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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
NOVEMBER, 1958

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By Authority of

CB-PH-2
Robert M. Gen 4/6/92
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Compiled by
Operation Managers

December 15, 1958

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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TABLE I. HLO FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE November 30, 1958

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	At close of month		At beginning of month		Additions		Separations	
	Exempt	NonExempt	Exempt	NonExempt	Exempt	NonExempt	Exempt	NonExempt
Chemical Research and Development	122	95	217	123	96	219	1	2
Reactor & Fuels Research & Development	169	114	283	163	110	273	7	1
Physics & Instrument Research & Development	64	26	90	63	26	89	1	0
Biology Operation	36	43	79	36	43	79	0	0
Operation Res. & Syn.	14	3	17	14	3	17	0	0
Radiation Protection	34	99	133	34	99	133	0	4
Laboratory Auxiliaries	45	181	226	45	181	226	1	3
Financial	16	33	49	16	32	48	0	0
Employee Relations	48	28	76	54	29	83	1	1
Programming	15	4	19	15	3	18	0	0
General Totals	564	628	1192	564	624	1188	15	11
Totals excluding internal Transfers	564	628	1192	564	624	1188	8	8
Composite Separation Rate								1.8456
Separation Rate (based on separations leaving G. E.)								.3355
Controllable Separations Rate								.0000

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BUDGETS AND COSTS

Costs for November were \$1,555,000 an increase of \$77,000 over the month of October. Fiscal year to date costs are 36% of the budget which reflects an increase of \$625,000 in NPR authorizations received from IPD during the month.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

Penetration of uranium through M-388 slug jackets during autoclaving at 300 C to 360 C is much slower than laboratory diffusion studies at these temperatures would predict.

Three, seven-rod clusters of co-extrusion Zircaloy-clad uranium have been successfully irradiated for more than a month in the 3x3 ETR test loop.

Autoclave and loop tests at 300 C of intentionally defected Zircaloy-2 co-extrusion clad rod fuel elements show a uniform failure pattern for a given type of defect.

A cold extrusion billet consisting of a Zircaloy-2 housing and a uranium billet was produced by direct casting of uranium into the billet housing.

Recent experiments show that autoclaving of Zircaloy process tubes can be done at low steam pressures with significant savings in equipment costs and procurement time.

Four new KER Zircaloy process tubes have passed inspection at the vendor's site and are in transit to HAP0 for final inspection and non-destructive testing.

A new high temperature graphite experiment is operating in the MTR with four samples controlled at 750°, 750°, 975°, and 1050° C. Discharge is scheduled for early February 1959.

Attenuation tests with ferrophosphorus concrete at 100 C have been completed.

A four-rod Al-Pu cluster is under irradiation in a KER loop, and a seven-rod cluster test, with high temperature coolant, is in preparation.

Aluminum has been air injection cast into an eight-mil wall, 1/2-inch diameter stainless steel tube, 78 inches long. The resulting bond between the aluminum and the steel withstood five cycles from room temperature to 450 C.

Rod straightening of Zircaloy jacket tubing over a stainless steel mandrel, reduced the variation in inside diameter to one mil, from five mils.

Rapid heating of Zircaloy-2 clad UO_2 prior to hot swaging has been performed by resistance heating.

Columnar grains have been developed in UO_2 heated in a tungsten filament furnace at temperatures below the melting point.

An 18-inch long, seven-rod cluster of swaged UO_2 in Zircaloy-2, and an eight-foot long unit consisting of the inner seven rods of a nineteen-rod cluster were charged into the KER loops.

Sample PRTR Zircaloy process tube flanges were tested at 300 C and in every case the tube burst at approximately four times the proposed operating pressure without damage to the flange.

PRTR Phase I construction is 45% complete versus 56% scheduled. Phase II construction is 30% complete versus 35% scheduled. The PRTR Phase III contract was awarded to Shaw and Estes for \$1,587,000. Phase II-A (PRTR River Structure) construction has started.

As a result of a study by APED, a fission gas detector system has been selected for PRTR rupture detection.

Design of the PRTR Fuel Element Examination Facility shielding and services is 80% complete.

PFFP over-all construction is 48% complete; design is 85% complete. PFFP Phase II construction is 46% complete versus 43% scheduled.

2. Chemical Research and Development

Further laboratory tests confirmed that dichromate addition to the Purex HA Flowsheet prevented loss of neptunium to the aqueous waste, but also confirmed the deleterious effect on gamma decontamination. Means of eliminating or circumventing this secondary effect are being studied.

Other tests confirmed the feasibility of using dichromate to effect neptunium extraction in rework processing of the plant 3WB stream.

Batch countercurrent runs completed during the month demonstrated satisfactory extraction of neptunium in the Redox HA column when the extraction section was operated at slightly higher acidity.

A series of semiworks scale experiments under "standard" Redox conditions and with Niflex or Darex feeds prepared from irradiated uranium has been completed at Oak Ridge National Laboratories. Preliminary data indicate adequate Redox column capacity and satisfactorily low waste losses. However, the ruthenium decontamination obtained is of major concern for the acid Non-Production Fuels type feeds.

Laboratory and pilot plant Darex dissolution studies further defined the conditions necessary for satisfactory feed preparation from stainless steel elements. Similar Zirflex studies are under way on Zircaloy-clad elements. The fabrication of a Hastelloy-F pilot plant dissolver and condenser is essentially complete except for heat treatment. Preliminary results indicate that Hastelloy-F may be suitable for Darex conditions as well as for Zirflex, Sulfex, and Niflex feed preparations.

A number of expository experiments were conducted on the dissolution of uranium-molybdenum alloys.

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Studies were continued to confirm the feasibility and further define conditions for the thorium-228 removal from uranium-alloy systems. This application of a potassium-aluminum chloride pyrochemical extraction offers an effective way to decontaminate the U-233-aluminum alloys to permit lower level fuel element fabrication.

Redesign of the sample turret of the x-ray spectrograph has given a considerable improvement in the sensitivity of detection of light elements. Service applications of controlled coulometer direct assay of uranium and plutonium in dissolved, irradiated metal confirmed that the new method was considerably faster, resulted in less analyst radiation exposure, and was at least as accurate as previous methods.

A sensitive transistorized amplifier-chronometer was designed and assembled for detecting the initiating shot and then recording the time for surface wave and reflected waves to reach a geophone. Such seismic techniques, if feasible, could furnish much needed definition of many features of the underlying strata.

3. Physics and Instrument Research and Development

For the NPR, PCTR measurements have begun to "check out" a lattice containing a seven-rod cluster of 0.926-inch rods. A feasibility study of a hot pressurized exponential assembly to support the NPR Program was started. For the longer-range Production Reactor Program exponential pile measurements continued on a large solid fuel element (1.92-inch diameter).

Nuclear safety work on non-production fuels has succeeded in fixing the maximum "always safe" quantity (minimum critical mass) of 3% enriched rods of 0.926-inch diameter by two separate experimental techniques which gave closely agreeing results. PCTR measurements were continued to obtain similar information for handling oxide powder at this enrichment. Experiments were begun to determine the nuclear safety requirements for handling 1.25% enriched I and E fuel rods.

In the Plutonium Recycle Program a study was made of nuclear safety requirements for handling Pu-Al alloy fuel elements from the PRTR. According to the study, a single slug bucket containing chopped up elements will be subcritical.

The large-scale sampling planned for the AEC-Air Force cooperative atmospheric physics program will be feasible only if automatic counting of particles trapped on filters can be used. Field testing of an improved version of our recently developed particle counter has shown greatly improved reliability as compared to the initial model.

Additional construction materials for the body monitor were tested for radioactivity by Radiological Physics Operation.

Satisfactory progress was made on the many development projects in the instrument field, among which were: Use of scintillation detection on portable survey instruments, portable dose rate integrator, air monitoring and the dog counter.

4. Biology

Activity densities in all wildlife forms continued unchanged except for rodents, where the thyroid activity rose from low levels to those prevailing a year ago, and whitefish, where local migration also raised last month's low values.

Like Pu and some other elements, Zn^{65} is absorbed from the stomach and intestinal tract of young rats (two weeks old) about five times more than older rats.

Grass irrigated by a sprinkling system with Columbia River water contained more Zn^{65} than did barley irrigated with 100% effluent by application to rills. This may be of some importance in hazard control with the new limits that may be imposed. These measurements will be further checked.

There are three criteria for the valid use of the OR (observed ratio) for estimating Sr^{90} hazards. The first is that the OR must not be influenced by the environment. We have shown this does not hold in past work. The second is that the Sr and Ca must be thoroughly mixed. We have shown theoretically that this does not occur in some systems. The third requirement is that the OR should not change with time. We have theoretically shown that constancy is unlikely, and experimental evidence was obtained showing that it is lacking under several conditions.

In preliminary data, it appears that internally deposited plutonium decreases the survival time of rats following x-irradiation.

We believe we are the first laboratory to show that DTPA is effective in decreasing plutonium body burdens in rats when intragastrically administered. The dose used, however, was rather high.

The substance, erioglaucine, was tested in mice for its radiation protective effect. It appears that this substance is markedly effective.

5. Programming

A special study, performed at AEC request, was completed concerning the estimation of fuel value of plutonium isotopes in single pass burnup application. Study indicated the impossibility of applying simple formulas to characterize the fuel value of plutonium, this being a complex function of isotopic content and reactor physics parameters. In some reactor types examined, special situations were uncovered in which use of high exposure plutonium for enrichment leads to surprisingly long reactivity life times.

Formulation of the RBU code, in conjunction with American Standard personnel, was essentially completed. De-bugging is now in progress.

More elaborate calculations were made of expected PRTR plutonium fuel throughput rates. Results indicate that throughput rates based on previous calculations are materially lower than those which will actually be experienced.

A step-wise plan was defined for delivery of canned sections of irradiated PRTR fuel elements to the separations plant in standard buckets prior to the

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provision of the non-production fuels processing facilities. Chemical processing envisioned comprises use of the Zirflex process in the Redox plant. The processing of this fuel can be completed in accordance with the over-all schedule requirements without major additions of facilities.

The Task Force on Radiological Evaluation was organized. Initial studies got under way concerning the preparation of estimates of environmental radiation dose.

Technical and Other Services

A plutonium metal turning punctured the finger of a CPD employee who was known to have a deposition of about 5% of the MPBB. Excision of a small amount of tissue reduced the plutonium in the wound from 0.0072 μc to .0022 μc .

One case of plutonium deposition was confirmed as a result of an incident involving ruptured hood gloves in the 234-5 facility. The intake is probably less than 5% of the MPBB.

Release of I^{131} to the atmosphere averaged 12.3 curies per week presumably because of inadvertent processing of short cooled metal. The peak emission was 15 curies on November 13. There was no significant increase in vegetation contamination levels.

The development of a new computational scheme for the testing of hypothetical econometric models was completed during the month. This development should reduce the cost of this type of computation to 5 - 10% of the cost of previous methods.

Particular emphasis was placed during the month on the measurement of fuel element quality and the relationship between the measured quality and fuel element performance. An analytical program in this area has been prepared in collaboration with IPD and FPD personnel.

Appreciable progress has been made in revising the fuel element failure model to account for the presence of low exposure ruptures. The implications of this revised model are of great importance in the future prediction of rupture rates.

Statistical and mathematical assistance on 18 separate problems was given within HLO to other departments and operations. Of particular interest are formulas for constructing estimates of the parameters in a Gaussian plume concentration function, and the development of a mathematical theorem on the uniqueness of a particular class of functions of a complex variable. The latter provides a first step toward the better classification and interpretation of signals received from the eddy-current testing method for fuel elements.

There were 16 authorized projects (exclusive of PRTR and PFFP) at month end with total authorized funds of \$6,402,400. The total estimated cost of these projects is \$8,656,500. Three projects were completed during the month and one new project was authorized. There are no new projects awaiting AEC approval. Project proposals for eleven new projects are in preparation.

A compilation of instructions from HOO on the classification of NPR is being readied for distribution to the field.

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The volume of emergency work requests in the Technical Shops increased substantially during the month. Part of this increase is due to normal delivery dates being extended because of increased work load.

Supporting Functions

The FY 1959 Midyear Budget Review was completed during the month and submitted to Contract Accounting for HAP0 consolidation. HLO has requested \$20.9 million, an increase of \$936,000 over our last budget. Major increases were \$460,000 for PRP and \$675,000 for NPR.

The annual physical inventory of Reactor and Special Materials was completed during the month. Total value of the physical inventory was \$716,089 compared with a book inventory of \$716,404.

Final results of the Good Neighbor Fund indicates annual contributions have increased 90.8% during the campaign; total participation increased 3.9%.

HOO-AEC obligated additional funds under our contract during November for Washington Designated Programs in the amount of \$275,000. Total funds now authorized for Washington Designated Programs amount to \$500,000 which fulfills our request for FY 1959 funds.

At month's end, the staff of the Hanford Laboratories Operation totalled 1192 employees, including 564 exempt and 628 nonexempt employees. There were 479 exempt employees possessing technical degrees, including 270 B.S., 105 M.S. and 104 Ph.D.

There are currently 24 open nonexempt requisitions. Twelve of the requisitions were received during the month and 12 vacancies were filled.

The Company prepared a new proposal to the HAMTC in an attempt to settle the points in dispute in the Wonacott case. It is expected that the proposal will be ready for submission to the Council early in the coming month.

One grievance was received during November. It was submitted by a Radiation Monitor claiming final contamination survey work had been assigned to women laundry workers. The Step I answer was not satisfactory but the grievance is considered settled at Step I due to expiration of the time limit.

Grievances processed since January first now total 28, including 3 non-unit grievances: 19 were answered satisfactorily at Step I, 8 at Step II, and one is pending time limit at Step II.

The arbitrator's decision in connection with the Maki case has not yet been given. During the month, 18 Athena, Oregon, science students toured HLO facilities.

The preliminary sign up for Savings and Security Program was conducted during November. Enrollment statistics for the 1,058 eligible employees who were on the active payroll on November 30, 1958 are as follows:

	Exempt	Nonexempt
Eligible	564	494
Enrolled	558	441
Revocation	4	51
*No Return	2	2

*Absent because of vacation, illness, or business trip.

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K. N. Burnham, a Field Clerk in Laboratory Auxiliaries Operation, retired optionally as of December 1.

An offer was extended to one Ph.D. and one Ph.D. rejected our offer. In addition, employment offers were extended to four experienced BS/MS candidates: Four accepted and three were placed on the roll. HLO accounted for two offers, one acceptance and one placed on the roll, bringing the total HLO experienced BS/MS acceptances for the recruiting year to date (9-1-58 to date) to ten.

Thirty-two Technical Graduates remain on the Program. It is apparent that critical shortages are developing in several areas and every attempt is being made to fill these with mid-year graduates.

Laboratories personnel worked a total of 169,593 man-hours during the month with no disabling injuries. Since September 1, 1956, a total of 5,084,060 man-hours have been completed with no disabling injuries. The medical treatment frequency for November was 1.12 as compared with 1.64 during October.

There were 2 security violations during the month, bringing the total for the calendar year to 44.

Paul F. Gast

for Manager,
HANFORD LABORATORIES

P. F. Gast:kss

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REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Waste Disposal of HNO₃-HF Etch Solution. The large volumes of solutions contemplated for use in etching pose a problem of safe disposal of depleted solutions. The fluoride ion is a poison and cannot be dumped into ground waters in large quantities. One proposed solution to the problem is to dump the etch solutions into a limestone (CaCO₃) bed. The acid will be neutralized by the carbonate with the evolution of CO₂, and the HF will be precipitated as CaF₂. This has been tried on a laboratory scale and found to be satisfactory. The CaF₂ forms as a fine precipitate which remains in suspension for several hours. CaF₂ is a naturally occurring mineral (fluorite), insoluble in water, and safe for disposal. No crust- ing over of the bed was observed, and the CaCO₃ remained active. In the operation of such a neutralizing bed, the flow should be from top to bottom, countercurrent to the gas bubbles. Care will be needed in piping design, so CaF₂ will not settle out and plug the system.

Gasless Etch Solution for Zr-2. The standard HNO₃-HF etch for Zr-2 evolves large quantities of NO and NO₂ as reduction products. The etch process half reactions are:

For the etching of PRTR and NPR Zr-2 tubes, gas generation inside the tube will interfere with the etching action. The gases are also toxic and irritating. An etching solution which releases little or no gas would solve these problems. The requirements for a Zr-2 etch solution are:

1. HF to attack the zirconium.
2. An acidic oxidizing agent to depolarize the cathode and attack the Sn, Ni, Fe and Cr in Zr-2.

The HNO₃-HF solution in current use meets these requirements. However, other solutions are possible. One solution is a mixture of HF, H₂SO₄, CrO₃, and H₂O. The reactions are:

With the proper concentrations of HF and CrO_3 the hydrogen reaction is suppressed and the depolarization reaction is the reduction of Cr^{+6} . The following solution has been found to produce a bright etch on Zr-2 with very little gas evolution:

CrO_3 - 100 g/l

HF (48% solution) - 10% by volume

H_2SO_4 (96% solution) - 3% by volume

H_2O - 87% by volume.

It should be emphasized that these concentrations are not optimized and that little corrosion data have been taken for Zr-2 etched with this solution. However, in one qualitative test, Zr-2 etched this way showed a good black film after 19 hours at 400 C, 1500 psi steam. It appears that this solution or some similar solution can be developed to provide a gasless etch solution for Zr-2 tubes. Solutions of this type will be just as corrosive to materials of construction as HNO_3 -HF. HF will be evolved slowly from all acidic HF solutions, so adequate ventilation will be needed but with a much lower capacity than that required by the HNO_3 -HF process.

Low Pressure Autoclaving of Zircaloy-2. If the corrosion resistance of Zircaloy-2 could be measured at pressures much lower than the 1500 psig normally used, great economies could be obtained, both in cost and lead time, for the autoclaves for testing the PRP and NPR tubes. Preliminary autoclaving tests at 400 C, 100 psig steam, appear to be as effective as tests at 400 C, 1500 psig steam. The 100 psig steam tests showed up poor surfaces, defective welds, corrosion prone zirconium, and acid stained material just as well as a parallel 1500 psig test.

Dynamic Corrosion of Aluminum. In August and September three-month dynamic corrosion tests in deionized water were started at 200, 250 and 300 C. The three dynamic systems operated off the same water supply, were adjusted to similar refreshment rates, and were fitted with identical test sections. These runs, therefore, provide an uncommonly good basis for evaluating the effects of temperature for this environment. The sampling schedule was designed in part to evaluate the replacement effect observed at Argonne and Chalk River. At these sites it has been observed that coupons, charged after the test is under way to replace samples withdrawn for analysis, are subject to higher corrosion rates than the original charge. The following table summarizes the pertinent data obtained here thus far in the Hanford tests.

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Time	Corrosion at 250 C and 25 fps		Corrosion at 200 C and 7 fps	
	X-8001	M400	X-8001	M400
1 mo. original	1.80 mils	1.70 mils	0.53 mils	0.50 mils
1 mo. replacement (1)	1.89	1.86	1.23	1.28
1 mo. replacement (2)	1.62	1.63		
2 mo. original	2.37	2.27	0.88	0.80
2 mo. replacement (1)	2.18	2.21		
3 mo. original	2.73	2.61		

The replacement effect does not exist at 250 C, but may exist at 200 C. Some attempts have been made to interpret the dynamic corrosion rates in terms of the solubility of corrosion product at the three test temperatures. In all cases the rates were several times those predicted from solubility data. Large amounts of corrosion product in the form of flakes accumulate in the loop during a run. This tends to verify that an erosion effect rather than an anomalous high solubility effect is operative.

X-8001 AlSi Bond Test. A standard fuel element canned in an X-8001 jacket and AlSi bonded, was heated for four months at 350 C in water in an autoclave. The examination consisted of a qualitative test of the mechanical properties of the AlSi bond and a metallographic inspection of bond layer. Wafers about 3/8" thick were cut from the piece, one near each end and one near the center. The wafers were then cut into two semi-circular sections. The can was readily detached from the core with a pair of pliers showing complete failure of the metallurgical bond.

Metallographically polished sections of the bond layer showed a fairly uniform five-mil intrusion of an aluminum-uranium intermetallic compound, possibly UAl_3 , into the uranium. There was no indication at all of uranium diffusion into the aluminum jacket. The section also showed the can fit very closely to the core even though no metallurgical bond existed. The silicon-aluminum second phase was completely spheroidized. The oxide blisters toward the weld end of the can showed local attack of about five to six mils.

H-Reactor Rear Face Pigtaills

The recent failures of a number of austenitic stainless steel pigtaills on the rear face of H Reactor has caused concern as to the cause of failure. Operating data show an excellent correlation of the failures with increased flow in the pigtail caused by changes in the fuel element loading. Presumably the increased flow results in increased vibration of the pigtail.

An examination of several of the failed pigtaills shows the failures to be circumferential or longitudinal cracks. Some cracks extend through the wall and cause the pigtail to break in parts. Metallographic

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examination of three failed areas showed a branching network of transgranular cracks mostly originating on the exterior. Cracks of this type are usually associated with stress corrosion. Dye checking and visual examination of several random pigtailed failed to reveal any cracks on the exterior surface. Chemical analysis of the scale on the outside of three of the pigtailed showed chloride concentrations of less than 0.03%. The possibility of highly localized concentration of chloride was not examined.

A new pigtail will be fatigue tested in reactor water to help determine the expected life of 304-L stainless steel in this service and the type of failure experienced.

Radiometallurgy Laboratory Studies

Radiometallurgy activities during the month in support of the 2000 Program have included a continuation of the examination of a 9900 MWD/T, U-Mg alloy slug (GEH-3-8); continued x-ray diffraction and tensile testing studies of low-temperature irradiated uranium; continued metallographic studies of Zircaloy-clad, uranium swelling capsules (GEH-3-31), and a stainless-steel-clad, 4-rod cluster from KER test K-3-2. Results and conclusions will be reported in detail in connection with the respective development programs.

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.

Low density plutonium has been fractured and examined in the electron microscope. Holes with diameters as small as 0.1 micron were detected; the holes were not distributed uniformly over the fracture surface but were concentrated in clusters. Electron microscope studies on plutonium are continuing.

One of a series of fractographic specimens of uranium dioxide has been fractured and replicated for electron microscopy after irradiation. Replicas of the fracture surface are being examined. The fracture surface of the specimen will also be ground, polished, etched, and replicated for supplementary metallographic studies. Similar studies on irradiated uranium specimens are also in progress.

Five specimens of uranium carefully precharacterized as to geometry, hardness, metallography, and x-ray diffraction line shapes have been encapsulated, and the five capsules containing NaK as a heat transfer medium are being autoclaved prior to shipment to the MTR. The capsules will be irradiated to various burnups at different irradiation temperatures.

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The deformation and ultimate fracture of a uranium microtensile specimen and a Zircaloy-2 microtensile specimen at 400 C have been photographed in the hot stage facility. The uranium deforms primarily by slip at this temperature, but extremely wide twins also form just prior to fracture. The 16 mm cine film records of these tests are currently being studied.

Recrystallization and Recovery of Zirconium Alloys. The kinetics of recrystallization and recovery in zirconium and Zircaloy-2 and Zircaloy-3 are being determined to establish optimum conditions of heat treatment during fabrication operations. Percent cold work, temperature, time, and heat treatment atmosphere have been selected as variables.

An apparent anomaly in the corrosion behavior of cold worked Zircaloy-2, heat treated in air and helium results in an "S" shaped curve for weight gain versus exposure time in 680 F water. This effect is suspected to result from reforming of the protective oxide after "breakaway" corrosion begins. All subsequent zirconium corrosion tests are to be visually inspected each time they are removed from the test autoclave. The appearance of the specimens will be reported along with the weight gain data, as an aid to interpreting their corrosion behavior.

Diffusion Studies. A knowledge of diffusion in various uranium/barrier metal/clad metal combinations is important in the design of fuel elements. An estimation of the maximum times and temperatures at which slugs could be run during tests in the KCR pressurized water loop without failure due to cladding penetrations will be required in the near future. Penetration into X-8001 cladding in AlSi bonded, depleted uranium slugs is now being studied. Eleven slugs have been autoclaved at various times and temperatures. Seven of these slugs have each been cross sectioned at three locations. Metallographic examination has shown that specific details of the diffusion zones in the slugs vary from one point to another. However, the major constituents of the diffusion zones are generally UAl_3 , which forms adjacent to the uranium, and a layered compound, probably USi_3 , which appears between the UAl_3 and the AlSi. Measurement of the diffusion zones in slugs autoclaved 21 days at 300 C, 28 days at 300 C, 14 days at 360 C, and 28 days at 360 C showed that the UAl_3 compound layer increased in thickness due to heat treatment. Penetration rates were much lower in these slugs than in laboratory diffusion couples annealed at the same times and temperatures.

Preferred Orientation in Zircaloy-2 Process Tubes. Preliminary examination of Zircaloy-2 process tubing has disclosed a crystallographic preferred orientation of the crystallites. Since a hexagonal close packed structure is anisotropic in physical and mechanical properties, the performance of the tubing under reactor conditions is directly related to the orientation of the grains. For tubing that was annealed after extrusion and then drawn to five percent cold work, the predominant orientation is an alignment of the (0001) basal planes parallel to the tube axis. These planes are aligned in this direction at the expense of the (1010) planes.

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Tubing drawn to 17.8 percent cold work appears to have a more complex type of preferred orientation. The (1120), (1013), and (1122) planes all have a greater than random population in a direction parallel to the tube axis, with the (0001) only slightly above random and the (1011) well below random.

Studies of annealed material show that preferred orientation persists but is somewhat altered after a heat treatment at 750 C for two hours. Pole figures for these materials are being obtained to completely describe the deformation and annealing textures.

Effects of Low Temperature Irradiation on the Properties of Uranium. The purpose of this test is to find the threshold of detectable neutron damage to uranium through a series of low temperature and short exposure irradiations. The specimens were irradiated in the snout facility at 105-KW to exposures ranging from 10^{15} to 10^{18} nvt or from 5×10^{-7} to 5×10^{-4} total atom percent burnup. Post-irradiation tensile, hardness, and annealing tests are being performed to determine the amount of damage induced and the ease of removal.

A statistical analysis reveals that the average Rockwell A hardness of uranium varies with exposure time at 2.2×10^{12} nv thermal flux according to the following relationship:

$$\bar{y} = 47.626 + 1.813 \log_{10} X$$

where $\bar{y}$ = average Rockwell A hardness at a particular irradiation time
X = irradiation time in seconds.

Taking into account all random variability of the data, one can be 95 percent confident that the true slope parameter (e.g., the coefficient "1.813" in the above equation) lies between 1.313 to 2.313. If the hardness plot is extrapolated to the zero time point, an incubation period of about two minutes before which no hardness change can be said to occur is indicated. Tensile data of the as-irradiated specimens also suggest a linear variation of the yield strength as a function of log exposure time. The average yield strength corresponding to one spike cycle was 37,500 psi compared to 26,800 psi for the unirradiated controls. An extrapolation of the yield strength to the zero time point indicates an incubation period between two and five minutes long.

Study of Irradiated Zirconium Alloys with Electron Microscopy and X-ray Diffraction. The effects of reactor irradiation on the microstructure and properties of zirconium alloys are being evaluated by studies of high resolution metallography, x-ray diffraction, hardness, optical microscopy, and damage annealing kinetics.

Pre-irradiation testing has been completed for five specimens of Zircaloy-2 representing each worked condition. These specimens were encapsulated for irradiation in a KER loop for an anticipated 3000 MWD/AT exposure at about 230 C. Charging is scheduled at the next shutdown.

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Recovery of Lattice Expansion in Irradiated Molybdenum. The study of the annealing kinetics of molybdenum irradiated to a cumulative neutron dosage of 2.3×10^{19} nvt has been completed. A final report (HW-57903) summarizing the results has been issued. Work is continuing on the x-ray diffraction characterization of damage in molybdenum irradiated to 10^{20} nvt. An annealing study of specimens irradiated to these higher levels is also in progress.

Creep in Cold Worked Zircaloy-2. The creep properties of Zircaloy-2 are considerably improved by small amounts of residual work. The extent to which increasing amounts of cold work improve creep properties and the effect of flow stress recovery occurring in the test temperature range is not known. These effects are to be determined in order that Zircaloy-2 fabrication conditions can be specified for process tubing. Long time creep tests in vacuum of Zircaloy-2 are being made with cold work, stress, and temperature as variables.

Five vacuum creep units have been installed and proof tested. During the month excessive vibration of the extensometer systems was observed. A modified vacuum pump mount was installed which eliminated the major portion of the vibration.

Flat Zircaloy-2 specimens with 15, 25, and 45 percent cold work were fabricated. These levels of work correspond to the amounts of residual work that may be introduced into tubing during fabrication.

Testing of Zircaloy-2 specimens will begin in the coming month.

Magazine Facility Irradiation of Zircaloy-2. A program of elevated temperature irradiations of zirconium and Zircaloy-2 tensile specimens in the KE magazine facility has been initiated. Zirconium tensile specimens 0.060" thick, approximately 3/8" wide, and 4-1/2" long, have been prepared and will be irradiated in small aluminum capsules, approximately 6" long and 1/2" in diameter. Each capsule contains five samples. Specimen temperatures to 300 C will be obtained by varying the heat transfer media surrounding the specimens. Two capsules will contain argon and will be irradiated in a CO₂ atmosphere. Two capsules will be sealed under vacuum and will be irradiated under reduced pressure in a magazine tube. A thermocouple, spot welded to the center sample, at the middle of the specimen, will be used to record the specimen temperature during irradiation. Dummy capsules will be irradiated for one reactor cycle. If temperatures of 300 C are obtained, the Zircaloy-2 irradiations will begin. At least 100 tensile specimens of Zircaloy-2 representing various degrees of cold work will be irradiated to total integrated exposures from 10^{19} to 10^{21} nvt. Tensile tests will then be performed at room temperature and at elevated temperature.

Zircaloy-2 Irradiations in the ETR. Information is currently needed concerning property changes in high strength materials which may occur under combined high temperature and high flux environments. An assembly containing seven annealed Zircaloy-2 tensile specimens has been prepared and is now being irradiated in the 3x3 Loop facility, exposed to the water at

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approximately 250 C. Two more assemblies, one containing seven specimens of 15 percent cold worked Zircaloy-2 and one containing seven 25 percent cold worked Zircaloy-2 specimens, have been fabricated. They will be charged with the next ETR fuel element irradiation.

New Fuel Element Development

Restraint of Uranium Swelling by Zirconium Cladding. The swelling behavior of unalloyed clad uranium operating with a cladding surface temperature of 250 to 350 C, and a maximum fuel temperature of 450 to 600 C is of importance for Hanford's fuel element development work. In order to provide such swelling data, five experimental capsules containing Zircaloy-2 clad coextruded uranium fuel rods have been fabricated and shipped to the MTR and ETR for irradiation.

Post-irradiation metallographic examination of GEH-3-31, the first of the above fuel rods to be irradiated, shows no unusual features in the irradiated uranium core. The uranium-zirconium bond is intact. GEH-3-32, presently undergoing irradiation in the MTR, has approximately one-half of the 3500 MWD/T goal exposure. The center uranium core temperature has averaged about 420 C. The central uranium temperature of GEH-3-57, charged in the ETR on October 31, increased during its first reactor cycle from 550 C to 604 C. GEH-3-58 was charged in the ETR on November 22, but no uranium temperature measurements have been received.

In order to determine the dependence of fuel element swelling upon cladding and uranium temperatures, cladding thickness, and exposure, a series of capsule irradiations in Hanford reactors is planned. An initial capsule was irradiated to verify the physics and heat transfer calculations. This verification must be obtained before the remaining capsules can be assembled. The ratio of measured to calculated temperatures was approximately 0.7 during the first two-thirds of the irradiation and approximately 1.1 during the final one-third.

This difference may be caused by time dependent changes in thermal conductivity of the capsule or changes in the reactor flux distribution. An attempt is now being made to correlate the effect of reactor control rod movements and discharge of poison columns on the front-to-rear flux distributions. Radiometallurgy examination of the capsule will be made to determine whether any apparent changes have occurred that would affect its thermal conductivity.

Rod Cluster Fuel Elements. Three, 7-rod cluster coextruded fuel elements (Zircaloy-clad uranium metal) have been operating satisfactorily in the GEH-10 loop facility during the past month. Outlet coolant temperature reached 280 C while the fuel was operating at 70 kw/ft. This specific power was 25 percent lower than expected due partially to 4.8 kg of cobalt which was charged around the fuel. Goal exposure for this irradiation is 1500 MWD/T.

Four stainless steel clad rod cluster fuel elements, being irradiated in a K-through hole facility, have reached an exposure of 2500 MWD/T. Goal

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exposure for this irradiation is 3500 MWD/T. All thermocouples are operating satisfactorily and indicate that the fuel is operating at 86 kw/ft with a maximum core temperature of 270 C. The bond coefficient for heat transfer between the uranium and stainless steel interface is calculated to be 3800 BTU/hr/ft²/°F. Rod cluster fuel elements are being tested in KER Loops 1 and 3. The objective of the Loop 1 test is to determine the operating characteristics of a Zircaloy-2 clad 7-rod element with close packed rods. The inter-rod spacing between elements is 0.050". Rod warping will be measured in the Loop 3 test which consists of two- and three-foot long Zircaloy-2 clad coextruded uranium rods. Both tests have accumulated about 900 MWD/T. Goal exposure is 1000 MWD/T.

Four, 7-rod cluster fuel elements one foot in length and one, 3-rod cluster fuel element three feet in length have been fabricated and will be charged into the LER Loop 3 facility during the next reactor outage. The 7-rod cluster fuel elements were fabricated from Zircaloy-2 clad coextruded fuel rod containing 1.6 percent enriched uranium. The 3-rod cluster fuel element was fabricated from coextruded rod with integral end closures made during the extrusion. This test will determine the dimensional stability of such fuel rods during high temperature irradiation.

Components for eight, 7-rod cluster fuel elements, four with 20-mil jackets, and four with 30-mil jackets, have been fabricated. These fuel elements will be assembled and delivered to the reactor for charging into the KER Loop 1 facility early in December. Two additional fuel elements, one with a 20-mil jacket and one with a 30-mil jacket, will have two rods purposely defected and exposed to 300 C water in ex-reactor flow loops.

Coextruded Zircaloy-2 Clad Uranium Fuel. Testing to determine the behavior of coextruded Zircaloy-2 clad uranium fuel, defected, and exposed to high temperature water is being conducted. Simulated failures have been produced at 300 C in an induction heated autoclave and loop. The tests made to date on side-defected and end-defected 0.630" diameter "as-extruded" rod, with unbonded end caps, indicate a fairly uniform behavior pattern for a given type of defect. There appears to be a varying incubation period before the onset of failure and a varying rate of uranium corrosion under identical test conditions. This may be related to partial plugging of the defect holes.

