absolute ceilings of the various programs. Receiving particular attention in this regard are the combined FPD Research and Development Programs which require severe economy moves to remain within authorized funds.

RESEARCH AND DEVELOPMENT1. Reactor and Fuels

Design of the Plutonium Recycle Test Reactor is 50% complete. A scope revision was issued specifying numerous changes required in connection with removal of the 1500 kw turbine-generator. A contract was awarded by AEC-HOO for installation of temporary construction facilities.

Development of Pu-Al fuels continued with preparation of cluster assemblies for MTR and KER irradiations. Work included:

- (1) Extended period ex-reactor mock-up runs to monitor corrosion, fluid flow and mechanical behavior of fuel assemblies.
- (2) Study of variables in air pressure and mechanical pressure injection casting of Pu-Al into long jacket tubes.
- (3) Defected fuel element corrosion testing of various aluminum matrix materials.

In the latter tests, conducted in 350 C water, Al-Si alloys displayed negligible post-rupture swelling tendencies in contrast to standard 1245 aluminum which corroded rapidly.

Two test specimens, each consisting of enriched UO₂ powder loosely poured into 1" x 6" Zircaloy cans which were then welded shut, were irradiated to ca. 900 MWD/T in the MTR. Post-irradiation examination of one specimen revealed no gross dimensional change although extreme temperatures were reached. Sintering appeared to have occurred to within 20-30 mils of the jacket wall.

Externally ribbed, thin-wall zircaloy jacket tubing has been successfully fabricated by Nuclear Metals Inc. by direct extrusion.

Seven-rod, metallic uranium cluster elements co-extrusion-clad with Zircaloy-2 and hot-pressed, washer-type I and E slugs with no bulkheads were subjected to ex-reactor rupture testing in 290 C water. In both cases the extent of damage over two-hour periods was surprisingly small and no flow decreases or pressure drop increases occurred. Nickel plating of washers on the flat surfaces as well as on the curved surfaces was found to be beneficial.

Development of an aluminum clad rod and concentric tube fuel assembly for NPR use has been undertaken, supplementing continuing NPR work on coextruded rod cluster and I and E washer-type fuel assemblies.

Difficulties encountered over a period of several months in bonding hot press, washer-type I and E fuel elements have been greatly alleviated by application of a more severe preplating etch prior to nickel plating; this permits reduction of pressing time and temperature.

Fabrication of "Tru-line" washers by upsetting of rod stock could substantially simplify the production of segmented I and E fuel elements. The development of optimal conditions for this procedure is progressing favorably.

Use of high voltage alternating current as a power source in electron beam vacuum welding is under investigation. To date the quality of welds has not differed appreciably from those obtained with DC power.

Favorable preliminary results were obtained in investigation of the feasibility of butt-welding two Zircaloy-2 extrusion blooms to provide stock for tube reducing NPR process tubes to final dimensions.

2. Chemical Research and Development

A prototype continuous dissolver was placed on test operation successfully with an initial load of regular aluminum clad metallic uranium fuel pieces.

Added emphasis was put on dingot metal dissolution problems. Results are reported on the nature of nitric acid attack on ingot, dingot, and high carbon dingot uranium specimens; pitting attack at metal inclusion sites appears important.

Better decontamination of zirconium-niobium and ruthenium was obtained by increasing the operating temperature of the HS column prototype in the Mini cell equipment operating on the proposed Purex Phase II flowsheet.

Increasing use is being made of the thermal ionization mass spectrograph for precise analyses of plutonium isotopes of importance to several research and plant problems.

Volatilization of fission products did not occur when synthetic Purex 1WW waste containing trace quantities of the actual waste stream was treated in the laboratory with formaldehyde. Limiting theoretical stoichiometry has been demonstrated, and minimized waste volumes measured.

Tri-laurylamine was found to be a satisfactory extractant for neptunium.

A HAPO developed contact alpha counter and a gamma absorptiometer are contributing to effective control of the Purex plutonium anion exchange

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prototype by measuring feed and resin plutonium concentrations respectively.

Work in support of the Non-Production Fuels Reprocessing program includes continuing preparation for pilot scale development tests on mechanical saws, materials selection, Darex pilot plant fabrication, and some significant test runs of a zirflex prototype. Defining dissolution times, process variables, and characterizing solid "cruds" in the dissolver solution are problems from reported initial runs.

On the Plutonium Recycle Program, the first pyrochemical flowsheet was followed in the laboratory wherein UO_2 was dissolved in cryolite, extracted (and reduced) in molten aluminum and scrubbed with KAlCl_4 to remove plutonium, leaving an aluminum-uranium alloy. Pu can in turn be removed from the KAlCl_4 phase using a calcium solution in aluminum.

A study was made to characterize the chemical form of P^{32} found in reactor effluent; pyrophosphate predominates.

3. Physics and Instruments

Measurements of the physics parameters of cluster-type fuel elements considered for the NPR, using 0.9-inch diameter rods, were completed. The lattices measured included two coolant volumes produced by using two separation distances between the rods in the cluster. Measurements were also made without coolant. Some progress was also made in a study of theoretical methods for dealing with cluster elements.

Work continued on experiments related to the slightly enriched uranium dissolver problem with further experiments on randomly arranged slugs and on mixtures of slugs of two diameters. Work was begun to determine the reactivity of concentrated uranyl nitrate, water mixtures at enrichments around 2%.

Work on the temperature coefficients of existing production reactors when containing higher exposure slugs has been progressing.

For the PRP, experimental work was begun in the PCTR to determine the effects of plutonium spike columns distributed among uranium oxide fuel columns. Some work was completed on an improved computational method for dealing with the resonance capture of neutrons by uranium, but the comparison with existing methods has raised some questions of interpretation and correctness of the results.

Consultation on nuclear safety problems included: Review for FPD of storage specifications, and the effect of non-fissionable materials on storage safety of elements containing 0.96%, 1.47% and 1.61% U-235; review of handling procedures in the Radiometallurgy Laboratory; study of the dissolution of plutonium metal in 234-5; review of shipping arrangements for Pit 65 pieces at the request of HOO-AEC; discussion of increased batch size in Task I-II, 234-5 Bldg.; preparation of criteria for safe design of an ion exchange column for plutonium recovery from a waste stream in the Purex plant; inspection of the new L-Package at Purex; review of shipping containers for enriched oxide.

Exploration of the distribution on the Wahluke Slope of material from a simulated "slow simmer" reactor disaster continued at a site near 100-F.

Development of new devices and techniques for body monitoring continued in the rock-shielded facility constructed last month. In a case of ruthenium deposition, an amount of Ru^{106} was measured corresponding to 1/400 of the maximum permissible body burden. The study of old plutonium deposition cases by searching for Am^{241} also appears promising.

Instrument development work continued satisfactorily, with emphasis on all-scintillation, all-transistorized combinations.

In the basic data field, work progressed on determination of total neutron cross sections of iridium, copper, platinum, and U^{235} in the low energy range, and on the analysis of measurements of the fission cross sections of Pu^{239} and Pu^{241} . A measurement of the absorption cross section of high purity graphite was attempted. Experimental work on the neutron age in hydrogenous materials was completed. A series of proton γ measurements in argon and nitrogen was completed.

4. Biology

Young chinook salmon were not affected by 4% reactor effluent, either as a constant concentration or as a varying concentration to simulate expected effects of Priest Rapids Dam. This test is continuing but is yielding unexpected results where threshold toxicity was previously observed.

Uptake of short-lived radioelements from fresh and undiluted reactor effluent was measured in bean plants. Thirteen radioelements were identified.

From incomplete experiments it appears that DTPA (diethylene-triamine-penta-acetic acid) is markedly more effective than EDTA in removing firmly bound plutonium from the bone, when this agent is repeatedly administered.

Another "insoluble" type of particle was observed to move rapidly from the lung following inhalation. Twenty-four hours after inhalation of AgI^{131} only 10% remained in the lungs, with most of the radioelement in the thyroid. This surprising result will have to be followed up, probably by labeling also the silver.

Technical and Other Services

Two cases of plutonium deposition, both appearing to be less than 10 per cent of the MPL, were confirmed. Both were detected by routine sampling, and probably occurred in 1957. Confirmed plutonium cases total 218 of which 20 occurred in 1957.

Doubled emission rate was attributed to decreased cooling time of metal dissolved at Purex and was largely responsible for a weekly average emission of 11.2 curies of I^{131} .

Work on the input-output simulation study for HAPO was continued. The general scope and techniques of simulation as applied at another General Electric

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component were reviewed in detail. Discussions were also held concerning the general problems connected with the simulation of HAPO and the potential manpower and data processing requirements.

Work on the CPD Control study was concentrated primarily on the accountability system. A basic description of present inventory and administrative accounts has been prepared and preliminary work started on the construction of the corresponding biases and imprecision matrices. Knowledge of these is essential to a better understanding of the accountability system.

Further discussions were held concerning the impact of the full adoption of economic ground rules on HAPO activities.

Statistical and mathematical assistance on 30 separate problems was given to other HAPO components. Work on the predictability of fission gas release from irradiated UO_2 capsules and development of improved operational control charts for FPD were two of the items of particular interest.

Project CG-660, Modifications and Additions to the Metallographic Cell - 327 Building, was completed during the month. A work order will be issued to the operating component for start-up and adjustment. The project closing cost will be about \$135,000; authorized funds are \$135,000.

Radiographic Testing Operation worked extensively on MTR fuel plates during the month. Work has involved radiographing of the plates on a production basis as well as development of radiographic techniques for the work.

A brief symposium on the Windscale Reactor Incident was arranged and presented to a group of about 100 HAPO persons.

Supporting Functions

Significant changes in funds available for FY 1958 equipment received during the month were (1) \$6,500 from CPD to cover a portion of the cost of a special contour machine, (2) \$10,000 from IPD to cover an unexpected increase in the amount needed for vacuum creep testing units (\$35,000 was previously provided by FPD) and (3) \$55,000 from Contract Accounting in reply to an urgent request by Reactor and Fuels R and D for \$159,000 to finance equipment critically needed this year.

Costs written off to SS Material Consumed in Research - Non-Fund during January amounted to \$360,000. This represented a backlog of material which required reprocessing from three programs as follows: (1) Project Whitney - \$185,000, (2) PRP Studies - \$88,000 and (3) Exponential Pile Loading - \$87,000. Material returned to the production stream during February is expected to result in additional substantial charges.

Agreement letters with HOO-AEC covering the fabrication of Pu-Al and U-233 fuel elements for MTR are in the process of revision to reflect higher estimates of cost.

AEC has advised that funds available for the Plutonium Recycle R and D Program will be \$363,000 less than requested in the Mid-Year Budget Review. Also equipment is considered a separate ceiling and the amount established (\$400,000) is not to be exceeded without the approval of the Division of Reactor Development, Washington, D.C.

Authorizations for budget purposes, of CPD, FPD and IPD sponsored research and development programs have been received for FY 1959. Generally they provide for the going rate in FY 1958 plus estimated escalation.

A narrative outlining the status of measurements in Hanford Laboratories has been prepared. This will be used in conjunction with discussions with management.

Overtime control levels, which are to remain in effect for 1958, have been established for each HLO Level 3 component.

Extensive study of personnel records in Personnel Accounting, Employee Relations - HLO and Employee Relations - Relations and Utilities Operation has been made in hopes of improving coordination and consolidation of these records.

At month's end the staff of the Hanford Laboratories Operation totalled 1129, including 506 exempt and 623 nonexempt employees. There were 422 exempt employees possessing technical degrees, including 222 BS, 103 MS and 97 PhD's.

The AFSWP program was concluded on February 14, 1958. The ASEE Summer Institute has accepted 10 applicants for the HLO program this summer.

A total of 375 HLO employees attended the annual Information Meeting which was conducted two evenings during the month.

Tours were conducted for 100 high school science students and 45 college students on Edison Day.

At the February Suggestion Board Meeting, nine suggestions were reviewed and six were approved for awards totalling \$360.00. Payments of these awards are being deferred pending establishment of a suggestion budget.

The HAMTC has not yet replied to the Company's most recent proposal in the Regional Monitors negotiation.

Three new grievances were received during February. One was submitted by a non-unit employee and discussions at Step II have not yet been requested. However, the investigation is continuing. Two were from the Teamsters and one was settled at Step I. A Step II answer is pending on the other.

HLO personnel worked a total of 182,108 man-hours during February with no disabling injuries. On February 10 HLO won its first President's Safety Award for completion of 528 days without a disabling injury.

There were 44 medical treatment injuries giving a frequency of 2.42 as compared to 1.60 last month.

There were 4 security violations during February.

HM Parker

Manager,
HANFORD LABORATORIES

HM Parker:kss

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REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATIONTECHNICAL ACTIVITIES

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A. FISSIONABLE MATERIALS - 2000 PROGRAM1. METALLURGY PROGRAMCorrosion Studies

Organic Coolant Studies. A small recirculating loop has been placed in operation in which monoisopropyl biphenyl, MIPB, is recirculated through a tube of Zircaloy-2 at about 370 C. This facility will be used to evaluate the compatibility of Zircaloy and hot MIPB in a system in which the hydrogen, which results from the thermal decomposition of the MIPB, is not allowed to build up in pressure.

Hydriding studies of uranium, zirconium and Zircaloy-2 in MIPB have continued. Thus far, tests have been conducted at 300, 350 and 400 C. The exposures were for six days at five psi hydrogen partial pressure and 100 psi total pressure. After exposure the zirconium and Zircaloy samples were analyzed for hydrogen and the uranium was stripped of its corrosion product in 10 percent sulfuric acid at 50 C to obtain a weight loss due to exposure. The results to date are shown in the following table:

Hydriding in MIPB in 6 Days
at 350 C and 5 lb/sq in. H₂ Pressure

	<u>Initial H₂</u>	<u>Final H₂</u>
Zirconium	12 ppm	350 to 975 ppm
Zircaloy-2	3	140 to 540

Hydriding of Uranium in MIPB
6 days at 5 lb/sq in. H₂ Pressure

<u>Temperature</u>	<u>Weight Loss</u>
300	93.0 mg/cm ²
350	11.5 mg/cm ²
400	5.0 mg/cm ²

Although the hydrogen data on the zirconium are at present incomplete, previous experience has shown an increase in hydride formation with increasing temperature. It is of interest to note the unusual behavior of uranium. The attack decreases with increasing temperature. This has been attributed to the decreased stability of uranium hydride at elevated temperatures.

Radiometallurgy Laboratory Studies

Thorium-Oralloy Capsules - GEH-3-12 (RM-118). Six thorium-oralloy capsules are being irradiated at the MTR to various degrees of burnup. Examination has been requested to determine the effect of irradiation upon these capsules.

The third capsule, H-3, representing 1-1/2 percent burnup, has been examined. Optical measurements of the capsule showed that canned diameter measurements taken ninety degrees from each other differed by 0.002 inch and were 0.003 inch greater than before irradiation.

Optical measurements of the uncanned element revealed a diameter increase of 0.002 inch and a length increase of 0.002 inch. A bend test of the fuel element gave the following information: Modulus of Elasticity 4.42×10^6 psi; Modulus of Resilience 5.08×10^3 psi; Ultimate Stress 2.34×10^5 psi. The density of a wafer cut from one of the broken elements was found to be 11.585 g/cm³, compared to a value of 11.69 g/cm³ measured before irradiation. Hardness values obtained were 59.3 ± 0.7 Rockwell A.

GEH-4-3B HAPU Size U-Mg Slug (RM-165-A). The HAPU size U-Mg slug was found to have increased in volume as a result of irradiation. The slug was sectioned and faxfilm replicas were taken of the surface after metallographic preparation. Examination of the replicas at magnification up to 3000X disclosed no voids or other changes in the uranium which would explain the volume increase.

GEH-4-E Examination of Zircaloy-2 Clad, Four Rod Cluster Fuel Element (RM-210). A prototype four rod natural uranium fuel element cluster, clad in Zircaloy-2, was irradiated as GEH-4-E in the Materials Testing Reactor to a calculated exposure of 780 MWD/T. It was discharged November 10, 1957, and shipped to the Radiometallurgy Laboratory for post-irradiation examination. Two previous irradiations of stainless steel clad cluster fuel elements of this type at 110 and 570 MWD/T have demonstrated excellent in-reactor performance.

The present rods were fabricated by cold swaging of Zircaloy-2 tubing onto uranium rods which had been machined from the cores of beta heat treated production pieces. The rods were sealed by welding in Zircaloy-2 end plugs in an argon atmosphere. Assembly was accomplished by welding the rods to Zircaloy-2 end spacers for maintenance of the inter-rod spacing. It was requested that the fuel element be irradiated in an asymmetrical neutron flux to make the test more rigorous.

Dimensional stability of the canned assembly was excellent, the maximum deviation from pre-irradiation measurements being 0.003 inch. Microscopic examination of a longitudinal section of one of the rods showed no bonding of the Zircaloy-2 cladding to the uranium. Abnormal quantities of stringer inclusions were present in the uranium, whose structure indicated medium and low alpha phase irradiation temperatures. Samples from the centers of each of the rods have been dissolved and submitted for burnup analysis of the U-235.

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Diffusion Capsules GEH-3-9 (RM-97). Three capsules containing uranium-aluminum and uranium-AlSi diffusion couples were irradiated to determine the effect of irradiation upon the diffusion characteristics of these couples. One capsule containing two uranium-AlSi diffusion couples has been opened and four planes across each diffusion boundary have been examined and photographed. Diffusion occurred in discrete areas extending from edge to edge through the center of the capsule. The maximum depth of diffusion is not known at this time. The areas of diffusion appeared to extend about equal distances into both the uranium and AlSi. This capsule designated as GEH-3-9 No. C was found to have been irradiated to a U-235 burnup of 0.0074 a/o. The temperature of irradiation is not known.

Production Test IP-32-A Irradiation of Insulated Fuel Elements (RM-176). Three four-inch cored insulated natural uranium fuel elements were exposed to 600 MWD/T in KW Reactor. Metallography of element No. 2 has been completed. The core of this element was found to be closed for about two-thirds of its length. Metallographic examination of a wafer from this fuel element showed a very porous structure throughout, but especially in the area where the core hole was originally. It is believed that the closure of the core hole was not caused by melting but rather by growth of the uranium. A faxfilm replica has been taken of this sample for observation by electron microscope.

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.

Two irradiated specimens, a U-MgSi and a cored insulated U element, have been examined microscopically. The U-Mg revealed no cracks or voids even though a swelling of three percent had been noted from macroscopic measurements. In contrast with this, the cored specimen, which after irradiation had essentially no core, contained a myriad of holes; the size of individual holes and the total volume of the holes increased from the specimen edge to its center. The holes range in size from a fraction of a micron to as large as 20 microns. They are cylindrical in cross section and have depths at least as great as their diameters. A longitudinal section parallel to the axes of the holes will be used to determine more accurately the depths of the holes and whether the holes are interconnected.

Specimens of uranium have been heated into the beta phase on the hot stage. As the alpha structure reverts into the beta, two types of transformations have been observed; the differences possibly arise from the differences in grain orientations and differences in the heating rate. The one type is best described by a movement of a relatively straight alpha-beta interface along the specimen. This interface does not appear to be retarded as it passes through a prior alpha grain. The second type is a discontinuous, irregular shaped interface in which propagation occurs in widely differing directions and at widely different rates.

The study of the fracture surfaces in preformed impact specimens irradiated to four levels of burnup, in the range 0.02 to 0.1 a/o, is continuing. A phase of this study involves a comparison of the fracture microstructure with the microstructure revealed on a polished and etched face of the specimen. The effect of various fracture temperatures and post-irradiation annealing treatments on the microstructure of fracture specimens is being determined.

Effect of Heat Treatment Upon Corrosion Resistance of Zircaloy. Corrosion tests in 680 F water are being run on specimens of Zircaloy-2 and Zircaloy-3 in the as-worked and heat treated conditions at the Bureau of Mines, Albany, Oregon. The 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 have been completed. The samples were in test until the weight gain exceeded 100 mg/dm². A group of vacuum melted Zircaloy-3 specimens with the same heat treatments as the argon melted Zircaloy-3 have been in test 240 days. These specimens exhibit lower corrosion rates throughout than the argon melted Zircaloy-3. The only harmful treatments indicated thus far are 800 C treatments in air. Ninety vacuum heat treated specimens of Zircaloy-2, argon melted Zircaloy-3, and vacuum melted Zircaloy-3 with the same temperatures and times of treatment as mentioned above have been in test 56 days. The corrosion rates are lower throughout for these samples as compared to the rates of samples treated in air or helium.

Radiation Damage and Recovery of Molybdenum. Radiation damage to the crystal structure of molybdenum is under investigation by an analysis of the x-ray diffraction lines, density, and microhardness. The kinetics of damage recovery, as well as pre-post irradiation data are being studied. Density determinations were made for samples representing the range of neutron flux exposures from 6.5×10^{16} nvt to 1.2×10^{20} nvt. The density of the unirradiated control samples is 10.210 ± 0.005 gm/cm³. The irradiated samples vary in density from 10.170 gm/cm³ at an exposure of 6.5×10^{17} nvt to 10.150 gm/cm³ at an exposure of 1.2×10^{20} nvt. These values are tentative and preliminary, thus, no comparison with theoretical x-ray values or attempt to estimate the defect concentration can be made at this time. The significance of the data is the trend of decreasing density (increasing volume) with increasing neutron flux exposure. Of particular interest is the indication of an increased volume for the three samples with 1.2×10^{20} nvt exposure in spite of the fact that the lattice parameter is slightly less than the unirradiated value. These values are preliminary and will be checked by more precise means.

Recovery of the lattice parameter at temperatures from 400 C and above is still being investigated. The latest results in this region indicate that the same equilibrium lattice parameter may be obtained by two different temperature paths, as predicted last month. The fact that above 400 C each temperature produces a certain net decrease in lattice expansion for a given initial concentration distinguishes the mechanism in this range from that occurring between 100 C and 200 C. Another difference is the fact that time for equilibrium to occur increases with increasing temperature in the 400 to 500 region. There are indications

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that a second order reaction is involved. Tests at 600 C in progress now will enable a more definite statement of the annealing mechanism to be formulated.

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, and (U-Zr) alloy/Al couples. The effect of thermal cycling during the diffusion anneal, on the rate of diffusion of uranium into AlSi, is also being determined. Four U/Ni/Al diffusion couples have been vacuum annealed at 530 C and two have been vacuum annealed at 569 C. These couples consist of a 0.001 inch thick disk of nickel between a 1/4 inch thick disk of uranium and a 0.005 inch thick disk of 2S aluminum. All diffusion interfaces were carefully cleaned before assembly. The first two U/Ni/Al couples were annealed forty-four hours at 530 C. One of these was cross sectioned to produce a plane perpendicular to the diffusion interfaces. Two uniform phases formed by interdiffusion between the nickel and aluminum were found. In addition, a third, non-uniform phase was found along the uranium/diffusion zone interface. The first phase next to the aluminum was 0.001 inch thick, the second was 0.002 inch thick, and the non-uniform phase was 0.0007 inch thick. All of the nickel had been consumed by the diffusion reactions. Photofluorometric analysis of the outer surface of the aluminum in a second couple annealed forty-four hours at 530 C showed a uranium content of about 60 ppm. However, this may be due to contamination or other errors in the analytical method. The aluminum in the two couples which were annealed 162 hours at 569 C appeared to have been completely penetrated by the Ni/Al compound.

A U/Al diffusion couple which was irradiated in the MTR at approximately 250 C was cross sectioned in four planes perpendicular to the diffusion interface. Small points projecting 0.0002 inch into the aluminum from the original U/Al interface appeared to be diffusion product. The diffusion zone of this couple and a similar couple which was examined previously have been photographed at a magnification of 280X. Data are being obtained by measuring the diffusion zone in the photographs and statistically analyzing the results.

Inert Gas Mobility and Swelling Experiments. The diffusion and agglomeration of the noble gases, krypton and xenon, produced by fissioning of U-235 have resulted in pronounced swelling of irradiated fissionable materials. This swelling appears to be markedly dependent on irradiation temperature and uranium burnup. Due to the possible effect of such swelling on fuel elements in proposed reactors, a basic study of the diffusion rate of those gases in pure metals and in both single and two-phase alloys have been initiated. These alloys are used to determine the effect of the precipitated phase on the inert gas diffusion and of the increased creep strength upon the swelling.

An application of the Volmer-Weber-Becker-Doring theory of nucleation was made to explain the rate of nucleation of voids and cracks in the swelling of irradiated uranium. The general equation for the precipitation of the gas phase at random sites in the uranium metal is:

$$\Delta G = a_1^{2/3}(S-s) + b_1 (\Delta G_v + E-e)$$

The first set of terms is the surface energy and the second is the volume energy or work involved in creating a void nucleus. An application of this equation for several simple nuclei shapes indicates that the inert gas ions will behave as a solution unless a "cluster" of ions of a critical size is formed by diffusion in the uranium. If the uranium yields isotropically, the shape with the lowest free energy, ΔG , is a sphere of radius 1.6×10^{-6} cm (80 atoms in diameter). If the elastic energy for flow of the uranium E is less in one direction, the shape of the nucleus is a cylinder with the axis in the direction of less restraint. If the degree of anisotropy is slight, an oblate spheroid would be formed. Gamma phase irradiation will tend to give spherical voids and alpha temperature will give cylindrical or oblate spheroidal voids.

The above results are for the case of random nucleation in the volume of the metal, where there is no surface energy, s , contributed by an imperfection or an elastic stress, e , already present at the site of the nucleus. Both of these factors reduce the critical size of the nucleus.

It was determined by statistical thermodynamics that the critical nucleus size is independent of the inert gas concentration and diffusivity. However, expressions have been obtained for the rate of formation of the void and crack nuclei which indicate that the gas concentration and mobility are definitely to be considered in even a preliminary consideration of nucleation of the voids and cracks that produce swelling of irradiated uranium.

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 lead assembly has been reading greater than 10^7 ohms resistance between thermocouple lead wires, but the asbestos insulated wires went through an unexplained loss of resistance to a low of 169,000 ohms. This loss occurred immediately on reactor startup. A slow recovery in resistance occurred until after 170 hours a reading of 10^7 ohms was recorded between lead wires for the asbestos insulated assembly also. To date, the two assemblies have been irradiated for only 17 days, since KW Reactor has been experiencing some operational difficulties.

The capsules, heaters, and heater lead wires for the 300 C thermocouple stability test have been fabricated. The capsules have been filled with National Bureau of Standards melting-point lead, and they will be calibrated prior to pile insertion. It has been proposed to run a "dummy" control capsule outside of the reactor concurrently with the capsule being irradiated. Instrumentation for this has been designed and is now on order. Thermocouple leads for the test will be either quartz or asbestos insulated, depending on the outcome of irradiation testing now in progress on the insulating characteristics of the two materials.

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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. During the month two elevated temperature tensile tests were performed at the Radiometallurgy facility - one at 300 C and the other at 450 C. Both tests were made on uranium exposed to 0.10 a/o burnup. The purpose of these tests is to determine to what extent neutron damage affects the mechanical properties of uranium at elevated temperatures.

The ultimate strengths at 300 C and 450 C were 61,000 psi and 21,200 psi, respectively. The first value is about 35 percent higher than a comparable value for unirradiated uranium; whereas, the second value is about 15 percent lower. The yield strength (0.2%) was 58,400 psi at 300 C and 18,900 psi at 450 C. These values are, respectively, about 90 percent and 50 percent higher than those for unirradiated uranium. Finally, both specimens exhibited less than one percent elongation.

It can be seen from these data that the effect of neutron damage on the yield point of uranium is much greater at 300 C which is below the self-diffusion range than at 450 C which is within this range. Since atomic diffusion will permit the climb of moving dislocations over defects or obstacles, it follows that at temperatures higher than 450 C the yield strength of irradiated uranium will approach that for unirradiated uranium more closely. A test of this material at 600 C should prove interesting from this standpoint.

New Fuel Element Development

Insulated Fuel Elements. Insulated fuel elements are of interest because the higher uranium temperatures during operation should enable the fuel element to operate with a decreased tendency to fail by thermal stress splitting. The swelling of the cored insulated uranium fuel elements which were operated in a K through-hole to 620 MWD/T has been studied with the aid of the electron microscope. Voids ranging in size from about 0.1 μ to 20 μ were observed throughout the cross section of the uranium with the larger size voids predominating at the fuel element interior and the smaller size voids predominating near the fuel element surface where the uranium operating temperatures were lowest. It appears that many of the voids are not spherical but have a longer dimension in the longitudinal direction of the uranium core. Microscopy of a longitudinal section of the uranium fuel is planned to determine if void growth has any directional preference.

A deterrent to the application of unbonded fuel elements in general, and insulated (unbonded) fuel elements in particular, is the possible manner of severity with which such a fuel element may rupture. To demonstrate the rupture behavior of an operating insulated and unbonded fuel element, one has been intentionally failed at the MTR in the GEH-4 facility. The fuel element contained a thermocouple for axial temperature measurement during operation and failure. Failure was caused by a hydraulically operated rupturing mechanism. The insulated fuel element was loaded in

the MTR, and the necessary thermocouple and hydraulic connections were made during the second week of February.

On February 14, the MTR went up to full power and after operating for 37 minutes, the rupturing of the fuel element was accomplished. The axial temperature of the cored insulated fuel element was 500 C at the time of rupturing. Exactly one minute after rupturing, the gamma monitor of the GEH-4 facility effected a "Junior Scram" of the MTR because of the facility water activity. Forty-five seconds of this one minute time interval was required for the facility coolant to pass through the water activity decay portion of the GEH-4 facility. Apparently, the remaining 15 seconds was the time required for activity to enter the coolant stream from the failed fuel element. There was no observed fuel element temperature fluctuation during the one minute interval between rupturing and scrambling. When the MTR was scrambled, the fuel element temperature fell rapidly to 210 C, then rose abruptly to 380 C, and then decreased to the ambient water temperature. There is no ready explanation for this temperature behavior during the scram, and there were no similar behaviors recorded on the MTR instrumentation. The fuel element was subsequently discharged from the MTR and unloaded from its basket without difficulty. There was no indication of fuel element swelling. The element is now at the HAP0 Radiometallurgy facility for post-rupture examination.

Tube and Rod Fuel Element. On January 28, 1958, the job of fabricating aluminum clad rod and tube fuel elements was started. A fuel element 20 to 30 inches long that would fit in the KER loop tubes was selected. Uranium dimensions were: rod - 0.938 OD; tube - 1.44 ID and 1.780 OD. Fabrication of the rod did not appear to present any major problems, therefore, effort was concentrated on fabrication of the tubular elements. Three, 20-inch long, tubular fuel elements are now ready for transfer to BMI where gas pressure bonding will be attempted during the week starting March 3.

The uranium tubes were vacuum cast into a cored graphite mold, machined to the correct internal and external dimensions and nickel plated. The plated uranium tubes were placed in the jacket tubes, nickel plated aluminum end caps were pressed in place and vacuum welded. The assembled elements were then outgassed for several hours at 450 C at 10^{-5} mm of Hg pressure. A small hole in one of the end caps allowed the off-gas to escape. After the outgassed elements had cooled in vacuum, they were promptly transferred from the vacuum furnace to the vacuum welder where the seal was completed.

Cold Closure Fuel Elements. Substantial economies in fuel element fabrication may be realized through application of the cold closure process. Work continues to develop the various process operations on such problems as attainment of good surface lubrication which is essential to cold closure fabrication. A good lubricant must: (1) be simple to apply, (2) prevent surface damage to the jacket and die material, (3) reduce the forces required to perform the particular operation, and (4) be easily

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removed, if necessary, after use. Two lubricants have been found which meet the above conditions. Several methods of I & E closure are being considered. Tools have been designed to prove feasibility of each method.

Lead-Dip I & E Segmented (Washer) Fuel Elements. The mode of failure of a segmented core fuel element provides a desirable operational safety factor by minimizing process tube damage. In order to determine the in-reactor performance of this type element, the "C" and "K" geometries have been fabricated and charged. Ten elements have recently been discharged from the KER Test Facility after approximately 350 MWD/T exposure at 240 C coolant temperature. Superficial examination of these elements revealed no noticeable corrosion of the M-388 jacket nor can wall deformation caused by differential expansion of the core. Four tubes alternately charged with "C" size I & E segmented core and standard I & E elements are currently being irradiated to exposure goals of 200, 600 and 800 MWD/T. Tools are being assembled to fabricate an additional four-tube charge of "C" size I & E segmented core fuel elements. This PT will run to rupture.

NPR Hot Pressed Fuel Elements. The first charge of NPR, segmented, I & E enriched fuel elements has been completed. In addition to the original order, eight solid core normal uranium fuel elements have been fabricated, two of each jacketing alloy, for corrosion testing of the jacketing material. Five additional fuel elements were fabricated for rupture testing. All were made of normal uranium KER washers, nickel plated as a corrosion barrier; however, two of these elements had the nickel plate machined off the faces and the other three were canned in the as-plated condition. Rupture test results indicated that the wafers which were entirely covered with the nickel plate exhibited better rupture characteristics than those plated on the edges only, apparently due to a compartmentalization effect. The time variable of the pressing cycle was changed from seventeen to four minutes to restrict the formation of the brittle time-pressure-temperature sensitive NiAl_3 layer. The present pressing conditions are a temperature of 600 C at a pressure of 12 tsi for a four-minute pressing cycle.

Rod Cluster Fuel. Rod cluster fuel elements satisfy many of the requirements for high specific power operation in the NPR. A test of four-rod clusters with large inter-rod spacing is now being completed in KER loop 3. A seven-rod cluster element test has been designed and is under construction for operation in KER loop 1. Four-rod cluster elements with stainless steel cladding have been exposed to 1200 MWD/T in KER loop 3. About 70 percent of this exposure has been accumulated with the outlet water temperature at 235 C. Goal exposure for these fuel elements, now operating at 43 kw/ft, is 2000 MWD/T. The seven-rod fuel test will operate in KER loop 1 during April. Fuel rods for the two 12-inch length test assemblies are Zircaloy-clad co-extruded uranium with 0.630 inch outside diameter and 0.030 inch clad. This rod was selected from 120 feet of co-extruded uranium received from Nuclear Metals Inc. The specific power of this test will be 70 kw/ft maximum, and the outlet water temperature will be held at 275 C for the duration of a 1000 MWD/T exposure.

A four-rod cluster fuel element with unbonded Zircaloy-2 cladding was irradiated in the MTR for an exposure of 680 MWD/T. Previous measurements of the fuel assembly after irradiation indicated diametral expansion. Metallographic cross sections, however, showed negligible diameter change. The uranium surface roughening is reduced by the cladding, but no bonding occurred during irradiation. A diffusion layer appears in the clad wall near the core interface.

Two, seven-rod fuel assemblies with 0.058 inch inter-rod clearance and 0.040 inch rod-to-tube clearance were intentionally defected and ruptured in 290 C water out-of-reactor. One assembly was defected by a 0.025 inch diameter hole facing toward the center of the bundle. Corrosion proceeded to split about 1-1/4 inch of the cladding in the vicinity of the defect. The remaining element was defected by a hole drilled into the end cap. Damage was more severe in this case; about 2-1/4 inch of fuel rod length being disrupted. Both elements show a large improvement in rupture safety over stainless steel clad and aluminum clad AlSi bonded uranium previously tested. Both were easily discharged from the test section with 100 pounds force.

Preparation of KER-Size Segmented I & E Enriched Uranium Test Elements. Continued difficulty was experienced in applying a satisfactory nickel plate on the enriched uranium washers used in preparing NPR test elements for the KER loop. This necessitated considerable development work. Eventually it was found that the application of a somewhat more severe preplating etch led to an adherent plate, while reduction of pressing time, and temperature produced a satisfactory bond. Fabrication of the current quota of NPR test elements has now been completed, and development work has been resumed to determine the most satisfactory and economical method of plating and/or selectively stripping plate from the washers. Following fabrication, this lot of test elements was put through non-destructive quality tests as insurance against early failure during exposure. A resume of the test applied is to be issued in document HW-55034.

Examination of KER - 1.6 Percent Enriched Washers. Representative specimens were obtained for metallurgical examination from the lot of 1.6 percent enriched KER-size washers being processed for hot-press canning. Samples were taken before and after vacuum outgassing for determination of hydrogen content, density, and chemical impurities. The results show that the material is well within production specifications, and that the vacuum outgassing treatment has reduced the hydrogen content to a very low level. Thirty samples, representing each outgassing treatment, were macro-etched and examined for grain size, and seven samples were examined for inclusions and stringers and observation of the microstructure. A thin surface layer of very fine grain size was observed on the washer faces resulting from recrystallization, during the vacuum outgassing, of a cold worked layer produced in surface grinding. Beneath this layer the macro grain size was quite uniform and appeared to be nearly 100 percent equiaxed recrystallized grains of 0.2 to 0.3 mm average diameter determined by the 20 X grain size eye piece method. Comparison of 100X photomicrographs of the material with a 100X grain size chart for uranium indicated that the grains of the material are 0.09 to 0.110 mm average diameter.

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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 has been 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). Thus far, a randomly oriented, fine-grained material obtained by beta heat treating followed by alpha phase vacuum annealing to promote recrystallization and remove hydrogen has proven most amenable to upsetting. During the month a series of heat treatments have been performed on dingot uranium stock to obtain as fine a recrystallized grain size as was obtained in ingot uranium. Of the treatments investigated, beta treating at 675 C with a direct water quench followed by a two-hour 600 C vacuum anneal has provided the finest recrystallized grain size. Only one test has been made with the intermediate die cavity, and in this test no apparent reduction in barreling during upset was observed. Best results to date have been obtained with stock temperatures of 450 C, die and punch temperatures of 350 C and 175 tons load. It is planned to increase the die temperature and load for the next tests.

High Temperature - High Pressure Bake Testing of Fuel Elements. Fuel elements intended for high temperature - high pressure service conditions are being evaluated for U-clad bond interdiffusion or other interactions by baking at 450 C under approximately 1000 psi nitrogen. Baking of an AlSi bonded fuel element at 450 C and 1000 psi for 1500 hours caused a significant diffusion of U through the bonding layer and into the aluminum cladding. Before baking, the uranium concentration changed from 100 percent (fuel surface) to about one percent in a distance of 0.004 inch. After baking, the uranium concentration was found to change from 100 percent to about one percent in a distance of 0.012 inch. This change in the dimension of the U concentration gradient was determined using alpha track autoradiograph analysis. Alpha track autoradiographic and spectrographic analyses of the outer surface of the clad after bake testing have given negative or conflicting results insofar as uranium concentration is concerned. These methods do not have sufficient sensitivity to measure the amounts of uranium which may diffuse to the cladding surface. The most recent results, obtained by wet chemical analysis, indicate that a concentration of uranium of 7 ppm ($\pm 30\%$) exists at the surface of the above mentioned baked AlSi fuel element.

Model for Determining Fuel Element Swelling Rates. The material in a reactor fuel element operates under various temperatures and stress conditions. The composite effect of these conditions must be considered when determining the overall rate of fuel element swelling. A model has been proposed which considers (1) the effects of diffusion rates of the fission gases on internal gas pressures; (2) the swelling rate of elementary volumes of material in terms of internal pressure, previous expansion, temperature, and self-restraint of the material; and (3) a method of combining these elementary rates in order to determine the overall dimensional changes of fuel elements. A rough draft describing

this model has been circulated for comments on the validity of the various assumptions. Further work using this method of analysis awaits acceptance of the feasibility of the proposed model.

