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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
JANUARY, 1958

Compiled by
Operation Managers

February 15, 1958

CLASSIFICATION REVIEW FOR DECLASSIFICATION BUT LEFT UNCHANGED
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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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TABLE I. HLO-FORCE REPORT AND PERSONNEL STATUS CHANGES

Date January 31, 1958

FORCE REPORT

	At close of Month			At beginning of Month			Additions		Separations	
	Exempt	Non-Exempt	Total	Exempt	Non-Exempt	Total	Exempt	Non-Exempt	Exempt	Non-Exempt
Chemical Research and Development	128	99	227	128	97	225	4	3	4	1
Reactor & Fuels Research & Development	154	99	253	153	101	254	3	0	2	2
Physics & Instrument Research & Development	56	25	81	56	25	81	0	0	0	0
Biology Operation	34	43	77	35	43	78	0	0	1	0
Operations Res. & Syn.	15	3	18	15	3	18	0	0	0	0
Radiation Protection	43	123	166	44	153	197	0	2	1	32
Laboratory Auxiliaries	46	180	226	46	182	228	0	3	0	5
Financial	16	34	50	16	34	50	0	0	0	0
Employee Relations	13	11	24	13	11	24	0	1	0	1
General	1	2	3	1	2	3	0	0	0	0
TOTALS	506	619	1125	507	651	1158	7	9	8	41
Totals excluding Internal Transfers	506	619	1125	507	651	1158	5	5	6	37

Composite Separation Rate- -3.822
Separation Rate (based on separations leaving G.E.)- -3.200
Controllable Separation Rate - .622

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

Date January 31, 1958

Component	PROMOTIONS			EXEMPT TRANSFERS (2)				NON-EXEMPT TRANSFERS	
		Non-Exempt		To HLO		From HLO			
	Exempt	To Exempt	Non-Exempt	From Other HAPO	From Other G.E.	To Other HAPO	To Other G.E.	To HLO	From HLO
Chemical	4	0	6	2	0	3	0	0	0
Reactor & Fuels	11	0	3	2	0	0	0	0	0
Physics & Instrument	0	0	3	0	0	0	0	0	0
Biology Operation	1	0	2	0	0	0	0	0	0
Operations Res. & Syn.	1	0	1	0	0	0	0	0	0
Radiation Protection	0	0	2	0	0	0	0	1	1
Laboratory Aux.	0	0	0	0	0	0	0	2	1
Financial	0	0	0	0	0	0	0	0	0
Employee Relations	1	0	0	0	0	0	0	0	0
TOTALS	18	0	17	4	0	3	0	3	2

(1) Data through 1/31/58
(2) Transfers within HLO not included

SUMMARY

BUDGETS AND COSTS

Fiscal year to-date costs are $9,626,000 at the end of January or 54% of the $17,940,000 of the FY 1958 mid-year Review Budget as adjusted to reflect changes received from the Product Departments. January costs of $1,418,000 showed a slight reduction from December.

Cost-budget relationship of the total of 2000 Program Research and Development appears to be in order; however, some adjustment of personnel assignments must be made to keep the individual authorizations in balance.

From a budget standpoint, plutonium recycle research and development costs are 44% of the budget; however, the latest financial plan from HOO-AEC provides $500,000 less than the current budget. Taking this into consideration, costs are 52% of the financial plan. No information has been received from HOO-AEC in regard to our request to have the $500,000 cut in plutonium recycle funds restored.

Process technology cost-budget relationships also indicate further adjustment will be required in the work performed for IPD and CPD.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

Authority to proceed with Plutonium Recycle Test Reactor (PRTR) procurement and construction is expected momentarily. Bid packages for temporary construction facilities and Phase I of the reactor construction have been prepared.

During the month funds in the amount of $3.3 M were authorized for FY-1958 procurement and construction expenditures and commitments on the Plutonium Fabrication Pilot Plant. Of this sum $1.9 M was transmitted to the General Electric Company for expenditures and commitments directly managed by the Company.

Encoding of the IBM-650 fuel economics program is virtually completed. This program will be used in conjunction with the Generalized Plutonium Recycle Analysis (GPR) program. By inserting appropriate physics constants for a particular reactor into the GPR and by inserting detailed fuel and fuel processing cost estimates into the economics program, the economics of the reactor under study can be completely analyzed.

An element of question concerning reactors of the NPR type is the rate of film buildup on the river water side of river-water high temperature-deionized-water heat exchangers. After five months operation under somewhat less severe conditions than might obtain in an NPR system, an exchanger under test at 1706-KE has not shown a decrease in neat transfer coefficient.

[redacted]

A four-tube production test was completed in which standard 1245 aluminum alloy clad fuel elements were alternated with fuel elements identical except for an autoclave treatment with 1% chromic acid. Maximum weight losses of the latter were 1/3 to 1/5 those of the standard elements.

The Superior Tube Company shipped 22 ribbed, B-D-F, Zircaloy-3 process tubes during January. Improved dimensional tolerances and reduced rib twist were evident from an analysis of Superior's inspection report. The eight tubes received from Superior in November were delivered to IPD for installation in-reactor.

Two Pu-Al alloy specimens have been discharged from MTR without incident after an estimated burnout of 60% of the original Pu atoms.

Examination of three cored, insulated fuel elements irradiated to 620 MWD/T revealed near complete closure of the core void, again demonstrating that fission gas swelling occurs at high uranium temperatures.

The feasibility of using unsintered UO_2 powder as a reactor fuel is being investigated via MTR irradiation of two Zircaloy clad, 1" x 6", enriched UO_2 powder fuel elements. The irradiations have proceeded uneventfully since charging on January 20.

Cold compaction and hot extrusion of blended UO_2 and Al powders have given extrusions of good surface quality and 95% of theoretical density. Cold swaging of similar mixtures in stainless steel jackets gave 99% of theoretical core density.

Using an electron beam gun, the high temperature behavior of UO_2 was observed. Sintering and rapid sublimation occurred but melting did not. This behavior was consistent with deductions made on examination of UO_2 capsules irradiated at high core temperatures.

Irradiation testing of metallic uranium, rod cluster fuel assemblies for NPR use has included (1) a four-rod Zircaloy-2 clad cluster irradiated in the MTR to 680 MWD/T, (2) a four-rod stainless steel clad cluster irradiated in the MTR to 550 MWD/T, and (3) a four-rod, stainless steel clad cluster still under irradiation in KER-3 Loop after ca. 900 MWD/T exposure. No warp or failure occurred; slight dimensional changes occurred in isolated instances. Corrosion testing of co-extruded, Zircaloy-2 clad, four-rod cluster assemblies is in the final stages preparatory to irradiation in KER-1.

2. Chemical Research and Development

A carefully integrated study between laboratory research and pilot plant activities on the Purex Plutonium Anion Exchange Process showed difficulty might arise from the rate at which Dowex-1 could be mechanically moved around the moving bed prototype unit. Laboratory results showed Permutit SK resin to have good capacity and elution characteristics. Subsequent pilot plant testing proved this new material would mechanically move with relative ease and as a result the Purex plant prototype ion exchange unit was satisfactorily started up with Permutit resin.

In support of fission product recovery, preliminary data show that air present in steam used to hydrolyze cesium zinc ferrocyanide greatly increases the conversion rate of this material compared with use of air free steam. Liter scale "cold" runs to demonstrate the flowsheet for cesium removal from the Purex waste are in progress and the multi-curie cell in 222-S is being prepared for hot runs on this larger scale.

Very favorable results were obtained on laboratory scale destruction of nitric acid in synthetic Purex 1WW waste using formaldehyde operating on a continuous process. The process inherently reduces waste volume. Preparations are being made to repeat the experiment using hot waste raw material.

A better appreciation for neptunium inventory in HAPO fuel slugs was obtained from more precise neptunium-237/plutonium-239 ratios determined for dissolver solutions obtained from carefully measured I and E slug irradiations. The results show about 1/3 higher neptunium concentrations than older data.

Screening tests for materials suitable for use in the Non-Production Fuels Separations Program continue to show alloys suitable for use in an HNO_3-HF dissolver system. To date Haynes-25 alloy appears adequate if annealed; as-welded coupons were badly attacked. Hastelloy-F alloy likewise appears suitable with close control of specifications. The testing program also includes screening numerous non-metallic plastics and elastomores for their resistance to corrosive solutions.

Tests on direct volatilization of chloride from Darex dissolver solutions have been completed until certain problems brought out by the tests can be evaluated. Work on solvent extraction techniques for chloride removal continues.

In support of the Plutonium Recycle Program, continuing laboratory scale tests on the Zirflex process include experiments to determine the influence of significant quantities of zirconium in the ammonium fluoride dissolver solution on fuel bearing core materials such as plutonium aluminum alloys and plutonium uranium alloys. No unfavorable results have been observed to date and certain favorable trends were attributable to the presence of zirconium in the dissolver fluid.

A study on methods to produce mercury-204 in practical quantities has been completed.

A new ground water level survey was prepared to include the influence of the basalt ridge separating Cold Creek Valley from the remainder of the Project area; new contours show a need to restrict 200 waste ground disposal compared with previous data.

Work continues on methods and mechanisms to effectively retain strontium and cesium ions on soil or mineral columns. Promising results were achieved in the selective removal of cesium-137 from solution by a column of crushed pollucite ($Cs_2O.Al_2O_3.4SiO_2.H_2O$).

3. Physics and Instruments

The collection of experimental information on nuclear safety of dissolvers for enriched uranium fuel elements continued during the month with experiments on 1.44% I and E elements randomly dumped into a cylindrical tank and for a mixture of rods of two different sizes. Analysis of data from random arrays is being made to establish safe limits. Experimental work to determine safe concentrations of enriched uranyl nitrate-water mixtures was begun and calculations of reactivity of 3% enriched oxide-water mixtures have been carried out as an aid in planning experiments with this material for the power reactor fuel reprocessing program.

The program to survey lattices for NPR use continued with measurements being made on seven rod, cluster type elements. For this element, the point of no reactivity change upon loss of water is near a lattice spacing of ten inches.

The program to measure the reactivity temperature coefficient with plutonium in the fuel elements of production reactors made slow progress in the improvement and testing of the experimental apparatus.

In the Plutonium Recycle Program the PCTR was used for measurements of the effects of plutonium spike enrichment, the comparison of Pu-graphite with Pu-Al fuel elements, and in obtaining additional parameters of the 19-rod oxide cluster in an eight-inch lattice. The conversion ratio measured for this fuel-lattice arrangement agreed closely with the theoretically calculated values used in PRTR planning.

Additional measurements were made of the concentration on the Wahluke Slope of airborne contamination arising from a simulated "slow simmer" reactor disaster.

A method for using "pencils" as fixed monitors for fast neutron dose has been developed and will be further tested by the Radiological Development Operation. The body monitor shield in 329 Building was completed and its use for testing and developing instrumentation for the permanent body monitor was begun.

Instrument development work continued satisfactorily. For example, a developmental model of a portable monitor which can quickly determine the energy of gamma radiation was successfully field tested.

Work in the basic data field included improvements in the techniques of analyzing cross section data, installation of time-of-flight equipment on the Van de Graaff, work on cross standardization of cross section measurements with other laboratories, measurement of neutron moderation in kerosene (stand-in for diphenyl), and continued progress on construction of the new neutron spectrometer.

4. Biology

Fish exposed to reactor effluents under conditions expected to be produced by Priest Rapids Dam showed no adverse effects.

[redacted]

Metabolism studies of strontium and calcium in plants and animals continue to show that the interrelationship of these two metals is not as simple as is generally supposed.

Following intravenous injections of plutonium citrate, kidneys are showing a surprisingly slow turnover rate, although the bone remains the critical organ.

Strontium-sulphate, ordinarily considered insoluble, when inhaled by mice as radioactive particles, is turned over to the bone with surprising rapidity.

Following the intragastric administration of radio-yttrium to rats, severest damage was found in the large intestine rather than in the more radio-sensitive small intestine. This is probably because of the longer retention time in the large intestine.

Technical and Other Services

Four cases of plutonium deposition were confirmed. All appeared to be less than 10 per cent of the MPL, although one case involved an employee who received gross facial contamination. The total number of cases of plutonium deposition on record is 216.

A document giving the general scope of the CPD Control Study was issued. The basic process flow diagrams have been brought up to date and described by the use of a matrix method. The collection of operating procedures, vessel instrumentation and other source data is well under way.

At the request of the Utilities Operation, R and U, some further work is being done on the electrical distribution study previously completed by the Operations Research Section.

Statistical and mathematical assistance on 31 separate problems was given to other HAPO components.

There are 15 authorized projects currently active in HLO excluding the Plutonium Recycle Program projects. These projects total as follows:

Reactor and Fuels R and D	7 projects	$2,869,000
Chemical R and D	3 projects	1,265,000
Physics and Instruments R and D	2 projects	250,000
Radiation Protection	2 projects	221,000
Weapons	1 project	295,000

There are six projects awaiting initial Commission approval. These have a total estimated project cost of $5,136,000.

All projects are proceeding substantially on schedule with the exception of three projects as previously reported. Other projects, for which funds have not been released by AEC, are substantially behind the project planning schedules. Principal of these are the Radiochemistry Hot Cell, the Metallurgical Development Facility (306 Addition) and the Critical Mass Laboratory.

[redacted]

The survey and inspections of Laboratories' pressure vessels is estimated 75% complete. This survey does not include code piping systems. A survey of pipe systems will be made in special situations.

A revised Hanford Classification Guide was completed by the HAPO task force and submitted to the HOO Classification Committee for review.

Supporting Functions

1. Financial

The remaining funds available for attendance at off-site training courses and seminars during FY 1958 have been allocated to Level 3 components.

Quarterly inventory reports for the quarter ending December 31, 1957 were received from all HLO custodians of Reactor and Other Special Materials. All reports were found to be in agreement with Property Accounting records.

Funds allocated to HLO from the Product Departments for R and D programs have been adjusted during January as follows:

IPD	$140,000
FPD	75,000
CPD	(27,000)
	$188,000

Hanford Laboratories will allocate General Overhead costs to Research and Development-New Production Reactor in accordance with the policy established by IPD whereby accounting rules which govern distribution of overhead will in general follow project-type procedures.

Year-end business in connection with pension, insurance, taxes, and other data required by federal and local authorities as well as Schenectady has been completed.

Special arrangements were made with FPD to obtain an additional $35,000 for 2000 Program equipment to cover some badly needed creep testing units.

Formal notification was received from HOO-AEC which reduced the cost of heavy water to $15.00 per pound for the Plutonium Recycle Test Reactor project.

2. Employee Relations

At month's end the staff of Hanford Laboratories Operation totalled 1125, including 506 exempt and 619 non-exempt employees. There were 421 exempt employees possessing technical degrees, including 221 BS, 103 MS, and 97 PhD's.

Twenty-eight Personnel Meter Clerks were removed from the rolls during the month via reduction in force. One Serviceman was removed as a result of the seniority bumping procedure.

The HOO-AEC has approved the 1958 Summer Institute of Nuclear Energy for Engineering College Faculty Members.

Forty Spokane high school science teachers visited HLO facilities during the month. Also the 4-man crew of E. R. Murrow's show "See It Now" was escorted through HLO facilities.

Preliminary plans for the 1958 AEC Radiological Physics Fellowship Training program are now being conducted by a member of the Radiation Protection Operations.

HLO personnel worked a total of 200,384 man-hours during January with no disabling injuries. Since reorganization, 9/1/56, HLO employees have worked a total of 3,207,628 man-hours without a single disabling injury.

There were 32 medical treatment injuries during January with a frequency of 1.60 as compared to 1.77 last month.

Two government vehicles driven by HLO employees were involved in a collision in Richland with total damages amounting to $97.50.

There were 7 security violations reported during the month.

Negotiations with the Field Inspectors continued.

Six grievances were received during January. In every case they were jurisdictional in nature regarding misassignment of work.

The Company has agreed on a list of names to be used for the selection of an arbitrator in the Maki case which is expected to come up for arbitration in the near future. T. G. Marshall has been selected as a representative on the Arbitration Committee.

H M Parker

Manager,
HANFORD LABORATORIES

HM Parker:kss

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Aluminum-Nickel-Titanium Alloys. A series of aluminum alloys with varying nickel and titanium contents was cast at Hanford and a comparable series was made by the Kaiser Aluminum Corporation. The nominal nickel concentrations varied from 0.032 w/o to 1 w/o and the titanium concentration from 0.1 w/o to 0.3 w/o. When these alloys were tested in 350 C water, all but the alloys containing 1 w/o nickel had failed intergranularly at the end of four hours. The only alloy of the group which showed any promise at all was a 1% Ni, 0.28% Ti alloy cast at Hanford, and even this one showed evidence of intergranular attack after 163 hours at 363 C. Since the nickel and titanium contents of four of the alloys were approximately comparable to the 198X alloy which shows superior corrosion resistance, the difference in corrosion resistance is evidently in the casting or fabrication techniques.

Effect of Casting and Fabrication on Corrosion Resistance. An investigation into the effect of casting and fabrication variables on corrosion resistance has begun. Among the variables to be investigated will be holding time in the molten condition (i.e., to effect homogenization), casting temperature, cooling rate, and percent cold work. The first series of alloys was made up from X-8001 caps melted and cast in the vacuum melting unit.

Alloy	Casting Temp.	Cooling Time (788 C to 200 C)	Percent Cold Work
X-8001	788 C	3 hours	75
"	"	10 minutes	75
"	"	5 "	75
"	"	"	60
"	"	"	45
"	"	"	25
"	"	"	10

These alloys are being tested in 350 C static water. The slow-cooled alloy failed intergranularly after 46 hours in test. All the rest of the alloys show approximately the same corrosion rate after 328 hours in test.

In-Reactor Corrosion of Fuel Elements Autoclaved in 1% Chromic Acid. Four tubes of fuel elements were discharged at goal exposure of 600 MWD/T under PT-IP59A. In this test aluminum clad fuel elements (1245 alloy) autoclaved in 1% chromic acid were charged alternately with standard fuel elements.

These four tubes of fuel elements have been examined, weighed, cleaned, and visually re-examined. The maximum weight losses of the chromic acid autoclaved fuel elements were 1/3 to 1/5 of the maximum weight losses of the corresponding standard elements. Some light localized corrosion was observed on many of the standard and test elements as groove pitting in the rib area. This corrosion was considered as started by charging damage.

Chromic acid autoclaving applies an exceedingly corrosion resistant film, one that partially survives goal exposures and even the post-exposure cleaning procedure. It has shown its merits in two in-reactor tests. Consideration is recommended for reactor application, particularly for fuel elements in high-rib tubes or where corrosion of the upper surface of the fuel element might be limiting the reactors. Some further development work will be necessary to establish this process on a production scale.

Organic Coolant Studies. The solid-liquid phase diagrams for the binary systems of the five most promising organic coolant candidates have been completed. All of the systems showed regions of solid solubility. The biphenyl-phenanthrene binary appeared to form a solid solution at all compositions. The ternary system, biphenyl-ortho terphenyl-meta terphenyl has also been completed. The results to date are summarized below:

Organic Coolant Phase Relationships

Eutectic Composition (Mole Percent)	Eutectic Melting Point, °C	Regions of Solid Solubility
43% biphenyl, 57% ortho-terphenyl	29	0-25% biphenyl 65-100% "
65% biphenyl, 35% meta terphenyl	45	0-47% " 78-100% "
55% biphenyl, 45% napthalene	40	0-30% " 70-100% "
70% biphenyl, 30% phenanthrene	58	0-100% "
76% ortho-terphenyl, 24% meta-terphenyl	39	0-65% ortho terphenyl 82-100% " "
65% ortho-terphenyl, 37% napthalene	31	0-17% " " 76-100% " "
70% ortho-terphenyl, 30% phenanthrene	39	0-30% " " 85-100% " "
41% meta-terphenyl, 59% napthalene	49	0-10% meta-terphenyl 54-100% " "
50% meta-terphenyl, 50% phenanthrene	56	0-35% " " 62-100% " "
57% napthalene, 43% phenanthrene	52	0-39% napthalene 73-100% "
37% biphenyl, 48% ortho-terphenyl, 15% meta-terphenyl	23	

Radiometallurgy Laboratory Studies

Production Test of Seven-Rod Cluster Fuel Elements (PT-IP 46-A)(RM-182). The examination of a seven-rod cluster fuel element (PT-IP 46-A) which had been irradiated in a KE through hole to an estimated exposure of 1075 MWD/T was completed. The uranium, which had expanded 1 to 3 mils in diameter, was in direct contact with the stainless steel jacket around most of the circumference. The amount of burnup of U-235 atoms was determined for the center rod and an outside rod from each cluster and showed that the center rods, as expected, had received slightly less exposure than the outside rods. The results are given below.

Rod Number	a/o Burnup	Approximate MWD/T	Identification
43	0.134	1155	Outside rod, first cluster
44	0.088	760	Center rod, first cluster
50	0.130	1120	Outside rod, second cluster
51	0.106	915	Center rod, second cluster

The indicated temperature of irradiation, on the basis of hardness results and metallographic examination, was in the medium uranium alpha phase region (300 to 450 C).

As a result of the examination, it was concluded that the individual rods performed satisfactorily. No evidence was noted of incipient rod failure or any condition likely to result in failure. However, the spider and rings holding the rods had been twisted in handling, indicating a need for strengthening the method of maintaining the rod spacing in the clusters.

Cluster Fuel Test - GEH-4-B (RM-181). Metallographic examination of the samples removed from Rod #2 of the stainless steel clad, four-rod natural uranium cluster fuel element (irradiated in the MTR) showed a uniform grain size across the diameter with abnormally high amounts of inclusion stringers present. The hardness values were also uniform, averaging 67.6 Rockwell A.

Uranium growth, in the form of surface bumping, was noted, and at several points growth had progressed to the extent that the surface had formed into the contours of the cladding. The stainless steel cladding exhibited exceptional integrity in containing the growth. Although pressures, created by the uranium growth, were probably large at contact areas, no deformation of the 30-mil thick cladding occurred.

An asymmetrical neutron flux, which had been requested prior to irradiation to make the test more rigorous, was indicated by the results of the burnup analysis. Atomic percent burnup of the U-235 in each of the rods was as follows: #1 - 0.060, #2 - 0.076, #5 - 0.087, and #6 - 0.078.

Diffusion Capsules - GEH-3-9 (RM-97). Three capsules containing uranium-aluminum and uranium-AlSi diffusion couples were irradiated to determine the effect of irradiation upon the diffusion characteristics of these couples. One uranium-AlSi capsule was opened, and microscopic examination

of the diffusion couple revealed that diffusion had occurred. Microphotography of the diffusion areas is continuing.

Production Test IP-32-A - Irradiation of Insulated Slugs (RM-176). Three, four-inch, cored, insulated, natural uranium fuel elements were exposed to about 600 MWD/T in KW Reactor. Examination showed that uranium had deposited in the core of element #5. Metallography of a wafer from this area, as well as a wafer from the opposite end of the element, revealed a porous structure in which bubbles could be found almost all of the way to the edge of the wafer. Hardness data and metallographic observations indicated that a major portion of the element had been heated into the gamma phase (> 770 C).

Element #2 has been sectioned and the core was also found to be filled with uranium for about two-thirds of its length. Hardness and metallographic examination will be started shortly.

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.