Rod and Tube Fuel Element. A tubular type fuel element is one candidate proposed for the Hanford NPR. Nuclear Metals, Inc., has coextruded Zircaloy-2 clad uranium tubes with close tolerances on the diameters, clad thickness, and straightness. Two, 3-foot length rod-and-tube fuel elements were built for tests in the Hanford KER loops. The fuel tubes are 1.785" OD x 1.380" ID with 0.030" thick clad. The diameter of the fuel element including tube supports is 2.025 ± 0.005". Supports are spaced 90° apart around the tube circumference at one-foot intervals. Sixteen supports are required for each element. During the month two elements were charged into KER Loop 4. Some of the variables being studied in Loop 4 are: end closures (welded and integral closed), heat treatment

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(salt bath and vacuum beta transformation), end cap type (flash welded and relief welded designs). The two elements are generating 360 kw for a specific power of 60 kw/ft. This corresponds to a power density of 11.4 w/gm or an effective flux in the fuel element of 3.3×10^{13} neutrons/cm²/sec. The maximum clad surface temperature is 270 C. Goal exposure is 1000 MWD/T.

Length Limits on Vertical Fuel Elements and Mechanical Design of End Caps. Vertically supported fuel elements have length limitations which depend upon the position of the support, the number of horizontal guides, and the details of the end supports. A rough draft report, HW-58248, was written which describes some of the mechanical length limits due to support of the fuel element's weight, and their effect on the end cap design. Since end cap design must be given special consideration in both horizontal and vertically supported fuel elements, two mechanical tests were proposed. A program for actual design of specimens and testing apparatus for one mechanical test method have been started.

Contact Conductance of Fuel Element Materials. Thermal contact conductance work was summarized in a topical report, "Contact Conductance of Fuel Element Materials," prepared for presentation at the Fifth Nuclear Congress. The conductances of most contacts are approximated by the following formula:

$$h_t = 0.04 \left(\frac{P}{Y} \right)^{0.52} \times \frac{K_m}{\sigma} + k_f/\delta$$

where h_t is total contact conductance, P is the pressure on the joint, Y is the yield strength of the softer material at test temperature, K_m is the harmonic mean conductivity of the two materials, σ is ten times the combined root mean square roughness of the materials, and k_f is the conductivity of the fluid in the joint.

Temperature monitored fuel elements were assembled in a four-rod cluster to measure, in-reactor, the effect of irradiation on pressure dependence of contact conductance. These elements developed small leaks through the Swage-lock joints that were not conclusively revealed until after a total of one week of autoclave testing. Another set with improved end closure design is being fabricated.

Production Test of "C" Size, I & E Hot Pressed Fuel Elements. The pressing phase of the current hot press production test has been completed. Each of these elements was pressed for a time of five minutes following a three-minute time delay at temperature. A pressure of twelve tons per square inch at a temperature of 600 C was used.

A total of 152 elements was completed and submitted for cleaning, machining, and testing. Uranium quality was extremely poor, resulting in a rejection rate of more than fifty percent of the cores. Most of the imperfections were stringers and striations on or near the surface of the uranium metal which the nickel plate did not cover.

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Self-supported Fuel Elements. Self-supported fuel elements are designed to position fuel elements accurately in process tubes. The supports, attached to the fuel element jacket, are designed to eliminate cocking or bowing and the resultant "hot spot" formation caused by coolant flow restrictions. PT-IP-84-A has been increased in scope to include 13 more tubes in B Reactor. Fuel element charges are now being fabricated for these tubes. All results of irradiation exposure under this test have been satisfactory. Further testing is required to determine the full capacity of this type of element.

Uranium Melting and Casting Activities. Fabrication of cold extrusion billets by the direct casting of uranium metal into Zircaloy billet housings should offer substantial savings in both time and money. By effecting a bond between the uranium and Zircaloy, the probability of producing a final bonded element should be substantially increased.

Billet shells were fabricated by swaging an NPR process tube to approximate size, then machining to the final dimensions of 2.700" OD, with an approximate wall of 0.125". The inside tube was machined from solid rod so that the resulting tube was 0.740" OD and 0.485" ID. Base plate was cut from a 1/8" sheet of Zircaloy. All components were welded by an electron gun in vacuo.

Dingot uranium was used in the casting operation to maintain a low carbon content. This metal was heated to a temperature of 1450 C prior to pouring into the heated graphite mold. The extrusion cup was assembled as part of the mold, with all graphite fitting tightly against the Zircaloy. This assembly was preheated to a temperature of 1080 C prior to casting.

Upon cooling, the entire assembly was found to have shrunk 0.050" in diameter on the OD, several thousandths on the ID, and very slightly in length. Bonding was uniform.

Back Extrusion. Development of the technique for the back extrusion of Zircaloy-2 end closures for UO₂ PRTR fuel elements is just about complete. Washers have been back-extruded into flat bottomed cups. The wall heights, both internal and external, are too low to be acceptable. A thicker Zircaloy-2 washer will be used to provide more material for increasing the wall height.

2. REACTOR PROGRAM

Coolant Systems Development

Corrosion of Zr-2 in Present Reactors. The corrosion of zirconium alloys is of interest not only because it could limit the life of the process tubes, but also because it introduces long-lived Zr⁹⁵ activity into the water. Corrosion rates of zirconium in process water at temperatures up to 100 C out of the reactor are so low that no accurate measurements have been made. No in-reactor measurements of zirconium corrosion rates in process water at 100-120 C have been made. A program to study corrosion of Zr-2 in the reactor has been planned in cooperation with the Chemical Research Operation, which is measuring the radioactivity of the effluent water.

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Decontamination Studies. Efforts to remove the black oxide film from Zircaloy-2 coupons exposed in 300 C water were unsuccessful. Solutions tested were: Turco 4501, alkaline permanganate-ammonium citrate solutions, 50% H_2SO_4 , 75% H_2SO_4 , Turco 4512, 75% H_3PO_4 , and 1% HF-10% HNO_3 . Two more solutions were tested this month for their ability to remove the oxide film from aluminum coupons exposed to 300 C water. The solutions were (1) a 10:1 ratio of HNO_3 to HF and (2) a 4% H_2SO_4 - 12% Cr_2O_3 solution. These solutions removed the film in eight hours at 90 C, but also removed three to four mg of aluminum (~ 0.05 mil). These solutions may be useful for removing films from samples exposed for long periods.

Samples of carbon steel and of sensitized and non-sensitized stainless steel were defilmed by several candidate decontaminating procedures. The loss for stainless steel ranged from 0.00 to 0.01 mil/hr; for carbon steel the range was from 0.01 to 0.07 mil/hr. The heaviest loss (0.07 mil/hr) was experienced with 1051 carbon steel.

Rupture Testing of New Fuel Element Designs. Four coextruded uranium and Zircaloy-2 fuel elements were ruptured in 300 C water. The first was a beta heat-treated 1.78 OD by 1.38 ID tube defected in one end-void with a 25-mil hole. After two hours exposure both end caps had been separated from the core, but no evidence of tunneling between ends was noted. The largest diameter after rupture was 1.86 inches, from a pre-rupture diameter of 1.78 inches. The rupture had not progressed down the length of the fuel element more than $1/4$ inch.

The second and third elements were tubes 1.78" OD by 1.38" ID in the as-received condition. Both were tested for two hours at 300 C. The first of these was defected in the side with a 25-mil hole. After exposure, the rupture was centered at the defect with a 2-inch diameter portion raised, cracking the Zircaloy can. The other tubular piece was defected in the void of one end. After the run, both end caps again had been separated with no evidence of tunneling between the ends. This time, however, the rupture had progressed about two inches toward the center from each end for the complete circumference of the piece. In view of the failure of the undefected ends, Fuel Element Design Operation has changed the design of the Zircaloy end plug.

The last element tested consisted of four as-extruded 0.63" OD rods. Each rod was defected with a 0.030" slit extending 0.010" into the uranium. Two of the slits were three inches long and located in the center of the six-inch rods and the other two slits extended the full length of the rods. After exposure at 300 C for one hour, an extremely small amount of damage was done along the slits, but considerable damage was evidence at the end caps of the rods with the full length slits.

In-Reactor Testing. Loops KER-1 and KER-3 are operating as scheduled with no change in status. The charge in KER-2 was discharged November 9, after approximately 130 days in the reactor at a maximum outlet temperature of 205 C. The fuel elements in the test consisted of four Zr-2 clad enriched 4-rod clusters, eight Mint slugs clad in X-8001, 26 aluminum-clad Doe slugs, and one thermocouple assembly. The thermocouple slug was a solid

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uranium core clad in X-8001. The proposed new charge was not ready at the time of the outage, so a back-up charge of one 8-foot ceramic cluster element was placed in this tube. This ceramic fuel element will be left in the reactor only about one to two months to evaluate the effect of short-term irradiation on mechanical stability. Zircaloy coupons were placed in the tube to determine the effect of irradiation on corrosion.

Loop 4 was discharged November 17, when the gamma monitors went off-scale, indicating a leakage of fission products into the coolant stream. The charges consisted of 14 Doe elements and one Doe thermocouple slug, all clad in X-8001. The activity levels in the water were too low to be measured accurately; however, a gamma scan of a water sample at 200-E did indicate the presence of Cs^{137} , Zr^{95} , and other fission products. From a superficial examination it was impossible to determine which piece, if any, had failed. The charge had been in the reactor about 100 days at a maximum outlet water temperature of 205 C; this is about one-half of the intended exposure. The thermocouple slug indicated the surface temperature did reach 290 C.

The new charge placed in KER-4 on November 17 consisted of two rod-and-tube uranium fuel elements and one 7-rod cluster UO_2 fuel element. Aluminum coupons were placed in the flux zone to measure the effect of irradiation on corrosion.

Organic Decomposition. An attempt is being made to determine what effect, if any, nickel may have on the pyrolytic decomposition rates of MIPB. Three refluxes were set up, one containing nickel foil, one with an M-388 coupon, and the other with a 2S aluminum coupon. Although it will require about a month to obtain measurable tar contents, it was noted that after two days the MIPB with the 2S coupons was much darker. The MIPB containing the M-388 had darkened only slightly, and the one with the nickel foil had hardly changed color.

Structural Materials Development

NPR and KER Tubing. An offer has been made to and accepted by Mallory Sharon Metals Corporation to settle Contract DDR-28 for \$2000 plus \$100 for cutting and crating. None of the five tubes met specifications, but it is recognized that they will have some value for destructive testing. The tubing is to be cut to convenient lengths for shipment to HAP0. Care will be exercised not to cut through any defective areas that can yield valuable information in the testing program.

Six KER tubes were inspected at Tube Reducing after their final pass on the Tube Reducer. One tube had broken in half during reduction, and another had severe transverse cracks. Of the remaining four, three had small surface cracks. After surface conditioning all four passed inspection by the General Electric inspector and are presently in transit to HAP0.

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BDF Tubing. Inquiries for the production of 300 to 400 BDF tubes have been sent out to Mallory Sharon Metals Corp., Superior Tube Co., Tube Reducing Corp., and Harvey Aluminum. It is expected that four 100-tube orders will be negotiated by early February 1959.

Mallory Sharon Metals is investigating the application of a swaging machine called "Intraform" to the forming of BDF Zircaloy tubes. Successful reductions of 67% on tube blanks were observed at the Cincinnati Milling Machine Company. Subsequent to the visit, short lengths of ribbed tubes with 60% and 50% reduction in cross section area were made; the fabrication of short pieces of BDF tubes to scale is scheduled for mid-December.

Nonmetallic Materials Development

High Temperature Graphite Irradiation GEH-9-7. The latest high temperature MTR graphite experiment, GEH-9-7, was charged on November 11. The reactor reached full power on November 17, at which time the four samples had attained temperatures of 349°, 580°, 778°, and 738° from gamma heating. Supplementary heat has been added to bring the temperatures to 750°, 750°, 975° and 1050 C. This experiment is intended to operate four cycles and be discharged about February 2, 1959.

Thermal Expansion. Accurate data on the coefficient of thermal expansion of graphite are required for the design of the NPR to assure that excessive stresses do not develop in process tubes where they pass from the shield into the graphite moderator. Since thermal expansion coefficients of any graphite are dependent on the materials and processes used in its manufacture, until these are established, precise prediction of stack movements cannot be made. Limits can be determined, however, and to aid in establishing these realistically, the variations in thermal expansion resulting from process and coke variations are being studied. The effect of process variables can be studied since samples of graphite made from Texas coke representing the major methods of producing reactor grade graphite are available. The results for Texas coke graphite gas baked and purified at 2450 C are given in the following table.

Thermal Expansion Coefficients of TSGBF Graphite

<u>Sample Orientation With Respect to Extrusion Axis</u>	<u>Coefficient of Thermal Expansion in/in°C, 25 to 425 C</u>		
	<u>Maximum</u>	<u>Minimum</u>	<u>Average</u>
Transverse	4.71×10^{-6}	3.79×10^{-6}	4.39×10^{-6}
Parallel	2.55×10^{-6}	2.88×10^{-6}	2.67×10^{-6}

Previously reported (HW-39043) values for TSGBF graphite were slightly lower since they were obtained over the temperature range of 25 to 325 C. AGOT and "F" processed Texas coke graphite will be measured, as well as graphites produced from other cokes being considered for use in the NPR.

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Thermocouple Development. Five experimental Geminol P-N couples and a control group of standard iron-constantan couples have now operated in 105-KE for three months without any failures. Temperatures indicated by the Geminol couples and the adjacent standard couples at the center of the reactor in a standard stringer show that the Geminol couples are reading about 5 C higher than the iron-constantan couples.

Irradiation Damage to Plastics and Elastomers. Intrinsic viscosity measurements in a series of Lexan polycarbonate films irradiated to various doses up to 10^9 roentgens confirm the hypothesis that irradiation degradation occurred by a chain scission mechanism. Thermal degradation, however, as indicated by infrared measurements on model arylcarbonate compounds, probably proceeds by molecular rearrangement without appreciable change in molecular weight.⁽¹⁾ A theory is being developed to explain the differences in the two types of degradation.

The effect of carbon black additions on the radiation behavior of nitrate elastomers has been reported earlier.⁽²⁾ Studies have now been completed on the effect of the acrylonitrile content on the radiation induced changes in the nitrile rubbers. The results are summarized below:

1. The radiation induced hardening is independent of acrylonitrile content.
2. Upon irradiation, tensile strength increased with increasing acrylonitrile content.
3. Elongation is retained at low doses but decreases with increasing acrylonitrile content at higher doses.
4. Flexibility decreases with increasing acrylonitrile content upon irradiation.

This information is useful both in understanding the role of the polymer in a radiation field and also for the practical application of these nitriles in radiation fields.

Thermal Hydraulics Studies

Reactor Flow Hazard Studies. Steady state experimentation to determine the thermal hydraulic characteristics of reverse flow through a process tube were started. The data from these tests will be used to help predict what will happen in a tube which has lost a front hydraulic connector. The first tests showed that critical flow through the front end discharge and two phase flow through the front fittings strongly influence the hydraulic behavior in these tests. As a result the apparatus was modified to more closely simulate the front fittings of a reactor.

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- (1) Information on thermal degradation obtained from General Electric's New Products Development Laboratory, Pittsfield, Massachusetts.
 - (2) Albaugh, F.W., Reactor and Fuels Research and Development Operation Monthly Report, HW-56640 A1, July 15, 1958.

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The initial tests show that the hydraulic characteristics are a function of the enthalpy of the discharging water-steam mixture. If this holds true for the full range of test conditions, it will permit the examination of less variables in the construction of boiling curves for reverse flow for any combination of rear header water temperature and tube power.

Hydraulics Studies. Use was made of the Hydraulics Laboratory KER tube mockup by IPD - Reactor Fuels Operation to demonstrate the operability of a KER facility discharge chute to IPD operations personnel. The chute will be used to catch and prevent damage of some of the more intricate experimental fuel assemblies prior to careful examination of radiation effects on the elements. The chute attaches to the rear nozzle barrel and is essentially a metal box with a wire mesh top to catch the fuel assemblies as they are discharged. The box can then be lowered into the discharge basin.

Laboratory data were obtained to determine what front header pressure would start flush discharge of a support charge including some aluminum solid pieces. It was found that a front header pressure of about 120 inches of water (± 5 inches) was required to cause the support charge to begin to move when no active charge was in the tube.

Three stainless steel prototypes of each orifice size for the D Reactor re-orificing program have been procured from a vendor on a special purchase order by IPD. Flow tests have been conducted with these prototypes in the Hydraulics Laboratory. The results show that these orifice assemblies will be satisfactory and will meet the ΔP flow requirements for this program.

Heat Transfer Calculations. An analysis is being carried out to determine transient fuel element temperatures (in particular, surface temperatures) under flow interruption conditions in the KER Loops. The purpose of this analysis is to determine the maximum shutdown time for various conditions of flow interruption. At present, the case under study is the condition where the coolant flow is completely eliminated, and the fuel element is surrounded by air at atmospheric pressure. It was assumed for this case that no heat is transferred from the fuel elements.

A solution to the Novier-Slokes equation for laminar flow in an annulus was obtained and compared with the conventional pressure drop equation using the hydraulic diameter concept and for $f = 64/Re$. The exact solution gave pressure drops which were about 50 percent higher than those calculated from the hydraulic diameter-friction factor equation (Darcy equation). Upon further investigation this same solution was found in Knudsen and Katz. They indicated that experimental measurements give friction pressure drops which are 35 percent, rather than 50 percent, higher than the Darcy equation.

The problem of predicting temperature events in present Hanford reactors following a complete water loss has been rewritten in Fortran computer coding for solution on the IMB 709. At present, the plans call for the problem to be taken to UCLA for solution about the week of December 8.

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Critical Flow Experiments. Additional data have been obtained from the critical flow experimental studies but have not been analyzed completely. Visual observations were made of the discharge from a three-inch long, one-half-inch bore, sharp edge nozzle under critical flow conditions. With high upstream pressures, a cone was visible protruding from the discharge end of the nozzle. The base of the cone seemed to be about the diameter of the nozzle bore, and its length was about one-half inch. As the upstream pressure was lowered, the cone moved back into the nozzle discharge. At upstream pressures in the neighborhood of 50 psi the cone had completely disappeared from view. It appears that the cone was made up of a mixture of water and vapor, and the vapor bubbles collapsed as they emerged from the nozzle discharge. Also, at upstream pressures of 50 psi, a pressure tap located in the middle of the nozzle indicated extreme pressure variations for very small changes in the downstream pressure. The pressure at the nozzle mid-point would jump from 24" of Hg vacuum to five psig with a 1/4 psi change in downstream pressure. At an exact location this pressure would jump back and forth with no variation in downstream pressure. A possible explanation is that the vena contracta is exploding and the flow fills the entire channel to give the high pressures, and then reforms to give the low pressures.

Miscellaneous. The two rectifiers, the saturable reactor, and the control panel for the rectifier system to increase the 189-D electrical heat generating capacity were received. The construction contract for the installation of the electrical equipment and for the modification of the low pressure heat transfer apparatus to accommodate the increased heat generation capacity has been awarded.

The resistance between sheath and wires of one iron-constantan thermocouple sheathed in stainless steel was determined at temperatures up to 1600 F. The thermocouple was heated in an electrical furnace. The sheath to wire resistance was essentially constant at 5 to 10 million ohms up to 800 F. Above this temperature the resistance dropped by a factor of 10 for each 250 to 300 F temperature rise.

Mechanical Equipment Development

Organic Cooling System Components. The MOTS-1 facility operated for a total of 168 hours at temperatures from 300 to 350 C. Tests using MIPB were completed. The system was flushed and filled with an eutectic mixture containing 25 percent biphenyl, 20 percent meta terphenyl and 55 percent ortho terphenyl. Testing of mechanical seals continued.

Shielding Studies

Attenuation Studies. The test on ferrophosphorus concrete baked at 100 C is complete. The fast neutron relaxation length for this test was found to be 7.7 cm. The foils from the test on ferrophosphorus concrete baked at 200 C are being counted, and the test slabs are being baked at 300 C. The test on ordinary concrete baked at 200 C is being analyzed. The ordinary concrete slabs, after being baked at 300 C, were placed in one of the test wells on top of the DR Reactor. The pure iron test slabs were placed in the other test well.

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Thermal Shield Studies. The heavy aggregate concrete test slabs for the 105-C shielding facility have been completed. Fabrication of the test insert for the borated mortar thermal shield test is 50% complete.

Calibration constants and operating voltages were determined for 12 ion chambers for use with the C facility. Five rejects have been rebuilt for recalibration.

B. WEAPONS - 3000 PROGRAM

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

C. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Fuels Development

PuO₂-UO₂ Irradiation Capsules. Two Zircaloy-clad capsules containing two compacts each of high density PuO₂-UO₂ mixed crystal oxides in a UO₂ matrix were fabricated and autoclaved. The compacts contain 0.026 a/o PuO₂, have densities of about 91 percent of the theoretical value, and will generate the same specific power that an Al - 1.8 w/o Pu alloy rod of the same diameter would produce. Two additional capsules are currently being prepared and will contain mechanical mixtures of PuO₂ and UO₂ in the form of low density (65 percent of theoretical) compacts. Plans are to ship all four capsules to the MTR in December.

Irradiation Stability of PuAl Alloys. Eight capsules with Zircaloy cladding and Al-Pu and Al-Si-Pu alloy cores with nominal plutonium concentrations of 5, 10, 15, and 20 w/o have been fabricated, autoclaved, and shipped to the MTR. These capsules will be irradiated to fractional burnup values for the plutonium atoms of 25 to 50 percent and will have a central core temperature of 400 C. A second set of eight similar capsules is currently being fabricated and is tentatively scheduled to be irradiated to 50 to 100 percent fractional burnup of the plutonium atoms and to have 400 C central core temperatures. These irradiations are being made to determine the upper limit of plutonium concentration in these alloy fuel materials before dimensional instability or swelling becomes a serious problem. The irradiated specimens will also provide needed material for separations and reprocessing studies.

High Burnout Al-Pu Alloy Capsule Irradiations. Four Zircaloy-clad capsules containing Al - 1.65 w/o Pu and Al - 12% Si - 1.65 w/o Pu alloy cores have been fabricated and autoclaved. Two capsules of each core material are ready for shipment. These specimens will be irradiated to a fractional burnout of the plutonium atoms of 80 to 100 percent. These experiments will verify and supplement results obtained with similar capsules under similar irradiation conditions but with fractional burnout values from 15 to 60 percent of the plutonium atoms.

SECRET

Injection Cast Al-Pu Alloy Capsule Irradiations. Two Zircaloy-clad capsules containing Al - 1.8 w/o Pu alloy, vacuum-injection cast cores are currently being prepared for jacket welding and autoclaving. Present plans are to ship these capsules to the MTR in December. These capsules are fabricated by injection-casting the core material directly into the jackets. The cores are not bonded to the jackets and have as much as 0.007-inch diametral clearance. The objective of this test is to evaluate fuel capsules fabricated by this fabrication technique and to obtain irradiation experience prior to cluster irradiations.

Diametral-Tolerance Test, Al-Pu Alloy Capsule Irradiations. Four Zircaloy-clad capsules containing Al - 1.8 w/o Pu alloy cores are currently being assembled for welding and autoclaving. The MTR test is being performed to establish whether or not the tentative diametral tolerances on core OD and tubing ID for Pu-Al fuel elements are satisfactory. The four capsules will have values for the difference between core OD and tube ID of from 0.001 to 0.006 inch. Arrangements are being made to ship these capsules to the MTR early in December.

Al-Pu Alloy Clusters for KER Irradiation. One 4-rod Zircaloy-clad cluster containing Al - 8 w/o Pu and Al - 12 w/o Si - 8 w/o Pu alloy cores is being irradiated in Loop 3 of the KER facility. Discharge date is estimated to be the latter part of November or first of December 1958. A second cluster of similar design which has been delivered to the reactor is scheduled to be charged in Loop 1 during the first quarter of 1959.

A 7-rod cluster fuel element with extruded Al - 1.8 w/o Pu alloy cores and Zircaloy-2 tubes is being fabricated. The element will duplicate as nearly as possible the appearance and construction of the center rod and 6-rod ring of the latest cluster design for the Al-Pu alloy, 19-rod, PRTR fuel element. The test specimen will be about 30 inches long and will be assembled with quick-disconnect type end caps. Current plans are to complete the fabrication by January 1, 1959.

PuO₂ Impregnated Graphite Capsule Irradiations. Fabrications of the components for the PuO₂ impregnated graphite capsules is on schedule. The graphite pieces have been machined to size and are presently being impregnated with PuO₂ by the Chemical Research Operation. The Zircaloy cans have been successfully machined to the final sizes after encountering a considerable amount of difficulty. The diametral dimensional tolerances required for this experiment, ± 0.0002 inch, were difficult to obtain. Residual stresses and ovality in the as-received tubing necessitated machining and honing the cans from fully annealed bar stock. It is essential that the diametral tolerances be closely controlled for this experiment because small variations in the helium filled heat transfer gap between the graphite and the can wall have a large effect on the temperature drop across the gap.

Plutonium Oxide Fuel Materials. A diffractometer pattern was run on a physical mixture of UO₂-PuO₂ which had been in the sintering furnace when the furnace heating element failed (1620 C). The mixture contained 16.6% PuO₂ to simulate the chemically precipitated mixed crystal oxide and was

90.2 percent dense. Again, line broadening was observed in the high angle reflections; however, the alpha component of the FCC planes 331 through 620 were symmetrical enough to yield a lattice parameter calculation. Extrapolation to unity of a plot of the lattice constant versus $\sin^2 \theta$ gave an a_0 value of 5.4596 Å. This is further evidence that solution of PuO_2 in the UO_2 takes place during sintering, due to diffusion.

Injection Casting Development. The Kux Machine Company is nearing completion of the fabrication of a fuel-element-containing-block, and associated components needed for evaluation of the fuel element die casting process. Forty-seven 90-inch lengths of stainless steel and seven lengths of Zircaloy tubing have been shipped to Chicago. The die casting experiments will be made sometime during December.

Thin-wall stainless steel tubing could conceivably be substituted for Zr tubing for future fuel elements. To explore the feasibility of injection casting into such tubing, one casting was made in which aluminum was injection cast into a 78-inch long, 0.560 OD, 0.008-inch wall stainless steel tube. Aluminum was forced into the tube with 25 psig air pressure. After casting, the tube remained at a red heat for a period several times longer than normally experienced with 0.030-inch wall tubing. The stainless tube was not etched beforehand, and yet a bond was formed between the core and clad with sufficient strength to reduce the tube OD from 0.560 to 0.555 inch. Mechanical stripping of the tube from the core revealed a typical, relatively brittle bond. A 9-inch and a 12-inch length of this casting were thermally cycled in a muffle furnace for five cycles from room temperature to 450 C. The aluminum core and the stainless tube expanded and contracted as a unit with no apparent separation. If it is possible to consistently bond aluminum to thin wall stainless tubing, it would not be necessary to leave a space at the end of the fuel rods for longitudinal expansion. Further tests will be made to verify these results.

Injection casting into Zircaloy tubes has resulted in porosity in the core due to outgassing of the zirconium. Argonne National Laboratory (ANL 5442) has reported similar results when uranium alloys were cast bonded into Zr cans, and found that it was necessary to vacuum anneal the Zr cans at a temperature 100 C above the uranium pour temperature in a vacuum of 0.08 micron for four hours just prior to making the castings to eliminate the porosity. It will not be possible to carry out a similar anneal of 8-foot long Zr tubes at HAPO until a vacuum annealing furnace is available for annealing and storing tubing.

Pyrometallurgical Techniques. A method of recycling Pu from Al-Pu alloys through Bi back into Al-Si-Pu alloys was described last month, when it was reported that the process might be quite temperature dependent during the AlSi extraction step. Experimental studies are being continued, with closer control of the temperature during the extraction steps.

A modification of the Bayer process represents a method of reprocessing Al-Si-Pu or Al-Pu alloys. In the Bayer process, used in refinement of bauxite, alumina is dissolved by hot caustic, entering solution as NaAlO_2 while the impurities in the ore remain as a residue. In the Bayer process

the residue is discarded. However, in dissolving Al-Si-Pu or Al-Pu alloys in caustic, the residue containing Pu and Si would be treated and reprocessed. Experimental results on 32 g of 20 w/o Pu-Al-Si alloy dissolved in caustic showed a 13 g residue of fine metallic powder, assaying 45% Pu (90% recovery). Experimental results on complete reprocessing of a 2 w/o Pu-Al alloy have not been received.

Casting Techniques. Casting techniques are being developed for the production of extrusion billets from which the Pu-Al fuel rods will be fabricated. The objectives are to develop techniques for routine production of extrusion billets which meet the following requirements:

1. Vertical segregation less than 5% of nominal Pu content.
2. Radial segregation undetectable by radiography.
3. Surface quality sufficient to eliminate need for machining.
4. Porosity insufficient to affect the extrusion properties of the material.

The maximum billet size required is 2-1/2" diameter by 11" long. The casting equipment which will be in operation in a hood in January is a hydraulically controlled tilt-pour 50 kw induction melting furnace. Casting techniques applicable to the new equipment are being investigated with smaller, hand-pouring crucibles. Several aluminum extrusion billets, 2-1/2" diameter x 11", were cast into graphite molds using a pouring cup to control the pouring rate. The surface of the billet did not require machining, and no porosity was detected in cutting the billets to length. Al-Pu billets, 2" diameter, were cast to evaluate radial segregation, which is affected by cooling rate. Conditions were determined in which no radial segregation was visible in the radiographs of Al - 1.8 w/o Pu alloys and eutectic Al - 13 w/o Pu alloys, but radial segregation was detected in Al - 7 w/o Pu alloy cast under similar conditions. Gravity segregation in hypoeutectic Al-Pu alloys can result only from incomplete solution of plutonium. Previous experience has shown that gravity segregation is eliminated with adequate stirring at the holding time and temperature which is determined by the composition of the alloy charge. When the new casting equipment is ready, the above techniques will be combined and evaluated to determine the correct conditions for routine production of extrusion billets.

Extrusion Development. Metallographic work has been completed on samples cut from Pu-Al and U-Al rods extruded with the small prototype press. There appears to be only a very slight amount of micro-segregation (no evidence of macro-segregation) and very few voids. The variation of grain size across a transverse section of the extrusion exhibited extremely small grains at the surface of the rod and a grain size at the center nearly identical to the as-cast structure. Several metallographic specimens were tested to determine hardness with the Tukon microhardness tester. A diametral traverse was employed across the polished surface, with typical values for the diamond pyramid hardness number as follows: 45.5 (edge),

40, 36 (center), 39, 45 (edge). The average values of DPHN for all samples ranged from 25 to 40, depending upon the degree of cold work and the alloy content (% U or Pu in aluminum).

Machining has not yet begun on the tensile specimens for mechanical testing. It is planned to compare the tensile properties of the as-extruded rods with those of extruded-annealed rods.

Extrusion development has continued using stand-in materials for Pu-Al with the 280-ton press. Radiographs of the nominal 0.500-inch diameter extruded U-Al alloy rods of 1.8, 6, 10, 15, and 20 w/o U showed sound structures. One 20 w/o U extrusion contained a sizeable blister. The radiograph of the cast billet showed an extremely large cavity in the center of the billet. Several other billet radiographs also showed cavities. None of these, however, were as large as the cavity in the blistered extrusion. A degree of void space in the billet seems tolerable before affecting the quality of the extrusion. Segregation in the cast billet is broken up during extrusion and dispersed longitudinally along the length of the rod.

Sixteen 1100 alloy, 1.5-inch diameter, aluminum billets were cast into 8-inch lengths and hot extruded at 75, 88, 95, and 99.5 percent reductions in area. Flat-face shear dies were used. The billet and container temperatures were 400 C, and the lubricant was oil dag. Surface finish was excellent in all instances, and the maximum diameter variation was 0.0015". Extrusion pressures varied linearly with the log % reduction from a maximum of 13,590 psi for the 99% reduction to 11,570 for the 75% reduction.

Welding Development. Due to the inability to remove all of the etching solution from between the fuel element and the spacing wire of Mark I PRTR fuel elements, an experiment is being conducted to weld the wire to the end cap after autoclaving. This would eliminate the need for etching the entire rod with the wire in place.

Fuel Core Insertion Studies. Experimentation indicates that uniformity of the inside diameter of zirconium tubes can be accomplished by inserting a mandrel of slightly smaller diameter into the tubes and running them through the rod straightener several times each. The manufacturing tolerance of +0.005 - 0.000 inch on the ID of tubing causes difficulty in holding the diametral gap between core and cladding of 0.003 inch, needed for intimate contact at reactor operating temperatures.

19-Rod Cluster Engineering Design and Testing. A new model 19-rod cluster, designated the Mark I-D, has been designed (H-3-13302, 07, 08, and 09). This model is designed for remote assembly and disassembly the same as the Mark I-C but incorporates a head weld between the end cap and the tube instead of the previous circumferential weld.

Two fuel-element clusters have been designed for irradiation-testing in ETR. Both are of the Mark I-D design with a few alterations. One is a 19-rod cluster with an overall length of 45 inches (H-3-13303 and 04), the other is a 7-rod cluster which is the 19-rod cluster with the outer 12-rod ring removed (H-3-13305 and 06).

Another 7-rod cluster fuel element has been designed to meet the requirements for irradiation testing in KER (SK-3-8021, 22, and 23). This element is 27 inches long and designed for a horizontal position in the reactor.

The full-length, 19-rod cluster undergoing hydraulic testing in K East Area was removed for inspection after two weeks of 110 gpm water flow at 580 F. All parts looked the same as when installed including the Zircaloy wire wrapped rods. The helical wire wraps on the rods and the wire rings banding the 19 rods showed no signs of loosening. The element will next return for thermal-cycle tests. One of the quick disconnects was tested for 20 days in 400 C, 1500 psi steam and when removed was still in good working order.

UO₂ Fuel Development

Swaged UO₂ Fabrication. The density of the UO₂ cores in swaged fuel elements can be increased by increasing the temperature of the UO₂ during the swaging. Conceivably, less expensive types of UO₂ powder can be fabricated satisfactorily by swaging at elevated temperatures. With Zircaloy-clad fuel rods, it is desirable to minimize the heating time in order to lessen contamination of the Zircaloy. Resistance heating experiments were conducted in which the UO₂ in typical PRTR fuel rods (0.6" OD) was heated to 600 C in less than a minute. Additional experiments are being performed.