Uranium Alloys. The wafer/washer fuel element concept is a candidate for NPR application since it fails in a preferred and desirable manner. Since it is possible that perhaps as much as 20 percent of the volume of a wafer/washer fuel element may have to be occupied by aluminum partitions to maintain the preferred manner of failure, it may be advantageous to substitute for this large volume of aluminum bulkheads an alloying addition of somewhat equivalent reactivity effect which may provide comparable or superior benefits. Accordingly, several uranium alloys which might possibly be substituted for the wafer/washer concept are being prepared for corrosion evaluation. These alloys are:

- (1) U - 3.8 w/o Si (Epsilonized)
- (2) U - 1 w/o Nb
- (3) U - 0.5 w/o Mo
- (4) U - 0.25 w/o Cr.

The alloys will be melted and cast into one inch diameter billets, fabricated to one-half inch diameter rods and prepared for testing. Evaluation will include corrosion testing of the base alloy and ELMO flow loop testing of AlSi bonded and hot press nickel bonded alloy fuel elements.

Restraint of Uranium Swelling by Zirconium Cladding. Data have been reported on the swelling rates of unrestrained uranium irradiated in the 400-800 C temperature range. To date, no data are available on the swelling of unalloyed uranium restrained by high strength cladding and irradiated with a 250-350 C cladding surface temperature and a maximum fuel temperature in the range 450-600 C. In order to obtain initial data for the above temperature conditions and restraint conditions similar to those of proposed NPR fuel elements, a NaK capsule MTR irradiation has been designed. Final assembly and shipment of the capsule to the MTR was accomplished early this month. Irradiation of the experiment to an exposure of 2500 MWD/T is scheduled to begin about March 10. It is expected that the leads from the thermocouple in the uranium core will have to be cut after the first cycle because of the capsule's location in the reactor. It is desirable in evaluating the swelling data to have a record of the uranium time at temperature for the entire irradiation period. Therefore, a second assembly identical to the first is being readied for shipment to the MTR, and it is planned that it be irradiated in a reactor position that will not require removal of the thermocouple leads.

To obtain additional data, a series of NaK capsule experiments for irradiation in Hanford reactors is being designed. Basically, the capsule consists of a fuel rod centered in a thick walled aluminum can of approximately normal Hanford slug size. Surrounding the fuel rod is an annulus of NaK to serve as a heat transfer media. The desired cladding

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surface temperatures can be obtained by varying the thickness of the NaK annulus. The fuel rods will be 0.570 inch in diameter and approximately four inches long, having 0, 0.020, and 0.030 inch Zircaloy-2 cladding.

For equal power generations and proportional dimensions, two fuel elements will have equivalent temperature distributions between the cladding surface and center of the fuel, and equivalent mechanical conditions for thermal stresses, swelling, and swelling restraint. Therefore, the data from these tests may be extrapolated to fuel elements of other diameters.

Two 305 Test Pile experiments designed to measure the following were made: (1) the relative flux values axially along the four-inch fuel rod, and (2) the effect on the flux if equal lengths of alternating uranium and low neutron absorbing material are substituted for a long rod of uranium. It was found that the flux is relatively flat over the entire length of the fuel rod and only in the last one-fourth inch at each end of the uranium does the flux increase become significant. The results of the second test showed a 2.5 percent increase in the flux at the middle of the long uranium rod as compared to that at the middle of the shorter rod. Therefore, it will not be necessary to apply any correction factors for the length of the uranium to the final flux calculations.

The test capsule must provide a reservoir into which the NaK heat transfer medium can expand as the fuel and NaK are heated and as the fuel swells. In order to accommodate a four-inch specimen and the required volume of reservoir, capsules for the low and high temperature cases must be 8.6 and 10 inches in length. These requirements eliminate the possibility of using standard Hanford cans as the outer clad. Capsule and closure designs using machined components are being developed.

Thorium-Uranium Alloy Fuel Material. Thorium - 2.1 w/o fully enriched U alloy is being investigated as part of a program to secure basic irradiation damage data. The third of six restrained specimens being irradiated at the MTR has been examined at the Radiometallurgy facility. These specimens are restrained by 0.120 inch of Zircaloy-2 cladding. Capsules irradiated to 0.5 and 1.5 a/o burnup were dimensionally stable. Some swelling occurred in a capsule irradiated to 1.5 a/o burnup. A 0.003-inch maximum increase in the capsule diameter (0.622 inch initially) was noted with this specimen, and the fuel sample itself increased 0.002 inch in diameter.

U-Mg Matrix Fuel Material. Uranium-magnesium matrix material is being investigated as a possible high burnup fuel. An attempt has been made to discover why the U-Mg material irradiated at the MTR in the shape of a HAP0 size fuel element swelled a calculated 3.25 v/o. Optical microscopy has given no hints as to the cause of the swelling. A replica of the irradiated material was prepared across a cross section of the fuel by Radiometallurgy, and this replica was examined in detail with the electron microscope by the Physical Metallurgy Operation. No evidence of voids in either the uranium fuel or the magnesium matrix was found, nor were there any other observations made which might explain the apparent dimensional instability.

Electron Beam Vacuum Welding. High voltage alternating current as a power source is being investigated to determine if it will make the electron beam process more economical and also expand the scope of use. Satisfactory welds have been made on standard HAPO I & E AlSi bonded elements and also unbonded aluminum clad fuel elements with AC power. Micro and macro sections of welds made with AC indicate that the quality is the same as closures made with direct current. The only detectable difference observed to date is that the AC weld has a slight ripple on the surface of the weld bead. AlSi dispersion in the fusion area was compared and the limited investigation indicates that the complete mixing of the AlSi takes place with either type of power. It appears that welds of equal quality can be made on aluminum components using either AC or DC. It will be necessary to evaluate the relative merits of the two types of power more completely to determine if any advantages are to be obtained with a specific type of supply.

Fuel Element Supports. With the advent of Zircaloy-2 clad fuel elements for use in the PRTR and the testing of this type of element for the NPR, it is necessary to develop a fuel element support system which will accurately position the elements in the reactor. One method of attaching Zircaloy-2 supports to 0.030 inch thick Zircaloy-2 tubing or co-extruded elements is by resistance spot welding. An 0.080 inch diameter bridge type support system attached to the tube with a spot weld spaced 1-1/2 inches along the length of the continuous support has been developed and is now being evaluated. The attachment area is bonded over an area of approximately 0.012 square inch per spot. The strength of a single spot in tension is approximately 700 pounds. With an inert gas shielding arrangement, the attachment area can be protected during the welding cycle so that the corrosion resistance of the joint is not impaired. The tab normally required for resistance spot welding is not required; therefore, the crevice at the point of attachment is very narrow, a few thousandths of an inch, and the amount of element jacket covered is essentially the same as the rail width. This system can be used with existing equipment and adapted to almost any diameter of thin walled tubing or co-extruded fuel element shapes with no distortion or warping of the elements.

Plating Laboratory Improvements. The need for controls on the various baths and solutions has become increasingly apparent during the recent trouble with KER washer plating. As a result, a system of controls is being developed for all critical steps in the plating process. A representative from the Illinois Water Treatment Company, manufacturer of the deionizer which supplies water for the plating laboratory, has studied the causes of malfunctioning of this device, and he made recommendations for remedial measures. He recommended replacing the filter ahead of the deionizer to provide a flow of 30-35 gpm, and also the installation of a water softener to furnish soft water for regeneration, without which proper operation of the deionizer can never be expected. Steps are being taken to carry out his suggestions.

HAPO Liaison at the MTR. The numerous Hanford irradiation programs at the MTR and ETR have necessitated a continuous liaison contact at the NRTS. The start of installation for the first of Hanford's two high

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pressure water fuel testing facilities continues to be in doubt. Unofficial word now indicates that installation will be set back again to April 15. The delays result because Kaiser Construction Company has not completed the installation of the GE-ANP facilities, which were originally scheduled for completion February 15, 1958.

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. Visual examination was made of heat exchange surfaces after six months operation. Only slight scale buildup was evident. No change was observed in heat transfer coefficient, although there is evidence of silt deposits in semi-stagnant parts of the exchangers. Material accumulation on the carbon steel baffles of the exchanger with the 175 F bulk cooling water outlet temperature continues to be greater than in the exchanger with 200 F bulk outlet. Microscopic examination of particles on the baffles showed no particular differences between the two exchangers.

Following construction of a make-up tank and feed lines, operation of ELMO-2 with a saturated solution of 1,5-dihydroxyanthraquinone at 180 C and a pH of 6.0 was started. This material has been suggested by ALCOA as a possible corrosion inhibitor. The initial seven to ten days were used to condition the loop and perfect solution make-up techniques. Coupons of aluminum, stainless steel, and carbon steel will soon be charged to evaluate corrosion inhibition effects. During the shakedown period decomposition of the anthraquinone apparently occurred. The decomposition was accompanied by a decrease in pH which may cause high carbon steel corrosion rates. Samples are to be submitted for analysis to determine the nature of degradation products.

Five fuel elements were tested in the ELMO-4 isothermal rupture test facility. Two of these were seven-rod clusters of rods of co-extruded uranium and Zircaloy-2, and the other three were hot-pressed washer-type I & E slugs with no bulkheads. The co-extruded cluster slugs, after being defected with a 25-mil pinhole, were tested at 290 C for two hours. In both cases the extent of rupture damage was surprisingly small. When the rod was defected in the void at the end of rod, the rupture progressed only three inches, and when the rod was defected in the side, the ruptured length was only 1-1/4 inches. In both tests about 100 lbs force was required to remove the ruptured assembly from the tube. No flow decreases or increases in pressure drop were experienced. The small extent of rupture indicates an excellent bond between the uranium and the Zircaloy-2.

Three hot-pressed, wafer, I & E slugs were tested to evaluate (1) flow blockage of the outer annulus, and (2) the effects of nickel plate "bulkheads" between wafers. To determine if the raised rings which were observed in previous tests would completely block the outer annulus,

a slug was tested that had the inner hole plugged. The wafers were nickel plated on the curved surfaces only. This slug was hot press bonded on the outer and inner surfaces; however, an improved bond over the two previously reported slugs was provided on this slug by decreasing the press time from 17 minutes to four minutes.⁽¹⁾ The test was run for one hour at 280 C. The annulus flow was not completely blocked, and the maximum pressure drop across the slug occurred after 43 minutes. The maximum OD of the ruptured slug was 2.07 inches, leaving a minimum annulus of at least 0.015 inch. Only half of the slug had ruptured, again an improvement over the previously tested slugs. The other two slugs tested used uranium washers nickel plated on all surfaces. The rupture characteristics of these slugs were superior to those slugs that did not have nickel plating on the flats of the wafers. The amount of flow obstruction was much less, and the first rupture indications were evidenced about 15 minutes later. Also, only one-fourth of each slug was ruptured as opposed to a minimum of one-half with those slugs that had only the outer and inner surfaces plated. Only nominal forces were required to remove the ruptured slug from the tube.

Operation of the ELMO-5 facility continued during the month at a pH of 10.0 with LiOH and a loop temperature of 290 C. Negligible corrosion rates have been obtained thus far for 304 stainless steel. Equilibrium corrosion rates of SA 212, 1032, and 1051 carbon steels were found to be quite low, 0.1 mil/year, after two months exposure. Two oxygen scavenger tests were also performed. Loop water was conditioned in the first test by adding one bomb of a 0.35% hydrazine solution three times a day. For the second test a 0.70% solution of hydrazine was added. Encouraging results were obtained during the initial stages of the first test. Data on oxygen content for the latter part of the first run and the entire second run are unreliable, presumably due to deficient sampling techniques. A closer controlled test is scheduled.

Testing in ELMO-6 at 300 C to determine the effectiveness of high Al/H₂O ratio in pH 4.5 H₃PO₄ was terminated during the month. The data are still being processed for alloys M-388, M-400, and X-2219. Alloys A-1, A-2, C-1, and C-2 (NPR candidate aluminum alloys) developed groups of shallow pits four to five mils in diameter. In addition, alloys A-1 and C-1 began to develop blisters. Most of the attack appeared confined to one side of the coupon surfaces. The canned slugs tested under similar conditions in ELMO-7 did not show extensive pitting attack on the outside surface of the can, and it thus appears that the inside surface of the can is subject to the worst attack. Water will not normally contact this inside surface, hence alloys A-2 and C-2 should be suitable for in-reactor testing. The ELMO-6 loop is now being set up to expose hot-press canned Cow slugs of A-2 alloy at 300 C, pH 4.5 H₃PO₄. This will furnish additional out-of-reactor information necessary to evaluate the characteristics of this alloy.

(1) Personal communication with G. S. Allison.

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Hot press canned Elephant slugs clad in NPR candidate aluminum cladding alloys (A-1, A-2, C-1, and C-2) were tested in the ELMO-7 facility at 316 C and pH 4.5 H_3PO_4 . After three weeks at four fps flow velocity the A-1 and C-1 alloys showed a few 1-2 mil blisters. All alloys showed a few small pits (about one-mil deep) scattered over the surface. After one week at 20 fps a few minor pits were found on A-2, C-1, and C-2 alloys. Blistering was noted on the rail attachment welds on all types of elements, but fewer were observed on the C-1 and C-2 type elements. Elements using the 3/4-inch long rails showed no particular evidence of physical weakness. An investigation has been started to definitely determine the cause of the blistering and its effect on the strength of the attachment welds.

Operation of the ELMO-9 facility continued at 250 C and pH 4.0 H_3PO_4 . The test is designed to determine if pH 4.0 H_3PO_4 has any deleterious effects on stainless steels and weld areas. No additional evidence of the intergranular corrosion has been obtained on sensitized 304 after three months exposure. Data to date suggest that pH 4.0 may be the borderline for the intergranular attack since it has been observed on one specimen.

High Temperature In-Reactor Loops Tests. The KER-1 loop was charged with 19 stainless steel clad cluster slugs under Production Test IP-144A on 2/13/58, following successful low temperature (110 C) functional operation. The loop was scheduled to operate at maximum authorized temperatures to check the loop equipment and operation at these elevated outlet temperatures. However, the development of a leak in the effluent piping on 2/15/58 necessitated switchover to one-pass process water.

Excessive leakage of the dump valve in the KER-2 loop has necessitated operation on single pass process water since 1/31/58. At that time the ten Elephant slugs were discharged at 270 MWD/T following 32 exposure days at an average effluent water temperature of 224 C and an average inlet temperature of 197 C. Indicated corrosion rates were 0.4 to 1.1 mil/month, at maximum surface temperatures between 240 and 247 C. These rates were 1/2 to 1/3 those predicted from experience in the H Loop. The loop will remain on process water until the replacement parts for the dump valves are received and installed. The valve parts are scheduled for shipment on 2/28/58. One of the primary pumps had the heat barrier isolation gasket replaced and is in the process of having a balanced impeller installed.

The KER-3 loop was operated with single pass process water as a result of excessive leakage of the dump valve. Prior to low temperature operation, the current charge had accumulated only 24 days exposure to 225 C water temperature. Replacement parts for the dump valve are scheduled for delivery 2/28/58. Following repair of the dump valve, the loop will resume operation at 240 C outlet, pH 6-7.

Ten lead-dip Elephant slugs were discharged from the ELMO-4 loop on 2/23/58 due to excessive dump valve leakage. Since these slugs were on recirculation for only a few days and on single pass operation for a week, they were not retained for examination. Replacement parts for the dump valve are scheduled for delivery on 2/28/58.

Organic Coolant Studies. Due to seal failure the Dean Brothers pump in the ORA-1 ex-reactor facility was replaced with a chempump and the loop is now operating at 370 C to evaluate the effect of MIPB on candidate fuel cladding materials. The current test will be terminated in two weeks after six weeks total exposure. The next run will be at 400 C.

The ORA-3 ex-reactor facility is in service to evaluate seals and closures in high temperature organic service. Loop operation at 575 F has been continuous except for a three-day shutdown to add a new test section. Under test is a soft-iron serrated gasket using smooth machined flanges. There is no indication of leakage after one week of operation. Another soft iron gasket having no serration and using serrated flanges showed no leakage after five weeks. The Barco expansion joint leaks slightly but is tolerable.

A laboratory apparatus for studying removal of hydrogen, water, and tar from organics was designed. Procurement of materials is under way. Pyrolytic decomposition studies are about 90 percent complete.

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. A new production test is being written for operation of these tubes at elevated outlet temperatures in the range of 130 to 150 C.

In a test to determine the effect of radiation on corrosion (PR 105-550-E, Supplement A), tube 2943-KE, charged with dummy slugs containing flux monitoring gold foils, operated satisfactorily. The tube is scheduled for discharge at the next reactor outage, after approximately 100 days at 110 C outlet temperature.

To date, the ex-reactor test to evaluate the localized corrosion characteristics of M-388 aluminum under H Reactor operating condition has now proceeded for 85 days of 150 scheduled days at 120 C and 45 gpm. The test to compare M-388 and 1245 aluminum in process water with 1.0 ppm dichromate and intermittent purging has now proceeded for about three weeks at 140 C and 40 gpm. Slug jackets are scheduled for early examination. A test was started to evaluate several aluminum alloys in a venturi type restriction where cavitation or erosion may occur.

In a test to evaluate carbon steel corrosion in reactor effluent water, additional carbon steel (ASTM A7) samples were removed from the floating sample rack in the 107-KE effluent basin. These samples are in the process of being decontaminated, cleaned, and weighed.

In a test to determine the effect on aluminum corrosion of irradiation in a Zircaloy-2 process tube, the fifth weighed charge of metal was removed from the tube. The tube itself will remain in the reactor for some time. Additional charging of weighed metal is not planned.

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Decontamination Studies. A detailed program for studying the decontamination of carbon steel for the NPR was prepared. A literature search was made, and it was found that there has been little work done thus far on carbon steel decontamination. WAPD is the only significant source of information. Their only recommendations concern the use of solutions (called RDS and ODS) similar to solutions recommended for KER decontamination. WAPD has attempted to decontaminate the SIW carbon steel heat exchanger system at Arco. Attempts are being made to get information on results of these tests.

M-388 aluminum alloy coupons were exposed to decontaminating solutions at 65 C. Replicas were made of the surfaces before and after exposure. A thirty-minute treatment with a reducing solution removed all traces of machine scratches. A generalized attack was noticed over the whole surface. Localized attack was noticeable after thirty minutes exposure to an oxidizing solution. The surface was covered with pits and protrusions. Some areas were also relatively immune to attack by this solution.

Crud Studies. A literature search is in progress to survey work done elsewhere in this field. Very few definitive documents have been located.

Service Work. Replacement of corroded Filter Head loss sensing elements with elements made from a different aluminum alloy was recommended to KE-KW Maintenance Engineering Operation, IPD. Frequent flushing or continuous flow through the chambers was also suggested to reduce the pitting attack. Spectrochemical analyses, supported by spot tests and density measurements, indicate that present elements are made of a high copper content aluminum alloy, such as 2011 (11S). This type of alloy is not as corrosion resistant toward Hanford filtered or process water as are other alloys, such as 1100 (2S) or 6063 (63S). Pitting of this aluminum at low temperatures is more severe in stagnant water than in rapidly flowing water. The use of elements made of either 1100 or 6063 alloy instead of 2011 type alloy and establishment of frequent flushing or continuous flow through the chambers was recommended to reduce the rate of pitting attack.

Thermal Hydraulics

Flow Hazard Studies. Experimental heat transfer studies of the response of reactor process tube assemblies to imposed hazardous operating conditions were continued. Eleven experiments were performed further simulating the transient response of a "C" I & E fuel element in a "C" process tube to sudden step reductions in flow. This series of experiments now totals 38 transient runs. It has been found that the initial pressure reduction following a sudden plugging occurrence upstream of the tube inlet is not as great as calculated from theoretical considerations. This is of concern for it means that it may be possible under the present method of calculating limits for solid fuel elements to incur certain flow reductions in "C" process tubes that would not be detected by the Panellit gage system but would lead to boiling burnout and possible melting of the fuel elements. While the range of these specific flow reductions is not known exactly, it is believed to be restricted to a

small range of tube powers. The problem concerns moderate flow reductions, just large enough to lead to boiling burnout. In the event of large flow reductions the initial pressure decrease is large, even though not as great as calculated, and a Panellit trip can be assured.

The high top of annulus temperatures associated with eccentric I & E fuel elements is deemed to cause the discrepancy between the actual and theoretical initial pressure reductions following a sudden plugging of the flow upstream of the process tube inlet. The high water temperatures cause local boiling effects which seem to cushion the sudden pressure change. This is in spite of the provision for flow interchange between the internal and external cooling channels at the simulated slug junctions. Changes in the experimental apparatus have been designed to provide exact positioning of the heater rod within the process tube and thus allow a more precise examination of eccentricity effects.

Hydraulic Studies. Information was obtained and reported concerning flows and pressures in process tubes during the low flow conditions encountered after reactor shutdowns during charge-discharge periods.

An experimental study was made of the pressure drop across solid aluminum dummy slugs containing a 1/2 inch axial hole. Use of a few of these pieces in dummy trains is being examined as a means to increase the pressure at the end of the active section in the process tube in order to suppress boiling at the top of the annulus for I & E fuel elements.

Work was nearly completed on the rearrangement of piping in the hydraulics laboratory to accommodate test sections for pressure drop measurement of PRTR fuel elements. The rearrangement of piping will also provide for special test sections to study two phase pressure drop and critical flow.

Construction was started on test sections designed to investigate the phenomenon of critical flow in pipes and orifices. Initial tests will be aimed at revealing the effect of thermodynamic unequilibrium on mass rates of flow during critical flow.

A heat balance analysis was made of the KAPL 120 loop with the purpose of investigating methods of determining heat generation rates within the fuel elements. Results indicated that the physical makeup of the loop and the methods used to measure temperature and flow rate are such that heat generation rates cannot be calculated accurately by heat balance methods.

High Pressure Heat Transfer Apparatus. The thermal stress cycling test of the section of process tube proposed for an ETR installation was completed. After 500 cycles the test section revealed no visible signs of deterioration although numerous difficulties were experienced with the high pressure apparatus during the test. Equipment troubles included breakdown of two different pumps (one of which required extensive repairs), failure of a preheater pressure vessel, and numerous gasket failures. Not all of the difficulties could be attributed to the thermal cycling tests but were charged to the inherent difficulties to be expected with

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experimentation with large pieces of apparatus at high temperatures and pressures. The replacement parts for one recirculating pump were shipped on February 13, and it is expected that the pump will soon be placed back in service.

The vertical test section was subjected to initial "shakedown" runs prior to readying the equipment for experimentation with electrically heated mockups of PRTR fuel elements. As part of this proof testing, a brief program was initiated to determine boiling burnout data at conditions similar to those previously run in the horizontal test section. The first burnout point, determined with a 1.44-inch solid rod at a pressure of 1500 psia and a heat flux of 107,000 B/hr ft², revealed that film boiling started initially on one side of the vertical heated surface but soon spread around the entire circumference. Once the initial film boiling was established the circumferential spread seemed to be self-propagating with a gradual increase in the temperature of the heated surface.

Project CG-661. Six bids for the rectifier system to provide added heat generating capacity were received and opened on February 5. Prices ranged from \$169,000 to \$377,000. An engineering evaluation of each proposal was made, and recommendations were submitted to the AEC.

Heat Transfer Coefficient Studies. Initial experimentation was started on an electrically heated mockup of a seven-rod fuel element similar to the type under consideration for the NPR. The test section consists of 0.625-inch Hastalloy rods spaced 0.05 inch apart with nine thermocouples installed at various points in the surfaces of the heated rods. Results of these first experiments were inconclusive because of difficulty with the thermocouples but indicated that this experimental method would prove adequate to define the heat transfer characteristics of closely spaced rods.

A brief analytical study was made of the temperatures in the cladding of a fuel element that had an area of poor bonding between the uranium and the cladding. The study was made at the request of Testing Methods, FPD, and was aimed at determining the temperature distribution to be expected in regions of bond defects in fuel elements during a revision of the frost test where heat is to be supplied by eddy currents. A brief numerical type solution indicated that for a uniform heat addition rate of one KW per lineal inch, an unbonded region of cladding 1/2 inch in diameter would have a temperature 50 F above the uranium temperature compared to 12 F in the cladding at points unaffected by the unbonded region. After power was removed, it could be expected that the cladding temperature in the unbonded area would drop to the uranium temperature within 1.0 second compared to 0.5 second for the rest of the cladding.

Organic Heat Transfer Studies. Experimentation was continued to investigate surface fouling of unirradiated MIPB on heat transfer surfaces. Fouling was encountered in four of eight runs made at surface temperatures between 830 and 950 F, bulk temperatures between 500 and 700 F, velocities of 10.5 ft/sec, and heat fluxes between 300,000 and 440,000 B/hr ft². The fouling was detected by both an approximate 20 percent decrease in heat transfer coefficients and visual examination of the heat transfer surface.

A spectrographic analysis and a carbon determination of the film deposit from one of the earlier runs indicated 40 percent carbon; trace amounts ($< 0.01\%$) silver, beryllium, bismuth, and titanium; moderate amounts (0.01 to 1.0%) barium, calcium, chromium, manganese, molybdenum, nickel, tin and zinc; moderate to strong amounts (about 1.0%) of aluminum, iron, sodium, lead, and silicon; and strong amounts ($> 1.0\%$) of copper and magnesium.

As the exact threshold of the surface fouling that is being experienced has not been defined, plans have been made to make additional runs with closer control over variables likely to influence the formation of the film.

Carbon Steel Heat Exchanger Tests. Design was completed and construction started of a small test section to determine fouling of a carbon steel heated surface when cooled by Columbia River water. The test section will consist of a 0.675 inch OD carbon pipe heated internally with an electric heater and cooled with raw river water. Fouling will be detected by a decrease in the heat transfer coefficient as indicated by an increase in temperature of the heated surface.

Mechanical Equipment Development

Organic Cooling System Components. The Duraseal mechanical pump seal operated for a period of 102 hours at 665 F in MIPB. No difficulties were experienced with the seal. The two aluminum and two iron flat gaskets under test continued to operate with no signs of leaks. Two gasket leaks developed during the month; one a flexitallic gasket, the other a ring joint orifice plate. No leaks developed in either compression fitting connected jumpers or flared fitting connected jumpers. A small leak developed in one of the screwed fittings under test.

The facility is being redesigned to relocate the Chempump, install a large mechanical seal pump, install a "flanged type" heater, and install indicating lights and additional safety interlocks.

Shielding Studies

Attenuation Measurements. All of the gold and sulfur foils from the unheated ordinary concrete and 320 C magnetite concrete experiments were counted and the data sent to IBM for processing. The ordinary concrete is now being baked at 100 C. No further experiments with the magnetite concrete are planned. Attenuation measurements of the ferrophosphorous concrete test slabs in the as-cured condition continued during the month. The ion chambers to be used in determining gamma relaxation length of the ferrophosphorous concrete have been fabricated and assembled. The chambers have been calibrated over the range of 750 Kev to 2 Mev and are ready to be placed in the test slabs during the next DR Reactor shutdown.

Thermal Shield Studies. A program document (HW-54829) on experimental studies on thermal shields was issued. Sixteen thermocouples were prepared for the C Reactor experiment. Shop work started on access ports

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for the thermocouples. A prototype ion chamber for use on the C Reactor Thermal Shield Test Facility was fabricated and tested. Two more such chambers will be fabricated for use in the facility.

Neutron Spectrometer. The last component, the 100-channel analyzer, needed for final assembly of the neutron spectrometer was delivered on February 17. Final assembly of the spectrometer is now under way. Calibration and standardization of the instrument is scheduled to start next month.

Service Work. Work is continuing on a request from the Chemical Processing Department to calculate the shielding requirements for the isolation and packaging portion of the Cesium Recovery Plant. A rigorous calculation of the heat generated by the cesium chloride during storage in the shipping container is necessary. Preliminary estimates made by CPD on the most conservative assumptions indicated that the temperature of the powder might rise to 600-700 F. The most severe assumption used in making this estimate was that all of the gamma radiation could be absorbed in the source. Since temperatures this high could produce warpage of the shipping container and melting of the lead shielding near the source, it is necessary to obtain an accurate calculation of the volumetric rate of heat generation in the container and in the shielding. Results of this calculation will determine if cooling or special handling of the shipping container will be required.

Service rendered to IPD comprised the continuance of calculations to determine core and reflector neutron fluxes for the NPR using two-group diffusion theory. Reflector savings, critical bucklings, and enrichments were determined for an infinite radial reflector, and finite reflectors of thickness 50, 75, and 100 cm. As expected, the calculated reflector savings are about 50% greater than the corresponding one-group result for the thicker reflectors. The effect of this on critical enrichment is negligible (about 0.1% change), but the effect on the relative power for the flattened reactor could be important. The flattened core (three-region, two-group) has been set up as the solution of eight simultaneous, homogeneous, linear equations and transmitted to the Data Processing Operation for solution. There are two improvements that two-group theory can provide versus one-group in relative power calculations for the flattened reactor: (1) better value for reflector savings; (2) better flux curve near the boundary. These effects will be studied separately since the first could be incorporated into the one-group formalism without doing a complete two-group calculation, while the second requires a complete two-group treatment. Thus, if only the reflector savings are significant, the greatly increased complication of two-group calculations will not be required for further routine calculations.

Nonmetallic Materials Development

Graphite Burnout Monitoring. Weight losses from graphite burnout samples discharged from channel 3478-D on January 24, 1958, indicate a maximum oxidation rate of 2.05%/1000 operating days for a fourteen-month exposure period. The rate for the previous sample series irradiated in this channel was 1.86%/1000 operating days. Graphite burnout monitoring

samples discharged from channel 2577-DR indicate an unusually low oxidation rate of 0.06%/1000 operating days. A maximum rate of 0.24%/1000 operating days was observed for the previous sample series. Samples in the low flux downstream part of both D and DR Reactors were more radioactive than the center or upstream samples. A radiochemical analysis is being made to identify the isotopes causing the increased activity.

Reactor Graphite Monitoring. A redesigned core boring device for obtaining graphite samples from reactor tube blocks was used successfully at DR Reactor. Revisions in the core borer design reduced the diameter of the drive sections and simplified and strengthened the coupling between these sections. This has reduced the possibility of equipment breakdown during a coring operation and has resulted in greater ease in positioning and assembling the device. Five samples, taken for the purpose of monitoring stored energy were recovered from 2577-DR, a bare channel in which burnout rates are being monitored. Data obtained from the cores are representative of conditions existing in filler block regions of the reactor. Estimates of the stored energy content of the cores have been made from the C_0 spacing. The results are shown in the table below:

Radiation Damage to Reactor Graphite
Dry Tube 2577-DR

<u>Sample</u>		<u>Properties</u>		
<u>Distance From</u> <u>Front Van</u> <u>Stone Flange</u>	<u>Position on</u> <u>Tube Block</u>	<u>C_0 Spacing</u>	<u>Crystallite</u> <u>Size, L_c</u>	<u>Estimated</u> <u>Stored Energy</u>
8' 8"	Bore	6.786 Å	550 Å	60 cal/g
9' 6"	Outside	6.798	305	65
9' 6"	Bore	6.791	300	60
10'	Outside	6.791	265	60
10'	Bore	6.795	280	65
20' 11"	Bore	6.746	235	35
22'	Bore	6.742	218	35

A correlation of C_0 changes with stored energy at several temperatures indicates the above stored energy estimates are the maximum values to be expected. They will be checked by heat of combustion measurements at the National Bureau of Standards.

High Temperature Graphite Irradiations. A three-cycle irradiation of graphite samples in the GEH-9-6 assembly was completed in the L-42 position in the MTR on February 10. Four graphite samples were controlled at 1050, 975, 750, and 750 C. The facility has been discharged and is scheduled for disassembly in the MTR hot cell on March 4.

The difficulty reported last month with the control units for the Hanford controlled temperature irradiations (PT-IP-21A) has been corrected. After bridge circuit modification in the feed back loop, enough reset is now available to perform the necessary control. Minor additional testing is in progress to determine optimum control settings.

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Gamma Irradiation of Plastics and Elastomers. It is desirable to conduct accelerated radiation damage tests in plastics at dose rates of 10^4 r/hr and higher. At lower dose rates, periods of years are required to demonstrate practical radiation damage limits for existing materials. Over the range of 10^4 to 10^7 r/hr the effect of dose rate on the mechanical properties of most plastics has been shown to be negligible. A gamma irradiation facility is now being installed which will allow the irradiation of a few selected materials at about 10^2 r/hr for long periods of time. These studies will extend the present knowledge on the effect of dose rate so that data on damage effects accumulated over a period of days or weeks at 10^4 to 10^6 r/hr may be applied with more certainty for irradiation service conditions of 10^2 to 10^3 r/hr.

Radiation Effects on Candidate Organic Coolants. Infrared analyses have been completed on methyl biphenyl and monoisopropyl biphenyl which were irradiated at 320 C to an integrated neutron dose of 2.14×10^{18} nvt thermal and 2.03×10^{18} nvt fast. A composite sample of biphenyl irradiated at 50, 54, 60, and 320 C to an average exposure of slightly less than the above was also analyzed. Very little difference between infrared spectra of irradiated and unirradiated samples was found even though distinct color changes and other property changes occurred, as reported in HW-52815. The infrared results indicate that no gross changes have occurred in the type or number of functional groups present. The formation of polymers and larger aromatic ring systems and also some smaller hydrocarbons and hydrogen gas, as indicated by previous work, is not inconsistent with the infrared results.

Structural Materials Development

NPR Zircaloy-2 Process Tubing. The first extrusions for Reactive Metals, Inc., have been made at the Adrian, Michigan, Plant of Bridgeport Brass Company. These are three short pilot tubes and two full-length pieces. Technical difficulties have delayed extrusion of the remainder of the order. The pilot tubes are to be sent to Tube Reducing Corporation immediately upon de-jacketing and conditioning.

Chase Brass and Copper Company has not yet extruded the final tubes on their order, but the ingots have been forged and are being machined. They are putting the final touches on their welding fixture and expect to make some experimental welds by approximately the first of March. Their welding fixture will allow them to evacuate the weld area and back-fill with inert atmosphere.

Allegheny Ludlum Steel Company has extruded four of the six new KER-size Zircaloy-2 tubes under contract DDR-32. They were described as excellent extrusions with an exceptionally smooth surface. Welding and radiography during the last week in February is expected to produce the first full length welded extrusion bloom for shipment to Tube Reducing Corporation about the first of March.

Experimentation has continued in the HAP0 laboratory to demonstrate satisfactory butt-welds on NPR-size tubing. Although an area of discoloration at the outer edge of the heat-affected zone persists, corrosion and rolling tests indicate that this discoloration may be innocuous. Samples including the discolored areas have been submitted to accelerated corrosion tests with no indication of preferential attack. Similar samples have been cold rolled to 40 percent reduction in area without fracture.

Advance Studies

Multiple-Hole Fuel Elements. The application of multiple-hole ("inverted cluster") fuel elements to operation with super-critical water as a coolant is being surveyed. Fossil fuel power plants have been constructed to use water at 3500 psi, with net conversion efficiencies of 40%. Use of water at super-critical pressure as a reactor coolant could result in capital cost reductions of 1/4 to 1/3.

In the multiple-hole fuel element, process tube and fuel jacketing functions are simultaneously served by small diameter coolant tubes within the fuel, rather than by process tubes and external jackets. These small diameter tubes can have considerably thinner walls to contain coolant at a given pressure. In addition, the permissible stress level in these "expendable process tubes" is much greater than the stress levels allowed for the larger conventional process tubes, on the basis of creep and embrittlement limits. It appears practical to contain water at 4000 psi in a 3/8 inch ID tube with a wall thickness of 0.019 inch without exceeding a hoop stress of 25,000 psi in the tube wall. A Zr process tube with 3.75 inches ID would have a wall thickness of 20 times this value at present allowable design stresses of 12,500 psi.

Stainless steel may be used as tubing material because of the thin tube walls and because the tubes and coolant are located within the fuel. This location reduces the neutron flux and proportional loss at the tubes. It also reduced the reflection of thermal neutrons by the coolant prior to their reaching the fuel.

Fluidized Pellet Bed Reactor Study. Calculations are essentially completed, and a report is being prepared. The economic evaluation portion is based on two reactor sizes, equivalent in power to the PRTR and the PG&E reactor.

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.

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C. CUSTOMER WORKCorrosion Studies

Corrosion of H Reactor Pigtailes. Pigtailes from the rear face of H Reactor were examined to determine whether any corrosion damage resulted from the use of Turco 4306B cleaner to decontaminate the rear face on September 23, 1957. To date, no evidence of unusual corrosion has been obtained. Six of these pigtailes were fatigue tested by the Physical Metallurgy Operation with the following results. Four pigtailes resisted more than 9.4×10^6 cycles before failure while two resisted less than 3.3×10^6 cycles before failure. Three of these fatigued samples and three as-received pigtailes were metallurgically sectioned and showed no evidence of unusual corrosion. These results are in marked contrast to previous tests on pigtailes from other reactors all of which have shown poor fatigue resistance. It is possible that the sampling of pigtailes from the reactors has not been random.

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-109AC continued. Longitudinal sectioning of the male end revealed that undercutting had progressed to and around the end of the slug and back along the inner spire for a distance of about one inch. Examination of the longitudinal sections following electrocleaning indicated that the peripheral beta phase zone extended to the end of the uranium. Metallography of a wafer from this end of the slug is being performed in order to more definitely establish the extent of the beta phase zone.

Corroded I & E Fuel Elements. The 105-C Basin examination of I & E fuel elements irradiated under PT-IP-44-A and IP-45-A revealed several slugs which appeared to have undergone corrosion attack associated with small black particles embedded in the jackets. These particles were similar to fly ash in appearance. Corrosion attack was also observed along the top surface of several other slugs. The reduced flow through the upper portion of the coolant annulus resulting from the large slug diameter (1.474 inches) apparently caused this attack. Two slugs from this test were selected by the Fuels Fabrication Development Operation for more detailed Radiometallurgical examination. The irradiation and fabrication history of the slugs selected is tabulated below:

Piece Number	151	W-15-2-56
PT	IP-45-A	IP-44-A
Tube Number	1587-C	3363-C
Discharge Date	12/4/57	10/23/57
Exposure - MWD/T	572	768
Canning Method	Hot-press	Pb-dip (control pc.)
Jacket Material	1245 Al	1245 Al
Type of Attack	Top surface corrosion	Embedded particles

Metallographic examination of a transverse section through the most severely corroded section of slug number 151 revealed traces of intergranular attack. The attack at the grain boundaries did not extend more than one or two grains deep. Jacket thickness measurements revealed a minimum aluminum thickness of one mil and a maximum of 21 mils in the corroded area. All but one of the embedded particles initially observed on slug W-15-2-56 were not visible after transfer to the Radiometallurgy examination cell, and this was not as pronounced as originally observed. An attempt is being made to remove the particulate matter from the corrosion pit in which it is embedded for identification.

Examination of Ruptured M-388 Clad Slug from IP-39-A (RM-219). Further examination of the M-388 clad ruptured slug from IP-39-A disclosed two large unidentified particles embedded in the AlSi under the cap. The particles, whose major dimension was about 1/8", appear to have been in position when the slug was canned. Samples of the particles have been obtained, and an attempt will be made to identify the material by x-ray diffraction methods.