A specimen of 50 percent cold worked Zircaloy-2 has been heated to 900 C in the hot stage facility. Analysis of the film, exposed during heating, shows that recrystallization can be studied without the aid of an etchant. Several specimens of uranium containing 10 ppm hydrogen have been heated to 700 C. The 16 mm movie film from these experiments shows slight changes in the size and shape of the hydride particles; no clean cavity forms at the site of the hydride inclusions. Thermocouples spot welded to such specimens indicate a transformation temperature of 660 C ± 10. Rapid or slow cooling through the transformation temperature does not appear to affect the phase transformation temperature which is revealed by sudden changes in the microstructure.

As a part of a fundamental study of the relationship of reactor irradiation to the appearance of fracture surfaces in irradiated uranium, the surfaces of uranium with burnups of 0.07 a/o and 0.10 a/o have been studied optically and in the electron microscope. The complete study will include such variables as temperature of fracturing, post-irradiation annealing, and burnup level.

Radiation Damage and Recovery of Molybdenum. Molybdenum and zirconium are being studied by x-ray diffraction techniques after irradiation to improve the basic understanding of radiation damage in metals. The kinetics of damage recovery are also being studied.

Irradiation of molybdenum to various exposure levels from 6.5×10^{16} to 6.7×10^{18} nvt produces an expansion in lattice parameter which increases with exposure. The percent increase in lattice parameter with respect to the unirradiated state is a sensitive measure of average distortion and defect concentration within the metal due to irradiation. This fact is

being used to determine the kinetics of damage removal in molybdenum by isothermal annealing techniques.

Isothermal anneals at 400 C have been completed. Previously, results were obtained for 500 C annealing wherein effects cease to be observed after twenty-seven hours at temperature. However, at 400 C the annealing reaction rate approached zero in one hour. For two different samples of equal defect concentration, only 53 percent of the initial damage remained after completion of the 500 C anneals while 77 percent remained at 400 C. At 500 C, it was noted that initial rate of recovery was dependent on defect concentration. These data plus the fact that no integral reaction order is present would seem to indicate that a spectrum of activation energies is involved. It would also appear that the defects are grouped at various distances from each other; the close interstitial-vacancy pairs apparently disappear at lower temperatures. The energy required for recovery at 400 C and above is most probably a function of the distance between defects. If this proves to be true, successively higher temperatures should produce equilibrium at lower concentrations as the energy is supplied to annihilate the more remotely associated defects.

Pre-Irradiation Study of Thermocouples. A knowledge of the errors in temperature measurement using thermocouples in a neutron flux is essential for the quantitative evaluation of the effects of neutron irradiation on materials. Due to a lack of such information, a program of measuring thermocouple stability in-reactor is currently in progress. Thermocouple contact has been improved in the capsule to be used in the 300 C stability test. Springs have been added to maintain a force to hold the beads against the bottom of the thermocouple well. Thermal arrests with no variation in emf have been recorded for 35 seconds, and a variation of only 0.02 millivolts appears in 45 seconds. Since the conditions in-reactor will tend to elongate the thermal arrest, the capsule design seems to be satisfactory. The in-reactor tests to determine the characteristics of quartz and asbestos insulation commenced on January 16, 1958. Two hairpin assemblies were inserted into the X-2 level of KW Reactor. Initial indications are that both assemblies are operating satisfactorily.

Diffusion Studies. A knowledge of the interdiffusion of various uranium/barrier metal/clad metal combinations is essential in the design of fuel elements. Diffusion is being studied in U/Ni/Al, U/X-8001, U/Zr, and (U-Zr) alloy couples. The effect of thermal cycling during the diffusion anneal, on the rate of diffusion of uranium into AlSi is also being determined.

Six U/Ni/Al diffusion couples have been annealed at 530 C. These couples consist of a 1/4" thick disk of uranium in contact with a 0.001" thick disk of nickel, which is in contact with a 0.005" thick disk of 2S aluminum. In the first three couples, which were annealed twenty-four hours at 530 C, a Ni/Al diffusion zone consisting of one phase 0.002" thick, and a second phase 0.008" thick, was formed. A third phase only 0.0002" thick was formed next to the uranium. This phase is probably a uranium compound. An autoradiograph of the U/Ni/Al diffusion zone showed that there was no gross movement of uranium out into the Al/Ni diffusion zone. The diffusion zone was very uniform.

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Three U/Ni/Al couples which were annealed sixty-five hours at 530 C were separated by zirconium disks having highly oxidized surfaces. The zirconium disks were interposed between the aluminum disks of two adjacent couples in a single clamp to prevent self-diffusion and subsequent adherence of the two aluminum disks. The nickel completely penetrated the 0.005" thick aluminum at many points; all of the nickel was consumed in the Ni/Al diffusion zone. Both the aluminum and Al/Ni compound apparently reacted with the zirconium, penetrating about 0.0007" into the zirconium at some points. Microhardness measurements indicated that a continuous solid solution formed in the uranium near the uranium/diffusion zone interface.

Cross sectioning of a U/Al couple, irradiated at 250 C in the MTR has been completed. Small points of diffusion product appeared to project about 0.0002" into the aluminum.

Hanford Irradiation - PT 3NA. The design of advanced fuel elements depends upon knowledge of the effects of radiation on the significant mechanical and physical properties of uranium. A program to obtain this information for beta heat treated uranium is under way. During the month chemical burnup determinations on specimens representing each burnup level were reported. The chemically determined values varied from the calculated values by about 15 percent. Five elevated temperature tensile tests were made in the Radiometallurgy Facility. One test was performed on a 0.031 a/o burnup specimen at 450 C, and tests were performed on unirradiated control specimens at 300, 450, and 600 C. The ductility of the unirradiated control specimens increased markedly with temperature, and those tested at 600 C did not break although elongation exceeded 40 percent, the limit of the equipment. The 0.031 a/o burnup specimen showed an elongation of 3.4 percent at 450 C compared to 37.5 percent for the unirradiated control specimen tested at this temperature. However, in spite of the high elongation of unirradiated specimens, as the testing temperature increases, the ultimate and yield strength values for the 0.031 a/o burnup specimens and the unirradiated specimens approach one another in magnitude. At 450 and 600 C there are only small differences in these values.

Radiation Damage in Thorium-Uranium Alloys. Alloys of thorium containing 1 w/o oralloy (93 percent U-235), 4 w/o oralloy, and 5.4 w/o oralloy have been obtained for irradiation tests to determine changes in mechanical properties and some physical properties due to burnup. Tensile specimens and samples to be used for density, hardness, and metallography have been heat treated and fabricated from the 5.4 w/o oralloy alloy with both high and low carbon content.

A new irradiation capsule was designed for these tests to permit irradiation in a 5/8" diameter napkin-ring stringer at the MTR. A number of these capsules have been fabricated. Heat transfer conditions for the capsule assemblies were calculated as a function of flux density. Calculations relating total atom burnup as a function of alloy composition, flux density, and time of irradiation were also prepared.

Pre-irradiation density measurements for the 5.4 w/o oralloy specimens were completed to provide bases for comparing post-irradiation density data. The density of this alloy containing practically no carbon was 11.88 g/cm^3 compared to 11.60 g/cm^3 for pure, extruded thorium. The density of this same alloy containing 1500 ppm carbon was 11.81 g/cm^3 showing the effect of carbon in decreasing the density of the alloy.

Production of High-Purity Uranium. Production of high-purity uranium will provide a supply of this material for use in basic physical metallurgy studies. Dendritic uranium of spectroscopic purity is being obtained by electrowinning from a molten KCl-LiCl-UCl_3 salt bath. Vacuum melting of the dendrites will be used to produce uranium ingots for fabrication into the required specimens.

Direct chlorination of the uranium dioxide feed material in the stainless steel cell resulted in excessive corrosion of the cell. Uranium hexachloride is now used as the feed material. It is produced by chlorination of a concentrated uranium dioxide molten salt solution in a quartz cell. The concentrate is then frozen and can be stored indefinitely since uranium hexachloride does not react with air or moisture.

Inert Gas Swelling and Mobility Experiments. Swelling of irradiated uranium fuel materials is attributed to the internal stress developed in the metal by precipitation of the inert fission gases into internal voids. The rate of nucleation and growth of the gas phase is dependent upon the diffusion mobility of the gases and the rate of generation of the gases by burnup of the uranium atoms. Swelling is an increasingly important problem in the development of fuel elements for reactors which will operate at higher temperatures and up to 0.2 percent burnup of the atoms.

Xenon gas has been introduced into an Ag - 7.5 Cu alloy for the determination of the effect of precipitation of the gas at the interface between the Ag matrix and the finely dispersed Cu phase. Analysis of the xenon gas content has shown that the electrical glow discharge introduces an average of one atomic percent of xenon per day at the discharge temperature of 250 C and 5 millimeters xenon gas pressure. Most of the gas is trapped on the cathode surface since xenon does not diffuse rapidly at this temperature. Gas introduced into uranium in the same manner corresponds to a xenon generation rate of eight percent burnup per day or a thermal flux in natural uranium of 2×10^{22} nvt. The rate of xenon introduction will be reduced considerably at higher temperatures since the gas will evaporate from the surface because of its increased mobility. If the rate can be controlled, the xenon gas discharge can be used to study the swelling of uranium at higher temperatures in the absence of neutron radiation.

New Fuel Element Development

Insulated Fuel Elements. Radiometallurgical examination of the three cored insulated uranium fuel elements which were irradiated in a K through-hole facility to 620 MWD/T has continued and is nearing

completion. The last of the three elements to be examined, which was the downstream piece in the through-hole assembly, verifies that a severe power and fuel temperature gradient existed across the three test elements. Complete closure of the 3/8" diameter core for nearly its full length by uranium swelling has been observed. Gas porosity is observed fairly uniformly throughout the entire uranium cross section. The insulated fuel element which will be intentionally ruptured during operation in the MTR has been received there and is scheduled for loading and testing about the second week of February.

Co-axial Tube Fuel Element. The co-axial tube fuel element is of interest because it may offer a better split failure resistance than a corresponding sized cored fuel element. The current irradiation test of this fuel element concept has just been completed at the MTR. Two co-axial tube fuel elements, one containing an axial thermocouple, have operated for one MTR cycle to about 200 MWD/T. Temperatures indicated by the thermocouple in the fuel element revealed that the initial U-U interface thermal contact conductance was greater than assumed. During operation, the thermal contact conductance increased to that which was initially assumed, i.e., 1000 BTU/hr/ft^2/F. When a temperature of about 565 C was reached on the hotter side of the U-U interface, it appeared that the pressure on the U-U joint was rapidly relieved. The decreasing pressure decreased the contact conductance value and permitted a rapid rise in the core temperature to the gamma phase region. During subsequent operation, the inner co-axial piece fluctuated in the temperature range of about 800-900 C. A stepwise power startup of the MTR from near zero power just prior to the end of the cycle provided temperature and fuel element power data which revealed that the gap had changed appreciably since the initial startup. The gap change permitted the axial temperature to rise rapidly at low power until the gamma phase was reached and then to level off in the low gamma phase temperature range as the power increased. The two fuel elements were discharged from the test facility shortly after startup of the following MTR cycle because of facility leakage. It is hoped that further operational data may be derived from post-irradiation examination of the two fuel elements.

Lead-Dip Canned Segmented I & E Fuel Elements. The fail-safe feature of the segmented fuel element is a desirable reactor property. If fuel element failure occurs, the mode of failure minimizes process tube damage. Forty-nine lead-dip canned KER size I & E segmented fuel elements were fabricated for in-reactor evaluation. These elements were examined for closure quality, heat transfer, void areas, braze layer inclusions, and general metallurgical soundness. Twenty-four fuel elements were of reactor quality. Ten weld rejects were etched with caustic to establish AlSi penetration of the can wall. There was an average can wall thickness of 0.027" with a minimum and maximum wall thickness of 0.022 and 0.038", respectively. Twelve elements were charged into KER loop 4. After approximately two weeks exposure, the elements were discharged because of loop trouble. Post-irradiation examination of these elements is planned.

Hot Press Segmented Fuel Elements. As part of the NPR program, eight solid I & E KER-size fuel elements have been fabricated and submitted for out-of-reactor corrosion testing. In addition, four wafer fuel elements were made for flow loop and rupture tests. Once these preliminary pieces were finished, the entire effort was switched to fabricate segmented elements of 1.6 percent U-235 enriched material. Considerable difficulty has been encountered in plating these washers causing the program to be temporarily delayed. One problem is excess oxide which is being alleviated by a change in the vacuum outgassing cycle to incorporate a degrease and nitric acid pickle prior to outgassing. This tends to remove excess oxide on the wafer as well as any adhering organic matter which would tend to cause unnecessary gas evolution.

Procedures previously developed for providing nickel sweater-coats on inner and outer cylindrical surfaces of washers with slight overlap around the edges onto the flat faces were generally unsatisfactory. Due to time limitations, four different approaches are being investigated simultaneously to produce suitable nickel-clad washers for the fabrication of a test lot of elements in time for charging on the next shutdown. These are: (a) plate washers all over; dissolve nickel coat from unwanted areas in nitric acid, shielding appropriate parts of the surface with acid-proof gaskets; a device for multiple application of this method is being developed; it will handle 15 washers at a time, requiring 5-10 minutes for loading, processing, and unloading the lot; (b) plate washers all over; remove plating from unwanted areas by machining in a lathe; this is a slower process, but it is speeded up somewhat by use of a special holding collet, and it is at present the only method developed enough to be applied in practice; however, damage to the nickel coat by the collet jaws is a constant hazard and skillful lathe operation, stopping at the precise depth, is important; (c) load washers in a plating rack in such a manner that plating occurs only where wanted; a rack to hold two columns of uranium washers plus silicone washer separators was developed earlier; a practical problem in this method is that of providing adequate current flow between uranium washers and at the same time complete sealing against entry of the plating solution between them; proper centering of the silicone spacers also causes trouble; if these problems can be solved, the multiple washer column method should be the best because of the high rate of production possible, the one-time handling, and the saving in nickel; and (d) coat flat faces of uranium washers (both sides) with adhesive lead foil, trim edges to desired dimensions, plate washers on multiple rack, peel nickel coated lead off and remove adhesive from washer with solvent; this method is undesirable because the lead foil tends to trap and carry over nitrates from the etch bath. A plating bath was ruined in this way, necessitating making up a new one with considerable loss of time.

Sylvania Hot-Pressed I & E Fuel Elements. Work has been started on the quality evaluation of a new lot of eight-inch I & E elements prepared by Sylvania Electric Products, Inc. Results to date indicate only slight improvement over former lots from SEP with respect to jacket surface quality and regularity of wall thickness. Apparently the drastic caustic etch treatment is still being used to remove the surface lubricant required for pressing. Nickel sweater-coat thickness also appears to be

quite variable, ranging from approximately 0.0002" to approximately 0.0015" on the same element.

Rod Cluster Fuel Testing. Rod cluster fuel elements satisfy many of the requirements for operation of the NPR. A twenty-element charge of four-rod cluster elements is being irradiated at KER loop 3 to gain data for design of NPR fuel. The description of the fuel charge follows.

The elements contained 0.570 diameter natural uranium rods clad in but not bonded to 0.030" stainless steel clad. The charge had accumulated 85 operating days on January 21, 1958. Accumulated exposure at that time was 890 MWD/T. Average bulk outlet temperature in the loop was 225 C, and maximum bulk outlet 235 C. The elements were operating at 43 kw/ft (11.4 watts/gm). The charge is presently running on low temperature water because of a valve leak. A production test has been written to increase goal exposure of this test to 2000 MWD/T.

Examination of GEH-4B, four-rod stainless steel clad cluster element irradiated in the MTR has been completed by Radiometallurgy. No external dimensional changes occurred. All four cores contracted in length and grew in diameter after 550 MWD/T exposure. The amount of these changes is about normal for anisotropic growth in cold irradiated beta treated uranium. The core expansion absorbed the cold clearance of the unirradiated assembly but did not cause expansion of the can.

A four-rod cluster clad in Zircaloy-2 and irradiated as GEH-4E at the MTR is being examined at Radiometallurgy. No warp is evident on viewing, but preliminary measurements give the diameter of one rod as 0.580". Original diameter was 0.569". This large change cannot be accounted for as anisotropic growth in beta treated uranium after 680 MWD/T.

Ten samples have been cut from 100 feet of NMI Zircaloy-2 clad rod intended for irradiation at KER loop 1. These have been fitted with end caps, welded, heat treated, and pickled exactly as is intended for the KER loop 1 test. They are now being corrosion tested in 350 C water. All components for assembly of a KER loop 1 charge of four-rod elements containing co-extruded Zircaloy-2 clad uranium rods have been received. February 15, 1958, remains the completion goal date. Two mockup seven-rod clusters using NMI rod have been completed. Two additional mockups containing co-extruded material with intentional defects are near completion. These four seven-rod assemblies will be used at 1706-KE for rupture testing and pressure drop testing during February.

Tru-line Washers. One of the methods being developed for the fabrication of Tru-line washers is the upsetting of rod stock. The chief advantages of this method are: (1) scrapless production of washers with accompanying economy, and (2) built-in Tru-line feature eliminating additional fabrication. An experimental die set has been used during the month to determine the conditions required to upset 11/16" diameter rod to KER size washers (1.696" outer diameter). The stock temperature, die temperature, material, and its heat treatment have been varied. Rod blanks prepared from ingot uranium have been used in the following conditions: (1) alpha-

rolled-recrystallized, (2) beta quenched plus alpha phase vacuum annealed, and (3) beta quenched plus gamma phase vacuum annealed. The alpha-rolled-recrystallized material deformed non-uniformly due to crystallographic texture and the large grained gamma annealed material deformed non-uniformly and indicated severe shear failures between neighboring disoriented grains. Material quenched from the beta phase with an air delay to give maximum cooling rate through the phase change followed by vacuum annealing at 600 C to remove hydrogen and refine the structure to equiaxed fine grains has proven most amenable to upsetting. The ingot uranium is somewhat better after the same heat treatment than the dingot uranium stock due to the finer recrystallized grain size. The temperature of both the die and specimen stock has been increased to obtain the required upset without fracture on the outer periphery. With the die and punches heated in air to 350 C, and the uranium heated to 450 C in silicone oil, the material has been deformed to nearly the correct dimensions without failure at a load of 175 tons. A number of modifications have been made to the original die set to adjust the volume of metal to be upset and to reduce the friction on the initial punch. An intermediate die cavity has been made to attempt to reduce the barreling of the stock and will be employed on the next tests.

Thermal Contact Conductance of Fuel Element Materials. The previously reported measurements of thermal conductance between aluminum and Zircaloy-2 can now be supplemented with the results of a test involving aluminum-uranium, uranium-uranium, and uranium-aluminum joints. This test was run continuously for over two weeks; and the parameters, heat flux through joints, load on the joints, temperature of joints, and pressure of helium around the specimen were varied. The important parameter, surface roughness of the specimens, was not changed. Each specimen had the same surface roughness of 6-8 microinches RMS. The results of the test as reported here are tentative until further data processing is completed.

The couples were initially loaded for twenty hours with 900 pounds. Interface pressures were 4600 psi. Due to this high initial load, subsequent load variations showed a negligible effect on the U-Al thermal contact conductance values. The U-U thermal contact conductance values did show a pressure dependence. At a flux value of 90,000 BTU/hr/ft^2/F, an increase of interface pressure from 148 psi to 1340 psi increased the U-U thermal contact conductance from 570 BTU/hr/ft^2/F to 1000 BTU/hr/ft^2/F. It appears that the U-U thermal contact conductance increases as the mean interface temperature increases but is little affected by flux variations.

Fuel Element End Closures. End closures formed by swaging cladding over a rod with rounded ends contained in an unbonded jacket were previously shown to be immune to thermal ratcheting under high pressure high temperature fuel element test conditions. This type of closure offers a number of potential advantages, if it can be applied to bonded aluminum or Zircaloy-2 jacketed cluster elements. Development work on this process was started.

Some of the advantages of this type of closure are: (1) it is a point type closure with small weld area, (2) it is a pressure vessel shape that contains no stress concentration points (3) it is a streamlined shape that may have hydraulic advantages, (4) separated machined end caps are

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eliminated in this type of closure, and (5) the process may be amenable to high production rates.

High Temperature - High Pressure Bake Testing of Fuel Elements. Candidate fuel elements for high temperature - high pressure service conditions are being evaluated for U-clad bond interdiffusion or other interactions. Simulated service conditions are produced by baking the fuel elements at 450 C under approximately 1000 psi nitrogen.

Two significant results have come from the alpha track autoradiograph analysis of the bake tested AlSi canned fuel elements. One is the extreme care in sampling that is necessary if one is to establish that no penetration of the jacket by uranium has occurred. Since the work is done in a uranium laboratory, it is easy to transfer a few ppm of uranium to the sample mechanically and to incorrectly attribute this to diffusion through the jacket. The other result was a determination of uranium concentration versus distance of penetration into the clad before and after bake testing. In a typical section through an AlSi bonded jacket the uranium concentration changed from 100 percent to less than one percent in a distance of 0.004". After bake testing this type of fuel element 1500 hours at 450 C and 1000 psi gas pressure, the uranium concentration changed from 100 percent to less than one percent in a distance of 0.012". This change in the uranium concentration gradient in the cladding indicates that diffusion of the uranium fuel through the bonding layer and into the cladding is occurring. The extent of this diffusion to the outside of the cladding is of the greatest concern, but this has not as yet been quantitatively determined.

A second AlSi canned fuel element has been removed from the bake testing autoclave after about 900 hours at 450 C and 1000 psi pressure. A surface rippling at two locations was noted on this fuel element, and this observation duplicates that of the first AlSi canned fuel element which was tested.

The aluminum clad, hot-press nickel bonded fuel element that has been high temperature - high pressure bake tested has been removed from the test after 2000 hours at 450 C and 1000 psi pressure. This element appears sound except for three dimples in the can wall corresponding to uranium support points in the nickel plating bath. To prevent the possible loss of this fuel element by failure of the jacket, it has been removed for destructive metallographic examination and for the possible determination of diffusion data.

Restraint of Uranium Swelling by Zirconium Cladding. Data have been reported on the swelling rates of unrestrained uranium irradiated in the 400-500 C and 600-700 C temperature ranges. To date no data are available on the swelling of unalloyed uranium restrained by high strength cladding and irradiated with a 300-350 C cladding surface temperature and a maximum fuel temperature in the range 450-600 C. In order to obtain data for the above temperature conditions and restraint conditions similar to those of proposed NPR fuel elements, a NaK capsule MTR irradiation has been designed. A goal exposure of 2500 MWD/T is planned. Welding of the test fuel rod and capsule are being completed. Irradiation of the experiment should

begin in February. To obtain additional data, a series of NaK capsule experiments for irradiation in Hanford reactors is being designed. Basically, the capsule consists of a fuel rod centered in a thick walled 2S aluminum can of approximately normal Hanford slug size. Separating the fuel rod and can is an annulus of NaK to serve as a heat transfer media. The desired cladding surface temperatures can be obtained by varying the thickness of the NaK annulus. The fuel rods will be 0.570" diameter and approximately 4" long, having 0, 0.020, and 0.030" Zircaloy-2 co-extruded cladding.