In earlier experiments UO₂ was swaged satisfactorily in 0.035" wall stainless steel tubing. During the past month UO₂ was swaged in type 304 stainless steel tubes having wall thicknesses of 0.020", 0.015", and 0.007" to determine the relation of the wall thickness to the maximum density attainable. Stainless steel tubing 0.6" in diameter with walls 0.007" thick collapsed during swaging. Tubing with thicker walls was swaged successfully, as indicated below. The initial OD was 0.75".

<u>Wall Thickness, In.</u>	<u>UO₂ Density, % of Theo.</u>
0.035	85.5
0.020	85.0
0.015	84.7

Concentric Rod and Tube Fuel Elements. Flow tests have been completed on a mockup of a three-foot rod-and-tube element to obtain data for calculations of the in-reactor performance of a similar Zircaloy-2 clad assembly which is being fabricated for testing in the ETR 3x3 Loop.

UO₂ for Chemical Processing Studies. Fifty stainless steel clad fuel rods, 36 inches long, containing one-half-inch diameter UO₂ pellets were delivered to Chemical Development Operation for chemical processing studies.

High Temperature Studies. Large, columnar grains of UO₂ similar to those observed in irradiated UO₂ were formed at temperatures below the melting point of UO₂ in a tungsten filament furnace. This is further evidence that columnar grain formation in UO₂ does not necessarily indicate

solidification from the melt. Such crystal growth often has been accepted as evidence of solidification from the melt, and maximum fuel element core temperatures have been estimated on this basis. Determinations of the thermal conductivity of UO_2 between 800 C and 2000 C were continued. Melting phenomenon occurring in UO_2 , UC, and UN and mixtures of these three compounds were successfully photographed through a high-temperature microscope.

Irradiation of Swaged UO_2 Capsules. Irradiation of swaged capsules containing enriched UO_2 are continuing in the MTR. Exposures to date are 2750 MWD/T. Capsules containing natural UO_2 have attained exposures up to 2000 MWD/T. No failures have occurred.

VBWR Irradiation of Nine Rod Fuel Assembly. The irradiation of nine fuel rods of enriched UO_2 swaged in Zircaloy-2 cladding is continuing without incident. The rods have been exposed in the VBWR at full power for approximately eight weeks.

Irradiation of Tubular Fuel Element. Eight percent enriched UO_2 was chemically recovered from grinding sludge for use in completing the fabrication of tubular fuel cores for irradiation in SRE. The cores are being drilled with six thermocouple holes 0.032" in diameter.

Irradiation of Zircaloy-Clad, 18" Swaged Fuel Assembly. A 7-rod cluster identical in geometry and spacing method to the eight-foot element under irradiation in a KER Loop, but 1-1/2 feet long, was fabricated by swaging UO_2 in Zircaloy-2. This unit was charged into a KER Loop.

Irradiation of a Three-Rod, Swaged Fuel Element. A three-rod, swaged fuel element, one foot long, consisting of 1.6 w/o enriched UO_2 clad in Zircaloy-2, was irradiated successfully to 450 MWD/T in the MTR. The measured power generation was 37.5 kw/ft of fuel. This element was discharged and returned to Hanford for post-irradiation inspection.

Irradiation of Unsintered UO_2 Powder Fuel Element. Gross melting experiments involving unsintered, enriched UO_2 powder loaded in Zircaloy-2 tubes, 1" OD x 6" long, have been conducted by irradiation in the MTR. A number of new phenomena have been revealed as described previously. To study the relocation behavior of the UO_2 in these earlier experiments, a 12" long, 1" OD, Zircaloy-clad fuel element containing 3.2 w/o enriched UO_2 has been fabricated for irradiation in the MTR. The element is expected to operate at a heat flux of approximately 750,000 BTU/hr/ft².

Irradiation of Eight-Foot Swaged Fuel Assembly. In order to study the stability under irradiation of a swaged fuel cluster of PRTR fuel element length, an assembly consisting of the inner seven rods of a 19-rod cluster was fabricated. The rods contained UO_2 swaged in 0.030" wall thickness 304-L stainless steel tubing. Separate rods were spaced in the required geometry by 0.072"-diameter stainless steel wires wrapped around four of the fuel rods, using 10" pitch. The complete rod bundle was held together and spaced in a horizontal process tube by 0.115"-diameter stainless steel wire wrapped around the bundle on a 10" pitch. This unit was charged in a horizontal KER high temperature loop early in the month.

Coolant Systems Development

Component Testing. A prototypical 19-rod cluster Pu-Al fuel element with 17 stainless steel clad rods and two Zircaloy-2 clad rods with Zircaloy wires spiraled around the rods to promote mixing has run three weeks in the ELMO-7 test loop, two weeks at 580 F and one week cycling between 250 and 580 F. Examination at the end of the two-week steady state run showed no evidence of movement of the two Zircaloy rods or elongation of the wire wraps. Corrosion of the cladding beneath the wires was noted, however, as a result of inadequate rinsing after etching.

The O-ring seal design planned for the inlet fitting on the PRTR process tube failed twice on thermal cycle testing on ELMO-7. A leakage rate of 685 ml/hr was noted over a short interval for the second O-ring. This design was replaced with a Flexitallic gasket seal which has operated 335 cycles between 300 and 500 F with no leakage. Leakage was noted on a Flexitallic gasket nozzle-process tube seal after about 150 thermal cycles while no leakage was observed on a Flexitallic gasket-sealed cap or Parker flared tubing fitting outlet connection after 375 cycles.

Structural Materials Development

PRTR Process Tube Fabrication. Chase Brass and Copper Company is making the extrusions to be used by Tube Reducing under their contract to produce 100 PRTR process tubes. Of the first thirty-eight billets processed, thirty-two are apparently of good quality, three had excessive eccentricity, and three failed to push. The extrusion of some of the second group of 42 billets was observed at Chase on November 11. No difficulties were experienced. The remaining 56 billets under this contract are scheduled for processing on November 18 and 25.

Tube Reducing has scheduled the first rocking operation on a pilot lot of 12 extrusions for the last week in November. Five are currently at Tube Reducing and, with minor conditioning, ready to be rocked; the remaining seven have been sent back to Chase for further pickling to remove traces of the copper jacketing.

PRTR Process Tube Bursting. Ten Zircaloy-2 tubes, each 10" long with a flange on one end, were received from Chase Brass and Copper Company. The flanges on these tubes were fabricated by the three methods listed below:

<u>Tube Identification No.</u>	<u>Type of Flange</u>	<u>Description</u>
1, 2, and 3	Threaded ring	Tube and ring threaded & welded on end only.
4, 5, 6, and 7	Welded ring	Slip-fit ring welded on both sides.
441, 443, and 444	Built-up ring	Filler wire weld-deposited on tube.

These tubes were burst-tested as part of a program to determine which type of flange is preferable for the tapered tubes for PRTR. Tubes numbered 1, 2, 3, 5, and 441 were tested to failure. In every case the tube failed before any measurable deformation occurred in the flange. The following table gives a resume' of the pressures and stresses involved in the tests.

Tube Identification No.	Bursting Pressure Total (psig)	Total Transverse
		Hoop Stress - Tube (psi)
1	5,300	43,600
2	5,100	52,400
3	5,200	55,400
5	5,300	52,900
441	4,200	57,700*

*Tube #441 had great variations in tube-wall thickness and did not break at the thinnest point as measured before bursting; therefore, the calculated hoop stress is high.

PRTR Jacket Tubing. One set of ribbed tubes for the Mark II-b nested tubular fuel element has been received from NMI. They are being subjected to a rigorous inspection before being released to Ceramic Fuels Development Operation. Contract DDR-29, under which these tubes were produced, is being modified and extended to develop an improved method for the final sizing of this type tubing. Wall thickness and number of ribs will be increased on this phase of the work.

New Rochelle Tool Corporation has made good progress in the development of their rib-to-tube welding machine. They are nearly ready to produce acceptance samples on the small size tube. The major problem of scoring by the sliding contacts appears to have been solved by use of silver-graphite contacts. In answer to our request, New Rochelle Tool Corporation has submitted a proposal to modify the contract for this machine. This modification would add conversion features to the machine enabling it to weld either a right or left-hand spiral rib to small diameter tubing.

Radiometallurgy Laboratory Studies

Radiometallurgy activities during the month in support of the 4000 Program have included a continuation of the examination of 1000 MWD/T UO₂ capsules (IP-149-D) by obtaining Faxfilm replicas of fracture surfaces, and a continuation of metallographic examination of UO₂ powder elements (GEH-4-30). Results and conclusions will be reported in detail in connection with the development program of Ceramic Fuels Operation.

Thermal Hydraulics Studies

Thermal Hydraulic Studies Associated with the PRTR. Experiments were completed to demonstrate adequate mixing of the moderator in the PRTR calandria. In these experiments, which were carried out on the full-scale calandria mockup in 185-D, velocity distributions within the calandria were determined for three different orifice arrangements. An orifice arrangement was

finally chosen that would produce a slightly higher velocity in the center of the calandria so as to encourage sufficient mixing when the reactor was operating with the moderator level below the top drain orifices.

Pressure drop data were obtained in the Hydraulics Laboratory for a prototype Mark II-B (tube, tube, rod) fuel element and a Mark III-Modified (tube, tube) fuel element for PRTR. Flow ratios for the various flow channels have been investigated by selective plugging of the various channels.

Construction was started on a special apparatus to measure the local heat transfer coefficients in a 19-rod cluster fuel element. While this apparatus will use a nonheated test section, a separate test section is under construction for electrically heated experiments at prototypical pressures and temperatures.

Mechanical Equipment Development

Design Test PR-20 - Calandria Characteristics. Testing of the prototypical compressor began, to determine the effective life of the compressor seal. Preparations for moderator level control tests were begun. The test procedures were outlined and are now being circulated for comment.

Design Test PR-25 - Shroud Tube Bellows. The stainless steel bellows with brazed aluminum ends were received from the Solar Aircraft Company. These bellows have been subjected to 14,000 flexure cycles and to corrosion tests during the past three weeks. There are no signs of damage from either type of test. Testing of the bellows received from the Masters Products Manufacturing Company revealed that the gas leakage rate exceeded specifications when the bellows were cold. However, the gas leakage rate was only 0.3 cubic foot per day when the bellows were heated.

Design Test PR-50 - Reactor Piping Seal Testing. Process Tube Assembly "A", containing all prototypical seals, was installed on ELMO-7 for thermal cycling. The "O" ring on the process tube inlet fitting failed twice and was replaced with a spiral wound gasket. After 736 temperature cycles from 580 to 200 F while at a pressure of 1900 psi, the process tube to nozzle seal was leaking slightly. There were no signs of leaks at any of the other seals. It has been recommended that the gasket in the process tube inlet fitting be changed from an "O" ring to a spiral wound gasket. Process Tube Assembly "B", with Marmon Conoseals, has completed 200 thermal cycles on the MEDO facility without signs of leakage.

Modified methods of sealing the outlet gas seal are being studied, and alternate gaskets have been ordered. The "O" ring of the original design does not provide an adequate seal.

Design Test PR-51 - Reactor Piping Structural Integrity. Flexure testing of the shortest outlet jumper was started. Approximately 25,000 cycles were completed without signs of leakage, permanent distortion of the jumper, or loosening of the Parker fittings. The evaluation of the strain gauge data is not yet complete.

Design Test PR-63 - Process Channel Leak Detection Facility. The final report, HW-57700, was issued during November.

Single Tube Prototype Mockup. Acceptance test procedures were written to cover fabrication and startup of the facility. During the final hydrostatic pressure test of the mockup, one of the 65 kilowatt heaters leaked. A new heater is being fabricated and installed. Preliminary cold flow tests on the mockup were carried out using the Bingham pump at a discharge pressure of 1000 psi and a flow of 125 gpm. Necessary piping and other components have been added to the mockup to permit helium pressurization and saturation of the water with helium to duplicate PRTR conditions.

PRTR 8-Inch By-Pass Valve. The purchase requisition was rewritten to provide for the check disc to hang in the open position as a fail safe feature of the valve, and for a maximum pressure-drop through the valve of 0.1 foot of water at a flow of 400 gpm.

PRTR Shim Control. The prototypical shim control element was received. The plastic mockup to test the clearances of the shim control element is being installed.

PRTR Charge-Discharge. A prototype of the discharge hook was completed and preliminary testing completed. The hook successfully supported a load of 2064 pounds, an overload of 100 percent. As a safety feature, the hook is designed not to release a fuel element if the solenoid of the hook is accidentally actuated. Tests were conducted to determine the maximum load that the hook would release. The results indicated that the maximum releasing load was approximately 65 pounds. The hook will be redesigned to reduce this maximum releasing load to approximately 30 pounds, since a 19-rod Pu-Al fuel assembly weighs approximately 60 pounds.

Shielding Studies

PRTR Studies. Two flow transmitters supplied by Panellit, Inc., (0-10 psid and 0-25 psid, e.g., lb/(sq in) differential) have each received over 500,000 full-scale cycles and have remained in calibration. The speed of response of the 0-10 psid unit has been found to be within 0.05 second of the response of the 0-25 psid unit when no copper tubing was included in the test.

Calculations have been made of the shielding required around the moat of the biological shield of the PRTR.

One resistance temperature detector, supplied by Charles Engelhard, has satisfactorily completed over 1000 thermal cycles. This test simulated the thermal cycling expected for ten years of normal reactor operation. Another unit is being returned to the vendor for his examination since it apparently jumped calibration after 500 cycles.

PRTR Design Development

Phase I PRTR Construction Status. The Phase I PRTR contractor is approximately 45% completed versus 55.7% scheduled. The contractor was authorized to install a 1" fiber glass insulation board between the steel containment vessel and the inner concrete wall to compensate for possible stresses resulting from shrinkage of the containment shell during welding of penetrations.

Review of calculations for the structural and mechanical design of Phase I and Phase II is approximately 25% complete.

Scope work on a ventilation stack of increased height was begun.

An operational test of the PRTR 30-ton crane was witnessed at Yuba Manufacturing Division, Benica, California. The crane is scheduled for disassembly and loading on rail cars during the first week of December.

Phase II PRTR Construction Status. The Phase II PRTR contractor is 30% completed versus 35% scheduled. Steel erection was started for the superstructure, and mechanical work is proceeding in the basement portion of the facility.

Phase II-A PRTR (River Structure) Construction Status. The Phase II-A PRTR contractor has moved equipment to the site and is excavating and grading the service road. Since the area is mostly "blow" sand, a design change was prepared to add on 6" stabilization course on the access road.

Phase III PRTR Construction Status. The Phase III PRTR contract was awarded on November 14 to Shaw and Estes of Dallas, Texas, in the amount of \$1,587,000. The fair cost estimate was \$2,873,000.

Instrumentation and Control. On the basis of a study made by APED of rupture detection systems of potential value to the PRTR, a fission gas detector was chosen as the system which appears most likely to meet the requirements of the PRTR. The system will make use of the fact that the helium solubility in the primary system decreases as the primary coolant is cooled and depressurized, thereby sweeping significant amounts of fission gases (if present) with it. A sample of the gases taken from each process tube will be continuously monitored. Scoping of this system is scheduled for completion on January 15, 1959.

The specifications of the high level safety amplifiers were changed to eliminate the requirement for three of the lowest ranges. This change was necessary to permit the use of presently developed equipment. Ranges now required are: 0-100, 0-300, 0-1000, and 0-3000 microamperes.

Two automatic controller layouts submitted by the controller designer were reviewed during the month. Clarification of certain design details, including the interlock system and some trip functions, is required prior to approving the design. The present design utilizes standard components,

some of which require minor modifications. Since little hardware is required, maintenance and reliability is expected to be little different from any other standard instrumentation systems containing four or five control instruments.

The shim control prototypes were completed and shipped by APED on November 13, two days ahead of schedule. These assemblies are to be tested at HAPO. The replacement motors having radiation-resistant, unfilled ceramic-insulated windings are yet to be delivered.

Further information on the burning out of the formex-insulated motors under test at Glove Industries indicates that this incident was caused, at least in part, by the high viscosity of the Shell APL grease used in the gear boxes. The grease was developed for use in heavier equipment. The replacement motors will be lubricated with SHELL ETR grade B grease, a light-weight, temperature and radiation resistant grease recommended by Shell Oil Company for this application. The recommendation was based upon extensive radiation testing.

Consideration is being given to possible modification of the shim control design to provide additional insurance against breakage of a chain and inadvertent dropping of a rod. Modifications under consideration include the addition of a torque limiting slip clutch to the drive chain and a spring-loaded catch which would catch on pins placed in the guide tube if chain tension above the rod was released.

Construction Engineering Operation has been requested to proceed with the design of the PRTR gas moisture detection system. Design of this equipment had been held up pending the completion of tests providing information as to system requirements. The system design will center about a bank of Foxboro "Dewcel" humidity detectors. These elements will operate at 0°F and will be sensitive to dew points as low as -30 F. Each cell can monitor the combined gas samples of seven or eight shroud tubes (through a manifolding system), or by appropriate valving can monitor a single tube. An uncooled additional detector will be connected by valved lines to all sampling manifolds. This detector will be used for monitoring any sample which exceeds 0°F dew point.

Process Piping. An operational test of the prototype primary coolant pump seals was witnessed at the Byron Jackson Pump Company plant at Los Angeles. The primary seal failed after about 3-1/2 hours of operation. Pump speed, and circulating fluid temperature and pressure, were being increased during the period and, except for pressure, the final conditions for the intended 100-hour hot test were not attained.

Disassembly of the seal showed severe scoring of the stellite and graphite surfaces of the primary seal, together with considerable chipping of the edges of the graphite. There was no apparent damage to rubber O-rings, cups, or the secondary and outer seals. Laboratory tests of the primary seal were scheduled for immediate resumption, and the 100-hour hot test will be started again during the first week of December after careful inspection and cleaning of parts and the installation of a screen to trap out foreign material in the primary seal cooling system.

Shielding. Scope revision number 108-2, requesting a revision of the shielding moat to eliminate the outer seal wall and substitute vertically moving lead doors for the water fill, was prepared. Scope drawing SK-3-8043 was prepared to show the new arrangement.

Fuel Element Examination Facility. The detailed design of the cast iron and steel shielding and the necessary ventilation and services is approximately 80% complete.

The design of the wide-angle viewer is approximately 75% complete.

PRTR Physics. Because of the favorable peak to average power ratios found with the spike enriched, D₂O reflected PRTR, the work reported in HW-58016 is being extended to include 1.8 w/o Pu-Al spike loaded with Mark I UO₂ fuel. Although the initial heat generation is higher than the Mark I UO₂ in the same neutron flux, indications are that it may be utilized in place of the 1.65 w/o Pu-Al and thus achieve higher Pu burnup.

Three-group flux calculations are being carried out to obtain vertical flux distributions and reactivity as a function of moderator level and fuel element hanger length. Also, a more accurate representation of the top and bottom shields has been incorporated to obtain shield fluxes simultaneously.

A study to determine the reactivity effect of H₂O impurity in the primary coolant has been undertaken. Calculations are nearly complete, and preliminary results have been obtained. These show that a small reactivity gain accompanies the introduction of light water into the coolant, to about 20 mole percent H₂O/D₂O in the UO₂ region of the reactor. This is due to the resonance escape probability and non-leakage probability increasing more rapidly than the thermal utilization decreases. The thermal utilization becomes dominant beyond 20 percent, and a net decrease in reactivity results. However, this will not be the case in the Pu-Al spike region of the reactor since the resonance escape probability is very high initially. Therefore, the utilization is completely over-riding and a net loss in reactivity is obtained. The two effects will tend to compensate to at least five percent H₂O.

Plutonium Fabrication Pilot Plant

Construction is 48% complete. Project design is approximately 85% complete.

Phase II Construction. Phase II construction is 46% complete compared to 43% scheduled and is progressing at better than the scheduled rate. The rapid progress being made at the present time is due to the installation of partially prefabricated mechanical elements, such as the under-floor exhaust ducts and drain piping. Concrete work is 73% complete. Very little interference from weather conditions has been experienced; the contractor has provided tarpaulins and heaters for the protection of freshly-poured concrete.

The contractor for the door alarm system has failed to meet required deliveries of drawings for approvals, but no interference with Phase II construction has resulted.

Phase III Design. The design schedule completion date of December 12 for Phase III installation contract will be met, it presently appears.

Procurement. Project procurement is proceeding on schedule. Requisitions totaling about \$690,000 in estimated cost have been transmitted to Purchasing Operation. Purchase orders totaling \$507,058 have been placed. The actual purchase price for the orders thus far placed has been about \$42,000 under the estimates.

Hazards Evaluation

The Preliminary Safeguards Analysis of the PRTR was reviewed by the Advisory Committee Reactor Safeguards on November 6, in Washington, D.C. No information of the official action taken by ACRS has been received.

A contract with Battelle Memorial Institute is being negotiated for the analysis of fuel temperature excursions following possible loss-of-coolant incidents in the PRTR. This study will include an evaluation of the sensitivity of fuel elements to the reintroduction of coolant at varying times after the loss of coolant.

PRTR Pressurized Gas-Cooled Loop Facility

CO₂ Gas Loop. The project proposal for Project CAH-822, the PRTR gas loop, has been approved by General Electric Company and forwarded to the Atomic Energy Commission.

Revisions to the gas loop flow diagram have resulted in some simplification of piping and the elimination of several valves which were formerly required to operate at 1100 F and 500 psig. All critical control valves are now operating in lower temperature (about 450 F) regions.

A document outlining working relationships for the gas loop project has been written. The schedule included in this document calls for completion of the loop facility for beneficial use by May 15, 1960. Scoping of the project is to be completed by January 15, 1959.

2. BASIC SWELLING STUDIES PROGRAM

The diffusion of the inert fission gases, krypton and xenon, and subsequent void formation, results in swelling of irradiated fuel materials. This swelling appears to be dependent upon irradiation temperature, restraining pressure, burnup, burnup rate, fuel composition and fuel material parameters such as purity, residual work, and grain size.

In order to determine the effect of purity on swelling behavior, it is considered necessary to obtain high purity uranium as a base material for the swelling experiments. A newly built, small, electrolytic cell has been constructed of Zircaloy-2. High purity salts (LiCl, KCl) were used to prepare the salt bath electrolyte. Three percent enriched uranium was dissolved in the bath, and the cell anodes were made of the same material. High purity enriched uranium dendrites were obtained within two hours of

starting the electrolysis. Several pounds of fine uranium dendrites (about 99.99%) were produced during the month. They are of high purity in spite of the use of rather impure enriched uranium anode feed material. The analysis of the dendrites is given below with the major impurities listed. For purposes of comparison a typical analysis of ANL produced dendrites of depleted uranium is also shown.

	<u>HAPO (3% U)</u>	<u>ANL (Depleted U)</u>
K	40 ppm	200 ppm
Li	20	100
Si	13	15
N	~10	10
Al	10	7
C	> 2	5
Mg	15	2
Fe	15	0.2
Cu	10	11
Ni	10	11
<hr/>		
Estimated Total	135 ppm	340 ppm
Impurities		

The analysis of the HAPO dendrites compares favorably with that of ANL dendrites.

Most of the parts are prepared for assembly of the first irradiation capsules. The remaining parts (thermocouples, heaters, and instruments) must be procured off-site and will not be delivered until January 15.

A new advanced type of swelling irradiation capsule is being designed. It is intended for constant pressure, controlled temperature irradiation of a large uranium specimen with provision for a continuous measurement of the sample volume during irradiation.

Metallographic study of available specimens of irradiated uranium continued during the month. A sample irradiated to 0.2 atomic percent burnup was examined. It was annealed for one hour at 600 C to determine the influence of post-irradiation annealing on the 200 Å diameter voids observed in the specimen after irradiation. The specimen is being polished in preparation for subsequent etching and replication.

The most powerful restraining force on small bubbles in uranium, according to calculations, is the surface tension. It is of the order of 1000 ergs per cm² of surface area of the bubbles, but it has not been measured as yet in solid uranium at any temperature. A measure of the surface tension of uranium metal as a function of its temperature is very important to the understanding of the basic mechanisms involved in swelling. A review of the literature was made which revealed three independent methods of determining surface tension of solid metals. The most promising one involves increasing the load on a fine metal wire to find the maximum load for which

no deformation takes place at a particular temperature. An apparatus is being designed on this principle to make precise measurements of the surface tension of uranium and to determine the effect of temperature on surface tension.

3. GAS COOLED POWER REACTOR PROGRAM

Graphite Studies

Graphite Oxidation Studies. An oxidation apparatus was constructed for studies of the CO₂-graphite reaction. The weight loss of a graphite sample was measured during the oxidation process at the temperature of reaction. A sample of type KC graphite, two inches long and 0.42 inch in diameter, was suspended in a heated quartz reaction tube from one arm of an analytical balance. The balance was of the optical beam variety which projects unbalances to a maximum of ± 10 milligrams. A furnace surrounding the quartz reaction tube and graphite sample was maintained at 700 ± 5 C, and the gas flow rate was 0.4 ft³/hr. After an initial period of 20 hours (0.02% oxidation) weight loss became a linear function of time. The weight loss was 0.098%/day (least squares analysis) after the initial period. The total weight loss was 1.05% for the 246.5-hour experiment.

Visual observation showed pitting of the graphite sample surface. Surface area of the sample will be measured by the B.E.T. nitrogen adsorption method and compared with the specific surface area of 0.473 m²/g measured before the weight loss experiment. Compression strength will be measured and compared with an unoxidized sample cut from the same bar of graphite. A second oxidation experiment at 750 C is in progress.

Compression Strength Studies. When graphite serves as a structural material as well as a neutron moderator in a gas cooled reactor, strength considerations may determine the allowable rate of oxidation during the life of the reactor. Compression strengths of TS-GBF graphite samples having various diameters and lengths were measured to determine the optimum sample size for testing. Related pairs of graphite cylinders cut with the major axis perpendicular to the extrusion direction and having a diameter of one inch and length of 1.76 inches ruptured at average pressures of 4478, 4581, 4462, and 4494 psi, respectively. Analysis of four similar samples of 0.42 inch diameter and one inch length showed average rupture points of 4548 ± 205 , 4536 ± 157 , 4404 ± 71 , and 4536 ± 142 psi. From these tests it is concluded that the smaller sample size is satisfactory for compression strength tests, and that results appear not to be invalidated by local imperfections. In an attempt to further reduce the sample size, cylinders 0.25 inch in diameter and 0.587 inch long were tested. While the results have not been statistically analyzed, it is apparent from the variations that samples this size are less reliable for accurate compression strength data.

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HW-58244

D. CUSTOMER WORK

Radiometallurgy Laboratory

Examination of Depleted Uranium I & E Elements From 105-C (RM-253). Examination of several 0.2 a/o U-235 depleted I & E uranium fuel elements was continued. An area suspected of water penetration through a weld defect was discovered in the female cap of element 253A (Tube 2079-C). Several water channels leading through the AlSi bonding layer surrounding the spire were found in the uranium adjacent to the female cap. The bonding of aluminum can to AlSi to uranium surrounding these water channels appeared to be very good.

I & E Hole Failures From 4985-KW and 4259-KE (RM-252). Two internally and externally cooled natural uranium production fuel elements from 4985-KW and 4259-KE, in which the can wall of the internal coolant annulus had ruptured, were received for examination. Visual examination of the piece from 4259-KE showed that the can wall of the inner annulus had failed at a point approximately one and one-half inches from the male end of the slug. A warp of 0.040 inch was observed over a two and one-half inch length, the origin of warp being at the midpoint of the slug and extending toward the male end. Cracks in the weld were observed over one-fourth of the weld area in the male cap. A uranium oxide formation, approximately one-half inch in length and three-sixteenths inch in diameter, which caused the internal can wall to part in tensile failure, was seen on the interior surface when the slug was sectioned through the rupture area. No splitting of the uranium metal was observed. Additional sections were made immediately upstream and downstream from the rupture area. These sections will be examined to determine whether or not the original water entry site was in the rupture area.

I & E Hole Failure - 2582-C (RM-249). The examination continued of an I & E enriched element from 2582-C which had failed at the internal spire about two inches from the female end. Longitudinal sectioning of the element adjacent to the point of failure revealed that the spire can wall was severely corroded and that the spire was not bonded to the uranium over a distance of at least one inch from the rupture. Examination of the inner spire has revealed only a surface attack of the aluminum by the reactor water. No pitting type, or intergranular corrosion has been found. However, an unusual type of apparent impurity, which lies normal to the direction of extrusion, has been seen. This "impurity" extends nearly through the can wall. Metallographic examination of a wafer showed that the bonding layer between the spire and uranium had separated and that there was a water channel between the AlSi layer and the uranium. Work to determine the nature of the initial water penetration is continuing.

Examination of Undissolved Material From Purex (RM-258). Two of several hundred pieces of uranium which would not dissolve under normal operating conditions in the Purex plant were selected and shipped to the Radiometallurgy Laboratory for examination. Visual examination of the pieces showed them to be in the shape of crude cylinders having irregular surfaces. The lengths were approximately six inches and diameters varied from one-half inch to five-eighths inch. The material was identified as uranium, and metallographic examination of a transverse section showed the material to have extremely large grains.

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HW-58244

Metallography Laboratories

A development program has begun to adapt a Syntron vibratory machine for semi-automatic polishing of metallographic specimens. Satisfactory results have been achieved in the adaptation of this unit for polishing at ORNL. One of the attractive features of a modified unit is the ability to process up to 24 specimens simultaneously. The progress of the polishing on any sample can be observed merely by removing it from the unit for inspection without disturbing other samples or interrupting their polishing cycle. Many of the intermediate and fine polishing operations can be performed by the Syntron units, thereby freeing laboratory personnel for other work.

A Bausch and Lomb research metallograph has been added to the 306 Building metallography facilities.