Examination of the can wall in the hot spot region showed that corrosion in this region did not penetrate the can wall. Results to date have not disclosed any intergranular corrosion. The study of the can wall in the hot spot region is continuing to verify the absence of intergranular corrosion.

Examination of Stainless Steel Tubing from KAPL-120 Loop (RM-217). Cracks developed in a section of 3/8" stainless steel tubing in the KAPL-120 loop in 100-H Area. The cracked section was removed and sent to Radiometallurgy for examination. Results of the examination showed that the failure was due to stress corrosion cracking which started from the outside of the tubing. Water soluble chlorides leached from the magnesia insulation are believed to be the source of the corrosive environment.

Metallography Service

An evaluation of the quality of 15 Sylvania hot pressed, nickel plated I & E fuel elements has been completed for the Fuels Preparation Department. Examination and measurement of sections taken from these elements has shown the following. The aluminum caps and bases, can walls, and spire walls are quite uniform in thickness. The diffusion weld closures are all good. The average nickel thickness on the caps and bases ranged from 1.75 mils to 0.43 mil; however, the effective nickel diffusion barrier was found to be zero on 12 out of the 15 elements since aluminum-uranium diffusion was found on these elements. Nickel measurements on the OD and ID of the elements showed a range of average thicknesses from 1.43 mils to 0.63 mil. The minimum thickness on any one element was often only about 50% of the average thickness. A transverse section from each of four elements contained areas where aluminum-uranium diffusion had occurred. Two of these elements had a definite eccentricity to the nickel plate, and therefore some very thin plated areas. The other two elements did not have any noticeable faults in the nickel plate, but since areas of aluminum-uranium diffusion were found, it is felt these two may have been held in the hot press too long. The hot press treatment caused some slight upsetting of the uranium as shown by a decrease in the ID as well as an increase in the OD of the center sections of the elements. A final report on this investigation is being prepared.

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Total samples processed: 211

Photographs:

Micrographs 212

Macrographs 70

Total 282

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-55162 A2.

J W. Albaugh

Manager, Reactor and Fuels Research
and Development Operation

FW Albaugh:kb

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JJ Cadwell	2/3-4 2/5-6	US-AEC, Washington, DC GE-APED, San Jose, Calif.	Geneva Conf. Program Mtg. Discuss irradiation in APED - VBWR.	J Simmons WK Woods	Yes No
EA Evans	2/5-6	GE-APED, San Jose, Calif.	"	"	"
RJ Anicetti	2/5 2/6	WAPD, Bettis Field, Pittsburgh ANL, Lemont, Ill.	Attend UO ₂ Panel Meeting Discuss ceramic fabrica- tion technology	J Belle JF Schumar J Handwerk	Yes "
JW Goffard	2/11-14	Phillips Petroleum Co., Idaho Falls, Idaho AEC-100, Idaho Falls, Ida.	Observe loading of a sub- sequent controlled failure of a fuel element.	R Fernow --	Yes "
JC Tobin	2/24-25 2/26-27	WAPD, Bettis Field, Pittsburgh ANL, Lemont, Ill.	Mtg. re application of Zr in water-cooled reactors Discuss mutual problems re physical metallurgy	B Lustman JF Schumar	Yes Yes
SH Bush	2/26	ASM Meeting, Spokane, Wn.	Present paper	HW DeMoney	No
R Harrington	2/6	Stanford U., Palo Alto, Calif.	Deliver talk to chemistry students under HAPD Univ. Relations Program	CJ Pings	No
RE Nightingale	2/4	Div. of Research, AEC, Washington, DC	Geneva Conf. Program Mtg.	D Stevens	No
LA Hartcorn	2/26-27 2/28	Mallinckrodt Chem. Wks., St. Louis, Mo. BMI, Columbus, Ohio	AEC Metallographic Mtg. Consult on metallographic practices & techniques	RF Hartman DM Cheney RF Dickerson	Yes Yes
HP Oakes	2/11-12 2/13	Carpenter Steel Co., Union, N.J. Mallory Sharon, Niles, Ohio Damascus Tube, Greenville, Pa.	Consultation on Zr fab- rication " " "	N Chernik WC Fetter Mr. Burd	No " "

A1-30

HW-55162

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VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JW Riches	2/12 2/13 2/14	Baker Co., Newark, N.J. Columbia Natl. Corp., New York Tube Reducing Corp., Wallington, N.J.	Consult re Zr fabrication " "	Mr. Hartnett RS Morse SN Randall	No No "
	2/24-25 2/26	WAPD, Bettis Field, Pittsburgh Bridgeport Brass & Copper Co., Bridgeport, Conn.	Mtg. on Zr technology Consult re Zr fabrication	B Lustman Mr. Ludington	Yes No
	2/27	Allegheny-Ludlum, Watervliet, N.Y. Tube Reducing Corp., Wallington, N.J.	" "	RE Rohrabaugh SN Randall	" "
PJ Pankaskie	2/13-14	Tube Reducing Corp., Wallington, N.J.	"	SN Randall	"
JF Fletcher RE Dunn	2/12-14	GE-ANPD, Cincinnati, Ohio	Discuss reactor control design techniques	WJ Lawson	Yes
JR Triplett	2/17-19	American-Standard, AE Div., Mountain View, Calif.	Consult on contract for computer code development	EJ Leshan	Yes
OJ Wick	2/11	AEC, Washington, DC	Attend meeting on plu- tonium technology	G Courtney RO Roth	Yes

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Bldg. & Area Visited
JA Fellows	2/4-7	Mallinckrodt Chem. Wks, St. Louis, Mo.	Discuss uranium metal- lurgical problems	SH Bush GS Allison JC Tobin WE Roake	Yes	303,325,326, 300; 105-KE
P Loewenstein HF Sawyer	2/5-7	Nuclear Metals, Inc., Cambridge, Mass.	Discuss fuel element program	JE Minor GT Geering SH Bush JC Tobin	Yes	303,325,326, 300; 105-KE

A1-31

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HW-55162

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VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
B Lustman	2/13-14	WAPD, Bettis Field, Pittsburgh, Pa.	Discuss irradiation effects, fuel elements, & uranium dioxide	JJ Cadwell SH Bush EA Evans JC Tobin	Yes	303, 325, 326, 300
HR Maine	2/14	Metals & Controls Corp., Seattle, Wn.	Discuss fabrication of metals	JJ Cadwell SH Bush EA Evans JE Minor JC Tobin	No	326, 300
H Pearlman	2/18-19	Atomics Int'l., Canoga Park, Calif.	Discuss engineering consultation program on UO ₂ problems	JJ Cadwell EA Evans WE Roake	Yes	303, 325, 326, 300; 105-KE
FW Davis	2/19	US-AEC, Div. of Reactor Dev., Washington, DC	Selection of metallurgical exhibits	JJ Cadwell SH Bush	Yes	303, 300; 234-5, 200W-32
AA Strasser L Moskowitz	2/21	Nuclear Develop. Corp., White Plains, N.Y.	Discuss UO ₂ fuel fabrication technology	JJ Cadwell EA Evans	Yes	325, 326, 300
JE Sobel	2/25	Bausch & Lomb Co., Seattle, Wn.	Inspect & adjust microscopic equipment	TK Bierlein	No	326, 300
RA Quadt	2/5-7	Hunter Douglas Corp., Riverside, Calif.	Discuss development contract re utilization of Zr	JW Riches	Yes	700; 303, 300
V Kolba P Brown	2/17-18	ANL, Lemont, Ill.	Discuss thermocouples, monitoring & flow measurements	RE Nightingale JM Davidson WL Thorne	Yes	326, 325, 300; 1707, 100-D
CD Vail	2/11-14	Minneapolis-Honeywell, Richland, Wn.	Adjust Honeywell equipment in 326 Bldg.	JM Davidson	No	326, 300
SA Holden S Vandenberg	2/25	GE - APED, San Jose, Calif.	Discuss corrosion of high temperature aluminum alloys	LH McEwen FW Woodfield JA Ayres C Groot, RL Dillon	Access Permittees	328, 300

HW-55162 DEL

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VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Bldg. & Areas Visited
MH Bartz E Brown	1/30	Phillips Pet. Co., Idaho Falls, Ida.	Discuss fabrication of MTR fuel elements	OJ Wick TC Nelson	No	2704-Z, 231-Z, 200-W
J Irwin	2/10-14	ORNL, Oak Ridge, Tenn.	Discuss MTR fuel elements	TC Nelson	No	231-Z, 200-W

A1-33

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HW-55162

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PLUTONIUM RECYCLE PROGRAMMONTHLY REPORT - FEBRUARY 1958REACTOR & FUELS RESEARCH & DEVELOPMENT OPERATIONPlutonium Fuels Development

Al-Pu Alloy Capsules for MTR Irradiation (GEH-3-24). Irradiation in the MTR of the four Zircaloy clad capsules with Al - 1.65 w/o Pu and Al - 12 w/o Si - 1.65 w/o Pu alloy cores had been completed. The last two capsules have sustained a fractional burnout of the Pu atoms of 55 and 60%, and are currently undergoing examination in the Radiometallurgy Laboratory at Hanford.

Visual and dimensional inspection of the capsule jackets revealed that no apparent significant changes had occurred.

Al-Pu Alloy Capsules for MTR Irradiations (GEH-3-32 through GEH-3-39). It is desired to irradiate aluminum-plutonium alloys to high exposures which contain higher Pu concentrations than the 1.65 w/o used for the GEH-3-24 test. The purpose of this experiment is to gain irradiation experience in the MTR on these materials for use in design of plutonium fuels. Attempts will be made to determine the upper limits of Pu concentration, temperature, and burnout before dimensional instability and/or swelling becomes a problem. The irradiated specimens will also provide needed materials for separations studies. Tentative plans are to prepare a total of eight capsules for irradiation testing. There will be one Zircaloy clad specimen (0.5" in diameter x 2" long) of each of the following alloys:

- (a) Al - 5, 10, 15 and 20 w/o Pu, and
- (b) Al - 12 w/o Si - 5, 10, 15 and 20 w/o Pu.

As in the GEH-3-24 experiment the Al-Si-Pu alloy samples are being investigated since they exhibit superior aqueous corrosion resistance. Flux depression calculations have been made by the Advanced Engineering Operation and show that for MTR irradiations of Al - 5, 10, 15 and 20 w/o Pu alloys the ratio of the flux at the core center to the flux at the core surface will be 0.92, 0.80, 0.65, and 0.51, respectively. The ratio of the average flux across the core to the flux at the core surface will be 0.96, 0.89, 0.80, and 0.72, respectively. This information is being submitted to the Thermal Hydraulics group for calculations of the heat transfer data required.

Al-Pu Alloy Clusters for KER Irradiation. The testing of the four-rod cluster with aluminum cores, Zircaloy-3 tubes and Zircaloy-2 caps is continuing in the ELMO-7 loop. To date, the cluster has been exposed to the pressurized light water coolant for 565 hours at 240 C and 526 hours at 316 C. Buff or white corrosion product was observed adjacent to the welded cap joints and on full length strips on the tubes. Insufficiently pure atmosphere during the welding operation is believed to be the cause of the corrosion zones around the weld. The small four-capsule cluster which was prepared to evaluate recent welding

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chamber modifications is also being tested in the ELMO-7 loop. After exposure for 311 hours at 316 C, the pickled capsules welded by the tungsten inert gas and electron beam methods appeared satisfactory at the weld areas but were commencing to display faint white color corrosion product on the tubes. The unpickled samples were severely affected on the tubes and at the weld areas, especially those which were welded by the tungsten inert gas method. The cluster corrosion test is continuing.

Because of the corrosion problem encountered with the Zircaloy-3 tubing all of the completed irradiation test cluster components are being thoroughly examined. Samples of the fuel materials, Al - 8 w/o Pu and Al - 12 w/o Si - 8 w/o Pu alloys, which were submitted for verification of the Pu content have been analyzed. They showed a marked variation (4 w/o to 17 w/o Pu) in the Al-Si-Pu rods; however, the Al-Pu samples were in close agreement with the expected values. The new results were obtained by a titration method and are reported to be quite accurate. Investigation of the anomalous data is continuing.

Casting of Al-Pu Alloys. Several properties of cast Al-Pu alloys up to 13 w/o Pu have been determined. The hardness of the alloys increased from 32 DPHN for pure aluminum to 47 DPHN for Al - 13 w/o Pu. The density increased from 2.70 to 2.98 gm/cc. The yield strength increased from 3600 psi to 8000 psi and the ultimate strength increased from 11,000 psi for pure aluminum to 22,000 psi for the Al - 13 w/o Pu alloy. Considerable scatter occurred in the ultimate strength values because failure of the specimens apparently occurred at small voids or inclusions in the cast structure. The thermal expansion and micro-structure will be determined.

Pyro-metallurgical Techniques. The reconstitution of spent fuels utilizing pyro-metallurgical processes offers potential advantages of time and economy. Since liquation of Al-Pu alloys is difficult because of the narrow temperature range of the liquid plus solid region, silicon was added to an Al - 2.2 w/o Pu alloy until the AlSi eutectic composition was reached, thus increasing the temperature range of the two-phase region. The freezing point of the Pu-Al₄ is 652 C and the AlSi eutectic freezes at 577 C. The Al - 11 w/o Si - 2 w/o Pu alloy was held at 590 C for one hour and liquated. The analysis of the decanted metal was 0.32 w/o Pu whereas the analysis of the residue was 3.72 w/o Pu.

Air Pressure Injection Casting. The density of nine long castings cast by injection with air pressure ranged from 80 to 87% of theoretical as determined by length and weight measurements. All nine of the 89" long tubes were evacuated with the dip tube submerged below the surface of the melt and were filled in a vertical position.

Radiographs of three of the castings revealed shrinkage and gas voids in the castings. Generally the voids in the lower part of the rods were shrinkage type whereas those in the upper portions appeared to be gas voids. A six-foot long stainless steel tube which had been filled with aluminum by atmospheric pressure was slit its full length for examination. This casting had been made into a heated 1/2 diameter tube which had been evacuated at the top with no constriction at the bottom to hinder the flow of the metal. The density of this casting was 90% theoretical and the few voids that were found were minor shrinkage voids with the exception of a short non-filled area near the top. It

appears necessary to eliminate the constriction at the bottom of the fuel tubes and to cast into evacuated tubes. One casting using a mild steel tube was quite strongly bonded to the tube wall at both ends. The tube preheat and melt temperatures were 300 C and 760 C, respectively.

Mechanical Pressure Injection Casting. Experiments in mechanical pressure casting 2S aluminum into both evacuated and unevacuated 7'4" long tubes have been made. Three castings were made in which the tube was first evacuated before the molten aluminum was mechanically injected. In all three rods extreme porosity was observed at the top. Two of the rods were cast through a 3/8" diameter injection inlet and were held under 800 and 1000 psi during solidification. They exhibited small blowhole type voids and excessive shrinkage throughout their entire lengths. The third rod was cast through a 1/4" diameter inlet at 1200 psi and was very sound for a length of five feet. A few small voids were observed along the tube wall; however, the central portion was completely free of defects. The density of this six-foot length was 92% of theoretical. Future modifications to the equipment include direct resistance heating of the casting tube rather than the surrounding pressure vessel, alteration of the hydraulic pump piping, and increased pressure during solidification.

Extrusion Program. Modifications were continued to increase the capacity of the prototype press from 125 to 284 tons. Construction of most components has started, and all detail design is 90% completed.

Tubing for PRTR Fuel Element Development. Additional metallographic examination of the initial six seamless Zircaloy-3 tubes is being conducted to determine the cause of the full length strip-like defects which were noted on some of the radiographs. The nineteen tubes received in the second shipment have been radiographed. The quality of the tubing appears good; however, internal gall marks, which on the radiographs appear to be caused by extrusion mandrel pickup of the material were detected. Spectrographic metallographic and corrosion examinations are in progress. A shipment of 325' of reactor grade Zircaloy-2 tubing (0.5" ID x 0.020" wall) excessed by APED was received and is being submitted for examination.

Facilities. Design work is in progress on the hoods and associated equipment for the reduction of PuO_2 by Al under a cryolite flux to produce Al-Pu alloys. These alloys are needed both for development of plutonium-aluminum fuels and for PRTR fuel element clusters. Present plans are geared to a capacity of 20,000 grams of Al - 1.65 w/o Pu alloy per shift which is sufficient alloy for one complete 19-rod cluster fuel element. Preliminary drawings are being examined for satisfactory equipment operation and criticality hazards.

Preparation of equipment and facilities necessary for the fabrication of Pu-containing oxide fuel materials is nearing completion. A hydraulic press has been placed in the oxide hood and piped to a 10,000 psi pump. Operation of the press will be performed remotely from outside the hood. The heating element connection on the hydrogen sintering furnace has been changed to facilitate easy removal of the ceramic muffle should replacement be necessary under contaminated conditions. The furnace has been placed on a stand and flanged to the hood face. Considerable work remains to be done on the hydrogen gas system for the furnace before it can be used for Pu, hence the possibility of using vacuum sintering initially will be investigated. Preliminary design of a compacting die based on

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an estimate of the volume shrinkage during sintering has been completed. A ball mill, shaker, vibrating table, drying oven, and mixer as well as shelves and storage racks have been placed in the hood. Experimental compaction of non-radioactive powders will begin shortly.

U-Pu Test Pieces for PCTR. Thirty electroless nickel coated Al - 0.69 w/o Pu foils and ten electroless nickel coated 2S aluminum blanks were completed. After many unsuccessful attempts at drilling small diameter holes in U-Pu alloy discs, a satisfactory method was developed, and the special flux monitoring slug which simulates 1000 MWD/T exposure is ready for assembly. The nine sections for the slug have been machined and the special pin sections have been slotted and drilled to accommodate the rectangular tabs and the twenty-seven monitoring pins.

UO₂ Fuel Development

Irradiation of Fuel Elements Containing Unsintered UO₂. Fabrication-wise, a fuel element of elegant simplicity would consist of loose powder poured into a tube which could be closed at each end. To determine the in-reactor behavior of such a fuel element, enriched UO₂ powder (3% U-235) was inserted into a Zircaloy can 1" OD x 6" length and a cap welded into place by heliarc. A second, similar element was fabricated, with the cap welded into place in a vacuum, using an electron beam gun. Both fuel elements survived one cycle in the GEH-4 facility of the MTR, with an exposure of approximately 900 MWD/T. Radiometallurgical examination revealed no swelling of either of the elements, although essentially complete sintering of the UO₂ had occurred in the one element which was sectioned. A layer of powder estimated to be only 0.020-0.030" thick separated the dense, sintered UO₂ from the can wall. A fission gas measurement will be made with the second element, prior to sectioning the element.

Nested Tubular Fuel Element, Internal Support of Cladding. The structural behavior of Zircaloy-2 cladding in fuel assemblies at anticipated PRTR operating conditions is being investigated. A short six-inch section of the outermost Zircaloy cladding tube (0.030" x 3" OD) developed for the PRTR Mark IIA fuel element was loaded with UO₂ rings and autoclaved 68 hours in 1600 psig, 325 C steam. A temperature excursion at startup carried the pressure to 1900 psig. Although these conditions are far more severe than expected in PRTR (1075 psig, 284 C), no collapse or deformation of the cladding occurred. Cold core-to-cladding radial clearance of 0.003" and spacings of 0.010" between UO₂ core rings were incorporated as practical minimum assembly clearance and expansion gap. The test confirmed the previous assumption that such unsupported areas would not collapse under external operating pressure. Further breakup of the UO₂ core material, typical of expected in-reactor operation, was caused by rapid thermal cycling between 400 C and 20 C. The test section was then autoclaved an additional 130 hours in 1145 psig, 560 F steam. No deformation of cladding was observed.

Fabrication of Uranium Dioxide by Swaging. A number of variables involved in the swaging of UO₂ powders are being studied to determine the feasibility of this process for low cost fuel element fabrication. Results during the past month have further demonstrated that oxide densities after swaging depend on the type and thickness of the cladding material used. In a standardized test, sintered and ground UO₂ was cold swaged in one-inch OD tubing with the following results:

<u>Cladding Material</u>	<u>Wall Thickness of Cladding Before Swaging</u>	<u>Density of UO₂ After Swaging, % of Theoretical</u>
304 stainless steel	0.065	87
304 stainless steel	0.035	86
Zircaloy-3	0.030	84

The above densities were obtained with a 40 percent reduction in UO₂ cross sectional area. Further reductions did not appreciably increase the oxide densities. A study correlating the densities that are obtained with various types of UO₂ powders swaged in 1" OD x 0.035" wall stainless steel is expected to be completed in March.

An inverted, four-die rotary swage machine (Farmer-Norton Model No. 15 SI) has been ordered, with delivery scheduled for March. This swage is unique in that it has a stationary spindle which eliminates the twisting action normally encountered with conventional rotary swages.

Although long fuel element rods are easily fabricated by swaging, irradiation tests of swaged UO₂ have been limited to capsules a few inches long. It is proposed to irradiate at HAP0 a swaged UO₂ fuel element three feet long with stainless steel cladding of 0.570" OD and 0.032" wall thickness. The element has been fabricated and contains UO₂ cold swaged to 86 percent of the theoretical density. End caps were welded into place by heliarc, leaving a helium-filled gap between the UO₂ and each of the caps. A flow tube mockup assembly of the same dimensions was fabricated for pressure drop measurements. Irradiation of a three-rod steel jacketed element will be performed in the MTR as GEH-4-27, beginning with the cycle of March 3, 1958.

The Continuous Ball Milling of Uranium Dioxide. The uranium dioxide powder produced by the continuous ball mill and air classifier recently installed in the ceramics laboratory was analyzed spectrographically for impurities and was found to compare favorably with powder ball milled in the usual manner, i.e., batchwise in one gallon jars. A slight increase in iron content, from 14 to 53 ppm, was detected in the continuously processed powder. Silicon concentration also increased from 7 to 16 ppm. Impurity content of the continuously processed powder is expected to decrease with further use of the equipment.

UO₂ Sintering Studies. Uranium dioxide can be sintered to high density in a steam atmosphere at a relatively low temperature. The sintered material has an O:U ratio slightly greater than 2.00, and it has frequently been postulated that the excess oxygen is responsible for the improved sintering behavior. Samples of "PWR grade" UO_{2.03} were oxidized in air to obtain UO_{2.08} and UO_{2.12}, which was then sintered in hydrogen to evaluate the effect of the O:U ratio upon densities obtained during hydrogen sintering. The surface area of the UO₂ was 0.6 m²/g both before and after oxidation. The untreated and oxidized "PWR grade" UO₂ powders were cold pressed at 25 tsi and sintered for four hours at 1600 C. Increasing the O:U ratio of the untreated "PWR grade" UO₂ powder, without changing its surface area, has no effect on the relatively low sintered density of the material, which was 75 ± 1 percent of the theoretical.

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Vacuum Cast Zircaloy End Fittings. Radiographic inspection of the previously reported vacuum cast Zircaloy end fittings indicates that these fittings would be acceptable for in-reactor use. Almost all of the radiographs revealed small spongy areas in structural sections of the castings. These areas would not be expected to affect the gas tight integrity of the end cap when welded in place.

Fission Gas Release from UO₂ Powders. Studies of fission gas release from pressed powder test specimens are expected to lead to better understanding and predictability of in-reactor performance of non-sintered UO₂ powders. Specimens irradiated in the MTR revealed the following relationship:

$ML \text{ Xenon} = 2.767 \times 10^{-5} \text{ (nv)} 2.39 e^{3.34A} \sqrt{f \text{ (Enrichment)}} \sqrt{g \text{ (Irrad. time)}}$
 where A is the specific surface in m²/gm. The functions $\sqrt{f \text{ (Enrichment)}}$ and $\sqrt{g \text{ (Irrad. time)}}$ will be defined by additional powder irradiations. Tentatively, the enrichment function is a direct proportionality but the time function is not.

High Temperature Studies. High temperature studies of UO₂ and other ceramics are being conducted to determine the limitations and to predict the operating characteristics of these materials under in-reactor conditions. Assembly of a carbon-arc image furnace having two twelve-inch parabolic mirrors was completed and will be used to obtain the desired temperatures. A new coil was designed and fabricated for high temperature induction heating apparatus, which will be used to determine the volume change in UO₂ during melting. This information is needed to design fuel elements which can withstand operating temperatures at which melting may occur.

High temperature characteristics of UO₂, UC, and UN also are being investigated by means of an electron beam gun. It was observed that although UO₂ sublimed rapidly in a vacuum at approximately 2200 C, UC and UC-UO₂ mixtures melted at approximately 2000 C, with no evidence of sublimation.

Thermal Hydraulics Studies

Installation of the PRTR calandria and moderator mockup in 185-D was completed except for the dump valve and the gas control system. Preliminary flow tests were started, however, and liquid level was maintained in the calandria by controlling the rate of discharge from the moderator tank. This method proved satisfactory except when the liquid level in the calandria reached to top overflow openings. In this case the increase in liquid flow caused an increase in gas pressure in the moderator tank of sufficient magnitude to force large volumes of gas to bubble up through the calandria. Plans were made to correct this situation by a finer control on the discharge from the moderator storage tank.

Work continued on the design and construction of an electrically heated test section simulating the Mark IIb fuel element. Material for construction is either on hand or has been shipped and detailed drawings are 50 percent complete.

PRTR Instrumentation

A program was initiated to specify instrumentation to detect (1) heavy water loss from the PRTR to the atmosphere within the containment vessel, and (2) accumulation of impurities in the primary, moderator, secondary, and

reflector coolants. It appears that the instruments to detect loss of heavy water into the atmosphere will be very sensitive since it is desired to detect a loss of less than one pound per hour.

Facilities were examined and evaluated for testing prototypes of the resistance temperature detectors and flow monitors to be used on the PRTR. A rough draft of a design test for testing resistance temperature detectors was prepared.

Coolant Systems Studies

No apparent change in the corrosion rate of the Zircaloy-3 clad plutonium-aluminum type four-rod cluster element considered for irradiation testing in KER was observed during exposure in ELMO-7 for 525 hours at 600 F, 4.5 pH adjusted by phosphoric acid addition preceded by 565 hours at 460 F, 4.5 pH. No corrosion was noted on two pickled Zircaloy-3 clad rods in a three-inch long, four-rod cluster assembly run in ELMO-7 for 311 hours at 600 F, 4.5 pH. Two unpickled rods in the assembly including the heliarc end cap welds on one rod were corroding with the exception of the electron beam end cap welds on one rod.

The pressure drop on an NPD design Mark I fuel element was measured at 10.5 psi at 120 gpm at room temperature. The pressure drop on a Mark II element was 32 psi at 120 gpm and room temperature. The high pressure drop on the Mark II element is being rechecked. A very preliminary check of the flow distribution around an NPD design Mark I element in the polariscope has shown no obvious flow distribution problems. A more detailed check will be made following a few minor modifications to the equipment.

A review of the literature (HW-54879) concerning stress, crevice, galvanic, and uniform corrosion of austenitic stainless and carbon steels in high temperature boiler feed water was completed.

Mechanical Equipment Development

Design Test PR-20 - Calandria Characteristics. The installation of the calandria and moderator storage tank was completed. A three-inch air controlled valve was installed in parallel with the existing ten-inch "butterfly type" drain valve of the moderator storage tank to provide more accurate control. Internal calandria lighting is being installed for motion picture studies of the calandria liquid level.

Design Test PR-24 - Calandria Shroud Tube Bellows. Corrosion testing of shroud tube bellows was completed. The bellows subjected to the live steam and water drip tests failed. Several breaks developed in the convolutions, the seams rusted out, and the stainless-aluminum welds became porous. The cold bellows subjected to the hot saturated air test also failed. Three breaks were discovered in the convolutes, and again the stainless-aluminum weld became porous. An increased development program to solve the bellows problem was started.

Design Test PR-25 - Shroud Tube Collapsing Pressures and Installation. Both the shroud tubes and the 1-1/2 inch thick aluminum plate arrived during the month. Collapsing test fixtures were installed and testing was started. One tube was tested at 750 F and collapsed with 16 psi air pressure. Initial planning of the fabrication tests was completed, and detailed drawings of test fabrication methods were begun.

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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 test program on the flare-type seals was completed. A test section utilizing the two proposed process tube inlet fittings and four 2-inch flared fittings was cycled 217 times on ELMO-7 from 310 F to 550 F and 323 times on a special static test fixture from 150 F to 540 F. The process tube inlet fitting using a sleeve held by a split ring was superior to the process tube inlet fitting using a threaded process tube. Both the process tube inlet fittings and the four flared fittings passed the cycling tests satisfactorily. Torque requirements were undesirably high, being between 700 and 900 ft-lbs. Annealing the flared fittings provided a leak-proof joint with approximately half the torque required to seal an "as-formed" flare.

Seal No. 3 - Inlet gas seal - The work on this seal has been completed.

Seal No. 4 - Process tube to outlet nozzle - End 2A, employing a delta gasket, leaked during the first cool-down period during thermal cycling tests on ELMO-7; however, the gasket reseated after cooling. The cause of the gasket failure was differential thermal expansion between the stainless steel and zirconium. The fitting was re-tightened and replaced on ELMO-7, but again failed. The fitting was removed from ELMO-7 for further modification. End 2B, employing a flexitallic gasket, held during the two cycles.

Seal No. 5 - Nozzle cap seal - Cap assembly "A" was removed from ELMO-7 and disassembled. The flexitallic gasket resealed, but the self-energized "O" ring would not reseal due to surface flaws formed during seating. The "O" ring was replaced by a flexitallic gasket and the fitting installed on ELMO-7 for thermal cycling. After six cycles, this new flexitallic gasket was leaking slightly. End 1A of this assembly, designed for a flexitallic gasket, was not leaking during the tests. Cap assembly "B" with a "dome" seal and a Bridgman seal was cycled 20 times on a static test rig from 185 F to 530 F. No leaks were observed in either of the seals or the four 1-3/4 inch flared fittings used on this cap assembly. The cycling tests are continuing.

Seal No. 6 - Outlet gas seal - Three types of packing were tested during the month. The first packing was a combination of John Crane No. 177 and a ring of soft filled, grease impregnated packing. This combination made a satisfactory gas seal but required a force of 500 lbs to pull the assembly apart. The second packing tested was John Crane Superseal. This packing has a gas leak rate of one quarter cubic feet per day after baking at 600 F. The leak rate did not increase after several days of testing. The last packing tested was Duraseal Type "D". After baking, this packing had a gas leak rate of one-half cubic feet per day. The notable quality of this packing was its ease of compression.

Three short section prototype process tubes were received. The first tube is being fabricated and will be fitted with the following seals:

- (a) Nozzle cap - interchangeable flexitallic gasket and "dome" seal
- (b) Outlet jumper to nozzle connection - flared fitting

- (c) Process tube to nozzle connection - a seal of special design termed a "banana ring" gasket.
- (d) Inlet jumper to process tube connection - Solid "O" ring held by a four-bolt flange. The flange is held to the process tube by a split ring.

Design Test PR-51 - Reactor Piping Structural Integrity. The fabrication of jumper flexure test fixtures continued during the month. The completion date is estimated to be March 10. Four hundred feet of stainless steel jumpers were ordered for jumper fabrication.

Design Test PR-63 - Process Channel Leak Detection. Design of the needed test fixtures was completed.

Other Activities. Single Tube Prototype Facility (Phase I) - Construction of this phase was approximately 35 percent complete. The design of the pump for this phase is now firm and delivery is expected in June or July 1958.

Single Tube Prototype Facility (Phase II) - Construction of this phase was approximately five percent complete. Orders for all materials will be placed within the next two weeks.

Full size PRTR Process Pump - The purchase order alteration was accepted by the vendor. The pump is scheduled for delivery in November 1958.

PRTR Injection Pump - The purchase order was placed and the pump is scheduled for delivery in May 1958.

Eight-Inch Check Valve - The bids for this valve are being evaluated. It is expected that the order will be placed next month.

Fourteen-Inch Gate Valve - Delivery of the valve is scheduled for July 1958.

PRTR Inlet Piping Valves - Delivery of the valves is scheduled for March 1958.

PRTR Jacket Tubing

Samples have been received from Nuclear Metals Inc., of the first ribbed tubes extruded with steel as the jacketing and spacing material. These 0.750" ID tubing samples show sound bonding of the ribs. After some further preliminary work with this small-size tube, testing will proceed with one of the larger sizes for the Mark IIB element.

Final signatures were affixed to the New Rochelle Tool contract on February 11. The schedule of operations originally agreed to was predicated on signing the contract by January 1. Correcting this schedule to February 11 indicates that the vendor should be able to deliver satisfactory Zircaloy specimen tubing with ribs attached by high-frequency welding by approximately June 15.

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Corrosion Studies

Zirconium-Uranium-Water Corrosion. A literature study of the hydriding and corrosion reactions of zirconium and uranium has led to several hypothesis which can be postulated concerning the conditions necessary for hydriding of zirconium:

1. Case I: It is known that zirconium can be hydrided easily by admitting pure hydrogen to zirconium which has been vacuum annealed above 650 C. Above this temperature the ZrO_2 film rapidly dissolves in the metal leaving a highly reactive pure metal surface. Pure hydrogen reacts with this surface at temperatures as low as 100 C, and probably even slowly at room temperature. If, in an operating fuel element, the interior surface of the Zircaloy jacket were to reach 600 to 650 C, or probably even a lower temperature over a month or so, a surface would form which would react very rapidly with any hydrogen present. The interior surface of a weld is also a prime area where hydriding can start. The rate of hydriding of such a surface is affected considerably by trace contaminants in the hydrogen, especially water which helps to reform the protective film.
2. Case II: It is reported that zirconium can be hydrided through the oxide film by external hydrogen. However, the reaction rate is much slower than in Case I, above, and there is no documented case where this has occurred in the presence of steam. A number of cases are reported in which zirconium did not hydride when exposed to both hydrogen and steam at high temperature. Thus water, even in trace quantities, appears to inhibit the hydriding reaction. The mechanism is not yet clear, but with water present the oxide film is continuously being reformed, whereas in the absence of water, defects which develop in the oxide film may allow rapid diffusion of hydrogen into the metal.

Two experiments were run this month in support of Case II above. Coupons of Zircaloy-3 and uranium were tied together and exposed for 20 hours in 150 C and 260 C water. In both cases the uranium was completely attacked with the formation of considerable quantities of uranium oxide and hydride. In neither case was there any significant hydrogen pickup by the Zircaloy-3.

An exception to the above is the case where zirconium picks up hydrogen from its own corrosion reaction. $Zr + 2H_2O \rightarrow ZrO_2 + 2H_2$. There is evidence that the zirconium picks up from 10 to 30 percent of this hydrogen, but this case is not the same as external hydrogen diffusing to the metal.

3. Case III: There is some superficial evidence that nickel may catalyze the hydrogen pickup of zirconium. Any source of atomic hydrogen would also be expected to cause a rapid reaction with the zirconium.

4. Case IV: The role of uranium in the hydriding of zirconium would appear to be a secondary one, by such mechanisms as: (a) providing hydrogen via a uranium-water reaction, (b) dehydrating the hydrogen, thus removing water that would inhibit the reactions, and (c) producing heat to accelerate the hydriding reaction.

Experiments are now being planned to test these hypothesis.

Tensile Testing of Hydrogenated Zircaloy-2. Tensile testing of a series of 50 hydrogenated specimens prepared to contain 3, 50, 100, 200, and 500 ppm hydrogen is approximately 45 percent complete. The completed tests were made at room temperature, 300 and 400 C. These incomplete data indicate that the yield strength (0.2% offset), the percent elongation, and the percent reduction in area may be sensitive to hydrogen at room temperature. In these three properties there was a decrease in the observed values with increasing hydrogen concentration. At the two elevated temperatures the deviations of hydrogenated from vacuum-annealed Zircaloy-2 specimens were small or indecisive. The latter was also true at all three temperatures for the properties: ultimate tensile strength, proportional elastic limit and modulus of elasticity.

The purported hydrogen content of the test specimens has not been in acceptable agreement with the analyzed content. Current work is directed toward resolving this discrepancy through (1) the preparation of hydrogenated specimens adaptable in their entirety to the vacuum extraction analytical apparatus and (2) the requisition of off-site standards.

Corrosion of Aluminum-Uranium Alloys. The corrosion of aluminum-uranium alloys is being studied with the assumption that their corrosion behavior will be similar to that of aluminum-plutonium alloys. The experimental variables include: (1) silicon content of the aluminum (0 and 12%), (2) uranium content of the sample (1.6, 4.5 and 6.0%), (3) quality of cladding (none, small hole, and long slot), and (4) wrought versus cast structures.

The 1/2 inch diameter by three-inch long cylinders were subjected to corrosion testing in water at 350 C. In Test I the samples were clad in Zircaloy-3 tubing, pre-defected with a 1/16 hole. This test ran for 72 hours. No samples failed, although there was surface oxidation of the aluminum. For Test II the samples recovered from Test I were split longitudinally, and the aluminum alloy cores were removed from the jackets. The split aluminum alloy pieces were tested bare for 22 hours. The samples containing silicon largely survived, while the samples without silicon were largely destroyed as shown in Table I. In Test III a new set of canned pieces were slotted longitudinally on a band saw (about a 1/16" cut). These samples were tested for 24 hours, with results very similar to Test II, as shown in Table I.

In Test I the holes evidently became plugged with oxide, subsequently excluding water from further direct contact with the aluminum alloy. The Al-Si-U alloys are decidedly more corrosion resistant than the Al-U alloys, and the 6.0% uranium in aluminum is more resistant than the 4.5% U or 1.6% U in aluminum alloys.

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TABLE I

CORROSION TESTING OF URANIUM-ALUMINUM ALLOYS

Alloy Type	Metal Condition	Test I	Test II	Test III
1.65 w/o U in Al	Cast	No swelling - surface oxide	Destroyed	Can swollen, alloy destroyed
1.65 w/o U in Al	Wrought	" "	"	Can split, alloy destroyed
4.54 w/o U in Al	Cast	" "	"	Can swollen, alloy destroyed
4.54 w/o U in Al	Wrought	" "	"	Can split, alloy destroyed
6 w/o U in Al	Cast	" "	Intergranular attack on cut face	Can starting to swell
6 w/o U in Al	Wrought	" "	Destroyed	Can badly swollen
1.65 w/o U in AlSi	Cast	" "	Surface oxide only	No dimensional change
6 w/o U in AlSi	"	" "	Spotty white oxide. Starting intergranular attack on cut face.	" "
6 w/o U in AlSi	Wrought	" "	Heavy white oxide. Starting intergranular attack.	" "

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Aluminum Alloy Testing. Tests up to seven weeks in 360 C deionized water have shown that aluminum alloy A-2 (X-8001 plus 0.1% titanium) is the most resistant of four aluminum alloys procured from Hunter-Douglas. Alloy A-2 is substantially better than X-8001 at these temperatures. Corrosion tests in 350 and 500 C superheated steam have been somewhat erratic but generally confirm the 360 C water experience.

Comparisons among different lots of X-8001 can stock have shown ALCOA samples to be somewhat less prone to blistering at 360 C than competitive material.

A five-gallon high pressure autoclave has been equipped with a high flow test section. Corrosion rates of samples in the high (25 ft/sec) flow section have been found higher than those in the low (0.5 ft/sec) flow section by a factor of 1.5 to 2.0. The water velocity effect differs considerably from alloy to alloy in the order of resistance to flow effects: M-400 X-8001 = an on-site experimental alloy (4.3% Ni, 0.38 Fe). Corrosion rates in the low flow section were in good agreement with previous data at this temperature. The feed and bleed rates in these three experiments were the same, and hence if solubility of aluminum oxide were the only rate controlling factor, the corrosion rates should have been the same.