Primary flux calculations, based on the described capsule design, were made using the P-3 Flux Distribution Program on the 650 digital computer. From this information approximate power generations in the test fuel rod were calculated for natural and 1.6 percent enriched uranium. The values thus determined were, respectively, 20 and 36 kw/ft for the natural and enriched uranium. The P-3 program calculations assume an infinite length of uranium, whereas in these tests the uranium rods will be separated axially by almost an equal length of low neutron absorbing material. Also, because of this extensive "window" of low absorption material, the relative flux values between the end and center of the uranium may vary considerably. Therefore, three 305 test pile experiments have been designed to measure: (1) the relative flux values axially along the test fuel rod, (2) the relative flux values axially along the test fuel rod with a high neutron absorber at each end of the uranium, and (3) the effect on the flux if equal lengths of alternating uranium and low neutron absorbing material are substituted for a long rod of uranium. With this information, more accurate flux and power generation calculations can be made.

Theoretical Study of Swelling. In addition to the prototype experiment designs, the following theoretical investigations have been made: (1) the time dependent diffusion in a sphere, (2) rate of volume increase in a thick walled spherical shell under internal and external pressure, and (3) the deformation of a cylinder due to a temperature, burnup, and pressure dependent swelling rate. These investigations were unified into a theory for swelling which can be used to calculate the deformations in cylindrical fuel elements. A rough draft of this work has been prepared and circulated for comments. Before numerical calculations can be made using the above theory, a secondary creep law will have to be evaluated for uranium in the high temperature regions, and the theory will have to be programmed for the digital computer. Also, additional theoretical work should be done to study the effects of surface tension on the swelling rate.

Electron Beam Vacuum Welding. An adequate weld closure is essential prior to testing of co-extruded U-Zr elements. During the month seventeen co-extruded Zr-U elements were closed with plug type end caps on both ends. Tests currently under way include weld penetration, tensile weld strength, and rupture characteristics. Results to date indicate that electron beam vacuum welding is a thoroughly satisfactory method of closing co-extruded Zr-U elements.

Because of the higher melting point of aluminum oxide, the layer of oxide on two mating unbonded surfaces has a tendency to remain as a fissure in the root of the weld. Various methods have been tried in an attempt to eliminate this root fissure. The most successful to date has been an air powered vibrator operating approximately at 400 cps. The vibration of the molten weld seems to physically break down the oxide barrier and eliminates the fissure. Further work remains to be done to determine amplitude which can be tolerated, optimum frequency, etc.

There has been some difficulty in attaining good closures utilizing conventional weld techniques on hot press type elements due to the nickel barrier layer. Three Sylvania hot press elements were closed by electron beam vacuum welding. One was given a vibrated weld and the other two were given smooth welds of different penetrations. The welds were sectioned and microstructures were studied. All three appeared satisfactory; however, three is too limited a number from which to draw definite conclusions.

Outgassing of the air absorbed on the surface of the uranium oxide powder caused difficulty when attempting to close elements containing uranium oxide powder by conventional welding methods. This problem is minimized by electron beam vacuum welding because the vacuum tends to cause outgassing before the welding. Five elements of this type were welded by the electron beam vacuum process. Results indicate that it is possible to obtain good closures by this method, but a number of factors remain to be evaluated.

Vectorscope Instrument. Measurement of aluminum wall thickness and nickel sweater-coat distribution has been greatly facilitated by the development of a new "Vectorscope" instrument for use by the Testing Methods Laboratory. Patterned after the earlier model, but embracing improved features, the new instrument gives simultaneous non-destructive thickness measurements of the aluminum and nickel layers, thus saving much time and extra handling of the test specimens.

Vacuum Melting Furnace. Centrifugal casting equipment has been installed in the NRC vacuum melting and casting furnace. This completes the installation, and upon satisfactory performance the unit will be formally accepted. A helium leak detector was used to locate all obvious leaks, and necessary repairs were made to eliminate them. Molds and crucibles are now being constructed for several alloying and casting programs.

2. REACTOR PROGRAM

Coolant Systems Development

Ex-Reactor High Temperature Studies. The 180 C, pH 4.0, w/H_3PO_4 test in ELMO-2 was terminated during the month after five months operation. Examination of the sensitized and non-sensitized 304 stainless steel coupons after this exposure revealed no intergranular corrosion. In addition, no serious general corrosion was observed. Complete data for the aluminum alloys are not as yet available; however, the corrosion rates of M-388, M-400, and M-457 were 0.09 mil/year after 12 weeks. The loop is being

revised to permit operation at 180 C, pH 6-7, 150 ppm 1,5-dihydroxyanthraquinone. Alloys of aluminum and selected carbon steels will be tested. The selection of 1,5-dihydroxyanthraquinone as a corrosion inhibitor was made on the basis of experiments performed at ALCOA in static autoclaves.

Isothermal rupture simulation tests were performed on two hot-pressed, uranium-wafer, bulkhead-free, internally-externally cooled, M-388 clad, KER-sized fuel elements (Elephant slugs) to determine whether rupture characteristics were more severe than for similar slugs prepared by dip canning. Extrapolation of the behavior of dip canned slug performance to the hot press case was deemed questionable since dip canning appeared to lead to AlSi bonding on the flats of the wafers, which is tantamount to supplying at least partial bulkheads. After defecting the cladding, process conditions were applied briefly until flow was significantly reduced owing to uranium oxide formation. At 240 C, 100 minutes of exposure were applied, and at 280 C, only 20 minutes were needed to give the same flow reduction. In spite of severe oxide formation and the expected preferred longitudinal swelling, both fuel elements were easily removed from the undamaged process tube. In general, these tests indicate that hot press wafered elements behave much the same as dip-canned wafer elements. One aspect of uncertainty was noted, however. In several locations on each of the elements tested it appeared as though the aluminum jackets had contacted the entire tube periphery, leading to suspicion of significant blockage of the annular flow passage. Further tests were therefore scheduled to verify the magnitude of this effect. It should be noted that due to equipment difficulties the isothermal rupture simulation tests now in process are restricted to less than typical flow velocities.

Fabrication of ELMO-4-R, a replacement for ELMO-4, was started. After completion of the fabrication and in conjunction with the urgency of the present ELMO-4 loop rupture tests, the loop will be installed and the ELMO-4 loop removed. A Chempump, 50 gpm at 50 psi, will be installed in the loop instead of the planned Byron Jackson pump, which is now being used in the ELMO-7 loop.

The 290 C, pH 10 w/LiOH test has been in operation six weeks in ELMO-5. The carbon steels (SA 212, 1032, and 1051) have excellent surface appearances and show a corrosion rate of 0.1 mil/year. The stainless steels (304 sensitized and non-sensitized) had negligible corrosion rates. The conditions for the operation of the loop appear quite good from both a corrosion and crud consideration. An oxygen scavenger study using hydrazine was started on January 20. During the first twenty-four hours of this test, dissolved oxygen was kept below 0.005 parts per million.

ELMO-6 operation continued at 300 C, pH 4.5 w/H_3PO_4, and 450 cm^2 Al/gal H_2O. After 12 weeks of operation corrosion penetrations were still in the range of error of the weighings. Coupons of alloys A-1, A-2, C-1, and C-2 were examined at weekly intervals. Alloy A-1 blistered after the first week, and the A-2 and C-1 alloys developed pitting. After three weeks, all alloys had started blistering. The failure of these alloys is attributed to the non-homogeneity of the coupon stock. Consequently, the test is being rerun using coupons made from I & E can stock.

ELMO-7 is operating at low flow velocities using a 15-hp Byron Jackson pump until the regular 45-hp pump can be sent to Los Angeles and repaired. One hot-press canned Cow fuel element clad in each of the new A-1, A-2, C-1 and C-2 aluminum alloys and a lead-dip canned X-8001 (M-388) clad Elephant have run 215 hours at 316 C, 1850 psi with a 4.5 pH adjusted by phosphoric acid addition. This test also serves to evaluate methods of support of the fuel elements. All element supports except those on the M-388 clad element were 3/4 inch long. The M-388 clad element supports were one inch long, and thus appreciably weaker. All supports were affixed to the jacketing by inert gas welding and were of the same alloy as the can stock. After 215 hours of operation, visual examination revealed no obvious corrosion attack on the fuel element surfaces. The 3/4 inch rails appeared to be in excellent condition except for some damage obviously incurred during charging. The one inch rails were found to be in varying stages of collapse, deduced to arise from the long span and the effect of temperature on the strength of aluminum. Blistering was noticed on areas of the supports in close proximity to the welds, universally in the case of M-388 cladding, partially on alloys A-1 and A-2, and not at all on alloys C-1 and C-2. The blistering is deduced to result from gas entrapment during welding causing expansion of the softened aluminum at operating temperature. The blistering appears to reach equilibrium within two to three weeks after the elements are subjected to test conditions and seems not to progress thereafter. Tests indicate that blistering does not weaken the strength of the bond between cladding and support. Thus, from these tests it appears that by the use of short spans to compensate for the reduced strength of aluminum at operating temperature, and perhaps with the development of improved gas-free welding techniques, satisfactory supports for aluminum fuel elements can be achieved. Further tests along these lines are now in progress.

No depression caused by operation was noted on the internal or external surfaces of the new alloy clad elements; however, several depressions ranging up to about 3/8 inch diameter were found in the internal cooling annulus of the Elephant element. These depressions were found in inspection after only 48 hours operation. The Elephant element was removed from the loop after 215 hours because of the possibility of its rupturing. The following elements were charged into a special corrosion test section of ELMO-7 for testing at coolant velocities of 20 fps to determine if the corrosion rate of any of the alloys is velocity sensitive: One Cow element clad in A-2 alloy, one Cow element in C-1 alloy, one Cow element clad in C-2 alloy, and one Elephant element clad in X-8001 alloy.

The crack observed in the main loop piping of ELMO-9 was found to be transgranular and was assumed to be caused by stress corrosion cracking. The cooling water jacket used oxygen and chloride containing water at about 100 C; these conditions coupled with the unrelieved stress developed in the expansion of the pipe (due to heat) could cause stress corrosion cracking. The current test of 250 C and pH 4.0/H_3PO_4 continued in an effort to determine if any intergranular corrosion develops on sensitized 304 stainless steel. Only one coupon has been found to have any such attack; this coupon was 304L stainless steel. The attack occurred after two months exposure. The test will continue for approximately two more months.

High Temperature In-Reactor Loop Tests. The Zircaloy-2 process tube was installed in KER-1 on January 7. Operating water temperatures in the range of 265 to 275 C were approved for this tube. Parts for the No. 1 primary pump were received and are being installed in the pump. Both pumps in the loop now have balanced impellers. The loop will be able to operate continuously in-reactor after February 3.

KER-2 was on process water twice during the month for a total of 50 hours for (1) repair of a heat exchanger leak, and (2) because the low flow trip was not reset after pump tests and the safety circuit caused the loop to dump. The loop has operated with Elephant slugs for 27 days at an average outlet of 225 C, pH 4.5/H_3PO_4. The tube will be discharged at the next outage if suitable hot-pressed Elephants are available. Examination of the Cow slugs discharged from the loop revealed only minor corrosion. Exact rates are unknown as the slugs gained weight and could not be cleaned of corrosion product.

Starting on January 6, KER-3 was on process water for 66 hours for replacement of the carbon steel pigtails with stainless steel pigtails. On January 14, outlet temperature of the loop was lowered to 100 C to prevent excessive cutting of the leaking dump valve seat and plug. On January 17, during a reactor outage, several attempts to reseat the dump valve were unsuccessful. At that time the loop was put on single pass process water operation. This single pass operation will continue until the end of February when the spare parts for the valve are due for delivery. The loop instrumentation was responsible for a reactor shutdown on December 27. This shutdown was due to malfunctioning of the high heat exchanger exit temperature reset switch. The loop has operated 84 days at an average outlet temperature of 225 C with stainless clad clusters. Exposure to date is 720 MWD/T.

Primary pump No. 2 of KER-4 was reassembled with a balanced impeller. On January 8, the loop was charged with 10 lead dip Elephant slugs. On January 14, the outlet temperature of the loop was lowered to 100 C to prevent excessive cutting of the leaking dump valve seat and plug. On January 17, the loop was placed on single-pass process water cooling. It will remain on single pass operation until approximately the end of February, at which time spare parts for the dump valve will be available. KER-4 operated for four days at an average outlet of 228 C prior to one pass operation. It will be charged with hot pressed Elephants when the dump valve is fixed and operated at 230 C, pH 4.5, and an extended aluminum surface area to water ratio.

Organic Coolant Studies. The slugs in ORA-1 were inspected after four weeks of operation at 700 F in MIPB. They were all in excellent condition and showed no visible change from the two weeks inspection. The seal in the Dean Brothers pump failed again. The possibility of replacing this pump with an available Chempump is being considered.

A series of cadmium ratio measurements were completed in the ORA-2 test hole assembly. The results confirm those obtained earlier in the 305 pile. These numbers are used in calculating the epithermal neutron exposures in the loop.

Operation of ORA-3 was continuous with no severe leakage nor heater fouling occurring. Temperature was approximately 575 F.

Scoping of ORA-4 was completed for an in-reactor organic loop using a front-to-rear tube; the cost estimate is under way. Since the side-test-hole scope was completed, there were a few major changes relative to design criteria. From operating experience in the KER loops, it was learned that a majority of reactor scrams was caused by malfunctioning of scram instruments. To avoid these costly outages of a reactor, it was decided to duplicate all scram circuits on ORA-4; both must fail before a scram is effected. An auxiliary blower to contain any organic vapor in the event of a major leak was also added as a safety precaution against possible reactor building contamination. Other major changes included an automatic de-pressurization system, elimination of sight glasses, and duplication of annunciators in KER and 105 control rooms. These additions will add substantially to the cost estimate on the front-to-rear scope and would likewise increase the estimate of the side test hole scope.

A study of the infrared absorption spectra of irradiated MIPB was made. Definite differences in the structure of tars produced in various manners; e.g., by reactor radiation, gamma radiation, or pyrolytic action, were found. These results confirm conclusions that were previously drawn from observations of physical property changes.

A study of the problem of removing two "trouble-makers"; i.e., water and hydrogen, from an organic system was started. Clean-up in addition to the use of the present degasifier may be desirable. Certain metals which may serve to scavenge hydrogen at operating temperatures are barium, nickel, and calcium. Many adsorbents are satisfactory for water removal at low temperatures but will not work at temperatures of 600 F. Barium oxide and magnesium may prove to be satisfactory at these temperatures.

The use of "Goetze" soft iron gaskets is being investigated. Results to date appear to be excellent. Iron gaskets may have an advantage over soft aluminum gaskets in that there is less possibility of creep.

Low Temperature Corrosion Studies. Production Test 105-550-E, to determine the effect of pH on corrosion of fuel elements and components in present reactors, continued during the month. Two tubes were discharged on January 7. One tube was supplied pH 6.0 process water, and one was supplied pH 7.0 process water. These tubes were recharged with weighed metal. The determination of operating limits at increased outlet temperature in the range of 130-150 C is essentially complete, and a new production test will be written.

Tube 2943-KE, charged with dummy slugs containing flux monitoring gold foils, has operated 65 days at 110 C outlet temperature. The test is scheduled for 90 days exposure.

The test to evaluate the localized corrosion characteristics of M-388 aluminum under H Reactor operating conditions has operated for 60 days at 120 C and 45 gpm. The test is scheduled for 150 days exposure. A test

was started to compare M-388 and 1245 aluminum in process water with 1 ppm dichromate and intermittent purging with 25 ppm of diatomaceous earth. These aggravated conditions may indicate the mechanism or causes of the localized corrosion attack at H Reactor. A test section is being fabricated to test M-388 and various other aluminum alloys in a venturi-type restriction where cavitation, erosion or local boiling may occur.

Corrosion rates for the steel samples exposed in the floating sample rack in a 107 KE basin averaged 0.88 mil per month for the nine month exposure period. A calculated "equilibrium" corrosion rate for the period between sample removals (after 6 months initial exposure) is 0.40 mil per month.

Service Work. Corroded sensing elements from the K water plant filter head loss instruments were sectioned and examined. Density measurements and spot tests indicate the elements were made of 2024 aluminum alloy. A high copper content results in reduced corrosion resistance for this aluminum alloy (as compared to 1100 alloy) in process water. Appropriate recommendations for control of this pitting attack will be made after a further study of the pitted pieces has been made and confirmation of metal content is received from spectrographic analysis.

Another nickel-plated slug was discharged from the mockup and although the exposure was about three times as long, no adverse corrosion effects were noted. However, the scale which formed on the surface of the slug could not be removed after several attempts at cleaning.

Examination of the raw-water cooled heat exchangers after five months operation continued to show a slight build-up in scale but with little change in heat transfer coefficient. There is now little difference in the amount of scale on the tubes of the exchanger operating at 175 F raw water outlet and the one operating at 200 F outlet. At the end of four months operation, the exchanger with the higher outlet temperature had the heavier scale. The scale on the tubes of either exchanger was easily removed by rubbing. Particle build-up on the baffles was greater on the cooler outlet exchanger. Microscopic examination of particles from the baffles indicated more organic material in particles from the cooler exchanger. Particles from the hotter exchanger appear more closely to resemble cinders. Contact with the reactor design group sponsoring the test established that no quantitative heat transfer coefficients are expected from these tests. The test is expected to give only a qualitative indication of the amount and type of scale build-up to be expected from heat exchangers operating at these conditions.

Decontamination Studies. The process tube used in the test evaluating the effects of a five-minute, 3 oz/gal Turco flush was removed, sectioned, and descaled. Visual observation showed no apparent corrosion anywhere on the tube which could be directly attributed to the presence of Turco.

Attempts were made at decontaminating a pump impeller removed from KER-4 to a radiation level where it could be balanced without causing excessive

dosage rates to the workers. This impeller was in service for over 1400 hours at 180-200 C at a pH of 4.5. Initial surface reading on the impeller was 1200 mr at 2". After treatment with the below listed chemicals (in order of use), the surface reading on the impeller was reduced to 500 mr at 2".

	Decontaminant	Temperature	Length
1.	$KMnO_4$-NaOH followed by HNO_3-$Fe(NH_4)_2(SO_4)_2$	Boiling	One hour for each
2.	5% HNO_3	"	Approx. one hour
3.	20% HNO_3 and 3% HF	Room temp.	2 hours
4.	30% HNO_3 and 10% Na_2Cr_2O	60C	30 minutes

Particulate Matter Studies. Samples of water from single pass in-reactor tubes 4456 and 5063, KER-2 and KER-3, and the KER Makeup System were examined under the electron microscope. Photographs were taken of particle types found in each system. An unsuccessful attempt was made to obtain particles from KER-4 under operating conditions. The Formvar films decomposed after a week's exposure in the high temperature water.

Thermal Hydraulics

Flow Hazard Studies. Experimental heat transfer studies of the response of reactor process tube assemblies to imposed hazardous operating conditions were continued. Previous experiments had indicated that with a test section simulating I & E fuel elements, pressure fluctuations occurred which were attributed to varying boiling conditions with recurring heat shifts between hole and annulus. To verify these pressure fluctuations with test sections which would simulate reactor conditions with more precision, experiments were performed with allowance for flow between the internal and external flow streams at the slug junctions. This interjunction flow was provided for by drilling two radial holes 1/16 inch in diameter every eight inches along the heater rod. The determination of steady state boiling curves for C I & E fuel elements in a C process tube at tube powers 500, 750, 1000, and 1250 KW revealed that allowance for interjunction flow almost completely eliminated the pressure fluctuations. The data conformed quite closely to that of C solid slugs, except that the boiling curves were not carried to as low flows. This indicates that film boiling probably starts at higher flows for these I & E heater rods as compared to solid rods due to the higher top of annulus temperatures. The temperature differential between the top and bottom surface of the I & E heater rod ranged up to 100 C.

A total of 26 experiments were performed which simulated the transient response of a C I & E fuel element in a C process tube to sudden step reduction in flow. In these experiments, which were performed at tube powers between 900 and 1250 KW and initial outlet water temperatures up to 125 C, allowance was made for the interjunction flow. In one test performed at 1150 KW, the flow of water was suddenly reduced from 42 to less than 3 gpm

while heat to the test section was maintained at full power for 3-1/2 seconds before being reduced according to a simulated reactor scram. The temperature of the heater rod as indicated by a thermocouple located near the top surface during this test did not exceed 312 C. The initial pressure reduction at the venturi throat was very large, but the pressure increase accompanying the steam formation after flow reduction was not sufficient to also cause a Panellit high trip.

Hydraulic Studies. Data were obtained of the pressure drop of special downstream dummy combinations for K process tubes. These types of dummy charges, which contain some solid aluminum slugs, are being studied by IPD as a means of process tube pressurization to prevent top-of-annulus boiling with I & E fuel elements in K Reactors. It was found that one solid slug increased the dummy pressure drop about 14 psi , and if the solid dummy was resting over the nozzle outlet, the pressure drop was increased about 40 psi at a flow of 50 gpm.

Exploratory work was done on studying the heat transfer characteristics from fuel elements through the analogy of mass exchange by diffusion to convective heat transfer. Standard sized solid slugs were casted of plaster of Paris and subjected to cold water flow in a BDF process tube in the 189-D Hydraulic Laboratory. The results were not entirely satisfactory in that while very little materials were removed from the slug adjacent to the ribs indicating poor mass and heat transfer as would be expected, removal of material from the rest of the slug was very spotty and non-uniform. It was also found that the dissolution rate was such a strong function of the length of time the plaster of Paris had cured that comparison between slugs of slightly different sizes would be difficult unless their curing conditions were identical.

Detail drawings were completed of a proposed small addition to the hydraulics equipment in 189-D. The addition would include a vertical facility to perform pressure drop studies on PRTR fuel elements at low pressures and a horizontal test section to facilitate critical flow experiments at low pressures. Construction time of this addition is expected to be three weeks.

Information which was gained during critical flow studies of "K" process tube outlet fittings has aided in correlation of the response limits of the "K" RTD (Resistance Type Temperature Detectors). Figures were prepared which allow interpretation of indicated RTD temperatures as a function of true temperature, rear header pressure, and flow rate except over a small range of true temperature near the initiation of critical flow.

Some early data, which showed severe temperature oscillations in the RTD location during high temperature - low rear header pressure runs, were rechecked in the laboratory using a thermocouple and then an Edison brand RTD (present reactor standard). There were three conclusions: (1) the absence of a dummy charge adds to the severity of the temperature oscillations, (2) an RTD sees only about 0.3 to 0.4 of the oscillation that the thermocouple indicates - presumably because of the heat capacity of the RTD well assembly, (3) for flow rates of 25 gpm or above and temperatures up

to 160 C, an RTD will not indicate any temperature oscillation when a dummy charge is used.

High Pressure Heat Transfer Apparatus. The Byron Jackson canned motor pump was returned to service after the leak between the process water and cooling water was stopped by installing a gasket between the warped heat stop and the pump sealing face. An additional 100 cycles were obtained on the thermal cycling test of the section of process tube proposed for an ETR installation. The test was halted when a fabrication weld opened up on one of the electrical preheaters. Cause of the trouble was thought to be overheating of the preheater shell when the section above the outlet pipe became air locked. Examination with the aid of radiographs indicated rather extensive damage to the upper portion of the preheater. Plans were made for temperature monitoring and continuous top bleed of the remaining preheater.

Studies were made of the FY-1959 budget items which call for the modification of the heat transfer apparatus. One item, which calls for additions to the high pressure apparatus to accommodate the additional heat generation rates under CG-661, will require additional bus bar systems, heat exchangers, preheaters, miscellaneous valves and piping, and flow meter instrumentation. The second item, which calls for additions to accommodate transient heat transfer experimentation simulating complete water loss to a fuel element, will require a water storage tank, quick acting valves, and extra instrumentation.