Samples processed during the month:

Total samples processed: 202

Photographs:

Micrographs	332
Macrographs	<u>44</u>
Total	376

J. W. Woodfield

For Manager, Reactor and Fuels
Research and Development

FW Woodfield:kb

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
TW Ambrose	11/12-14	Oregon State College, Corvallis, Ore. U. of Oregon, Eugene, Ore.	Recruiting	--	No
PA Scott WA Burns	11/21-22	Byron Jackson Pump Co., Los Angeles, Calif.	Witness pump testing	F Marrujo E Lindros S Winstein D Harlander O Bayard	No
	11/24	Yuba Consol. Industries, Benicia, Calif.	Witness crane test & pressurizer vessel design discussions.		No
WS Kelly	11/17	General Mills, Minneapolis, Minn.	Discuss preliminary manipulator specifications	DF Melton GC Kelly	No
	11/18	WF & John Barnes Co., Rockford, Ill.	Same as above.	W Taylor J Ross	No
	11/19	Maruel Schebler Div., Forg-Warner, Decatur, Ill.	Same as above.	L Velerder F Heuchling	No
	11/20	Greer Hydraulics New York, N.Y.	Same as above.	JF Cain GW Brooks	No
	11/21	AMF Atomics Greenwich, Conn.	Same as above.	N Ovuka, L. Scheib RS Bruns	No
JF Fletcher	11/12-13	GE-APED, San Jose, Calif.	Witness tests of shim control prototypes; discuss design of shim controls.	CC Ripley JI Sweeney RE Snowman	No
HK Nelson	11/4-8	Minneapolis-Honeywell, Philadelphia, Pa.	Technical liaison on PRTR automatic controller contract.	EB Dahlin	No
DJ Foley	11/9-12	CWSD; Kirkhill Rubber Co.; Master Products Co.; U.S. Flexible Metallic Tubing; Los Angeles, Calif.	Discuss calandria and inflatable seal design, & shroud tube bellows.	DJ Bentley RL Short Mr. Panfill FA McDonald	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
CS Powers	11/17-27	Sargent & Wilbur, Pawtucket, R.I.	Engineering consultation on contracts with vendors.	MW Jones	No
NG Wittenbrock RM Fryar	11/4-9	Haz.Eval.Branch, ACRS, Washington, DC	Discuss PRTR hazards with HE Branch & ACRS.	HD Smyth	Yes
LG Merker	11/16-30	Clearing Machine Corp., Chicago, Ill. Harper Electric Furnace, Buffalo, N.Y. Sargent & Wilbur, Pawtucket, R.I. Industrial Process Engrs., Newark, N.J.	Engineering consultation on contracts with vendors.	P Delmar HD Roth MW Jones I Rubin	No No No No
RM Fryar	11/4-9	Comm. on Reactor Dev., Washington, D.C.	Discuss PRP with Ad Hoc comm. on Reactor Dev.	HD Smyth	Yes
AL Bement	11/3	Ford Instrument Co. Long Island, N.Y.	Discuss procurement of specialized creep capsule components and development and fabrication of such capsules.	C Hauer	No
	11/4	Schaevitz Engr. Co., Pennsauken, N.J.		A Brosh	No
	11/5	E. C. Smith Engr. Co., Conshokoken, Pa.		EC Smith	No
	11/6	Rho Engr. Co., Los Angeles, Calif.		M Gordon	No
	11/7	Saginaw Steering Co., Los Angeles, Calif.		G Widmoyer	No
JJ Cadwell EA Evans	11/3	duPont Savannah River Plant, Aiken, S.C.	Discuss UO2 program.	PH Permar	Yes
	11/4	US-AEC, Washington, D.C.	" in-pile creep studies.	JM Simmons	Yes
	11/5	New Rochelle Tool Co., New Rochelle, N.Y.	" contract.	--	No
	11/6.	Nuclear Metals, Inc.	" program for extrusion of ribbed fuel sheathing tubes.	P Loewenstein	Yes
	11/7	GE - Dresden Nuclear Power Sta., Joliet, Ill.	Visit Dresden reactor site.	FA Hollenbach	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JJ Cadwell	11/8	U. of Wisconsin, Madison, Wisc.	Faculty contacts.	--	No
EA Evans	11/8	Midwest Res. Corp., Chicago, Ill.	Discuss high temperature studies.	--	No
JC Tobin	11/4	US-AEC, Washington, D.C.	Discuss in-pile creep studies program.	JM Simmons	Yes
	11/5	E. C. Smith Engr. Co., Conshohocken, Pa.	Discuss procurement of specialized creep capsule components and fabrication of such capsules.	EC Smith	No
	11/6	Rho Engr. Co., Los Angeles, Calif.		M Gordon	No
	11/7	Saginaw Steering Co., Los Angeles, Calif.		G Widmoyer	No
JM Tobin	11/4	ANL, Lemont, Ill.	Discuss procurement & availability of ultra high purity electrolytic U for basic swelling.	L Lloyd	Yes
	11/5-6	Michigan State U., Lansing, Mich.	PhD recruiting.	--	No
B Mastel	11/17-21	4th Annual Norelco Microscope School, Mt. Vernon, N.Y.	Attend school.	--	No
RG Wheeler	11/19-21	ORNL, Oak Ridge, Tenn.	Discuss creep of Zircaloy	DS Billington J Wilson	Yes
DR Stenquist	11/21	Western Gear, Seattle, Wn.	Consult on fabrication of feeding device for swage machine.	--	No
	11/21	Continental Can Co., Seattle, Wn.		--	No
RJ Anicetti	11/24-28	Fellows Gear Shaper Co., Springfield, Vt.	Observe experimental rod forming in cold forming machine.	JF Jones, Jr.	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
DC Kaulitz	11/20	Rohr Aircraft, Chula Vista, Calif.	Discuss 6x9 in-reactor facility.	--	No
	11/21	Convair Aircraft, San Diego, Calif.	Discuss impact extruding.	R Monsees	No
	11/22	Res. Welding & Engr. Co., Los Angeles, Calif.	Discuss R&D & welding contract.	J Garfield	No
	11/24-25	Convair Aircraft, Pomona, Calif.	Discuss impact extruding.	J Ottestad	No
	11/26	Consol. Electro Dynamics, Los Angeles, Calif.	Discuss instrumentation for creep & swelling programs.	--	No
RE Nightingale	11/3-8	U. of Wisconsin, Madison, Wisc. U. of Minnesota, Minneapolis, Minn.	PhD recruiting	--	No
JW Riches	11/5	New Rochelle Co., New Rochelle, N.Y.	Consult on fabrication of zirconium.	CA Tudbury	No
	11/6	Nuclear Metals, Concord, Mass.		P Loewenstein	Yes
JW Riches	11/7	Allegheny-Ludlum, Watervliet, N.Y.		RE Rohrbaugh	No
RL Knecht	11/10	Superior Tube Co., Norristown, Pa.		HW Cooper	No
	11/11	Chase Brass & Copper Co., Waterbury, Conn.		DK Crampton	No
	11/12	Tube Reducing Co., Wallington, N.J.		CL Megargle	No
	11/13	Cincinnati Milling Co., Cincinnati, O.		H Carylyle	No
	11/14	Hunter-Douglas, Riverside, Calif.		RA Quadt	No
	11/5-6	Mallory Sharon Niles, O.	Same as above.	GB Brown	No
RE Falkoski	11/6-7	Los Alamos Scientific Lab., Los Alamos, N.M.	Discuss impact extrusion and U-233.	J Kircher W McNeese	Yes
FWJ Bailey FMD Freshley	11/6-7	GE-APED, San Jose, Calif.	Discuss fuel elements.	J O'Rourke MJ Sanderson	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
PG Pallmer HR Gardner RD Nelson	11/17-19	Dow Chemical Co., Denver, Colo.	Present paper at Pu Metal- lurgy Conference	--	No
OJ Wick RW Stewart	11/18-20	"	Attend Pu Metallurgy Conference & technical discussions.	LA Matheson	Yes

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldg. Visited
WA Brobst JV McNamara	11/3	AEC, Health & Safety, Discuss health, safety & Chicago, Illinois. fire protection consider- ations in handling Pu.	HE Hanthorn	No	700; 760	
D Reece	11/17-	Natl. Res. Corp., Boston, Mass.	Discuss high vacuum eqpt.	SH Bush DC Kaulitz RS Kemper	No	300; 306, 326
S Kass	11/24- 25	WAPD, Bettis Field, Pittsburgh, Pa.	Preparation for AEC Cor- rosion Symposium.	RL Dillon VH Troutner JA Ayres JE Minor C Bennett JW Goffard	Yes	300; 325, 326, 314 100K; 1706KE, 1704 700; 762
C Lindquist S Isserow		KAPL, Schenectady Nuclear Metals, Concord, Mass.				
RS Miller AW Dromerick T Stevens	11/5	Amer. Car & Foundry, Discuss Gas Cooled Re- Washington, D.C. actor Graphite studies. Kaiser Engrs., Oakland, Calif.		JM Davidson DE Baker TJ Clark EM Woodruff FW Woodfield	No	300; 326
PG Boyer		Idaho Op. Office, Idaho Falls, Ida.				
EW Sinnott	11/24- 26	U. of Michigan, Ann Arbor, Mich.	Consulting Agreement No. 199.	FW Woodfield SH Bush, JJ Cadwell OT Wick	Yes	300; 325, 326, 306 200W; 231Z, 234-5

VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldg. Visited
BL Greenstreet FL Carlsen	11/12-14	ORNL, Oak Ridge, Tenn.	Discuss Gas Cooled Reactor Program	JM Davidson RJ Anicetti RF Corlett	Yes	300; 325, 326 700; 762
BL Bailey	11/18-	Great Lakes Carbon, Niagara Falls, N.Y.	Discuss graphite for NPR & technical criteria for non-contracting graphite	RE Nightingale JM Davidson DH Curtiss RE Trumble	Yes	300; 326 100; 105-C, 200; 2101
WC Riley	11/20-21	BMI, Columbus, O.	Discuss experimental features of HAPO BMI contract.	RE Nightingale FW Woodfield HH Yoshikawa	Yes	300; 326 100D, 1703
EA Wright	11/5-7	Wolverine Tube, Allen Park, Mich.	Consult on fabrication of Zircaloy in NPR design	HP Oakes	No	300; 326 200 E; 100K; 105-KE 1706-KER
RC Westphal AL Maharam	11/17	WAPD, Bettis Plant,	Discuss hot lab eqpt. of use to WAPD.	LD Turner	Yes	300; 327
F Brown	11/18	General Atomics, San Diego, Calif.	Discuss metallurgical testing & examination processes.	LD Turner	Yes	300; 327
MH Bartz EH Davidson	11/12	Phillips Pet. Co., Idaho Falls, Ida.	Discuss MTR fuel elements.	OJ Wick	No	200W; 2704Z

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATIONMONTHLY REPORTNOVEMBER 1958FISSIONABLE MATERIALS - 2000 PROGRAMREACTORSTUDIES RELATED TO PRESENT PRODUCTION REACTORS

Lattice neutron temperature experiments continued in the heated TTR thermal column. Irradiations were made at 20 C, 80 C, and 150 C. No results are available on this work as yet.

An OMNICODE program was written and debugged for the diffusion equations for a two-temperature system.

Instrumentation

Several tests were conducted on Borescope-Television systems in cooperation with electrical development operation of IPD to determine the feasibility of using a closed circuit TV camera with a process tube borescope. Such a system would be desirable if it permitted rapid interpretation of a stuck ruptured slug situation by a number of people outside the radiation zone. The tests demonstrated that the detail of the TV picture was inadequate. A report is being prepared which describes the tests, gives polaroid pictures of the results, and states our conclusions.

Development continued on the circuitry for the magnetic core storage elements. This will be used in some of the studies for which the goals and technical approach are now being outlined.

An instrument for determining low-level gamma activity levels underwater was proposed for use at the H reactor. The instrument has a scintillation detector, transistorized circuitry, and is battery operated. The cost of such an instrument was estimated at approximately six-hundred dollars.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Exponential pile measurements on 1.92-inch-diameter natural uranium fuel elements were obtained as follows:

<u>Lattice Spacing</u>	<u>Buckling (10^{-6} cm⁻²)</u>	<u>Volume Ratios</u>		
		<u>H₂O/U</u>	<u>C/U</u>	<u>Al/U</u>
6 3/16-inch - dry	- 448	--	11.64	0.264
6 3/16-inch - wet	- 230	0.288	11.64	0.264

CEGLA

Experiments were begun in the PCTR to measure k_{∞} and β for seven-rod clusters of 0.926-inch-diameter natural uranium rods, air cooled in a 10 1/2-inch graphite lattice. Measurements were also started on the relative magnitude of the adjoint ratio at the central cell and at two surrounding buffers.

A feasibility study of a hot, pressurized exponential assembly to support the NPR program was started.

Information appropriate to the preparation of the Plant and Equipment Analysis Report and Project Proposal for the full scale PCTR was turned over to Laboratories Auxiliaries Operation.

Agreement was reached with IPD physicists on a series of exponential experiments which will produce data applicable to rod-and-tube and tube-and-tube type fuel elements.

Instrumentation

Assistance was given to the Ceramic Fuel Development Operation of HLO in deriving a method of measuring the thermal conductivity of materials at high temperatures by means of optical pyrometry.

STUDIES RELATED TO SEPARATIONS PLANTS

Subcritical multiplication measurements were made on a water-moderated lattice fueled with 0.925-inch-diameter, three percent enriched rods. The minimum critical mass was determined to be 394 pounds at an H_2O/U volume ratio of 3.3. Buckling measurements were made with the same assembly. The critical buckling determined from these exponential pile measurements was in excellent agreement with the buckling obtained using the critical approach technique.

PCTR measurements were continued to establish nuclearly safe H/U ratios for three percent enriched UO_3-H_2O mixtures. Experiments were completed at an H/U ratio of six using two methods of moderation; in one case, water was used and in the second, polyethylene in the form of small pellets mixed with the UO_3 powder. These data are being analyzed.

Technical liaison in support of the design of the Plutonium Critical Mass Laboratory was continued. The detailed design is now about 69 percent complete.

The neutron age measurement facility was dismantled. The foil standardization required for final data reduction was completed.

Testing and adjustment of the electronic instrumentation of the new mass spectrometer was continued.

Exponential experiments for nuclear safety determinations were started using 1.25 percent enriched I and E fuel rods. Preliminary calculations show a buckling of about $4650 \times 10^{-6} \text{ cm}^{-2}$ for a 2.2-inch hexagonal array in water, H_2O/U volume ratio of 2.29.

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REACTOR DEVELOPMENT - 4000 PROGRAMPLUTONIUM RECYCLE PROGRAM

A study was made of the nuclear safety considerations in loading chopped-up PRTR fuel elements (Pu-Al alloy containing 1.8 percent Pu by weight) in the present slug buckets. A single slug bucket will be subcritical. Under water, a 12-inch spacing is required between buckets and in air, a single plane array will be safe with 48-inch spacing between buckets.

For a more complete understanding of the PCTR k_{∞} measurements, a core flux calculation using the VALPROD IBM-650 program appears worthwhile. A table of cross sections required for this code was prepared from the work of others and from fundamental data.

Instrumentation

The range of focus of the profilometer was increased from about two inches to five inches by a modification in design which places focus compensating lenses close to the first relay lens of the periscope. Details of the diameter measuring unit were worked out.

The design drawings for the wide angle viewer were 70% completed. Assistance was given to the draftsman by providing more detailed sketches of the type of construction desired in the parts outside the examination pit.

GAS COOLED REACTOR PROGRAM

Fabrication of test core components is scheduled to begin the first week in December and be completed by March 1. Assuming all materials are received from ACF by January 15, the experimental work could begin by March 15.

OTHER

At the request of CPD a study was made of the criticality problems of processing MTR-type plutonium-aluminum alloy fuel elements (Pu content ≤ 15 percent by weight). Based on calculated values, the minimum critical mass for this type fuel element in water is 500 grams of Pu. If it can be guaranteed that the plates will remain straight during dissolution, the minimum critical mass is about 700 grams.

CROSS SECTION PROGRAM

The new three-crystal spectrometer was used to investigate the slow neutron scattering cross sections of water and zirconium hydride. The effects being investigated were apparently below the present detectable limit of the spectrometer.

Data on the 0.3 ev fission resonance of Am^{241} have been taken with improved precision and are about 50 percent accumulated.

Improvements were made to the Van de Graaff accelerator and pulse detecting equipment used in the fast neutron cross section investigations.

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BIOLOGY AND MEDICINE - 6000 PROGRAMENVIRONMENTAL STUDIESAtmospheric Physics

Development work on the automatic fluorescent particle counter was continued by the Instrument Development Operation in collaboration with Atmospheric Physics personnel. As reported previously, variability of filter thickness had introduced large uncertainties in the calibration of this instrument. Following a drastic revision of the geometry of the alpha source-filter-photo-cell, the instrument was recalibrated by this Operation. The calibration uncertainties have been reduced at least fourfold and, with further refinement, the instrument should be fully operational by next June.

Following extensive contacts with manufacturers, procurement of equipment for next summer's field program was begun. Bids for air pumps and motors have been solicited. Auxiliary equipment and hardware have been specified and will be procured in the near future. A request for twenty towers on a loan basis from the U. S. Army Signal Corps was directed to the HOO-AEC, and has been formally presented to the Signal Corps by the AEC.

Final arrangements for conversion of an Army messhall to a field servicing facility were completed. Negotiations for office and laboratory space in 200-W continued.

DOSIMETRY

More construction materials for the body monitor were tested for radioactivity: Some threaded rods were acceptable, surface contamination was found on some cap screws, caulking putty was unacceptable. Two measurements were made of the background in the iron room. For integral counts above a pulse-height equivalent to 0.1 Mev these gave results 75% and 42% of the background in the rock shield. Part of the difference in these results is due to difference in position in the room and part to decay of fresh fallout on the room surfaces (they have not yet received their final cleaning).

A case of plutonium deposition in a wound that was reported last month was studied again. After treatment, 2.4% of the original burden had been found at the wound site. Fifteen days later and with no further treatment, 0.4% remained.

A new case of plutonium deposition in a wound was studied and found to have 0.0072 ± 0.004 μ c in the wound. Following surgery the next day, 32% of the original burden was still in the wound. Twenty-nine percent was found in the excised tissue. The wound burden had not decreased four days after surgery.

It was found that bulging of the thin window of the large proportional counter was changing the relative size of similar pulses obtained from different parts of the counter. Some of this could be avoided by not using the counter wires near the edge of the counter; this results in only 5% loss in efficiency. The small end-window proportional counter was completed and tested. Resolu-

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tion was poor as expected. For wound counting, minimum detectable amounts of about 4% of the permissible body burden (0.04 μ c) were obtained.

The silicone plastic used as the center layer in safety glass was tested for coupling scintillators to photomultiplier tubes. It would have the advantage over liquid couplers that it would not leak out. It was found that, if air bubbles can be eliminated from the seal, very little pulse height is lost in the plastic; elimination of the air bubbles is quite difficult.

The entire month was spent on maintenance-type activities with the positive ion Van de Graaff. The corona stabilizer was rejuvenated and tested, the generator aligned, a new belt and a new ion source were installed, the belt-charge supply was reconstructed and a beam-energy homogenizer added, and the proton-moment detector was recalibrated. The accelerator is now in operation again. The homogenizer was tested and found to increase the energy control and reduce the spot size. A remotely controlled positioner for instruments and shadow shielding was installed. A new oscillator for the time-of-flight system is being installed.

Fabrication was begun of a long counter that is expected to be reproducible enough to be duplicated in other laboratories. The Hanford Type B BF₃ tube was redesigned slightly for use in this counter. A small Pu-Be source was received that had been designed for insertion into this counter for calibration purposes.

A large Pu-Be source obtained by Calibrations Operation was examined with the double-moderator. The average energy of the emerging neutrons was found to be lower than expected. It was hypothesized that this was due to moderation within the source. To check this hypothesis similar measurements were begun on the smaller source obtained for the long counter.

Studies aimed at improving low-dose pencil ion chamber techniques continue to indicate that improvements are needed in the pencils themselves. A Victoreen "stray radiation" chamber borrowed from Radiological Development showed excellent reproducibility. The stem containing the insulator and central electrode assembly from this chamber has been incorporated into a regular Victoreen pencil to see if better reproducibility of the latter can be achieved.

A check of the linearity of the condenser-divider method of measuring Van de Graaff voltage was completed for the range 0.75 to 1.66 Mev. The system was linear within the experimental uncertainties of about 1%. A paper describing this system was prepared for submission to a technical journal.

The Manager, Radiological Physics was invited to become a member of the Committee on Quantities and Units of the International Commission on Radiological Units and Measurements. This committee is to review and study the basic quantities used in radiation dosimetry and their units of measurement with the purpose of recommending additions and changes at the Tenth International Congress of Radiology (1962).

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INSTRUMENTATION

The work continued on detection techniques for use in radiation protection instrumentation. Laboratory testing is in progress on components for the prototype hand and shoe counter which employs a single scintillation detector for each hand surface capable of detecting the alpha and beta-gamma components of contamination. This instrument is expected to be ready for demonstration by about March of 1959. Fabrication continued on equipment for demonstrating the use of scintillation detectors on portable surveying instruments. It is expected that by March of 1959 this equipment will be ready for demonstration. A new source configuration for the zinc-sulfide particle counter resulted in the elimination of the problem caused by filter thickness differences. More detail on this is included under customer instrumentation. Experiments utilizing the tribo-luminescence effect indicate that a dust measuring instrument might be practical. Dust particles impinging on a tribo-luminescent material cause scintillations which can be observed by a phototube.

Effort continued on sensitivity improvement techniques. Inertial separation of airborne particles was accomplished for use with continuous alpha air monitors, but much more work is still needed. The techniques for calibrating and adjusting the dual alpha air monitoring system were worked out. More on this instrument appears under customer instrumentation.

Work on automatic techniques included the investigation of a portable dose rate integrator. The experimental instrument employs a battery operated miniature motor which turns a disk. The disk movement, with appropriate scale factor, is integrated by a simple but effective optical method to indicate the integral of the dose rate. The dose rate reading, as measured with a CP, is put on the dose rate integrator by means of two dials; one for the CP range and one for the CP reading. Another automatic technique being investigated is the passive analog computing-type network for possible use in the radioanalysis laboratory. The experimental equipment gave readings for the quantities of five different radioisotopes in a sample with an accuracy of about one part in 500 when the pertinent multichannel analyzer readings were known. All decay factors were assumed to be constants equal to unity.

WASHINGTON DESIGNATED PROGRAM

The new mass spectrometer for this program is nearly ready for operation. Tests showed that the over-all sensitivity will be in the correct range. The detection efficiency of the system is expected to be of the order of 10^{-19} ampere when ion pulse counting detection is used.

CUSTOMER WORK

Analog Computing

The neutron flux and power distributions for three loadings of K reactors consisting of various combinations of enriched and absorbing materials were computed using two-group equations.

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Time delays in the temperature changes which could result from the malfunction of heat exchanger valves in one of the KER loops was computed.

Dynamic design of the pressurizer for the NPR continued.

Assistance was given to others in running their problems on the Digital Differential Analyzer.

Weather Forecasting and Meteorology Service

<u>Type of Forecast</u>	<u>Number Made</u>	<u>% Reliability</u>
8-Hour Production	90	78.1
24-Hour General	60	75.5
Special	142	90.1

November became the seventh straight month with above-normal temperature and the fifth straight with below-normal precipitation. Departures, however, were small. A cold wave near midmonth and another during the last six days reduced the over-all monthly average temperature to 40.6 as compared to a normal of 39.9. Although precipitation occurred on 15 of the first 20 days, the absence of any measurable amount thereafter held the monthly total to 0.77 inch as compared to a normal of 0.86. Strong winds occurred on several dates with highest speeds (peak gust 58 mph) observed on the 3rd.

Instrumentation

Testing and adjusting were continued on the prototype dual alpha air monitoring system for use at Purex. Two high-level alpha air monitors are operated independently to activate a differential alarm circuit and recorder. Such operation materially reduces the effects of Radon-Thoron background problems. Assuming a 20% detection efficiency, the filtering is of a nature so that an alarm "setting" of 200 d/m would result in a 20% probability of one false background alarm in any one year.

The sensitive gamma scintillation transistorized monitor for the Regional Monitoring Operation was calibrated and field tested. The instrument employs a 5" x 5" terphenyl in polyvinyltoluene crystal detector. The device was calibrated with a known-value Ra source in a nearly free-air calibration. The results showed the instrument to be linear to $\pm 5\%$ of full scale on any of the three ranges. The first range full scale value was determined to be 0.015 mr/hr corresponding to 10,000 c/m. Ranges two and three were 10 and 100 times this value respectively. The instrument drives a 1.0 ma chart recorder, and it has been used now in three flights over the area and on the river with good reproducible results.

The experimental medium-level scintillation alpha air monitor was successfully used at the Biology Operation for a second month. Several tiny light leaks in the crystal detector cover were repaired. The instrument is installed in the inhalation laboratory where animals are allowed to breathe air contaminated with Pu²³⁹. The instrument will alarm if the "clean" atmosphere exceeds 60 mpc of Pu²³⁹ in 20 minutes.

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The Zinc Sulfide Particle-Counter for the Atmospheric Physics Operation was extensively modified concerning the detector head. A new source holder was prepared using a disk with a center hole. The 200 μ c source (Pu^{239}) is peripherally deposited on the centerless disk and the disk is mounted, clean-side down on the phototube. The particle-filters are counted while in position above the disk. Such a system was originally specified but, up to now, it was not possible to obtain a non-scintillating source of 200 μ c size. Counting a number of filters, with the same visual number of particles per filter, on the scintillation counter, the errors obtained were about $\pm 20\%$ which seems acceptable. Attempts will be made to reduce this error, if possible.

The Dog Counter, an instrument used for in vivo monitoring in animals at Biology for radioisotopes Pu^{239} , Sr^{90} - Y^{90} , Ru^{103} , Ru^{106} and Cs^{137} , operated reasonably well for the month. However, to alleviate background difficulties due to the pile being "up" and also due to the 100-F settling basin proximity, it has been decided to additionally shield the counter with lead bricks. Due to the peculiar placement of the counter, above ground and with the open "end" facing the pile building, there has been some background interference problems. The lead bricks should reduce, considerably, this effect.

A work request was received for the design and fabrication of a detector for the alpha filter counter in the Finished Products Operation of CPD.

Optical

The photoelectric controller test stand was completed and tested. Operating instructions were written and delivered with the unit to the Relations and Utilities Electrical Operation.

An authorization of \$13,400 for work on the PRTR combination 5X viewer and Profilometer was received and design work was started. Developments on this are indicated under the 4000 Program portion of this report.

The routine optical shop work included the fabrication of a telescopic viewer for the 105-C fuel examination facility profilometer, an underwater borescope probe for the 105-C fuel examination facility, and a TV camera mount for use in the TV-Borescope tests. Three borescopes were serviced and a lead glass brick was polished. Fabrication was started on eight glass bearings for spare parts.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
C. L. Peterson John Wilson Henry Schmitt Tom Tracy C. Vale	11/5	Minneapolis-Honeywell Regulator Co. Philadelphia, Pa.	Discuss instrumentation.	RA Harvey	No	300: 329
R. F. Shea	11/11	Knolls Atomic Power Lab. Schenectady, N. Y.	" "	RA Harvey	No	300: 329
J. H. Kendron	11/19	G-E Aircraft Nuclear Propulsion Dept. Idaho Falls, Idaho	Discuss telemetering.	RA Harvey	No	300: 329
D. W. Magnuson	11/20-21	Oak Ridge National Lab. Oak Ridge, Tenn.	Discuss reactor physics experiments.	JE Faulkner	Yes	300: 326 100: 105-DR 105-KE
H. Bichsel J. Spangler	11/27-30	Univ. of Washington Seattle, Wash.	Work on thesis.	WC Roesch	No	300: 3745-B

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. E. Heineman	11/4-7	Mass. Institute of Technology Cambridge, Mass.	Recruiting.	George Hazzard (General Electric)	No
N. Ketzlach	11/12-14	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	UK-US Meeting on Criticality Data.	A. D. Callihan	Yes
P. F. Gast	11/12-13	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Meeting of Advisory Committee on Reactor Physics.	R. A. Charple	Yes
	11/14	" " " "	UK-US Meeting on Criticality Data.	A. D. Callihan	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. A. R. Kent	11/10-11	G-E Res. Lab. Schenectady, N. Y. Knolls Atomic Power Lab. Schenectady, N. Y. General Eng'g Lab. Schenectady, N. Y.	Attend Res. Lab. Conference on Thermionic Conversion. Discuss instrumentation.	-- L. J. Cherubin W. W. Schultz Mr. Truan	Yes Yes Yes
B. R. Leonard	11/13-14	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Meeting of Neutron Cross Section Advisory Group.	J. L. Fowler J. A. Harvey	Yes
W. C. Roesch	11/13	G-E Research Lab. Schenectady, N. Y.	Discuss radiation damage.	J. W. Corbett	No
	11/14	Mass. Institute of Tech. Cambridge, Mass.	Discuss whole body counting.	R. D. Evans	No
	11/15	Columbia University New York, N. Y.	Discuss radiation dosimetry.	W. Gross	No
	11/17	U. S. AEC Washington, D. C.	Discuss natural level dosimetry.	R. W. Johnson	Yes
	11/18-19	U. S. AEC Washington, D. C.	Project Tutor Technical Consultants Panel.	A. D. Starbird	Yes
	11/20	Walter Reed Hospital Washington, D. C.	Discuss whole body counting.	K. Woodward	No
I. T. Myers	11/17-18	X-10, Union Carbon & Carbide Oak Ridge, Tenn.	Attend Solid State Physics Information Meeting.	T. E. Bartner J. Harter M. S. Wechsler	No
	11/20	RCA Princeton, N. J.	Discuss radiation damage.	J. J. Lofersky P. Rappaport	No
	11/21	Argonne Nat'l Lab. Lemont, Ill.	" " "	W. Primak W. Ramler	No

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. A. Kottwitz	11/17-18	Oak Ridge National Lab. Oak Ridge, Tenn.	Information Meeting for Solid State Div.	--	No
G. R. Hilst	11/18-20	U. S. Public Health Ser. Washington, D. C.	Attend Conference on Air Pollution.	L. E. Burney	No
	11/21	" "	Confer on meteorology program in USPHS.	Mr. MacKenzie	No
	11/24-26	Div. of Biology and Medicine, AEC Washington, D. C.	Attend Meteorology Leaders Conference.	Mr. Holland	No
	11/26	Dept. of HEW Washington, D. C.	Attend meeting called by Sec'y Flemming (representing President of the A.M.S.)	L. E. Burney	No
E. D. Clayton	11/20	Oak Ridge National Lab. Oak Ridge, Tenn.	Meeting on shipment of low enrichment uranium and its compounds.	A. D. Callihan C. Keller	Yes

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Chemical Research and Development

RESEARCH AND DEVELOPMENT

FISSIONABLE MATERIAL - 2000 PROGRAM

IRRADIATION PROCESSES

Oxidation and melt-down experiments on high-exposure metal are being scoped and designed. Capacity and other characteristics of a 6 KW induction furnace have been studied for application in these experiments. Quartz furnace tubes fabricated for the external container for the specimen have proven satisfactory in preliminary tests. Equipment for small sample, low level fission product volatilization experiments was assembled and tested using unirradiated metal. No difficulties were experienced.

Reactor Decontamination

Analytical results on the leaching of rupture debris radioisotopes from trench soils by solutions of Turco 4306-B have indicated that minimal leaching would occur if the spent cleaner were treated with caustic to pH 5 or greater and then diluted with 50 parts of reactor coolant. The results are being summarized to provide a basis for recommendations for the safe disposal of such spent cleaning solution to a trench.

Uranium and plutonium in dissolved, irradiated metal were assayed directly by the controlled potential coulometer in test service applications of this new method. The direct plutonium analysis was four times faster than previous methods, was at least as accurate, and caused much less radiation exposure to operators. Precision was better than one per cent for both uranium and plutonium. Plutonium was reduced at 0.54 v and oxidized to Pu (IV) at 0.82 v. In the molar hydrochloric acid medium, uranium did not interfere. Iron, as a contaminant from the dissolver, gave a slight interference which was corrected by an iron reduction at 0.3 v and suitable calculations. Chemical Research, in developing the method, found that iron would adversely affect accuracy at any iron/plutonium molar ratio greater than ten.

Anion exchange greatly simplified preparation of dissolver solution uranium for mass spectrographic assay. Dowex-1 gave excellent decontamination and removal of chemical interferences. The technique was used on six Atomics International samples ranging from 10 to 89 per cent U-235.

SEPARATION PROCESSES

Anion Exchange

Decontamination of Purex LBP. Data from three runs confirm the beneficial effect of addition of fluoride in the loading and wash cycles in improving decontamination of plutonium from those fission products present in Purex LBP. Of particular interest is a run in which the feed (prepared from Purex plant LBP) was made up to 6.1 M HNO_3 , 0.06 M HF , 0.3 M $\text{Al}(\text{NO}_3)_3$, vice 7.2 M HNO_3 in the usual case. Fission

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product decontamination factors in this run were greater by factors of six to seven than decontamination factors measured in earlier runs which differed only in the use of feeds containing 7.2 M HNO_3 , no HF and no $\text{Al}(\text{NO}_3)_3$. The 43 g/l plutonium product from this run had a G/AT ratio of only 6×10^{-13} (microcuries fission product gamma/alpha count) vice a typical plant product ratio of $2 - 3 \times 10^{-11}$. Plutonium breakthrough occurred somewhat earlier in this run.

Kinetics of Plutonium Absorption. A basic study of the kinetics of absorption and elution of plutonium in the nitrate system was concluded with measurements of the rate of absorption of plutonium from a 5 g Pu/l 7.2 M HNO_3 solution by Dowex 1 X-4 (50 - 100 mesh), and of the equilibrium capacity of Dowex 1, X-1 (50 - 100 mesh), for plutonium out of the same solution. Equilibrium resin capacities essentially identical (within experimental error) were obtained at 1 g/l and 5 g/l Pu indicating that the resin can be almost saturated with plutonium at 1 g Pu/l in the solution phase. The absolute rates of absorption of plutonium by Dowex 1, X-4, were also essentially identical at 5.0 g Pu/l and 1.0 g/l, indicating that the fractional rates of exchange are identical and, therefore, independent of solution concentration. This is a rather conclusive indication that the rate-controlling step in the absorption process is the diffusion of the plutonium species in the resin phase. A report, HW-55893, "The Recovery, Purification, and Concentration of Plutonium by Anion Exchange in Nitric Acid," J. L. Ryan and E. J. Wheelwright is being prepared.

Plutonium Processes

234-5 Off-Gas Filter. A Selas 50-micron pore-size filter pencil (approximately 1-inch diameter by 8-inches long) is currently being evaluated for removal of solid particulate from the off-gases from either the plutonium oxalate calciner or the proposed plutonium chloride converter. With cerium fluoride dust as a "cold" stand-in for plutonium powders and with air as the fluidizing medium the pencil filter has demonstrated excellent performance. It is estimated that, under actual plant conditions, the filter could be used more than 100 hours before simple air (or gas) backflushing would be required. When the filter is backflushed, essentially all the powder cake is removed. After repeated regenerations the pressure drop of the freshly backflushed filter has leveled off at approximately 10 inches of water.

234-5 Oxalate Filter. The fabrication of a disk-type filter, to be evaluated for 234-5 Building use in plutonium oxalate solution filtration, is nearing completion. The filter has been designed to permit quick replacement of the filter media. In evaluating this filter, several filter disc media are to be tested including: (a) a porous ceramic rigid media, (b) a sintered-wire stainless steel mesh, (c) acid resistant cloths and felts, and (d) a porous Kel-F disc.*

* A polychlorotrifluoroethylene fabricated by the M. W. Kellogg Company.

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Feed Preparation

Dissolution of DIngot Uranium. Further dissolution rate studies indicate that fluoride ion effectively accelerates the dissolution of uranium by nitric acid even in the presence of aluminum at an Al/F mole ratio of one. Corrosion rates for sensitized 304-L stainless steel in boiling simulated dissolver solutions (6 M HNO_3 - 1 M UNH) were from three to five mils per month when the fluoride concentration was from 0.1 M to 1 M and the Al/F mole ratio was one. Decreasing the Al/F mole ratio increased the corrosion rates markedly.

Flurex Development

Further studies on the use of Tirreloy B as an anode material show poor useful life (ca. 75 amp.hr.) at 0.5 amps/in.² in Flurex anolyte. This experiment was done to check a suggestion by the manufacturer (Ionics, Inc.) that longer useful life might be obtained at lower current density.

WASTE TREATMENT

Nitrate Destruction

Experiments performed in the Semiworks nitrate destruction unit to date indicate that:

- a) Approximately three mols of nitrate present in Purex 1WW are destroyed per mol of formaldehyde reacted.
- b) The nitrate content of the feed may be reduced by a factor of two to three.
- c) The reaction is relatively insensitive to the temperature of the feed and to the location (above or below the pct liquid) of the formaldehyde entry point.

During recent experiments, flooding has occurred in the feed tower (3-inch diameter, packed with 1/2-inch raschig rings). The tower was replaced with a 4-inch diameter unit packed with 1/2-inch Intalox saddles. Subsequent experiments have indicated that this tower is not flooding under normal operating conditions.

Observation Wells

Results of scintillation counter probes of wells near the Purex A-8 crib indicated that there has been no downward progression of gamma emitters since February, 1958. Depths of penetration range from 125 feet to ground water at 235 feet. Gross beta measurements in ground water at this location indicate a gradual decrease. Gross beta concentration in ground water near the Purex A-24 crib continues to rise. The highest level measured was 2.4×10^{-4} uc/cc.

A well is to be drilled near the 327 Building in the 300 Area to monitor ground water near the area where a leak occurred in a waste line.

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Disposal to the Ground

Tests were made to determine what the effect would be of the addition of unneutralized U-Plant condensate to the WR 1, 2, and 3 cribs. Results indicated that most of the Sr⁹⁰ now held on the soil would be eluted quite rapidly by the acid waste. Tests were started with U-Plant condensate adjusted to various pH values to determine the degree of neutralization necessary to obtain satisfactory Sr retention in the TY cribs.

Soil column tests were started to determine the feasibility of predicting Sr⁹⁰ and Cs¹³⁷ breakthrough on the basis of Ru¹⁰⁶ or gross beta breakthrough curves for Purex A-24 waste. It was found that Ru sorption is so slight that it cannot be used for accurate prediction of Sr or Cs breakthrough. Gross beta data are being analyzed.

Further tests using Amberlite IRA-400 synthetic anion exchange resin for removal of Pu from Recuplex process waste showed that greater than 95 per cent of the Pu is removed from 171 column volumes of waste. This may be accomplished in a column at a flow rate equivalent to 105 gal/ft²/day. Work being done to obtain maximum uptake of Pu by the resin includes investigation of acid or metal nitrate additions to favor the Pu anion complex formation, flow rate, column dimensions, and resin type and particle size.

High-Level Wastes

Calculations of the expected release rate into surrounding soil of Redox D-8 high-level waste in the event of a tank rupture indicated that no greater than four gallons per day would be expected to be lost from a rupture opening of 100 square inches. At this rate, the specific retention capacity of the soil beneath such a tank would not be exceeded for more than 40 years.