Aluminum Corrosion Studies. To obtain further insight into the mechanism of high temperature aqueous aluminum corrosion, coupons of 1245 and X-8001 aluminum alloys were exposed to water for 300 C for various periods of time. These coupons were then exposed for additional periods of time at 250 C exposure. In the cases where the coupons corroded by a uniform corrosion mechanism at the higher temperature, subsequent exposure at the lower temperature resulted in less additional attack than that experienced by fresh coupons. This is in agreement with results previously reported for similar experiments. However, in the cases where the high temperature exposure exceeded the induction time and "intergranular corrosion" had begun, the opposite results were obtained. That is, the subsequent exposure at the lower temperature resulted in considerably more additional attack than that experienced by fresh coupons. The implication is that once the rapid "intergranular attack" has begun, the attack proceeds rapidly even under conditions which would not normally produce such rapid attack. It appears that whatever change takes place during the induction time that produces "intergranular attack" is a permanent change.

In order to determine what effect the destruction of the protective corrosion product film would have on the high temperature aqueous corrosion of aluminum, a device was constructed to mechanically scratch an aluminum coupon while it was being corroded in an autoclave. The device produced a deep scratch through the corrosion product film, thereby exposing fresh aluminum metal. A coupon of 1245 aluminum was scratched after having corroded for two hours at 280 C. A coupon of X-8001 aluminum was scratched after corroding for two hours at 350 C. These coupons were permitted to corrode for an additional 16 hours after being scratched. In both cases there were no unusual corrosion effects observed. The fresh metal exposed by the scratch proceeded to corrode in a uniform manner forming a new film of protective corrosion product.

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Electron micrographs were obtained of the corrosion product films formed in water containing phosphate ions at 180, 260, and 300 C. The basic aluminum phosphate (i.e., augelite) crystal structure was observed at 180 and 260 C. However, the crystal structure formed at 300 C appeared similar to boehmite, the alpha monohydrate of aluminum, indicating that the phosphate-inhibited corrosion product does not form at 300 C. Additional studies are under way to determine the regions of stability of the phosphate-inhibited films. Electron micrographs were obtained of the underside of the Augelite corrosion product film. It had an amorphous appearance and showed no grain boundary attack as is found in the absence of phosphate.

The film formed on aluminum by autoclaving in one percent chromic acid inhibits the uniform corrosion process. Electron micrographs were obtained of the films formed on 1245 and X-8001 aluminum in one percent chromic acid after 40 hours at 170 C. Even at 30,000X magnification the films appeared amorphous and very smooth and flat. X-ray analysis has previously shown these films to be amorphous.

PRTR Design

General. Overall design is 50% completed. Scope Revision 99-10 was issued. This revision includes changes required by the removal of the 1500 KW turbine-generator, while maintaining prescribed levels of safety, experimental flexibility, and operating economy. The scope revision is not expected to affect the overall project schedule.

Jensen-Rasmussen and Company and B-E-C-K Construction were awarded the contract for installation of temporary construction facilities. This contract is for facilities required for both PRTR and PFPP construction. The accepted bid was for \$116,500, with a fair cost estimate of \$130,850.

Phase I-R. The Phase I bid package was completed and issued. Bids are scheduled to be opened March 20, 1958.

Phase II-R. Design of this phase is 60% completed. Bids have been received for the primary pump discharge piping check valves. Specifications for the main heat exchanger have been completed.

Phase III-R. Design is 35% completed.

Detail design of the reactor core components (calandria and reflector shells) was completed. Procurement specifications have been prepared.

A scope revision will be issued to cover changes in the helium gas system which have been indicated as detail design has progressed.

Flowmeter venturis have been relocated in the inlet jumpers to facilitate replacement, and the jumper piping has been standardized at 1-3/4 inch diameter. Flow restrictor orifices will be moved to the outlet nozzle, with provision being made for future installation at the process tube inlet for boiling operation.

Revision of inlet and outlet assemblies to incorporate flanges is indicated by the difficulty which will be met in applying a high tightening torque to a single nut at the inlet connection location.

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Instrumentation and control were discussed at a conference at ANPD, Evendale. Represented sites included ANPD, GEL, HAP0, and KAPL.

Design Development

Instrumentation and Control. Preliminary tests with the PRTR calandria mock-up indicate that the moderator surface within the calandria will be smooth.

A study, based on perturbation theory, of PRTR shim control rods indicates tentatively that 3/8 inch diameter stainless steel rods will provide sufficient control. This conclusion is being checked by the use of alternative methods of calculating rod strengths.

The analog computer physics simulation which was used in the safeguards analysis has been revised and enlarged. It will be used to investigate transient effects of control parameter changes. Information to be obtained includes the time response rate for a power level change after a control valve movement and data on the maximum allowable control rod flutter at a steady power setting.

Containment Vessel Pressure Equalization. Scope change 99-11 and an interim report, HW-54962, were issued. These summarize recommendations for building revisions which affect venting and shield plug tiedowns.

Power Outage Study. An analysis of PRTR operating requirements under conditions of BPA failure and total loss of electrical power has been issued as HW-54982. Recommended provisions include:

1. Installation of a 300 KW diesel-generator for emergency power.
2. Installation of a low capacity, high pressure boiler feedwater pump for shutdown service.
3. Emergency H₂O injection into the calandria ring headers to prevent fuel element melting in the event of rupture of a process tube jumper.
4. Increase in instrument compressed air storage capacity to provide an operating reserve in case of total loss of power.
5. Separation of the primary coolant and moderator systems to permit early detection of D₂O leakage.
6. Installation of a 10 KW DC-powered alternator to supply instrument power during shutdown in case of a total power outage.
7. Installation of a separate helium storage to permit pressurization of the primary coolant system during a total power outage.
8. Use of sanitary water to operate the fog-spray system.

Reactor Physics. A flattened flux distribution for the PRTR with H₂O reflector was computed. The flat zone radius is 65 cm for a tube power limit of 1.2 MW.

PCTR measurements on the Mark I UO₂ fuel elements indicate that the discrepancy between experimental and calculated reactivities is due not to the eta factor in the multiplication constant but to the resonance escape factor. The same situation would be expected to apply to Mark II fuel elements. Diffusion theory disadvantage factors and the effective surface area of the fuel, calculated by the Dancoff-Iskenderian method, are both in disagreement with the measured values.

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New fast effect (epsilon) calculations have been made for Mark IIb fuel elements. The value obtained is 1.009, which is in very good agreement with previous experimental and calculated values.

An improved method for obtaining diffusion coefficients from Monte Carlo flux tallies has been devised and will be used in the RBU computational program being developed by American Standard.

Cycle Analysis. Computer programs are being applied to the calculation of fuel costs for uniformly enriched plutonium recycle and non-recycled uranium fueled reactors.

A 650 computer program has been provided to furnish loss terms for the Generalized Plutonium Recycle (GPR) program.

PFPP Design

General. "Relationships and Responsibilities for the Plutonium Fabrication Pilot Plant Project," (HW-54640) was prepared to guide working arrangements among HAPO components. Design Council weekly meetings were regularly scheduled.

Phase I-L. The bid package for Phase I-L (outside utilities) was completed. A combined contract was awarded for this phase and for PRTR temporary construction facilities, as reported under "PRTR Design".

Phase II-L. Completion of design and the awarding of a construction contract for Phase II-1 (building and building utilities) are scheduled for FY-1958.

Three minor scope revisions and two scope interpretation letters were prepared. A "50% Design Complete" status cost estimate is in preparation.

Determination was made of the GE-AEC procurement which will be necessary to maintain a 10-month construction schedule for this phase, and procurement was started.

The scope of the fire detection system and of the plant protection alarm system were clarified. The resulting fire detection system is considered very advanced and is expected to be highly efficient in early detection of small fires. The building protection alarm system makes provision for full building operation without alarms, for complete perimeter alarm on off-shifts, and for perimeter alarm except at the main entrance for partial off-shift operations.

The ventilation system provides fifteen changes per hour of filtered and washed air. Air will be supplied through diffusers near the ceilings and will be exhausted through prefilters near and in the floors. Exhaust air will be filtered again before being discharged from short roof stacks. The ventilation design prevents recycling of exhaust air. The entire exhaust system is fireproof or flame-retardant, and further fire protection is provided by a dry-pipe fog system located in the main exhaust plenum.

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATIONMONTHLY REPORTFEBRUARY 1958FISSIONABLE MATERIALS - 2000 PROGRAMFUELSNuclear Safety, Critical Mass Consultations

1. Fuel Preparations Department Studies

- A. Nuclear safety of some of the existing allowable arrays for the storage of 0.96%, 1.47%, and 1.61% U-235 enriched fuel elements were reviewed for safety in the water-flooded condition. It was determined that the arrays would remain subcritical even if flooded. These results will be incorporated in the FPD Nuclear Safety Specifications.
- B. At the request of FPD, the effect of the presence of B-metal or Chemical 7260 on the nuclear safety of arrays of enriched uranium fuel elements was examined. The nuclear safety of arrays of enriched fuel elements is not affected by the presence of either of these materials.

2. Nuclear Safety Radiometallurgy Laboratory (HLO)

General rules for the nuclear safety in handling all enrichments of uranium fuel elements were submitted for a determination of their applicability to storage problems of the Radiometallurgy Laboratory. Word of their applicability is awaited before they are documented as specification. Further study will be required if the general rules are too restrictive.

REACTORSTUDIES RELATED TO PRESENT PRODUCTION PILESExposure and Temperature Coefficient with Synthetic Slugs

Pin-bearing slugs have been canned by the Plutonium Metallurgy Operation for use in flux traverse measurements. Special pin holders also have been fabricated for counting the Pu-bearing pins in an uncontaminated counter. Measurements on 1000 MWD/T slugs will begin in March.

Lattice Neutron Temperature Study

Heat was applied to the TTR thermal column oven for 30 minutes in a successful trial run to $\sim 90^{\circ}\text{C}$.

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The fission foils that are to be used in the lattice neutron temperature study experiment are now being normalized.

Thermal Neutron Flux in a Medium With a Temperature Discontinuity

The method of replacing the partial differential equation for this problem with an approximately equivalent set of difference equations has been used to compute the flux at a network of values for energy and position in a small test problem. The speed of convergence of the iterative scheme used to solve the equations was satisfactory. This fact, coupled with the other advantages of the method, indicated the value of a suitable computing machine program to carry out such calculations for various moderator temperature conditions. Work on this machine program is now in progress.

Instrumentation

Tests are continuing to determine the optimum system for three-color temperature measurements. It was originally intended that the response of a photocell to three bands of light passed by interference filters would be displayed on an oscilloscope. The temperature would be determined by the calibration on the filter adjustment carriage. Photoconductive sensors were found inadequate for this type of work. A multiplier phototube gave the required sensitivity and frequency response. The most recent tests indicate that an improvement in sensitivity is realized if the three filters are changed slowly and the peak voltage read for each filter. This simplifies the instrument by eliminating the oscilloscope and may permit the use of a cadmium sulfide cell instead of the multiplier phototube.

A study was started on information storage devices for use with experimentation on two and three dimensional data presentation devices. It is proposed that sufficient data storage capacity will be available to statically simulate an actual system.

STUDIES RELATED TO FUTURE PRODUCTION PILES

Development of Methods of Calculating Reactor Parameters

Cluster Element Calculations

The effort on this program during the current month has been directed toward collection of existing information, including experimental flux traverses and lattice parameters for hollow rods and clusters and theoretical calculations using the P-3 machine program.

Machine Computational Programs

The latest revisions in the routine buckling program, which provide for inclusion of fast source corrections, have been assembled and are being debugged. Other parts of the program are operational.

The 650 OMNICODE program to solve the 4×4 determinant for a 2-group, 2-region spherical reactor has been completed for three desired cases. Results of first runs gave incorrect results. The input data are being reviewed to see if they

were correct.

A flexible OMNICODE program for least squares analysis has been written for the 650 and has operated satisfactorily with data supplied by Reactor Lattice Physics. Also at the request of Reactor Lattice Physics, the in-hour equation for a pure U-235 system was programmed in OMNICODE.

Lattice Measurements for Cluster Fuel Elements

The material buckling of a seven rod cluster of 0.926-inch-diameter uranium rods with a separation of 70 mils has been measured in a 14-inch graphite lattice. The value obtained with H₂O coolant is $-33 \times 10^{-6} \text{ cm}^{-2}$. This geometry gives mole or atom ratios of $C/U = 71.3$, $H_2O/U = 0.46$, $Al/U = 0.47$.

STUDIES RELATED TO SEPARATIONS PLANTS

Measurement of k_{∞} for Uranyl Nitrate - Water Mixtures

Experimental work was started on the "full scale" phase of the criticality experiments for determining k_{∞} of enriched uranyl nitrate - water mixtures. The uranium enrichments used were 2.1%, 2.2%, and 2.3% at an H/U ratio of 12; several measurements were also taken at an H/U ratio of 14 with the 2.1% and 2.3% enrichments. The data analysis has not been completed.

Buckling Measurements for Random Arrays of Enriched Uranium Slugs

In reference to the dissolver problem, an additional buckling was measured for 1.44% enriched I and E fuel elements in a random array; the canned dimensions of these fuel elements were 1.47 inches O.D., 0.37 inches I.D., and 8.6 inches in length. Previous measurements with these fuel elements had resulted in H₂O/U ratios ranging from 1.74 to 1.80, with an average of 1.78; the average buckling was 3515 μB . This experiment gave an H₂O/U ratio of 1.93 and a buckling of 2775 μB . The larger H₂O/U ratio was probably due to partial bridging of the elements against the side of the small tank which would be less likely to occur in a larger tank.

Buckling Measurements for Mixed Lattice of 0.926-inch and 1.66-inch Slugs in Water

Two buckling measurements were made using a fixed lattice of 1.007% enriched uranium consisting of alternate rods with diameters of 0.925 inch and 1.66 inches. The results of these measurements are tabulated below:

<u>Exp. No.</u>	<u>Distance Between Alternate Rods</u>	<u>H₂O/U (By Volume)</u>	<u>Bucklings (10^{-6} cm^{-2})</u>
49	1.95"	1.30	2692
*46	2.05"	1.45	2605
48	2.20"	1.84	2078

* Measured in January.

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The plot of these buckling values versus the H_2O/U ratios is interesting since for the higher two H_2O/U ratios the measured bucklings for the combination are lower than that for either of these rod sizes separately at the same H_2O/U ratios. However, for the H_2O/U ratio of 1.20, the buckling is higher than either rod size alone at this H_2O/U ratio. These measurements provide some additional information about the buckling for fuel elements in a random array, in which case the fuel elements, in essence, can bunch together approximating fuel elements of different diameters.

Plutonium Critical Mass Facility

The current status of the Plutonium Critical Mass Laboratory is given as follows: A telegram concerning the status of HAPO project proposals was sent by the Division of Production to the Local AEC Office advising that the need for the critical mass laboratory was approved; however, initiation of work on this facility would await the result of a scoping survey of other AEC sites by the Division of Production. The telegram also advised that Washington will want to review and approve the proposed work when the preliminary design is complete.

Nuclear Safety, Critical Mass Consultations

1. Nuclear Safety in 234-5 Building Processing

- A. A theoretical study of the nuclear safety in the dissolution of plutonium metal in a 5.75-inch I.D. dissolver indicated a minimum critical mass for the system of 1.5 kg plutonium when the undissolved metal was surrounded by plutonium polymer and 2.1 kg plutonium when the plutonium in solution was in the form of plutonium nitrate. The results of this theoretical study agree with previous postulations (HW-51937); namely, that a more reactive system can exist during dissolution than exists either before or after dissolution. A similar study for a 2.5-inch diameter dissolver indicated a decrease in reactivity during dissolution when the undissolved metal was surrounded by plutonium polymer. From this study a maximum safe batch size of 2 kg plutonium (safety factor of at least 2) was indicated. This conservatism is necessary at this time because of the lack of experimental data as well as an insufficiency of the theoretical development. It is felt, however, that multiplication measurements in the 2.5-inch-diameter vessel could result in an increase of this maximum allowable batch size.

- C. Discussions were held with members of CPD regarding methods of increasing the batch size of the 6-inch glass vessels (THT, SNCT, and RCTR) in Hoods 1-4 (Batch Task I-II Hoods). Two methods were proposed: (1) Change the vessels to 5-inch-diameter vessels, or (2) remove the lead and lead-glass shielding surrounding these vessels so that, outside the vessels walls, the nearest neutron reflectors are the hood walls.

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2. Nuclear Safety in Purex Processing

- A. Design criteria for nuclear safety of an ion exchange column to recover plutonium from the LWW Purex Prototype was submitted to Facilities Engineering of CPD.
- B. At the request of the CPD contact engineer for Purex, an inspection was made of the new L-Package to determine the safety of the package after installation of a number of catwalks in the system. These catwalks are required for contact maintenance. The incorporation of holes in the metal jackets surrounding the insulation in the upper loops of the stripper and concentrator was recommended to insure nuclear safety in the event of corrosion leaks through these loops.

3. Nuclear Safety UO_3 Manufacture

Nuclear safety of the conical shipping containers was reviewed. A numerical formulation for the geometric bucklings of cones was made as a function of the vertex angle. The completion of this study awaits further information from CPD regarding maximum moisture content of the UO_3 powder.

Neutron Age Measurements

Another run was completed on the monoenergetic age measurement. The small diameter neutron source was used in the determination of age in kerosene. This completes the presently planned experimental program. The data obtained in the kerosene experiments are presently being reduced for age calculations.

More exact calculations have been made on the age in water obtained from this program. A still somewhat tentative result of 14.7 cm^2 has been obtained for the age of Na-Be neutrons to indium resonance. This is to be compared with a value of 13.9 cm^2 obtained from the first preliminary measurement. The value of 14.7 cm^2 is expected to extrapolate to about 14.3 cm^2 for a point source. The error analysis on these measurements is not complete but the suggested result seems to be significantly higher than values of about 13.3 cm^2 which have been obtained theoretically.

Mass Spectrometer for Plutonium Analyses

Mechanical construction of this spectrometer is proceeding according to schedule in Technical Shops. The electronic instrumentation fabrication has not been started because of delay in delivery of components and is about four weeks behind schedule.

REACTOR DEVELOPMENT - 4000 PROGRAM

STUDIES RELATED TO THE PLUTONIUM RECYCLE PROGRAM

Plutonium Spike Measurements

The PCTR data on the plutonium spike column in a lattice work of UO_2 -cluster fuel elements have been taken with two different poisoning configurations. The analysis is now proceeding.

Resonance Escape Theory

The present calculations of the effective resonance integrals of the 18 resolved resonances of U-238 have led to results, the significance of which are still to be interpreted. When these calculations for the five rod sizes being used are fitted by least squares to the form $a + b \sqrt{S/M}$, the parameter a has a negative value. A better approximation appears to be a quadratic in $\sqrt{S/M}$. When this form is fitted by least squares and the narrow and wide resonances are considered separately, the result for the wide resonance is

$$\sigma_a \text{ (eff)} = -0.559 + 19.83 \sqrt{S/M} + 1.09 S/M$$

and for the narrow resonances is

$$\sigma_a \text{ (eff)} = 0.416 + 0.86 \sqrt{S/M} + 1.48 S/M$$

The source of the negative a value for the wide resonances has not yet been found. Inclusion of the origin as a fixed point in the curve would eliminate this objection, but this procedure has not been completely justified.

Instrumentation

Work continued on the final design of the 5X viewer for the Fuel Inspection Facility.

The study of possible systems for slug rupture detection continued. A summary of the results of this system is expected to be available by the middle of March.

CROSS SECTION MEASUREMENTS PROGRAMPu-239 and Pu-241 Low Energy Fission Cross Sections

The data for the normalization of the low energy fission cross sections of Pu-239 and Pu-241 to the 0.1 ev values have been completed. These data now give a fairly complete picture of the detailed fission cross sections below 1 ev and will allow critical comparisons with resonance theory. The Pu-239 values at low energy are about five percent lower than the old value obtained at Hanford. The normalizations obtained were:

$$\text{Pu-239: } \frac{\sigma_f \sqrt{E} \text{ (0.0047 ev)}}{\sigma_f \sqrt{E} \text{ (0.10 ev)}} = 0.776 \pm 0.008$$

$$\text{Pu-241: } \quad \quad \quad " \quad \quad = 0.815 \pm 0.016$$

U-235 Low Energy Total Cross Section

The U-235 absorption cross section was determined to vary as $1/v$ over the energy intervals 0.0025 to 0.0047 ev to a precision of about ± 0.2 percent. Comparison of the measured $1/v$ value with the shape of the absorption cross section and fission cross section yields the variation of η in this region. The interpretation is complicated only by the assumptions regarding the scat-

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tering cross section. Using the scattering cross-section variation deduced at Brookhaven one obtains a constant value of η at 0.0025 ev compared to 0.10 ev to a precision of about one percent. When a constant scattering cross section value of 11 barns is assumed the cold neutron value of η is two percent higher than the 0.1 ev value. The implication of this result is that η for U-235 has a maximum variation of about two percent for monoenergetic neutrons of energy less than 0.1 ev and is most probably very constant over this interval. These results are to be compared with measurements at Brookhaven which show an increase in η with energy of about two percent over this interval and results from Argonne showing a five to ten percent decrease.

Copper Cross Section

Low energy total cross section measurements were made on a copper sample from 0.0025 to 0.0047 ev. Extrapolation of these results to thermal yields an absorption cross section of 3.63 ± 0.17 barns for 2200 m/sec neutrons. This value was obtained for comparison with the value of 3.77 ± 0.03 barns obtained from PCTR measurements. The rather large uncertainty in the crystal spectrometer value results from uncertainty in the calculated correction for residual neutron scattering below the Bragg cut-off energy. It does not seem likely that the precision of the result could be greatly improved from a study of the residual scattering so that further measurements are not planned at this time.

Absolute Fission Cross Section Measurements

A total alpha count of the U-235 standard fission foil has been made by Analytical Laboratories. The result is in excellent agreement with a previous measurement made at KAPL.

Time-of-Flight Measurements

The effort this month was devoted to a study of time resolution in detectors and electronic systems. The five-inch 7170 photomultiplier tube was tested for the spread in initial pulse time which results from transit time differences over the face of the photocathode. It was determined that a three-inch-diameter region could be used with a time spread of ± 0.5 millimicrosecond. The use of this large area should result in a factor of ten increase in usable solid angle at the detector over the 6810 photomultiplier tube. It was also determined that the gain of the EFP60 amplifier tubes of the chronotron might be improved by changing the present operating voltages.

Three Crystal Spectrometer

A design error was discovered in the assembly of the spectrometer which necessitated modification of the third crystal table. Installation is proceeding slightly ahead of schedule and somewhat below estimated cost.

Graphite Cross Section

The absorption cross section of graphite for 2200 m/sec. velocity neutrons has been determined by a danger coefficient technique. To render any moderating effect of the graphite samples negligible, the samples were positioned within the heavy water tank in the core of the PCTR. The cross section value was

normalized to a copper standard whose absorption cross section was taken to be 3.77 ± 0.03 barns. A preliminary value of the cross section of the 1.024 ± 0.006 di-graphite sample is $4.66 \pm 0.15 \times 10^{-27}$ cm². Further analysis is to be done since this value is high by at least ten percent.

TEST REACTORS OPERATION

An improvement was designed for the driver rod graphite blocks so that the D₂O calandria mockup with 9" spacing could be increased in size. An additional row of buffer tubes can now be used and better flux spectrum matching should result.

A large number of circuit drawings were made and final checking before reproduction is now being done.

Improvements were made for the source drive mechanism. More reliable operation should result.

New safety sheets were fabricated for the TTR and revised upper position limit switch assemblies were completed. When the equipment installation is completed a worthwhile increase in reactor reproducibility should result.

The TTR reactor circuitry drawings were essentially completed. Final checking before reproduction is in process.

BIOLOGY AND MEDICINE - 6000 PROGRAM

BIOPHYSICS RESEARCH

Atmospheric Physics

Field measurements of the transport and diffusion of materials emanating from the 100 Areas and moving across the Wahluke Slope were continued. The fourth in this series of experiments was completed on February 13th when the source was placed near the 100-F Area and airborne concentrations near ground level were measured along a N-S line approximately four miles east of 100-F. The surface wind velocity during this experiment was W at 10-15 mph, but considerable vertical wind shear was evident during the first part of the experimental period. Large-scale variability of wind direction once again caused wide lateral spreading of the tracer material; this "meandering" of the tracer plume was very well defined by time resolution of the concentration using the drum samplers. Typical dilution ratios over the 6.5 mile cross-wind sampling line were of the order of 10^{-9} sec/m³. The minimum dilution ratio, observed at 4.5 miles from the source, was 8×10^{-8} sec/m³.

More detailed analyses of the data from the experiment conducted during January showed that the centerline of the time-mean plume probably passed over or slightly outside one end of the sampling line and specification of the minimum dilution ratio for this experiment is not possible. Other data from this experiment tend to substantiate previous experimental results, however.

Studies of the theoretical aspects of vertical diffusion rates in stable atmospheres have been continued in an effort to provide clear physical rationale for

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the effects of buoyancy on atmospheric diffusion processes. A very preliminary result of these studies suggested that the intensity of the vertical component of the turbulent motions is more strongly controlled by the mean wind speed (or the basic energy supply) than by the density gradient. The scale of the turbulence, or the permitted spectrum of turbulent motions, appeared to be dominated by the density stratification, however.

DOSIMETRY

The large scintillator that developed a leak earlier was replaced free-of-charge by the manufacturer. It was used to make a careful study of background in the rock-shield low-background facility. At 0.1-Mev gamma-ray energy, the background is twice what it is in a good lead shield; at 2 Mev it is 1.4 times greater. These facts are consistent with the expected excess of low energy rays in shields made of low atomic number materials. In general, the spectrum is consistent with that from radium.

A case of ruthenium deposition was analyzed in the low background facility. 0.0063 microcurie of Ru^{103} and 0.0077 microcuries of Ru^{106} were found. For comparison, the maximum permissible body burden of Ru^{106} is three microcuries. Estimated uncertainty is 25% of which more than half is due to uncertainties such as the amount of Cs^{137} present.

The large plastic scintillator was tested further in the low-background facility. All of the AFSWP students were counted. They will also be counted at Los Alamos and at Walter Reed Hospital; this will permit intercomparison of the three laboratories.

The gamma-ray spectra of two-year old plutonium was studied. Enough Am^{241} was found to have grown into the sources to make study of old plutonium deposition cases by searching for this daughter appear very promising.

It was found that ground potentials of different parts of the electron Van de Graaff were not actually equal. The method of measuring Van de Graaff voltages used in the calorimetry work was materially improved by supplying a separate common ground. A gas cell needed for this work is being fabricated.

The Van de Graaff accelerator operated satisfactorily during the month. A paraffin shield is being placed between the analyzing chamber and the target area to cut down neutron background.

Radiological Development Operation has ordered some B^{10} and B^{11} with which to make slow neutron pencils to test the area monitor concept described last month.

A study was made of the angular response of the double moderator to Ra-Be neutrons. There was 14% variation with angle. Some data for PuF_4 neutrons was obtained from CPD that showed slightly different, but again quite small, variation. This is much better than earlier rough tests had shown. Measurements at other energies are needed, but perhaps the angular response is within acceptable limits. While preparing several double moderators for field use, Radiological Development found them to be very reproducible from one to another.

Another series of proton W measurements was completed. Simultaneous proton

counting and ion current measurement were possible. Argon and nitrogen gave 26.5 and 37.0 ev/ip, respectively. These are equal within the probable errors to the values for alpha particles. Attempts to measure CO₂ and a tissue-equivalent gas by simultaneous counting and current collection were unsuccessful.

INSTRUMENTATION

The scintillation transistorized Alpha Hand Counter is still operating successfully in general 329 Bldg. use after about four months of continuous operation. No maintenance or recalibration has, as yet, been necessary.

The combined alpha, beta, gamma Hand and Shoe Counter, using scintillation detectors for alpha and GM tubes for beta-gamma was completed in modification and is now in general building use. An additional cable-connected scintillation alpha probe and an additional cable-connected GM tube were added to the instrument. The readout for these two external, separately activated probes is by loudspeaker. These probes are for clothing monitoring. The instrument, which can replace the "Four-Fold" and "Five-Fold" instruments, is the size of a "Five-Fold." Hanford plant drawings have been made and are being checked for accuracy. The instrument has performed satisfactorily for its one week of general building use.

Development work was started on an all-scintillation all-transistorized combination alpha, beta, gamma Hand and Shoe Counter. Some of the circuitry will be similar to that used in the scintillation Alpha Hand Counter.

The all-transistorized scintillation slow neutron count-rate meter was preliminarily tested using slow neutrons from the Sigma pile at the Calibrations Operation Building. Initial results were satisfactory for slow neutron sensitivity measurements.

The experimental portable scintillation transistorized gamma energy analyzer was used at 100-H and Redox about twelve working days this month with good results. The instrument determined gamma energy analysis data in various locations in a matter of minutes of use. Field acceptance of this instrument is very good.

The investigation of proximity sensing devices for use with an experimental robot monitor was continued. The robot monitor is visualized as an instrument which can scan automatically the floor of a room and provide information relative to radioactive contamination.

A different approach to alpha air monitoring is being investigated. Experimental instrumentation was assembled to compare the effects of the expected rate of rise of activity on a filter due to air alpha contamination with the effects of the observed rate of rise due to background. Rough calculations indicate that about 500 times the maximum permissible concentration of air plutonium contamination will cause an alarm in about two minutes. By comparison, the high level Alpha Air Monitor alarms in approximately 60 minutes with an air contamination of 500 times the maximum permissible concentration.

Laboratory testing of the central station equipment for the Radio Telemetering

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Station was continued. The data amplifiers and the call-tone generators were fabricated on-site and have been tested satisfactorily.

The zinc sulfide particle detector for the Atmospheric Physics Operation needs only some machining work to be completed and be ready for delivery.

The final machine work and shield assembly work for the Dog Counter for the Biology Operation was continued and is almost completed. Complete system testing will follow.

A complete work estimate for a scintillation Fish Counter for the Biology Operation was completed. This instrument will be used to determine the extent and location of various radioisotopes in fish used in conjunction with the Aquatic Biology experimentation program.

Tests of films prepared for optical autocorrelation measurements give the expected patterns when the test film is mostly opaque and the simulated tracks are transparent. Because of low contrast, no pattern is detected when the tracks are opaque and the background transparent. Work is continuing to increase the contrast in order that the autocorrelation pattern of an opaque track can be detected. These autocorrelation effects are being studied as a possible method of counting particle tracks on film badges.

Evaluation tests were completed on a prototype dose-integrator, an experimental fast neutron scintillation dose-rate meter, a commercial miniature high-voltage power supply, and on a commercial pocket gamma alarm dosimeter.

WASHINGTON DESIGNATED PROGRAMS

Mechanical construction of the mass spectrometer is proceeding on schedule in Technical Shops. The components of the vacuum lock assembly were successfully chrome plated and the critical job of grinding these parts is in progress. The electronic instrumentation fabrication has not been started because of delay in delivery of components. Tests are underway to determine the suitability of H. S. Martin Company mercury diffusion pumps as replacements for the more expensive Consolidated Electrodynamic Corporation pumps used in the original design.

CUSTOMER WORK

Analog Computing

The computer was inoperative for an 8-day period due to modification and power supply failures. Goodyear Service personnel installed two additional cooling fans on the computer and made additional modifications as specified by the factory. Minor operating troubles were corrected as requested.

For the PRTR Gas and Water Dynamics study, a set of dump characteristics were established and runs made. A review of the runs established a need to change the equations of the system. These changes are being made and additional runs will be evaluated.

The exact configuration of the heat exchanger system for the NPR is not available and various computer runs are being made to aid this part of the program for study of NPR heat transfer characteristics.

In the Waste Tank Temperature Study, additional data have been supplied by the customer and the computer set-up has been completed. This problem will be run when machine time becomes available.

The problem on Californium build-up in the PRTR is currently being run on the computer and will be completed on or before March 7, 1958.

Weather Forecasting and Meteorology Service

<u>Type of Forecast</u>	<u>Number Made</u>	<u>% Reliability</u>
8-Hour Production	84	81.3
24-Hour General	56	87.5
Special	132	97.7

The past month was warm, cloudy and wet. The average of 44.5 was the highest for February in 46 years of record. Daily means were above normal without exception. Each of the first 26 days was high; in only one month since the Station was established in 1944 has there been more cloudiness. Precipitation totaling 1.48 inches was about 75 percent more than normal.

The past month completed one of the warmest winter seasons since records began in 1912. Temperatures December, January and February averaged 40.0, the only warmer winter of record was 1933 and 1934, when temperatures averaged 41.1.

The past month completed the first winter season of record with no measurable snowfall. Prior to this winter, the least seasonal total was 2.5 inches during the winter of 1938 and 1939.

Analyses of data taken in studies of the problem of oxides of nitrogen in the vicinity of the 313 Building resulted in a definite recommendation that either the effluent from the slug pickling apparatus be vented through a stack to a height of at least 80 feet above grade or the emission rate from this facility be reduced from the present 10-11 lb/hr to no more than 1.5 lb/hr. It was also determined that the effluent from the acid etch apparatus in this building is within tolerance limits and no corrective action with regard to this facility is required. These recommendations were made in collaboration with Industrial Hygiene Operation personnel.

Studies of the oxides of nitrogen problem in the vicinity of the 321 Building were continued.

Instrumentation

Three completed and tested alpha, beta, gamma fixed-filter (4" x 8") counters were delivered to the 200 Areas for counting usage.

A work order and instructions were given to the Technical Shops for the fabrication and assembly of the dual alpha air monitoring system.

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DECLASSIFIEDOptical Service

A large Lenox Borescope was modified for Irradiation Testing Operation. The modification included the design of a new eyepiece and the design of a lamp section which increases the illumination by at least five times.

Assistance was given to the HLO Chemical Separations Operation in securing a periscope (war surplus aircraft periscope) for use in observing pulse columns in the 200 Area.

Design modifications were made on a periscope to be used at 105-F Area.

Other work included the routine servicing of all of the 327 Bldg. optical equipment, the fabrication of an arc image furnace, and the modification of a transit.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Buildings Visited
R. J. Walker	2/3	University of Calif. Berkeley, Calif.	Discuss Instrumentation.	WG Spear	No	300: 329
H. Marx	2/6	Technical Associates Pasadena, Calif.	Discuss Instrumentation.	WG Spear	No	300: 329
J. G. Simmons	2/10-13	Goodyear Aircraft Corp. Long Beach, Calif.	Service Analog Computer.	WD Cameron HH Burley	No	300: 326
G. Stukenbroeker	2/17-18	National Lead of Ohio Cincinnati, Ohio	Discuss Exponential Experiments and Criticality Problems.	ED Clayton N Ketzlach	Yes	300: 303 305-B
J. L. Powell	2/24-28	Univ. of Oregon Eugene, Oregon	Consultation.	JE Faulkner	Yes	300: 303 305-B 105-KE
G. C. Gill	2/27-28	Univ. of Michigan Ann Arbor, Mich.	Confer on Micro-meteorological Instrumentation and Tracer Methods.	GR Hilst JJ Fuquay	No	200-W: 622

B-14

HW-55162 DEL

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
P. F. Gast	2/3	Division of Reactor Development, AEC Washington, D. C.	Attend Review Meeting for Geneva Conference Papers.	IF Zartmann	Yes
H. W. Lefevre	2/3	Columbia University New York City	Discuss Time-of-Flight Techniques.	W. W. Havens	No
	2/4-5	Argonne National Lab. Lemont, Ill.	" "	Dr. F. Lynch	Yes

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VISITS TO OTHER INSTALLATIONS (Continued)

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. E. Faulkner	2/3-4	Argonne Nat'l Lab. Lemont, Ill.	Mass Analysis Measurements on Enriched Carbon-12.	Dr. BI Spinrad	Yes
	2/5	Univ. of Wisconsin Madison, Wis.	Discuss Physics Work.	Prof. RG Herb	No
G. R. Hilst	2/5-7	Robt. A. Taft Sanitary Engr'g Center US Public Health Serv. search Planning Seminar. Cincinnati, Ohio	Invited Participation in Air Pollution Research.	AC Stern	No
E. D. Clayton	2/10	Univ. of Washington Seattle, Wash.	Present Paper to Dept. of Chem. Eng. Seminar.	Dr. AL Babb	No
E. J. Seppi	2/11-13	Phillips Petroleum Idaho Falls, Idaho	Discuss Resonance Theory and Inelastic Scattering.	M Moore R Brugger	Yes
A. E. Tucker	2/12-14	Aircraft Nuclear Propulsion Dept. G-E, Evendale (Cincinnati, O.)	Attend Reactor Controls Meeting and Discuss Analog Applications.	WJ Lawson SW Ahrends	Yes
B. R. Leonard	2/18-21	(Univ. of California) Los Alamos Nat'l Lab. Los Alamos, N. Mex.	Attend Los Alamos Chalk River Fission Seminar.	Dr. RB Leachman	Yes

B-15

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HW-55162 DEL

Chemical Research and Development

RESEARCH AND DEVELOPMENT

FISSIONABLE MATERIALS - 2000 PROGRAM

IRRADIATION PROCESSES

Analytical Service

File coolant radioanalysis included numerous developments: A Purex chemist and two laboratory assistants began training in preparation for transfer of coolant radioanalysis to that operation. The gamma-gamma coincidence counter was recalibrated for Cu^{64} . The potassium cobaltinitrite purification of cobalt shows consistent chemical and radiochemical yields and gives suitable decontamination from other emitters such as Mn^{54} , a serious interference with Co^{58} measurements.

KER #1 loop water containing 2 ppm LiOH has 0.6 to 4×10^{-3} μc tritium oxide/ml. Cr^{51} and Zn^{65} represented 2.1 and 2.8 per cent of the total beta activity in production reactor effluent water. Manganese and chromium chemical separations were made more rigorous to give very satisfactory purification of Mn^{54} and Cr^{51} occurring in KER loop water.

Organic coolant study continues to receive measurements of tars, viscosity, and density by established methods. Adapting methods to higher temperatures was stopped because of program de-emphasis.

Automatic Analyzing Monitor

Good instrument stability and reproducibility of results was obtained in the test monitoring of seven isotopes and total beta radiation per unit volume of reactor effluent. Study continues to effect minimum maintenance effort on the equipment.

Uranium Oxidation Experiments

In initial experiments, excessive oxidation of uranium occurred in nominal argon atmosphere and temperatures up to 1240°C . This is believed to be caused by improper techniques in de-gassing the equipment and during insertion and removal of the sample. Modifications of the equipment and techniques were completed and a new series of blank runs planned for March.

300 Area Waste Disposal

A sampling traverse of the Columbia River conducted $1/2$ mile below the 300 Area in January, 1958, yielded samples which contained uranium in concentrations just slightly above background. This confirms previous findings that adequate and nearly complete dilution of 300 Area Wastes is realized within a short distance downstream of the 300 Area at all times of the year.

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SEPARATIONS PROCESSES

Feed Preparation

Continuous Dissolver. Dissolution experiments on aluminum clad metallic uranium have been started in the 5-inch-diameter tower. The first runs were characterized by large perturbations in the tower vacuum, product concentrations, and product rate. The equipment has been modified to reduce reflux surges and/or siphoning of dilution water into the tower. Since modification, the unit has operated smoothly.