Project CG-661. This project will provide additional heat generation capacity for heat transfer studies in the 189-D Laboratory. Bids on the rectifiers are expected to be opened during the first part of February. An order was placed with the Whitlock Manufacturing Company for a shell and tube heat exchanger to use as an intermediate heat remover in the low pressure apparatus. Delivery of the item is expected in May or June of 1958

Heat Transfer Coefficient Studies. Work was continued on test section designs for studying flow and heat transfer using seven-rod fuel elements. Construction was completed on one design which consists of seven 0.625 inch rods spaced 0.05 inch apart. This design is being installed in the 42-inch test section of the low pressure apparatus for initial experimentation. Five other designs were completed and include such things as adjustable rod spacing and experimentation on the high pressure apparatus.

Organic Heat Transfer Studies. A recorder was installed on the apparatus to monitor the surface temperature at the downstream end of the test section on a continuous basis. The recorder is equipped with a microswitch connected in the control circuit which cuts the power to the test section and preheaters in the event of excessive surface temperatures.

A thirteen-hour surface fouling run was made with MIPB under the following conditions:

Velocity	- 5 ft/sec
Bulk temperature	- 380 F
Surface temperature	- 900 F
Heat flux	- 135,000 B/hr-ft^2
Static pressure	- 300 psig.

During the run no appreciable change was observed in the heat transfer coefficient. However, the experimental heat transfer coefficient was only 58 percent of that predicted by the Dittus-Boelter correlation. Inspection of the test section revealed a black deposit on the heated portion. The deposit was soft, easily scraped from the surface and looked like carbon black. A sample was taken for analysis.

Additional determinations of heat transfer coefficients were made at lower surface temperatures to recheck the calibration of the apparatus. At velocities of 10, 15, and 20 ft/sec, bulk temperatures of 500 F, and static pressure of 140 psig, the experimental heat transfer coefficients were within one percent of the Dittus-Boelter equation. However, at 5 ft/sec, the experimental value of heat transfer was 82 percent greater than that predicted by the equation. By increasing the static pressure to 250 psig, the experimental value of heat transfer coefficient became within 20 percent of the Dittus-Boelter value. The MIPB was then sampled and found to contain 95 gpm of water. It is not certain why this amount of water should have such a marked effect at a velocity of 5 ft/sec and apparently have no effect at higher velocities.

Mechanical Equipment Development

Organic Cooling System Components. The 15 KW preheater for the organic facility (MOTS-1) was installed. This unit consisted of six calrod heater units wired in three separate heating circuits. A total of 19.5 KW is now available and is more than sufficient to raise the system temperature to the desired value. During the month the facility was operated at 300 psi and 665 F. The flared fittings were cycled 13 times and showed no signs of leaking. Most of the screwed fittings required tightening after the first full temperature run. Items presently being tested include: two mechanical pump seals, two flanged jumpers, two iron gaskets, two aluminum gaskets, and a pipe dope.

The Duraseal mechanical seal was removed after 40 hours of operation. The seal showed no signs of damage other than the loss of gaskets in the flange joint and the stuffing box. The seal was repaired and is now ready for further testing. The John Crane mechanical seal was installed with a heat exchanger for cooling of the seal. The seal failed after 37 hours of testing. Examination of the seal revealed that a pin had sheared and ruined a teflon "O" ring and chipped the rotating face. This seal appears to be very alignment sensitive and is affected by vibrations from the seal motor. The seal was repaired and is ready for additional testing. Two aluminum and two iron gaskets were tested. The aluminum gaskets replaced the Garlock gaskets in the mechanical seals and the iron gaskets were tested between two ring joint flanges. After 37 hours of testing, the aluminum gaskets showed no signs of leaks. Although the iron gaskets have only been installed for a short period of time, these gaskets appear to be performing satisfactorily. A torque of 50 ft-lbs per bolt was required to seal the aluminum gaskets in eight-bolt flanges, while 100 ft-lbs of torque was required to seal the iron gaskets in the same type of flanges.

The organic fire tests were completed during the month. These tests were run at a temperature of 650 F and a pressure of 350 psi. The conclusions drawn from the tests were: (1) there is no danger of spontaneous ignition at the test temperature; (2) MIPB is fairly hard to ignite and does not burn too vigorously; (3) the flame is easy to extinguish with carbon dioxide; (4) a high percentage of vaporization will result when the organic is released to the atmosphere; masks would be required to fight any resultant fire; and (5) a cold water spray seems to be the best extinguishing agent for MIPB fires.

Irradiation Testing Engineering

Shielding Studies. Attenuation measurements of ordinary concrete in the as-cured condition were completed. Foils from the last measurement are currently being counted. The test slabs were removed from the test well and placed in the oven for baking at 100 C. The 27-day curing period of the ferrophosphorus concrete slabs was completed and attenuation measurements in the as-cured condition were started. The density of the ferrophosphorus slabs, calculated from weights taken at the end of the curing period, was 4.83 gm/cm^3.

The last aggregate tank for the experimental nose tank on the C Reactor facility was completed. Thermocouples and foil holders remain to be fabricated. Overall fabrication is estimated to be approximately 80 percent complete.

Work was started on a request from the Chemical Processing Department to calculate the shielding requirements for the isolation and packaging portion of the Cesium Recovery Plant. The major items being considered are the shielding requirements for the viewing window and the product shipping container. A check will be made of the adequacy of the existing cover blocks, shielding walls, crane cab and building roof at the isolation and packaging cell. Calculations on the thickness of the viewing window are critical in that remote manipulations will be performed at a console in front of the window.

At the request of the Reactor Modification Design Development Operation, measurements of neutron leakage associated with a VSR assembly of a new design installed at KE Reactor were made using the neutron dosimeter. Measurements obtained from two step-plugs of different design indicate that the proposed design will almost double the neutron background on top of the reactor.

Final assembly of the neutron spectrometer is awaiting delivery of the 100 channel analyzer. Delivery of the analyzer which was originally scheduled for September is now scheduled for February. A report, HW-54277, "Description of the Fast Neutron Spectrometer," D. E. Wood, January 6, 1958, describing the spectrometer and the program for its use was issued.

Conversion of the counters in the 1704 Counting Room from Geiger to proportional counters was 90 percent complete. Several units of equipment for gas flow counting were examined. The necessary components to operate three

lead pigs and the sample changer were obtained and are being assembled. These components will be evaluated for stability and reliability over the next few months.

Calculations are in progress, as requested by the Reactor Design Analysis Operation, IPD, to determine the optimum reflector thickness, the required enrichment, and the required shield thickness for the NPR. In addition, it will be determined if the use of two and three group diffusion theory offers a significant advantage over the one group theory in these calculations for the case of an undermoderated large reactor. Manual calculations will be made prior to using the IBM 650 for these determinations.

Nonmetallic Materials Development

Low Density Graphites. The irradiation effects on low density graphites being considered for use in future production reactors are being determined through irradiations in the hot and cold test hole facilities at Hanford and by controlled high temperature irradiations in the Materials Testing Reactor. An extruded, GBF processed, Texas coke graphite with a density of 1.23 g/cc made by the National Carbon Company was recently discharged from the hot test hole with an exposure of 905 MD/AT at 525 C. Expansion of 0.02 percent in samples cut transverse to the extrusion axis and contraction of 0.001 percent in the parallel samples were found. These are approximately the same rates found in TSGBF graphite with a density of 1.65 g/cc. As reported previously, irradiation of the low density material at 750 C in the Materials Testing Reactor resulted in a contraction rate slightly higher than that of the 1.6 g/cc density TSGBF material.

High Temperature Graphite Irradiations, GEH-9-6. The Materials Testing Reactor L-42 irradiation is continuing in its last scheduled cycle of a three-cycle irradiation with controlled temperatures of 1025, 975, 750, and 750 C for the four units. This irradiation will be terminated February 10, provided KAPL 37-2 is ready for charging. In the event that KAPL 37-2 is not charged, GEH-9-6 will remain for an additional cycle or longer if conditions permit.

PT-IP-21A (PT 403). The Hanford controlled temperature assembly for irradiation in the range 30-400 C is nearing completion, and the instruments for control are being tested under a variety of process control conditions. It was expected that control, particularly on semi-static processes would be better than has been found. It has been noted that the control amplifier linearity is not as good as it could be, and this may be a contributory cause of difficulty. The instruments do a good job in handling process disturbances of large magnitude, but lack the ability to recognize small deviations of the control point, implying a drop out of the reset mode in a narrow zone near the set point. An improvement in pulse linearity from the converter would help substantially, and the vendor has been contacted to obtain information leading to a method of improvement. The vendor is also furnishing two factory-tested units to determine whether there is something fundamentally defective in the units previously received.

Graphite Burnout Monitoring. Weight losses from graphite burnout samples discharged from channel 3461-B on 12/20/57 indicate a maximum oxidation rate in the center of the reactor of 1.44%/1000 operating days for the seven-month exposure period. This rate is slightly greater than the rate of 0.90%/1000 operating days observed for a previous sample series irradiated during the 13-month period ending May 10, 1957, but is still below the limit of 2%/1000 operating days. Channel 3461-B was recharged with weighed graphite samples.

Preliminary burnout data from the hot test hole at C Reactor indicate a

experimental in-reactor service and have been released to IPD. An additional 22 tubes have been shipped by Superior Tube Company. It is expected that these tubes will be thoroughly inspected by March 1, at which time those passing inspection will be released for installation in the reactors.

KER Tubing. The effort toward fabricating 16 short KER size process tubes called for under DDR-11 is nearing completion. Tube reducing will be completed when two final extrusions are cold reduced.

NPR Tubing. Work has proceeded in the HAPO laboratory to develop the proper techniques and fixtures to produce a sound, uncontaminated butt weld. Results of these tests will be used to provide process assistance to vendors where needed. Tests thus far have shown the need for cooling of the weld joint. A suitable water cooled fixture has been designed, and tests will be resumed early in February upon completion of this fixture.

A discussion was held with Allegheny Ludlum personnel to transmit HAPO welding experience to date. Agreement was reached in principle, although they differed somewhat in details of their approach. Allegheny Ludlum expects to be ready to make the first welds on this NPR tubing order about February 15.

Two of the machines at Tube Reducing Corporation are being modified to accept a blank long enough to produce a 57-ft tube. This work is progressing satisfactorily and will be completed by mid-February.

Zircaloy Design Data. The Zr creep testing program at Battelle Memorial Institute is being revised to extend the range of creep-rate and creep-rupture data required for NPR special studies. Also, an appropriation request and purchase requisition are being prepared for acquisition of five vacuum creep units to be installed at HAPO.

Some preliminary design work on an in-reactor creep testing capsule has been initiated. The primary aim is to design a test capsule which can be satisfactorily used in a horizontal test hole.

Advance Studies

H_2O Fluidized - UO_2 Pellet Bed Reactor. A feasibility study of the fluidized bed reactor concept has been in progress. This analysis has been directed toward the refinement of the reactor physics aspects, the fluidization characteristics, and the general economics of this type reactor. Two 70 MW reactors have been sized and associated flow rates and fuel ball sizes established. The design criteria for the 465 MW reactor as proposed by Astley are being reaffirmed.

Values of f and p from cell cases obtained from reactor design analysis were found to be unusable because of improper cross sections used in the input. Similar cell cases were rerun using consistent cross sections for ball radii ranging from 1.05 cm to 0.55 cm. Cases with solid

fractions ranging from 0.3 to 0.6 were run for each ball size. Photos of $\frac{k\ eff}{\eta} = f\ p\ \epsilon$ vs. solid fraction were made for each ball size at a given reactor size. Having established allowances of 30 mk for xenon saturation, 20 mk for reactivity loss due to temperature increase to 250 C in startup, and 10 mk for control, the η needed to yield k eff = 1 for startup was determined for especially attractive ball sizes. From these curves the enrichment and fluidization values for normal operation are found. Reactivity change due to exposure was found for a 1.1% enrichment and 0.65 cm radius ball using the program recently provided by R. L. Reynolds.

C. CUSTOMER WORK

Radiometallurgical Examinations

Enriched I & E Slug Failure (RM 218). The examination of an enriched I & E fuel element which failed during irradiation in the KE Reactor was started at the request of the IPD Process Analysis Operation. Details of the irradiation are tabulated below:

PT:	IP-109-AC
Tube No.:	3249-KE
Date Charged:	11/24/57
Date Failed:	12/25/57
Tube Exposure:	250 MWD/T
Slug Power:	111 kw/ft
Enrichment:	0.94% U-235
Cladding:	1245 alloy.

The slug emitted high activity fission product gases and was therefore canned shortly after discharge. No difficulties from this source were encountered after it was transferred to the Radiometallurgy Laboratory, six days following discharge. Visual examination revealed a large oval-shaped hot spot located directly opposite the tube rib marks and centered between the slug ends. The jacket material located in the center of the hot spot zone was nearly completely corroded away. This area was approximately 2-1/2 inches long by 3/4 inch wide. Although the uranium lying directly beneath the jacket hole was relatively unattacked, the entire jacket was uniformly swollen by approximately 45 mils as a result of undercutting attack by the coolant. The uniformity and extensiveness of this undercutting indicates that the coolant became distributed over the entire uranium surface in a very short time following initial penetration. There was no evidence of warp and the internal cooling channel appeared to be in good condition, although examination was

limited to sighting through the bore. Metallographic examination of a transverse wafer from the center of the slug revealed that a 1/4 inch wide band of metal located around the periphery had been heated above the alpha-beta transformation temperature (660 C). The band was quite uniform in width except in the vicinity of the hot spot where it became considerably more narrow. The macro-structure of this wafer indicates that the peripheral transformation occurred after the failure as a result of external heat transfer loss caused by the formation of an insulating blanket of uranium oxide between the uranium and jacket. The sharp reduction in volume of transformed metal in the vicinity of the hot spot indicates that appreciable cooling was maintained in this area. No microvoids were observed in any part of this section, indicating that temperatures did not exceed 900 C. This also suggests that the fission gases released following discharge escaped from the relatively large volume of finely divided uranium oxide formed at the surface of the uranium. Metallographic examination of a transverse jacket section is incomplete but has revealed severe intergranular attack at the edge of the hole, but relatively mild attack a short distance away from the edge.

Examination of Ruptured M-388 Clad Slug From IP-39-A (RM 219). A production test (PT IP 39-A) was irradiated to compare the behavior of Ni-Al alloy X-8001 with the standard 1245 aluminum alloy. A ruptured X-8001 jacketed slug from this test is being examined to determine the mechanism of failure and the extent of corrosion. Identification data on the slug are given below:

PT:	IP 39-A
Piece 4 Series 59J	
Discharge date:	12/3/57
Tube:	2569-H
Exposure:	486 MWD/T
Core:	Natural uranium
Cladding:	X-8001 aluminum alloy.

There was a circumferential crack in the can at the cap and uranium interface which extended for approximately 1/4 of the circumference. Extensive corrosion of the can had occurred. The corrosion near the point of the crack resembled the erosion corrosion attack which had been observed on the X-8001 jacketed slug from PT 105-622-A-60. The corrosion over other areas of the slug was of a rougher appearance.

A large "hot spot" was also observed extending almost the full length of the slug on the side opposite the rib marks. Although severe corrosion had occurred in this region, it did not appear to penetrate the can.

Examination of a Heavily Corroded 1245 Aluminum Fuel Jacket From IP-39-A (RM 207). Microscopic examination of a heavily corroded 1245 aluminum fuel jacket from IP-39-A showed the presence of foreign material in the aluminum. It was decided therefore that this slug was not typical of the production test, and another slug will be transmitted for examination.

Examination of a 5/8" Cored Slug From IP-30-A (RM 192). A one-inch long longitudinal section has been examined from the cap end of an unruptured, 5/8" cored, enriched slug from IP-30-A. The uranium had not been centered

in the can. The AlSi bonding layer was almost non-existent on one side and was parted to approximately 1/4" from the cap end.

The aluminum end plug did not fill the provided recess in the uranium, leaving a circumferential void around the bottom of the end plug approximately 40 mils across and 77 mils high. Large macro cracks in the uranium originated at the notch in the recess and were seen on both sides of the plug.

C Split Failures (RM 185). Examination has been completed on the second split failure of nine ruptures which occurred in seven tubes of the 105 C Reactor after a hot startup in March 1957. The uranium had split in a 180° fracture the entire length of the slug dividing it into two nearly equal halves. The fracture surface exhibited a smooth cleavage plane on one side which extended from the core (approximately 3/8" from the slug axis) to the can over the entire length of the slug. Metallographic examination and hardness data indicated the uranium had not operated at recrystallization temperatures. The quality of the uranium was good. No microcracks or abnormal amounts of inclusions were observed.

Metallography Service

An evaluation of the quality of 15 Sylvania hot pressed, nickel plated I & E fuel elements is being conducted for the Fuels Preparation Department. The fifteen elements represent a statistical sampling from about 1500 elements which are to be used in a reactor production test. Initially sections were taken from both ends of each element and examined for thickness and integrity of nickel coating, evidence of aluminum-uranium diffusion and thickness of bases and end caps. Also, the quality of the weld closures and the uniformity of the can wall will be inspected. To date, five of the elements have shown evidence of aluminum-uranium diffusion at both the cap and base ends, while seven others have shown diffusion at one end only. The nickel thickness on the caps and bases has varied from a thin, porous condition (effectively no coating) to a uniform coating of 0.0017 inch. Measurements of cap and base thicknesses have revealed only minor variations.

Transverse sections from each end and the middle of all 15 elements were inspected for overall dimensional changes and can wall thickness. Two sets of measurements were taken on each wafer section in order to reveal any eccentricity of the components and all three sections were deemed necessary to reveal any upsetting of the elements which may have occurred during hot pressing. The measurements showed that the elements were eccentric by less than 0.003 inch and that upsetting had occurred in most of the elements. The upsetting had increased the overall diameter at the center of the elements by an average of 4 to 5 mils and at the same time had reduced the aluminum wall thickness by 3 to 4 mils. Effectively, the entire dimensional change at the center of the elements was produced by enlargement of the annulus.

Aluminum-uranium diffusion has been detected on at least one of the transverse wafer samples. Measurements of the nickel thickness on the transverse wafers are in progress.

Samples Processed During the Month

Total samples processed: 298

Photographs:

Micrographs	246
Macrographs	74
Total	320

The following Trips and Visits Reports apply to activities on 2000, 3000, and 4000 programs. Technical activities on the 4000 Program are reported separately in HW-54760 A2.

F. W. Albaugh

Manager, Reactor and Fuels Research
and Development Operation

FW Albaugh:kb

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
LH McEwen	1/6-7	ORNL, Oak Ridge School of Reactor Technology	Lecture on reactor technology	PG Lafyatis	Yes
	1/8	Naval Research Lab., Washington, DC	Technical discussions re organic coolants.	CW Ewing	No
JA Ayres RL Dillon	1/30-31	Aluminum Co. of America, Pittsburgh, Pa.	Confer on corrosion resistant alloys.	RH Brown	No
SH Bush	1/6-10	duPont Co., Aiken, S.C.	Attend meeting of Working Committee of the Fuel Element Dev. Comm.	TC Evans	Yes
DC Kaulitz	1/6-10	Phillips Pet. Co., & AEC-IOO, Idaho Falls, Ida.	Discuss ETR high pressure loops.	H Watanabe	Yes
LJ Chockie DR Stenquist	1/16-17	Sutton Engineering Co., Pittsburgh, Pa.	Demonstrate swaging of stainless steel & zirconium tubing with 4-die swage.	RA Bland	No
SH Bush	1/15	American Society for Metals, Seattle, Wn.	Exchange speaker	--	No
DC Kaulitz	1/28-31	Phillips Pet. Co., & AEC-IOO, Idaho Falls, Ida.	Discuss ETR facilities	H Watanabe	Yes
C Groot	1/30	Utah State University, Logan, Utah	Give talk on corrosion	MC Cannon	No
JW Riches	1/10	Hunter Douglas Corp., Riverside Calif.	Consultation on aluminum and zirconium	RA Quadt	No
JW Riches PJ Pankaskie	1/27	Battelle Memorial Institute, Columbus, Ohio	Consultation on zirconium fabrication	F Shober	Yes
PJ Pankaskie	1/20	Wilson & Sprow Spokane, Wn.	Inspect tube forming equipment	HE Wilson	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Date of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JW Riches	1/28 & 1/31	Mallory Sharon Metal Corp., Niles, O.	Consultation on zirconium fabrication	WG Fetter & WC Greenleaf	No
	1/29	Chase Brass & Copper Co., Waterbury, Conn.	" "	DA Crampton	No
	1/30	Allegheny-Ludlum Steel Corp., Watervliet, N.Y.	" "	RE Rohrabaugh	No
HP Oakes	1/23	Western Pneumatic Tube Co., Kirkland, Wn.	" "	C Eckman	No
RC Aungst	1/16	Allegheny Ludlum Steel Corp., Watervliet, N.Y.	" "	RE Rohrabugh	No
	1/17	Tube Reducing Corp., Wallington, N.J.	" "	S Randall	No
JF Fletcher	1/11-18	Borg-Warner Corp., Decatur, Ill.	Evaluate proposals for shim control assembly	F Heuchling	No
		Fairchild Camera & Instruments, Syosset, N.Y.	"	A Rochman	No
		Sundstrand-Denver, Denver, Colo.	"	RB Foster	No
		Food Machinery Corp., San Jose, Calif.	"	FE Vandersyde	No
		GE-APED, San Jose, Calif.	"	JI Sweeney	No
NG Wittenbrock	1/17	Aero-Jet Gen. Corp., Azusa, Calif.	Discuss experimental results of metal-water reactions.	HM Higgina	Yes
	1/22	KAPL, Schenectady, N.Y.	Discuss reactor safe-guards	HL Mars	Yes
JC Fox	1/15-18	Allied Eng. & Production Corp., Alameda, Calif.	Evaluate proposals for PRTR fueling equipment design	HE Miller	No
		GE-APED, San Jose, Calif.	"	JI Sweeney	No
		Food Machinery Corp., San Jose, Calif.	"	FE Vandersyde	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
TC Nelson	1/6-10	Union Carbide & Carbon Co., Oak Ridge, Tenn.	Fabrication of MTR fuel elements at HAPO	RL Beaver	Yes
		Phillips Petroleum Co., Idaho Falls, Ida.	"	MH Bartz	Yes
WB Weihermiller	1/6-10	Union Carbide & Carbon Co., Oak Ridge, Tenn.	"	RL Beaver	Yes
		Monarch Tool Co., Sidney, O.	Design problems on proposed lathe.	CA Bickel	No
OJ Wick	1/7-9	AEC, Washington, DC	AEC Conf. on U-233 fuel	WN Munster	Yes
		BNL, Upton, L.I., N.Y.	Attend thorium-U-233 symposium	B Manowitz	Yes
TC Nelson	1/16-17	AEC, Washington, DC	Discuss Trans-U elements	I Zartman	Yes
CS Powers	1/19-20	Puget Sound Naval Shipyard, Bremerton, Wn.	Special disc procurement	F Muth	No

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
JS Burns D Verhagan	1/13	Van Waters-Rogers, Seattle, Wn.	Discuss potential shielding materials their company could supply	LH McEwen S Goldsmith DE Wood	Access Permittees	328, 300
WJ Vasil	1/7-8	Clearing Mach. Co., Seattle, Wn.	Discuss press equipment for cold closure	HJ Pessl	No	326, 300
GR Cole AS Ferrara	1/14-15	duPont, Aiken, S.C.	Information on swaging	EA Evans WE Roake RJ Anicetti DR Stenquist	Yes	325, 314, 306, 300

VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
WF Libby et al	1/14	US-AEC, Washington, DC	Visit ceramic labs.	EA Evans	Yes	325, 300
JD Rogers	1/27-28	Philips Electronics, San Francisco, Calif.	Service electron microscope	B Mastel	No	326, 300
MJ Sinnott	1/27-31	U. of Michigan, Ann Arbor, Mich.	Consultant services	FW Albaugh JJ Cadwell SH Bush OJ Wick	Yes	325, 306, 326, 328, 300; 231, 234-5, 200-W
CD Vail	1/7-10 1/14-17	Minneapolis-Honeywell, Richland, Wn.	Inspect & adjust Honeywell equipment	JM Davidson	No	326, 300
CS Slenning	1/8-9	Minneapolis-Honeywell, Spokane, Wn.	"	JM Davidson	No	326, 300
G McFarland	1/30	Dow-Corning Corp., Seattle, Wn.	Discuss nonmetallic materials	R Harrington	No	326, 300
HW Cooper	1/21-23	Superior Tube Co., Norristown, Pa.	Discuss Contract DDR-5 re zirconium fabrication	JW Riches	No	303, 326, 300; 700; 200-E
B Bailey	1/30	Great Lakes Carbon, Niagara Falls, N.Y.	Discuss nuclear graphite & capabilities of their plant	EM Woodruff RE Nightingale	No	700
WW Lowe	1/31	Pickhard-Warren-Lowe, Washington, D.C.	Consult on fuel costs	RM Fryar M Lewis	Yes	700

PLUTONIUM RECYCLE PROGRAM

MONTHLY REPORT - JANUARY 1958

REACTOR & FUELS RESEARCH & DEVELOPMENT OPERATION

Plutonium Fuels Development

MTR Irradiation of Al-Pu Alloy Capsules. Irradiation of four Zircaloy-clad capsules in the MTR with Al - 1.65 w/o Pu and Al - 12 w/o silicon - 1.65 w/o Pu alloy cores has been completed. The last two capsules were exposed to a flux greater than the requested value of 2.9×10^{14} nv; however, the actual measurement on the flux monitoring wires has not been obtained yet. It is estimated that the fractional burnout of the plutonium atoms on these last two samples may be on the order of 60 percent.