Document HW-58211, "Status Report - Disposal of Aluminum Bearing Radioactive Wastes by Gelation," was prepared and issued. It summarized the pertinent results and presented recommendations for possible future studies.

Radiant Heat Spray Calcination

Electrical work on the eight-inch by twelve-foot radiant heat spray calciner was completed at month's end. The electrical resistance heating was tried out and seemed to work very satisfactorily, corroborating design calculations. As soon as lagging is complete, the unit will be ready to operate.

The possibility of boosting particle temperature by means of a gas-solid surface reaction is being investigated in the three-inch unit. The scheme involves adding material to the feed which will decompose to carbon by pyrolysis, ignite in the hottest zone of the reactor, and boost the particle temperature to the melting point. This would produce a glassy product without requiring that the calciner be operated at an excessive temperature. Calculations based on literature data indicate that the idea is feasible.

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TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Neptunium Recovery

Recovery of Neptunium in Purex. Miniature mixer-settler runs made during the month confirmed the previously reported deleterious effect of dichromate on gamma decontamination in the HA unit (by a factor of ca. 19). Aqueous entrainment by the plant solvent used in this run was observed to be severe when dichromate was present in the unit and this effect is believed to be at least partly responsible for the observed decline in fission product decontamination. Fortunately, most of the additional activity in the organic product (HAP) from the HA unit followed the plutonium in the LB unit so there is some basis for optimism that uranium decontamination would not be severely damaged by such operation.

Aqueous entrainment was much less severe using olefin-free n-dodecane in conjunction with a synthetic 3WB stream containing dichromate. Decontamination factors for zirconium-niobium and ruthenium were lower by factors of only 2.4 and 1.4, respectively. Thus, there is a possibility that proper choice of solvent would permit dichromate to be utilized to improve neptunium recovery. However, it should be noted that it will probably be necessary to limit the operating temperature to something less than 40 C in columns containing dichromate and the advantages of high temperature operation for fission product decontamination will therefore be lost.

A miniature mixer-settler run with plant 3WB and plant solvent confirmed the feasibility of using dichromate to effect extraction of neptunium in rework processing of 3WB. Near-quantitative recovery of the neptunium was obtained, entrainment was much less severe, and a zirconium-niobium decontamination factor (from feed to organic product) of 770 was obtained.

Recovery of Neptunium in Redox. Batch countercurrent runs completed during the month demonstrated satisfactory extraction of neptunium in the Redox HA column system when the extraction section was operated at slightly higher acidity. Addition of 0.2 M HNO_3 to the solvent (HAX) resulted in recovery of greater than 99 per cent of the neptunium with four extraction stages, whereas the present Redox flowsheet resulted in recovery of only 13 per cent. The altered extraction section acid profile resulted in significant loss of fission product decontamination in these runs. If later acid-deficient cycles can absorb the decontamination lost in the first cycle, operation of the HA column with acidified hexone would permit neptunium to be refluxed and concentrated via the waste backcycle pattern presently in use in the Redox plant. Neptunium would be extracted with uranium and plutonium in the HA column and would be recycled with the aqueous waste from the acid-deficient LA column. The extent to which neptunium could be recycled in this fashion will be ultimately limited by the extent to which neptunium is lost to waste in the HA column and to the plutonium product. Since neptunium which follows uranium in the LB column will be largely recovered in the aqueous waste from the 2D column, a LB flowsheet which forces neptunium into the uranium stream is preferred. This could perhaps be accomplished by using ferrous sulfamate as the reductant, rather than ferrous ammonium sulfate.

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Reduction. The two 5 gram neptunium buttons previously obtained by bomb reduction were remelted and cast under high vacuum into a magnesia mold. The small regulus thus obtained was machined to remove surface oxide. This operation resulted in a 2.1 gram bright silvery metal cylinder which, by spectroscopic analysis, contained less than 0.03 per cent of impurities. This material is being used as a primary sample for analytical studies.

Irradiation. A magnesium oxide-ten weight per cent neptunium oxide mixture has been prepared by calcination of co-precipitated magnesium ammonium carbonate and (probably) neptunium(V) hydroxide. Plans are being formulated for irradiating this material in the MTR to establish the technical feasibility of using this as target material and for chemical research studies.

Distribution in the KCl-AlCl₃-Al System. In order to evaluate the possibility of processing irradiated neptunium-aluminum alloy by an adaptation of the pyrochemical process currently under study for application to the plutonium recycle program, distribution data were obtained for neptunium in the system KCl-AlCl₃-Al. In the potassium chloride rich region (AlCl₃/KCl = 0.6 to 0.8), K_{NP}^* values of 0.2 to 0.35 were obtained, representing reductions of about 15 to 25 per cent for equal weights of each phase. This value is about an order of magnitude greater than for plutonium, under the same conditions, hence the possibility of a separation process by preferential extraction of plutonium exists. Like the other actinides in this same system, a peaking of the extent of reduction was noted in the vicinity of an AlCl₃/KCl ratio of 1. The maximum value seen in these runs was 1.1, corresponding to a reduction yield of slightly more than 50 per cent.

Anion Exchange Recovery of Neptunium. Recovery from Purex 3WB is marginal under conditions that correspond to a high (five per cent) uranium recycle and high flow rates. At the same flow rates but with 0.5 per cent uranium recycle, much improved results were obtained. Under conditions of continuous recovery (5.5 mg Np/l), 440 column volumes were passed for an instantaneous loss of 14 per cent and an integrated loss of only four per cent. Loading of the 30 - 50 mesh Permutit SK resin was 2.5 g/l of resin, very close to theoretical.

In other experiments, neptunium(IV) was extracted with ten per cent trilaurylamine diluted with the high boiling aromatic diluent Amsco D-95, and only one permanent organic phase was observed at higher concentrations up to at least nine grams/liter. This would seem to be quite adequate for current program purposes and this application is being investigated.

Studies of pressure drop were continued in a 6-inch-diameter glass column with a packed height of 52 inches of Permutit SK, 20 to 50 mesh, anion exchange resin. Pressure drops across the free-settled resin bed in the presence of sulfamate-produced gas were about three-fold higher (0.74 psi-ft/gpm) than those obtained in the absence of gas (0.26 psi-ft/gpm), at flow rates of 7 M nitric acid from 2.5 to 7 gpm.

*
$$K_M = \frac{\text{gM/g metal}}{\text{gM/g salt}}$$

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Resin fluidization studies were made in 7 M nitric acid. The maximum bed expansion varied essentially linearly with flow rate over the range studied with a slope of about 40 per cent expansion per gpm per sq.ft. The maximum flow rates required to expand the bed 50 and 100 per cent were, therefore, approximately 1.25 and 2.5 gpm per sq.ft., respectively.

A series of runs was made to study liquid channeling, using uranium as a tracer to denote deviations from "plug" flow. Preliminary comparison of runs made with and without gassing indicates that initial breakthrough occurs after approximately the same liquid throughput. However, the tracer concentration in the effluent increased initially at a considerably faster rate under the gassing conditions, reaching a value of 5 per cent of the feed concentration with ca. 15 per cent less throughput than the non-gassed column.

Analytical Services. Neptunium analysis data shows that the alpha energy analyzer can find as little as 0.001 per cent plutonium impurity. Pre-amplifier and power supply improvements made the greater sensitivity possible. However, such a sensitivity may not always be reached, since sample plates sometimes have excessive foreign solids.

Multicurie Cell Investigation

A cerium recovery run (using the McKenzie persulfate process) and an acid side cesium run (with zinc ferricyanide) were completed during the month, but no analytical results are available. The cerium run appeared successful; however, the precipitate volume in the cesium run was a factor of two to four smaller than expected. It is not known whether this indicates incomplete recovery or whether it is due to a higher solubility of zinc ferricyanide as compared to cesium zinc ferricyanide.

Strontium Recovery

Experiments were done with synthetic LWV to further evaluate the extraction of strontium with di(2-ethyl hexyl) phosphoric acid. When the LWV was neutralized to pH 5.5 the extraction coefficient of strontium from the supernate was 1.7, that of cerium was about the same (1.5), and some cesium and ruthenium were also extracted. Thus, a process for strontium recovery with this solvent would not only require an iron removal step but also give an impure product. Salicylic and sulfosalicylic acids were tried as complexing agents to prevent the precipitation of the iron. This was unsuccessful; however, the iron salicylate complex extracted into Amsco solvent. This reaction might be of value for removal of iron from waste solution.

Cesium Recovery

A workable flowsheet for the wet chemistry portion of the cesium recovery process has been demonstrated in plant-scale equipment. Optimization of the flowsheet will require definition of the maximum tolerable iron and absorbed CO₂ contamination prior to the cesium precipitation strike. Analytical data to define the efficiency of the cesium precipitation and centrifugation steps are pending.

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Drawings for over half of the prototype cesium isolation and packaging equipment have been submitted to shops for fabrication. The fabrication of these components is about 40 per cent complete making the overall fabrication roughly 20 per cent complete.

The first steam coil fabricated for the Hastelloy B Crystallizer cracked during heat treatment. This coil was made from 1/2-inch Hastelloy B tubing wrapped upon a stainless steel mandrel. The coil-and-mandrel assembly was subjected to a solution heat treatment at 2100 F to relieve stresses. The coil cracked in several places because it was constrained too tightly upon the mandrel. A second coil made from the same tube stock and heat treated totally unrestrained did not crack. A final coil will be made from 1/2-inch Hastelloy B pipe by the technique used successfully on the second coil.

Tests have been completed on the metal "O"-ring seals for the product container. The final tests were made with non-specification seals and cap tightening torques to define the variation from specifications which might be tolerated. Properly dimensioned assemblies withstood pressures in excess of 1000 psig as well as repeated pressure and thermal cycling.

Ion chambers developed for measurement of cesium-137 in shipping containers have performed satisfactorily except that the ion currents obtained are larger than necessary. For actual prototype use chambers of smaller volume are planned.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

Titration of Acid in Niflex Samples

The usual HAPO titration method with oxalate complexing for the determination of free acid is applicable to Niflex process solutions with no evidence of bias, even in the case of a sample having a low acidity. The HAPO method is applicable without obvious bias to high acid Darex solutions but fails when applied to low acid and neutral Darex solutions. The Niflex solutions differ from the Darex solutions by having high fluoride, higher average acid, and lower uranium and stainless steel concentrations.

Carrier Concentration Method in Spectrographic Analysis

Study was begun on the basic mechanism of the widely used carrier concentration method of spectrochemical analysis of uranium, plutonium, and refractory oxides. The preliminary experimental data taken with uranium using six representative carriers, several impurity elements, and a variety of electrode and excitation conditions were analyzed statistically. In addition, some experiments were performed with the carrier being volatilized into the arc independently but simultaneously with the impurities from the sample instead of being mixed with the uranium oxide in the electrode crater. The results of these studies indicate the following:

1. A carrier is definitely beneficial in the analysis.
2. The carrier shortens the time before appearance of the impurities in the arc over that observed with no carrier.

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3. The intensity of emission is influenced most strongly by the arc current.
4. Various carrier materials show markedly different effects on the impurities and matrix excitations.
5. Mixtures of two carriers appear to show independent and additive effects.
6. Some of the effects of the carrier are obtained when it is added into the vapor phase only.

EQUIPMENT AND MATERIALS

Test Facility

A test facility has been installed in the 321-A Building which permits testing of full-scale separations plant process equipment such as pumps, agitators, valves and rotameters. The facility uses the four 30,000 gallon tanks which were previously used for the storage of 321 Building waste. Manifolding permits interconnection of the tanks or using each of the tanks as separate pump reservoirs. Currently on test in this facility are the following deepwell turbine pumps:

- a. A pump containing a splined, two-piece, slinger cone being evaluated for use in reducing throttle bushing leakage in separations plant pumps.
- b. A pump-agitator combination. Holes have been drilled in one of the stages of a deepwell turbine pump and the liquid jetting from these holes is used to provide tank agitation.
- c. A deepwell turbine pump which contains a new special Hanford designed discharge head. With this design, the liquid throttle bushing is relocated so that moderate leakage will be contained within the process tank.

Pump Development

A Sigmamotor pump, a peristaltic type pump supplied by CPD Facilities Engineering, was tested for possible use as a metering pump in 234-5 Building. After 100 hours operation frequent adjustments became necessary to maintain dependable flows. After 400 hours operation the vibrating "fingers" and cams were seriously worn (as much as 1/8-inch in some spots).

Plutonium Oxide Chlorinator

To simulate the conditions which would be present in the off-gas lines of a phosgene chlorinator, samples of Hastelloy B and C, and 304-L stainless steel were exposed to a mixture of water-saturated air and phosgene which had passed through a region at 500 C. When the temperature in the exposure region was about 100 C corrosion rates were 5, 9, and 70 mils/mo. for the B, C, and 304-L, respectively. Liquid was present in the exposure chamber throughout the run. At about 200 C in the exposure chamber, Hastelloys B and C corroded at about one mil/mo. The stainless steel (304-L)

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was not tested at this temperature. Condensation products from the reaction mixture appear to be more corrosive to the materials tested than does the vapor phase.

Non-Metallic Materials

Abrasion tests were conducted on Phenoline 300* and Amercoat 74 Surfacor* to determine their suitability for use in the PRTR. Tests indicated that the abrasion resistance of the two protective coatings are comparable. Variations in abrasion resistance were within the demonstrated reproducibility of the test method.

PROCESS CONTROL DEVELOPMENT

Assistance to Chemical Processing Department on Process Control Instrumentation

Extensive testing has shown a commercial ultrasonic level detector unsuitable for reliable measurements of resin level in ion exchange columns. Primary reasons for the poor performance of the instrument are insufficient power from the transmitter and a poor reflection from the resin surface. However, it is believed that the sonic principle can be applied to this problem if the instrument is more favorably coupled to the transducer, thus increasing the power output. In addition, the fundamental frequency of the transducer could be increased from 100 KC to 1 MC to improve the acoustic reflectance from the resin surface. Consultation with Testing Methods Operation personnel (FPD) indicates they may be able to supply a suitable circuit design to accomplish these improvements.

The use of boron for criticality control during dissolution of enriched fuels is being studied by CPD personnel. In this connection, a continuous boron monitor for the chemical addition lines on the Redox A or C dissolver is desired. Preliminary laboratory experiments were performed to establish the feasibility of measuring the boron concentration of aqueous solutions by a neutron absorption technique. These experiments established that several physical arrangements of a plutonium-beryllium neutron source, and a thermal-neutron-sensitive scintillation screen produced approximately a 30 per cent difference in counting rate when water was replaced by a 1 g/liter boron solution. A continuous boron monitor based on neutron absorption techniques is reported to be commercially available. If applicable it will be tested as a prototype for this use.

Uranium Photometer

Two more phototubes were prepared and calibrated (making a total of four) for the HSP instrument during the month. In the fabrication of the phototubes, the 328 Building instrument shop has switched from "Scotch cast" as a potting medium to "Multiplastic" and from a soldered cathode connection to a mechanical pressure connection with the result that finished phototube rejections have dropped to zero. Following a few minor chassis changes, the instrument will be moved to the Purex plant for installation.

* Phenoline 300 is a product of the Carboline Company and Amercoat 74 is a product of Amercoat Corporation.

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Magnetic Flowmeter Tests

Replacements for the three original Fischer-Porter magnetic meters have been received and tested using water at the UO_3 plant. The rebalancing voltage on one of the replacements was too low and necessitated returning the meter to the vendor.

A vendor's drawing of the electrode assembly indicated that, although a "Viton A" polymer "O"-ring is used to seal the electrodes into the fluid pipe, the Teflon liner is actually making the seal. It appears that this assembly will be suitable for UNH service.

Calciner Automation

The main programmer has been constructed and checked out together with the steam programmer and suitable mockups. All design and wiring defects have been corrected. Some additional refinements are necessary, however, to make the programmer more reliable.

Contact Alpha Monitor

An alpha sensitive scintillation screen prepared by a vacuum distillation technique was tested for possible application on the contact alpha instrument. Although the results were completely negative, the potential of the screen was so attractive that attempts have been made to secure similar screens for further testing.

Gamma Monitor Cells

Drawings of the gamma monitor cells Models III and IV have been brought up to date incorporating changes recommended by the vendor to improve product quality. A new drawing (H-4-39144) has been issued covering the design of Models V & VI cells in which fluorothene, teflon, or linear polyethylene tubing is specified for the monitored volume.

Hot Semiworks Alarm System

An alarm system monitoring 11 temperatures, 2 pressures, and 1 liquid level, was put into service on November 5, to protect the Hot Semiworks under its standby status. One call-out has been experienced and investigation showed a low temperature in the Hot Shop due to lack of steam in the heating system.

NON-PRODUCTION FUELS REPROCESSING

Mechanical Processing

Shear Tests. Continued tests with a 40-ton hydraulic shear, equipped with a straight moving knife and a "V" stationary knife, cutting tubular and solid stainless steel and simulated reactor fuel assemblies (ceramic-filled stainless steel tube bundles), showed the following results:

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- a. Shear forces required for the V-straight blade combination are intermediate (about 15,000 lb./sq.in. for the ceramic bundles) between those required for all straight blades (10,000 lb./sq.in.) and those required for all V blades (19,000 lb./sq.in.).
- b. Shear forces for rod bundles or tubes are predictable from shear equations used for solid stock.
- c. Chopped fragments (cut length - 3/4-inch) occupied from 30 per cent to 60 per cent of the total volume of a 5 3/4-inch I.D. right circular cylinder. Hollow pipe segments, when sheared, occupied 30 per cent of the volume, while the chopped filled tubes occupied approximately 60 per cent.

Future shear study emphasis will be placed upon (a) blade geometry refinement to provide minimum cutting force, (b) defining materials for maximum blade life, and (c) demonstrating a shear system which will successfully control particulate contamination and metal fires.

Shear System Fabrication. A shear system which will permit testing of underwater shearing is about 75 per cent complete. Startup is scheduled for the first week in December. Auxiliaries for this system include an offgas filter system, a chain-drive shear feed, and a hydraulically-positioned product basket.

Feed Preparation

Darex. Pilot plant dissolution of stainless steel tubing followed by dissolution of uranium metal slugs was continued. An attempt to control the rate of stainless steel dissolution by slowly metering 4.6 M nitric acid - 1.8 M hydrochloric acid into the dissolver was not successful. Initially, the stainless steel dissolved rapidly and complexed the chloride present; this essentially stopped the reaction until the free chloride again built up to levels favorable for stainless steel dissolution. During the two uranium metal dissolution portions of the experiments, the conditions for rapid uranium dissolution were maintained with resulting dissolution rates of about 200 mils/hr. Acid consumption for uranium metal dissolution was 3.0-3.7 mols acid/mol U.

Chloride was removed from the dissolver solution in the same manner as in a previous run that did not contain uranium. Chloride concentrations were reduced from ~46,000 ppm to ~980 ppm (dF = 47) for solutions without uranium and from ~36,000 ppm to ~800 ppm (dF = 45) for solutions with uranium.

Laboratory studies better defined the conditions of stainless steel dissolution, uranium metal dissolution, and chloride removal. It was found that 304-L stainless steel stops dissolving in 3-5 M acid when the nitrate to uncomplexed chloride mol ratio rises to 8-10. Stainless steel dissolution is unaffected by the presence of uranium in solution. Uranium metal dissolves rapidly (170-190 mils/hr.) in solutions greater than 1.5 M acid only when nitrate to chloride mol ratios are less than 4.5 - 5.0.

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Welded and unannealed Hastelloy F coupons exposed to Darex dissolver solution and offgas have shown no perceptible corrosion after exposure in one run.

Niflex. Installation of a vacuum melted Hastelloy F pilot-plant dissolver system for Niflex studies is 35 per cent complete. Dissolver fabrication is 90 per cent complete and the condenser is 85 per cent complete. The dissolver consists of a 9-inch diameter, 8-foot steam jacketed tower connected to a 24 by 24 to 30-inch vapor section. The condenser is a 9-foot jacketed tube assembly. No weld crack-ing has been observed during the fabrication of the dissolver and condenser.

Zirflex. Zircaloy clad metallic uranium slugs (3-5 per cent Zy) were de-clad under normal Zirflex conditions. Uranium losses to the centrifuged coating waste were 0.08 and 0.09 per cent of the uranium charged (1.5 g/l). The de-clad metallic uranium was crusted with a black-green material which flaked off into the dissolver. Flakes and precipitated uranium in the system were nearly one per cent of the uranium charged. Flakes and precipitate were readily soluble in nitric acid.

Additional experiments with heavily oxidized (deionized water at 680 F for 308 days) Zircaloy-2 coupons have confirmed that the dissolution proceeds by undercutting and pin-hole attack. However, all samples were at least 80 per cent dissolved after Zirflex attack for 12 hours.

Sulfex Process. Analytical data on the rate of accumulation of uranium in solutions have been obtained to supplement previously reported data on the build up of plutonium and fission products when irradiated UO_2 (ca. 500 g Pu/ton U cooled ca. 20 months) is exposed to boiling 4 M H_2SO_4 . These data indicate a constant dissolution rate of 0.008 mg U/min./cm², greater by a factor of about 100 than dissolution rates observed in the same system for unirradiated UO_2 , either as powder or as sintered and machined cylinders. It is noteworthy that the uranium dissolution proceeded at a constant rate, in marked contrast to the plutonium and fission product build up which proceeded at a low rate for the first four to five hours and thereafter at a six-fold higher rate.

Experiments with the same irradiated UO_2 gave immeasurably low rates of dissolution of UO_2 when stainless steel was being simultaneously dissolved in the same vessel. A similar effect was observed with unirradiated UO_2 . After the stainless steel had been completely dissolved, the rate of dissolution of the UO_2 increased markedly and within three hours the fission product activity in the solution had increased to the value which would have been expected if stainless steel had not been added. This observation, coupled with other experiments in which the presence of dissolved stainless steel was found to have only a minor effect on the rate of dissolution of UO_2 , indicate that the inhibiting action of dissolving stainless steel is due to short-lived products or intermediates (presumably hydrogen) formed during the stainless steel dissolution. With the irradiated UO_2 used in these experiments, a stainless steel dissolution rate in the range of 0.007 to 0.04 "moles" stainless steel per hour per liter of solution appeared adequate to prevent dissolution of the UO_2 .

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Studies of the reactions between dilute sulfuric acid and uranium and UO_2 in a cobalt-60 gamma radiation yield disclosed that:

1. Uranium metal dissolves to yield only uranium(IV) while a mixture of uranium(IV) and uranium(VI) is produced from UO_2 .
2. The G value for oxidation of uranium(IV) to uranium(VI) in 4 M H_2SO_4 , 0.01 - 0.02 M U is about unity at room temperature and 90 C.

Cold studies confirmed that uranium(VI) is reduced by bulk uranium metal at a rate of about 5×10^{-5} moles/hr, cm^2 metal surface in boiling 4 M H_2SO_4 and revealed that a minor amount of reduction of sulfate occurs, SO_2 being detected in the off-gas and a finely divided solid uranium compound being formed. Uranium dioxide proved the only constituent of the solid which could be identified by X-ray diffraction.

Dissolution of Uranium-Molybdenum Alloy

Studies this month have concerned primarily attempts to dissolve U-Mo alloy in HNO_3 or $\text{HNO}_3\text{-HF-Al}(\text{NO}_3)_3$ solutions without formation of solids. The three per cent alloy can be dissolved without solids formation in HNO_3 maintained at just below boiling to terminal uranium and HNO_3 concentrations of about 0.5 and 1-2 M, respectively. At higher terminal uranium concentration, lower terminal HNO_3 concentration, or if the solutions are boiled during the dissolution, voluminous yellow solids are formed.

A number of exploratory experiments on the dissolution of U-Mo alloy in $\text{HNO}_3\text{-HF-Al}(\text{NO}_3)_3$ solutions have been made. In no case was a solution completely free of solids obtained. However, conditions were found in which only a trace of a red-brown solid (composition not yet determined) was formed. These conditions require a terminal uranium concentration less than 1 M (maximum uranium concentration between 0.5 and 1 M), an Al/F mole ratio less than one (maximum ratio appears to be between 0.5 and 0.75), and an F/Mo mole ratio in the terminal solution of 10 or greater. Minimum terminal acidity varies with the F/Mo mole ratio and may be as low as 0.5 M at F/Mo ratios around 30. When dissolutions of U-3 per cent Mo alloy were made under conditions outside those above, voluminous cream colored solids were obtained which, when washed and dried, ranged from two to eight weight per cent based on the weight of alloy dissolved. Composition of these solids has not yet been determined. They are readily soluble in dilute carbonate solutions. Preliminary analyses indicate about 20 and 16 weight per cent uranium and molybdenum, respectively.

Tentative results from a single experiment indicate that molybdenum may be successfully separated from uranium in Redox-type solvent extraction of solutions obtained by dissolution of U-Mo alloy under conditions producing only trace solids.

In dissolutions of U-Mo alloy under simulated Darex core dissolution conditions, cream colored solids, similar in appearance to those already described, are formed if the solution is boiled. Solids are not formed if the solution is maintained below 80 C. Heating the clear solutions so obtained to greater than 80 C following dissolution produces the solids.

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Materials of Construction. Studies on the effect of post-welding heat treatment of locally-welded vacuum melted Hastelloy F show:

- a. No preferential weld metal attack occurs on exposure to boiling 3 M H_2SO_4 - 10 g/l stainless steel solution in either the "as welded" or the solution annealed condition.
- b. Severe weld metal attack on "as welded" specimens by Niflex dissolvent (1 M HNO_3 - 2 M HF) can be reduced greatly by solution annealing for one hour at temperatures from 1900 to 2100 F. The higher annealing temperatures are the more effective. A specimen annealed at 1860 F showed greater weld metal attack than "as welded" specimens.
- c. "As welded" specimens suffer weld metal attack under alloy core dissolving conditions (HNO_3 -HF- $\text{Al}(\text{NO}_3)_3$) only if the Al/F mole ratio is less than one.

Base metal corrosion rates for the two heats of Hastelloy F used in the construction of the 321 Building dissolver are 50 to 100 per cent higher under both Niflex and Sulfex conditions than test specimens previously used in laboratory studies. Both heats appear to be within specifications for carbon content (< 0.02 per cent).

The corrosion of Hastelloy F, Carpenter 20, and 304-L under oxidizer conditions (boiling 1 M UNH, 0.15 M $\text{Na}_2\text{Cr}_2\text{O}_7$ - HNO_3) increase markedly with increasing acidity (from < 1 mil/mo at 0 acid to about 5 for Hastelloy F, 10 for Carpenter 20, and 44 for 304-L at one molar HNO_3). When the oxidizer solution contained also $\text{Al}(\text{NO}_3)_3$ and HF, considerably lower corrosion rates were observed for 304-L (Hastelloy F and Carpenter 20 were not tested). An unexplained reduction of dichromate which occurred in these solutions may account for the decreased corrosion.

Studies on the corrosion of Hastelloy F and Carpenter 20 by HNO_3 -HF- $\text{Al}(\text{NO}_3)_3$ solutions proposed for dissolution of alloyed cores show that an Al/F mole ratio of about one is required to prevent excessive attack on these metals.

Corrosion rates for 304-L, Hastelloy F, and Carpenter 20 in boiling 3 M NH_4HF_2 (proposed as a Zirflex dissolvent) are excessive (25 to 175 mils/mo).

Laboratory studies on the corrosion of Hastelloy F under Darex dissolving conditions confirm the good resistance observed in a single test in the 321 Building. Evaluation of the corrosion resistance during the chloride removal step is in progress.

A coupon of Carpenter 20 (unstabilized) bent to an angle of about 60° and exposed to boiling 4 M H_2SO_4 showed extensive cracking on the I.D. of the bend but no cracking on the O.D.

High Accuracy, Large Volume Measurements. A study of instrument systems for the measurement of liquid level in a large-volume tank of dissolver solution has narrowed to three types of instrumentation:

1. Four-line air purge dip tube system using a digital readout manometer.
2. Four-line air purge dip tube system using a high accuracy pressure transducer with digital readout.
3. High accuracy sonic level indicator with digital scaler readout.

Operations Research has supplied information (HW-57866) outlining a statistical procedure for the calibration of a large vessel.

Solvent Extraction

Laboratory Studies. A series of mini-mixer settler runs simulating Redox first cycle extraction and scrub (8 extn. stages - 4 scrub stages) of Niflex process feed solutions was made. With optimum feed compositions, overall decontamination was a factor of about 30 lower than obtained in control runs simulating present Redox conditions except for reduced uranium concentration in the feed. Ruthenium and Zr-Nb were the principal contaminants in the product stream. Uranium and plutonium losses in the Niflex runs compared favorably with those in the control runs. Neptunium followed uranium and plutonium more thoroughly in the Niflex runs (>98 per cent) than in the control runs (75 per cent). At constant total nitrate in the feed, increased feed acidity resulted in markedly reduced decontamination. This effect was more pronounced at low (0.2 M) concentration of uranium in the feed than at high (0.6 M) uranium concentration. In general, decontamination was better at the high uranium concentration than at the low. Changing the U, stainless steel mole ratio in the feed had little or no effect on decontamination. Slightly better gross gamma decontamination was obtained at low (5.0 M) than at high (6.3 M) total nitrate concentration in the feed. Results obtained with simulated feeds spiked with Redox dissolver solution were essentially the same as those obtained using spike material prepared in a laboratory-scale dissolution of irradiated uranium under Niflex conditions. Oxidation of plutonium in this latter solution was as rapid as in simulated Niflex solutions. Batch contact studies paralleling the mini runs are in progress to obtain desired distribution ratios. Analytical data are as yet incomplete. Variations in decontamination with feed composition, so far observed, are the same as in the mini runs.

The organic product streams from the mini-mixer-settler runs just described were stripped and the resulting aqueous phases were used to prepare feeds for batch contact studies simulating second cycle extraction and scrubbing. In all cases, the feeds and the scrub solutions were 0.2 M acid deficient. The results obtained in these studies indicate that much of the decontamination lost in the first cycle due to the use of acidic feeds may be regained in the first column of the second cycle if it is operated acid deficient. Overall gross beta and gamma decontamination factors (from feeds to the mini runs to unscrubbed organics after second cycle extraction contact) for all Niflex feed solutions used differed by no more than a factor of seven.

Semiworks Redox Processing of NPF Feeds. Approximately eleven semiworks scale experiments under "standard" Redox, Darex, and Niflex conditions have been completed at Oak Ridge National Laboratories. Uranium irradiated to 200-300 MWD T at about

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- 0.15 MW/T and cooled for about 6 months was employed. Preliminary data indicate that gross gamma decontamination factors (HAF/HCU) are about 1000-2000 for standard Redox conditions, about 60-100 for Darex conditions, and about 30-50 for Niflex conditions, with ruthenium the major contaminant in all cases.

Waste losses and flooding rates were relatively independent of flowsheet conditions except low flooding rates were obtained with feeds containing high silicon concentrations.

REACTOR DEVELOPMENT - 4000 PROGRAM

Separation of Thorium-228 from Uranium-232

An informal document, HW-58058, entitled, "Application of Pyrochemical Processing Developments to the Uranium-233 - Aluminum Fuel Element Program" by W. L. Lyon, R. H. Moore, and E. E. Voiland has been issued summarizing the application of potassium-aluminum chloride extraction to the removal of thorium from uranium-aluminum alloy.

Extension of distribution studies to the aluminum chloride rich zone of the phase diagram has disclosed K_{Th} (metal to salt distribution ratio) values a factor of 10 to 100 times lower than in the KCl rich region. These studies are being continued to determine the feasibility of thorium-228 separation to decrease MTR fuel plate activity during fabrication.

X-Ray Spectroscopy

The sample turret of the X-ray spectrograph was modified to bring the sample in closer proximity to the X-ray tube. This together with use of a tube of a new design resulted in a remarkable improvement in sensitivity, particularly with respect to the detection of light elements. For example, the count rate of the aluminum fluorescence of an aluminum-12 w/o silicon alloy is four times that obtained before modification. Investigation of three standard aluminum-silicon alloys containing from 10 to 12 weight per cent silicon indicates that silicon content can be determined to ± 0.2 per cent absolute by X-ray spectroscopy. A formal report, HW-57941, entitled, "Non-Destructive Testing of MTR Type Fuel Plates by X-Ray Absorption and Fluorescence Techniques," by M. C. Lambert has been published summarizing work in behalf of this program.

Amine Extraction of PRP Fuels

The effect of very high radiation doses on the decontamination performance of tri-laurylamine-diluent mixtures was studied where the diluent was either xylene or Amsco D-95. The solvents were pre-equilibrated to nitric acid and given a large exposure of 52 watt hours/liter in the cobalt-60 source. They were then used for extraction-scrub experiments and compared with un-irradiated solvent. The results indicate that degradation of the diluent causes inferior zirconium-niobium decontamination and that the Amsco D-95 is inferior to xylene in this respect. Thus, the over-all gamma decontamination factors dropped from 2.6×10^4 to 3.4×10^3 with xylene and from 2.2×10^4 to 630 with Amsco D-95.

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Hydrogen in Dissolver Off-Gas. The Davis gas analyzer has been calibrated for use in hydrogen-air-nitric oxide mixtures such as produced in the dissolution of plutonium-aluminum fuel elements. The lower explosive limit is slightly higher with nitric oxide present. However, calibration has been made on hydrogen-air mixtures which gives a slight additional safety factor when nitric oxide is present.

BIOLOGY AND MEDICINE - 6000 PROGRAM

Geology and Hydrology

Well 699-14-40 encountered basalt at an altitude of about 100 feet above sea level. The Cold Creek anticline was more accurately located by this finding.

Sediments of the Ringold formation were further confirmed to rise above the water table in an area including well 699-14-40. The top of the Ringold conglomerate lies up to 30 feet above the water table from south of well 699-11-45 nearly to 699-24-33, and eastward nearly to the Columbia River. These sediments thus lie in and east of the ground water saddle through which most of the ground waters from the Separations Areas will pass as they flow southeastward around the south end of the ground water mound and toward the Columbia River.

Analyses of ground water hydraulic data show clearly the great difference between the Ringold sediments and the glaciofluvial sediments in their abilities to transmit water. The various analytical methods, although varying in degrees of reliability, each indicate that the glaciofluvial sediments are roughly 100 times more permeable than are the Ringold deposits. Permeabilities of Ringold sediments vary from 100 - 600 gpd/sq.ft. and of glaciofluvial sediments from 10,000 - 60,000 gpd/sq.ft.

Further work on the centrifuge test for study of specific retention of moisture in soil revealed a relationship between the final moisture content and size of the soil sample. This is believed due to surface tension at the bottom of the centrifuged sample. A soil subject to drainage by simple gravity can hold permanently a higher percentage of moisture than a sample subject to centrifugation. Thus a longer test at lower speeds may provide a more reliable method of estimating true specific retention.