Dingot Uranium Dissolution Studies. Metallographic examination of partially dissolved wafers of Ingot, Dingot, and high carbon Dingot uranium showed that solvent attack in end grain areas was pitting in nature. Pitting density appeared relatively constant for the three types but depth of pitting decreased in the order given. The intensity of pitting attack in Ingot metal appears to be influenced by the inclusion paths. Similar inclusions are much less prominent in the Dingot samples. Further dissolution rate studies with beta heat treated uranium - carbon - silicon alloy wafers have shown no direct relationship between dissolution rate and carbon content, silicon content, or the as-cast grain size.

Solvent Extraction

Purex IC Column Studies. Studies directed toward increased Purex IC Column capacity were continued. Experiments in a 3-inch-diameter glass column with a 9-foot-long "plant" type cartridge (stainless steel nozzle plates, 0.125-inch-hole diameter, 10 per cent free area, 4-inch plate spacing) indicated that decreases in the aqueous-to-organic ratio produced significant increases in the column capacity at flooding. Variations in pulse amplitude had little effect on the capacity of the column although flooding frequencies changed appreciably.

Coalescence and Plate Wetting. Investigations were continued on the "zebra" and coalescence phenomena in pulse column cartridges containing alternately two linear polyethylene and four stainless steel sieve plates with 1-inch plate spacing. Studies in a 3-inch-diameter by 3-foot-high glass column operating with a high delta specific gravity system containing a uranium-free, 11 M HNO_3 aqueous phase and a 30 per cent TBP in spray-base organic phase have indicated that:

- (a) Coalescence was generally poorer than that in systems more closely analogous to Purex Flowsheet conditions.
- (b) Apparent optimum pulse amplitudes (0.6 inch) and plate hole sizes (3/16 inch) existed for maximum coalescence.
- (c) The "zebra" emulsion effect (aqueous continuous in the stainless steel sections and organic continuous in the polyethylene sections) was generally difficult to establish in this system.

Purex Mini Runs

The effect of operating the HS column at elevated temperature was studied in a Mini run employing 25 per cent fission product level feed. Flow ratios were

nominally those proposed for the Purex phase II flowsheet. The HA and HC units were operated at ambient temperature, and the temperature in the HS unit was varied from 25 C to 70 C. Increasing the HS temperature from 25 C to 70 C increased the overall decontamination from zirconium-niobium by a factor of about three (from 5×10^4 to 1.5×10^5) and increased the decontamination from ruthenium by a factor of about nine (from 1×10^5 to 9×10^5).

Solvent Studies

In the proposed two-cycle Purex flowsheet, second cycle solvent (II00) will be exposed to aqueous feeds containing 10 to 100 times more activity than at present. When present plant II00 was contacted with this level of activity for 20 minutes at 40 C, the activity which was extracted by the solvent and which could not be removed by scrubbing with five per cent sodium carbonate solution was only 16 per cent greater than that originally present in the plant II00.

Diluent Degradation

Results obtained in experiments in which hydrocarbon diluents were exposed at 50 C to four molar nitric acid solutions containing 0.02 per cent dissolver solution and initially 0.1 molar sodium nitrite are not easily interpreted. Certain of the diluents continued to pick up fission product activity in a fairly regular fashion throughout the exposure. The activity of some of the diluents, however, increased to a maximum and then decreased. It was noted that certain of the diluents which are known to contain appreciable quantities of naphthenes (Deo Base and Shell diluents) degraded much more rapidly than those which are essentially 100 per cent paraffins (Soltrol, Amsco, and n-dodecane). Treating the diluents with 20 per cent oleum to remove unsaturated and aromatic compounds improved the stability to chemical degradation of only the diluents which were essentially 100 per cent aliphatic hydrocarbons. Shell E-2342 and ultrasene appeared to be more subject to chemical degradation after the treatment. Six diluents which meet present Purex flash point specifications (140 F minimum) can be listed in order of increasing stability to chemical attack, as follows: Shell diluents, Deo Base, Ultrasene, Soltrol-170, and n-dodecane.

Profile Column

The profile pulse column facility in the 1F multicurie cubicle of the 222-S Building is complete, and shakedown runs are in progress with nitric acid and cold uranium feeds.

Analytical Service

Continued use is being made of the thermal ionization mass spectrometer for measuring isotopic plutonium. Numerous performance characteristics have become more clear. Beside having no memory effect, other ions do not interfere. Health hazard is low because sample size is in the few microgram range. Absolute precisions (95 per cent C.L.) are: Pu^{239} , ± 0.11 per cent; Pu^{240} , ± 0.087 per cent; and Pu^{241} , ± 0.022 per cent. Accuracy data will result from a sample exchange program with other AEC sites. Services included analyses of Chalk River material, five analyses

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to support the Z-Plant gamma activity study, and five analyses supporting the preparation of plutonium bearing fuel for MTR. Spectrometer capacity is only one sample per day but modifications are planned to increase production.

Emission spectrographic services supported the New Production Reactor study. Nearly 200 samplings of four new types of aluminum alloy were analyzed for impurities. A critical deadline was met even though completely new spectrographic calibrations were required. Also, inactive cesium, strontium, and arsenic in water were measured to help determine the origin of corresponding radioisotopes. Precision is ± 15 per cent. Detection limits are: Cs, 0.4 micrograms/liter; Sr, 20 micrograms/liter; and As, 10 micrograms/liter.

The 325 Building 6-inch lead cave was completed for dissolving burnup samples and making simple decontaminations. Numerous cold runs led to successful handling of the first hot sample. It was a 50 gram uranium sample reading nine R at two feet. Samples of greater activity are expected.

Plutonium radioassay and acid measurements characterized various organics, (dibutyl butylphosphate, tribromoethane, and pentachloroethane each in CCl_4 diluent) as to their plutonium extraction efficiency. Potassium oxalate failed to complex the organic phase plutonium enough to permit accurate acid titration. Substituting ammonium oxalate and a dibromothymolsulfonphthalein end-point (pH 6-8) reduced plutonium hydrolysis and gave sharp end-points.

Analytical services were started for pilot plant studies of dissolving zirconium-clad fuel elements. Solids settled out of samples taken for analysis. Redissolving was difficult. In addition, fluoride caused etching of glass containers, giving some inaccuracy in fluoride analysis. Operations have eliminated those problems by diluting samples when taken and using plastic containers. Fluoride was measured by thorium titration of distilled fluosilicic acid. While technology was sound some delay was caused by a second program adding to the demand for that analysis. Zirconium was measured by weighing the oxide.

Support was given to a study of UO_2 reduction by aluminum. Uranium assay of the Al-U product follows dissolution in hydrochloric acid and bromine. Ceric sulfate titration of the uranium is superior to titration with chromous sulfate.

Z-Plant Gamma Activity Study

Facilities Engineering Operation, CPD, initiated a study of product gamma activity at various process stages to aid in designing potential shielding in the Z-Plant. The same samples could be used to determine gamma activity growth of Pu^{241} daughters, Am^{241} , and U^{237} . Increased radioactivity becomes of major importance in highly exposed power fuels and is of immediate interest to 234-5 Development Operation. Accordingly, the analysis of product samples has been undertaken to establish gamma decontamination, growth, energy, and source identification.

WASTE TREATMENT

Nitric Acid Destruction

"Cold" experiments were completed aimed at establishing the minimum amount of formaldehyde required to destroy the excess nitric acid in simulated Purex Phase II LWW. It was found that 94 to 98 per cent of the free nitric acid was eliminated with a formaldehyde flow of only one mole per four moles of nitric acid. This approaches the limiting theoretical stoichiometry very closely. It was also found that the de-acidified product could be evaporated to about one-third of the original LWW volume before precipitation was observed. Drying and calcination of the concentrated waste resulted in an even smaller volume of as little as seven gallons of compacted solids per ton of uranium.

The behavior of fission products during the formaldehyde treatment was established by adding a spike of plant LWW to the feed. No activity whatsoever could be found in the overhead nitric acid condensate, implying excellent deentrainment of gross activity and a ruthenium decontamination factor greater than 10^5 . This may be compared to ruthenium decontamination factors of 100 to 10^4 in laboratory studies of conventional Purex nitric acid recovery and indicates that volatilization of fission products will not be a problem in the formaldehyde process. A summary report on this subject is in preparation.

Calcination of Purex Waste

Unneutralized synthetic Purex LWW was dried, ground to a powder, and calcined in a tube furnace at temperatures of 150 to 900 C. Qualitatively, volatilization of ruthenium was observed to decrease at high temperature operation or by addition of formaldehyde vapor to the air stream passing through the furnace. The weight loss on calcination increased with temperature and was 27 per cent at 500 C and 43 per cent at 900 C. The calcined solids were leached with hot water and the weight loss noted. This was about 45 per cent of the air dried weight, and was not a function of temperature of calcination. In one experiment, phosphoric acid was added to the LWW before drying and calcination. The resultant glassy melt was ground to a powder and leached with boiling water for two hours. The weight loss was only 0.6 per cent. Silicate and borate additions were less effective than phosphate in reducing leaching losses.

Special Geological Studies

The fixed-price portion of the CA-700 well drilling project was completed January 31, on schedule.

Observation Wells

No major changes in the pattern of ground water contamination were evidenced by analyses of routine ground water samples. However, special samples from a point 30 feet beneath the surface of the ground water in a well south of the 217-BY crib indicated a 90 per cent reduction in radioactive material concentration over that previously measured. This marked decrease is attributed to a change in the direction of ground water movement in this area, probably as a result of the slow

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spread of the Purex ground water mound. Samples from test wells monitoring the 216-BC cribs and trenches continued to show sporadic contamination at about the same concentration as that previously found. Detectable concentrations of radioactive material were found in test wells 11, 12, and 17 miles, respectively, south-east of the 200 East Area. The concentrations in these samples were far below that considered hazardous in drinking water.

Twenty-one additional wells were probed with the scintillation well probe. Readings were made with the instrument suspended at the water surface in wells from which water samples had been taken and analyzed. A close correlation was found between the probe readings and the concentration of radioactive material in the water and this may prove useful for providing rapid estimates of ground water contamination in new wells and for predicting imminent breakthrough to the water table.

Disposal to Ground

When the acid CAW waste from the Recuplex plant infiltrates normally basic soil the solution is gradually neutralized and aluminum, calcium, and magnesium hydroxides precipitate in the soil pores retarding further infiltration. Pretreating a soil with acid will permit the wastes to infiltrate a greater distance before such plugging occurs, essentially increasing the capacity of the crib.

Laboratory experiments were performed to determine the optimum acid concentration and flow rate conditions for the conditioning of soils by acid treatment. The flow rate is affected by the generation of CO_2 in the soil as the acid reacts with calcium carbonate; the infiltration rate diminishes with acid concentration because of the more rapid generation of CO_2 ; the total volume of acid required for conditioning a given volume of soil diminishes with increasing concentration. Conditioning with 0.05 N nitric acid gave an infiltration rate of about 10 gal/ft²/day. It would require about 165 gallons of this acid to treat one cubic foot of typical soil to produce a soil pH of 2.0. Studies of the plutonium retention on soils treated in this fashion were commenced to confirm earlier indications of adequate exchange.

The presence of natural Cs and Sr in process water may well influence the exchange properties of soils for radioisotopes of the same element in the wastes. The raw water supplied to the 200 Areas was found to contain about 0.0006 ppm Cs and about 0.1 ppm Sr.

The presence of plutonium in the soil at the bottom of a 150 foot well adjacent to the 234-5 Building waste crib was confirmed. Six other shallow wells in the immediate vicinity are suspected of containing plutonium contamination. Plutonium contamination at this depth (50 feet above the regional ground water) resulted in a recommendation that a new crib and monitoring wells be provided in the immediate future.

Soil sample radioanalysis and well-probe results provided very good definition of the radioactivity deposition patterns in the sediments under the abandoned 216-S1 and 2 cribs. Correlation of geological and contamination profile data yielded useful waste movement and radioisotope adsorption information. Insufficient waste inventory data and the lack of soil samples from immediately below the cribs resulted in little success in obtaining a gross beta material balance around the cribs.

Gelling of Wastes

The moisture content of the aluminosilicate gel in the 300 Area test disposal pit has not changed significantly since the test started. This behavior is in sharp contrast with the data collected from the laboratory soil column test in which it was found that after about 3 months 75 per cent of the water was lost, about one-half of which went to the atmosphere, the remainder to the soil. This difference in experimental findings indicates that concern over loss of moisture from the gel to the soil may have been over emphasized. Samples of the soil below the test pit are to be taken within a few months and analyses should further clarify these differences in experimental results.

Waste Disposal

An engineering evaluation of the submerged combustion and bent-tube evaporator methods for coating waste concentration was begun. Study was also initiated on integrated processes which combine fission product recovery (for cesium-137) with ultimate high level waste disposal. An ultimate disposal concept is regarded as the more significant objective.

FISSION PRODUCT AND TRANSURANIC ELEMENT RECOVERY

Cesium Recovery

The manipulators, tanks, and other equipment for the full-level, liter scale testing of cesium recovery flowsheets have been installed in the 222-S multicurie cell, and shakedown runs will begin in early March.

Complete analyses have been received on a second set of seven samples of Purex plant 1WW. Iron and sodium concentrations were considerably lower and closer to flowsheet values than in the first set. Nickel and chromium results showed that only a minor fraction of the iron stemmed from equipment corrosion. In addition, the high aluminum to sodium ratio in some of the samples indicated that more aluminum is present than could be due solely to incomplete removal of coating waste prior to uranium dissolution, suggesting that the aluminum cans are not completely removed by the coating removal step. An interim report will be issued on these results as soon as sufficient data are obtained on plant operating conditions at the times of sampling.

Neptunium Recovery

Laboratory data are being obtained on the sulfate complexing of neptunium(IV) and on the probable path of neptunium in the second plutonium cycle. This is in support of a Purex plant test aimed at partitioning neptunium with plutonium in the 1B column (with eventual recovery from the ion exchange waste). From the extraction coefficients obtained, it appears that 0.05 M sulfate is a marginal neptunium partitioning agent. Oxalate was much more effective than sulfate, and fluoride was about twice as effective as oxalate, all on an equimolar basis.

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The Purex LBP is treated with excess nitrite to oxidize the plutonium prior to extraction in the II A column. Some experiments were run to determine the effect of this treatment on neptunium behavior. Very little reaction occurred until the solution contacted the II A solvent. Half to two-thirds of the neptunium then appeared to be rapidly oxidized to the inextractable (V) state with, however, only very slow oxidation of the remainder. These results indicate that most of the neptunium entering the II A cycle will be lost to the II AW under present flowsheet conditions.

The suitability of tri-laurylamine for extracting neptunium has been investigated. The extraction behavior of neptunium(IV), (V), and (VI) into tri-laurylamine from nitric acid solutions was very similar to that with tri-octylamine. Extraction coefficients were slightly lower when expressed on a volume concentration basis but were nearly identical on a mole basis. Thus, E_a^0 for neptunium(IV) from 4 M nitric acid into ten volume per cent tri-n-laurylamine-Amsco was 33 versus 66 for tri-n-octylamine-xylene. Tri-laurylamine-Amsco would appear to be a very satisfactory substitute for anion exchange for the isolation of neptunium.

Cesium Isolation and Packaging

The scope drawing SK-2-2332, "Process Flow Diagram," was approved and issued. The assignment of services to various cell nozzles is being worked out in a joint effort with Chemical Processing Department, Facilities Engineering personnel. Upon the completion of this phase, the preparation of detailed construction drawings for the isolation and packaging facility will begin.

Tests show that the rate of reaction of $Cs_2ZnFe(CN)_6$ with steam and air above 400 C is constant. At this temperature a reaction time of about four minutes is required to render the cesium totally leachable with water. The optimum air-to-steam ratio for the hydrolysis reaction above 400 C is 1.2 moles air per mole of steam.

ANALYTICAL DEVELOPMENT

X-Ray Fluorescence

In preliminary experiments, a method for determining the thickness of cladding materials on uranium was demonstrated which is based on the absorption of the characteristic uranium-X-ray by the cladding. With present equipment, aluminum thickness can be measured to 30 ± 0.1 mil and zirconium thickness to 5 ± 0.02 mils. The use of 150 KV exciting X-rays would extend the measurable thickness to 1.5 inches for aluminum and 0.125 inches for zirconium. This technique may be of value for a non-destructive method of determining cladding thickness on fuel elements.

EQUIPMENT AND MATERIALS

Continuous Calciner Hinged Agitators, 224-UA Building

Four continuous calciners equipped with hinged agitator assemblies operated during the month without shutdown due to agitator failure, although one sheared pin (1/2-inch diameter) was found in a routine inspection of K-cell calciner. Larger shear pins of 304-L stainless steel, as well as pins of both annealed and heat-treated

17-4 PH stainless steel, are being evaluated with a falling-weight impact tester in 321 Building in an attempt to provide an optimum pin design. First results show that 19/32-inch diameter pins can be used without agitator arm damage.

Bearing Test Program

Alumina bearing and journal samples, manufactured by Coors Porcelain Company, were tested. While operated submerged in tap water in the speed range from 1000 to 3000 rpm, no detectable wear occurred at loads up to 30 psi. At loads greater than 30 psi the wear varied as the load and velocity, with a wear rate of 40 micro-inches per hour occurring at 60 psi load and 3000 rpm. The surface roughness ranged from 30 to 45 micro-inches and remained essentially unchanged by wear.

Non-Metallic Materials

Linear polyethylene has shown insignificant changes in physical and chemical properties when irradiated to greater than 10^9 R of gamma irradiation. On the basis of these encouraging results a sample holder containing 20 samples of linear polyethylene was fabricated and sent to the Purex Plant for immersion in HAF solution to determine the relative effects of beta irradiation.

Pro-Fax, a polypropylene manufactured by Hercules Powder Company, has demonstrated unusual chemical resistance to typical Hanford process solutions. It has been unaffected after 30 day immersion at room temperature in 60 per cent HNO_3 , CAX, HAX, CCl_4 , 50 per cent caustic, hexone, and aqua regia (both 5 M HNO_3 - 2M HCl and 12 M HNO_3 - 1M HCl).

Deepwell Turbine Pump

The Johnston Splined-Shaft Pump installed in the 100 per cent UNH solution tank (X-30) in 224-U failed after 8 months service. Failure of the pump presumably resulted when some black iron set screws corroded away and allowed a shaft spacer to drop down on the vapor bushing. This in turn produced hammering and shaft whip which eventually broke the glass bearing and throttle bushings at the top of the pump. On the basis of the encouraging results obtained on this pump in this difficult service the pump is being rebuilt. A conical slinger will be included on the pump when it is reassembled.

NEW PROCESSES

Flurex Development

A statistical study of the effect of temperature, current density, fluoride and ammonium concentration, and pH on the anodic corrosion of types 304-L and 347 stainless steels in alkaline ammonium nitrate has been completed and an analysis of variance is in progress. Corrosion rates observed ranged from 1.6 to 28 mg/amp. hour. Based on 50 cents per pound for 304-L or 347 stainless steel, the cost for anodes of these materials would range from 0.02 to 0.4 cents per pound of uranium. Previous studies indicated a cost of about two cents per pound of uranium for platinum anodes. Type 304-L corroded significantly less rapidly than type 347. Heat treatment (sensitization) of the 304-L had little effect on its anodic corrosion rate.

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Further studies of the effect of catholyte operating variables on current efficiency for uranium reduction were made. These are desired to permit estimation of equilibrium operating conditions for assumed catholyte bleed rates and to assist in choosing optimum operating conditions for the cell. The data are essentially complete for catholytes containing only fluoride as anions. They point out the need for minimizing cathode current density in the interest of high cell efficiency and low uranium concentration in the bleed. Addition of H_2SO_4 to the catholyte, suggested to decrease electrical resistance, causes an appreciable decrease in product yield. The effect is due to incomplete precipitation of product rather than to a decrease in reduction efficiency. The use of sulfate is feasible provided total fluoride concentration is kept relatively high (ca. 0.3 M) and cathode current density is low (1 amp/in.²). The conductivity of catholyte solutions covering an appropriate range of UO_2F_2 , NH_4F , HF , and H_2SO_4 concentrations was measured to provide data in support of these catholyte studies.

Earlier studies showed that the direct current conductance of Nepton CR-61 cation membrane under Flurex operating conditions is considerably lower than predicted from conventional alternating current conductance measurements. Further studies show that this membrane exhibits polarization at relatively low current density. Polarization is interpreted as a layer in or on the surface of the membrane which becomes depleted in ions. It is analogous to concentration polarization which may occur adjacent to an electrode in an electrolytic cell. Permutit 3142 cation membrane also shows polarization but at current densities above those satisfactory for Flurex operation. Cation membrane polarization was shown to depend on feed compartment UNH concentration and on the anionic composition and concentration of the catholyte.

Purex Anion Exchange Concentration Step

In studying the elution behavior of Permutit SK (20 - 50 mesh) resin, it was found that with 0.6 M HNO_3 elutriant a maximum product concentration of 59 g/l was obtained at both 40 C and 60 C but less tailing occurred at 60 C.

A study of the loading and elution kinetics of Dowex 1, X-4 (20 - 50 mesh) resin showed an elution rate at 60 C comparable to IRA-401, but the 60 C loading rate was somewhat poorer than for IRA-401 and considerably poorer than the loading rate of Permutit SK at this temperature.

Recovery of Plutonium from Purex 1WW

Radiation Stability

Exposure of Permutit SK resin in 7.0 M HNO_3 to a gamma radiation dose of 2.2×10^8 R at 60 C in a cobalt-60 source softened the resin beads and caused the resin volume to increase by 70 per cent when the acid was replaced with water. Although the plutonium absorption capacity of this resin was not determined it is probable that this resin would not be usable. Amberlite IRA-401 irradiated under like conditions was damaged to a lesser extent. Addition of sulfamic acid to the Amberlite resin to inhibit nitrite formation did not reduce the radiation damage as measured by plutonium absorption capacity. Irradiation of Permutit SK resin at room temperature to

3.4×10^8 R did not damage the resin beyond operational use. No change was observed in the plutonium absorption capacity on irradiating Permutit SK to 2.57×10^8 R, the maximum radiation dose for which plutonium capacity data have thus far been obtained.

It should be recognized that exposure of resins to gamma radiation under static nitric acid solutions represents very probably a more severe condition than the resin would encounter in an operating column. For this reason it is difficult to extrapolate these results to plant operation. However, it is felt that the damage from plutonium alpha radiation to the Permutit SK resin in the Purex prototype facility (in which the resin is exposed to flowing nitric acid streams at 60 C) should not become severe until after several months of operation.

Pyrochemical Processing

The preference of plutonium for the salt phase of an Al-KAlCl₄ system was reaffirmed when seven grams of aluminum was contacted with ten grams of KAlCl₄ in which 2.5 grams of UO₂ and about 0.1 grams of PuO₂ had been dissolved. Based on preliminary analytical data, about 96 per cent of the plutonium remained in the salt phase. This result agrees well with data obtained from an experiment in which the plutonium originated in the metal phase (cf. HW-54760-C, p. C-17).

PROCESS CONTROL DEVELOPMENT

Assistance to the Purex Plutonium Resin Column Controls

The gamma absorptiometer, measuring the plutonium concentration on the resin, is now being used as the primary control for the resin push cycle. The cycle is manually adjusted to maintain a constant plutonium concentration as indicated by the absorptiometer.

The contact alpha counter on the incoming 2BP stream was put into operation early in the month. Calibration is not yet complete, but the instrument is used empirically for detecting abnormal plutonium concentration in the 2BP stream. For example, on one occasion the normal output signal of 40 per cent chart dropped to 7 per cent of chart in three hours. As a result of the early detection of this off-standard condition, plant losses or rework volumes were minimized.

The spare conductivity probe for the C Column is being altered so that it will extend into the column bore. The present position essentially flush with the column wall appears to give conductivity data which lags behind the main stream.

The fluorothene gamma monitor cell on the Redox IBP stream monitor has operated satisfactorily for one month. A glass cell on the 2BP stream has also performed well.

Assistance to Purex Plant

Sampling facilities for the 100 stream gamma monitor are complete. The electronics are being checked out and calibration data compiled. Start-up of the monitor will be with a simple discriminatory counting system. A differential counting system is

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being developed to subtract the iodine count from the total count in order to increase the detectors sensitivity to other fission products in the extremely high iodine background. The latter system will be installed later if the laboratory tests prove it to have a significant increase in sensitivity.

Contact Alpha Counter Development

The 234-5 contact alpha monitor was reinstalled in the supernate recycle transfer line February 11. Sitting idle for approximately 7 months apparently had no ill effects on the instrument as it responded immediately to the first plutonium solution transferred through the sensing unit.

Although the response of the instrument to plutonium solutions is very encouraging, a direct determination of the plutonium concentration from the instrument's read-out has not been possible. A widely fluctuating background activity is believed to be the reason for the inability to obtain a suitable instrument calibration. Steps are being taken to minimize the background fluctuations and/or to minimize the effect of the background activity on the read-out.

Densitometer for Purex HA Column

A dual diameter float was fabricated and is now undergoing test. This new float designed for the range 0.94 to 0.98 sp.g. units includes several features which should improve its reliability and stability. These are as follows:

1. Three air lift tubes, each in a separate channel, are attached to the outside of the float guide tube to improve circulation through the sampling leg.
2. A dash pot (hydraulic damping device) with a high damping coefficient, is being used in place of the original damping capacitor. (This is in the instrument not in the column.)
3. The float sensitivity to density was increased by a factor of three, by using a two diameter float. (This also allowed using a float 13-1/4-inches long vs. a 32-inch length for a uni-diameter float.)

Tests to date indicate adequate circulation resulting from the three air lift tubes. The high damping coefficient dash pot reduces the pen speed from 5 to 90 seconds (full scale travel) and appears to minimize the float oscillations caused by pulsing. Some difficulty is being experienced with the float sticking.

NON-PRODUCTION FUELS REPROCESSING

Feed Preparation

Mechanical Processing. Installation of a cut-off saw, to be used for evaluating various sawing procedures and techniques for processing non-production reactor fuels, is about 40 per cent complete. A number of different type saw blades have been ordered for testing with the saw. These include: a Carbide-tipped blade, a friction blade, abrasive wheels, and diamond wheels.

Fused and sintered alkaline earth porcelain has been ordered for use as a "cold" stand-in for UO_2 in simulated fuel elements to be made for destructive testing.

Zirflex Process

Measurement of the ammonia evolved during the dissolution of Zircaloy-2 in NH_4F - NH_4NO_3 solutions disclosed that 4.9 moles of ammonia are evolved per mole of zirconium dissolved. This, together with the observation that no more than minor amounts of nitrogen, hydrogen, or oxides of nitrogen are evolved in the reaction, suggests that the dissolution process in six molar ammonium fluoride solutions containing 0.5 molar or greater ammonium nitrate can be represented by the equation:

The origin of small and variable amounts of solid residue obtained when Zircaloy is dissolved in mixtures of ammonium nitrate and ammonium fluoride is under current investigation. This material has not yet been identified but does not appear to be metallic tin.

Uranium-zirconium alloy containing 9 w/o zirconium is attacked at an appreciable rate by a boiling solution of 6 M NH_4F , 1 M NH_4NO_3 . With 6 M NH_4F the alloy was attacked at an average rate of 0.3 g/hr, cm^2 over a three hour interval, but the rate decreased to 0.2 g/hr, cm^2 during the second three hour interval, presumably because of formation of a protective coating of insoluble uranium(IV) fluorides. With 6 M NH_4F , 1 M NH_4NO_3 the rate of attack remained constant at 0.6 g/hr, cm^2 over three consecutive three hour intervals, and the insoluble uranium salts showed no tendency to adhere to the alloy sample. It should be noted that a rate of 0.6 g/hr, cm^2 is quite appreciable, nearly as high as the rate of dissolution of uranium metal in 8 M HNO_3 .

This observation suggests the possibility of processing uranium-zirconium alloys containing moderate amounts of zirconium by dissolving the zirconium and simultaneously converting the uranium "quantitatively" to insoluble fluorides which can be separated from the zirconium-containing supernate, converted to hydrous oxides by alkaline metathesis, and finally dissolved in nitric acid for processing.

Zirflex Pilot Plant Studies. Pilot plant studies were initiated on the dissolution of Zircaloy metal with aqueous ammonium fluoride solution. Experiments to date have employed 10-20 liters of boiling 6 M NH_4F - 0.5 M NH_4NO_3 to dissolve 1 to 1.5 kilograms of scrap Zircaloy tubing or sheet metal. The studies have indicated:

- (a) Terminal dissolution rates of unoxidized metal which were lower than expected. (Recent studies suggest that this decrease in rate is due to the partial pressure of ammonia over the solution and can be avoided by sparging with air.)
- (b) Production of copious quantities of "brown" (from the sheet metal) and "black" (from the tubing) precipitates.
- (c) Very slow dissolution of the one metal charge which was deliberately subjected to oxidizing conditions.

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Darex Pilot Plant Studies. The Darex installation is approximately 15 per cent complete. The dissolver shell has been completed and most of the dissolver internal piping has been prepared for installation. Delays in the receipt of the remaining titanium plate and tubing items have slowed fabrication of the condenser and acid receiver. However, all of the titanium on order is expected to be on site by mid-March.

Removal of Chloride from Darex Dissolver Solution. Two additional "direct boil off" runs were made concluding laboratory work on this problem pending further economic evaluation of alternate procedures. These runs demonstrated a high chloride removal rate by a combination of two-fold concentration followed by rapid boil-off of 60 per cent HNO_3 and a high air sparge rate. Residual chloride was reduced to less than 0.1 g/l in about five hours total time. The nitric acid requirement is greater than for previously described procedures but time is gained. In both runs the feed solution was spiked with radioactive ruthenium. About 20 per cent of the ruthenium was volatilized. A summary report covering removal of chloride from Darex dissolver solution by both direct boil-off and solvent extraction is in preparation.

Corrosion Studies. In studies on materials of construction for use in fluoride systems, attention is being concentrated on Hastelloy-F because of its unusually good resistance to HNO_3 -HF solutions. Hastelloy-F containing low carbon (ca. 0.01 per cent) corrodes at about two mils/mo. in boiling 1M HNO_3 - 2M HF with no indication of preferential attack; with intermediate carbon content (0.04 per cent), intergranular corrosion is serious and at high carbon (0.08 per cent), the metal is also subject to severe sensitization during welding. Attempts are being made to obtain samples of low carbon base metal welded with low-carbon metal. Weld sensitization in such specimens will be studied to determine if post-welding heat treatment is necessary. Corrosion rates for low carbon Hastelloy-F in 1M HNO_3 -2M HF under heat transfer conditions (metal temperature 125-135C) were about five mils/mo. and no preferential attack was observed.

In Huey-type tests, low carbon Hastelloy F showed corrosion rates of less than 0.05 mils/mo. in boiling solutions of 4 M NH_4F , 4 M NH_4F - 0.5 M NH_4NO_3 , 1M $(\text{NH}_4)_2\text{ZrF}_6$, 10 per cent NaOH - 20 per cent NaNO_3 , and synthetic Redox coating removal waste. Corrosion rates in boiling 60 and 40 per cent HNO_3 were about 1.2 and 0.4 mils/mo, respectively. Data to date on the resistance of low carbon Hastelloy-F to Zirflex dissolver solutions under heat transfer conditions are erratic with respect to both general attack and pitting. Further tests are in progress.

A gray deposit, assumed to be titanium oxide, observed on some of the welds made in the fabrication of the 321 Building Darex dissolver caused concern as to the corrosion resistance of such welds. Laboratory tests show no decrease (over unwelded titanium) in corrosion resistance to either Darex dissolver solution or 65 w/o nitric acid.

Titanium Valve Development. Initial testing on the all-titanium control valve (nominal 1 gpm) for possible use in the Darex system has indicated the basic operability and feasibility of the solenoid-type valve. The valve in its present stage of development would be suitable for the Darex pilot plant application. For more universal application a less head-and-flow sensitive design is being developed.

Process Studies

Although several alternatives have yet to receive attention, the work done so far indicates three methods on which further study will be directed more intensively. They are: (1) the leaching of core material from fuel elements which have been mechanically disintegrated, (2) the dissolution of zirconium jacket material by the Zirflex process and the dissolution of stainless steel by the nitric-HF process in equipment fabricated of material which will resist corrosion by both process reagents, and (3) a method which requires two separate sets of dissolution facilities to accommodate the Zirflex and Darex processes. Some minimum facilities for mechanical disassembly are also required for the latter two methods.

Stability of Feeds Containing Niobium

Solutions containing uranium and niobium at a mole ratio of 3.8 (9 w/o Nb) are stable at niobium concentrations of at least 0.25 molar and at nitric acid concentrations of 0, 0.5, and 2.0 when the ratio of fluoride to niobium is maintained at ten, nine, and eight, respectively.

This type of dissolver solution would result from dissolution of uranium-niobium alloys in mixtures of nitric and hydrofluoric acids. Such dissolver solutions would be blended with aluminum nitrate solution to prepare feeds which could be processed through stainless steel extraction equipment without excessive corrosion. Optimum aluminum nitrate and nitric acid concentrations for fluoride to niobium mole ratios of eight to ten are the subject of present investigations. At present it appears that a mole ratio of fluoride to aluminum of unity results in a stable solution when the concentration of niobium does not exceed 0.1 molar and the concentration of nitric acid is 0.5 molar or greater.

Preliminary studies indicate that these feeds can be processed more effectively using a Purex-type process since nitric acid scrub solutions could be used without causing precipitation in the extraction section. Precipitation in the extraction section is a definite possibility in a Redox-type process employing aluminum nitrate scrub streams.

REACTOR AND DEVELOPMENT - 4000 PROGRAM

Reprocessing of PRP Fuels by Amine Extraction

Additional information has been obtained on the use of tri-laurylamine-n-octyl alcohol - Amsco solutions for the recovery of plutonium. The extraction of plutonium from aluminum nitrate-nitric acid solutions (such as would result from dissolution of plutonium-aluminum alloys) was investigated as a function of aluminum nitrate and nitric acid concentrations. Extraction was essentially quantitative for single pass - equal volume contactings provided the aluminum and nitric acid concentrations were both greater than about one molar. Optimum conditions for the stripping of plutonium from the organic with ferrous sulfamate were established, and stripping presents no difficulty.

The extraction of fission products into ten per cent tri-laurylamine - two per cent n-octyl alcohol - Amsco was measured as a function of nitric acid concentration.

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Ruthenium extraction decreased with increasing acidity, but zirconium-niobium and gross gamma extraction increased. This latter behavior is similar to that with tributyl phosphate and contrary to that previously observed with n-octylamine-xylene. An attempt was made to clean up the used organic by scrubbing at room temperature with caustic or carbonate. Although only a small fraction of the fission product activity is extracted, none of the extracted ruthenium and only half of the zirconium-niobium was removed by this scrubbing procedure.

Pyrochemical Processing

Aluminum-Plutonium Reconstitution

Preliminary experiments have shown that aluminum-uranium alloy can be impoverished in aluminum with apparently no significant loss of uranium if the molten alloy is made the anode of an electrolytic cell using cryolite as the electrolyte.

Starting with an initial content of 0.7 weight per cent uranium, enrichments to 1.2 and 2 weight per cent were readily achieved with no apparent loss of uranium from the alloy. If applicable to plutonium, this approach offers possibility of a simple controllable method for reconstituting fuel material alloys.

PRTR Fuel Reprocessing

A test flowsheet for recovering plutonium-aluminum alloy from uranium dioxide fuels was developed based on previous batch studies. The following steps are envisioned:

1. Contacting the UO_2 with aluminum-cryolite. Uranium and plutonium are reduced to the metal and extracted into the aluminum.
2. Scrubbing the molten metal with $KAlCl_4$. At least 95 per cent of the plutonium and a small amount of uranium enter the salt phase.
3. Contacting the molten salt phase with aluminum - 5 weight per cent calcium. Plutonium and uranium are reduced and subsequently transfer to the aluminum phase.

When a 20 gram portion of an aged, irradiated, sintered UO_2 test piece was subjected to this flowsheet, decontamination factors of 6, 40, and 800 were obtained for cerium, ruthenium, and cesium, respectively.

Non-Rigid Fuel Cores

Further data on the stability of Bi- UO_2 slurries were obtained from a series of experiments in which uranium concentration, oxygen to uranium ratio, and time of settling were varied. Conclusions reached are as follows:

1. In the direct preparation method (reaction of uranium with bismuth oxide) there is an indication that part of the uranium oxide formed has a density greater than bismuth; another part with a density less than bismuth. This implies the possibility of a highly stable system based on a suitable particle size distribution of the oxide.

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2. Stability increases with increasing UO_2 concentration, primarily because of viscosity effects.
3. The maximum oxygen to uranium ratio for wetting in the systems tested lies between 1.67 and 1.95. Failure to achieve wetting in systems having high oxygen to uranium ratios is perhaps due to corrosion or oxidation phenomena.

Fuel Development

Reliability of the plutonium radioassay method applied to plutonium alloy fuels was studied. Plutonium Metallurgy Operation requires an accuracy of greater than ± 5 per cent. Results of the studies indicate plutonium is adsorbed on glass walls. The adsorbed plutonium is not removed by acid rinsing, but is removed by acid re-fluxing. Glass dissolvers should be thoroughly boiled out when the plutonium content of alloy samples changes by more than a few per cent. The magnitude of error was about 1 per cent for the dissolver and 1-2 per cent for the remaining glassware involved. Adsorption was the only identifiable source of error. A standards program indicated the total error was of the same magnitude as the adsorption error and well within the necessary ± 5 per cent.

The processing of PRTR fuel elements is being studied concurrently with similar fuel element compositions encountered in the work on Power and Propulsion Reactor Fuel Processing. It is quite certain that facilities provided for the whole gamut of power reactor fuels require no significant changes in order to accommodate PRTR fuel compositions as now proposed.

Flowsheets for PRTR fuel processing by the tri-lauryl amine process were developed to show up areas needing further study and to establish conditions for batch scale studies. Consideration was suggested for the study of idealized low volume, high concentration processes which encourage development of small and compact plants.

BIOLOGY AND MEDICINE - 6000 PROGRAM

A study was undertaken to determine the removal of 16 reactor effluent water radioisotopes from Columbia River water by natural processes in its travel from the reactors to the Pasco - Kennewick area where the water is used for domestic purposes. A similar study on ten radioisotopes was completed last year. These same ten isotopes were included in this year's study, and the results obtained to date show good agreement with the depletions measured in the first study. The six additional radioisotopes are Ga^{72} , Sr^{89} , La^{140} , Ce^{141} , Ce^{143} , and Sm^{153} . Complete results for four of these have been obtained to date and are tabulated below.

<u>Radioisotope</u>	<u>Per Cent Depletion*</u>
Ga^{72}	6
La^{140}	34
Ce^{143}	65
Sm^{153}	61

*Per cent depletion represents that amount of the radioisotope added to the river by the reactors which does not appear in water samples taken at the Pasco-Kennewick Water Plant Inlets. Decay connections are made.

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Because of the similar chemistry of lanthanum, cerium and samarium, one might expect their depletion values to agree more closely. However, since part of the La^{140} arises from the decay of Ba^{140} present in the water, a lower "depletion" value is reasonable.