Pre-Irradiation Testing of Al-Pu Alloy Cluster Prototypes. A four-rod cluster with swaged Al cores, Zircaloy-3 jackets, Zircaloy-2 end caps and stainless steel spiders was examined after use in an ex-reactor loop for 565 hours in 240 C water followed by 215 hours at 316 C. As reported earlier, after 443 hours of service, buff-colored corrosion bands were noted on the welded ends of all tubes. It was found that the buff-colored product rubbed off easily and revealed a more tenacious whitish film. Also, a distinct, full length, fairly uniform longitudinal strip of buff-color corrosion product about 1/4 to 3/4 inch wide was observed on all the tubes. Similar observations have been reported at other sites, and they are believed to be caused by slow cooling of the material during the final annealing. The cluster was recharged into the ELMO-7 loop to continue pre-irradiation testing.

A set of four Zircaloy-clad capsules was fabricated and assembled into a cluster for dynamic elevated temperature corrosion tests in the ELMO-7 loop facility to evaluate welding methods employed. Two of the capsules were welded by electron beam welding and two by use of the evacuable welding chamber. One capsule of each weld type was pickled in a HNO_3-HF solution after cap welding. The cluster was inserted in the ELMO-7 loop and the test is proceeding.

All cluster jacketing components are prepared for the KER irradiation and 305 Pile tests which will follow the above preliminary work. The Al - 8 w/o Pu and Al - 12 w/o Si - 8 w/o Pu alloy cores are ready for assembly. The heat transfer calculations for the KER test are ready for issuance in document form. The thermal conductivity values assumed for the Pu alloy core materials are being verified experimentally.

Casting of Al-Pu Alloys

Al-Pu alloys of Al - 0, 2, 4, 6, 8, 10 and 13 w/o Pu were cast into 1/2 inch diameter rods from which tensile specimens will be prepared for mechanical property and microstructure determinations. The radiographs were satisfactory and tensile specimens are being machined.

Air Pressure Injection Casting. The prototype injection casting equipment was modified to increase the metal injection rate. An air receiver, larger piping, and rapid acting air operated vacuum valve were installed which decreased the fill time from 12 to 4 seconds. The air cylinder for raising the melt crucible

did not hold in the raised position, and because of this, the dip tube did not stay immersed in the melt during casting. With the melt crucible locked in the up position, it was determined that the fuel tube could be evacuated to about 29 inches of Hg while it was immersed below the surface of the liquid. Two injection castings have been made with submerged evacuation and with the fuel tube vertical rather than inclined. The first such casting was not completely successful because of insufficient metal in the crucible. In the second casting, aluminum reached the closed end, but there was a 9-inch long irregular void in this upper end. The dip tube design is being changed in an effort to remedy this situation. A tube which was only partially filled because of insufficient melt was sectioned lengthwise and examined. The molten aluminum apparently runs out of the sharp edged orifice at the bottom of the tube as a fine spray until it reaches a height of about nine inches. Above nine inches, the metal appeared to freeze first on the tube wall to form an inner tube of aluminum through which the remainder of the fuel element is fed. The exterior surfaces of this incompleted casting exhibited cold shuts for 36 inches of its 62-inch length. Microshrinkage was found in other castings made at higher temperatures. It is believed that these two types of defects can be minimized to an extent approaching commercial die casting quality by proper design and techniques.

Mechanical Pressure Injection Casting. The mechanical pressure injection casting equipment has undergone minor modifications and now appears to be operating satisfactorily. A major problem has been seizing between the piston and the cylinder walls resulting from the increased expansion of the piston when the superheated melt is poured in. A 1/4-inch thick insulator was placed on top of the piston which alleviated this situation. Injection castings have been made with Al and Al - 12 w/o Si at 800 C and pressures ranging from 140 to 1000 psi. Radiographs indicate that the castings are quite porous. The high injection velocity causes a turbulant condition resulting in air entrapment. In an effort to minimize turbulence, the orifice was increased in diameter from 1/4 to 3/8 inch and the piston velocity was reduced 50 percent. Two castings were made with these alterations and the number of voids decreased; however, the slow rate of rise caused the metal to solidify before the tube was filled. Experimental castings into an evacuated tube will begin shortly. It is felt that turbulence on high velocity injection will have no adverse effect when injecting into an evacuated tube.

Extrusion Program. Modifications were started to increase the capacity of the prototype extrusion press from 125 to 284 tons. Modified platen prints were sent out for bid, and off-site fabrication of a 12-inch bore, 5000 psi hydraulic cylinder was started. Detailed design for tooling, hydraulic system, and other component parts was initiated. Layouts of the press support, frame, and press hood were completed.

Powder Compact Extrusions. Blended mixtures of 1.87 w/o UO_2 (1.65 w/o U) and Al powder were cold compacted and hot extruded. The compacted billets were hot extruded through shear dies with an extrusion ratio of 9 to 1. The surface finish of the extrusions was for the most part good, but some poor areas were observed. Representative samples of extruded compacts were heated in air at 600 C for two hours. A volume increase of about 0.4 percent was observed for extrusions with about 95 percent at theoretical density. The extrudability of the cold compacted aluminum powder - UO_2 billets was equal to that of cast aluminum billets. A blended mixture of aluminum powder and 1.8 w/o UO_2 was cold swage compacted in a

stainless steel jacket by the Fuels Fabrication Development Operation as requested by Plutonium Fuels Development. A total reduction of 77-1/2 percent was taken which resulted in a core density of approximately 99 percent of theoretical. Failure of the jacket in the form of longitudinal cracks occurred at this point.

Tubing for PRTR Fuel Element Loading. Examination of the first six pieces of Zircaloy-3 tubing for use in fabricating the first 19-rod cluster loading for PRTR has been completed except for oxide hydrogen analyses and elevated temperature static and dynamic corrosion tests. Nineteen pieces of Zircaloy-3 tubing from the second order are currently undergoing radiographic examination and eddy current tests.

Fuel Element Cluster Design. An improved design for the 19-rod cluster fuel element has been made which incorporates several new features. While the rods are still attached individually to the top bracket by the retaining rings, the bottom bracket is now connected to only the center rod with a roll pin. This permits each rod to expand or contract independently. The cost of the bottom end caps has been cut in half, and the tolerances on the tubing length are not as critical. Two cluster assemblies using this new design are being fabricated for testing and evaluation.

Corrosion of Fuel Matrix Materials. The corrosion rate of Al-Pu alloys under PRTR operating conditions is an important consideration in respect to the time that a ruptured fuel element may be allowed to remain in the reactor without fission product contamination of the reactor system. Since facilities for the autoclave testing of plutonium fuel will not be available for some time, Al-U alloys are being used as stand-in materials in order to select the most promising aluminum alloy composition for use with plutonium. Corrosion specimens of the following five Al-U alloys were prepared: Al - 1.7 w/o U, Al - 4.5 w/o U, Al - 6 w/o U, Al - 12 w/o Si - 1.6 w/o U, Al - 12 w/o Si - 6 w/o U. These alloys were cast and jacketed in Zircaloy cans. The Corrosion and Coating Operation is currently testing the specimens.

U-Pu Test Pieces for PCTR. The core pieces for the two special 1000 MWD slugs have been machined, and the holes are being drilled. The Al-Pu pins, nickel tubes, and Al-Pu tab have been fabricated and meet all specifications. The electroless nickel plating technique for coating the Al-Pu foils with 0.003 + 0.0001 inch of nickel has been successfully developed, and the 10, 2S aluminum dummy foils are finished.

UO_2 Fuel Development

Irradiation of Enriched UO_2 Powder. The irradiation of U-235 enriched UO_2 powder is part of a program to determine the feasibility of using unsintered powder as a reactor fuel. Two Zircaloy enclosed, enriched UO_2 powder elements, 6" long and 1" OD were fabricated and are being irradiated as GEH-4-26 in the MTR during the period January 20 to February 10, 1958. The elements are centered in the B block basket or process tube by an internally ribbed, aluminun liner formed by swaging. Operation to date has been satisfactory.

Prototype PRTR Fuel Element Irradiation. An irradiation test of a prototype PRTR nested tubular fuel element would be desirable prior to the charging of the PRTR. Discussions have been carried on with representatives of AECL for some months

with the objective to obtain use of the new E-20 loop in the NRU reactor for such an irradiation test. A preliminary test proposal has now received approval of the AEC. The test would be conducted within the framework of the joint USAEC-AECL Cooperative Technical Program. A formal irradiation test proposal, HW-54614, has been written and will be submitted through USAEC channels during February 1958. If it is approved, two Mark IIa fuel elements will be delivered to Chalk River, tentatively in July 1958, for irradiation to 5000 MWD/T. A fortuitous set of circumstances will make operation of the test element in the E-20 loop nearly identical to that anticipated in the PRTR.

Wheel-Shaped UO_2 Fuel Element. Extruded, internally ribbed, I & E tubing of M-388 aluminum alloy was used to fabricate fuel elements by isostatic pressing. The assembly process consisted of welding in a bottom end cap, filling the tube with uranium dioxide powder, inserting aluminum wafers in the top, and welding in a top end cap by means of the electron beam welding process. To insure uniform distribution of the powder during the subsequent isostatic pressing, the fuel elements were vibrated while in a horizontal position and pressurized with 1200 psi helium. After this initial compaction, the fuel elements were pressed at 40,000 psi in the hydrostatic press. An element of this type will be fabricated for irradiation in the GEH-4 facility of the MTR. The irradiation test proposal has been approved.

Nested Tubular Fuel Element Mock-up. The nested tubular fuel element mock-up has been reassembled and returned on schedule to Coolant Systems Development for hydraulic testing. Excessive void sections in the fuel tubes, caused by an inadequate fuel loading method, had previously allowed distortion of the cladding by the coolant pressure. Damaged cladding tubes were replaced by new tubes and void spaces were filled with machined, steel rings. Ribs were removed from damaged tubes and attached to the new tubing by spot welding. End fittings were remachined to size and welded in place on the repaired fuel tubes. The assembly will now withstand pressures exceeding those anticipated in the PRTR.

Swaging of Uranium Dioxide. A number of variables involved in the swaging of ceramic powders are being studied to determine the feasibility of this process for fabricating high quality, low cost fuel elements. Stainless steel, Zircaloy, and aluminum have been employed as cladding materials. A 1.440" OD x 0.060" wall aluminum tube filled with sintered and ground UO_2 powder was swaged to form a UO_2 compact having 82 percent of the theoretical density. This is appreciably lower than densities previously obtained with Zircaloy-3 and stainless steel claddings. This relation between the type of cladding material and the oxide density obtainable by swaging is being studied further. Photomicrographs were used to investigate the condition of Zircaloy-3 cladding after swaging. Little or no diffusion of either oxygen or uranium into the Zircaloy-3 cladding was detected, either before or after annealing. Acicula in the Zircaloy-3 indicate that some of the alloying materials may be precipitating out, which could decrease the strength of the Zircaloy-3.

Al_2O_3 specimens clad in stainless steel and Zircaloy-3 were swaged with a Farmer-Norton Inverted Swage in a demonstration by the Sutton Engineering Company. This swage has four dies, instead of two, and is unique in that the dies fit into a stationary spindle which prevents twist or whip of the work piece during swaging. The twisting action normally encountered with rotary swages has frequently caused the rupture of thin cladding materials containing UO_2 powder.

Gamma Absorptometer. Determination of the density of uranium dioxide fuel element cores to within ± 0.15 percent was accomplished with a gamma absorptometer developed in cooperation with the Chemical Research Operation. Design of a compact unit for installation in the Ceramic Fuels Laboratory has been initiated as a result of these findings. Lower costs and improved quality control in fabricating PRTR fuel elements are expected when the instrument becomes available for routine use.

High Temperature Studies of Uranium Dioxide Using an Electron Beam. The high temperature characteristics of UO_2 are being investigated by means of an electron beam gun. This is part of a continuing study to compare the high temperature characteristics of UO_2 under in-reactor and ex-reactor conditions. The UO_2 sublimed rapidly at temperatures near its melting point. Samples of UN, UC, and US are being prepared for similar studies.

Deep Drawing of Zircaloy-2. Heating both the Zircaloy-2 stock and the dies to 400 F in oil has markedly improved the deep drawing characteristics of Zircaloy-2. Circular trough-like end closures proposed for the nested oxide fuel elements are being formed in this fashion. The pronounced change in ductility of zirconium resulting from the hot oil will be exploited on other tube drawing and expanding operations.

Facilities. Design of the 300-ton Kux automatic tableting press for cold pressing UO_2 compacts was completed in January. The press is scheduled for delivery in May 1958. Dimensions of the cold pressed UO_2 compacts were supplied to the press vendor to enable design and fabrication of the dies. These dimensions were determined from studies of shrinkage of UO_2 compacts during sintering and are expected to result in finished pieces having dimensions close to those specified for the PRTR.

Construction of the pusher-type hydrogen atmosphere sintering furnace for sintering UO_2 compacts is expected to be completed in January. Delay in construction was caused by the long term delivery of the special Al_2O_3 muffles.

A preliminary layout and flowsheet was prepared for PRTR uranium fuels. Design of jigs and fixtures for fuel element assembly was initiated.

Thermal Hydraulic Studies

Progress continued in installing the PRTR calandria and moderator mockup in 185-D. This piping work, which is being performed by Minor Construction, is 95 percent complete.

Equipment modification drawings of the high pressure apparatus were completed for two-phase pressure drop and critical flow studies. Detail designs were also completed for the test sections and the momentum chamber as well as designs of critical flow nozzles for use in the low pressure apparatus. Entrance and pipe diameter effects are to be studied in initial experiments.

Design Test Proposal PR-10. Initial design work was done on test sections to allow experiments on subcooled burnout at pressures between 500 and 2000 psia and at temperatures just slightly below the saturation temperature. Test sections contemplated include heat transfer from one surface to water in annular flow and from two heated surfaces separated by water flow.

Coolant Systems Development Studies

Testing was continued at 316 C, 4.5 pH, on the Zircaloy-3 clad four-rod cluster proposed for KER irradiation testing after 565 hours of testing at 240 C, 4.5 pH. Examination after 215 hours at 316 C indicated the corrosion to be accelerating at this temperature over 240 C operation.

A 3-1/2 inch long Zircaloy-3 clad four-rod cluster assembly was charged in ELMO-7 to test corrosion of the end cap welds. Two of the four rods were welded by the electron-beam method while two were welded by heliarc. The assembly has run 100 hours at 316 C, 4.5 pH, but no examination has yet been made.

Nozzle cap assembly "A" using a Flexitallic gasket on one end and a self-energizing "O" ring on the other has run 150 hours at 316 C following 280 hours at 240 C with no leakage.

Modification of the polariscope to take a PRTR fuel element mockup has been completed. Preliminary examinations are presently scheduled for January 27.

A literature review of crevice and galvanic corrosion of stainless and carbon steel systems in high temperature water was completed. A report reviewing stress cracking, crevice, galvanic and uniform corrosion information is being prepared. Available information indicated that crevice corrosion was not a problem with carbon or stainless steel heat exchangers in high temperature water with an oxygen content less than 0.1 cc/kg. Galvanic attack was not severe when the exposed anode (e.g., carbon steel) area is large in relation to the exposed cathode (stainless steel) area in contact.

Mechanical Equipment Development

Design Test PR-20 - Calandria Characteristics. The construction and installation of the calandria and moderator storage tank was 95 percent complete. All instrumentation for the moderator dump tests has been ordered. The dump tests will begin by the middle of March and will be completed in April 1958.

Design Test PR-24 - Calandria Shroud Tube Bellows. The live steam corrosion test using 3 psi steam was started during the month. On the second day of the test, the bellows elongated excessively, requiring the installation of tie-down straps to compress the bellows to its original length. After three days of testing, approximately 10 leaks developed in the convolutes. These leaks do not appear to have increased with further testing.

Design Test PR-25 - Shroud Tube Collapsing Pressures and Installation. The construction of the facility was approximately 40 percent complete. A survey of methods of attaching the thin-walled shroud tubes to the tube sheet was begun.

Design Test PR-50 - Reactor Piping Seal Testing. Seal No. 1 - Inlet jumper to inlet piping connection, Seal No. 2 - Inlet jumper to process tube connection, Seal No. 7 - Outlet jumper to outlet nozzle connection, and Seal No. 8 - Outlet jumper to outlet header connection - all four of these seals are 1-3/4 inch flared tubing fittings. These seals are being evaluated as a group using a 2-inch flared process tube inlet assembly. This fitting is now being tested on

a small static thermocycling facility which was constructed in the 314 Building. At present, 180 cycles have been completed. The temperature range during the cycling test was from 150 F to 540 F, and the pressure range from 90 psig to 1250 psig. Heat-up time per cycle was from 13 to 16 minutes, and cooldown time from 3 to 4 minutes. The thermal cycling tests will be completed by February 7.

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

Seal No. 4 - Process tube to outlet nozzle - this fitting assembly is awaiting thermocycling. These tests are expected to begin next month.

Seal No. 5 - Nozzle cap seal - cap assembly "A" is awaiting thermocycling. This assembly consists of two seals; one using a flexitallic gasket, the second a self-energized "O" ring. Cap assembly "B" passed the hydrostatic tests during the month. The revised dome seal was tested using several ring designs. Each ring produced a good seal; however, some collapsed due to the high loading forces. Sealing was effective with a torque of 150 ft-lbs. The Bridgman seal of this cap assembly is now being revised in the technical shops.

Seal No. 6 - Outlet gas seal - three types of packing were tested by baking the test assembly at 600 F. The John Crane Superseal No. 4 packing shrank until the cinch nut could be removed by hand. After eight hours of testing the John Crane No. 177 packing, a small original gas leak had not changed appreciably. The packing was stuck in the assembly and required a force of 50 pounds to remove the inner piece from the assembly.

When testing a combination of asbestos and grease impregnated packing, a very small leak was noted at the fitting both before and after baking. A force of 350 pounds could not break the bond between the assembly and this packing. Two other packings are ready for testing and one other type has not yet arrived on-site.

Design Test PR-51 - Reactor Piping Structural Integrity. The fabrication of the jumper flexure machine was started during the month. The estimated completion date is March 5. A one-quarter scale model of one-fourth the reactor face and the connecting piping was completed.

Design Test PR-63 - Process Channel Leak Detection Facility. The tests were scoped and the detailed design of the facility was started.

Other Activities. Single Tube Prototype Facility (Phase I) - Construction work on Phase I was resumed during the latter part of the month following the delivery of some of the valves and instruments. Construction of the pump for this phase has been delayed pending a final decision on the full size process pump. A revised shipping date will be available from the vendor within the next week.

Single Tube Prototype Facility (Phase II) - All drawings and specifications for this phase have been approved, thereby completing the design of the facility. Material procurement is proceeding through Construction Operation except for the components for testing and the instrument panel. A revised cost estimate for the complete facility will be requested from Estimating.

Full size PRTR Process Pump - A purchase order alteration was approved to enlarge the pump casing and to change the impeller design, thereby increasing the pump head to 260 feet at a flow of 4200 gpm. The pump drive unit was changed from a single speed 350 horsepower motor to a two-speed, two-winding motor rated at 350/38.9 horsepower and speeds of 1800/600 rpm. The smaller flow rate obtained from the lower pump speed will provide the required cooling water flow during reactor shutdowns.

PRTR Injection Pump - The 15 gpm Aldrich triplex injection pump was approved by Advance Engineering and Design Engineering. The purchase order for the pump is now being processed. Delivery of the pump is expected in May 1958.

Eight Inch Check Valve - The revised specifications have been approved and requests for bids issued.

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

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

PRTR Jacket Tubing

Nuclear Metals Inc., is continuing efforts to improve the rib-to-tube bond on extruded, externally ribbed tubes. In their latest effort, steel has been substituted for copper as a jacketing and spacing material. Extruded at a higher temperature, these tubes have shown an excellent bond.

The contract with New Rochelle Tool Company to design equipment to attach spacer ribs to PRTR jacket tubing has been signed and is now designated as Contract No. AT(45-1)1078.

Aluminum Oxide Solubility

Experimental determinations of the solubility of alumimum oxide corrosion products in deionized water at six temperatures in the range 200 to 350 C have been made in a stirred autoclave. The rate of weight loss of aluminum per unit volume of water passed through the system, from which the solubility is calculated, has been found independent of time of test and sample size. It is also tentatively indicated that the rate of metal removal is insensitive to moderate change in stirring speed and water flow rate. The concentration of aluminum oxide in the effluent water is therefore assumed to represent a close approach to its solubility.

The logarithm of the solubility appears to be a linear function of reciprocal temperature. An extrapolation of high temperature solubilities is in good agreement with estimates by ANL and Alcoa at 50 and 25 C. The actual temperature dependence of aluminum oxide solubility is not large. Values of the solubility read from a smoothed plot of the data are as follows:

Temperature °C	Solubility of Al_2O_3 Grams/Liter
100	0.9×10^{-4}
200	1.7×10^{-4}
300	2.4×10^{-4}
350	2.8×10^{-4}

The above data represent a correlation of 16 experimental runs at six different temperatures over the range from 100 C to 350 C and are recommended in place of the preliminary numbers reported in October and November. It is no longer believed that the solubility goes through a maximum at about 300 C, as reported tentatively in November.