Laboratory methods are being worked out for the investigation of rate of sinking of high salt solutions in ground water.

A laboratory method was devised and tested for extracting water from the bottom of soil flow models under tension. The tests were successful in indicating that the effective depth of laboratory flow models can be increased thus simulating field conditions more closely.

Field Apparatus Development

Several specialized pieces of apparatus were designed, fabricated and tested. A large-surface tensiometer for use in soil column experiments was assembled from porous stainless-steel; it reduces materially the time required in performing measurements of water tension in soil columns.

A soil tamper to prepare specimens for laboratory permeability measurements was devised. The apparatus permits reproducible compaction of soil in the permeameter cells.

A field investigation of seismic methods was initiated. A sensitive transistorized amplifier-chronometer was designed and assembled for detecting the initiating shot and then recording the time for the surface wave and refracted waves to reach the geophone.

A glass wool filter train used for removing particulates from uranium cut-off operations was found to be greater than 99.9 per cent efficient. Particle size distributions and composition are under study.

Soil Chemistry and Geochemistry

Calcite columns were used to test decontamination of solutions containing Sr^{90} , Pm^{147} , $\text{UO}_2(\text{II})$, Pu^{239} , and Zn^{65} . The Sr^{90} and Pm^{147} experiments were completed. Removal of Pm from solution is not as great as removal of Sr, but a decontamination factor of 10^3 can be obtained under favorable conditions of high temperature and low flow rate. It was found that straight line isotherms can be obtained by plotting df versus flow rate on logarithmic probability paper. Lines for different temperatures can then be extrapolated to a convergence point which would represent a maximum df, or full equilibrium value. It was also found that doubling column length results in more than double the df. This is being investigated further.

Work was started to determine the best combination of mineral reactions for decontamination of the D-2 waste stream.

Zinc, lead, manganese, and iron carbonates can be used in place of calcite for removal of Sr and would allow an easier separation and recovery of Sr^{90} if desired. X-ray diffraction of the products resulting when these carbonates are placed in alkaline phosphate solutions showed them to be basic phosphates with an apatite structure. Under the same conditions, however, copper carbonate was converted at least in part to copper oxide.

Studies were commenced with soils from which carbonates had been removed. Results should aid in clarifying the competition between ion exchange and replacement reactions for the various significant ionic species.

Ground Water Investigations

A study was started on the effect of unsaturated flow of solution through a soil on the exchange reactions of ions dissolved in the solution. In connection with this work, thermistor methods for measuring soil moisture content were investigated.

Analysis of the breakthrough data for columns of various lengths showed that on a logarithmic probability plot of C/C_0 versus column volumes, the breakthrough lines for longer columns have a greater slope; for all lengths of columns the lines cross near the 50 per cent breakthrough level. Extrapolation to the very low C/C_0 values of 0.1 MPC showed that very long columns are much more efficient in sorbing nuclides

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than short columns. Thus the linear extrapolation used to predict breakthrough of nuclides into ground water with data from short laboratory columns should be quite conservative. The conditions are more accurately predicted by the Thomas-Hiester-Vermeulen theory.

Data were analyzed from soil columns operated at various pH levels. Some evidence was obtained indicating the continuous formation of a non-exchangeable form of Sr, probably a mineral such as apatite, although no phosphate is added to these solutions. The possibility that there was enough soluble phosphate naturally present in this soil sample to permit the uptake of Sr by apatite formation is being investigated. The major anion present is sulfate; formation of a sulfate analog of apatite was eliminated by the finding that there was little or no uptake of Sr under similar conditions in a pure calcite column with no phosphate added.

Reactor Radioisotopes

Measurements were made on the residue and the filtrate of a sample of 100-B reactor effluent water taken November 10, 1958, which was filtered through a Millipore (HA) filter. The results are tabulated below together with the results from a Columbia River water sample taken October 9, 1958, at Pasco, Washington.

PERCENT RADIOISOTOPES REMOVED BY MILLIPORE FILTRATION

	<u>Na²⁴</u>	<u>P³²</u>	<u>Sc⁴⁶</u>	<u>Cr⁵¹</u>	<u>Mn⁵⁶</u>	<u>Cu⁶⁴</u>	<u>Zn⁶⁵</u>	<u>As⁷⁶</u>	<u>Ba¹⁴⁰</u>	<u>La¹⁴⁰</u>	<u>Ce¹⁴³</u>	<u>Sm¹⁵³</u>	<u>Np²³⁹</u>
Effluent	0.7	4.4	73	3.4	4.9	26	28	2.6	10	80	86	97	1.0
River Water	0.9	43	84	3.3	---	15	67	3.6	9	42	--	26	1.4

Sc⁴⁶, La¹⁴⁰, Ce¹⁴³, and Sm¹⁵³ are present largely on filterable solids. Cu⁶⁴ and Zn⁶⁵ are associated with the solids to a significant degree. P³² and Zn⁶⁵ in the river are more associated with the solids than they are in the effluent. Cu⁶⁴, La¹⁴⁰, and Sm¹⁵³ in the river are less associated with the solids, perhaps due in part to depletion of some of the particulate material to the river bottom during the flow to Pasco.

Chemical Dosimetry

Preliminary experiments performed in the Biology Operation have shown that erioglau-cine, the compound found to react most efficiently with the radicals formed in irradiated water, offers significant protection to irradiated mice. Of the mice receiving an injection of erioglau-cine prior to irradiation, seven out of ten were

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living 30 days after absorbing a dose of 800r of X-radiation. Only one out of ten uninjected mice was alive 30 days after absorbing an equal dose. Better protection may be possible with greater amounts of injected erioglaucine. It is of interest to note that erioglaucine-injected mice turn blue for several hours following the injection.

Manager,
Chemical Research & Development

LP Bupp:WOS:bp

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ORGANIZATION AND PERSONNEL

E. M. Duke, Jr., Chemist I, was hired and assigned to Chemical Development Operation.

M. C. Fraser, Engineer II, transferred to Irradiation Processing Department.

W. R. Hamilton, Engineer II, transferred to Fuels Preparation Department.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
Erich Pohland Yves Sousselier A. Erik Haeffner Einar Saeland	11/3-4/	Eurochemic Mol, Belgium	Discuss chemical reprocessing, Pu recycle, waste disposal, etc.	LP Bupp WH Reas DW Pearce OF Hill	No
J. E. Richardson W. G. Thorp J. Gronin	11/6/	Burns & Roe Co. Hempstead, New York	Examine NPR site and discuss geological conditions affecting waste disposal there.	RE Brown	No
O. E. Homelster J. R. Nims D. E. Bloomfield	11/7/	PRDC Detroit, Michigan	PRDC Fuels Processing.	AM Platt RJ Sloat OF Hill	Yes
W. R. Smith	11/21-24/	APED San Jose, Calif.	Consult on Hastelloy-F fabrication problems.	RE Burns	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
K. J. Schneider J. E. Mendel	11/1-24/	ORNL Oak Ridge, Tenn.	Consultation on reprocessing of NPF fuels.	FL Culler	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. K. Hilliard	11/6/	AEC - Division of Reactor Development Germantown, Md.	Discuss fission product volatilization studies.	HG Mebree	No
D. L. Reid	11/5-7/	Washington State Col. Pullman, Wash.	Attend Water Resources Conference	---	No
F. P. Brauer	11/4-9/	AEC Washington, D.C.	Attend meeting on Washington Designated Programs	DR Miller	Yes
E. E. Voiland	11/6-7/	Los Alamos Scientific Laboratory Los Alamos, N. M.	Discuss high temperature chemistry & U-233 MIR fuel plant problems.	J. Kircher RD Baker	Yes
G. B. Barton	11/10-11/	Argonne Nat. Lab. Lemont, Illinois	Discuss waste treatment & high temperature processing.	WA Rogers	Yes
	11/12/	M.I.T. Boston, Mass.	Discuss waste disposal.	MI Goldman	No
	11/13-14/	Brookhaven Nat. Lab. Upton, New York	Discuss waste treatment & high temperature processing.	LP Hatch	Yes
	11/17/	Johns Hopkins Univ. Baltimore, Md.	Discuss waste disposal.	A. Wolman	No
	11/18-20/	Oak Ridge Nat. Lab. Oak Ridge, Tennessee	Discuss waste disposal, fission product recovery, & high temperature processing.	FL Culler	Yes
B. M. Johnson	11/24/	Chalk River Ottawa, Ontario, Can.	Discuss waste disposal processes.	LC Watson	Yes

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
E. W. Christopherson	11/10-19/	University of Tennessee Knoxville, Tennessee	Recruiting	---	No
		University of Arkansas Fayetteville, Arkansas	Recruiting	---	No
		Vanderbilt University Nashville, Tennessee	Recruiting	---	No
G. J. Alkire	11/17-19/	Ohio State University Columbus, Ohio	Recruiting - PhD	---	No
W. R. DeHollander J. L. Daniel	11/19-21/	University of Washington Seattle, Washington	Recruiting	---	No
D. M. Hunnicutt	11/24-26/	Idaho Falls, Idaho	Environmental Sampling	---	No
E. M. Johnson	11/25-26/	McGill University Montreal, Canada	Discuss waste disposal processes	WH Gaubin	No

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BIOLOGY OPERATION

- A. There were no significant personnel or organization changes during the month of November 1958.

B. TECHNICAL ACTIVITIESFISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Atmospheric Contamination

Concentrations of I^{131} in thyroid glands of jack rabbits were about the same as last year. Values were as follow:

<u>Collection Site</u>	<u>$\mu\text{c/g}$ thyroid</u>		<u>Trend Factor</u>
	<u>Average</u>	<u>Maximum</u>	
Wahluke Slope	5×10^{-3}	6×10^{-3}	+ 25
Prosser Barricade	2×10^{-3}	3×10^{-3}	+ 5
4 Miles SW of Redox	2×10^{-3}	3×10^{-3}	+ 20

Fission products were present in rabbit tissues in the following amounts, which were slightly higher than those of last year.

<u>Sample Type</u>	<u>$\mu\text{c/g}$ wet wt.</u>		<u>Trend Factor</u>
	<u>Average</u>		
Bone	1×10^{-4}		+ 2
Feces	1×10^{-4}		+ 2
Liver	1×10^{-5}		-
Muscle	1×10^{-5}		-

Columbia River Contamination

Contamination levels for beta emitters in fish were about the same as last year. The annual upstream migration of whitefish brought fish from the Hanford Reserve into the Priest Rapids area. This caused the average contamination of the fish at Priest Rapids to increase three times the levels reported for the previous month. Values were as follow:

<u>Sample Type</u>	<u>Location</u>	<u>$\mu\text{c/g}$ wet wt.</u>		<u>Trend Factor</u>
		<u>Average</u>	<u>Maximum</u>	
Minnows (entire)	Hanford	1×10^{-2}	2×10^{-2}	- 2
Whitefish Flesh	Priest Rapids	2×10^{-4}	1×10^{-3}	+ 3
Whitefish Flesh	F - 1	1×10^{-3}	3×10^{-3}	- 2
Whitefish Flesh	Ringold	1×10^{-3}	3×10^{-3}	-

Effect of Reactor Effluent on Aquatic Organisms

Tests with rainbow trout were terminated early in the month with final results essentially as reported for October. A new series of tests was begun on November 5, at the 1706-KE facility with chinook salmon eggs obtained from the Washington State Department of Fisheries operations at McNary Dam. The new tests include routine monitoring of the 105-KE effluent at a strength of 2-1/2 per cent, and a comparison of the toxicity of 4 per cent normal effluent with 4 per cent effluent from Tube No. 4355 which contains a lower concentration of dichr mate. Results are not yet available.

The annual survey of salmon spawning in the Columbia River within the Hanford Reservation was completed. A total of 1485 salmon nests were observed, for an all time high since surveys were started in 1947. Nest counts were 168% of last year, 500% of the ten year average (1947-1956), and 950% of the brood year (1954).

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Phosphorus

The four-week period of feeding P³² to trout held at different temperatures was completed. Preliminary results indicate that the concentration of P³² in the fish reached equilibrium in two to three weeks at all temperatures.

Zinc

Additional data were obtained on the effect of age on Zn⁶⁵ absorption. Rats 14 days old showed a 24-hour retention (exclusive of the small amount remaining in the G.I. tract) of 87% of the administered dose. This high absorption is comparable to that previously observed in somewhat younger rats, and much higher than the approximately 15% absorption observed in 28-day and older rats.

Rats kept on a Zn⁶⁵-free diet for 200 days following a period of 200 days of chronic Zn⁶⁵ feeding, retained about 20% of the isotope built up in the body during the period of chronic feeding. After 400 days' chronic feeding, the concentration of Zn⁶⁵ in bone still appears to be increasing.

Herbivorous fish maintained in simulated streams with food plants that contained concentrations of Zn⁶⁵ in equilibrium with 0.1 µc/ml in the water appeared to reach their Zn⁶⁵ equilibrium in about two weeks. At that time the concentration of the isotope in entire fish, minus gut, was about 200 times the concentration in the water.

Grass irrigated by sprinkler with Columbia River water contained more Zn⁶⁵ than did barley irrigated with 100% effluent by application through rills. It appears that irrigation practices which apply water directly to foliage or other plant parts will produce concentrations of Zn⁶⁵ several orders of magnitude higher than attained by application of irrigation water only to the soil.

Strontium

Data are now available on the retention in rats of Sr^{90} and Ca^{45} over a period of 150 days following administration of a single intraperitoneal dose. These animals were maintained on diets containing .03, .1, 15, and 2.0% calcium. A rather clear-cut pattern is emerging from these data which indicate that the rate of loss of Sr^{90} from bone is not influenced by the calcium level in the diet, whereas the rate of Ca^{45} loss from bone is influenced by the calcium level in the diet. The loss of Ca^{45} is greatest on the 2.0% calcium diet, where it is similar to the rate of loss of Sr^{90} . On the lowest calcium diet there is practically no loss of deposited Ca^{45} . As a consequence of these facts, the ratio of $\text{Sr}^{90}/\text{Ca}^{45}$ in bone shows very little change as a function of time on the 2% calcium diet, but becomes increasingly a function of time as the calcium level in the diet is decreased. On the .03% calcium diet, the ratio of percentage deposition of $\text{Sr}^{90}/\text{Ca}^{45}$ in bone changes from approximately .65 at 4 days after radioisotope administration to a value of .3, 150 days after administration. The retention curves for Sr^{90} and Ca^{45} and the $\text{Sr}^{90}/\text{Ca}^{45}$ ratio in bone are well represented as power functions of time.

In the experiment designed to study the effects of added dietary calcium on the uptake, retention and transfer of Sr^{90} and Ca^{45} in ewes with suckling lambs, the 1.5-fold range of dietary calcium levels used resulted in no significant changes in the O.R. (milk-diet) or O.R. (blood-diet) for either Ca^{45} or Sr^{90} . Averaged maximum values for all ewes attained Ca^{45} or Sr^{90} in the blood, milk or bone of the ewes, as determined by after 5 to 6 days feeding, are shown below:

$$\begin{array}{ll} \frac{\text{Ca}^{45}/\text{Ca}^{40} \text{ (blood)}}{\text{Ca}^{45}/\text{Ca}^{40} \text{ (diet)}} = 0.27 & \frac{\text{Sr}^{90}/\text{Ca}^{40} \text{ (blood)}}{\text{Sr}^{90}/\text{Ca}^{40} \text{ (diet)}} = 0.13 \\ \frac{\text{Ca}^{45}/\text{Ca}^{40} \text{ (milk)}}{\text{Ca}^{45}/\text{Ca}^{40} \text{ (diet)}} = 0.48 & \frac{\text{Sr}^{90}/\text{Ca}^{40} \text{ (milk)}}{\text{Sr}^{90}/\text{Ca}^{40} \text{ (diet)}} = 0.10 \end{array}$$

The higher specific activity of Ca^{45} in milk, as compared with blood, was an unexpected finding for which no completely satisfactory explanation is available. It can perhaps be explained in terms of the unlabeled blood calcium derived from bone being, for some reason, less available for milk formation than the labeled blood calcium derived from the diet. All ewes were in markedly negative calcium balance throughout the experiment. There was no significant relationship between the calcium level in the diet fed and the state of calcium balance, but there was a definite relationship between the number of lambs per ewe (1 or 2) and the state of negative balance.

Insoluble precipitates of Sr^{90} were uniformly mixed in soils and the uptake of Sr^{90} by plants compared with uptake of fully soluble Sr^{90} also applied to soil. These tests using gallon cans showed that insoluble forms are 1/10th as available to plants as are soluble forms. Exceptions were noted with $\text{Sr}^{90}\text{CO}_3$ and $\text{Sr}^{90}\text{PO}_4$ in alkaline soils in which cases the Sr^{90} was 1/100th as available as soluble forms. These cultures will be recropped to determine the time required for soluble and insoluble forms to approach equal availability, this time being an indication of the time required for added Sr^{90} to approach an equilibrium state in soil.

Effects of calcium addition on Sr^{90} uptake are generally observed under conditions in which plant yield is also affected by calcium addition. To determine whether yield is a factor in the calcium effect, plants were grown in soils fertilized with increments of phosphate. Although yield was more than doubled, the concentration of Sr^{90} in the plants was unaffected.

Iodine

All groups of sheep and swine on I^{131} feeding showed an increase in Q/D for the month of November due to the onset of cold weather.

Control ewes, ranging in age from $3\frac{1}{2}$ to $7\frac{1}{2}$ years, were fed $0.15 \mu\text{c/day}$ of I^{131} until apparent equilibrium was reached (70 days) to see if the lowest chronic I^{131} regimen of $0.15 \mu\text{c/day}$ could be responsible for the gradual reduction noted in thyroid uptake with increasing age. The thyroid burden exhibited at equilibrium in these controls was from 0.08 to $0.23 \mu\text{c}$ lower than in ewes of the same age which had been on $0.15 \mu\text{c/day}$ for their entire lifetime. This reaffirms the findings of previous years that $0.15 \mu\text{c/day}$ of I^{131} is non-damaging to sheep under the conditions of our experiment.

Tungsten

The retention of tungsten in the rat has been followed over a period of 100 days following intragastric administration. Highest concentrations were present in the spleen up to the 100-day sacrifice, at which time concentrations in bone and spleen were approximately equal. It is not yet clear which of these two tissues should be considered the critical organ.

Plutonium

Rats injected with $10 \mu\text{c}$ Pu^{239} were found to die acutely after subsequent x-irradiation with as little as 200 r. Median survival time following the 200 r irradiation was 19 days. Of 12 rats receiving the plutonium-only, 1 died after 37 days and 1 after 43 days.

Except for excretion data, results are available from an extensive experiment comparing the therapeutic effectiveness of DTPA, a number of other chelating agents, and various combinations of DTPA with other materials. Therapeutic treatment was given intraperitoneally, approximately 1 hour after plutonium administration, and the animals sacrificed 5 days later. The therapeutic effectiveness of DTPA was superior to that of any other chelating agent tested and was not improved by simultaneous administration of Cardrase (a diuretic) or dinitrophenol. As compared with the controls, DTPA decreased the retention of plutonium in the liver by a factor of approximately 30, decreased retention in femur and spleen by a factor of 10 to 13 and decreased retention in the kidneys by a factor of 5 to 6.

Intragastric administration of DTPA (6mM/Kg), in conjunction with carboxymethyl-cellulose, an hour following plutonium injection, caused a 5 to 8-fold reduction in plutonium retention in femur, liver, spleen and kidney. This is the first indication of an orally effective therapeutic agent for plutonium.

Radioactive Particles

Gross examination of mice 500 days after inhalation of about $0.3 \mu\text{c Ru}^{106}\text{O}_2$ showed large fibrotic areas in lung tissue and enlarged pulmonary lymph nodes. Other lymph nodes appeared large and calcified. Several tumors were found associated with intestines and ovary. In general, gross examination showed more pathology than was observed in mice given comparable amounts of $\text{Ru}^{106}\text{O}_2$ by intratracheal injection.

Gastrointestinal Radiation Injury

Fifteen rats maintained on a dosage regimen of $0.5 \mu\text{c Y}^{90}$ daily, in drinking water, for a period of 6 to 8 weeks, show no grossly evident effects other than an immediate and sustained reduction of the lymphocyte count by 50%. Since a daily ingestion of $0.65 \mu\text{c Y}^{90}$ resulted in death in about 12 days, the daily threshold dose for early death from ingested Y^{90} must be within the narrow limits of 0.5 to $0.6 \mu\text{c/day}$. The gross pathology seen in the animals succumbing to chronic Y^{90} ingestion was only partially duplicated in rats severely dehydrated by reduced water intake and cathartic (MgSO_4) administration. Rats whose intestines were exteriorized and exposed to 600, 900, and 1200 r of x-radiation and subsequently placed on $0.5 \mu\text{c Y}^{90}/\text{day}$, via drinking water, showed no effects not anticipated from the x-radiation alone. No deaths resulted. Under these conditions the chronic ingestion of Y^{90} apparently did not contribute appreciably to the acute intestinal radiation syndrome. This may be due to the fact that the principal site of damage following external radiation is in the small intestine, while in the case of ingested radioisotopes, most extensive damage is seen in the large intestine.

Radiation Protective Agents

In very preliminary experiments employing materials of questionable purity, the compound, erioglaucine (previously studied by Kalkwarf in in vitro systems) showed a definite protective affect in LAF₁ mice. Of 10 unprotected mice exposed to 800 r only 1 survived for 30 days. Of 10 mice injected with erioglaucine at a dose level of approximately 1 g/kg, 10 minutes prior to irradiation, 7 animals survived the 800 r x-ray dose for a period of 30 days.

Relative Biological Effectiveness

A continuous flow technique was developed to measure the rate of loss of material from yeast cells packed in a column. Preliminary data suggest that leakage of potassium and phosphorus are related while leakage of UV absorbing compounds is independent. This method is more sensitive than the suspending method previously used and promises to be valuable in studying effects of lower radiation doses from H^3 , P^{32} and S^{35} .

W. K. Rosenberg
BIOLOGY OPERATION

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C. OFF-SITE VISITS AND HAPD VISITORS

Name	Dates of Visits	Company or Organization Represented/Visited	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
VISITS TO HANFORD WORKS						
Drs. FP Thieme, LB Carlson, Figley, Baltzo, R. Parker	11/3	U. of Wash., Seattle	Tour facilities and discuss program.	HA Kornberg and staff	No	100-F, 141-M 108-F, 146-FR
Dr. J. T. VanBruggen, 11/12 JC Elwood, Jean Scott, Alacia Marco (Chile)		U. of Oregon Medical School, Portland	Present a seminar and tour facilities.	HA Kornberg and staff	No	100-F, 141-M 108-F, 146-FR
JS Graham	11/14	AEC, Wash. D.C.	Tour Animal Farm and Aquatic Biol.	HA Kornberg	No	100-F, 141-M 146-FR
EP Boland, K Sprankle, CW Culp, FJ McCarty	11/14	Wash. D.C.	Tour facilities	HA Kornberg and Staff	No	100-F, 141-M 146-FR
Dr. George Lauff	11/20	U. of Michigan, Ann Arbor, Mich.	Tour facilities and observe Radioecology research program.	JJ Davis	No	100-F, 141-M 146-FR, 108-F
VISITS TO OTHER INSTALLATIONS						
L. A. George	11/15	Univ. of B.C., Vancouver, B.C.	Address Pacific NW Soc. of Exptl. Biol. and Med.	LB Carlson	No	-

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D. Lectures

a. Papers presented at meetings

Dr. L. A. George, "Pathologic Effects of I^{131} at the Pacific Northwest Section of the Society of Experimental Biology and Medicine," November 15, 1958 - Vancouver, B.C.

W. J. Clarke, "Biological Effects of Radiation on Man and Animals," Medical Clinic for Industrial Medical Physicians, Richland, Wash., November 19, 1958.

b. Seminars

W. C. Hanson, "Population Studies of Canada Geese at HAPO," November 5, 1958.

B. Kavin, "Distribution and Excretion of Intravenous Plutonium," Nov. 5, 1958.

Dr. J.T. Van Bruggen, Univ. of Oregon Medical School, "Studies in Lipid Metabolism," November 12, 1958.

R. C. Thompson, "Trip Report: Oak Ridge Biology Division and Health Physics Division Information Meeting and Lankenau Hospital Bone Conference," November 19, 1958.

E. Publications

a. HW Publications

None

b. Open Literature

Davis, J.J., "Dispersion of Radioactive Materials by Streams," J. Am. Water Works Association 50, 11 (1958).

Ballou, J.E., "Effects of age and mode of ingestion on the absorption of Pu," Proc. Soc. Exptl. Biol. Med. 98, 726 (1958).

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OPERATIONS RESEARCH AND SYNTHESIS OPERATION
MONTHLY REPORT

November, 1958

ORGANIZATION AND PERSONNEL

There were no changes in personnel during November.

OPERATIONS RESEARCH ACTIVITIES

Economic Studies

The rough draft of the report on the task force for "Evaluation of Capital Expenditures" was reviewed and most of the incompatible viewpoints of the task force members have been compromised. A final report is being prepared.

The development of a new statistical computational scheme for the calculation and testing of hypothetical models was brought to completion during the month. It is estimated that the cost of carrying out econometric model estimation and testing by the new methods will be 5-10% of the cost required by methods existing at the time this project was begun.

Data preparation for the calculation of the first set of reactor models was completed and the data sent to Data Processing Operation. A ninety-five equation hypothetical model of the reactor sector was built up and prepared for calculation and testing.

CPD Control Study

The historical study of plutonium B-PID's within CPD was completed. A presentation of this history will be included in the final summary report on the CPD Control Study. Work on this report was continued.

Team evaluation of the analytical tools developed for the Z-Plant information study led to further changes permitting a greater degree of definition of the elements comprising the Z-Plant processes. A complete revision of the model followed. Due to the fact that the 702 computer capacity is assigned, the conversion had to be performed on EAM facilities.

Other

Work continued on the development of practical models for NPR spare part procurement.

STATISTICAL AND MATHEMATICAL ACTIVITIES IN SUPPORT OF RESEARCH PROGRAMS

2000 Program - Metallurgy

Several meetings were held to discuss possible methods of interpreting and explaining temperature data collected from an in-reactor test on a fuel element. The precision of reactor tube water temperature estimation was evaluated, and the significance of the results discussed with interested personnel.

Discussions were held concerning the mathematics of fitting a corrosion model to experimental data which can delineate three corrosion mechanisms: uniform, intergranular, and pinhole.

Confidence intervals for the uranium hardness incubation period were constructed to supplement previous analysis on the relation between uranium hardness and irradiation time.

2000 Program - Reactor

Questions on the design of a physical properties test for proposed NPR fuel element end caps were answered.

2000 Program - Separations

Complete analytical expressions and a table of their numerical values were derived from the previously reported mathematical model for the radiant heat transfer process in a spray calcinator, and the results reported to interested personnel.

4000 Program - Swelling Studies

Consultation in connection with the fuel element swelling program was continued.

6000 Program - Biology and Medicine

Work continued on the mathematical model of migration of radioactive particles within a biological system. Further efforts were concentrated on attempts to sharpen the model so as to make it a useable theoretical tool for biologists and other experimental workers.

Work was begun on statistical analysis of data on miscellaneous fish tests.

6000 Program - Atmospheric Physics

Formulas for constructing estimates of the parameters in a Gaussian plume concentration function were derived and reported to the Atmospheric Physics Operation. The formulas were specifically designed for data from the A.F.-A.E.C. deposition and diffusion study.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR THE PRODUCT DEPARTMENTS

Process Control (FPD)

Statistical assistance was given in connection with the non-wetting of fuel elements. Specifically, experience for different time periods was compared and the use of control charts to evaluate the significance of changes in the degree of non-wetting was recommended.

Measuring Product Quality (FPD)

Attention is being given the general problem of measuring fuel element quality by variables measurements. Specific assistance given in this problem area consisted of the following: (1) determination of proper sample sizes for total bond count; (2) investigation of sort data to determine whether or not presently.

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defined lots are homogeneous in this respect (further analyses are being performed in order to investigate the reasons for lack of homogeneity uncovered in this preliminary analysis); (3) analysis of existing stud-pulling data to see if such a variables measurement is feasible to employ in practice.

Fuel Element Performance (IPD and FPD)

Consulting work was done in connection with the preparation by IPD personnel of a proposal to improve fuel element quality by the use of variables measurements. Specific recommendations presented in this connection are contained in the following unclassified reports: (1) "Program for Improving Fuel Element Quality," 11-12-58; (2) "Describing Outgoing Quality," 11-21-58; (3) "Effects of Non-homogeneous Inspection Lots on Evaluation of Quality of Outgoing Product," 11-24-58.

Production Tests (IPD and FPD)

An analysis has been made of data from production test IP-68-A-90-FP, which was conducted primarily to investigate the relationship between porosity and the incidence of hot spots. The analysis of dimensional data is meaningful inasmuch as variables giving rise to high porosity may also affect dimensional stability. Results of the dimensional distortion analysis are given in HW-58245-RD, "Analysis of Distortion Data from Production Test IP-68-A-90-FP," 11-21-58. The analysis of the hot spot data is essentially complete and will be reported soon.

In connection with the design of production tests, existing methods of determining the sample size necessary to detect a given difference in warp are based on data collected prior to 1956. These are being up-dated using recent distortion data.

Rupture Analyses (IPD)

A study was made of side rupture data through the end of 1957 in order to investigate the adequacy of the mathematical model in current use. Using exposures adjusted for different powers and temperatures, it was found that more ruptures occurred at lower exposures than one would expect on the basis of this model. The model was therefore revised to account for the presence of such low exposure ruptures, and the implications associated with the acceptance of this revised model were discussed. (HW-58270 RD, "Revised Model to Describe Side Rupture Data," 11-25-58.)

An analysis is currently being made of I and E side rupture data (both natural and enriched) in order to determine whether or not the rupture model formulated on the basis of solid rupture experience is applicable, once adjustments for different reactor conditions are made.

A discriminant analysis to enable the prediction of which lots of I and E material are rupture prone based on 300 area reject data was abandoned in view of recently acquired information as to the inadequacy of using such reject data to describe lot quality.

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Final Product Specifications (CPD)

An investigation was made of the best allocation of numbers of dilutions and titrations associated with the final product analysis under the assumption that the total number of titrations is limiting. The criterion used was the number of degrees of freedom entering into the preparation of the tolerance statement, which can become extremely important in determining whether or not a given quarter's production meets specifications.

General

Sample data giving the hydrogen content of as received bare fuel elements were analyzed primarily in order to compare 1957 data with 1958 data. The question of whether or not the hydrogen content exceed specifications was also resolved.

In order to compare two methods of forecasting reactor production, several production forecasts for fiscal years 1956, 1957, and 1958 were compared with actual production figures. Some interesting results relating to differences between the estimated and actual figures as a function of time prior to the year under consideration were discovered.

A mathematical theorem on the uniqueness of a particular class of functions of a complex variable was proved and applied to the analysis of an analogous electrical network employed in the eddy-current testing method for fuel element defects. This theorem provides a first step toward the better classification and interpretation of the signals received from this testing device.

Further statistical training sessions employing the process simulator to consider problems of immediate concern to FPD personnel have been conducted.

OTHER STATISTICAL AND MATHEMATICAL ACTIVITIES

Work continued on attempts to solve a second-order quasi-linear partial differential equation which is implied by a mathematical model of a laboratory soil column exchanger. The solution, when obtained, will yield a soil column breakthrough ratio prediction curve.

A statistical study of data on the loss of technical personnel at HAPO within the past five years is being completed.

The final four lectures of a course on statistical methodology were delivered to personnel for Nuclear Physics Research Operation.

Assistance was given in the preparation of an IBM routine to be used in connection with tank calibrations. This routine employs a cumulative model which gives more realistic estimates of the uncertainties associated with a given calibration.

Carl A. Bennett

Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

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E-5

HW-58244

VISITS TO HANFORD WORKS

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

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
W. L. Nicholson	11/4 to 11/7	AEC-Div. of Research Washington, D. C.	Consultation on Wash. Des. Proj.	S. G. English et al	Yes
Carl A. Bennett	11/12 to 11/14	AEC-Div. of Research Washington, D. C.	Consultation on Wash. Des. Proj.	S. G. English et al	Yes
A. D. Wiggins	11/13 to 11/17	Western Regional Mtg. Inst. Math. Stat. Monterey, Calif.	Present paper	F. J. Massey, Jr.	No

PROGRAMMING OPERATION
NOVEMBER 1958

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. Irradiation Testing

At AEC request, a survey was conducted to estimate and describe Hanford irradiation space needs above and beyond those now available locally and in the MTR and ETR. Study indicated space to be required for the four following types of testing:

- (1) Fuel elements: 2500 psig, 320 C, known, reasonably constant and reasonably flat thermal flux of 2 to 6×10^{14} n/cm²/sec over a three foot length with cooling to handle heat transfer rates of 1,000,000 BTU/hr/sq.ft. Arrangements for test irradiation of test elements both vertically and horizontally.
- (2) Pressure tubing: Arrangement for testing three foot lengths of Zircaloy and stainless steel pressure tubing in temperature and pressure cycling to 2500 psig, 320 C at fluxes up to 10^{15} n/cm²/sec.
- (3) Corrosion: To supply basic corrosion information on aluminum, Zircaloy and stainless steel up to 2500 psig, 320 C and 10^{15} n/cm²/sec at heat transfer rates up to 1,000,000 BTU/hr/sq.ft.
- (4) Graphite: Arrangements for testing specimens at fast fluxes of 10^{15} n/cm²/sec.

B. REACTOR DEVELOPMENT - 4000 PROGRAM

1. Plutonium Recycle Program

Plutonium Evaluation

An AEC requested special study was concluded concerning once-through plutonium fueling of three selected reactors, representing graphite, light water, and heavy water types. The productivity of four different plutonium isotope compositions was determined in these reactors and the unit value of each isotope was computed by linear simultaneous equations. It was hoped that the value of other batches of plutonium could be determined by applying these unit values for each isotope present. This was considered a possibility since the four plutonium isotopes arising from reactor irradiation are sequential, i.e., $\text{Pu}^{239} \longrightarrow \text{Pu}^{240} \longrightarrow \text{Pu}^{241} \longrightarrow \text{Pu}^{242}$. The relative amount of each isotope is principally a function of total thermal neutron exposure with relatively minor variations introduced by variation of the neutron flux spectrum associated with reactor type and operating variables.