Separation and isolation of orthophosphate, pyrophosphate, tripolyphosphates, and a group of the higher poly- and metapoly-phosphates was accomplished from reactor effluent water samples by anion exchange techniques in a study to determine the chemical form or forms of P^{32} in these samples. Counting of the phosphate groups has shown that P^{32} is present mostly as pyrophosphate and more condensed phosphates, with very little orthophosphate (less than two to three per cent). As would be expected the phosphates slowly hydrolyze to the orthophosphate. These studies are important in understanding the uptake of P^{32} from the Columbia River below the reactors by the algae, plankton, fish, etc.

A small liquid scintillation counter was assembled and preliminary testing begun on the energy response to alpha emitting radioisotopes. Curves were obtained of Pu^{239} with a resolution of half maximum of sixty per cent. Improved resolution and efficiency and low backgrounds will be sought before testing the suitability of this instrument for low level alpha and weak beta counting, identification and calibration.

Re-examination of the protective effect of neopentyl alcohol which was reported as an outstanding protector last month failed to give the high value previously observed. The repeat determination was made on specially purified neopentyl alcohol, but subsequent determinations on the original material also gave low values.

Geology and Hydrology

Natural gas was encountered by the A. A. Durand driller near Hodges Ranch on the southeast end of the Rattlesnake Hills. The gas was encountered in a pocket in the basalt at a depth of about 600 feet. More gas is expected within about an additional 100 feet, where the water-supply well should encounter the main horizon of the lower Ellensburg formation that capped the Rattlesnake Hills gas field to the northwest.

The presence of gas, from an undetermined source at greater depths, high in the basalt series demonstrates at least some vertical permeability of the basalts. This contra-indicates the desirability of disposal of high level wastes into or beneath the basalts.

The Standard Oil Company of California stratigraphic test well on Rattlesnake Hills was reopened during the month.

Laboratory research continued to study the specific retention-time relationship through centrifuge moisture equivalent tests. Touchet sediments averaged 14 per cent moisture by weight following a one-hour test at 1000 gravities. After draining for 6 hours at 1000 gravities the moisture content was about 10 per cent by weight and this is estimated to be roughly equivalent to 250 days drainage at one gravity. The moisture content of the "dry" sediments as obtained in the field ranged from 2.5 - 4.0 per cent by weight. This is estimated to represent gravity drainage

for a period in excess of 5000 years. It also represents some unknown degree of evaporation, although the samples measured were obtained from buried formations in which evaporation would be minimized. It is hoped that a valid asymptotic curve can be constructed from such data which will give the appropriate specific retention-time relationship.

Laboratory research on unsaturated flow was continued to study the apparent fraction of soil moisture that does not effectively contribute to water flow. A soil containing 60 per cent clay was used for these tests. It was found that slightly more than 50 per cent of the saturated moisture content did not enter the flow relationship expressed by the Darcy equation.

Soil Chemistry and Geochemistry

The conversion of calcite to apatite by phosphate solutions was shown to be a reversible reaction, that may be written:

The equilibrium, however, strongly favors the apatite formation for most systems. Solutions containing bicarbonate and phosphate ions in ratios of 1:1 and 10:1 showed no measurable decrease in the removal of strontium ion by calcite. Between ratios of 10:1 to 100:1 the removal of strontium begins to decrease. It has been possible to get strontium decontamination factors as great as 10^9 by means of the phosphate-calcite reaction.

The rate of formation of apatite from calcite was studied using a P^{32} tracer. The reaction was found to be first order with respect to phosphate removal. For the system studied, a specific reaction rate of 0.040 hr^{-1} was computed. This reaction rate constant is independent of phosphate concentration but will vary with calcite grain size (surface area). Accurate measurements of calcite surfaces will be attempted to provide reaction rate data applicable to other systems. A similar reaction constant for strontium uptake was determined to be 0.018 hr^{-1} for the same system. The work confirmed the independence of the calcite-phosphate reaction to the initial concentration of the reactants (below that resulting in precipitation). The important variables are calcite surface area, contact time, and solution pH.

Ground Waste Investigations

The work planned to investigate the influence of temperature on the breakthrough of strontium from a soil column was completed. The temperature effect is a function of the species of ion being replaced by Sr on the soil. This function may be illustrated by means of the ratio of the volume of effluent passed through a soil column before breakthrough at 58 C to that at 18 C. This ratio for each of the systems is Mg - Sr, 0.48; Al - Sr, 0.69; Ca, Sr, Ba - Sr, 1.0; Na - Sr, 1.1; and Cs - Sr, 2.6. Tests were also made on three-ion systems, in which the strontium was accompanied in solution by another ion different from that initially on the soil. In such systems, 88 per cent of the observed temperature effect was found to be caused by the accompanying ion, and only 12 per cent by the ions initially on the soil. The temperature effect data are all in accord with the theory relating to dehydration of ions at the higher temperature.

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Glassware treated with Desicate was found to adsorb less radioactive material than untreated glassware while polyethylene adsorbed radioisotopes to a much greater degree. Column tests using both Desicate-treated glass columns and untreated columns showed little difference, indicating the minor influence of column walls on these tests.

Field Apparatus Development

Selection and testing of small volume positive displacement pumps continued. The Becker pump flow rate had fallen to 76 per cent of the original rate of 1.0 ml/min. after 10 weeks of operation.

Conditions required to maintain the stability and requisite sensitivity of thermistors as velocity-sensing elements were studied. Air bubbles on the sensing element will require the use of very small temperature differences with a resulting loss in sensitivity; this may be regained by improved detecting circuitry.

Commercial humidity-sensing elements were calibrated against standard humidity indicators for use in studies of unsaturated flow through soil.

The first full-scale test of the well packer was performed. The equipment became wedged or sand-bridged in the casing and has not been withdrawn to date. Further effort will be made when the more efficient winch becomes available.

A laboratory water de-aerator designed to provide air-free water for hydrology model studies neared completion.

Rupture detection instrumentation continued to indicate adequate sensitivity for radiological monitoring purposes. A recent rupture produced a signal indicating that the sensitivity was about 0.2 per cent of the 0.3 curie/minute working limit.

Manager
Chemical Research & Development

LP Bupp:bp

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
R. J. Walker	2/3-4/	Radiation Laboratory Livermore, Calif.	Discuss environmental monitoring and instrumentation related to health chemistry problems.	JM Nielsen RW Perkins	Yes
Dr. N. Mukherjee Mr. T. Lauritzen	2/10/	University of Alaska Fairbanks, Alaska	Discuss chemical research programs & tour 325 Bldg.	RJ Brouns	No
Dr. C. Konzak Dr. P. Sarvella	2/18/	Washington State Co. (Dept. of Astronomy) Pullman, Washington	Discuss use of Co-60 source for special radiations.	LL Burger	No
Dr. P. H. Emmett	2/21-22/	John Hopkins Univ. Baltimore, Maryland	Discuss heterogeneous reactions.	LL Burger EE Voiland MC Lambert	No
R. N. Parnell	2/25/	Office of Indian Affairs Department of Interior Missoula, Montana	Discuss the problem of the leaking Jocko Dam near Missoula, Mont.	DW Pearce RE Brown	No

C-21

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. W. Pearce	2/4/	AEC Washington, D.C.	Meeting of Committee #24, review of scientific papers for Geneva.	JA Lieberman	No
W. H. Reas	2/11/	AEC Washington, D.C.	Formulate plans on AEC sponsored plutonium technology symposium.	Division of Reactor Development personnel	Yes

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restrict- ed Data
J. H. Kleinpeter	2/3/	Phillips Petroleum Bartlesville, Oklahoma	Discussed plastics problems.		No
	2/4/	Carboline Company St. Louis, Missouri	Discussed protective coatings.		No
	2/4/	Williams Patent Crusher Company St. Louis, Missouri	Discussed mechanical crushing & pulverizing equipment		No
	2/6/	AIEE Convention New York, New York	Deliver paper.		No
	2/7/	Westlake Plastics Co. Philadelphia, Pa.	Discussed plastics problems.		No.
E. W. Christopherson	2/20-21/	ORNL Oak Ridge, Tennessee	Attend information meet- ing on Analytical Chem- istry.	AM Weinberg	Yes
C. A. Rohrmann	2/17-18/	AEC Gaithersburg, Md.	Attend selection Commit- tee Meeting for "1958 Summer Institute on Nuc- lear Energy - Chemical Processing."	G Courtney	No
E. T. Merrill	2/23- 3/6/	Linde Air Products Tonawanda, N.Y. Air Reduction Co. New York, New York Air Products, Inc. Allentown, Pa. Author D. Little, Co. Cambridge, Mass. American Air Liquids New York, New York Esso Research & Dev. Linden, New York	Discussions on classi- fied gas separations processes. " " " " "	HJ Kaiser SR Balcar Dr. C. McKinley SE Edon F. Kerry F. Kerry	Yes Yes Yes Yes Yes Yes

C-22

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BIOLOGICAL MONITORING

Atmospheric Contamination

Concentrations of I^{131} in thyroid glands of jack rabbits were about one-half those observed one year ago. Values were as follows:

<u>Collection Site</u>	<u>pc/g thyroid</u>		<u>Trend Factor</u>
	<u>Average</u>	<u>Maximum</u>	
Prosser Barricade	2×10^{-3}	3×10^{-3}	+ 2
Wahluke Slope	6×10^{-4}	1×10^{-3}	-
Four miles SW of Redox	8×10^{-4}	2×10^{-3}	- 4

Concentrations of fission products in rabbits were 2 to 10 times greater than observed one year ago. Values were as follows:

<u>Sample Type</u>	<u>Average pc/g</u>	<u>Trend Factor</u>
Bone	7×10^{-5}	-
Feces	4×10^{-5}	-
Liver	5×10^{-5}	+ 7
Muscle	1×10^{-5}	-

Columbia River Contamination

<u>Sample Type</u>	<u>Collection Site</u>	<u>pc/g wet wt. tissue</u>		<u>Monthly Trend</u>
		<u>Average</u>	<u>Maximum</u>	
Minnows (entire)	Hanford	2×10^{-3}	3×10^{-3}	+ 2

2000 - ProgramEffect of Reactor Effluent on Aquatic Organisms

Young chinook salmon were held in a 4 per cent concentration of reactor effluent and in an equivalent amount of effluent which was varied in concentration from 3.0 per cent to 6.2 per cent to simulate the magnitude of the fluctuation which may occur in the Columbia River when power is produced at Priest Rapids Dam. From previous experience it is expected that threshold toxicity will be observed in the 4 per cent concentration but no adverse effect is yet evident in either condition.

Young chinook salmon were also held in 4 per cent concentrations of gross effluent from the KE reactor and effluent from Tube No. 4963 which is at a lower pH. No adverse effects were observed for either type of effluent. This test was wiped out on the last day of the month when the river water supply

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to all troughs became lethal, presumably due to contamination with chlorine. Chlorine could have entered the water supply by an unanticipated and circuitous route which resulted from pump changes by the manufacturing operation in connection with a shutdown of the reactor. This test will be re-established with young salmon from the 146-FR Laboratory.

6000 - Program

METABOLISM AND TOXICITY OF RADIOACTIVE MATERIALS

Phosphorus

Administration of P^{32} to the group of trout being fed 0.06 $\mu\text{c/g}$ body weight/day was stopped on February 28 after completion of the scheduled 24 week run. The 26 fish which remain in the group will be sampled over the next five weeks to measure the rate of elimination. All fish in the group being fed 0.6 $\mu\text{c/g}$ were killed and sampled early in the month since they were so heavily damaged that they refused to accept the spiked food. The white cell count in this group had dropped to about 30 per cent of the controls by the fifteenth week.

Since a few of the fish in this test may spawn during the next two months, feeding of the isotope will be continued for the low level group (0.006 $\mu\text{c/g}$) in hopes that some information on the effect of deposited P^{32} on the viability of sex products may be obtained.

Uptake of Radioactive Material from Reactor Effluent Water

Barley straw harvested from the effluent plots in 1957 was analyzed by the gamma spectrometer for Zn^{65} and Cr^{51} content. Neither isotope was detected in barley from the control or 5% plots but appreciable amounts were noted in the 100% plots. Concentrations, calculated to time of harvest, were 7.5×10^{-6} $\mu\text{c Zn}^{65}/\text{g}$ dry straw and 9.1×10^{-4} $\mu\text{c Cr}^{51}/\text{g}$ of dry straw.

Uptake of short lived isotopes from reactor effluent was studied using nutrient solution to which fresh reactor effluent was added. In decreasing order of concentration in the bean leaves at the time of harvest, the identified isotopes follow: Np^{239} , Zn^{65} , P^{32} , Mn^{54} , Cu^{64} , As^{76} , Sc^{40} , Ba^{140} and traces of Co^{60} , Mo^{99} , Ru^{103} , La^{140} , Ce^{141} . Concentrations on the roots were, in most cases, appreciably higher by 1 or 2 orders of magnitude than concentrations in leaves. Data on the concentration of isotopes in the reactor effluent used in the study are as yet unavailable for comparison with the amounts in the plants.

Strontium

Following 30 days of conditioning on 4 diets containing from 0.03 to 2.0% calcium, tracer levels of Sr^{90} and Ca^{45} were added to the diets, and groups of 4 animals from each dietary calcium level were sacrificed after 3, 6, and 13 days. Sacrifices will continue at intervals up to 100 days following addition of the radioisotopes to the diet. Results from the early sacrifices are not yet available.

The initial phase of the short-term uptake and excretion pattern of Sr^{90} in the miniature pig was begun. Two baby pigs and one adult miniature pig were given 20 μc and 100 μc Sr^{90} each, respectively, placed in metabolism cages and blood, urine, and feces data collected. These animals will be sacrificed 15 days following dosing. A new metabolism cage, designed and constructed for these pigs, is being used.

In conjunction with the indwelling venous catheter for remote blood sampling, an experimental surgical technique for permanent, direct catheterization of the bladder through the ventral abdominal wall was developed. Urine can now be collected as formed, permitting direct correlation of urine and blood activity.

Barley grown on the same soil previously used for bean culture failed to show as marked a response to calcium addition and to anion effects as did the beans. It is uncertain at the moment whether the lessened effect of calcium is due to the length of time that the calcium was in contact with the soil or to a difference in the response of beans and barley.

Iodine

The last ewe in a special 5 μc /day group was sacrificed this month. This group was initiated to determine when damage started to occur histologically in sheep fed 5 μc I^{131} /day. The four animals in it were sacrificed at 12, 18, 24 and 36 months after the start of I^{131} feeding.

The 17 ewe lambs that received 3 mc of I^{131} at one feeding about 3 months ago (estimated 35,000 rad dose to thyroid) and which will be kept for their effective lifespan for observation of possible thyroid tumor development, showed a lowering of protein-bound-iodine, and increases in blood creatinine and urea. These data suggest progressive thyroid damage as a result of the I^{131} .

Plutonium

Partial results were obtained from an experiment to evaluate the effectiveness of chronically administered DTPA in removing firmly bound plutonium from the rat. The DTPA appeared to be significantly more effective than EDTA in reducing plutonium concentration in bone, and markedly more effective than EDTA in reducing plutonium concentration in the liver. Quantitative evaluation of the results must await the completion of analyses on excreta collected during the 4-week treatment period.

Radioactive Particles

In 80 mice inhaling I^{131} vapor the thyroid level of I^{131} attained a maximum after 20 hours. In mice inhaling "insoluble" AgI^{131} particles the thyroid level of I^{131} attained a maximum after 10 hours. In both experiments the lung burden decreased very rapidly to about 10 per cent of the initial level 24 hours after exposure.

Autoradiograms of tissues taken at times up to four weeks after exposure of mice to PuO_2 aerosol show an abundance of "alpha stars" in the alveoli, but none in macrophages as was seen following administration by intratracheal injection.

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In preparation for a study of the translocation of $\text{Sr}^{90}\text{SO}_4$ particles from pulmonary tissue, the trachea of a dog has been surgically externalized. This will permit the exposure of only the lower respiratory tract to $\text{Sr}^{90}\text{SO}_4$ aerosol and will eliminate the upper respiratory and gastrointestinal tracts as sites for absorption and translocation of Sr^{90} .

Gastrointestinal Radiation Injury

Additional experiments were performed to determine the effect of x-irradiation on the DNA content of, and DNA synthesis in, the G.I. tract. Experiments were also initiated to determine the effect of orally administered Y^{91} on nucleic acid in the intestine. Pilot studies to determine the protective effect of cysteine, administered orally, prior to intestinal irradiation, gave results which, while inconclusive, were sufficiently encouraging to warrant further study.

Relative Biological Effectiveness

Difficulties are being encountered in the microbiological technique for measuring RBE. Current work fails to identify the difference between genetic and viability RBE values which were initially reported. Compared to P^{32} , both S^{35} and H^3 show RBE values less than 1.

Confirming results reported last month, viability of yeast cells containing metabolized P^{32} drops off more rapidly than does viability of cells exposed to the same level of isotope in the buffer solution. Mutation studies of the same cultures failed to show an increase in mutation to correspond with the decreased viability in cultures containing metabolized P^{32} .

HA Kornberg
Manager
BIOLOGY OPERATION

HA Kornberg:mv1

C. Of Visits and HIO Visitors

Name Dates of Visit Company or Organization Represented and Address

VISITORS TO HAPO

Eugene P. Odum	2/10/58	NAS - University of Georgia	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
			3 month assignment to study methods and techniques in Radioecology.	J. J. Davis	Yes	146FR
Nolan Patterson	2/20/58	Shareowners Quarterly Los Angeles	Take pictures for magazine.	FP Hungate	No	100-F, 108-F 141-M, 146-FR
Allen Fisher, Anthony Stewart	2/24/58	National Geographics Magazine, Wash., D.C.	photographs for magazine	DE Warner RF Foster FP Hungate	No	100-F, 108-F 141-M, 146-FR
Biology Students and Faculty	2/28/58	Western Wash. College Billingham	Tour facilities	FP Hungate RF Foster WJ Clarke DE Warner	No	100-F, 108-F 141-M, 146-FR

VISITS TO OTHER INSTALLATIONS

J. J. Davis	2/15-21/58	Savannah River Operations, Aiken, South Carolina	Bio-Medical Program Director's Meeting
H. A. Kornberg	2/14-19/58	Savannah River Operations, Aiken, South Carolina	Bio-Medical Program Director's Meeting
N. L. Dockum	2/15/58	Vancouver, B.C.	Give speech on Applications of Autoradiography at Northwest Chapter of the Biological Photographic Association

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D. Lectures

a. Papers presented at meetings

N. L. Dockum, "Applications of Autoradiography in Research," at Northwest Chapter of the Biological Photographic Association in Vancouver, B.C., February 15, 1958.

J. J. Davis, "The Radioecology Operation at Hanford." Bio-Medical Director's Meeting at Savannah River Operations, Aiken, South Carolina.

b. Seminars

February 12 - J. J. Davis, "Hanford Radioecology Program."

L. A. George, "Comparative effects of beta irradiation on pig, sheep and rabbit skin".

E. Publications

Dockum, N. L., E. J. Coleman, and G. S. Vogt, "Detection of Plutonium Contamination in Humans by the Autoradiographic Method," accepted by Stain Technology.

OPERATIONS RESEARCH & SYNTHESIS OPERATION
MONTHLY REPORT

February, 1958

ORGANIZATION AND PERSONNEL

There were no changes in personnel this month.

OPERATIONS RESEARCH ACTIVITIESEconomic Studies

Preliminary scoping of the input-output simulation study for HAPO was continued. The general scope and techniques of simulation applied to management systems and the planning, organization, and technical aspects of the Home Laundry study were discussed in detail with the Operations Research and Synthesis Consulting Service. Discussions were also held concerning the general problems connected with the simulation of HAPO and the potential manpower and data processing requirements. Collection of the information and data necessary to the formulation of detailed plans for the HAPO study was started.

An interim report on the application of learning curve concepts to the prediction of future operating and capital costs is being prepared and will be completed in March.

Further discussions were held concerning the impact of the full adoption of economic ground rules on Hanford, and a presentation is being prepared for the General Manager's Meeting of March 12.

CPD Control Study

Concentration on accountability was continued. A tabulation of the amounts of plutonium and uranium as summarized in present inventory and administrative accounts (100, 300, 400 series) for the period July through December, 1957 was completed for the Purex, Redox and UO₂ plants. For the 234-5 plant this information is being assembled in matrix form to gain an understanding of the complex flow between physical portions of the process and related accounts. This matrix has been completed for the first three-month period. Using administrative accounts (300 - 400 series) a matrix of over-all CPD accounting is being constructed.

Preliminary work has been started on the construction of an estimation of the bias imprecision matrix corresponding to the above accounting matrices. While the reliability of this matrix will not be of high order, the estimates are expected to provide a basis for indicating weaknesses in the present system. The magnitude of the biases and imprecisions and their relationships also provide a better understanding of the accountability system.

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Other

The collection of pertinent information concerning the problem of operator coverage at electrical sub-stations in the outer areas was continued.

Discussions were held with CPD Employee Relations in connection with sensitivity survey results, and further discussions were held with IPD Plant and Industrial Engineering Operation management concerning the general problems associated with the attitude survey.

STATISTICAL AND MATHEMATICAL ACTIVITIES IN SUPPORT OF RESEARCH PROGRAMS2000 Program - Metallurgy

Further discussions were held with personnel of 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 environment. The basic approach in this model is to be quite different from previous ones. No preliminary data processing stage on directly measurable data will be needed prior to estimation of model parameters. Corrosion rate is to be expressed as a function of aluminum ion solubility and corrosion temperature, each of these in turn being expressed as functions of the measurable data, inlet and outlet water temperature and slug activity data. Before the present multiplicative model can be utilized the observable data must be transformed to local bulk water temperature data.

2000 Program - Separations

Work was continued for the Critical Mass Physics Operation on the estimation of parameters of a model for predicting neutron density in a bath into which uranium slugs have been dumped at random.

4000 Program - PRP

Further discussions were held with personnel of the Ceramic Fuels Development Operation concerning the results of a UO_2 powder irradiation experiment to determine the dependency of fission gas activity on packing density, enrichment, neutron flux, exposure time and surface area. Experimental designs were suggested for future experimentation to confirm and extend the empirical evidence so far obtained.

6000 Program - Biology

Work was continued on the statistical analysis of data on miscellaneous fish tests for the Aquatic Biology Operation. At their request a discussion was held to determine a possible approach to analysis of data on the uptake of radioactive cesium by the organisms in an aquatic community. It was determined that the mathematical model already deduced to explain the passage of radioactive tracer particles from region to region within an experimental animal could be used quite nicely in this situation also.

Work continued on the statistical analysis of data from a Ru and Pu inhalation turnover experiment on mice for the Pharmacology Operation.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR THE PRODUCT DEPARTMENTSProcess Control - Fuels Preparation Department

Proposals for replacing existing control charts for canning reject rates now prepared on an over-all basis by others prepared on a line-crew basis were well received by Quality Control personnel. These proposals resulted from analyses which demonstrated that the excessive number of out-of-control points which have occurred are due to combining data from non-homogeneous populations. Plans for integrating the preparation of control charts on this basis with the current control panel are being formulated. Monthly reject rates will be maintained as a historical record, but they will not function as process controls.

Further work was done in connection with the tendency of the penetration tester to reject I and E fuel elements having tube walls of acceptable thickness. Preliminary data from an experiment designed to evaluate its efficiency have been analyzed. Further assistance was given in designing an experiment to determine which combination(s) of probes and electronic units in the tester gives the best results. Calibration curves between tester voltage settings and tube wall thicknesses will also result from this experiment.

Another training session on techniques and principles of quality control was conducted for Quality Control technicians and engineers. The demonstration with the Process Simulator illustrated how analysis of variance techniques could assist in determining what variables affect the process yield, which is an indication of how one would adjust these variables to effect a given change in the yield. The importance of determining which variables are not significant was also emphasized.

Process Experimentation - Fuels Preparation Department

An experiment was performed in order to determine the effect of slug surface preparation on bond strength. Studs were welded on such surfaces, and the tensile strengths were measured by determining the force required to break off the studs. Results were reported verbally.

Production Tests - Irradiation Processing Dept. and Fuels Prep. Dept.

A report was issued presenting the results of the statistical analysis of data from Production Test 105-510-A-60MT. This test was conducted to determine the dimensional stabilities of slugs machined from vertically heat treated rods having different quench treatments. (HW-54934 RD, "Analysis of Data from Production Test 105-610-A-60MT -- Irradiation of Vertically Heat Treated Uranium," 2-12-58.)

Profilometer Study - Irradiation Processing Department

Data to calibrate the profilometer recently installed in C-basin have been analyzed. The precision of this profilometer with regards to warp and diameters was also estimated. ("Accuracy and Precision of the 105-C MEF Profilometer," OVO letter to T. L. Deobald, 2-4-58; "Warp Measurements: 105-C MEF Profilometer," OVO letter to T. L. Deobald, 2-11-58.)

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Fuel Element Failure Studies - Irradiation Processing Department

Considerable effort has been devoted to analyzing failure data collected after the most recent significant water quality change that occurred in spring of 1956. For side failures, the model currently in use has been modified to include the temperature variable. Split type ruptures have not been included in this model since other segments of this over-all failure study demonstrate that the variables that affect side failures will not affect splits in the same way. In particular, analysis of the relative number of splits occurring within one day after start-up, and the location of two types of splits (longitudinal and transverse) in the reactor, has shown statistical significance. Several discussions have been held with interested personnel on these problems.

Other

A study has been made at the request of personnel of the Electrical Development Operation on the wearing rate of the brushes on 4500 HP synchronous motors in the 100-F area. The study was concerned with comparing the wearing rates for eight different motors, comparing the wearing rate of a particular brush type with the brushes in current use and estimating the correlation between tension and wearing rate. Estimates were made of the number of operating hours before the brushes would reach specified lengths.

A new button factor was estimated for alpha-phase buttons for the fourth quarter of CY 1957. Current process averages and limits of uncertainty for model 201 parts from HAPO feed and from the war reserve stockpile were estimated. (HW-55047, "Current Process Averages for Accountability," 2-19-58.)

Assistance was given to personnel of the Finished Products Technology Operation in solving a differential equation which gives the amount of U-235 in suspension in a tank at time t .

Work has been done on the programming of more of the computations for final product specifications. Considerable time can be saved by calculating the sums, sums of squares, and coefficients entering into the components of variance models on IBM equipment.

A method of summability was applied to two series submitted by a member of Reactor Engineering Operation, Process and Reactor Development, IPD. Although neither of the series were infinite, they involved a large number of terms which would have called for many tedious and repetitive operations. The method reduced the problem to the evaluation of a single simple analytic expression.

Work continued on the evaluation of the 1957 minor injury data for the Employee Relations Operation with the hope of determining a realistic goal for reduction of minor injuries in the next year.

A second order non-linear partial differential equation was solved for the Process Reactor Development Operation, the results being presented in a letter to interested persons. (Unclassified letter to R. Cahoon, 2-17-58.)

Discussions were held with interested persons of the Equipment Development Operation concerning a rapid method of estimating the product variability of electrical instruments. The operational characteristics of the procedure were evaluated from the standpoint of estimating the expected number of defective instruments per lot accepted and recommendations were made concerning the number of instruments which could be tested simultaneously.

Work continued on the fitting of an analytical expression to data from a two-phase flow problem submitted by the Project Engineering Operation. The mathematical form will be incorporated into an IBM machine routine to facilitate interpolation among present empirical data.

OTHER STATISTICAL AND MATHEMATICAL ACTIVITIES

Activities for other Operations

Revisions were made in the form of the C-1 tank calibration tables as given in the unclassified document HW-54554, "Statistical Analysis of the C-1 and E-12 Tank Calibration Data," 1-15-58. These were transmitted to personnel of the SS Measurements Operation.

Complete tables useful in computing bias correction values for various fuel element - reactor combinations were prepared and submitted along with a cover letter to C. J. Shortess, "Bias Correction Tables," 2-4-58.

Preliminary work has been done to investigate the feasibility of using reactor data plus bias corrections to determine necessary Am-Cm corrections to apply to total alpha count in separations. It has been reported verbally to SS Measurements personnel that such an approach seems to offer possibilities in the event the present composite method of analysis proves to be unsatisfactory.

Activities within HLO

A statistical analysis of data comparing HAPO and Paducah estimates of isotopic analyses of UO_2 powder production was completed for the Spectrochemical Analysis Operation. (HW-55033, "Statistical Analysis - Comparison of HAPO and Paducah UO_2 Isotopic Analysis," 2-18-58.)

The Chemical Development Operation requested assistance in analyzing data from a recent experiment to investigate anodic corrosion of stainless steel as a function of molarity concentrations in the corrosive medium, temperature, and current density. The experiment was performed to facilitate evaluation of the florex process. (Unclassified letter to E. W. Neuvar, "Anodic Corrosion of Stainless Steel - Statistical Analysis," 2-27-58.)

A statistical evaluation of the current method of calculating Purex A-8 crib capacity was initiated for Chemical Effluent Operation.

An experimental design was suggested to personnel of the Radiological Development Operation for use in an experimental program to investigate properties of Eastman and du Pont personal monitoring film as a function of developer time, in-developer depth position, and developer temperature. Data from this experiment have been statistically analyzed and a report is being prepared.

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A discussion was held with interested persons of the Radiation Protection Operation on the problem of scheduling bioassay sampling for HAPO personnel. A method is desired of determining the sampling frequency for an individual which reflects the radiation hazard of the individual's job and his job location. A method was suggested for allocating a fixed total number of samplings per year among the HAPO employees, according to the past deposition incident record by job classification.

Consultations were held with a member of the Geochemical and Geophysical Research Operation, Chemical Effluents Technology, on appropriate methods of approximating and evaluating several infinite series which arise in the theory of the diffusion of contaminants in the earth.

OFFSITE VISITS

R. L. Basmann spent the week of February 10-14 in New York City consulting with W. H. Bloodworth and Martin Shubik of the Operations Research & Synthesis Consulting Service.

R. L. Basmann spent February 17 at the University of Chicago consulting on economic education and presenting a paper at the Economic Workshop.

R. Y. Dean spoke to the student body of the Burbank High School February 10 on "How Games of Chance Help Run Hanford."

Carl A. Bennett

C. A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

CAB:jbk

RADIATION PROTECTION OPERATION
MONTHLY REPORT-FEBRUARY, 1958

A. ORGANIZATION AND PERSONNEL

Organization

No significant organization changes occurred.

<u>Force Summary</u>	<u>1-31-58</u>	<u>2-28-58</u>
Exempt	43	42
Nonexempt	<u>123</u>	<u>123</u>
Total	166	165

B. ACTIVITIES

Radiation Monitoring

Experiments with radioisotopes in Biology Operation caused no overexposures of personnel and no spread of contamination. Excess equipment in the Hanford salvage yard was surveyed and released for public sale. Routine surveys in other 100 Area customer locations showed no unusual contamination.

Radiation monitoring was provided on an around-the-clock basis in 231 Building for Plutonium Metallurgy personnel preparing fuel-core elements for the MTR program. Lead-glass windows and lead-loaded gloves are to be procured to provide additional shielding for this work.

Two incidents involving high-level plutonium contamination occurred in the 325 Building laboratories. Decontamination of personnel was successful and subsequent bioassay results were all negative. Two incidents in 327 Building included one of inadvertent exposure of office workers to a 600 mr/hour beam for part of a minute.

A residential survey was required following discovery that a 306 Building employee had worn contaminated clothing home. A few items of clothing were returned to the plant; the maximum contamination level found was 2500 c/m.

A national conference on emergency monitoring teams and organization was attended at Idaho Falls.

A detailed report of Radiation Monitoring is contained in HW-55169.

Regional Monitoring

The average weekly emission of I^{131} was 11.2 curies, compared to 5.6 curies per week in January and 7 curies per week for the last twelve months. I^{131} deposition on vegetation on the project increased by a factor of two to 1.1×10^{-5} $\mu\text{c/g}$, while vegetation outside the project showed 1.5×10^{-6} $\mu\text{c/g}$. Increased emission of I^{131} from Purex resulted from decreased cooling time of dissolved metal. No unusual amounts of fallout from nuclear detonations were observed.

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Routine laboratory analysis of Redox stack gas samples for I¹³¹ was discontinued with acceptance of the Redox stack gas analyzing monitor recorder.

Raw water analyses at 100-F and Pasco showed 9.6% and 2.0% respectively of the continuous occupational MPC_{Gr}. The 100-F Area sanitary water was 2.9%, Pasco sanitary water was 0.6% and Kennewick sanitary water was 1.0% of the same maximum permissible limit.

The study of the effect of 100-K effluent line breaks was published as HW-54756. A detailed report of test well monitoring is contained in HW-55171. A summary of environmental contamination incidents at Hanford from 1952 through 1957 was published as HW-54636.

Exposure Evaluation and Records

Two cases of plutonium deposition, both appearing to be less than 10% of the MPL, were confirmed. Both were detected by routine sampling and probably occurred in 1957. Confirmed plutonium cases totaled 218, of which 20 occurred in 1957.

Two cases of ruthenium deposition occurred during burying of a Redox centrifuge December 30, 1957. Both appeared insignificant. The higher case was counted with the prototype body monitor; ruthenium was detected and correlated favorably with the urine results. A \$103,447 contract for the construction of the Shielded Personnel Monitoring Facility at 747 Building was awarded.

The summary of 1957 annual exposures measured by the beta-gamma film badges showed that exposures received by manufacturing personnel of FPD averaged 0.33 rads including 0.09 r, of IPD averaged 0.70 rads including 0.61 r, and of CPD averaged 0.70 rads including 0.45 r. Service personnel of these departments and other HAPO components averaged 0.09 rads including 0.05 r.

Radiological Development

Fabrication of the prototype badge reloading machine is practically complete, with testing scheduled for March. The badge feed system being designed will have a capacity of 1600 badges and can be loaded during machine operation.

IBM programming began on the analysis processing phase of bioassay results. The sample processing phase is essentially complete.

Specifications were approved for canvas boots, shoe covers, hoods and cotton surgeons caps, making a total of seven specifications submitted to the HAPO Standards Council for final approval and adoption. Field test of the interchangeable rubber overshoes showed them unacceptable because of short service life.

Development was undertaken of continuous gamma exposure rate equipment for two river monitoring stations proposed in the FY 1959 budget for Regional Monitoring Operation.

Documents were published on a portable impactor air sampler (HW-54219) and beta field dose rate determination for angular response with the Juno dose rate meter (HW-54886).

Calibrations

Routine neutron calibrations will no longer be performed with the Positive Ion Accelerator. To avoid maintenance and operating difficulties with the accelerator, and to calibrate with energies approximating field conditions, two neutron sources are being obtained. One will be a Pu-Be source of 10^7 neutrons/second, and the other a PuF_4 source.

The new standard exposure dose rate of radium encapsulated in platinum was adopted in calibrations beginning February 3.

Studies continued of modifications to extend the field life and to provide field battery checks of BF_3 and GM portable instruments.

Radiological Consultation

Maximum permissible limits for thorium were recalculated excluding dose from radium daughters formed after deposition in bone. The recalculated maximum permissible body burdens are $0.05 \mu\text{c}$ of Th^{232} and $0.01 \mu\text{c}$ of Th^{228} . Maximum permissible air concentrations are $6 \times 10^{-13} \mu\text{c Th}^{232}/\text{cc}$ and $2 \times 10^{-12} \mu\text{c Th}^{228}/\text{cc}$.

Three papers for the 1958 Geneva Conference are nearing completion. One on environmental exposures in 1957 estimates that a maximum of 50 per cent of the general population exposure limit could have been received by a few individuals eating whitefish and ducks collected at the areas of maximum concentration available to the public. Fallout on vegetation from nuclear detonations probably contributed about the same magnitude of exposure to the gastrointestinal tract as potential exposure from drinking raw Columbia River water.

The Quarterly Progress Report, Research and Development Activities in the Field of Radiological Sciences for the fourth quarter of 1957 was published (HW-54938).

Radiological Standards

Comments were submitted on AEC Manual Chapter 0524, "Permissible Levels of Radiation Exposure". The comments concluded that the chapter was both incomplete and premature.

C. EMPLOYEE RELATIONS

Safety and Security

There were three medical treatment injuries for a frequency of 1.15. One security violation occurred.

Suggestions

Three RPO suggestions were awarded a total of \$45. Two had intangible benefits; the third had an estimated annual saving of \$297.

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Three suggestions were submitted by RPO personnel. Two suggestions were received in RPO for evaluation, and four were completed, leaving three to be evaluated.

Relations

With essentially all of AEC biology and medicine activities now unclassified, J. W. Healy was relieved of responsibilities as a Responsible Reviewer.

An invitation to attend President Eisenhower's March 1958 Conference on Occupational Safety was accepted by J. W. Vanderbeek.

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 Visited
Col. L. D. Hanson	2/ 3/58	Sandia Base New Mexico	AFSWP Training Program	JW Healy	No	3746:300
E. H. Marx	2/ 6/58	Technical Associates Burbank, California	Discuss HAPO use of radiation protection instruments.	FH Sanderson	No	329, 3745 3706:300
A. C. Fisher A. Steward	2/25/58	National Geographics Washington, D. C.	Obtain photos and story on badges, pencils, etc.	HA Meloeny and Staff	No	3705:300
Maj. J. L. Terry	2/25/58	Kirtland Air Force Base, New Mexico	Discuss reactor accidents and associated problems.	JW Healy	No	3746:300

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HW-55162

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VISITS TO OTHER INSTALLATIONS

J. W. Healy	2/12-14/58	USAEC Idaho Falls, Idaho	Present talk to AEC Emergency Monitoring Teams	JR Horan	Yes
B. G. Lindberg	2/12-14/58	USAEC Idaho Falls, Idaho	Attend conference for AEC Emergency Monitoring Teams	GV Beard	Yes
J. W. Healy	2/17-19/58	Savannah River Plant Aiken, South Carolina	Attend meeting of Bio-Medical Directors and Health Physicists of the AEC.	Karl Herde GV Beard	Yes
A. R. Keene	2/17-19/58	Savannah River Plant Aiken, South Carolina	Attend meeting of AEC Health Physicists.	GV Beard	Yes
A. R. Keene	2/20/58	New York City, NY	Conduct meeting of ASA N2.2 Subcommittee on Radiation Exposure Records.	WA McAdams	No
H. V. Clukey	2/12-14/58	Oak Ridge Nat. Lab. Oak Ridge, Tennessee	Attend meeting of ASA Z-54 Subcommittee	IC Emerson HF Henry CM West	Yes

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The general findings are summarized in the following:

<u>Sample Type and Location</u>	<u>Activity Type</u>	<u>Average Activity Density μc/cc</u>	<u>Trend* Factor</u>
<u>Drinking Water and Related Materials</u>			
Benton City Water Co. Well	alpha	1.2×10^{-8}	--
100 Areas	beta	$(0.01 \text{ to } 1.3) \times 10^{-5}$	-2
200 Areas	beta	$(3.2 \text{ to } 6.7) \times 10^{-6}$	--
Pasco. Kennewick, McNary Dam	beta	$(0.04 \text{ to } 2.7) \times 10^{-6}$	-2
Backwash Solids -			
Pasco Filter Plant	beta	$0.44 \mu\text{c/gm}$	-3
Backwash Liquids -			
Pasco Filter Plant	beta	4.8×10^{-6}	-2
Anthracite, Sand Filter -			
Pasco Filter Plant	beta	$1.4 \times 10^{-3} \mu\text{c/gm}$	+2
<u>Other Waters and Related Materials</u>			
200 West Wells	beta	$< 2 \times 10^{-7} \text{ to } 3.9 \times 10^{-3}$	--
200 East Wells	beta	$< 2 \times 10^{-7} \text{ to } 4.2 \times 10^{-2}$	--
Wells Near 200 Areas	beta	$< 2 \times 10^{-7} \text{ to } 1.7 \times 10^{-6}$	--
Outlying Wells	beta	$(< 2.0 \text{ to } 7.4) \times 10^{-7}$	+3
Columbia River -			
Hanford Ferry	beta	6.2×10^{-5}	--
Columbia River -			
Below Reactors	beta	4.1×10^{-5}	--
Columbia River -			
Paterson to McNary	beta	1.4×10^{-6}	--
Columbia River - Mud	beta	$(0.2 \text{ to } 3.7) \times 10^{-4}$	--
Raw Water - Operating Areas	beta	$(0.007 \text{ to } 2.9) \times 10^{-5}$	--
Reactor Effluent Retention	beta	$14,000 \text{ to } 35,000 \mu\text{c/sec/reactor}$	-2
Basins to River		$(3.8 \text{ to } 7.6) \times 10^{-3}$	-2
Reactor Effluent Retention	alpha	$< 0.04 \mu\text{c/sec/reactor}$	--
Basins to River		$< 5 \times 10^{-9}$	--
I-131 in Farm Wastes to	I-131	1.5×10^{-7}	--
River			
I-131 in Columbia River -	I-131	9.0×10^{-8}	--
Hanford			

* 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.