Zircaloy-2 and -3 Corrosion Tests

Experiments are under way to evaluate two corrosion tests for Zircaloy-2 and -3; (1) 360 C water, (2) 400 C steam at 800 psig. A fourth group of samples has been removed from the 360 C water test after an accumulated exposure of 1194 hours (49.8 days). Three earlier groups were discharged after 54, 160, and 514 hours. No breakaway corrosion failures have occurred to date, with the exception of duplicate weldment specimens which showed local attack at the heat-affected zones along the weld bead. This same failure has been noted after all the shorter exposures as well -- and with little intensification with time. Cumulative weight gains now range between 25 and 39 mg/dm^2 (14 samples) representing an average penetration of 0.05 mil. Lustman and Kerze[1] report weight gains of 25 mg/dm^2 for Zircaloy-2 after the same exposure. Roughly 5 mg/dm^2 weight gains have been incurred since the last discharge at 514 hours.

Additional data have been obtained on the identity of the "poor" corrosion resistance coupons which exhibited breakaway corrosion after 24 hours in 400 C steam at 800 psig, excessive weight losses after 72 hours, and virtual destruction after 312 hours (13 days). Independent sources had identified the material as Zircaloy-2 and also as Zircaloy-3. In searching for an explanation for its relatively poor performance, spectrochemical analysis revealed that it was probably neither, but nominally pure zirconium instead. This conclusion conforms with the "poor" performance in superheated steam and "good" performance in 360 C water reported for unalloyed zirconium and also exemplified by these test coupons. Oxygen, hydrogen, or nitrogen concentrations at 800, 25 and 25 ppm, respectively, as measured by vacuum fusion analyses, were not considered detrimental.

It was reported in December that a mounted fragment of this material after 13 days in 400 C steam revealed a thin brittle core of totally penetrated zirconium which had been largely converted to the hydride. The hydrogen content of this "core" material has been found by vacuum extraction to be 1900 ppm.

Hydrogenation and Tensile Testing of Zircaloy-2.

A series of hydrogenated Zircaloy-2 tensile specimens containing 12 samples each at concentrations of 3, 50, 100, 200 and 500 ppm hydrogen have been prepared and submitted for tensile testing at room temperature, 100, 200, 300 and 400 C. Testing is in progress and all samples for the room temperature series have been pulled.

Corrosion of Canned Al-U Alloys

A test is being run to determine the effect of a pinhole rupture in a simulated Al-Pu fuel element (employing uranium as a stand-in for plutonium). A series of alloys containing 1.5 w/o, 4.5 w/o, and 6 w/o uranium in aluminum and AlSi in the wrought and cast condition have been canned unbonded in zirconium. A 1/16" diameter hole was drilled through the can wall into the Al alloy in the center of

(1) Lustman, B., and Kerze, F., Jr., "The Metallurgy of Zirconium," p. 633, McGraw-Hill Book Co., Inc., New York, 1955.

each piece. After exposure to 350 C water for 24 hours, none of the pieces showed any dimensional change.

Radiation Curing of Silicone Elastomers

Additional data have been obtained to indicate that the curing of silicone elastomers by gamma irradiation results in some increase in the materials resistance to immersion in high temperature water systems. Improved materials for O-rings and gaskets will be needed in future Hanford applications.

The following data on Silastic S 2071 show that hardness and tensile strength (the best indices of degradation) are changed less by the test conditions when the cure is accomplished by radiation.

Hot Water Resistance of Silastic C 2071

Test Conditions: 150 hours in water at 175 C

	Percent Property Change		
	Hardness	Elongation	Tensile
Heat Cured	-20.0	2.5	-67.8
Gamma Irradiation Cured (1.1×10^7 r)	-13.9	-18.6	-37.8

Tests now in progress on several silicones will determine whether a sufficient improvement in silicones for Hanford applications can be achieved by radiation curing to justify a continuation of this work.

Plutonium Fuel Cycle Analysis

Cycle Analysis. Encoding of the IBM-650 fuel economics program is essentially completed. A few test runs were made to locate errors. When completed, this program will be run in conjunction with the Generalized Plutonium Recycle Analysis (GPR) program. By putting appropriate physics constants for a particular reactor into the GPR, and by putting detailed fuel cost estimates and capitalization charges into the economics program, the economics of the reactor under study can be completely analyzed through the combined programs.

The recently completed IBM-650 computer program for calculating fuel effective neutron reproduction factors (η f p) was modified to calculate also ηf and η. This program is to be utilized for surveys of reactor characteristics and fuel performance. The input data required include the initial composition of the fuel, recycling requirements, and neutron temperature. The output includes fuel composition, various neutron production factors (such as η, ηf, ηf p, and $\bar{\eta}$) and initial conversion ratios as a function of flux time. For a particular reactor with its characteristic lattice parameters, maximum fuel exposure and throughput are determined from these data.

These quantities are currently being calculated in a study of the relative fuel values of Pu and U that was started last month. Twenty-four cases were run this month and a preliminary analysis made of the data. When this study is complete, the results will replace the approximations made in HW-49486-RD.

Two new fuel cost estimates were made: one for the Pu-Al spike element by injection casting, and one for the Pu-U alloy element. A preliminary analysis indicates that the injection casting method should be less expensive than extrusion methods and competitive with the cryolite method. Pu-U alloy, on the other hand, appears to be a more expensive method of making uniform cores than the sintering of PuO_2 and UO_2 mixtures.

Effective Pu-240 Cross Section. The Pu-240 cross section to be used in PRTR calculations has been determined. The self-shielding factor for 240 is strongly dependent on concentration; consequently, the results stated here hold only for PRTR cases. Conditions assumed were uniform recycle operation with natural uranium feed, a spectral index of 0.08, and a neutron temperature of 80 C. These conditions result in a steady state 240 concentration of 3.3×10^{19} nuclei/cc. The value obtained for the reactor effective cross section is 874 barns; this corresponds to a Westcott of 29. Approximate values for other temperatures are 20 C, $\int = 26$; 200 C, $\int = 32$; 400 C, $\int = 34$. It is important to note that these results hold only for r = 0.08.

PRTR Lattice Calculations. Thermal utilization calculations were completed on the Mk IIA fuel element to check those values obtained from PCTR experiments. Care was taken to duplicate the experimental geometry as nearly as possible. The values obtained compare as follows:

	P-3 Calc.	PCTR Meas.
D_2O Coolant	f = 0.926	f = 0.921
H_2O Coolant	f = 0.802	f = 0.794

Agreement between experiment and calculation is seen to be quite good, the calculation indicating a higher value with D_2O and H_2O by 5 and 8 mk, respectively. Some of this difference may be due to additional aluminum at the cell boundary in the PCTR measurement.

Calculations are now under way on the MkIIB thermal utilization, resonance escape probability and fast effect.

Reactor Theory. The double P_1 approximation, a spherical harmonious method, has been used to solve the neutron transport equation for several simple problems. The results are being evaluated numerically for comparison with the generalized diffusion theory results for the same cases. The results of the comparison will determine the method to be used in the reactor evaluation code now being developed.

Physics Assistance. The following assistance work has been completed at the request of other components of Reactor and Fuels Research and Development:

(1) A calculation of the flux depression in the "uranium swelling experiment capsule assembly" located in the MTR reflector.

(2) A dose rate calculation was reviewed on an aluminum-monel experimental assembly to be irradiated in ETR. An error in original calculations was uncovered, and the problem together with recommendations was returned to the originator.

(3) A flux distribution calculation on a UO_2 assembly to be irradiated in the KER loop.

(4) Flux distribution calculations on Pu-Al rods to be irradiated in MTR.

(5) Comparison of flux distribution in natural and enriched UO_2 rods in MTR and NRX, respectively.

Safeguards Analysis. A literature survey of metal-water reactions has been made. Several sites that have worked on the problem of metal-water reactions following a reactor incident were visited. It has been demonstrated experimentally that the molten metals, zirconium and aluminum, will react with water. The degree of completion of the reaction is somewhat dependent upon the size of the molten metal droplets; Higgins at Aerojet-General found that zirconium droplets of 2500 microns diameter gave 7 to 15 percent reaction while droplets of 100 microns diameter gave 40 to 80 percent reaction. Aluminum droplets at the melting point reacted only slightly with water, approximately 5 percent reaction, but at temperatures above 1300 C, the reaction was violent with up to 80 to 90 percent of the aluminum reacting. A general feeling exists that more complete knowledge of the basic mechanisms controlling metal water reactions is needed to make sound extrapolations from experimental data to reactor conditions. The AEC has issued invitations to bid on a study designed to enlarge our knowledge of the metal-water reaction rate controlling mechanisms.

Test Reactor Design

General. The residue of the $5 M congressional authorization for FY-1958 has been released by the Bureau of the Budget. Authority to proceed with construction and procurement is expected momentarily.

The bid package for temporary construction facilities is currently being compiled and should go out for bid very shortly. Bid opening for this package is scheduled for February 28 - the construction is to be completed within 75 to 90 days.

The bid package for Phase I of the reactor construction (the process structure and containment shell) will be let for bid as soon as it can be processed by the AEC subsequent to mailing of the TC bid package. The Phase I contract is scheduled to be let on March 28, with construction to take 14 months.

The design study requested by the AEC regarding removal of the turbine generator from the PRTR is nearing completion. The primary changes required will be (1) reduction of flow resistance in the primary loop to decrease shutdown power requirements and to increase the reliability of convective cooling, and (2) addition of a diesel generator of approximately 400 kw capacity. It is expected the

diesel will be kept hot but not operating and will be started upon reactor scram. The pump flywheels will be expected to carry the reactor load between the time of power loss and start-up of the diesel. It is expected that this basic scope change will be approved during the coming month.

Reactor Fueling Equipment. Discussions were held with representatives from the eight firms bidding on this design; three of these firms were visited and their plant facilities inspected. Supplementary proposals have been received from some of the firms. All proposals have been evaluated and the results of the evaluation are about to be transmitted to AEC-HOO.

Reactor Piping. Scope revision 110-1 was issued during the month. This lowers the inlet ring header to accommodate a jumper piping layout having lower thermal expansion stresses.

Shielding. The results of the study on pressure equalization in case of primary coolant line failure indicated that the space between the top biological shield might reasonably be briefly pressurized to 18 psi differential pressure through the shields. The secondary shield and top biological shield will be designed to withstand this differential.

Primary Coolant Loop Pressure Drop. Reinvestigation of pressure losses in the primary coolant piping system at design flow and temperature conditions indicated a possible header-to-header loss external to the calandria of 65 psi. This, together with a calculated pressure drop of 43 psi for the calandria section gives a total pressure loss for the coolant loop of approximately 108 psi. This exceeds by 25 percent the previous estimates based on preliminary piping and equipment design and arrangement.

Primary Coolant Circulation Pumps. Approval of design for fabrication of primary circulation pumps was given to the Byron Jackson Company upon receipt of a design proposal which will give an acceptable pump characteristic for parallel operation. The new design - slightly enlarged internal casing and impeller - shows a smoothly sloping head - capacity curve which is well below the pump shut-off head throughout the probable operating flow range of the coolant system.

The pumps will be designed for 4200 GPM at a total dynamic head of 260 feet (approximately 100 psi).

Heavy Water Injection Pumps. The low bid of the Aldrich Pump Company for positive displacement D_2O injection pumps was accepted during the month. These vertical triplex pumps will each operate at 350 RPM to deliver 15.9 GPM of D_2O at system design pressure. Fifteen horsepower drive motors will power each unit.

Primary Coolant Treatment and Activity Monitoring. The primary treatment system, as originally scoped, was deleted and combined in scope form with the D_2O activity monitoring system.

The new proposal requires a single high-pressure liquid-liquid heat exchanger having somewhat more heat transfer area than the original HX-2 in combination with a pressure reducing, degassing, flow regulating, and monitoring system.

A piping flow diagram, SK-1-6393, for the combination system was issued during the month.

D_2O Piping System. The D_2O piping system flow diagram, SK-1-6375, was revised and up-dated during the month to reflect changes brought about by removal of the turbine generator, recent revisions to scope, and the combination of primary treatment with process tube gamma monitoring.

Primary Heat Exchanger Fouling. The incorporation of a recommended fouling factor into the design of the primary heat exchanger could result in a considerable (40 to 50 percent) increase in tube area, heavy water holdup, and fabrication cost. In view of this, a brief investigation was undertaken to determine how far the controlled shellside pressure would have to be reduced over a period of time to compensate for reasonable fouling of the tubes.

This study showed that expected fouling could be accommodated at full heat duty by reducing drum pressure 100 psi over a period of time determined by fouling rate. Final drum pressure, before shutdown for tube cleaning, would be 325 psia.

Such an operating procedure and philosophy would appear quite reasonable in any case where there is no contemplated demand for steam at pressures above 325 psia.

Emergency Electrical Power. A survey of the emergency electrical power requirements of PRTR was completed during the month.

Maximum probable emergency power requirements will be about 262 KVA with a possible reduction to 195 KVA or less depending upon power factor improvement and the use of shutdown operating procedures which require intermittent operation of four auxiliary services - any two at one time. These services are: (1) helium compressor, (2) air conditioner, (3) instrument air compressor, (4) instrument alternator battery charger.

Analog Studies. The analog computer investigation of the gas balance and moderator system dynamics has resulted in the determination of control response time constants ranging from 200 to 1200 seconds. The time constant is defined as the time required for 63 percent of a total eventual level change to occur after a change in control valve setting. The time constant has been found to increase linearly as the level increases.

The machine has also been used to redetermine maximum rates of level change using various control valve combinations but not dump valves. The results indicate that the calandria could be taken from an empty to a full state in slightly more than twelve minutes. The vessel may be effectively emptied in fifteen minutes using the normal control valves or in five minutes if the quick-opening shutdown valve is used also.

The malfunctioning of several computer components has delayed completion of moderator dump calculations, but preliminary results indicate that the calandria can be emptied a little more quickly than previously predicted. It is now expected that the calandria can be emptied in less than five seconds. Work is proceeding on the eventual goal of a complete simulation of the reactor and its primary control system.

Instrumentation and Control. A total of seven firms indicated interest in performing the design of the PRTR shim control assemblies and in furnishing a prototype assembly. The proposals submitted by these firms were reviewed and evaluated during the month, and discussions were held with representatives of the firms involved. Recommendations are being prepared for transmittal to AEC-HOO.

A preliminary proposal for the reactor automatic controller was received from a vendor during the month. This proposal includes not only the controller but a considerable portion of the nuclear and thermal power instrumentation as well. The proposal as received contains several objectionable features which must be changed. Nevertheless, it is quite promising in its overall scope.

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

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FISSIONABLE MATERIALS - 2000 PROGRAM

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION PILES

K-Pile I and E Versus Solid Fuel Element

The results of these k_{oo} measurements made in the PCTR were reported last month and in HW-54516. The latter document mentions a systematic error which was suspected in the reported results. We are still considering some aspects of this question which relates to the variation in the adjoint flux distribution over an individual cell. Most perturbation calculations neglect this effect (c.f. Glasstone and Edlund, p. 397). The intracell, thermal adjoint flux distribution has been calculated with the IBM-702 P_3 code. This is the first time such a distribution has been calculated to our knowledge.

It has also been found that two systematic errors in the calculations were made which essentially cancel out. A detailed comparison of these results with K-pile startup data is being made and further work on the adjoints is being considered. A full report will be issued when the detailed work is considered complete.

The errors in these k_{oo} measurements are almost as small as those obtained in the K-pile startup measurements.

Dry 7-1/2-Inch Lattice Temperature Coefficient

As mentioned in the November 1957 monthly report the initial analysis of the PCTR data gave inconsistent results. The PCTR temperature coefficient of activity has since been remeasured and a new analysis of the temperature coefficient data yield a value of the total temperature coefficient having a precision of approximately 20 percent. This precision is disappointing and can be improved by approximately a factor of two by increasing the precision of the graphite temperature measurements. A reduction in the large background PCTR temperature coefficient would also improve this precision. Effort is being made to establish the source of this background temperature coefficient to see if it can be reduced by some simple modification of the experimental apparatus.

A study of the uncertainties in the determination of the total temperature coefficient of k_{oo} by the integral (PCTR) and differential (measurement of η, f, p, as a function of temperature) techniques has been completed. The analysis shows that about 80 percent of the uncertainty in the integral method arises in the determination of the mass of poison necessary to obtain

unit multiplication in the test cell at elevated temperatures. Unless this part of the error is reduced by a factor of ten, uncertainties in the cross sections and average fluxes are not significant. On the other hand the differential method includes uncertainties in η, due primarily to cross section data and errors in average flux values, which contribute an uncertainty in the temperature coefficient of k_{oo} of about 50 percent. Therefore, unless significant improvements are made in the cross section data, the integral technique yields a temperature coefficient which is more precise by at least a factor of two.

The problems involved in improving the oven cover plate have tentatively been solved. The cover will be fabricated and should be ready for the next temperature coefficient studies using the 2000 MWD/T synthetic slugs.

The laboratory mockup experiments of the slug heater for measuring metal temperature coefficients have progressed to the point where one may conclude that the present design of the slug heater will function satisfactorily. Final evaluation of the heat transfer characteristics will be made as soon as the mockup vacuum tank is completed by Technical Shops.

Arrangements have been completed with Plutonium Metallurgy Operation for canning the Pu-U slug pieces and pins to be used to obtain flux distributions and neutron absorption rates in the temperature coefficient studies using the synthetic high exposure slugs. Arrangements have also been made for decanning and counting these pins.

Measurement of Neutron Temperatures Upon Loss of H_2O Coolant

Additional flux traverse measurements were made through the thermal column of the TTR. Power has been applied to the thermal column heaters for a few minutes only. Minor adjustments are necessary to correct short circuiting.

Thirty of the nickel-coated Pu-Al alloy foils necessary for the temperature effect studies in the heated thermal column were received from Plutonium Metallurgy Operation. Fourteen nickel-coated aluminum comparison dummies were also received.

STUDIES RELATED TO FUTURE PRODUCTION PILES

Exponential Pile Buckling Measurements

The measurement of material bucklings for seven-rod clusters of 0.926-inch-diameter natural uranium rods has been extended to a 7-inch lattice spacing. Measurements have also been made using an assembly having increased water coolant volume. This was done by supporting the canned elements with linear polyethelene templates so as to provide a 70-mil rod separation compared to previous assemblies with no separation at all. The 1100 F aluminum process tubing was 3.290-inch I.D. x 0.065-inch wall. The water capacity was then 19.1 cc/cm. The bucklings measured this month are listed in the table below which also includes all previous results for these seven-rod clusters. The water-to-uranium ratios have been corrected for 0.4-inch aluminum spacers between the individual fuel elements.

Bucklings (10^{-6} cm^{-2}) of Seven-Rod Clusters in Graphite Lattices

Lattice Spacing (Inches)	Close-packed Dry	Close-packed Wet	Separated (70-mil Spacing) Dry	Separated (70-mil Spacing) Wet
7	-705	-407	-720	-290**
10-3/8	13*	25*	23	2
14	90*	19*		
(H_2O/U) Volume	0.37		0.66	
(H_2O/U) Molecule	0.26		0.46	

* Previously reported.

** See below.

There appears to be a small difference between the dry bucklings of the separated and close-packed clusters in both the 7-inch and 10-3/8-inch spacings. This behavior is reasonable on the basis of the slight changes in fast effect and resonance escape probability expected for the different geometries.

Examination of the values for the 7-inch lattice reveals the nonlinear effect of adding water even for such a grossly undermoderated lattice. The values for the 10-3/8-inch lattice point out that this spacing is near the crossover point for this fuel assembly for all reasonable amounts of water.

The results for the close-packed cluster indicate that the crossover point occurs at a 10-3/4-inch spacing with a positive buckling of 35 x 10^{-6} cm^{-2}. The results for the separated cluster indicate (with somewhat less certainty as yet) a crossover point of 10-1/4-inch and zero microbucks.

The buckling value for the separated cluster with water in the 7-inch lattice spacing (doubly starred in the table) is suspect in that the exponential pile did not produce a region of constant cadmium ratio at equivalent cell positions. No previous measurements with clusters exhibited this behavior. The reason for this effect is not yet understood.

Correlation of Exponential Pile Bucklings

An inspection of current results from the correlation calculations leads one to believe that a better correlation could be expected if systematic changes in the thermal utilization of a cell with lattice spacing and rod size were taken into account. A study of these spectral effects is being made.

Current Work on Graphite Purity

1. Graphite Exchange - The dih values of the eight bars selected for shipment to England are being determined in the Hanford Test Pile. The bars should be shipped about the first of March.

2. Diffusion Length of the Hanford Standard Pile - The 702 Program for computing fast source corrections has been proven to be correct. A re-evaluation of earlier measurements of the diffusion length for the Hanford Standard Pile can now be completed.

3. Graphite Cross Section Measurement - Preparations for a measurement of the absorption cross section of reactor grade graphite are being completed. The measurement should be carried out within the first half of February.

Development of Methods of Calculating Reactor Parameters

The investigation of fast effect has been completed and a report, HW-54687, has been submitted.

A study of methods of calculation of lattice parameters is now being made, considering fuel rods of various geometries with particular emphasis on clusters. These are being considered from the viewpoint of improving the validity of the theoretical approximations which are now being used.

Machine Computational Programs

Recent changes in the routine buckling program (BKL001) have been checked out and used once in the debug deck. Further improvements in this program and the accompanying data-processing utility program are being written to include fast source corrections.

Work on the revised P-3 program and the utility-type program (SOLNXN) for solution of simultaneous linear equations has been temporarily discontinued because an improved type of program more readily adapted to the 709 computer has been obtained from off-site. The improved Bessel function subroutine for use with the P-3 program is completely debugged and is setup for independent use. This program calculates $K_n(x)$ and $I_n(x)$ for $n = 0, 1, 2, 3$, and any x.

An OMNICODE program for the 650 has been written to solve the 4 x 4 determinant for a two-group, two-region spherical reactor. The program has been used for the case of positive buckling in each region and is being modified to accept negative buckling in both a finite and infinite outer region.

Instrumentation

Development efforts continued on the experimental logarithmic device utilizing active components. The successful development of such a device would provide a fast, highly accurate, wide-range period or general purpose logarithm generator.

STUDIES RELATED TO SEPARATIONS PLANTS

Measurement of k_∞ for Uranyl Nitrate-H_2O Mixtures

The data from the first measurements in the PCTR for determining k_∞ of enriched uranyl nitrate-water mixtures has now been analyzed. These measurements were taken with "miniature" tanks in order to determine the approximate enrichment values for use in the preparation of larger tanks for the full scale part of the

experiment. Only approximate values of k_{∞} can be obtained in the "miniature" phase since for this case the buffer thickness is not sufficient to provide the correct neutron energy spectra incident on the test cell. These first results therefore indicate, only qualitatively, that for $UO_2(NO_3)_2 \cdot 6\,H_2O$, k_{∞} will be unity for an enrichment of 2.2 percent.

Buckling Measurements for Fuel Elements in a Random Array Versus a Uniform Array

In connection with the dissolver problem, additional buckling measurements were taken with 1.44 percent I and E fuel elements positioned in a random array; the canned fuel elements were 8.6 inches in length with an O.D. of 1.47 inches and an I.D. of 0.37 inch. The results of these measurements are given below:

Exp. No.	H_2O/U (Volume Ratio)	Buckling (10^{-6} cm^{-2})
42*	1.78	3271
43*	1.78	3225
44	1.80	3787
45	1.74	3777

*Measured in previous month.