Reasonable results were obtained for the total fuel value of the isotopic mixtures analyzed; but because of the non-linearity of the problem, the individual isotope values so-determined could not be applied to ascertain the value of plutonium batches other than those analyzed in the specific reactors, nor could these individual values be used to determine the value of a single batch. The batch value exhibited the expected dependence on jacketing, fabrication costs, uranium price schedule, etc.

In accordance with AEC request, plutonium was considered as make-up enrichment for sweetening natural uranium to the enrichment originally specified for each reactor type. The possible error of this expedient was determined by a computation of the optimum combination of uranium enrichment and plutonium enrichment for different assigned plutonium values; this analysis indicated that some of the non-linear results obtained could be ascribed to this over-simplification needed to insure completion of the computation by November 24, 1958.

It is evident that the gross enrichment of uranium-238 bearing reactors with plutonium containing substantial quantities of plutonium-240 introduces effects not readily apparent from analysis of self-sustaining plutonium recycle data, wherein the plutonium to uranium-235 ratio is substantially less. The light water and graphite-water reactor studied were under-moderated and as a consequence exhibited "hard" neutron spectrums. In a "hard" neutron spectrum the relative effective absorption cross-section of plutonium-240 is substantially increased. As a consequence, it was found that the uranium-238 inventory of the under-moderated reactors had to be substantially reduced to achieve criticality with the use of plutonium enrichment containing significant quantities of plutonium-240. As previously reported, plutonium-240 is a valuable fertile material as it yields plutonium-241, which liberates more neutrons per thermal neutron absorbed than does plutonium-239. In some instances the fertility effect of plutonium-240 compensated for the burn-out of plutonium-239 at just the correct rate so as to yield unusually long reactivity life times. The unique value of plutonium composition in these reactors are in effect "singularities", i.e., plutonium batches of nearly the same compositions may not have increased reactivity lifetimes in this reactor. This effect was not found to hold in the D₂O moderated reactor. This then further complicates development of a simple relationship of individual plutonium isotope value and total value of a specific batch.

While the results from other sites are not complete, it does not appear that a simple relationship for the fuel value of various plutonium compositions can be developed. Furthermore, it appears that computations to substantially improve on the results obtained to date will require several man years of effort and firmer plutonium fuel processing costs than are currently available.

Development of RBU Computer Code

Study and analysis basic to formulation of the code was completed. A report describing the code and its underlying theory was likewise completed and is soon to be issued. This work is a joint effort of HLO and

American Standard personnel. De-bugging of the code is now under way, and is slightly behind schedule owing to personnel changes at American Standard.

PRTR Plutonium Fuel Throughput

In order to define more precisely the fission product content of exposed fuel and the radiation properties of recycled plutonium so that the separations and fabrication problems can be better appreciated, the Litton computer has been intensively applied to the development of the required data. In these computations the variations of the cross section of Pu-240 with its concentrations in the fuel (the self-shielding effect) has been included. The resulting data show that time for a given burn-out (50%) in early loadings will be substantially less than that estimated earlier. A significant effect on the initial PRTR operating schedule is thus indicated. These computations continue to be refined.

Facilities for Chemical Processing of PRTR Fuel Elements

A plan for the delivery of canned sections of PRTR fuel elements to the Redox plant dissolvers in standard buckets prior to the provision of facilities for nonproduction fuel processing has been defined. This plan involves several steps with need for close integration and scheduling in 300, 100 and 200 Areas. Studies were begun on means of assuring simplification. By the existing plan and the provision of a few jumper changes in the Redox plant the Zirflex process can be readily applied in existing stainless steel dissolvers to remove Zircaloy jackets. These facilities would also be needed in the nonproduction fuel processing program. After removal of the jackets fuel core dissolution would proceed by conventional methods, mercury catalyzed nitric acid for plutonium-aluminum fuel or nitric acid alone for uranium oxide fuels.

C. RADIOLOGICAL CONSULTATION

The Task Force on Radiological Evaluation was organized and initial assignments made. Members are R. L. Junkins, R. F. Foster, J. J. Fuquay, L. C. Schwendiman, Z. E. Carey and J. W. Healy, Chairman. First efforts are to be the preparation of estimates of the environmental radiation dose.

Invited papers for the American Nuclear Society meeting in December and for the GE Radiation Protection Conference in November were prepared.

Manager, Programming

LH McEwen:d1

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VISITS TO HANFORD:

Name	Date of Visit	Company or Organization Represented and Address	Reason for Visit	HAPO Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
R. S. Miller A. Dromerick	11/5/58	ACF Industries, Washington, D.C.	Gas cooled reactor discussions.	M. Lewis	Yes	300, 326
T. Stevens (Access Permits)	"	Kaiser Engineers Oakland, Calif.	"	"	"	"
G. Boyer	"	AEC - Idaho Operations Office, Idaho Falls, Idaho	"	"	"	"
Dr. J. VanDerSpeck	11/21	Administrative Director, Societe Belga Nucleaire, Brussels, Belgium	Discussions of utilization of plutonium as fuel.	M. Lewis L. H. McEwen	No	300, 3760

VISITS TO OTHER INSTALLATIONS:

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. H. McEwen	11/6/58	AEC - Washington, D.C.	Attend AEC Ad Hoc Advisory Committee Meeting on Reactor Development to discuss PRP.	H.D. Smyth J.B. Black M.W. Boyer E.V. Murphree A. Tammaro R.E. Willson	Yes
J. W. Healy	11/12-13	GE - Cleveland, Ohio	Attend Fourth GE Conf. on Radiation Protection. Delivered paper.	W.A. MacAdams	No
E. A. Eschbach J. R. Triplett	11/19-20	AEC - DRD Washington, D.C.	Plutonium value study.	Mr. D. Coburn	No

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DECLASSIFIEDRADIATION PROTECTION OPERATION
MONTHLY REPORT - NOVEMBER, 1958A. ORGANIZATION AND PERSONNEL

Edna D. Britch was placed on leave of absence on November 3, 1958. C. A. Grosclaude was transferred in from IPD on November 10, 1958. J. D. Cudmore was reactivated on November 14, 1958, and Margaret F. Peterson was re-engaged on November 13, 1958. D. D. Dickinson and J. M. Barton were transferred to IPD on November 10 and 17, respectively. E. R. Wood was transferred to R & F R & D on November 17, 1958. One transfer of employees within RPO was initiated on November 17, 1958 to provide increased job knowledge.

B. ACTIVITIES

A plutonium metal turning punctured the finger of a CPD employee who was known to have a deposition of about 5% of the MPBB. Excision of a small amount of tissue reduced the plutonium in the wound from 0.0072 μc to 0.0022 μc .

One case of plutonium deposition was confirmed as a result of an incident involving ruptured hood gloves in the 234-5 facility. Two ruptured gloves were discovered while decontaminating a process hood. Follow-up surveys indicated an intake of plutonium occurred. The intake is probably less than 5% of the MPBB.

Briquets of plutonium turnings, being melted in a bell jar within a hood in the 234-5 Building, ignited when the cooling water supply failed. The briquets were placed in a shallow pan inside the hood where they continued to burn without further incident.

On November 3, the process laundry began decontaminating respiratory equipment from IPD facilities. After decontamination, the masks were surveyed by laundry workers who have been instructed by Radiation Monitoring.

A dose rate of 12.5 r/hr measured two inches from a waste trailer at 340 Building represented the highest dose rate ever noted for this operation. Escort procedures were introduced to expedite movement through perimeter gates as exposures on the order of 1 r/hr at eighteen inches prevailed.

Release of I^{131} to the atmosphere averaged 12.3 curies per week presumably because of inadvertent processing of short-cooled metal. The peak emission was 15 curies on November 13. There was no significant increase in vegetation contamination levels.

Fallout of nuclear bomb test debris in eastern Washington, including the Hanford reservation, increased the fission product activity concentrations on vegetation to levels of two to four times those measured in October. The fallout decreased significantly by November 7, but a general increase was again noted during the last week of November.

Waste water samples from the 234-5 Building waste stream, collected at the point of discharge to the ditch which drains to the U-Swamp, contained increased amounts of plutonium. The maximum sample collected contained $1 \times 10^{-3} \mu\text{c/cc}$, compared to normal values of $10^{-8} \mu\text{c/cc}$. Daily sampling indicated a gradual decrease in plutonium content, with latest samples in the order of $10^{-6} \mu\text{c/cc}$.

The study of high-level gamma dose measurement with personnel monitoring film was essentially completed. Results with the Eastman Type 2 film were reported last month. Studies of du Pont 552 film, interpreted through the use of an X-ray

spectrometer, were completed. Methodology of using this technique for high dose interpretation was established. The accuracy obtainable was poorer than that previously reported.

The "stray radiation chambers" ordered from Victoreen arrived. These chambers are of two sizes. They are cylindrical in shape, having diameters of 5.7 cm and 11.0 cm and lengths about equal to their diameters. The electrical connections to these chambers are identical to the conventional radiation pencil chamber sockets and, hence, these chambers can be used with the pulse pencil equipment without alterations. The smaller chamber has a voltage to mr ratio of about 8.5 volts per mr when calibrated with radium gamma, and therefore gives a full scale range of 0.01 to 10 mr. The larger chambers are about ten times more sensitive and give a full scale range of 0.001 to 1 mr. These chambers and conventional pencils were used to measure the radiation level at the proposed location of the 100-F Area badge house.

The first full-scale decontamination of a reactor with Turco 4306-B was completed at K Area. The reduction in dose rate and the improved conditions regarding the requirements for respiratory protection and other radiological protective apparel exceeded IPD expectations. Dose rates at the rear face were reduced to between 10 and 15 mr/hr. The estimated savings to be realized through this decontamination will probably be exceeded.

C. EMPLOYEE RELATIONS

There was an exchange of one radiation monitor between the Regional Monitoring and the Radiation Monitoring Operations for training purposes.

There were no medical treatment injuries and no security violations during the month.

RPO personnel submitted two suggestions. Four evaluations were completed, and four suggestions were received for evaluation. No awards were made.

D. SIGNIFICANT REPORTS

HW-58330 "Regional Monitoring Activities, November, 1958" by B. V. Andersen.

HW-58331 "Waste Disposal Monitoring Activities Summary, November, 1958" by K. F. Baldridge.

HW-58256 "Monthly Report - November 1958, Radiation Monitoring Operation" by A. J. Stevens

The November issue of Nucleonics contained a report entitled, "Energy Discrimination in Gamma Dose Evaluation", by L. F. Kocher. A paper entitled, "Safe and Proper Handling of Radioisotopes Not Requiring a Specific AEC License", was presented by C. M. Unruh at the fall meeting of the Oregon Science Teachers Association. A talk entitled, "Considerations in Development of Safe Methods and Procedures for Commercial Handling of Radioactive Materials", was presented by H. V. Clukey at the Metals Industry Panel of the Governor's Ninth Industrial Safety Conference.

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Buildings	Data
Clarence Slover	11/10 - 11/58	Lexington Signal Depot, Lexington, Kentucky	Discuss radiation protection	A.R. Keene and Staff	No	300:3746, 3705, 3706, 3745, 329, 700:747
John Hughes	11/17/58	Commonwealth Edison Company, Chicago, Illinois	Discuss Radiation Protection Standards and job training	A.R. Keene and Staff	Yes	300:3746, 3706
W. A. Brobst J. V. McNemara	11/5/58	Chicago Operations Office, AEC, Chicago, Illinois	Discuss health safety and fire protection considerations and the handling of plutonium	A.R. Keene and Staff	No	300:3746
F. J. Arsenault	11/10/58	Westinghouse Special Products Atomic Power for Development, Pittsburgh, Pennsylvania	Discuss monitors for U-234, U-235, and Plutonium detection	F. H. Sanders	No	300:3706

VISITS TO OTHER INSTALLATIONS

R. H. Wilson	11/1 - 4/58	Argonne National Laboratory, Lemont, Illinois	Present a paper	Dr. J. Sedlet	No	
E. C. Watson	11/13 - 15/58	University of Rochester, Rochester, New York	Present a paper	Dr. J. Hirsch	No	
		Atomic Power Equipment Development, San Jose, California	Interview		No	
Carl M. Unruh	11/22/58	Canby Union High School, Canby, Oregon	Present a paper at the semiannual meeting of the	Robert Doty	No	

VISITS TO OTHER INSTALLATIONS

Carl M. Unruh (con't.)

		Oregon State Science Teachers Association	
H. V. Clukey	11/13/58	Governor's Safety Conference, Olympia, Washington	Present a paper Harry Schwartz No
	11/13/58	Washington State Pollution Control Commission, Olympia, Washington	Discuss Columbia River Advisory Group business A. T. Neale W. W. Saxton No
	11/17 - 19/58	AEC ad hoc Committee on Transportation of Highly Radioactive Material, Washington, D. C.	To review and discuss final draft of Committee's report R. C. Dalzell Yes
*J. W. Vanderbeek	10/12 - 15/58	Atomic Industrial Forum, Columbus, Ohio	Attend AIF Conference S. J. Harris No
A. R. Keene	11/12 - 13/58	GE Conference on Radiation Protection, Nela Park, Cleveland, Ohio	Present a paper Attendees No

*Inadvertently omitted from October 1958 report.

REGIONAL MONITORING - RESULTS (October 26 - November 23, 1958)

<u>Sample Type and Location</u>	<u>Activity Type</u>	<u>Monthly Average</u>	<u>Units*</u>	<u>Trend** Factor</u>
<u>Drinking Water</u>				
100-F Area	Isotopic	0.9	% MPCGI	--
Separations Areas	Total Beta	4.1×10^{-6}	µc/cc	+2
Pasco	Isotopic	0.3	% MPCGI	--
Kennewick	Isotopic	0.1	% MPCGI	--
Richland	Total Beta	$< 3.0 \times 10^{-8}$	µc/cc	--
<u>Columbia River Water</u>				
Above 100-B Area	Total Beta	3.0×10^{-8}	µc/cc	--
100-F Area	Isotopic	4.8	% MPCGI	--
Hanford Ferry	Total Beta	6.9×10^{-5}	µc/cc	--
Pasco	Isotopic	1.3	% MPCGI	--
McNary Dam	Total Beta	1.8×10^{-6}	µc/cc	+2
Vancouver, Washington	Total Beta	No Sample	µc/cc	--
<u>Waste Water</u>				
Outlying Test Wells	Total Beta	1.9×10^{-6} (max)	µc/cc	-3
Reactor Effluent Retention Basins to River	Total Beta	25,000	curies/day	--
<u>Atmosphere</u>				
Gross Dose Rate -				
Separations Areas	Beta-gamma	0.9	mrad/day	--
Residential Areas	Beta-gamma	0.6	mrad/day	--
I-131 Separations Areas	I-131	8.1×10^{-13}	µc/cc	+2
I-131 Separations Stacks	I-131	12	curies/week	+2
Active Particles - Project	--	6.6	ptle/100 m ³	--
Active Particles - Environs	--	15	ptle/100 m ³	+3
<u>Vegetation</u>				
Separations	I-131	1.1×10^{-5}	µc/gm	+3
Residential	I-131	5.6×10^{-6}	µc/gm	+3
Eastern Washington and Oregon	I-131	1.0×10^{-6}	µc/gm	--
Fission Products less I-131 - Wash. and Ore.	Beta	2.7×10^{-4}	µc/gm	+3

* The % MPCGI is the percent of the maximum permissible limit for continuous occupational exposure to the gastrointestinal tract calculated from drinking water limits.

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

EXPOSURE EVALUATION AND RECORDSExposure Incidents Above Permissible Limits

	<u>Whole Body</u>	<u>Localized</u>
November	1	0
1958 to Date	6	12

Gamma Pencils

	<u>Pencils Processed</u>	<u>Paired Readings 100-280 mr</u>	<u>Paired Readings Over 280 mr</u>	<u>Lost Readings</u>
November	40,148	94	1	7
1958 to Date	459,598	516	71	28

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>
November	10,104	952	94	17	46	3.69	23.66
1958 to Date	190,462	8,681	437	105	438	3.07	10.91

Low Neutron Pencils

	<u>Pencils Processed</u>	<u>Paired Readings 4-12 mrem</u>	<u>Paired Readings Over 12 mrem</u>	<u>Lost Readings</u>
November	0	0	0	0
1958 to Date	25,880	297	94	8

Neutron Film Badges

	<u>Film Processed</u>	<u>Readings 50-100 mrem</u>	<u>Readings 100-300 mrem</u>	<u>Readings Over 300 mrem</u>	<u>Lost Readings</u>
<u>Slow Neutron</u>					
November	550	17	1	0	0
1958 to Date	3,140	156	23	0	2
<u>Fast Neutron</u>					
November	622	0	0	0	2
1958 to Date	10,943	10	1	0	11

Bioassay

	<u>November</u>	<u>1958 to Date</u>
Plutonium: Samples Assayed	928	12,342
Results above 2.2×10^{-8} $\mu\text{c}/\text{sample}$	172	553
Fission Product: Samples Assayed	850	12,597
Results above 3.1×10^{-5} $\mu\text{c FP}/\text{sample}$	2	26
Uranium: Samples Assayed	271	3,277
Confirmed Plutonium Deposition Cases	1	17*

*Bringing all-time HAPD total to 229.

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	12.2	4.2	41	8.9	2.4	37
Hanford Laboratories	55.5	4.3	28	85.0	6.8	19
Chemical Processing	9.0	3.2	54	25.2	3.7	47
Chemical Processing*	27.8	16.2	2	21.7	13.5	3
Special Incidents	0	0	0	0	0	0
Random	1.6	0.8	40	0	0	0

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

Thyroid Checks

	<u>November</u>	<u>1958 to Date</u>
Checks Taken	0	25
Checks Indicating 0.01 μ c	0	0

Hand Checks

Checks Taken - Alpha	28,559	453,102
- Beta-Gamma	19,380	356,946

Skin Contamination

Plutonium	24	312
Uranium	0	68
Fission Products	59	580

CALIBRATIONSPortable Instruments

	<u>November</u>	<u>1958 to Date</u>
CP Meter	903	10,470
Juno	314	3,578
GM	1,228	14,446
Other	205	2,387
Total	2,650	30,881

Personnel Meters

Badge Film	928	12,887
Pencils	0	31,510
Other	368	4,247
Total	1,296	48,644

Miscellaneous Special Services

	213	7,558
Total Number of Calibrations	4,159	87,083

R. J. Jenkins
For the Manager
RADIATION PROTECTION

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - NOVEMBER, 1958

GENERAL

Safety performance of the operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 2.19 per cent, which is considered below average experience.

The absenteeism rate was 3.14 per cent, which is about average experience.

There were no security violations charged to the Operation.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 11,032 hours. The total shop work backlog is 18,635 hours of which 50% is required in the current month, with the remainder distributed over a three month period. Overtime worked during the month was 4.9% (735 hours) of the total available hours.

Distribution of time was as follows:

	<u>Man Hours</u>	<u>% of Total</u>
Fuels Preparation Department	1769	16.1
Irradiation Processing Department	847	7.7
Chemical Processing Department	530	4.8
Hanford Laboratories Operation	7573	68.5
Construction Engineering Operation	110	1.1
Miscellaneous	203	1.8

The number of requests from customers for emergency service increased sharply, resulting in a higher than normal overtime ratio. The work backlog remained at slightly over 6 crew weeks with 3 to 5 crew weeks considered to be the optimum backlog for this shop.

Two technical symposiums were held during the month - one on carbide cutting tools and the other on spray painting and the application of special coatings.

Quotations covering a jig boring machine were received and evaluated. The Knight No. 60 jig boring machine met all important specifications and as such was the lowest priced offering received. Delivery is expected in the month of January.

Security performance was considered satisfactory with no violations. Safety performance showed improvement with only 5 medical treatment injuries and no major injuries. Absenteeism due to illness remained at a higher than normal level (4%).

RADIOGRAPHIC TESTING OPERATION

With a full quota of man-hours available this month, activity for the Radiographic Testing Operation approached record volume. A total of 8,959 tests were made, of which 3,541 were radiographic exposures (including x-ray and gamma ray),

and 5,418 were supplementary tests. The supplementary test work included dimensional measurements (micrometric), eddy current, leak detection, penetrant, and ultrasonic (thickness measurements and flaw detection) tests.

Associated with the higher activity, a large number of pieces and samples were examined. A total of 1,368 items were handled. The feet of material represented by this total amounted to 17,522. These totals, taken together with the high number of tests performed, represents a high level of productivity because of the handling involved. Work was done for 19 different organizational components, representing most of the operating departments and service organizations. A total of 31 reports were issued, detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 28 different occasions for advice and information regarding general testing theory and applications for other than the jobs tabulated in Part II.

A new program was initiated in cooperation with Purchasing Operation to evaluate eddy current and radiographic testing of welded stainless steel tubing. An excellent opportunity has presented itself for such an evaluation with the ordering of some 57,000 feet of tubing for the PRTR primary heat exchanger. In view of the large amount of footage involved, use will be made of data processing facilities to provide a ready means of running cross-correlations. This program will be one of the first to use data processing in the field of nondestructive testing. The work being done is part of a continuing effort to find positive, but less costly, testing methods for materials evaluation.

Substantiation of Radiographic Testing Operation's radiographic findings on the PRTR containment vessel was received this month from the Chief Boiler Inspector for the State of Washington. An independent review of critical films was made and the inspector's report supports the interpretations made by Radiographic Testing Operation. Phase I construction of the containment vessel is essentially completed. A nominal amount of work is being done in prefabrication of the dome, including radiographic examination. In addition to the Radiographic liaison provided for Phase I, added responsibilities included overseeing leak testing practices and penetrant inspections.

A sizable contribution to plant operation will be made if current tests on detection of helium leaks using portable field equipment works out. Preliminary tests have been made demonstrating the accuracy of the method for detecting helium leaks in the order of 1×10^{-4} to 1×10^{-6} cc. per second. Novel use is made of a combustible gas meter by reverse operation. Largest value will be in the reactor areas where great amounts of helium are used. Evaluation of the method for this purpose is currently being made.

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>
CPD	63	28 1/2	28	4" SS power generator shaft 2' OD x 80 ft. long CS He tanks 5" sch. 40, SS longitudinal welded pipe

<u>Component</u>	<u>No. of Tests</u>	<u>Ft. of Weld or Material</u>	<u>No. of Pieces</u>	<u>Description</u>
CEO	3685	6201	179	304 L SS weld coupons, 5" sch. 10, SS weld coupons, PRTR containment vessel welds
FPD	10	1 1/2	1	Locate lithium-sulphate crystal
HLO	4918	10920 1/2	912	Hastalloy F pipe welds, Hastalloy B pipe and tank welds. 1" OD and 5/8" OD Zr. and SS clad UO ₂ fuel rods. 1.6% enriched fuel rods. Zr. clad U in NaK solution. GEH Al sheathed thimble assembly. .505", .599", .938" IDx.030" wall Zr. tubing. .750" ODx.035 wall Zr. tubing. 15% U-Al wafers; 1.6, 1.8, 10, 13, 20% Pu-Al wafers and cast fuel rods 1/2" and 5/8" diam. .562" ODx.008" and .030" wall SS tubing. BDF ribbed Zr. process tubes.
IPD	283	370 1/2	248	AEC-160 recirculating gas loop. 105 K step plugs, 7 3/4" diam. x 66" long, SS, aggregate concrete, boron, steel. Cross-header on rear base, 105 B.
TOTALS	8959	17522	1368	

FACILITIES ENGINEERING OPERATIONProject Activity

There were 16 authorized projects at month end with total authorized funds of \$6,402,400. The total estimated cost of these projects is \$8,656,500. Three projects were completed during the month and one new project was authorized. There are no new projects awaiting AEC approval. Project proposals for eleven new projects are in preparation.

The attached monthly project report details the status of individual projects.

Engineering Services

<u>Title</u>	<u>Status</u>
Modification of Elevator, 327 Bldg.	Installation started 12-1-58 by Security Fire Door Co.
Fabricate and Install XY Manipulator in Metallographic Cell	Work is complete.

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HW-58244

Title

Status

Improvements to Process Pump House -
147-F Building

Work stopped. Need for pump house is
limited.

Additional Pasture - 100-F Area

Work is essentially complete.

Removable Floor Grating - 3745-B Bldg.

Engineering work is complete. Fabri-
cation work remains to be performed.

Improvements to Traveling Crane - 314
Building

Equipment is expected on job site in
December.

Removal of Obsolete Equipment - 231-Z
Building

Work is 90% complete.

Minimize Vacuum Pump Oil Spray - 325
Building

Entrainment material is being installed.

Provide Additional Hoods in Room 7-2A
325 Building

Installation work initiated.

Expansion of Electrical Shop - 306
Building

Work estimated to be complete 12-5-58.

Decontamination of 314 Building

Estimates have been prepared on alternate
solutions.

Instrument Boom Support - 3745-B
Building

Work complete.

Scope Consolidation of Operation in
231-Z Building

Plans and cost estimates are being
developed.

Improve Lighting Rooms 11-1A and B -
325 Building

Work resulted in 26% increase of illumi-
nation. Further increase is being worked
on.

Replace Roofing on 146-FR and 222-U
Buildings

Work on 146-FR Building approximately 30%
complete.

306 Building - Air Conditioning Unit-
Condensate Revisions

Work complete.

306 Building Water Filter

Replacement parts have been received and
installation work has started.

Design and Drafting Services

Title

Status & Description

Cesium Recovery

Job is approximately 96% complete.

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<u>Title</u>	<u>Status & Description</u>
Fuel Element X-Ray Densitometer	Work 85% complete. Further information required before proceeding.
Non-Production Fuels Processing	Prototype Saw Assembly 75% complete. Prototype Shear Feed 10% complete.
Wet Storage Transfer CA-749	Detail drawings of tube plates 90% complete. Cranking mechanism 90% complete. Overall job 90% complete.
Tray and Tray Dolly CA-749	Design work 50% complete.
In-Reactor Tools for ETR Loops	Design and Drafting 100% complete.
Electron Beam Vacuum Welding Box - 306 Building	Design and drafting 100% complete. Box fabrication 85% complete. The design for electrical and instrument panel-push button operation of all valves, motors, controllers, welding and related equipment 65% complete.
Rod Holder and Drive	A device for holding and positioning UO_2 filled rods with plug inserts in welding machine. Work started.
Sample holder	A holder for sample of UO_2 for insertion in vacuum annealing furnace. Work started.
Equilibrium Chamber	A device to measure thermal conductivity of dense ceramics. 5% complete.
Melting Point Furnace	A furnace for determining the melting point of UO_2 . 5% complete.
Thermal Analysis Furnace	A vertical resistance furnace for determining the thermal properties of UO_2 . Work started.
Creep Capsule	A capsule for containing material to be tested under reactor conditions. Measurement of material to include stress elongation and temperature. Design 20% complete.
Test Section Mock-Up	A tube facility to simulate 3x3 and 6x9 test facilities in the ETR for mock-up and cold run purposes. 80% complete.
Wide Angle Viewer - PRTR Examination Cell	Work 70% complete.

Maintenance and Building Engineering

Costs - October - \$90,780
September - \$86,997

FYTD \$335,375 (28% of Budget)

As of 10-31-58 the expenditure forecast predicted cost to be 30% of the budget. The 2% difference in actual cost is partially attributable to reduction of machinery maintenance during a period when a new work order control procedure was initiated. Unusual maintenance activity is less than planned because of difficulties in obtaining air duct cleaning contractors. The increase in power operators cost reflects the addition of two more men.

Unusual Maintenance:

<u>Items</u>	<u>October</u>	<u>FYTD</u>
Painting	\$ 6,687	\$ 13,179
Revision H&V	2,399	3,336
Roofing	938	1,739
Crib Lines	1,521	1,521
Other	1,102	23,260
Total	\$ 12,657	\$ 43,035 (22.1% Budget)

Space studies are underway in 3760 Building to improve conference, lunch, and rest room conditions; and in 325 Building to relieve office and laboratory crowded conditions.

Arrangements are being made with CPD for housing of Atmospheric Physics personnel in "T" plant area.

A study of the 326 Building exhaust system has been initiated.

TECHNICAL INFORMATION OPERATION

A complete Geneva Conference Presentation Set was received and is on display in the Library. This 13 volume set of books covers current U. S. atomic energy technology. The set was sent to Technical Information Panel Members on behalf of the USAEC and the Division of Information Services. A pictorial survey of nuclear energy work in the United States entitled "Atoms for Peace, U. S. A., 1958" was also received and likewise is on display. This book includes a number of photographs of HAPO activities.

A letter on the Proposed Hanford Classification Guide was forwarded to the Manager, HOO. The letter recommended that the review of the proposed Hanford Classification Guide by the AEC Division of Classification be suspended for the present. Two reasons were given for this about-face.

1. The review is taking up a great deal of both AEC and GE time. This does not appear justified because the more liberal interpretation of the classification rules which had been hoped for when the proposed guide was written, is not being realized.

2. The Ninth International Declassification Conference will soon take place. Decisions made there may require extensive re-working of local classification guides and present efforts may be wasted.

A compilation of instructions from HOO on the classification of NPR is being readied for distribution to the field. This distribution is being made in addition to the normal procedure of updating the approved Hanford Classification Guide because (1) there is usually a considerable delay in inserting revised pages in the Guide and (2) HAPD personnel who do not hold copies of the Guide may need to know the new instructions.

The index to volumes 5-10 of Nuclear Science Abstracts was received during the month. Since this index duplicates a large part of the unclassified reports catalog for 1951-1956, subject and author cards for reports included in this index are being removed from the reports catalog. It is anticipated that these deletions will extend the life of the reports catalog five years. The entire project of removing the duplicate cards should be complete by July, 1959.

A reminder was received from GE Security that the required annual inventory of Research and Development reports and Atomic Weapon Data Reports should begin January 1, 1959. Accompanying the reminder was a list of "unaccounted for" documents from other AEC and contractor installations. This list will be checked at the time of inventory to make certain that these missing items are not at this site.

The first report and document accountability records created by Air Products Inc. under contract DOR-45 were received during the month. Some minor inaccuracies were noted in the record preparation and a letter was written to Air Products, Inc. asking for clarification.

Use of the IBM collator to proof document clearing cards were started during the month. When a document is returned to Files, charge-out cards filed by the chargee's name and by the number of the document are pulled. These are then matched on the collator. Only one error was turned up during the month, indicating that the document discharge operation is being accurately handled.

Working Volume Statistics

<u>Document Distribution and Files</u>	<u>October</u>	<u>November</u>
Documents routed and discharged (copies)	17,592	21,283
Documents issued (copies)	11,545	11,207
Documents sent offsite (copies)	4,614	2,965
Document reserves filled (copies)	910	872
Documents picked up and delivered	22,525	23,996

Document Accountability

	<u>October</u>	<u>November</u>
Holders of classified documents whose files were inventoried	563	330
Documents inventoried in Files (copies)	1,948	7,347
Documents destroyed or retired (copies)	3,690	5,334
Documents revised (copies)	1,286	1,480
Documents pulled and documents filed (copies)	11,387	11,599
Documents reclassified	627	807
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents on site	202,671	204,154

Reference and Publication

Books cataloged (new titles)	168	55
Books added to the collection (volumes)	388	272
Ready reference questions answered by professional staff	131	125
Literature searches by professional staff	119	119
Reports abstracted (titles)	264	216
Formal reports prepared (titles)	6	16
Offsite requests for HAPO reports (copies)	291	145
Reports released to CAP (titles)	45	24

Library Acquisitions and Circulation

Books ordered (volumes)	448	289
Periodicals ordered	166	97
Books circulated (volumes)	1,834	1,567
Periodicals circulated (issues)	4,289*	2,103
Inter-Library loans	89	73
Films borrowed or rented	28	31
Industrial film showings	55	67
Bound periodicals added to the collection	86	47

* Reported in error in October.

Library collection:

	<u>Main Library</u>	<u>W-10 Library</u>	<u>108-F Library</u>	<u>Ind. Med.</u>	<u>Totals</u>
No. of books	24,711	8,127	1,366	1,914	36,118
No. of bound periodicals	<u>11,306</u>	<u>1</u>	<u>1,431</u>	<u>96</u>	<u>12,834</u>
	36,017	8,128	2,797	2,010	48,952

Classification - DeclassificationOctoberNovember

Documents, including drawings and photographs reviewed for downgrading or declassification.	9	41
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification.	26	31
Documents submitted to Declassification Branch, Oak Ridge	78	9

LABORATORIES ADMINISTRATION

One new Organization and Policy Guide; No. 03.7, Health and Safety, was issued. This OPG and the Manual, Health and Safety retired thirteen OPG's.

Timely revisions were issued on four OPG's during the month.

Contract No. DDR-47, Supplemental Contract No. 1, Harper Electric Furnace Corporation was signed.

The following contracts are being negotiated:

No. DDR-29, Nuclear Metals, Inc., a modification to existing contract to develop externally ribbed Zircaloy tubing.

No. SA-38, The Swedish Hospital, a new contract under substantially the same terms for the exchange clinical data.

Consultant Agreement with Dr. Henry Eyring.

The following contracts are near completion and are to be closed out in the near future:

SO-7, Aluminum Company of America, for aluminum tubing.

CA-162, Betz Laboratories, Inc., for engineering services.

DDR-5, Superior Tube Company, for Zircaloy tubes.

DDR-6, Allegheny Ludlum Steel, for Zircaloy tubes.

DDR-11, Allegheny Ludlum Steel, for Zircaloy tubes.

DDR-30, Sciaky Bros. Inc., for Zircaloy welding.

DDR-44, Kux Machine Company, for development work.

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HW-58244

Contract No. DDR-39 with Solar Aircraft Company for a bellows assembly has been completed and closed.

The letter transferring animals in accordance with Contract No. SA-34, Future Farmers of America, Inc. was issued.

Assistance to Hanford, ATH-HLO-2-59, to Atomic Power Equipment Department for an engineering review of the Plutonium Recycle Test Reactor was approved by Hanford Operations Office and issued.

Manager
LABORATORY AUXILIARIES

JL Boyd:jcw

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MONTH November, 1958

NW - 58244	MONTH	November, 1958
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MONTH November, 1958

Radiation Protection

Work remaining to be performed on the project consists of finishing the plumbing, installing the cell door hydraulic system, laying floor coverings, finishing the cell interior, plus exterior and interior painting.

General Plant Projects - FY 1958 - AEC-2-23-58-L

CA-765	Additions to the 314 Building	\$40,000	\$46,000	100	100	10-14-57	-	-	3-7-58
			11-15-57	100	100	3-27-58*	11-15-58	11-15-58	
		USING COMPONENT							
	Reactor & Fuels R & D	PES ENGINEER							
		A. W. Hervin							

Reactor & Fields R & D

The General Electric Company portion of the project was closed out November 15, 1958 with an exception; delivery of the furniture remains to be completed. The Commission has indicated that their portion will also be closed out with an exception; installation of window screens.