<u>Sample Type and Location</u>	<u>Activity Type</u>	<u>Average Activity Density</u> <u>μc/cc</u>	<u>Trend*</u> <u>Factor</u>
<u>Atmospheric Pollution</u>			
Gross Alpha Emitters	alpha	(< 0.2 to 2.3) x 10 ⁻¹⁵	--
Gross Dose Rate - Separations Areas	beta-gamma	0.5 to 1.8 mrad/day	--
Gross Dose Rate - Residential Areas	beta-gamma	0.7 to 1.4 mrad/day	--
Active Particles - Separations Areas	beta	(1.5 to 4.5) x 10 ⁻¹³	-35
I-131 Separations Areas	I-131	(1.3 to 3.8) x 10 ⁻¹³	--
I-131 Separations Stacks	I-131	1.6 curies/day	+2
Ruthenium - Separations Stacks	Ru-103-106	0.01 curie/day	--
Active Particles - Wash., Idaho, Ore., Mont.	--	0.007 to 0.049 ptle/m ³	--
Active Particles - Project	--	0.003 to 0.10 ptle/m ³	-3
<u>Vegetation</u>			
Environs of Separations Areas	I-131	1.1 x 10 ⁻⁵ μc/gm	+2
Residential Areas	I-131	2.2 x 10 ⁻⁶ μc/gm	--
Eastern Washington and Oregon	I-131	< 1.5 x 10 ⁻⁶ μc/gm	--
Fission Products less I-131 Wash. and Ore.	beta	7.9 x 10 ⁻⁵ μc/gm	--
Alpha Emitters - Separations Areas	alpha	(0.2 to 1.8) x 10 ⁻⁶ μc/gm	-5

* 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.

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<u>RADIATION MONITORING</u>	<u>Hanford Laboratories</u>	<u>Minor & Major Construction</u>	<u>Others</u>	<u>Feb.</u>	<u>Year to Date</u>
Special Work Permits	1796	62	403	2261	4112
Routine and Special Surveys	1523	62	258	1843	3027
Air Samples	2305	2	168	2475	4452
Skin Contamination	2	0	1	3	4
*Class II Radiation Incidents	0	0	0	0	0
**Class II Radiation Incidents	0	0	0	0	4

EXPOSURE EVALUATION AND RECORDS

<u>Gamma Pencils</u>	<u>Pencils Processed</u>	<u>Paired Readings 100-280 mr</u>	<u>Paired Readings Over 280 mr</u>	<u>Lost Readings</u>
February	44,494	35	5	5
1958 to Date	111,558	82	14	8

Beta-Gamma Film Badges

	<u>Badges Processed</u>	<u>Readings 100-300 mrad</u>	<u>Readings 300-500 mrad</u>	<u>Readings Over 500 mrad</u>	<u>Lost Readings</u>	<u>Average Dose Per Film Packet</u>
						<u>mrad(ow)</u> <u>mr(s)</u>
February	21,839	1,157	33	7	41	3.21 11.01
1958 to Date	45,534	1,927	60	24	83	3.37 9.96

Slow Neutron Pencils

	<u>Pencils Processed</u>	<u>Paired Readings 4-12 mrem</u>	<u>Paired Readings Over 12 mrem</u>	<u>Lost Readings</u>
February	4,760	50	10	3
1958 to Date	8,700	90	13	3

Fast Neutron Film Badges

	<u>Badges Processed</u>	<u>Readings Above 50 mrem</u>	<u>Lost Readings</u>
February	1,488	2	1
1958 to Date	2,611	8	3

Bioassay

		<u>February</u>	<u>1958 to Date</u>
Plutonium: Samples Assayed		1,339	2,651
Results above 2.2×10^{-8} $\mu\text{c/sample}$		56	104
Fission Product: Samples Assayed		1,399	2,749
Results above 3.1×10^{-5} $\mu\text{c FP/sample}$		5	6
Uranium: Samples Assayed		305	673

*HLO Radiation Monitoring Customers
 **Other Plant Components

Uranium Analyses

<u>Sample Description</u>	<u>Following Exposure</u> <u>Units of 10⁻⁹ µc U/cc</u>			<u>Following Period of No Exposure</u> <u>Units of 10⁻⁹ µc U/cc</u>		
	<u>Maximum</u>	<u>Average</u>	<u>Number</u> <u>Samples</u>	<u>Maximum</u>	<u>Average</u>	<u>Number</u> <u>Samples</u>
Fuels Preparation	16.2	3.86	27	6.85	3.39	18
Hanford Laboratories	580.0	29.0	26	80.5	9.76	18
Chemical Processing	112.3	9.83	73	15.7	4.27	79
Chemical Processing*	64.5	9.97	38	10.3	6.03	4
Special Incidents	0	0	0	--	--	--
Random	2.03	0.88	22	--	--	--

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

Tritium Analyses

	<u>February</u>	<u>1958 to Date</u>
Samples Assayed	0	0

Thyroid Checks

Checks Taken	0	5
Checks Indicating .01 µc	0	0

Hand Checks

Checks Taken - Alpha	48,762	93,939
- Beta-Gamma	40,019	79,285

CALIBRATIONS

<u>Portable Instruments</u>	<u>Number of Units Calibrated</u>	
	<u>February</u>	<u>1958 to Date</u>
CP Meter	927	1,939
Juno	301	641
GM	1,258	2,645
Other	218	428
Total	2,704	5,653

Personnel Meters

Badge Film	1,140	2,220
Pencils	2,400	3,232
Other	295	690
Total	3,835	6,142

Miscellaneous Special Services	648	1,987
Total Number of Calibrations	7,187	13,782

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A. R. Keene
 A. R. Keene, Manager
 RADIATION PROTECTION

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - FEBRUARY, 1958

GENERAL

Safety performance of the Operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 3.23 per cent which is 0.13 per cent below January experience and well within established control limits.

The absenteeism rate was 3.17 per cent, a decrease of about 0.09 per cent below January experience.

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

One non-unit grievance was filed during the month and was answered satisfactorily at Step I.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 12,242 hours. The total shop work backlog is 24,119 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 1.6% (256 hours) of the total available hours.

Distribution of time was as follows:

	<u>Man Hours</u>	<u>% of Total</u>
Fuels Preparation Department	2390	19.5
Irradiation Processing Department	977	8.0
Chemical Processing Department	955	7.0
Hanford Laboratories Operation	7820	63.9
Construction Engineering Operation	53	.4
Miscellaneous	147	1.2

Customer demands for service remained firm with the total backlog of work slightly above the previous month. Overtime work decreased a small amount to the nominal level of 1.6% of the available man hours.

Safety and security performance was considered satisfactory with no major violations; however, the minor injury rate was on the high side of the forecasted parameter.

The absenteeism rate was 3.53% which is a considerable increase from the previous month but still below the forecasted rate.

TECHNICAL INFORMATION OPERATION

The fourth annual information meeting for employees of the Technical Information Operation was held in the 3760 building conference room on February 13. The report summarized the year's significant activities, answered a number of previously submitted employee questions, and take a general look at the year ahead.

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The HOO Classification Committee completed its review of the proposed Hanford Classification Guide (HW-55000) on February 19. The Committee recommended revisions for several topics in the Guide, and these changes were made. HOO transmitted the revised proposed Guide to the Divisions of Classification and Production in Washington on February 24.

Work on a systematic declassification review program was again undertaken during the month. This program was initiated about a year ago. However, work on the Hanford Classification Guide forced abandonment of the program at that time. Under the program, each Hanford-originated classified document will be reviewed for possible declassification or downgrading.

The responsibilities of the messengers in Technical Information have been rearranged. One messenger will work full time in the library, handling the library mail and shelving books. The previous "sharing" arrangement was unsatisfactory. One messenger in the Classified Files will provide special messenger service in the morning and deliver documents to the 700-1100 Area in the afternoon. The other three messengers will continue their present schedules. The new arrangement has permitted release of one of the assigned mail trucks.

One near serious incident occurred during the month. A Files messenger apparently fell asleep while driving a government vehicle, and drove through the gate at 100-H. He stopped after the patrolman yelled at him. Medical examinations (including x-rays) revealed nothing, and the conclusion is that he was suffering from lack of sleep. Appropriate disciplinary action has been taken.

Technical Information handled arrangements for the TS Workshop held for all HLO employees who have Top Secret clearance.

Several weeks ago we asked the United Kingdom Atomic Energy authority to loan us four films on the Calder Hall reactor. The request, along with others, eventually reached the AEC in Washington, which has arranged a schedule for the thirteen sites that asked to see the films. Hanford showings are to be around the first of June. The high interest in the films will necessitate careful planning of all showings, since the films can be on site for only one week.

The \$75 subscription to the translation of the Soviet Journal of Atomic Energy has been dropped because the main articles are being published in English in the Journal of Nuclear Energy from London. We have several copies of the Journal.

The HAPO master accountability tape was completed by Data Processing during the month. IBM cards for 37,638 changes in document accountability that occurred during the waiting period were processed at the same time to bring the tape up to date. Of this total, only 139 were rejected by the machine and had to be reconciled. Typical errors included failure to include suffix information, wrong document or copy number, classification changes, etc. The updated tape contains entries for a total of 215,275 SECRET and documented CONFIDENTIAL copies.

At the request of Technical Information, the Technical Liaison Specialist collected a sampling of photographs of HAPO activities for possible use in a book on the United States' program on peaceful applications of atomic energy. The book is being prepared under AEC contract by Arthur D. Little, Inc. for the second Geneva Conference. A pictorial treatment which will rely principally upon photographs and captions to tell

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a visual story of outstanding accomplishments to date is being considered. A "first cut" of potential material was requested.

The first Files inventory lists from the updated tape were received February 26. The inventory clerks report that the lists are in good condition.

A schedule for sending source data to Data Processing and requesting Files inventories has been established for the second Wednesday of each month. It is planned to request 60,000 items each month for Files inventory. At this rate, a complete inventory can be accomplished in four months minimum or five months maximum time. On this basis, a reduction in the number of inventory clerks appears feasible.

The IBM sorter (082) was delivered February 12. It is used for sorting name and document number route cards by transaction number, counting daily deliveries, counting daily source records punched, and sorting matched pairs of clearing cards. The sorted matched pairs are also run through the collator to confirm that both number and name cards are equal.

A large quantity of back-up data for special irradiation studies that KAPL made for HAPO has been shipped to us. The material is unclassified. A member of the Fuels Development Operation is working with Files in assigning appropriate titles to the loose-leaf binders in which the material has been placed.

Technical Publications prepared HW-54492, "Preliminary Hazards Evaluation, New Production Reactor" on a crash program basis. Copies of the report were submitted to the Advisory Committee on Reactor Safeguards.

The Commission has again been asked to place HAPO on the Standard Distribution List for reports in Category C-84, Reactors - Special Features of Aircraft Reactors. The letter of justification pointed out that much information being generated in connection with the design and construction of aircraft reactors will have possible application both to production reactors and the plutonium recycle test reactor. Numerous specific examples of this type of information were listed.

The necessity of having the proposed 300 Area location for the Plutonium Fabrication Pilot Plant and the Plutonium Recycle Test Reactor approved by the Advisory Committee for Reactor Safeguards resulted in an emergency request from the Commission for 22 copies each of HW-46461, HW-44703 and HW-49819. Since there was a shortage of the documents and time did not permit reproduction, copies were collected from holders on site, and were replaced later with reproduced copies.

RADIOGRAPHIC TESTING OPERATION

Total activity for the Radiographic Testing Operation was restricted this month due to extensive effort applied to MTR Fuel Plates. Despite the extra attention devoted to this important work, other jobs were maintained at a level sufficient to assure continuity of data. A total of 1020 tests were made of which 801 were radiographic exposures (including x-ray and gamma-ray) and 219 were supplementary tests. The supplementary test work consisted of only dye penetrant and ultrasonic testing. Another indicator of the amount of work accomplished is the feet of

material examined which, for this month, was 8569 feet, comparing favorably to the 9000 figure achieved last month. Work was done for 17 different organizational components representing all of the operating departments and service operations. A total of 14 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 14 different occasions for advice and information regarding general testing theory and applications for other than the jobs tabulated in Part II.

Work was performed in the following categories as indicated:

A. Construction

One construction project was worked on this month. The test work involved radiographic examination of 13,000 volt electric line splices. Nine pieces were examined and all of these appeared to be acceptable.

B. New Fabrications

No work relating to new fabrications was done during this month.

C. Maintenance

In the straight maintenance category the only job worked on involved additional work on the locomotive spring hangers reported last month. To be able to define more clearly the extent of possible damage, radiographs of different orientation from those previously made were taken. The part in question was approximately one inch thick by five inches wide by 18 inches long having sharp changes in section requiring the additional exposures.

In the preventative maintenance category a large amount of work continues to be done on pressure vessels to assure conformity with the ASME Boiler Code. In the 300 Area work was continued on the 303 autoclaves. This work is being coordinated with production activities so as to avoid interference with normal production operations. Results obtained to date show erratic weld quality and the program will be continued until all of the autoclaves have been examined. Miscellaneous vessels in the 300 Area were measured for wall and head thicknesses to obtain data for engineering calculations to show conformity with the ASME Boiler Code. This program is about 1/3 completed. In the 100-D Area 37 of the 60 foot long helium storage tanks were spot radiographed to allow Operations to use the 85% design pressure allowed by the ASME Boiler Code. It was necessary to use both X-ray and gamm-ray exposures on these tanks because of accessibility limitations. Only one tank was found to be questionable; an imperfect backing ring required that this tank be repaired. With the X-ray findings Operations now plans to go to the higher permissible pressures at considerable savings in gas usage and operational simplicity. In the 100-H Area the pressure vessel survey started earlier this year was completed with the examination of compressor tanks and air receivers. Consistent with the previous findings weld quality on the tanks examined appears to be below the minimum requirements of the Code.

D. Qualifications and Certifications

Two types of welders qualification coupons were examined this month. Standard half-inch and two-inch Schedule 40 stainless steel pipe butt welds were examined and fillet welds on cast iron as part of a special welding procedure.

E. As-Received Material

Work was continued on the program for Stores involving the radiographic examination of longitudinally welded stainless steel pipe. The material being examined this month is 1/4 inch and 1/8 inch Schedule 40 pipe. Considerable difficulty was experienced because of a spiral condition existing in the welded joint and the inability to positively locate the welded joint. A high rejection rate is being experienced in this material also (about 50% rejection on the 3 and 4 inch Schedule 40 stainless steel pipe examined last month). Most of the difficulty appears to be in incomplete weld filling resulting in deep crevices between the weld and the parent metal on the inside diameter of the pipe. It was interesting to note that in addition, numerous transverse cracks were found on some of the lengths of the pipe examined apparently resulting from the high reduction experienced in fabricating this pipe.

F. Assistance in Research and Development

Three major areas of interest were worked on this month including ceramic fuels, PRTR fuel element developments, and structural materials (zirconium tubing). In the ceramic fuels development work examinations were made both on component materials and trial assemblies. Considerable work was done in examining welded closures. Achieving successful weld closures is a difficult problem with the materials being used. Most of the work this month involved stainless steel tubes filled with uranium oxide. In addition, a so-called "trash-can" fuel element closure was examined. A special piece of 304L stainless steel tubing 6/10" in diameter was also examined for integrity. A large number of tests were made on PRTR trial assemblies, most of them involving various size tubing of different materials into which were cast alloys of varying plutonium content. Investigations were also continued on plutonium alloy cores pre-cast to shape. Component materials examined for the PRTR fuel element included zirconium and stainless steel tubing of various lengths and sizes. For the Structural Materials Development Operation work was continued on the non-destructive testing evaluation of zirconium tubing produced by various manufacturers on development orders. Principle effort has been on BDF size tubing with close comparison of various tests to be able to identify fabrication irregularities. Efforts are continuing to automate the equipment used in these examinations to allow speedier data taking.

Miscellaneous research and development work included zirconium tubing filled with a solid uranium core, short lengths of special stainless steel tubing, thorium alloy samples canned in aluminum for irradiation testing, KER size I & E wafer fuel element for wafer orientation, and stainless steel weld sections containing tungsten inclusions.

G. Semi-Production Testing

In conjunction with the MTR fuel element plate assemblies to be furnished to Phillips Petroleum at Arco, Idaho, the Radiographic Testing Operation has been engaged to make radiographs showing segregation and other discontinuities in the core billets, the core location in the rolled plate, and the final acceptance radiograph showing acceptable cladding thickness. Because of the short production time required to meet contractual obligations, considerable effort has been expended to allow production goals to be met. Small dimensional tolerances on the core location has required successive refinements in the radiographic technique used on the rolled plate. A satisfactory system has been developed which assures the required accuracy and gives the high production rate necessary.

Testing Statistics

<u>Component</u>	<u>No. of Tests</u>	<u>Ft. of Weld or Material</u>	<u>No. of Pieces</u>	<u>Description</u>
A. Chemical Processing Department	14	3-1/2	7	Cast iron weld coupons.
B. Construction Engineering Operation	10	6	9	SS weld coupons.
C. Fuels Preparation Department	38	51	18	KER-I&E wafer fuel elements and CS pressure vessel weldments.
D. Hanford Laboratories Operation	707	5918	1005	CS, SS, and Zr tubing. KER, UO ₂ and MTR fuel elements. KER and BDF process tubing. Misc. materials and assemblies.
E. Irradiation Processing Department	126	175-1/2	69	CS pressure vessels and electrical fittings.
F. Relations and Utilities Operation	125	2415	77	SS welded pipe and locomotive parts.
Total	1020	8569	1185	

FACILITIES ENGINEERING OPERATIONProject Activity

There were a total of 20 active HLO projects at month end with total authorized funds of \$3,755,400. The total estimated cost of these projects is \$9,666,000.

Three projects were completed during the month as follows:

CG-660, Modifications and Additions to the Metallographic Cell - 327 Building
CG-680, Corrosion Testing Facility - 314 Building
IR-231, Badgehouse Alterations for Self-Service - 100 and 200 Areas

One project, IR-236 - 321 Building Test Pit Enclosure, was submitted to AEC for approval and authorized during the month.

There are six project proposals in preparation.

The attached report summarizes the status of project work.

Engineering Services

The following list shows jobs active during the month:

<u>Title</u>	<u>Status</u>
Contaminated Waste Chute, 327 Building	Job complete; closed out.
Hood Repair and Relocation, 329 Building	Job complete; closed out.
Whole Body Animal Counting Room, 141-F Building	Job complete; closed out.
Breathing Air Installation, 141-FS Building	Installation complete except for correction of by-pass valve which is excessively noisy.
Correct Leaking Pump Seals in Plating Laboratory - 306 Building	Installation of seals held up pending replating of pump shaft to bring it to tolerance dimensions.
Budget Item B-75916 - Additions to the Radio-Metallurgy Building	Project Proposal has been prepared.
Preliminary Scoping and Estimating for Crane Improvements, 327 Building	Study complete; job closed out. A Project Proposal will be prepared for this work.

<u>Title</u>	<u>Status</u>
Replacement of Sump Pump, 329 Building	Job complete.
Provide Engineering Assistance	Work proceeding.
Preliminary Study, Acid System and Acid Dispenser Hood in the Bioassay Laboratory	Proposed arrangement has been sketched. High spot estimate being prepared.
Prepare Analysis and Recommendations to Lessen Sound Level and Improve Ventilation, Key punch Room, 3760 Building	Suggested modifications of existing damper settings have corrected ventilation problems.
Prepare Analysis and Recommendations for Air Filter on Vacuum System, 325 Building	Proposed arrangement is under consideration pending receipt of operating characteristics of the new fiber glass type filter in vacuum service.
Install Intercom System, 326 Building	Purchase Requisition G-352245 dated February 17, 1958 was issued for the intercom stations and associated wiring.
Construct Barn and Pasture, 100-F	Material being ordered.
Alterations to 3705 Building	Construction about 75% complete.
Provide Engineering Assistance for Equipment Installation, Basement 325 Building	Welder has been dismantled and placed in basement of 325 Building. An estimate for installation is being requested of C. O.
Repair Damaged 100-KW Water Heater, 189-D Building, for Code Compliance	Final approvals and issuance of construction drawing currently in progress.
Move Army Hutment and Install Near 108-F	Moving of hutment and laying new concrete floor slab, connecting power, and installing desert coolers was estimated at \$4500. AEC advised that official release may not be granted for approximately 45 days.
Extend 440 Service Line 200 Feet, 325 Building Basement	Purchase Requisition G-352248 dated February 25, 1958 submitted for 400 AMP air circuit breaker.

<u>Title</u>	<u>Status</u>
Prepare Layout Drawings, Estimate, for Structure, etc. for Expansion of 306 Metallurgical Development Building	Work proceeding.

All budget study work for Plant Acquisition and Construction for FY 1960 and Revisions to FY 1959 is complete. Data is now being compiled for HLO review.

Design and Drafting Services

Major work being produced includes the following:

Cesium Recovery - seven scope drawings completed. Redesign of packaging unit complete. Crystallizer tank and heating unit on chloride convertor 50% complete. Supporting structure 40% complete. Tanks and processing equipment (hydralizer, condensate mixer, scrubber, etc.) 40% complete. Condensers 5% complete. Scale mock-up under construction (primary use for jumper and pipe connections from unit to unit and from equipment to cell wall).

Electron Vacuum Welding - for production and research. This design to weld fuel elements in a vacuum chamber (Bell jar) through the use of a machine chuck and a high frequency electrode gun. 30% complete.

Draw Bench - this design to provide a means of drawing Al Tubing (1" - 4" diameter, 3' - 20' long).

Metal Rare Gas Collection Train - Problem: design a unit to collect rare gas from irradiated uranium while machining.

High Temperature Impact Sample Breaker - this design to produce an impact sample breaker for use in hot cells, 327 Building.

PRTR Test Element - this drawing made to provide outside manufacturer with data whereby he could supply drawings which would indicate feasible working limits.

25° Conversion Analyzer Chamber - drawing to modify existing equipment to provide greater range.

Wrist Badge Dosimeter - new design suggested by Swanberg - modify existing dosimeter and attach to expansion watch band.

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

Repairs to 100-KW Water Heater, HEW-445692, Drawing #H-1-10892.

Swage Die, Swaging Die to be used on conjunction with existing equipment for extrusion of uranium (experimental fuel elements).

Jig Drawing for Swaging Die - this drawing requested by 328 Shops to provide a means of holding the rough Swaging Die for final facing, boring, laping and polishing.

321 "As Builts" - arrangements 95% complete. Outside lines 100% complete. Plumbing and service piping 95% complete. Plumbing and drainage first floor plan 90% complete. Basement drainage and service piping 80% complete. Electrical 5% complete.

Focus Magnet and Cart - angle iron cart on casters to hold 500 lb. Focus Magnet.

Temporary Cut Off - temporary cut off in "B" Cell while Project 682 is in progress.

Cathodic Etcher - detail drafting.

Total drawings produced during the month total approximately 230 including revision work.

Approximately 11,250 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 five employees are "on loan" in our drafting room from other departments. Also, an additional five "on loan" draftsmen are supplying HLO's needs to R & D components in the field.

Maintenance and Building Engineering Services

The Office Equipment budget forecast FY 1960 and revision of forecast FY 1959 was coordinated and consolidated for HLO, and a justification was prepared.

Outer and 300 Area HLO buildings were inspected and the maintenance budget was prepared. An Unusual Maintenance forecast was also prepared.

The maintenance schedules have been reviewed and extended as part of our budget preparations.

The installation of the new 3,000 gallon Propane Storage Tank was completed this month. The heel in the old tank was burned off for safe handling of the tank. About 3 gallons of sludge was removed from the heater when the liquid line from the tank was disconnected. This sludge was buried when cases of personnel discomfort from the mercaptan indicator were reported in 325 Building. Gas service was provided from a temporary tank during the changeover. An outage was scheduled for the weekend when the necessary tie-in to the distribution grid was made.

The specifications and bid package for lump sum construction contract of 3707-C renovation are being prepared by FPD's Plant Engineering. Completion is tentatively scheduled for June.

Revised building procedures were issued for 326 Building and work is continuing on those for 329 Building.

A study has been initiated to improve the As-Built condition of drawings. A task force of FPD and HLO personnel has been established to insure the timeliness and correctness of the 300 Area Plot Plan.

Arrangements were made to finance the completion of the Breathing Air System - 141-FS Building. Completion is scheduled for 3-1-58.

Heating, ventilating and air conditioning equipment no longer needed in connection with Project CG-729 was excessed.

A detailed study was made of routine janitorial Work Order F-1566 covering the 108-F Building, to ensure continued service at the previous level.

The stacks and shelving have been ordered for the Library with delivery scheduled for mid-March.

The Survey and Inspection of Pressure Vessels is 75% complete. Completion is dependent upon receipt of thickness measurements from Radiographic Testing component.

A drawing of repair work for the 100-KW Water Heater in 189-D Building showing code repairs has been prepared. Final approvals and issuance of construction drawing is currently in progress.

Procurement and installation for the Shielded Cave in 325 Building has been completed.

LABORATORIES ADMINISTRATION AND TECHNICAL LIAISON

One new Organization and Policy Guide, No. 03.7.11, Civil and Plant Defense, was issued. No. 08.6.1, Transfer of Unirradiated Scrap SS Material, was withdrawn from the OPG series because the same information is now covered in SS Accountability Manuals. Timely revisions were issued on specific sections of six existing guides.

One letter of delegation of authority for work authorization was issued as well as specific delegations covered by OPG No. 02.3.1, Approval Authorizations.

The following consulting contracts were approved for signing by General Manager - HAPO:

CA-178 - Dr. R. E. Zirkel
CA-181 - Professor J. L. Powell
CA-182 - Dr. P. E. Church
CA-183 - Dr. Franklin I. Badgley

Contract DDR-30 with Sciaky Bros., Inc. and Contract DDR-36 with Battelle Memorial Institute was signed for zirconium and Zircaloy research and development work.

An Assistance-to-Hanford (No. ATH-HLO-1-58-B) letter was approved. This will provide assistance and services for Dr. T. I. Moran at Metallurgy and Ceramics Research Department, Schenectady, New York.

On February 17, 1958, the last two BF_3 counters were received on the KAPL order. The final payment still remains to be settled.

Coordination of preparations of papers, exhibits and movies for the 1958 Geneva Conference has continued. It now appears that about 40 papers, four or five exhibits and three or four movies will be contributed to the Conference by the Hanford Laboratories Operation.

A brief symposium on the Windscale Reactor Accident was arranged and was presented to an invited group of about 100 HAPD persons by three of the recent visitors to England who had participated there in conferences on the subject.

Manager
LABORATORY AUXILIARIES

JL Boyd:lt

HW-55162

February, 1958

MONTHLY PROJECT REPORT

UNCLASSIFIED

PROJECT NUMBER	TITLE	HANFORD LABORATORIES OPERATION				PROJECT PROGRESS IN PER CENT				STARTING DATE	DIRECTIVE COMP. DATE	Estimated COMP. DATE
		USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	AMOUNT DATE	DESIGN SCHED	CONSTR. ACTUAL	DESIGN SCHED	CONSTR. ACTUAL			
General Plant Projects - FY 1956 AEC-2-23X-56-L-2		Reactor & Fuels	\$ 132,000		\$ 140,000* 4-4-57	100	86	100	86	5-23-56 12-7-56	5-1-58	9-28-56** 4-1-58
CG-664	350° Flow Loop - 314 Building	REMARKS: Canned rotor pump has been received and is being assembled, after passing all performance tests satisfactorily. An estimate has been received from Construction Operation for installation of the loop in the building that conforms to the project estimate. Pressure testing of the loop will be performed when the pump is installed, probably the week of March 3. **Actual completion date.										
General Plant Projects - FY 1957 AEC-23-57-N-2		Radiation Protection	\$ 150,000		\$ 150,000 2-4-57	100	100	100	0	2-18-57 5-15-58	- - - 12-31-58	12-19-57* 10-1-58
CA-658	Shielded Personnel Monitoring Station - 747 Building	REMARKS: Bids for the construction portion of the project were opened Feb. 12, 1958. Eight firms made bids. The bids ranged from a low of \$103,707 to a high of \$169,995. The successful low bidder was Lewis Hopkins Construction Company. It currently appears the offsite procurement and fabrication of the cell will start about March 1 and be completed by May 15, 1958. Construction at the 747 Building site will commence about May 15, 1958 and barring unforeseen difficulties the										
	Engineer: D. S. Jackson											
		REMARKS: (CA-658 Continued) facility should be completed ready for HLO occupancy by October 1, 1958.										
		*Actual date.										
CG-680	Corrosion Testing Facility - 314 Building	Reactor & Fuels	\$ 111,765		\$ 135,000 5-2-57	100	99	100	100	10-3-56 5-2-57	- - - 3-15-58	1-24-57* 2-28-58*
		REMARKS: The stainless steel hood and sink have been transferred and installed in the 314 Building. Work was completed on 2-28-58. This project was completed two weeks ahead of Directive Completion date and with an approximate \$23,000 underrun.										
		*Actual project completion date.										
	Engineer: R. W. Dascenzo	Chemical R & D	\$ 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*
CA-700	Geological and Hydrological Wells - FY 1957	REMARKS: Thirty-seven wells, totaling 12,748 feet in depth, were drilled on this project. All drilling was completed on January 31, 1958. Work remaining on this project includes location and determination of top of casing elevation on 13 wells and unitization of the project										
	Engineer: D. S. Jackson											
		*Actual completion date of drilling work. ** Actual Date.										

UNCLASSIFIED

HM-55162

MONTHLY PROJECT REPORT

February, 1958

MONTHLY PROJECT REPORT													
UNCLASSIFIED		HANFORD LABORATORIES OPERATION											
PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT				STARTING DATE		DIRECTIVE COMP. DATE	Estimated COMP. DATE
				AMOUNT	DATE	DESIGN ACTUAL	SCHED ACTUAL	CONST. ACTUAL	DATE	DESIGN CONST.			
CA-728	High Level Exposure Facility Addition - 141-H Building	Biology Research	\$ 20,000	\$ 20,000	100	100	100	100	100	3-11-57	1-15-58	6-10-57*	11-14-57*
			REMARKS: Project was accepted November 19, 1957. Financial Closing Notice was prepared on January 28, 1958. Of the \$2,000 in funds authorized to the General Electric Company \$1,960 was expended. This project will no longer be included in this report.										
CG-729	Ventilation System Improvements - 222-U Building	Chemical Research	\$ 78,000	\$ 73,000	100	100	77	77	77	4-23-57	6-12-57*	5-28-57**	5-1-58
			REMARKS: A final inspection was held on the Fixed Price Contractor's work on February 21, 1958, at this time a few minor exceptions were noted. These exceptions were completed on February 28, 1958 which will be the actual completion date for the contract. This is approximately one month ahead of the contract stipulation. The contractor is submitting a claim for approximately \$2,000 for some s/s flanges on the ductwork ells and the filters in the exhaust filter boxes.										
	Engineer: A. W. Hervin												
			REMARKS: (CG-729 Continued) The facts are being obtained so that upon receipt of the contractor's claim a decision can be reached as to its validity. The CPFF construction contractor has essentially completed his work. However, there has been some necessary additional work such as, removal of obsolete exhaust fans and appurtenances, evaporative coolers along with wood platform and ductwork, and new grills in the ventilation ductwork. This work along with the contractor's claim										
			REMARKS: (CG-729 Continued) will cause this project to overrun \$5,000. A Johnson Service representative is installing controls on the air washer to the counting room and adjusting the controls on the other two air conditioning units. Plant Forces performed no work during this reporting period.										
CG-733	Plutonium Metallurgy Facility	Reactor & Fuels	\$ 295,000	\$ 295,000	100	100	89	89	89	5-14-57	9-25-57*	10-1-57**	5-1-58
			REMARKS: Beneficial use of Room 37 was accomplished on 2-21-58. A total of 5 rooms are now being used by Plutonium Metallurgy in addition to the offices, change rooms and lunch room area. Remaining work in Rooms 34 and 35 is connecting up the hood and glove box exhausts and some service piping. Lump Sum work has been completed.										
	Engineer: J. T. Lloyd												
				*Scheduled Date. ** Actual date.									

PROJECT NUMBER	TITLE	MONTHLY PROJECT REPORT										February, 1958	
		HANFORD LABORATORIES OPERATION		EST. TOTAL PROJECT COST		AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT				February, 1958	
		USING COMPONENT				AMOUNT DATE		DESIGN SCHED ACTUAL	DATE DESIGN CONST.	DATE DESIGN CONST.	DATE DESIGN CONST.	Directives	Estimate
IR-224	Biology Controlled Activity Water System - 100-F Area	Biology Research	\$ 19,997	\$ 19,900	6-27-57			100 100	1-2-57	7-22-57	1-15-58	4-11-58	1-21-58
	Engineer: D. S. Jackson	REMARKS: This project was completed on January 21, 1958. The Physical Completion Notice was issued on February 18, 1958.											
General Plant Projects - FY 1958 AEC-2-23-58-1	Engineer: D. S. Jackson	*Actual completion dates.											
CG-760	Expansion of the 3745-B Facility	Physics & Instr.	\$ 193,000	None to date	None to date			To be est 0	To be est 1*	To be est 9	To be est	6*	16*
	Engineer: R. C. Ingersoll	REMARKS: The project proposal was submitted to the AEC-HCO Review Board 1-23-58. The Commission returned the proposal to HLO February 20, 1958 for further justification. The project will be resubmitted.											
CA-765	Additions to the 314 Building	Reactor & Fuels	\$ 46,000	\$ 46,000*	11-15-57			99 98	To be est 10-14-57	To be est 4-20-58	11-15-58	3-7-58	11-15-58
	Engineer: A. W. Hervin	REMARKS: The Architect-Engineer, Carson & Moe, have submitted drawings and specifications for review. These have been reviewed by the General Electric Company and a meeting has been held with the Commission representative to explain our comments which will be formalized in a letter to the AEC the first part of March. This method was used to help the Architect-Engineer complete his work as soon as possible. Work has been started on gathering information to be incorporated in possible. Work has been started on gathering information to be incorporated in possible.											
	Engineer: J. T. Lloyd	REMARKS: (CA-765 Continued) the special conditions of the construction contract The General Electric Company portion of the design work has been completed, this includes design criteria and preliminary design only. \$6,140 of total funds have been authorized to the General Electric Company.											
CA-769	Additions to the 622 Building	Physics & Instr.	\$ 80,000	None to date	None to date			0 0	None est	None est	To be est	None est	None est
	Engineer: J. T. Lloyd	REMARKS: The project proposal was transmitted to the AEC-HCO on August 6, 1957 and forwarded to AEC-Washington. Word was received on January 28, 1958 that about 90 days would be required to assemble and review data prior to recommending action.											

HW-55162

MONTHLY PROJECT REPORT

PROJECT NUMBER	TITLE	HANFORD LABORATORIES OPERATION										February, 1958	
		USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT			STARTING DATE	DISACTIVE COMP. DATE	EST. CO. DA	February, 1958	Est. CO. DA
				AMOUNT	DATE	SCHED ACTUAL	DESIGN SCHED	CONST. ACTUAL					
CA-778	Expansion of the 305-B Building	Physics & Instr.	\$ 55,000	\$ 55,000	12-11-57	To be est	To be est	To be est	3-15-58	5-15-58*	5-1	February, 1958	10-15-58
REMARKS: The Design Criteria was submitted to the Commission February 7, 1958. The Commission is negotiating with an Architect-Engineer for Titles I, II, and services for the project.													

*Scheduled date.

CG-779	Alterations to the 321 Building	Engineer: R. C. Ingersoll		\$ 63,000	None to date		0	0	None est	To be est	None
					None to date		0	0	None est	To be est	None
REMARKS: The project proposal was transmitted to AEC-HOO on October 17, 1957. The request was forwarded to AEC-Washington on December 3, 1957. A letter of national justification was presented to the local AEC on February 3, 1958. This explained that recent studies indicate the potential feasibility of replacement one type of material with another. This would result in an estimated yearly of \$100,000. The AEC-Washington disapproved this project on February 14, 1958.											
		Engineer: I. T. Lloyd									

IR-234	Storm Windows and Sun Shades - 326 Building																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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*Actual project completion date.

IR-236	321 Building Test Pit Enclosure	Engineer: J. L. Lloyd										
			Chemical	\$ 19,000	\$ 19,000	0	0	0	3-3-58	6-28-58	3-6	
			R & D		2-28-58	0	0	0	3-21-58	6-28-58	6-	
REMARKS: This Informal Request was approved by the Commission on February 20.												
A check print is scheduled to be issued by design during the first week of March.												

Engineer: A. W. Hervin

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HW-5516.
February, 1958

MONTHLY PROJECT REPORT

PROJECT NUMBER	TITLE	HANFORD LABORATORIES OPERATION		PROJECT PROGRESS IN PER CENT		STARTING DATE	DISACTIVE DAYS	Estimated COMP. DATE
		EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT DATE	DESIGN SCHED ACTUAL	CONST. SCHED ACTUAL			
CG-672	Monochromatic Neutron Beam Facility - 105-KE Building	\$ 187,000	\$ 195,000 3-7-57	100	63	5-21-56	- - -	- - -
	Engineer: H. Radow			100	65	11-1-57	5-1-58	7-1-58
REMARKS: The installation is progressing favorably and final completion is currently indicated to be on or ahead of schedule.								
CA-681	Hanford Equipment in the ETR	\$1,200,000	\$ 900,000 8-12-57	100	0	9-17-56	4-57	5-29-57*
	Engineer: H. Radow			100	0	4-15-58	12-15-58	12-15-58
REMARKS: No official date for the start of installation by Phillips has yet been established by the Commission. It is informally indicated that the schedule date is now April 15, 1958. A Tentative construction schedule based on an assumed starting date has been prepared by CEO and submitted to the Commission.								
CG-682	High Level Cut-Off and Examination Cell - 327 Building	\$ 430,000	\$ 430,000 8-20-57	100	0	7-18-56	6-26-57*	- - -
	Engineer: A. W. Hervin			100	0	4-15-58	10-1-58	10-1-58
REMARKS: The vendor on the cut-off saw has completed approximately 90% of the detailed parts and approximately 35% of the assemblies and sub-assemblies. During the month drawing discrepancies were brought to attention by the vendor and have subsequently been resolved. The shipping date of April 15, 1958 appears to still be possible. The vendor for the shipping cask (promised shipping date 4-17-58) has all the materials on hand except for the lead and fabrication work is in progress.								
REMARKS: (CG-682 Continued) The materials for the cask lifting bail and push rod assembly are all on order and most of the items have been received by the vendor. The vendor of the meehanite cell requested an extension of time and has been granted an extension of one month (to April 15, 1958). This extension of time will not affect the completion date of the project. The machining sub-contractor for the cell vendor over-bored one hole, a satisfactory method of repairing this error is being worked out with the vendor. Due to floor load limitations on the north side of the building, a minor redesign of the cell supports is being made to accommodate the 14 ton casks when the materials in the casks are being unloaded directly into the cell.								
*Scheduled date.								