The average buckling is 3515 μB, and the average H_2O/U volume ratio is 1.78 ± 0.04. In order to evaluate more fully the decrease in buckling for the random array, the buckling was also measured for these canned I and E fuel elements in a uniform distribution. The H_2O/U volume ratio for this case was 1.97, and the measured buckling was 5264 μB. Before comparing the latter value with that for the random array, corrections must be applied for the differences in the amount of aluminum (process tubes) and the H_2O/U volume ratio; qualitatively these corrections increase the buckling to about 5500 μB; a P_3 calculation will be made to determine more accurately the effect of the aluminum process tubes.

The buckling was also determined for a 1.00 percent enriched uranium lattice consisting of alternate rods with diameters of 0.925 inch and 1.66 inches; the H_2O/U volume ratio was 1.45. For this lattice the buckling was 2605 μB with an estimated error of ± 250 μB. The buckling for a lattice of 0.925-inch rods at the H_2O/U volume ratio of 1.45 is about 3150 μB, and for 1.66-inch rods at this same volume ratio, 2715 μB; the average is 2932 μB. Thus, the buckling for the combination (fixed randomness of a sort) does not differ appreciably from the average.

Measurements have now been completed with three different types of fuel elements in random arrays. An error analysis of these measurements has predicted error limits which are rather wide as compared to the actual measurement errors, especially when the entire group of measurements are considered jointly; further work is required in connection with this error analysis.

The measured bucklings have all been lower for random arrays of fuel elements versus the uniform arrays, however, the errors in measurement have been large; the predicted error limits (for 95 percent confidence level) overlie the bucklings for the uniform distribution in two of the three cases.

Pending further error analysis of these data, it is not advisable to increase the critical mass limits for random distributions of fuel elements above that for uniform arrays.

Plutonium Critical Mass Facility

On January 15, a Criticality Meeting on Chemical Processing was held in the new AEC Building at Germantown; this meeting was organized by members of the AEC Division of Production. The current experimental work program of the Critical Mass Physics Operation at Hanford was reviewed and discussion given of the needs for, and justification of, a Plutonium Critical Mass Laboratory at Hanford. Discussions of similar type were also given by personnel of ORNL, Savannah River, and the Idaho Operations Office.

Research in Support of Reprocessing Power Reactor Fuels

1. Homogeneous Systems

Calculations have been made and planning is in progress for the experimental measurements of k_{∞} as a function of the H/U ratio for three percent enriched UO_3-H_2O systems. Calculations of k_{∞} for this enrichment with additional refinements on earlier works give the following results:

a. The maximum k_{∞} occurs at an H/U atomic ratio of between 7 and 8 and has a value of 1.37.

b. k_{∞} is unity at an H/U of 50.

The expression used for calculating k_{∞} was checked by comparing the calculated and experimental values of k_{∞} for approximately one percent enriched UO_3. Excellent agreement was obtained between the two sets of values except at low water densities where values as low as H/U = 4 were compared.

The generally good agreement is attributed to the method used for calculating the fast effect. Additional refinements, which are being considered for subsequent calculations of this parameter, are expected to give better agreement at the lower H/U values.

Calculations are now being completed, which will permit the design of the experimental apparatus for these k_{∞} measurements in the PCTR.

2. Heterogeneous Systems

Data on the criticality of heterogeneous systems with uranium enrichments up to three percent is needed in connection with the design of safe and efficient dissolvers.

It is planned to conduct critical mass studies with three percent enriched uranium rods in the TTR reactor room, where use can be made of the existing shielding and control instrumentation. Personnel participating in the experiments would be located in the TTR control room. These studies for determining the critical mass will consist primarily of subcritical multipli-

cation measurements (approach to but not reaching criticality) with adequate controls and safety mechanisms to insure against supercriticality. The studies will also include some exponential type buckling measurements.

Aluminum process tubes have been ordered for the uranium rods; a special pencil type Ra-Be neutron source has been ordered for use in these multiplication experiments; framework for holding the necessary safety mechanisms is under construction. Both control rods and a quick dump system will be utilized for nuclear safety.

The first quantity of the three percent enriched uranium is expected to arrive in April.

Nuclear Safety, Critical Mass Consultations

2. Nuclear Safety in Redox Processing.

A meeting was held with personnel of CPD to discuss criteria for a new vessel, safe by geometry, to replace L-16 which is a nonsafe recycle tank (has safe batch limit). The design basis for such a vessel was given to CPD.

3. Nuclear Safety in Purex Processing.

An inspection of the new Purex Ion Exchange System was made and criteria for contact maintenance procedures established. An addendum to the process specifications for the operation of the Purex Plant was written by members of CPD and approved by the Physics and Instrument Operation (HLO) for the nuclear safety of the ion exchange equipment.

4. Plutonium Alloy Metallurgy.

A meeting was held with personnel of the Plutonium Metallurgy Operation (HLO) to discuss the nuclear safety involved in the manufacture of MTR-type plutonium-aluminum alloy fuel elements containing about 15 percent plutonium. An inspection of the facilities for the manufacture of these fuel elements was made and criteria for the nuclear safety in their manufacture given.

5. Nuclear Safety UO_3 Manufacture.

(a) A talk on nuclear safety in processing enriched fuels was given to members of CPD connected with the operation of the UO_3 plant.

(b) A study of the equipment and processing operations of the UO_3 plant was made to determine those phases of the operation in which nuclear safety must be considered for processing enriched uranium oxides. The results have been summarized by W. G. Browne of CPD in an undocumented document entitled "Meeting With N. Ketzlach on 1-7-58 Concerning

UO_3 Plant Criticality."

Neutron Age Measurements

Two runs were made on the monoenergetic age measurement this month. The first was a background run in water using a dummy Na-Al source. The results of this run confirm that the effect of locally produced photoneutrons can be best obtained from the large Na-Be source data. The second run was the first measurement of the age in kerosene. The large Na-Be neutron source was used. The run proceeded satisfactorily and preliminary results have been obtained which seem to be in the expected region.

Mass Spectrometer for Plutonium Analysis

The construction of this spectrometer is proceeding according to schedule in Technical Shops.

REACTOR DEVELOPMENT - 4000 PROGRAM

STUDIES RELATED TO THE PLUTONIUM RECYCLE PROGRAM

Plutonium Spike Measurements

The plutonium spike measurement is now in progress in the PCTR. The worth of plutonium appears to be somewhat larger when in a spike column than when mixed in a UO_2 cluster. Exact calculations will be made for two cases in which the copper poison is distributed differently over the Pu spike and its nearest UO_2 fuel columns. This experiment will give the multiplication factor of an infinite medium composed of "supercells" which have a spacing of $\sqrt{7} \times 1$, where 1 is the fuel-rod-cluster separation (8 inches in the present experiment), and which are composed of 6 UO_2 clusters and 1 Pu spike cluster.

Measurement of p, ε, and Conversion Ratio for UO_2 Lattice

Two irradiations were made in the PCTR to determine p, ε, ICR for a 19-rod UO_2 cluster in an 8-inch D_2O moderated lattice.

Preliminary analyses give the following results:

$$p = 0.866$$

$$\varepsilon = 1.0178$$

$$ICR = 0.828$$

If we use the value obtained for k_∞ of 1.048 and for f of 0.892, we find a value of η of 1.333. No error analysis has been made as yet.

Comparison of Pu-graphite Fuel with Pu-Al Fuel

The Pu-graphite reactivity measurements were completed in the PCTR in support of the PRTR program. To date only preliminary calculations have been made on the data and no numbers are available.

Theoretical PCTR Studies

The problem of the thermal neutron distribution from a thermal line source in the presence of a cavity has been completed. Numerical evaluation for a particular case has been completed. A detailed description of the solution will be included in the Nuclear Physics Research Quarterly Report for October - December 1957.

Resonance Escape Theory

A re-calculation of the resonance escape probability for natural uranium as a function of rod diameter has been started. The 18 resolved resonances of U-238 are considered separately. The present investigation involves different formulations for the low energy wide resonance and the narrow resonances, in analogy to the treatment of J. Chernick (BNL-433). The effective resonance integrals obtained are expressed in the form $a + b\sqrt{\frac{S}{M}}$. Preliminary results give values $a = 0$ and $b = 23$. Hellstrand (Sweden) obtains $a = 2.52$, $b = 24.7$ experimentally. The value $a = 0$ does not include any 1/v statistical region contributions, whereas Hellstrand's value does. An indication of the importance of the 1/v and statistical regions is that Stein (WAPD) adds a value of 5.5 barns for their contribution. An estimate of their importance in the present calculations is now being made.

Instrumentation

Further study of possible systems for slug rupture detection was initiated at a meeting of Instrument R&D personnel with members of the Advance Engineering Operation. It was concluded that more information on detection limits was required before the best system could be specified. This information was received and the study is continuing.

The final design for the 5X viewer for the fuel inspection facility is being worked out.

The transistorized scintillation Alpha Hand Counter developed on 6000 Program funds is recommended for possible use in the PRTR facility.

CROSS SECTION MEASUREMENTS PROGRAM

Pu-239 and Pu-241 Low Energy Fission Cross Sections

All of the data on the energy variation of the Pu-239 and Pu-241 fission cross sections from 0.0025 ev to 0.0047 ev have been obtained and calculated. The Pu-239 data were obtained with a statistical precision varying from 1.0 to four percent at the lowest energies. The results show a larger deviation from 1/v over this small energy region than would have been anticipated, the observed deviation being about a three percent decrease from 1/v to lower energies. The statistical precision of the Pu-241 data was only 2 to 10 percent over the same region. The cross section seems to be 1/v to a precision of about ± 2 percent. The normalization of these low energy fission data has not been completed because of a breakdown in the fission channel electronics.

Cold Neutron Total Cross Sections

A satisfactory detector for the slow neutron region was obtained by the use of a BF_3 counter fabricated from a 4-inch section of aluminum slug can. The counter has about a 2-inch sensitive region and is used with the neutron beam transmitted through the side wall rather than the end thereby eliminating end effects which are very troublesome for cold neutrons. In addition, the small sensitive volume of the counter enables the use of adequate shielding so that the background counting rate is very low. This detector has been used with the mica crystal monochromator and beryllium filter to obtain transmission cross section data below 0.005 ev. Data taken on an iridium sample gave a 1/v variation of the Ir total cross section to a precision of about ± 0.2 percent which indicates that reliable data can be taken in this region to a very good precision. Data are also being taken on samples of U-235, platinum (to evaluate corrections for the platinum fission foil backings), gold (to further evaluate the system), and copper (for possible application to PCTR Cu cross section values).

Absolute Fission Cross Section Measurements

Alpha count data on the HLO standard U-235 fission foil have not been completed as yet by Analytical Laboratories. The electronic system for the dual chamber fission counter is complete and undergoing tests.

Subthreshold Fission Cross Sections

Six Np-237 fission foils were made by Analytical Laboratories by precipitation from a slurry when electrodeposition techniques failed. Fission cross section measurements on Np-237 will be started when the cold neutron measurements are complete.

Multilevel Resonance Formula

Significant results have been obtained from numerical calculations on the U-235 fission cross section using the IBM-650 computer program for the previously reported multilevel resonance formula. The formula was shown to reproduce to high precision the Breit-Wigner single level formula for resonances where interference should not exist. For cases where fission exit channels are restricted and interference exists it was rather surprisingly found that the radiative capture cross section component differed from the Breit-Wigner single level formulation. The difference was small but possibly of significance in cross section analysis. For the fission component it was found that interference effects could cancel out exactly for special cases, a result which had previously been obtained at Hanford from the Feshbach-Porter-Weisskopf (FPW) approximation for a multilevel formula. Comparison with the FPW formula showed significant differences (greater than 10 percent). Calculations so far have been restricted to only five energy points for a few cases from which a significant amount of information has been obtained. As a future step it is planned to attempt a detailed fit of the fission and total cross section of an isotope to see if this formulation can explain with confidence some of the processes occurring in slow neutron fission.

Time-of-Flight Measurements

Additional measurements were made on Be(d,n) spectra and chronotron performance for an invited paper presented January 27 and 28 at the Scintillation Counter Symposium.

The source of background neutrons was studied using a deuteron beam and a non-neutron producing target. Directional shielding was used to pinpoint the two primary sources of background to be the analyzing chamber where the D_2^+ ion is stopped and the chopping slits where the analyzed beam is swept. In addition, the head end of the Van de Graaff produces intense low energy X-rays. A shadow shield of 6 inches paraffin and 2 inches of lead reduced the background counting rate by a factor of ten.

Three Crystal Spectrometer

Consultation was continued to CEO on the spectrometer installation and specifications tests. Installation is apparently proceeding satisfactorily and according to schedule.

TEST REACTORS OPERATION

The Physical Constants Testing Reactor operated routinely during the month. There was one unscheduled shutdown due to an electrical outage.

The enriched uranyl nitrate-water, k_∞ measurements with mini-tanks were completed during the month. The PRTR experiments with impregnated graphite-Pu fuel were completed, and the spike enrichment experiments with Pu-Al fuel were started.

The Po-Be neutron source was replaced during the month. Revisions were made to the source drive mechanism which will simplify future maintenance.

The design criteria for the addition to the 305-B Building were forwarded to the Commission for review prior to preparation of the final draft. A counting room, computing room, office space, change room, and instrument and mechanical maintenance areas are planned.

Operation of the Thermal Test Reactor was routine during the month; there were no unscheduled outages. A new source (previously used in the PCTR) was installed in the reactor.

Redesign of the safety sheet winch and upper position control unit was completed and fabrication is progressing. Variations in position of the sheets now limit the reproducibility of reactivity measurements.

The measurements of the amount of boron absorbed from BF_3 by graphite were completed for Materials Development Operation.

A survey of all automatic counting equipment available commercially has been completed and a meeting has been called for discussion of these pieces of equipment and of the specifications for an automatic counter system for PCTR operations.

[redacted]

The new values of the delayed neutron fractions and mean lives recently published by Keepin, et al, have been used to construct a new table of reactivity versus reactor periods for a U-235 reactor system. The in-hour equation was programmed for the IBM-650 with sufficient flexibility to allow for future changes in the delayed neutron fractions and mean lives.

BIOLOGY AND MEDICINE - 6000 PROGRAM

BIOPHYSICS RESEARCH

Atmospheric Physics

One field experiment designed to continue measurements of the transport and diffusion of materials emitted from the 100 Areas and carried over the Wahluke Slope was completed. The emission point was again near 100-B Area and cross-wind, ground-level concentrations were measured at two and eight miles from the source. Final analyses of the data have not been completed but very preliminary results have suggested confirmation of earlier data reported last month.

Consideration was given to the equipment and manpower requirements needed to extend comprehensive measurements of atmospheric diffusion and transport to distances up to sixteen miles from elevated and ground sources. An expenditure of approximately $140,000 for field equipment and an increase in our annual operating R and D budget of $60,000 provide the minimum requirements for such a program. This planning study was completed in response to an informal request from the Air Force Cambridge Research Center for a preliminary estimate of our ability to perform such experiments under their sponsorship.

DOSIMETRY

A door for the rock-shield low-background facility was completed. It weighs 2-1/4 tons but moves quite easily on a system of rollers. Background in the shield was found to be the same as expected in the iron room of the Body Monitor.

Testing of the usefulness of a large plastic scintillator for Body Monitor work was begun in the rock shield. Energy resolution was poor; this was expected. There is sufficient sensitivity though to make use as a quick detector of unusual radioactivity appear promising.

Studies of two 14-inch photomultiplier tubes showed their sensitivity to be very nonuniform over the face of the tube. This does not affect their use with large plastic scintillators but does for better quality scintillators.

Field testing of the new method of using pencils is proceeding by Radiological Development Operation. No difficulties have developed with the method. Typical use of the pencil is to measure 1 to 2 mr in a three-day period.

The method of measuring Van de Graaff voltage needed in the electron calorimetry work is about developed. An insulated metal probe was placed in the wall of the Van de Graaff pressure tank. This and the high-voltage terminal form one arm of a capacitance divider. All but a few percent of the voltage

on the other arm is bucked out by a precision potentiometer. The remainder can be measured and recorded accurately with a vibrating-reed electrometer. The method works very well, but the effects of corona leakage and capacitor soak-in must still be evaluated.

This method of voltage measurement was used to operate the electron Van de Graaff at 0.1, 0.2, and 0.3 Mev. Stability was found to be good although control became sluggish. This is of interest because it may be possible to do the same thing with the positive ion Van de Graaff. There are some advantages to being able to do this in the D-D and D-T reactions.

The Van de Graaff accelerator operated satisfactorily during the month. Since the 0° beam is not being used at present, its plumbing was removed and the auxiliary diffusion pump moved adjacent to the analyzing magnet. This improved the vacuum characteristics of the machine and provided some room for storage.

An experiment was carried out that combined results from two of our previous studies. Slow neutron pencils were used in place of BF_3 counters in a moderated neutron detector. The pencils were charged to low voltages and read by the new pulse method in order to get low leakage and high sensitivity. It was found that one week's permissible dose from fast neutrons would give 60% of full scale reading on the least sensitive range of the present pencil reader. This makes the system very attractive as a fixed monitor for fast neutron dose. In addition, there is the possibility of adjusting the boron content of the slow neutron pencil till the neutron and gamma-ray sensitivities are equal; then one monitor would measure both neutron and gamma dose. By adding a pencil identical with the first but made with boron depleted of B^{10}, a separate measurement of gamma dose could be made. Further testing of these ideas will be carried out with Radiological Development Operation and they will develop the applications of the system.

Nuclear Physics Operation measured neutron spectra from $Be^9(d,n)$ to obtain performance data on the time-of-flight system.

A new series of proton w measurements for argon was made. The result was higher than the preliminary value. Use of the 256-channel analyzer uncovered parts of the experiment that needed improvement. Another series of measurements is being prepared.

INSTRUMENTATION

Hanford plant drawings for the Alpha Scintillation Transistorized Hand Counter have been completed and the instrument, in general test use in the 329 Bldg. for three months, is still operating satisfactorily with no maintenance or recalibration during that period. Minimum detectable alpha contamination level is fifty d/m.

The combined alpha, beta, gamma Hand and Shoe Counter has been completed except for the addition of two external cable-connected, loudspeaker readout probes. One of the additional probes will be a scintillation-type for alpha monitoring, and the other will be a G-M probe for beta-gamma monitoring. These probes (cabled), operating independently from the main instrument, will be used for clothing monitoring. Except for trouble with some glow-transfer-type decade

counting tubes, the main instrument has operated satisfactorily. This instrument, in a "package" the size of a Five-Fold, can replace both the Four-Fold and Five-Fold counting instruments. Alpha minimum detection limit is 200 d/m, and the beta-gamma limit is the same as for the Five-Fold. Hanford plant drawings are being made for the instrument.

The experimental portable scintillation transistorized gamma energy analyzer has undergone about six days of field testing at 100-H, 100-F, and 234-5 Areas. The results were satisfactory with gamma energy spectrum information found at many locations. Some of the locations had previously been checked for various gamma energies by time-consuming absorption curve methods. The scintillation energy analyzer found the energies and checked the results in a matter of minutes, and also determined several energy peaks in the region of 100-Kev to 500-Kev. These areas of energy had not previously been examined because of inadequate equipment.

Investigation and experimentation were started on a heating method, by induction heating, to be used to boil off radon and thoron from filters used to pick up airborne plutonium contamination. This will reduce the background levels of the millipore filters. Temperatures of 1000 to 1200°C will be used to char the filter.

The contract for the fabrication of twenty remote data stations for the Telemetering System has been awarded to IDL, Seattle. These stations will be fabricated to our specifications. A "test" (simulation) instrument has been designed to check the data stations synthetically when they are fabricated. The "test" instrument is being fabricated onsite.

The zinc sulfide particle detector for the Atmospheric Physics Operation is completed except for some machining and assembly of the counting head. Experments have shown that the instrument produces a count linearly related to the number of zinc sulfide particles on the filter over a range of 100 to 19,000 particles. These filters had been calibrated by actual optical counting. The range of linearity is adequate to meet the specified requirements.

The final averaging circuit for the pyroheliometer was designed and fabricated. This circuit provides a weighted average, with a thirty minute time constant, of the pyroheliometer at the Atmospheric Physics Meteorology Facility. Every

CUSTOMER WORK

Analog Computing

Computer running time continues to increase. No involuntary down-time was recorded this month.

The computer was shut down for a one-week period to perform a yearly check of all tubes and components. This work was coordinated with the instrument repair craft as specified.

New fans and top sections for the computer have arrived and will be installed by the Goodyear service representative on the next visit.

A portion of the first phase of the PRTR Gas and Water Dynamics problem was completed. A study was made on the steady state response of the system for various levels of D_2O. This data was supplied to Advance Engineering. Dump characteristics are now being set up for study.

A set of preliminary runs were made on the heat exchanger system proposed for the NPR. The objectives of the study were to evaluate the system for its range of variables and to justify the constants selected.

A set of runs were completed for the evaluation of the amount of Californium produced in the PRTR, at a fixed flux level and a given amount of Pu, for a period of 10 years. Results are being evaluated by the customer and it is anticipated that additional runs will be requested.

The first set of runs were completed on the temperature stress expected in the walls of the 200 Area waste tanks. These runs were made assuming no heat loss to the soil and no insulating layer in the tank. The customer is now establishing the data and requirements for additional runs.

In order to conserve computer equipment and to meet special requirements of the customers, a portion of the group's time is being spent on the development of special computer circuits. This month a single amplifier circuit for the NPR kinetics and a transport delay circuit were evaluated.

Weather Forecasting and Meteorology Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	93	81.1
24-Hour General	62	81.0
Special	171	92.3

Average temperature (37.1) and total precipitation (1.74 inches) during January were much above normal. These marks, however, were well below the respective record January highs of 42.5 and 2.16, both established in 1953.

Even more notable than the mild and wet weather during January was the lack of any measurable snow fall. There have been five previous such Januarys in 46 years of record. This was the first time of record, however, that a

snowless January has followed a November and a December, both of which were also snowless. The station did record 0.3 inch last October. However, even this meager amount missed lower elevations of the Hanford Area, including Richland where there had not been even a trace of snow during the entire winter up to February 1.

The studies of oxides of nitrogen in the vicinity of the 321 and 313 Buildings were continued. Analyses of data from these buildings were begun.

A new weekly demand record for the 24-hour general forecast was set with 1,759 calls the week ending January 12.

Instrumentation

Three alpha, beta, gamma 4 x 8-inch fixed filter counters for the 200 Areas have been completed and are now being tested before delivery. These units, employing two scintillation detectors, zinc sulfide for alpha and anthracene for beta-gamma, will simultaneously count for the above types of contaminants. Each detector head sees one-half of the 4 x 8-inch filter. Two separate scaling units are employed.

Authorization was received to start construction on a dual alpha air monitoring system for detecting and indicating the amount of airborne plutonium contamination in a 200 Area facility. The system will include two high-level alpha air detection and alarm systems with a third recording and alarm system that is actuated by differences in the first two systems. Increased sensitivity is expected by virtue of the automatic background reduction when the two systems are placed where the natural background effects are the same but the probability of simultaneous plutonium contamination is low.

Optical Service

A procedure was developed which will permit the use of two Leeds and Northrup optical pyrometers for two-color temperature measurements. One pyrometer has been modified by altering the effective wave-length of the light transmitted. A preliminary calibration of these instruments has been carried out using a ribbon filament tungsten lamp. A more complete calibration will be run while measuring the temperature of a tungsten crucible in which a black body cavity has been formed. This work is being done in cooperation with ceramic fuels development.