* The CPFF Construction Contractor started work on March 27, 1958 and the Fixed Price Contractor on May 14, 1958.

CA-778	Expansion of the 305-B Building			\$55,000	\$55,000	100	100	4-4-58	5-15-58	5-7-58
				\$55,000	12-11-57	100	100	6-7-58	10-15-58	11-25-58
				USING COMPONENT						
				Physics & Instruments R & D						
				R. C. Ingersoll						
				P&S ENGINEER						

Physics & Instruments R & D

Acceptance inspection was made with the Architect-Engineer, Contractor, Commission and FEO representatives on November 25, 1958. The project was considered physically complete with exceptions as of November 25, 1958. The exceptions include; adjustments to the roll-up door and replacing four Gamewell detector heads with Fenwal type heads as called for in the specifications.

UNCLASSIFIED

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BUDGET CLASSIFICATION		MONTHLY PROJECT REPORT										HW - 58244	
General Plant Projects - FY 1958 - AEC-2-23-58-L		HANFORD LABORATORIES OPERATION										MONTH November, 1958	
PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT			STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE	DESIGN	CONST.	
			AMOUNT	DATE	DESIGN	SCHED.	ACTUAL						
CG-779	Additions to Separations Development Facilities - 321 Building	\$25,000	\$27,900	5-22-58	100	100	100	5-26-58	- - -	9-26-58			
					100	99		6-19-58	1-31-59	12-31-58			
		FEO ENGINEER J. T. Lloyd											
REMARKS:													
All work is complete except installation of the rectifier and backwelding the threaded connections of the HF manifold. The vendor has extended the shipping date of the rectifier to December 5, 1958. AS Built work has been completed.													
CAH-794	Geological and Hydrological Wells - FY 1958	\$49,000	\$49,000	4-16-58	100	98		4-7-58	- - -	5-15-58			
					100	70		7-8-58	12-31-58	1-31-59			
		FEO ENGINEER H. E. Ralph											
REMARKS:													
Wells 1, 2, 3, 6, 7, and 10 have been completed. To date 2800 feet of hole has been completed. The fourth rig was set up over well site number 8 on November 18, 1958. Three of the four rigs are now operating on a two shift basis in an attempt to get back on schedule. It appears that the directive completion date of December 31, 1958 will not be met.													
CGH-796	Facilities for Isotope Study on Animals	\$47,500	\$49,800	5-22-58	100	100		5-22-58	7-27-58	7-25-58			
					100	100		6-12-58	11-1-58	10-30-58			
		FEO ENGINEER J. T. Lloyd											
REMARKS:													
Completion of exceptions has been delayed due to priority work in 100-K Area. The Physical Completion Notice was issued on November 10, 1958. This project will no longer be carried in this report.													

AM-7300-019 (5-58)

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UNCLASSIFIED

UNCLASSIFIED		BUDGET CLASSIFICATION		MONTHLY PROJECT REPORT										HW - 53244	
		General Plant Projects - FY 1958 - AEC-2-23-58-L		HANFORD LABORATORIES OPERATION										MONTH November, 1958	
PROJECT NUMBER	TITLE	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								
CGH-803	Alterations - Building 231-Z	\$40,300	\$49,600	6-2-58	None	None	100	100	None	7-7-58	11-15-58	10-21-58			
		USING COMPONENT		FEO ENGINEER										J. T. Lloyd	
		Reactor & Fuels R & D													

REMARKS:

Materials for the Buss duct have been ordered and it is expected that the work will be completed by December 30, 1958. The Physical Completion Notice was issued November 12, 1958. This project will no longer be carried in this report.

CGH-804	Ceramic Fuels Press Enclosure - 325 Building	\$41,000	\$41,000	6-2-58	100	100	63	55	6-19-58	1-15-59	8-1-58		
		USING COMPONENT	FEO ENGINEER										
		Reactor & Fuels R & D	R. C. Ingersoll										

REMARKS:

Installation of the steel caisson has been completed. Door, pipe chase and ventilation duct openings have been cut in the existing wall of the 325 Building. The press hydraulic unit was moved into the press enclosure on November 26, 1958.

* Contract completion date.

CGH-809	Electrical Modifications - 323 Building	\$40,000	\$40,000	6-30-58	100	87	0	0	7-30-58	3-1-59	11-30-58		
		USING COMPONENT	FEO ENGINEER										
		Laboratory Auxiliaries	R. C. Ingersoll										

REMARKS:

Comment drawings on redistribution of lighting and receptacle circuits were issued on November 21, 1958. Main switchgear is scheduled for delivery on site December 15, 1958.

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BUDGET CLASSIFICATION		MONTHLY PROJECT REPORT										HW - 58244	
General Plant Projects		FY 1958 - AEC-2-23-58-L		HANFORD LABORATORIES OPERATION		PROJECT PROGRESS IN PER CENT						MONTH	
PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		DESIGN			SCHED.			STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
			AMOUNT	DATE	ACTUAL	SCHED.	ACTUAL	DESIGN	CONST.	DESIGN			
IR-240	Removal of Obsolete Melt Plant Equipment - 314 Building	\$19,000	\$19,000	6-24-58	None	100	None	100	None	6-27-58	11-11-58	11-11-58	
REMARKS:		<p>This project has been completed. Preparation of the Physical Completion Notice has been started. This project will no longer be carried in this report.</p>											
Equipment Not Included in Construction Projects - Program Class 2900													
CG-661	Additional Heat Generating Facility - 189-D Building	\$475,000	\$664,000	9-18-57	100	0	100	0	12-6-56	12-10-58	8-31-59	10-15-58	
REMARKS:		<p>Ray Ashcraft of Grandview, Washington was awarded the contract for installation of equipment and architectural modifications. A meeting with the contractor has been tentatively scheduled for the first week in December.</p>											
CA-681	Hanford Equipment in the ETR	\$1,200,000	\$1,200,000	8-12-57	100	95	100	95	9-17-56	4-7-58	12-15-58*	9-2-58	
REMARKS:		<p>An incident, November 17, in the operation of the 3 x 3 loop caused a "scram" of the reactor. Checks, by CEO Design & Management personnel who went to Arco, revealed that the main flow control valve had failed because of a broken stem. This was the result of the very small lift for the flows being maintained, causing the disc to chatter against the seat. The 3/4" trim, to replace the originally installed 1" trim, was installed during the shut-down and the reactor is now back in satisfactory operation. However, the design engineers feel the valve does not yet operate as intended. The valve vendor has promised to supply new trim having tested flow characteristics conforming to specifications. Work on the fabrication of the 6 x 9 in-reactor loop at the Rohr Aircraft Corporation is progressing. One of the three tubes furnished to the fabricator was found to be out of tolerance. The supplier has promised to replace it. *Requesting extension to 5-1-59.</p>											

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BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900		MONTHLY PROJECT REPORT HANFORD LABORATORIES OPERATION						HW - 58244 MONTH November, 1958	
PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
			AMOUNT	DATE	DESIGN SCHED.	CONST. ACTUAL			
CA-695	Radio Telemetering Network	\$105,500	\$105,500*	9-23-58	100	55	2-22-57	4-15-57**	5-27-57
		USING COMPONENT			100	70	7-25-57	2-1-59	2-1-59
		Physics & Instruments R & D				FEO ENGINEER			
		J. T. Lloyd							
<p>REMARKS:</p> <p>The AEC has accepted Instruments Laboratories bid of \$800 for enclosures and minor modifications at five 100 Areas badge houses. All 21 stations are on the project and checking them out has started. Repairs to all towers have been completed or under way. The AEC has issued Modification No. 2 to the Directive increasing total project value to \$109,078 including transferred property having a book value of \$3,578.</p> <p>*Does not include transferred property valued at \$3,578.</p> <p>**Scheduled date.</p>									
CG-785	In-Reactor Studies Equipment - 105-KW Building	\$276,000	\$15,000*	2-12-58	100**	0	3-10-58	- - -	10-15-58
		USING COMPONENT			100**	0	- - -	- - -	- - -
		Reactor & Fuels R & D				FEO ENGINEER			
		H. Radow							
<p>REMARKS:</p> <p>The project proposal has been approved by the AEC-HOO Review Board. To date a directive has not been received.</p> <p>*For preliminary design, including management services and preparation of project proposal for total project funds.</p> <p>**Preliminary design only.</p>									
CGH-801	X-Ray Diffraction Cell - 327 Building	\$170,000	\$10,000	6-7-58	N.S.	0	6-10-58	- - -	2-15-59
		USING COMPONENT			40	0	- - -	- - -	9-30-59
		Reactor & Fuels R & D				FEO ENGINEER			
		R. W. Dascenzo							
<p>REMARKS:</p> <p>A revised project proposal for the remainder of design and total construction funds was prepared and submitted to the AEC on November 15, 1958.</p> <p>No design work was performed this month.</p>									

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BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900		MONTHLY PROJECT REPORT HANFORD LABORATORIES OPERATION						HW - 5844 MONTH November, 1958		
PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PERCENT			STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
			AMOUNT	DATE	DESIGN SCHED.	CONST. SCHED.	DESIGN			
CGH-805	High Temperature Tensile Testing Cell	\$150,000	\$10,000	N.S.	0	0	0	8-26-54	4-1-59	4-1-59
			8-4-58	42	0	0	- - -	10-1-59	10-1-59	
USING COMPONENT								FEO ENGINEER		
REACTOR & FUELS R & D								R. W. Dascenzo		
<p>REMARKS:</p> <p>A revised project proposal for the remainder of design and total construction funds was prepared and submitted to the AEC on November 10, 1958.</p> <p>No design work was performed this month.</p>										
New Construction - FY 1958										
CG-731	Critical Mass Laboratory	\$1,800,000	\$175,000	72	0	0	0	5-22-58	- - -	2-1-59
			5-12-58	69	0	0	0	3-1-59	- - -	12-31-59
USING COMPONENT								FEO ENGINEER		
Physics & Instruments R & D								D. S. Jackson		
<p>REMARKS:</p> <p>Design of Stage I continued slightly below schedule. Material and equipment lists were prepared. A revised project proposal was initiated, requesting total Stage I authorization plus funds for design of Stage II.</p>										
CA-744	Metallurgical Development Facilities	\$2,600,000	\$2,600,000	65	0	0	0	6-30-58	- - -	9-1-59
			11-5-58	56	0	0	0	N.S.	9-1-60	9-1-60
USING COMPONENT								FEO ENGINEER		
Reactor & Fuels R & D								J. T. Lloyd		
<p>REMARKS:</p> <p>A directive dated November 5, 1958, authorizing total project funds was received from the AEC. A Work Release Authorization dated November 12, 1958 was issued to CEO, assigning project management to them. Architectural design is essentially complete. Mechanical and electrical design work will be increased in tempo. The bid package schedule is held at the original completion date of February 1, 1959.</p>										

AM-7300-019 (5-58)

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H-17

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BUDGET CLASSIFICATION		MONTHLY PROJECT REPORT										HW - 58244			
New Construction - FY 1958		HANFORD LABORATORIES OPERATION		AUTHORIZATION INFORMATION				PROJECT PROGRESS IN PER CENT				MONTH		November, 1958	
PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AMOUNT		DATE		DESIGN SCHED.	CONST. SCHED.	ACTUAL	DESIGN	CONST.	STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE	
CA-749	High Level Radiochemistry Facility	\$960,000	\$960,000	10-31-58			100	17		6-15-58		6-15-58		11-21-58	
		USING COMPONENT	100	15			100	15		6-14-58		6-30-59*		7-15-59	
			FEO ENGINEER												
			R. W. Dascenzo												
REMARKS:		<p>Work Authority No. CA-749(5) was issued October 31, 1958 increasing money authorized to the General Electric Company by \$72,500 to a total of \$252,500. All drawings, specifications and ATPs had been submitted by the contractor for approval by November 21, 1958. They have all been approved or are awaiting comments. (1) Door frame between 325 and 325-A Buildings was set in place and concrete poured around frame, also 325 Building exterior wall was sand blasted. (2) Wet storage basin walls formed and poured, also basement floor slab in storage tank area. (3) Wet storage basin transfer ducts were set in place and concrete poured at top. (4) The main floor slab and beams are one-half formed. (5) The 325-A Building exterior ground grid system has been tied into the 325 Building system. (6) All lower level drains, embedded piping, and sump tank were piped up and tested.</p> <p>* The AEC has extended the Bohna Company contract to July 15, 1959, but has not changed the directive date.</p>													
CGH-790	High Level Radioactive Receiving and Storage Addition - 327 Building	\$325,000	\$325,000	6-25-58			93	N.S.		6-23-58		6-23-58		12-15-58	
		USING COMPONENT	85	1			85	1		10-9-58		2-1-60		2-1-60	
			FEO ENGINEER												
			A. W. Hervin												
REMARKS:		<p>On November 14, 1958 the AEC issued a directive changing the "Method of Performing the Work". In general, the CPFF Construction Contractor will perform work to the top of the main floor slab. The CPFF Contractor obtained a "Fixed Price" bid from Duke Electric Company for relocation of the overhead emergency lines. The relocation work was performed on November 25 and 26 with Plant Forces making the tie-ins on November 26. Pipe fitters have not been on the job due to priority work in the 100-K Area, consequently the crib line was not relocated. Work progressed on removing concrete from the existing wet storage basin. The west entrance to the existing building will not be available for cask shipments for the next 3 or 4 months. The new door on the east end of the canyon will accommodate casks up to three tons.</p>													
CGH-819	Increased Laboratory Waste Facilities - 300 Area	\$300,000	\$300,000	11-24-58			0	0		1*		1*		7*	
		USING COMPONENT	0	0			0	0		9*		21*		21*	
			FEO ENGINEER												
			A. W. Hervin												
REMARKS:		<p>AEC Directive HW-477, dated November 24, 1958, authorizing \$30,000 design funds has been issued.</p>													
		* Months after authorization.													

BUDGET CLASSIFICATION

General Plant Projects - FY 1959

BUDGET CLASSIFICATION		MONTHLY PROJECT REPORT										HW - 58244	
General Plant Projects - FY 1959		HANFORD LABORATORIES OPERATION										MONTH November, 1958	
PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT			STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE			
			AMOUNT	DATE	DESIGN SCHED.	CONST.							
							ACTUAL	ACTUAL	DESIGN	CONST.	DESIGN	CONST.	
	Automatic Columbia River Monitoring Stations	\$50,000		None	0	0		3-1-59	-	-	7-1-59		
				None	0	0		5-1-59	-	-	9-1-59		
			USING COMPONENT						FEO ENGINEER				
			Radiation Protection								D. S. Jackson		

REMARKS:

A project proposal has been prepared, all signatures have been obtained and it is being printed. The proposal requests authorization and funds to construct two continuous radiation monitoring stations on the Columbia River. One of these stations is to be located at the PRTR river pump house and the other to be located at the river pump house belonging to the City of Pasco Water Department.

REMARKS:

REMARKS:

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H.W. Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
14 HS Science Students	11-11	Athena, Oregon	Learn about Tech. Info.	S.P. Gydesen	No	300 - 3760
K. R. Fisher & M. J. Steffes	11-3	Super Tool Co. Detroit, Mich.	To discuss carbide cutting tools	L.J. Lucas	No	300 - 328, 325, 306
Tom McMullen	11-18	Elox Co. Gardena, Calif.	To service machines	L.J. Lucas	No	300 - 328, 306
J. M. Mohondro	11-18	Halladie Machinery Co. Spokane, Wash.	To accompany Tom McMullen & Discuss operation of machines.	L.J. Lucas	No	300 - 328, 306

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. G. Stave	10-31 - 11-1	J. K. Gill Co. Portland, Ore.	Discuss how our orders are handled, and the use of multiple order forms.	Alma Seaberg	No
C. G. Stevenson	11-8 - 11-25	General Electric Schenectady, N.Y. U.S.A.E.C. Washington, D.C.	Discuss exchange of tech. info. at GE; attend meeting of AEC T.I.P. Serve as official observer at the International conference.	C.G. Fick M.S. Day	No No
R. B. Socky	11-14	Puget Sound Naval Shipyard Bremerton, Wn.	Arrange for acquisition of one MEV VanderGraaff	W. Hanna	No

EMPLOYEE RELATIONS OPERATION MONTHLY REPORTGENERAL

At month's end, the staff of the Hanford Laboratories Operation totalled 1192 employees, including 564 exempt and 628 nonexempt employees. There were 479 exempt employees possessing technical degrees, including 270 B.S., 105 M.S. and 104 Ph.D.

EMPLOYEE RELATIONS

Reports of the results of the attitude survey discussions in Chemical Research and Development Operation and Fuels Development Operation were completed and forwarded to the appropriate managers.

PERSONNEL DEVELOPMENT

Approval was obtained to schedule the "Applied Creativity" course for 15 nonexempt semi-technical employees. Selection of a course leader is underway.

The final planning for the Armed Forces Special Weapons Project Training Program was initiated in conjunction with members of the Programming Operation and Radiation Protection Operation.

There are currently 24 open nonexempt requisitions. Twelve of the requisitions were received during the month and 12 vacancies were filled.

There were no force reductions or notices of force reduction during the month of November.

All HLO personnel cards were microfilmed in accordance with the annual personnel records microfilm program.

UNION RELATIONS

The Company prepared a new proposal to the HAMTC in an attempt to settle the points in dispute in the Wonacott case. It is expected that the proposal will be ready for submission to the Council early in the coming month.

One grievance was received during November. It was submitted by a Radiation Monitor claiming final contamination survey work had been assigned to women laundry workers. The Step I answer was not satisfactory but the grievance is considered settled at Step I due to expiration of the time limit.

Grievances processed since January 1st now total 28, including 3 non-unit grievances: 19 were answered satisfactorily at Step I, 8 at Step II, and one is pending time limit at Step II.

The arbitrator's decision in connection with the Maki case has not yet been given.

COMMUNICATIONS

The HAPO General Manager and the Managers of IPD, CPD, FPD and HLO presented a one-half hour television show on November 25. The presentation reviewed HAPO accomplishments in research, safety and radiation protection, production and employee relations.

During the month, 18 Athena, Oregon science students toured HLO facilities.

EMPLOYEE COMPENSATION

The preliminary sign up for Savings and Security Program was conducted during November. Enrollment statistics for the 1,058 eligible employees who were on the active payroll on November 30, 1958 are as follows:

	<u>Exempt</u>	<u>Nonexempt</u>
Eligible	564	494
Enrolled	558	441
Revocation	4	51
*No Return	2	2

*Absent because of vacation, illness, or business trip.

Annual exempt appraisals were conducted during November and the preliminary analysis of appraisal distribution has been completed. Plans for the annual salary review were developed.

Satisfactory progress is being made on the nonexempt compensation study. During the month, a tentative job description format has been completed and the representative jobs being used in the study are currently being written using this form which will permit final validation of the job evaluation scheme. The results of the annual 1958 wage survey data are currently being reviewed for inclusion in the salary structure portion of the study.

K. N. Burnham, a Field Clerk in Laboratory Auxiliaries Operation retired optionally as of December 1. He has been on illness leave since April 4, 1958. As of November 30, 1958, there are no employees on the HLO rolls who are scheduled for normal retirement during calendar year 1959.

Hanford Laboratories' participation in the Employee Benefit Plans is as follows:

<u>1958</u>	<u>Insurance</u>	<u>Pension Plan</u>	<u>Stock Bonus</u>	<u>Savings Plan</u>
Mar.	99.7	98.6	61.9	8.7
June	99.7	98.9	61.4	7.6
Sept.	99.7	98.8	61.6	6.5
Nov.	99.8	98.7	59.1	6.5

PROFESSIONAL PERSONNEL PLACEMENT

During the month of November, employment offers were extended to one Ph.D. and one Ph.D. rejected our offer. In addition, employment offers were extended to four experienced BS/MS candidates: four accepted and three were placed on the roll. HLO accounted for two offers, one acceptance and one placed on the roll, bringing the total HLO experienced BS/MS acceptances for the recruiting year to date (9-1-58 to date) to ten.

Ph.D. referrals from the Advanced Degree Personnel Office are now arriving in considerable numbers. Apparently, many referrals have been delayed by the failure of

coordinators to submit their trip reports as soon as they return from the campuses.

BS/MS recruiters visited twelve campuses during the month. Specific position referrals are beginning to trickle in from Engineering Services and as a result, two candidates have been extended invitations to visit.

Thirty-two Technical Graduates remain on the Program. It is apparent that critical shortages are developing in several areas and every attempt is being made to fill these with mid-year graduates so that it will not be necessary for Hanford components to hire the more expensive open market candidates.

A conference for members of the Technical Graduate Program was held. The HLO salary administrator attended and explained the philosophy and provisions of the exempt salary plan. Other topics discussed included the Savings and Security Program, reporting of absences, submission of attendance reports, and parking of government vehicles assigned to the outer areas in 700 and 1100 Area parking lots overnight.

HEALTH, SAFETY AND SECURITY

Laboratories personnel worked a total of 169,593 man-hours during the month with no disabling injuries. Since September 1, 1956, a total of 5,084,060 man-hours have been completed with no disabling injuries. The medical treatment frequency for November was 1.12 as compared with 1.64 during October.

There were 2 security violations during the month, bringing the total for the calendar year to 44.

The programmed change-over to ASA electrical receptacles in 326 Building is now 45% complete.

Manager,
Employee Relations

TG Marshall:tr

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HW-58244

VISITS TO OTHER INSTALLATIONS

<u>Name</u>	<u>Date of Visit</u>	<u>Company Visited</u>	<u>Reason for Visit</u>	<u>Personnel Contacted</u>	<u>Access to Restricted Data</u>
H.A. Paulsen	11/18	G.E. - Computer Dept. Phoenix, Arizona	Salary consultations	A.L. Randall	None

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TABLE II. NONEXEMPT EMPLOYMENT

<u>Nonexempt Employment Status</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Nonexempt Transfer Requests</u>	<u>Oct.</u>	<u>Nov.</u>
Requisitions			Transfer Requests		
At end of month	26	24	Active cases at end of mo.	62	70
Cancelled	1	2	Cancelled	1	1
Received during month	25	12	New	7	10
Filled during month	13	12	Transfers effected	1	6
Candidates Considered					
Total applications	54	29			
Total transfer requests from other at HAPO	9	1			

TABLE III. UNION RELATIONSGrievances Processed - January 1, 1958 to date

Total Processed 28 (includes 3 non-unit grievances)

Step I

Answered satisfactorily* 19

Step II

Pending Step II discussion 0
 Answered
 Satisfactorily** 8
 Pending time limit 1
 Pending arbitration decision 1

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

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

TABLE IV. PROFESSIONAL PERSONNEL PLACEMENT

A - Technical Recruiting Activity - HAPO - September 1, 1958 to Date

<u>Visits to Richland</u>					<u>Offers*</u>		<u>On the Roll</u>
<u>Cases Considered</u>	<u>Invited</u>	<u>Visited</u>	<u>To Visit</u>	<u>Extended</u>	<u>Accepted</u>	<u>Open</u>	
Ph.D. 241	45	8	6	11	3	2	3
Exp. BS/MS 148	19	9	7	22	18	2	15
Program BS/MS 121	-	-	-	4	2	1	2

*Offer totals include offers open on 9/1/58

Ph.D. 3
Exp. BS/MS 3
Program BS/MS 3

B - Technical Recruiting Activity - HLO - September 1, 1958 to Date

<u>Visits to Richland</u>					<u>Offers**</u>		<u>On the Roll</u>
<u>Cases Considered</u>	<u>Invited</u>	<u>Visited</u>	<u>To Visit</u>	<u>Extended</u>	<u>Accepted</u>	<u>Open</u>	
Ph.D. 241	45	8	6	6	1	2	2
Exp. BS/MS 130	13	7	5	13	10	2	9
Program BS/MS (Off Program Placement)	-	-	-	8	8	0	8

**Offer totals include offers open on 9/1/58

Ph.D. 2
Exp. BS/MS 2

In addition to the above activity, six exempt employees have transferred into HLO from other HAPO departments.

C - Technical Graduate and Technician Training Program
Month Ending November 30, 1958

	<u>TG Program</u>	<u>TT Program</u>
Number personnel on assignment	32	13
(HAPO TG Program31)		
(West. District E.P..... 2)		
Distribution of assignments by Depts.		
HLO	12	7
CEO	1	0
R&UO	0	0
FPD	0	0
LPD	15	6
CPD	4	0
Distribution of assignments by functions		
R&D or Engineering	28	13
Other	4	0

FINANCIAL OPERATION MONTHLY REPORTPersonnel

One non-exempt business recruit was employed in General Accounting making a total force of 49 at the end of November. This compares with a forecast of 50 by December 31, 1958.

General Accounting Operation

A project proposal is being prepared to cover the cost of providing approximately 3000 square feet of storage space for our central equipment storage program. Present plans include utilization of an existing surplus Army building. Beneficial use of such a facility is not expected before April 1, 1959.

The running analysis of estimating accuracy on appropriation requests is as follows:

	<u>No. of AR's</u>	<u>Authorized Funds</u>	<u>Actual Cost</u>	<u>(Over) Under-Run</u>
<u>Over-Run</u>				
By more than 10%				
Supplement Required	30	\$130 788	\$183 079	\$ 52 291
By less than 10%	42	315 892	330 581	14 689
<u>Under-Run</u>				
By more than 10%	52	341 145	240 083	101 062
By less than 10%	45	304 183	293 142	10 991

A new procedure established during November will permit employees to obtain air travel tickets for official business from the cash working fund cashier, 3702 Building, 300 Area. Arrangements for this service will be made by Traffic Operation with each employee when the tickets are confirmed.

Field work in connection with the physical inventory of uninstalled cataloged equipment in the custody of Biology Operation is complete and the reconciliation is in progress. Custodial personnel are currently conducting a search for 4 missing items. Seven items found during the count, not on record, will require further investigation prior to being added to record.

Preparations were completed and a procedure distributed for the physical inventory of uninstalled cataloged equipment in the custody of Physics & Instruments Research and Development Operation. The inventory will begin December 15, 1958 with an anticipated completion date of December 24, 1958 for field work.

In connection with placing equipment held for future use in a central storage area, an inventory of all existing storage areas is currently under-way.

A notification was received from the Commission relative to in-service dates on Plant and Equipment received from the AEC at an estimated net book value. Effective June 30, 1958, estimated values established by the AEC Property Branch are not to be changed through adjustments to the depreciation reserve, but rather,

the in-service date will be changed to agree with the reserve indicated on billings from the AEC. As a result of this ruling, 12 Army buildings received from the AEC in June 1958 are carried on our records with in-service dates of 1929, 1930 and 1931.

The expense portion of Project CG-733 - Plutonium Metallurgy Facility Expansion, \$107,507, was charged to account 3530 - Expense Portion Construction Projects. AEC approval for this transaction had previously been requested and granted.

The mid-year budget review for special materials, precious metals and spare parts, was completed and forwarded to Contract Accounting. Major changes between estimated June 30, 1959 balances and our current level occurred in platinum and zirconium.

Chemical Research and Development Operation will purchase 3,000 grams of sheet platinum for experimental work on the 4000 Program. Zirconium holdings are expected to decrease \$147,000 from current levels. Anticipated zirconium transfers from inventory for the balance of the year are:

<u>IPD</u>	
BDF	\$ 204 704
R&D - Fuels	23 839
Tubes	36 477
NPR - Fuels	89 400
Tubes	1 158 000
	<u>1 512 420</u>
 <u>HLO</u>	
Process tubes (PRTR)	114 959
R&D	161 303
Project 167	748 356
	<u>1 024 618</u>
	 <u>\$2 537 038</u>

The annual physical inventory report of Reactor and Special Materials was issued during the month of November. Total value of the physical inventory was \$716,089 compared to a reconciled book balance of \$716,404 resulting in a physical inventory adjustment of \$315.

In response to a request of SS Accountability Operation, material custodians were requested to submit outside material forecasts for the fourth quarter of FY 1959 and the first, second, third and fourth quarters of FY 1960. Upon receipt, this information will be consolidated into a report and forwarded to SS Accountability.

Cost Accounting Operation

The FY 1959 Midyear Budget Review was completed during the month and submitted to Contract Accounting on November 14, 1958 for HAPO consolidation and review by the General Manager - HAPO. The Midyear Budget Review requested \$20,941,000 for Hanford Laboratories, an increase of \$936,000 from the October Control Budget. The major increases were \$460,000 for PRP and \$675,000 for NPR.

An additional authorization of \$625,000 for NPR has been received from IPD and was included on November reports as an adjustment to the Control Budget. NPR funds for FY 1959 that have been allocated to HLO now total \$718,000 of which \$5,000 has been allocated to Chemical R&D, \$70,000 to Physics & Instruments R&D and \$643,000 to Reactor & Fuels R&D.

HOO-AEC obligated additional funds under our contract during November for Washington Designated Programs in the amount of \$275,000. Total funds now authorized for Washington Designated Programs amount to \$500,000 which fulfills our request for FY 1959 funds.

A review was made of all store orders placed by personnel of Hanford Laboratories during October 1958 to check for compliance with established procedures. The findings will be reported to the Level 3 Managers by letter. The major cause of improper practice was signatures by personnel not authorized.

An analysis of radiation monitoring services associated with Hanford Laboratories furnished to construction projects and subsequent meetings with management of the Radiation Protection Operation resulted in agreement not to charge construction projects at this time, since the present work load does not require personnel in excess of those required for normal operations. A review of radiation monitoring requirements will be made at the time the Construction Budget for FY 1961 and Revision of FY 1960 is prepared.

Personnel Accounting

Listings of all exempt employees on the payroll as of November 1, 1958 were prepared by Data Processing Operation by Level 4 components indicating all the information required for the proper administration of a Salary Review. These listings were transmitted with a letter explaining the procedure to be followed in completing and returning the lists. Lists were delivered to authorized individuals on November 19, 1958 to be returned December 17, 1958.

Final report of Good Neighbor Fund was issued on November 20 which indicated annual contributions had increased 90.8% during the campaign; total participation increased 3.9%.

Authorizations, Beneficiary forms, plus Prospectus, ABC of Bonds and Stocks and instructions as to the completion of the above-mentioned forms were delivered to employees on November 14. On November 17 Authorizations and Beneficiary forms were delivered to employees to be returned prior to December 1. Of the total employees eligible to participate, 46 non-exempt and 4 exempt employees have signed Revocation forms, for a total of 50 people. The 46 non-exempt employees who have signed Revocation forms will start receiving the 3.48% increase effective currently with December 1, 1958 plus a reduction in pension contributions on a current basis. Retro-active pension to October 1, 1958 will be paid in salary checks delivered December 19, 1958.

Auditing

Field work on the audit of Material and Equipment Furnished AEC Contracts has been completed and the report drafted. Work has started on the audit of Contracting and Procurement.

300 Area sign-in-sign-out registers were discontinued, effective November 6th, as a result of a joint HLO-FPD notification to R&U that their non-security use did not justify their maintenance.

Procedures

Further study concerning mechanization of commitments has resulted in favorable responses from Purchasing Operation. Modifications to an IBM card presently used by Purchasing will provide necessary input for Financial use. Purchasing Operation has also indicated that they may provide input service for AEC purchase orders.

Two meetings were attended to discuss complete mechanization of financial records and ledgers with other Procedure Specialists and Managers - General Accounting. Considerable work has been performed in analyzing records, procedures and reports pertaining to Plant Acquisition and General Books functions to determine individual needs as well as determine most appropriate overall method of control and input for HLO Financial Operation.

Assistance was provided Library Operation in establishing a new record system for procurement, receipt and issuance of periodicals.

Measurements

Compilation of narrative from the September Business Review was completed. A composite set of goals for Hanford Laboratories was prepared from those submitted by Level 3 components. Preparation of the Hanford Laboratories measurements report was in progress.

Payroll Statistics

<u>Number of HLO Employees</u>	<u>Total</u>	<u>Exempt</u>	<u>Non-Exempt</u>
<u>Changes During Month</u>			
Employees on Payroll at Beginning of Month	1 188	564	624
Additions and Transfers In	19	8	11
Removals and Transfers Out	(15)	(8)	(7)
Employees on Payroll at End of Month	<u>1 192</u>	<u>564</u>	<u>628</u>
<u>Overtime Payments During Month</u>	<u>November</u>	<u>October</u>	
Exempt	\$1 194	\$1 572	
Non-Exempt	<u>5 334</u>	<u>4 787</u>	
	<u>\$6 528</u>	<u>\$6 359</u>	
<u>Gross Payroll Paid During Month</u>			
Exempt	\$443 883	\$440 833	
Non-Exempt	<u>275 505</u>	<u>335 462</u>	
	<u>\$719 388</u>	<u>\$776 295</u>	

Participation in Employee Benefit
Plans at Month End

	<u>No. Participating</u>		<u>% Participating</u>	
	<u>November</u>	<u>October</u>	<u>November</u>	<u>October</u>
Pension Plan	1 165	1 171	98.7	98.7
Insurance Plan				
Personal Coverage	1 220	1 223	99.8	99.8
Dependent Coverage	806	804	-	-
U. S. Savings Bonds				
Stock Bonus Plan	705	722	59.1	60.8
Savings Plan	78	78	6.5	6.6

Insurance Claims

	<u>November</u>		<u>October</u>	
	<u>Number</u>	<u>Amount</u>	<u>Number</u>	<u>Amount</u>
Employee Benefits				
Life Insurance	-	-	-	-
Weekly Sickness & Accident	15	\$1 522	11	\$1 064
Comprehensive Medical	30	2 497	39	5 584
Dependent Benefits				
Comprehensive Medical	<u>62</u>	<u>5 192</u>	<u>81</u>	<u>6 377</u>
	<u>107</u>	<u>\$9 211</u>	<u>131</u>	<u>\$13 025</u>

Good Neighbor Fund

	<u>November</u>	<u>October</u>
Number Participating	824	813
Percent Participating	69.1	68.1

W. Sale
Manager - Finance

WS/bk

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

B. M. Johnson, Jr. G. B. Barton	Process Technology: Radiant-Heat Spray Calcination of Radioactive Waste Solutions- Parts I, II, III (HW-58202)
B. M. Johnson, Jr.	Process Technology: Use of Direct Gas Flame Combustion Within a Fluidized Bed to Supply Heat for an Endothermic Reaction Within the Bed
E. J. Wheelwright	The Use of Fluoride to Increase the Separation of Plutonium from Fission Products by the Nitric Acid Anion Exchange Process (HW-58327)
J. L. Swanson	Process for the Determination of Oxygen to Uranium Ratio in Uranium Oxide Powders

Paul F. Gast
for H. M. Parker

END

**DATE
FILMED**

8 / 24 / 92