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MONTHLY PROJECT REPORT

HW-55162

February, 1958

MONTHLY PROJECT REPORT														
PROJECT NUMBER	TITLE	HANFORD LABORATORIES OPERATION												
		USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT				STARTING DATE		DIRECTIVE NO.		EST. DATED DATE
				AMOUNT	DATE	DESIGN SCHED	CONSTR. SCHED	ACTUAL	ACTUAL	DESIGN CONST.	CONSTR. CONST.	DESIGN CONST.	CONSTR. CONST.	
CA-695	Radio Telemetering Network	Physics & Instr.	\$ 98,000	\$ 89,000	1-10-57	100	Not Sched	100	Not Sched	2-22-57	4-15-57*	5-27-57**	1-1-59	
		REMARKS: Negotiations by AEC with RCA for repeater station have failed. The AEC is now advertising for bids. Work by the contractor on the prototype model of the data station is progressing and most of the materials are on hand with expected delivery some time in March. The total estimated project cost indicates an overrun or a reduction in scope of work. GE will make recommendations on this matter during March. The projection completion date will be extended by the AEC.												
		REMARKS: (CA-695 Continued) *Scheduled date. **Actual date.												
CG-758	Ceramic Fuels Development Press and Furnace Additions	Reactor & Fuels	\$ 200,000	\$ 200,000	8-1-57	100	0*	100	5	8-22-57	2-1-58**	2-28-58#	10-1-58	
		REMARKS: Press Pit Architectural drawing being routed for approval. Bid package information will then be given to the Commission. Contractor's installation work on the furnace started 2-24-58. Scheduled completion date (furnace) 4-16-58. *The overall construction schedule has not been estimated 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	\$ 15,000*	\$ 15,000	2-12-58	0	0	0	0	3-10-58	- - -	6-12-58		
		REMARKS: AEC Directive HW-450, dated 2-12-58 has been received authorizing \$15,000 for preliminary design and necessary services to submit a revised project proposal for procurement and construction funds. A design order has been submitted to CEO for preliminary design and initiation of detail design.												
IR-231	Badgehouse Alterations for Self-Service - 100 and 200 Areas	Radiation Protection	\$ 13,500	\$ 18,500	8-29-57	100	100	100	100	7-1-57	- - -	9-15-57	2-17-58*	
		REMARKS: All work was completed and the project closed on February 17, 1958. Project unitization remains to be performed. The Physical Completion Notice has been prepared and submitted to HLO Financial Operation for checking.												
		*Actual project completion date												

MONTHLY PROJECT REPORT

HW-55162

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HANFORD LABORATORIES OPERATION

February, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION			PROJECT PROGRESS IN PER CENT			STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
				AMOUNT	DATE		DESIGN SCHED	CONST. SCHED	ACTUAL			
New Construction - FY 1958												
CG-731	Critical Mass Laboratory	Physics & Instr.	\$1,800,000	None	None	None	To be est	To be est	0	None est	None	None est
		REMARKS:	To date the AEC has not authorized funds on the project proposal request of \$175,000 for total design.									
	Engineer: R. W. Dascenzo	Reactor & Fuels	\$2,600,000	None	None	None	To be est	To be est	0	None est	None	None est
		REMARKS:	A revised project proposal is being prepared.									
CA-744	Metallurgical Development Facility											
	Engineer: R. W. Dascenzo	Chemical Research	\$1,070,000	\$ 20,000*	9-27-57	100***	To be est	To be est	0	7-11-57	None	7-1-58
		REMARKS:	To date authorization for total project funds has not been received. Preliminary design is complete.									
	Engineer: R. W. Dascenzo	Research & Fuels	\$ 95,000	None	None	None	None	None	None	None est	None	None est
		REMARKS:	A project proposal is being prepared for design money only on this facility.									
	X-Ray Diffraction Cell - 327 Building											
	Engineer: R. W. Dascenzo	Research & Fuels	\$ 150,000	None	None	None	None	None	None	None est	None	None est
		REMARKS:	A project proposal is being prepared for design money only on this facility.									
	High Temperature Tensile Testing Cell - 327 Building											
	Engineer: R. W. Dascenzo											

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G-22

HW-55162

DEL

VISITS TO HANFORD WORKS

<u>Name</u>	<u>Dates of Visits</u>	<u>Company or Organization Represented & Address</u>	<u>Reason for Visit</u>	<u>H.W. Personnel Contacted</u>	<u>Access to Restricted Data</u>	<u>Areas & Buildings Visited</u>
Students	2-25-58	Yakima Junior College	Learn about HAPO	CG Stevenson	No	3760 Bldg. 300 Area
Frank W. Davis	2-18, 19- 1958	OIC-AEC Washington, D.C.	Discussed metal-lurgical exhibits for the Geneva Conference	RW Benoliel, et al	Yes	325, 326, 327, 3760 Bldgs., 300 Area 231-Z Bldg. 200-West Area

VISITS TO OTHER INSTALLATIONS

<u>Name</u>	<u>Dates of Visit</u>	<u>Company Visited & Address</u>	<u>Reason for Visit</u>	<u>Personnel Contacted</u>	<u>Access to Restricted Data</u>
R. B. Socky	2-21-58	Society for Non-Destructive Testing, Seattle, Wn.	To present report on National delegates meeting		No
	2-21-58	Bremerton Naval Yard	Discussion of special film techniques	William Hanna	No
	2-21-58	Industrial X-Ray Engineers, Seattle, Wn.	using extra fast film for MTR fuel plates.	Harold Hovland	No

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EMPLOYEE RELATIONS OPERATION MONTHLY REPORT

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HW-55162-DEL

GENERAL

On February 28, 1958 the staff of the Hanford Laboratories Operation totalled 1129 including 506 exempt and 623 nonexempt employees. Of the total exempt employees there were 440 with college degrees including 422 technical degrees as follows:

<u>BS</u>	<u>MS</u>	<u>PhD</u>
222	103	97

In addition, there were 37 nonexempt employees with college degrees.

Distribution among the nine level 3 components is included in Table I.

PERSONNEL DEVELOPMENT AND COMMUNICATIONS

The training program for nine members of the Armed Forces Special Weapons Project was concluded on February 14, 1958.

Ten applicants were accepted for the AEC-ASEE Summer Institute of Nuclear Energy to be held here this summer. This will be the second year that HLO has conducted a Summer Institute in Chemical Processing.

Eighteen Technical Graduates and 6 Technician Trainees were on assignment within HLO at month's end.

Nine employees completed Conference Leading, three attended Data Processing, and management personnel from Reactor and Fuels, Physics and Instruments, Laboratories Auxiliaries and Employee Relations attended Financial Orientation.

Twelve people began Understanding People. The course is being conducted at 100-F for the convenience of HLO outer area employees.

Three PEM-1 sessions were started for a total of 48 HLO employees.

A total of 375 HLO employees attended the annual Employee Information Meeting. The meeting was held two evenings so that all employees would be able to attend.

One hundred high school science students visited HLO on Edison Day. During the month tours of HLO facilities were also arranged for 20 science students from Western Washington College of Education and 25 Yakima Junior College science students.

An editor and photographer from the National Geographic Magazine visited HLO facilities in connection with an atomic energy story which will appear in the magazine early this fall. Also, pictures of HLO were taken by a photographer for GE's "Shareowners Quarterly".

Thirty-four papers, articles and speeches were processed for release.

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PERSONNEL PRACTICES

Nine nonexempt requisitions were filled during the month. There is only one requisition, a Technologist R & D, for which a commitment has not been made.

There are three Group III secretary openings anticipated during the coming month.

There were no nonexempt force reductions nor force reduction notices issued during the month. One employee in HLO was transferred as a result of her request and was not replaced which eliminated a future force reduction.

Five Instrument Makers and one Machinist Journeyman in HLO have participated in the Supervisor Selection program.

Five transfer requests were received during the month of February.

Two 1-year, two 2-year, and two 3-year Attendance Awards were issued during the month of February.

Service Recognition:	<u>5 Years</u>	<u>10 Years</u>	<u>15 Years</u>	<u>20 Years</u>	<u>25 Years</u>	<u>Total</u>
Pins issued this month	8	6	-	-	-	14
Total pins out	469	257	1	2	1	730

The fifteenth Hanford Laboratories Suggestion Board Meeting was held February 20, 1958. Nine suggestions were presented for action and six were approved for awards totalling \$360. Payment of awards is being deferred pending establishment of a suggestion budget.

The percentage of HLO eligible employees who submitted suggestions are as follows:

1956 - 21% Calculated on the basis of the last four months
projected to an annual rate

1957 - 27% Hanford Laboratories

Preliminary suggestion statistics for the Company as a whole for the year 1957 compared to HLO are as follows:

	<u>GE</u>	<u>HLO</u>
Average Award	\$29.21	\$37.84
Ratio of Awards to Savings	16.1%	9%
Suggestions Adopted Per Thousand Eligible Employees	146	168

Mathias J. Fekete, Biological Attendant, Biology Operation, retired effective March 1, 1958.

During February 176 medical insurance claims were paid for Hanford Laboratories employees or their dependents totalling \$12,388.

Hanford Laboratories participation in employee benefit plans as of January 31, and February 28, is as follows:

	January 1958	February 1958
Insurance	99.6	99.7
Pension Plan	98.4	98.5
Savings & Stock Bonus	60.6	61.3
Savings Plan	7.5	8.2

Five deferments were requested during the month and four deferments were granted.

Military status of HLO employees is as follows:

<u>STATUS</u>	<u>Non-Technical</u>	<u>1A and</u>			
<u>Reservists</u>	<u>Other than 1A</u>	<u>Other</u>	<u>Non-Technical 1A</u>	<u>*Critical</u>	<u>TOTAL</u>
Standby	13	31	0	0	44
Ready	15	21	6	1	43
Total	28	52	6	1	87
<u>Non-Veterans</u>	<u>26</u>	<u>41</u>	<u>20</u>	<u>41</u>	<u>128</u>
TOTAL	54	93	26	42	215

Deferments Requests Pending	5
Deferments Denied, Appealed and Pending	0
Deferments Pending at Presidential Appeal Level	0

*Refers to those employees for whom deferments are currently being requested.

UNION RELATIONS

The Council has not yet replied to our most recent proposal in the Regional Monitors negotiations.

The Company and the Council have been unable to agree on the selection of an arbitrator in the Maki case. Therefore, according to the Contract language, the arbitrator will be named by the Federal Mediation & Conciliation Service.

Three grievances were received during the month of February. One was from the Radiation Protection Operation, one against Reactor & Fuels, and the third against Employee Relations. They are briefly described as follows:

A Laboratory Assistant "B" in the Radiation Monitoring Operation filed a grievance objecting to the distribution of overtime. The employee has not as yet requested to carry the grievance to the Step II level.

An FPD Serviceman filed a grievance claiming an HLO Engineer hauled two boxes of material from the 303 Area to 100-K East in a pickup. The Teamsters claim

jurisdiction of this work. The Step II Answer to this grievance will soon be forwarded to the Council.

The same FPD Serviceman who submitted the above grievance, filed another grievance against Health & Safety personnel for transporting sample safety prizes in a sedan for exhibit to HLO employees in the 100 Areas. This grievance was answered satisfactorily at Step I.

The grievances processed by this Operation since January 1, 1958 total nine. This number includes one non-unit grievance. The following is a breakdown as to the status of these grievances.

Step I

Answered satisfactorily*	4
Pending time limit	1**

Step II

Pending Step II discussion	0
Pending Step II answer	1
Answered	
Satisfactorily***	1
Pending time limit	2
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.

** Non-unit grievance.

***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.

TECHNICAL PERSONNEL PLACEMENT

PhD Recruiting

During the month five candidates visited Richland for employment interviews; four offers were extended; one was accepted; three were rejected; none were placed on the roll.

PhD - HLO - 9/1/57 to date

<u>Cases Considered</u>	<u>Visited</u>	<u>OFFERS</u>				<u>On the Roll</u>
		<u>Extended</u>	<u>Accepted</u>	<u>Open</u>	<u>Rejected</u>	
474	36	34	9	6	19	9

Offer totals include 14 offers extended during the last recruiting season which were open on September 1, 1957.

Offers accepted do not include 7 acceptances received during the last recruiting season from people who were not on our payroll on September 1. Four of the seven carry-over acceptances have reported on the roll to date.

A summary of PhD recruiting statistics appear in Table III.

Experienced BS/MS Recruiting

No experienced BS/MS recruiting was conducted during the month. One offer was extended and remains open to a military reactivate; one offer was rejected; one was placed on the roll.

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

<u>Cases Considered</u>	<u>Visited</u>	<u>OFFERS</u>				<u>On the Roll</u>
		<u>Extended</u>	<u>Accepted</u>	<u>Open</u>	<u>Rejected</u>	
74	7	7	2	1	4	4

Two people reported on the roll during September as a result of offers accepted prior to September 1, 1957.

A summary of BS/MS experienced recruiting appears in Table III.

Summer Programs

Two offer acceptances have been received for the Summer Professor Program.

Three offer acceptances have been received for the Summer Graduate Student Program.

Exempt Transfer Cases

There were four new requests for transfer received during the month. Two cases were closed by transfer within HLO.

Exempt transfer statistics appear in Table IV.

The attrition of exempt personnel for February:

Transfers	2
Terminations and deactivates	0

SALARY AND WAGE ADMINISTRATION

Up-to-date college degree and academic data for all HLO exempt employees were submitted to Data Processing. A complete "package" for these employees will then be available in a force report type listing by approximately April 1. The frequency of distribution of this report will be geared to the wants of the HLO level 3 managers.

Preliminary work has been initiated in preparing sample guides for possible revisions to the existing position descriptions and titles of our generic technical positions. The "package" will be submitted to appropriate HLO managers for their review and comments in the near future.

The following position changes were made during the month:

Positions Added	- 1
Position Guides Revised	- 7

The following position audits were completed:

Physics & Instrument R&D - 8
Radiation Protection - 7

At month's end, completed appraisals for 57 exempt employees were still outstanding.

The report on the Semitechnical Job Study has been completed and forwarded to the HAPO Employee Relations managers for their immediate review.

Twenty-nine nonexempt jobs were audited during the reporting period.

Preliminary work continued in the study on a Point Score Evaluation Plan for use in evaluating clerical-functional positions.

HEALTH, SAFETY AND SECURITY

During February Laboratories personnel worked 182,108 hours with no disabling injuries. Since September 1, 1956, a total of 3,389,736 hours have been completed with no disabling injuries. On February 10, HLO won its first President's Safety Award for completion of 528 days without a disabling injury.

There were 44 medical treatment injuries giving a frequency of 2.42 as compared to 1.60 last month.

Two serious injuries were recorded:

1. W. G. Spear, Instrument Development, received painful second degree burns when a container of boiling paraffin spilled on his hand.
2. J. W. Taylor, Fuels Development, received a bruised arm and hand, which were caught between the hydraulic feed and the door of the swager in 314 Bldg.

Two other unusual incidents are also reported.

1. One fire run was made on report of a smoking fluorescent light ballast in 329 Bldg.
2. Spillage of "drip oil" and odorizer during replacement of the 300 Area propane tank caused two occupants of 325 Bldg. to report to First Aid with complaints of illness from the odor.

There were 4 security violations in February.

Consultations were had with, and approvals given to, 20 operations on 33 problems.

Inspections of 8 operations were made during the month.

Security Operation was assisted in presenting the first monthly "Infractor School" for security violators.

Six operations were assisted in preparation of safety meetings.

There were 91 medical exams completed out of a scheduled 112.

ATTITUDE SURVEY

Follow-up discussions with Technical Information people on the attitude survey were completed during the month. A rough draft summary of the comments, analysis and conclusions is now being prepared. Items requiring immediate action have already been discussed with the level 4 manager.

Manager
Employee Relations

TG Marshall:tr

VISITORS TO HAPO

<u>Name</u>	<u>Date of Visit</u>	<u>Company or Organization Represented</u>	<u>Reason for Visit</u>	<u>Personnel Contacted</u>	<u>Access to Restricted Data</u>	<u>Areas and Buildings Visited</u>
Wm. Scholz	2/3/58	General Electric Co. Personnel Prac. & Comm. Rel. Serv.	Communications Consultation	T.G. Marshall	None	703 - 700
Col. L.B. Hanson AFSWP Field Command Surgeon	2/3 & 4	AFSWP	Coordination of AFSWP Personnel Training Programs	D.C. Fleckenstein J.W. Healy, A.R. Keene, R.W. Meisinger, W.C. Roesch, L.A. Temple	None	3746 - 300 3745 - 300 329 - 300 1705-F - 100-F 141-M - 100-F 108-F - 100-F

VISITS TO OTHER INSTALLATIONS

<u>Name</u>	<u>Date of Visit</u>	<u>Company Visited And Address</u>	<u>Reason for Visit</u>	<u>Personnel Contacted</u>	<u>Access to Restricted Data</u>
None					

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TABLE III. EMPLOYMENT - TECHNICAL PERSONNEL STATUS

I. Employment

<u>Non-Exempt Employment Status</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Non-Exempt Transfer Requests</u>	<u>Jan.</u>	<u>Feb.</u>
Requisitions					
At end of month	11	7	Transfer Requests		
Cancelled	0	0	Active cases at end of		
Received during month	10	5*	month	43	46
Filled during month	6	9	Cancelled	3	1
Candidates Considered			New during month	2	5
Total Applications	21	24	Transfers Effectuated	1	1
Total Transfer Requests			Planned Transfers		
from other at HAPO	4	0	Effective during month	0	0
Total Interviewed	0	0			

* 1 Cancelled Requisition reactivated

II. Technical Personnel PlacementPh.D. Recruiting - HLO - 9/1/57 to date

	<u>Cases Con-</u> <u>sidered</u>	<u>VISITS TO RICHLAND</u>				<u>OFFERS*</u>			<u>On</u> <u>The</u> <u>Roll</u>
		<u>Extended</u>	<u>Visited</u>	<u>To Visit</u>	<u>Open Invite.</u>	<u>Extended</u>	<u>Accepted</u>	<u>Open</u>	
Engineering:									
Chemical	52	21	4	6	2	6	2	1	-
Electrical	17	4	-	2	1	2	-	-	-
Mechanical	28	9	2	4	-	2	-	-	-
Met-Ceramics	46	24	6	4	4	5	-	2	1
Other	6	2	-	2	-	-	-	-	-
Science:									
Chemistry	213	35	11	10	6	10	4	2	4
Physics	211	82	11	24	22	8	2	1	1
Math-Statistics	30	3	-	2	1	-	-	-	1
Other	31	6	2	2	1	1	1	-	2
TOTALS	634	186	36	56	37	34	9	6	9

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

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

	<u>Cases Con-</u> <u>sidered</u>	<u>VISITS TO RICHLAND</u>				<u>OFFERS</u>			<u>On</u> <u>The</u> <u>Roll</u>
		<u>Extended</u>	<u>Visited</u>	<u>To Visit</u>	<u>Open Invite.</u>	<u>Extended</u>	<u>Accepted</u>	<u>Open</u>	
Engineering:									
Chemical	6	2	1	-	-	1	-	1	-
Electrical	8	2	1	-	1	-	-	-	-
Mechanical	11	4	3	-	-	2	-	-	-
Met-Ceramics	5	1	1	-	-	1	1	-	1
Other	13	-	-	-	-	1	1	-	1
Science:									
Chemistry	10	-	-	-	-	-	-	-	2
Physics	5	-	-	-	-	2	-	-	-
Math-Statistics	2	1	1	-	-	-	-	-	-
Other	14	-	-	-	-	-	-	-	-
TOTALS	74	10	7	0	1	7	2	1	4

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TABLE IV. Exempt Transfer Cases

	<u>February</u>	<u>January</u>	<u>Total</u>
Active cases at <u>beginning</u> of month	28	23	
New cases: Initiated by employee	1	2	3
Initiated by management*	3	5	8
Cases reactivated	<u>32</u>	<u>30</u>	
Cases closed: Transfers: Within HLO	2		2
Within HAPO			0
Other GE			0
Withdrawn		1	1
Terminated		<u>1</u>	<u>1</u>
	<u>30</u>	<u>28</u>	<u>4</u>
Active cases at <u>end</u> of month	30		<u>30</u>
Total cases - January 1, 1958 to date (includes 23 cases initiated prior to and active on 1/1/58)			34

Initiated by employee 13

Initiated by management* 21

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

TABLE V. Union RelationsGrievances Processed - January 1, 1958 to date

Total processed 9 (includes 1 non-unit grievance)

Step I

Answered satisfactorily* 4
Pending time limit 1**

Step II

Pending Step II discussion 0
Pending Step II answer 1
Answered
Satisfactorily*** 1
Pending time limit 2
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.

** Non-unit grievance

*** 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 REPORTPersonnel

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

General Accounting Operation

A request for forecasts of the distribution of nuclear materials outside production channels was submitted to HLO custodians. The request incorporated new requirements outlined in AEC Manual Chapter 7450. HLO custodians of nuclear materials were informed of SS Materials Survey 15, Part III and asked to submit data necessary for planning and scheduling the inventory. An AEC report concerning findings of SS Materials Survey 15, Part I was reviewed and an answer to portions applicable to HLO was forwarded to SS Accountability.

We were informed by Contract Accounting that a special report on AEC requests for services and information formerly required by the General Manager was being discontinued since reports issued to date did not indicate that a significant amount of time and effort was being expended for this purpose. HLO Level 3 Managers were so notified.

Coincident with the promotion of one BTC recruit to an exempt position in Relations and Utilities Operation, all other BTC recruits in HLO Financial were reassigned in order to further their on-the-job training.

An agreement letter documenting Commission concurrence to our fabricating Pu-Al fuel elements for the MTR at Arco was prepared and subsequently received Commission approval. This letter agreement contained an estimate of the total cost of the job which has since proven to be substantially below more recent calculations. Accordingly an addendum to the letter has been prepared and is in the process of being submitted to the Commission which requests additional funds in the amount of \$60,000. We are also in the process of formulating a letter to the Commission covering the fabrication of U-233 fuel elements for the MTR. A letter was received from the Commission authorizing this work at a maximum cost of approximately \$127,000; however, it appears that this estimate will also prove to be too low. The letter is now being drafted to the Commission which will increase the amount of the estimate.

Funds remaining for the purpose of attending offsite courses and seminars were allocated to level 3 components. Because of the limited amount available, some components received no money for this purpose.

We have been informed that an increase in the per diem allowance to \$11 per travel day has been negotiated with the Commission. It is our understanding that this increase will be retroactive to January 1, 1958. No action will be taken to implement this change until such time as a modification to Appendix "B" of the Prime Contract can be prepared.

Project proposals recommended for approval were:

High Level Radioactive Material Receiving and Storage	
Addition - 327 Building	\$325,000
321 Building Test Pit Enclosure	19,000

Appropriation requests receiving final approval during the month included:

57-HL5-93	3 Amplifiers 1 Oscillograph	\$ 700
58-HL7-51	Electrical Resistivity Measurement Apparatus	4 000
58-HL5-52	Oscilloscope & Accessories	3 300
58-HL5-53	1 Oscillograph Recorder, 2 Amplifiers	3 200
58-HL7-54	Vacuum Creep Testing Units	37 000
58-HL5-55	Neutron Flux Recording System	3 200
58-HL6-56	Air Sample Counter	2 500
58-HL7-57	Furnaces and Glove Box	22 000
58-HL6-58	2 Pulse Type Reading Device	<u>3 000</u>

Total Value Approved	<u>\$78 900</u>
----------------------	-----------------

CPD transferred \$6,500 of 3000 Program equipment funds to HLO to cover a portion of the cost of a special contour machine.

IPD transferred \$10,000 of 2000 Program equipment funds to HLO to cover additional charges on vacuum creep testing units.

An appeal was made to Contract Accounting for \$159,000 of additional funds for 2000 Program equipment to prevent curtailment of vital research and development activities for the balance of FY 1958. To date \$55,000 has been received from Contract Accounting and other HAPO Departments are reviewing their position to determine if additional funds can be made available.

Preparations are being made and a procedure will be issued for taking a physical inventory of shop stock material in the custody of Technical Shop Operation. The inventory is scheduled for April 5, 1958 and the physical count will be adjusted to reflect quantities on hand as of that date.

In connection with the annual physical inventory of uninstalled cataloged equipment, Missing Plant and Equipment Reports have been received from all HLO components except Chemical Research and Development Operation. We have been assured that all reports will be received during the first week of March 1958, at which time a Property Disposal Request will be prepared by Property Accounting for all HLO missing equipment and a summary report of findings issued.

The monthly HLO depreciation costs by Level 3 operation were revised and Cost Accounting was provided a revised schedule based on December 31, 1957 plant and equipment asset balances. This schedule is used by Cost Accounting in allocating depreciation costs incurred by HLO to the three product departments, IPD, CPD, and FPD.

Effective March 1, 1958, Property Accounting will assume responsibility for affixing identification tags to all HLO uninstalled cataloged equipment. This change in procedure will, we believe, result in (1) some improvement in the control of equipment, (2) assurance that tags are being affixed securely, and (3) more uniformity in affixing tags for expediency of physical inventories.

IBM listings were provided each property control custodian and/or property representative of all assigned uninstalled cataloged equipment. It is our intention to provide these listings on a quarterly basis for use as a check-list for periodic physical inventories and for reference purposes as an aid to better control of equipment.

Cost Accounting Operation

Information received from the AEC indicates that funds for the Plutonium Recycle Program for FY 1958 will be less than that requested in the Midyear Review. Amounts to be included in the next Financial Plan for this program are as follows:

	<u>New Financial Plan</u>	<u>FY 1958 Midyear Review</u>
Operating Costs	\$3 300 000	\$3 563 000
Equipment	<u>400 000</u>	<u>500 000</u>
Total	<u>\$3 700 000</u>	<u>\$4 063 000</u>

The revised amounts for Plutonium Recycle Program represent a decrease in operating funds over those currently in the budget of \$263,000 and a decrease in equipment funds of \$100,000. In addition, the AEC specifically stated that funds cannot be transferred between operating and equipment funds without prior approval of Washington AEC. Detailed budgets will not be adjusted until March reporting; however, February reports will be footnoted to call attention to the decrease.

Work on the FY 1959 Revised Budget and the FY 1960 Annual Budget progressed during February. Following are February highlights of the budget preparation.

1. As a result of the preliminary review of personnel, the HAPO General Manager requested a special report showing employees assigned to Research and Development programs for the periods covered in the current budget preparation as compared to 6-30-57 and 12-31-57 actual. The purpose of the report is to provide changes in personnel assignments so that the appropriate level of personnel assigned to Research and Development can be determined for all of HAPO.
2. A study was made of HLO budgeted personnel for the two years to determine the number of personnel (including supporting services and administration) assigned to HLO programs. Contract Accounting will use this information in their study to allocate HAPO General Overhead to the various HAPO components on the basis of personnel assigned to end programs. It was determined that of the average of 1,166 employees in FY 1959 and 1,206 in FY 1960 that 29.7% and 32.5% respectively are applicable to HLO programs. The effect of this new method of allocating General Overhead on HLO programs will be determined shortly. Preliminary budget dollar amounts for HAPO General Overhead generated by HLO

components were also furnished Contract Accounting to use in their tentative HAPO General Overhead allocation for FY 1959 and FY 1960.

3. Inventory requirements for Special and Reactor Materials for FY 1959 and FY 1960 were scheduled to be submitted March 14, 1958; however, the AEC requested the information be provided by February 21, 1958. HLO requirements were informally submitted by this date. Final submission will be on or before the original due date of March 14, 1958.
4. Authorization for CPD and FPD sponsored research and development and process technology funds are shown below. IPD amounts have not been confirmed formally; however indications are that they will be the same as FY 1958 authorizations plus an escalation of 7% for each fiscal year.

	<u>FY 1959</u>	<u>FY 1958</u>
<u>Fuels Preparation Department</u>		
(includes General Overhead)		
Research and Development		
Metallurgy - Category I	\$1 008 000	\$ 930 000
Metallurgy - Category II	549 000	507 000
Process Technology	100 000	130 000
	<u>100 000</u>	<u>130 000</u>
Total FPD Authorization	<u>\$1 657 000</u>	<u>\$1 567 000</u>
 <u>Chemical Processing Department</u>		
(Excludes General Overhead)		
Research and Development		
Separations Development (HLO		
"free" money)	\$ 331 000	\$ 303 000
CPD - Separations Development	949 000	1 166 000
Separation of Non-Production Fuels	929 000	408 000
Nuclear Materials Management		23 000
Weapons	149 000	66 000
Process Technology		
2000 Program	281 000	391 000
3000 Program	66 000	71 000
	<u>66 000</u>	<u>71 000</u>
Total CPD Authorization	<u>\$2 705 000</u>	<u>\$2 428 000</u>

Corresponding FY 1960 authorizations will be derived through mutual agreement on an escalation factor to apply to FY 1959 amounts.

Meetings with Level 3 and 4 Managers for budget approvals have been held for Financial, Employee Relations, Radiation Protection, and Laboratory Auxiliaries Operations. Approvals were obtained from all Level 3 and 4 Managers with the following results (Midyear Review shown for comparison):

	<u>Midyear Review</u>	<u>FY 1959</u>	<u>FY 1960</u>
Financial	\$ 467 000	\$ 494 300	\$ 522 800
Employee Relations	270 000	281 100	297 600
Laboratory Auxiliaries	3 144 000	3 490 100	3 572 400
Radiation Protection	2 136 000	1 977 500	2 049 000

Amounts for Buildings and Utilities budget included in Laboratory Auxiliaries are as follows:

Midyear Review	\$1 003 000
FY 1959	1 194 000
FY 1960	1 135 000

The AEC has requested that maintenance programs and associated costs be submitted for the ensuing fiscal year as supplementary information at the time annual budgets are submitted. A study of the first six months, FY 1958 actual equipment and building maintenance cost has been prepared and submitted to the HLO Level 3 Managers as an attachment to an instruction letter requesting maintenance estimates for FY 1959. The instruction letter set forth definitions, requirements, and approvals as outlined in AEC Manual, Chapter HA-5401.

A new study using Midyear Budget Review data, has been completed for the allocation of HLO depreciation to end-functions and to product departments for customer work, assessments and process technology. Total depreciation has increased from \$142 000 to \$149 000 a month. General Accounting provided current depreciation for each level three operation based on plant and equipment investment at December 31, 1957.

Cost commitment data were provided Reactor and Fuels R & D management pertaining to those purchase orders in excess of \$4 000, contracts and zirconium metal and fabrication orders which are expected to be costed by June 30, 1958. Commitments included in the report totaled \$405 000 of which \$270 000 will be charged to Plutonium Recycle Research and Development and of this amount \$153 000 represents zirconium metal and fabrication.

Personnel Accounting Operation

Effective with the month of January 1958, absenteeism and overtime reports formerly furnished for Level 4 components were eliminated and only over-all reports by Level 3 components were issued. The graph formerly issued on absenteeism was expanded to include expected and actual percentages of absenteeism for non-exempt female and male as well as all employees.

Overtime control levels for 1958 have been established for each of the Level 3 components at HLO. These control levels are to be in effect for calendar year 1958, thereby eliminating quarterly forecasts and quarterly consolidations by Personnel Accounting.

One employee of the Hanford Laboratories Operation on lay-off status requested an emergency loan of \$300. Upon receipt of completed application for loan, promissory note, and consent of wife, a check in the amount of \$300 was issued payable to this employee.

Procedures

A procedural study has been undertaken at the request of Facilities Engineering Operation to design a detailed maintenance record system for building equipment. The data system will provide a basic inventory of this equipment and current information as to cumulative maintenance done on integral portions of installations in each building. The procedures are being designed to meet the needs of this group using, insofar as possible, data and records now available in Property Accounting and FPD Maintenance.

Extensive efforts were made in a study of all personnel records existing in the Laboratories. Records maintained in Personnel Accounting, Employee Relations, HLO, and Employee Relations, R & UO have been identified and defined. Recommendations are being prepared of ways to achieve improved coordination and consolidation of these records.

A report was prepared for the Procedures Specialist, Computer Department, defining our current forms control program at HAPO. Information was included as to review procedures, form and functional classification systems, and record keeping methods used.

Arrangements were made for a demonstration which was held by representatives of the Columbia Ribbon & Carbon Manufacturing Company exhibiting their new transograph duplicating process. This process is an improved spirit duplicating system using new type masters and fluid, thereby eliminating a large portion of the smudging and staining formerly present with this method of reproduction. Further testing of this process is currently underway on duplicating equipment used in CEO Financial Operation.

An inquiry was made to W. H. Leavitt, Office Procedures Service, in an effort to define existing Company policies with regard to the management of financial records. A study is presently underway at HAPO to set-up complete retention and destruction schedules for all such records; information received from Office Procedures Service will be used to implement this study.

Beginning with January, 1958, summary statistics are being accumulated of forms control activities. Number of orders for forms processed is being noted as well as whether these orders are for new, revised, reordered, or eliminated forms. Estimated savings in the reproduction, stocking, and handling of forms is also being stated. As these statistics are accumulated, an indication of the total activities of this function will be supplied.

Evaluations are being made in conjunction with Procedures Specialists in other components of the potential clerical and time savings of consolidated weekly and monthly payroll preparation. Using this system one EDPM program and pay period may be used, for example. This procedure has been adopted in other Company components with success; investigations will determine its feasibility at HAPO.

A total of eight suggestions were evaluated by Financial Operation during the month, of which two were submitted by Financial employees. One suggestion in the latter category is awardable.

Auditing

The Administrative Services audit report was issued on January 31, 1958. Field work on the Physical Inventories audit is over one-half complete and the report was scheduled by the end of February.

No exceptions were found in the February 14, 1958 count and reconciliation of the HLO cash fund.

Measurements

A narrative outlining the status of measurements in Hanford Laboratories has been prepared. This will be used in conjunction with discussions with management.

Payroll StatisticsNumber of HLO Employees
Changes During Month

	<u>Total</u>	<u>Exempt</u>	<u>Non-Exempt</u>
Employees on Payroll at Beginning of Month	1 125	506	619
Additions and Transfers in	11	2	9
Removals and Transfers out	(7)	(2)	(5)
Transfers from Exempt to Non-Exempt	-	-	-
Employees on Payroll at End of Month	<u>1 129</u>	<u>506</u>	<u>623</u>

Overtime Payments During Month

	<u>February</u>	<u>January</u>
Exempt	\$1 220	\$1 232
Non-Exempt (five weeks in January)	<u>7 903</u>	<u>4 528</u>
Total	<u>\$9 123</u>	<u>\$5 760</u>

Gross Payroll Paid During Month

Exempt	\$386 609	\$385 017
Non-Exempt (Five weeks in January)	<u>262 478</u>	<u>327 500</u>
Total	<u>\$649 087</u>	<u>\$712 517</u>

Participation in Employee Benefit
Plans at Month End

	<u>Number Participating</u>		<u>Percent Participating</u>	
	<u>February</u>	<u>January</u>	<u>February</u>	<u>January</u>
Pension Plan	1 127	1 121	98.5	98.4
Insurance Plan				
Personal Coverage	1 173	1 172	99.7	99.6
Dependent Coverage	740	733	-	-
U.S. Savings Bonds				
Stock Bonus Plan	693	682	61.3	60.6
Savings Plan	92	84	8.2	7.5

Insurance Claims
Employee Benefits

	<u>February</u>		<u>January</u>	
	<u>Number</u>	<u>Amount</u>	<u>Number</u>	<u>Amount</u>
Life Insurance	0	\$ 0	0	\$ 0
Weekly Sickness & Accident	17	1 197	13	973
Comprehensive Medical	54	4 005	102	6 943

Dependent Benefits

Comprehensive Medical	105	7 186	127	9 722
	<u>176</u>	<u>\$12 388</u>	<u>242</u>	<u>\$17 638</u>

Good Neighbor Fund

	<u>February</u>	<u>January</u>
Number participating	725	722
Percent participating	64.2	64.2

Other Statistics

Travel

	<u>No.</u>	<u>February</u>	<u>No.</u>	<u>January</u>
Accounts Outstanding at beginning		\$21 071		\$ 7 043
Charges:				
Cash issued - by checks	21	4 595	32	8 124
by currency	44	10 965	51	13 392
Other - (Billings from other GE Components, moving expense etc.)		2 794		2 555
		<u>39 425</u>		<u>31 114</u>
Less:				
Expense vouchers processed				
Travel expense accounts	66	15 415	23	5 832
Other (moving expenses, conference expense, etc.)	9	1 516	9	675
Refund of advances	56	5 084	44	3 765
Billings to and from HAPO Components - Net		77		(229)
		<u>22 092</u>		<u>10 043</u>
Accounts outstanding at close	51	<u>\$17 333</u>	56	<u>\$21 071</u>
Ages of accounts outstanding				
15 days or less	44	\$14 686	50	\$18 346
16 - 30 days	6	2 332	4	2 485
More than 30 days	1	315	2	240
		<u>\$17 333</u>		<u>\$21 071</u>

Schedule of Non-Reimbursable Expenditures

Travel and Living Expense Variation
Conference Expense and Other

February

\$ 274
46
\$ 320

January

\$ 105
-0-
\$ 105

Activity in Cash Working Fund

Balance beginning of period
Cash disbursements
Replenishments to Fund

\$ 5 000
(10 965)
10 965
\$ 5 000

\$ 5 000
(13 392)
13 392
\$ 5 000

W. Sale
W. Sale
March 11, 1958

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INVENTIONS OR DISCOVERIES

All persons engaged in work that might reasonably be expected to result in inventions or discoveries advise that, to the best of their knowledge and belief, no inventions or discoveries were made in the course of their work during the period covered by this report except as listed below. Such persons further advise that, for the period therein covered by this report, notebook records, if any, kept in the course of their work have been examined for possible inventions or discoveries.

INVENTORTITLE OF INVENTION OR DISCOVERY

R. Bcrasky

Improved Specimen Screen Holder for RCA
Electron Microscope.

W. G. Spear

A Combined Alpha-Beta-Gamma Detector Probe

C. G. McCormack

Crash Valve

R. L. Brandt

J. Dunn

Sealed Internal Bearing Deepwell Turbine
Pump
_____UNCLASSIFIED

END

**DATE
FILMED**

11 / 24 / 92