The design of a three-color pyrometer was completed. This type of pyrometer is expected to permit the accurate temperature determination of materials whose emissivity varies with wave-length. Tests were made of the response of a lead sulfide photoconductor to demonstrate the feasibility of its use in the three-color pyrometer.

The objective lenses for the 105-C Optical Profilometer were redesigned and remade to be of shorter focal length. The profilometer is now in operation.

The routine Optical Shop work included fabrication of an alignment target for the reactor-charging machine, some adjustment lens mounts for a profilo-

meter and some photographic accessories. Two achromatic lenses were ground for the 105-C profilometer and fabrication was started on a color-temperature pyrometer.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

[redacted]

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
R. P. Dragoo	1/17	AEC Nuclear Material Division, 703 Bldg.	Study Portable Instruments.	WG Spear	No	300: 329
R. Fields	1/30	Convair Ft. Worth, Texas	Discuss Tracer.	GR Hilst JJ Fuquay	No	200-W: 622

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
W. D. Cameron	1/8	Ramo-Wooldridge Corp. Inglewood, Calif.	To discuss Analog Computer Techniques.	Irwin Pfeffer	No
E. D. Clayton	1/13-14	Oak Ridge Nat'l Lab., Oak Ridge, Tenn.	Discuss critical mass problems.	AD Callihan	Yes
	1/15	Div. of Production AEC Bldg. Germantown, Md.	Attend meeting to discuss need for Pu critical mass facility.	F. Baranowski	Yes
P. F. Gast	1/14-15	Production Div.AEC Washington, D. C. & Germantown, Md.	Discuss need for Critical Mass Facilities and Reactor Physics Program.	F. Baranowski	Yes
		Div. of Reactor Dev., AEC Washington, D. C. & Germantown, Md.	" " "	IF Zartmann	Yes

VISITS TO OTHER INSTALLATIONS (Continued)

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
W. C. Roesch	1/16	University of Wash. Seattle, Wash.	Discuss AEC Fellowship Program.	RM Baltzo	No
J. T. Russell	1/23-24	ORNL Oak Ridge, Tenn.	Discuss time-of-flight work.	CH Johnson	Yes
	1/27-28	Scintillation Counter Symposium Washington, D. C.	Attend symposium.	--	No
R. C. McCall	1/27-28	Scintillation Counter Symposium Washington, D. C.	Attend symposium.	--	No
D. A. Kottwitz	1/28	Brookhaven Nat. Lab. Upton, N. Y.	Discuss neutron slowing down and thermalization.	Dr. N. Corngold	No
	1/29-31	American Physical Society New York City	Attend APS meeting.	--	No
H. W. Lefevre	1/27-28	Scintillation Counter Symposium Washington, D. C.	Present a paper.	--	No
	1/29-2/3	Columbia Univ. New York	Discuss time-of-flight technique	WW Havens	No
J. E. Faulkner	1/27	GE Research Lab. Schenectady, N.Y.	Neutron damage work.	RW Schmitt	No
	1/28	KAPL, Schenectady	Reactor Physics work.	WR Kanne	Yes
	1/29-31	American Physical Society Meeting New York	Recruiting at American Phys. Soc. Meeting (Ph.D.)		No

[redacted]

Chemical Research and Development

ORGANIZATION AND PERSONNEL

L. P. Bupp, Manager, Reactor Engineering Development Operation, was appointed Manager, Chemical Research and Development Operation.

A. M. Platt, Senior Engineer, was transferred in from Chemical Processing Department to Chemical Development Operation as Supervisor-Chemical Engineering Development.

J. D. Ludwick, Chemist I - H, was hired and assigned to Chemical Research Operation.

F. P. Roberts, Chemist II, was transferred in from Fuels Preparation Department and assigned to Chemical Research Operation.

T. R. McKenzie, Engineer I-L, transferred out of Chemical Research to Chemical Processing Department.

H. E. Hanthorn, Senior Engineer, transferred out of Engineering Development Planning to Reactor and Fuels Research and Development Operation.

R. G. Geier, Supervisor, Chemical Engineering Development transferred out of Chemical Development to Chemical Processing Department.

A. E. Smith, Supervisor, Process Equipment Development, transferred out of Chemical Development to Chemical Processing Department.

R. J. Sloat, Senior Engineer, was appointed Supervisor, Chemical Engineering Development, Chemical Development Operation.

RESEARCH AND DEVELOPMENT

FISSIONABLE MATERIALS - 2000 PROGRAM

IRRADIATION PROCESSES

Analytical Service

All interested parties agreed to the feasibility of transferring coolant radioanalysis from 1706-KE to the Purex Analytical Control Operation, 202-A, 200 East Area. No longer needed is the 1706-KE expansion--CG-757, estimated at $77,500. Advantage is also expected from a shift operation which will relieve pressure on analysis of short half-life isotopes. Transfer details are being clarified.

Automatic Analyzing Monitor

Modifications incorporated into the monitor provided increased reliability of operation. Although sustained operation was achieved for a 24 hour period without any malfunction, a few failures occurred during the month and effort continued to eliminate every potential for these.

[redacted]

Uranium Oxidation - Melting Experiments

The laboratory procedures for the uranium oxidation and fission product volatilization experiments were expanded both in detail and scope. Included are the sequence of experimental procedures, calibration procedures, safety considerations and equipment which are necessary in order to carry out the planned program successfully.

Reactor Effluent

The sampling program designed to determine the influence of seasonal operating variables on the release rate of As^{76} to the river was initiated in B Area. The program will continue for at least one year.

A review was made of the reactor purges carried out in 1957 to determine if the current limitations on purge effluent disposal are adequate without being unduly restrictive. A comparison of the quantities of radioactive material found in 1955 with that found in last year's purge effluents showed no unexpected changes or trends. The isotopes of concern, Fe^{59}, P^{32} and Np^{239}, were all increased by about the amount anticipated and can be traced directly to an increase in operating level. In 1957, effluents from about 50 purges during reactor operation were sent to the river. The effluents from another 10 purges were sent to cribs. This total of 60 purges represents only about 50 per cent of the total allowable under the present procedures. The conclusion was reached that the present disposal rules are effective for preventing undue river pollution from purges while permitting effective use of the procedure.

SEPARATIONS PROCESSES

Purex

A new diluent, "Phillips Base Oil No. 1," showed no advantage over other commercially available hydrocarbon diluents. Aside from having a low flash point (136 F) this diluent was inferior to both Soltrol-170 and Amsco 123-90 W from the standpoint of pickup of gamma activity.

Multiple batch contacting studies employing Purex plant HCW, 1BXF, and 1AF indicated little hope for ever obtaining adequate fission product decontamination in a single cycle process with solvent of the quality of present plant first-cycle solvent. However, processing Purex 1AF and 1100 through a batch countercurrent 2D-2E cycle produced a uranium product of gamma ratio 1.7 with the 2D-2E flowsheet proposed for the two-cycle plant and a product of gamma ratio 1.4 when 0.01 M oxalic acid was present in all aqueous feeds to the 2D "column." In view of the fact that the HS and 1BX-1BS columns were omitted in this study, no correction was made for U-237, and natural uranium (containing UX_1 and UX_2) was added in the simulated 2E operation, these results indicate that the proposed two-cycle flowsheet should be capable of adequate fission product decontamination.

Talc of sub-micron particle size has been shown to exert interesting and potentially beneficial effects on liquid-liquid dispersions. This talc is organophilic, favors organic-continuous dispersions, produces coarser dispersions (whether organic or aqueous-continuous) and reduces coalescence time. Further, it adsorbs

large organic molecules and has been shown to be capable of removing emulsion-formers from TBP solvent systems. However, this talc did not remove any significant fraction of the fission product activity from a low-level Purex-type organic extract or significantly alter the fission product distribution ratios.

Feed Preparation

Uranium Dissolution Studies. Dissolution rates for Ingot, Dingot, and high-carbon Dingot uranium in 8 M HNO_3 were 0.75, 0.27, and 0.27 $gm/cm^2/hr$, respectively, corresponding closely to rates previously observed by Swanson and Bement. The high-carbon Dingot sample used was specially prepared by Mallinckrodt and was supposed to contain 400 ppm carbon. Analyses at HLO show only 240 ppm. Determination of grain size has not been completed.

A laboratory dissolution experiment was carried out to define the solution parameters most important to uranium dissolving rates. Uranyl nitrate-nitric acid solutions in the range 1-3 M HNO_3 and 5-9 M total nitrate were used with small amounts of H_2SO_4 and $NaNO_2$. Principal findings were (1) addition of 0.1 M H_2SO_4 or 0.2 M $NaNO_2$ did not increase the dissolving rate significantly (within ± 12 per cent), (2) the dissolving rate depends primarily on the total nitrate concentration (a factor of 15-20 in the range studied) and secondarily, on the free nitric acid concentration (a factor of 2-3 in the range studied), and (3) there was evidence of an induction period at the beginning of the dissolution. Further experiments to define more closely the effects of nitrate ion and free nitric acid are planned.

Solvent Extraction

Purex 1C Column Studies. Studies were continued toward the development of a cartridge for the Purex 1C Column to provide increased capacity under Phase II Flowsheet (HW-47889) conditions. The effect of pulse amplitude on 1C Column was studied in a 3-inch-diameter glass column with a 9-foot-long cartridge of stainless steel nozzle plates (10 per cent free area, 0.125-inch-diameter hole) on 4-inch spacing ("plant" cartridge).

At a volume velocity of 835 gal/hr-sq. ft., pulse amplitudes of 80 per cent and 140 per cent of the "standard" amplitude (0.5 inch) produced flooding frequencies of 110 per cent and 90 per cent, respectively, of the flooding frequency at 0.5 inch amplitude. At higher volume velocity, the effect of amplitude became negligible. These studies suggest that conditions other than the "standard" amplitude can be found which will permit efficient operation at both high and lower throughputs. The results of these amplitude studies are tabulated below:

Volume Velocity Gal/(Hr)(SqFt)	Flooding Frequency (Cycles/Min) a=0.7 inch	a=0.7 inch	a=0.4 inch
835	90 ± 5	100 ± 5	110 ± 5
1250	80 ± 5	85 ± 5	95 ± 5
1350	---	60 ± 5	60 ± 5
1257	60 ± 5	---	---

[redacted]

Operating conditions for the above runs were as follows:

Aqueous Phase Continuous
Aqueous to organic flow ratio = 1.0
ICF temp = 35 C ICX temp = 50 C.

Spiral Cartridges. Investigations of spiral cartridge capacities and efficiencies were continued in a 3-inch-diameter glass column using an HA extraction system. For spiral cartridge pitches of 2, 3, and 6 inches, flooding frequencies and capacities equivalent to the standard-type cartridge were obtained at operating amplitudes of 58, 78, and 88 per cent, respectively, of that used for the standard (no spiral) cartridge. (Tests were made on a Purex-type solvent in contact with aqueous solutions of 0.25 molar nitric with 11 g/l uranium, and 2.5 molar nitric with 240 g/l uranium.)

A comparison of mass transfer studies indicated a significant reduction, generally around 40 per cent, in the HTU or HETS values when a spiral cartridge with a pitch of 3 inches was used in place of a standard-type cartridge. This trend continued even when the operating amplitude of the spiral cartridge was reduced to give a capacity or flooding frequency equal to that of a standard cartridge.

Coalescence and Plate Wetting. Investigations were continued on the effects of pulse amplitude, aqueous to organic ratio, and perforated plate hole size on the flooding and coalescence (top interface), characteristics of a 3-inch-diameter by 3-foot-high glass pulse column containing alternately two linear polyethylene and four stainless steel sieve plates with 1-inch plate spacing. Systems used were uranium-free and contained aqueous nitric acid concentrations of 0.01 M or 1.5 M and 30 per cent TBP in Spray Base.

Coalescence was generally improved by decreasing the aqueous to organic ratios and increasing the pulse amplitude although optimum amplitudes may exist in the low acid system and at high A/O's in the high acid system.

Increasing the free area of the plate increased coalescence with the smaller (1/16-inch) plate holes but indicated an optimum for larger (1/4-inch) plate holes.

Flooding frequencies showed a tendency to drop slightly with increasing aqueous to organic ratio. Flooding frequencies were not significantly different for these cartridges between bottom or top interfaces.

Continuous Calcination

Hinged Agitator. Four hinged-arm agitator (SK-2-43238) failures occurred during the month in the 224-UA Building. Although the failures (attributed to blade failures and tramp metal) do not demonstrate an inherent design weakness, alternations with the shear-pin supporting agitator arm are being considered. One of the more favorable approaches being considered is the replacement of the shear-pin with a cantilever beam. The cantilever-beam design will be impact tested before it is recommended for installation in the 224-UA Building.

[redacted]

Mechanical Seal Rings. Wear rings for high temperature, non-lubricated, contact service are being developed for possible use as continuous calciner mechanical shaft seals. The most promising combination investigated to date has been Stellite No. 1 used in conjunction with 440 C stainless steel.

Fluidization Properties of UO_3

Studies of the fluidization properties of UO_3 powders have been completed. The detailed findings will be found in HW-54763, "Factors Affecting the Fluidization of Uranium Trioxide Powders," by B. M. Johnson.

Heat transfer coefficients for the reactor wall-fluidized bed interface have been empirically estimated for the UNH denitration system.

Ion Exchange

Pressure drop and flow characteristics of the anion-exchange resins Dowex 1-4X, 50-100 mesh and Permutit SK, 20-50 mesh were investigated in the semicontinuous ion-exchange contactor. The Dowex-1 resin, obtained from the Purex Plant prototype contactor, failed to push at aqueous feed rates commensurate with the plant capacity. The Permutit SK resin pushed with relative ease at the maximum projecting feed rates, exhibiting characteristics essentially identical to those reported last month for Amberlite IRA-401, 20-50 mesh resin. This Permutit resin is now in use in the Purex Plant prototype ion exchange unit.

WASTE TREATMENT, FISSION PRODUCT RECOVERY

Submerged Combustion

Since October, eight runs were made on the one million BTU/hour submerged combustion unit. Using the unit, solutions of sodium nitrate and "cold" coating wastes were concentrated. Using sodium ion as a tracer, detrainment factors of greater than 10^5 were measured. An interim report (HW-54624) summarizing the 25 runs made to date is currently being issued. Additional runs are planned to permit better understanding of the variables involved and to obtain data which would permit specification of design details for plant application.

Cesium-Recovery

Cold runs to test equipment for use in the full level liter scale 222-S multicurie cell demonstrations are in progress in a 300 Area mock-up facility. Following completion of these tests and correction of minor defects, the equipment will be installed in 222-S.

Cesium Isolation and Packaging

Scope drawings SK-2-2332, 2350, 2351, 2352, 2353 were issued for comments. Drawings were revised and made ready for final approvals. To facilitate the location and arrangement of equipment the construction of a wooden scale model of the cell and its components has been started.

[redacted]

Preliminary data on the steam hydrolysis of $Cs_2ZnFe(CN)_6$ indicate that air present with the hydrolysis steam very significantly increases the conversion rate. For example, a thirty-fold increase was noted at 375 C when a steam-to-air mole ratio of roughly three was substituted for steam alone.

Instrumentation for Measuring Quantity of Cesium^{137} in Shipping Containers

Detailed design of the ionization chamber for measuring cesium in shipping containers has begun. In view of the space available it appears that the distance between the ion chamber and source holder will be limited to about one foot. At this distance positioning becomes critical; for example, a precision of ± 0.1 per cent requires positioning to ± 0.006 inch. The geometry is further complicated in that the sample "as viewed" by the ion chamber is not a point source, but is in fact larger than the ion chamber. This latter problem can be minimized by using a production shipping container filled with a standard amount of cesium-137 as a calibrating source. Other design considerations are being investigated.

Rare Gas Fission Product Recovery

Estimates of practicable isotopic composition of krypton and xenon which may be recovered from dissolver off-gases were submitted in response to requests of CPD personnel.

Facilities for rare gas removal were inspected and personnel consulted on the recovery problems at the Idaho Falls Chemical Processing Plant.

Neptunium Recovery

Neptunium analytical results have been obtained on some special dissolver solution samples which were originally produced to determine the conversion ratio of I & E slugs. The irradiation history, uranium, and plutonium content of these solutions is known much more precisely than for normal plant feed and should, therefore, yield a refined value for the Np-237/Pu-239 ratio in Hanford irradiated metal. The Np/Pu weight ratios obtained were 4.02×10^{-3} and 4.25×10^{-3} for the I & E and solid slugs, respectively. These do not differ significantly from one another (95 per cent confidence limits = ± 15 per cent) but are about one-third larger than earlier values. This means that the amount of neptunium produced at Hanford is larger and the fraction appearing in the Purex uranium product smaller than previously thought.

Other analyses showed negligible quantities of neptunium in the Purex 1BP during the second half of November and early December. Also, preliminary results indicate that high acid 2D column operation during January has had little or no effect on the neptunium content of the uranium product. Laboratory experiments showed that about the same neptunium extraction coefficients were obtained at 40 C as at room temperature and that similar results were obtained with Shell E and dodecane as TBP diluents. In all cases favorable extraction was obtained for acidities ≥ 2 M provided traces of nitrite were present.

[redacted]

Nitric Acid Destruction

A series of runs were made to determine the minimum amount of formaldehyde required to destroy the nitric acid in synthetic 1WW corresponding to the Purex two cycle flowsheet. Addition of reagents was done in a continuous manner to eliminate any potentially dangerous induction period and to minimize the quantity of reactants in contact at any time. Thus, the formaldehyde and 1WW solutions were continuously introduced into a heated reaction pot from which the product overflowed. The preheated 1WW feed was added in a packed column where it contacted and reacted with the nitric oxide produced in the pot, thus improving the overall efficiency of formaldehyde utilization. Operation was extremely smooth. At a 4:3 mole ratio of free nitric acid to formaldehyde, a heavy precipitate formed in the pot and the pH of the product was 1.2. At a 2:1 ratio, there was only a very little precipitate and the pH was 0.1. At a 4:1 ratio (limiting theoretical), there was no precipitate, and the product pH was somewhat less than zero. These very promising results indicate that economical usage of the formaldehyde can be readily achieved in an inherently safe continuous reactor. The equipment is now being installed in a hood for hot runs to determine the behavior of fission products.

Iodine Chemistry

A series of experiments were performed in which an iodine-air mixture was passed through dilute (five per cent) nitric acid solutions containing 0.01 molar mercuric ion (simulating addition of mercury to the Purex acid removal facility). Iodine absorption was excellent and averaged 99.95 per cent for iodine concentrations ranging from 10^{-6} to 3×10^{-9} g I_2/ml air. Somewhat poorer iodine removal was observed at 10^{-4} molar mercury, or when the iodine concentration absorbed in the nitric acid was allowed to exceed the mercury concentration. However, iodine removal was also very good (88 to 100 per cent) even in the absence of mercury, suggesting that mercury addition may not be needed.

Special Geological Studies

Completion of the fixed-price portion of the CA-700 well drilling project is expected by February 1, 1958, the closing date for drilling.

Observation Wells

Samples of ground water from wells in the vicinity of the BC cribs and trenches indicate that radioactive wastes have definitely reached the ground water from these disposal sites. The maximum concentration of gross beta active material detected in the ground water at this site was 7.6×10^{-5} μc/cc.

A new survey of ground water levels was prepared from recently collected measurements. The survey included data from 22 wells not previously available. A contour map prepared from these data clearly indicates the influence of a buried basalt ridge separating Cold Creek Valley from the rest of the area and which restricts the development of the 200 West ground water mound to the south. The ridge has a signficant influence on the ground water movement from the 200 West Area.

An isolated, flat mound of ground water north of Gable Butte represents water recharged to the local aquifers during the high river stage last spring. The subsidence of this mound represents the source of part of the ground water flowing through the permeable gravels north of Gable Mountain, thus helping to explain the mechanism whereby the Columbia River furnishes water for the Gable Mountain "underground channels."

Disposal to Ground

The two batches of in-farm supernatant scavenged by CPD this month contained Co^{60} below the recommended test disposal limit of 4×10^{-4} μc/cc. However, since both batches demonstrated poor cesium adsorption in soil column tests, they were discharged to the 216-BC specific retention trenches. Following processing of batch 29, the scavenging program was discontinued for an indefinite period. The following summary tabulates volumes and activities of scavenged wastes discharged to the three major disposal sites; the 216-BY and 216-BC cribs, and the 216-BC specific retention trenches.

Site	Volume (gallons)	Beta (curies)	Sr^{90} (curies)	Cs^{137} (curies)
216-BY cribs	8,945,000	408,510	14,784	3,141
216-BC cribs	8,857,375	300,255	1,407	1,539
216-BC trenches	17,213,000	590,000	5,380	7,000
Totals	35,015,375	1,298,765	21,571	11,680

The total beta activity in scavenged waste supernatant liquid discharged to ground represents about 55 per cent of the beta activity sent to all ground disposal sites in the 200 Areas.

A review was made of the history and technical aspects of specific retention disposal of radioactive liquid wastes in the 200 Areas. Recommendation was made that the limit of the volume of waste discharged for specific retention be lowered from 10 per cent to 6 per cent of the soil column volume. Document HW-54599, "A History and Discussion of Specific Retention Disposal of Radioactive Liquid Wastes in the 200 Areas," by W. A. Haney and J. F. Honstead, was issued on January 20, 1958.

Laboratory data are being obtained to determine the feasibility of disposing of Recuplex wastes to cribs pre-treated with nitric acid. The addition of this waste to untreated soils causes plugging of the crib. Pre-treatment with nitric acid may prevent this plugging. Pu is readily removed by soils at a low pH from most solutions.

Three samples of Purex boiling tank condensate wastes were tested by standard laboratory soil column techniques to determine the capacity of the 216-A-8 crib. Strontium breakthrough was demonstrated after the passage of 12 column volumes for two of these samples and after 16.5 column volumes for the third. The crib had received a total of 7.9 column volumes as of January 1, 1958.

A new method was developed to simplify the collection of effluent fractions from soil columns. The system permits the collection of an effluent sample directly on a counting plate to reduce the handling required. The plated samples are collected for a five-minute interval from each three-hour period, the remainder of the effluent being sent to waste. The plates are permitted to dry by natural evaporation.

Gelling of Wastes - Field Work

No significant change in the moisture content of the aluminosilicate gel in the 300 Area test disposal pit was noted during the month. The moisture content of the gel near the surface of the bed has remained at about 85 per cent (wet basis), and the gel at the bottom of the bed contains 75 per cent moisture. Maintenance of the gel at these relatively high moisture contents is contrary to previous observations noted in laboratory scale investigations. Exploration of the soil beneath the gel bed to resolve these differences in gel behavior is planned.

Laboratory scale tests were started to evaluate the effect of additives on moisture loss from aluminosilicate gel to soil. Additives being investigated are "Separan 2610," Fuller's earth, bentonite, and gypsum. Identical gel-soil columns were prepared with various amounts of the above materials added to the gel. After four days, moisture penetrated to the bottom of the soil in all columns except those containing "Separan 2610"; relatively low moisture losses were noted in both these columns. This indicates that if a cheap additive can be found which has moisture adsorption effects similar to those of "Separan 2610," several of the undesirable characteristics of the original gel recipe will be minimized.

Ultimate High-Level Waste Disposal

Heat generation calculations for Purex 1WW were completed. Gamma radiation absorption anticipated in a compact cylinder of calcined waste was estimated.

ANALYTICAL DEVELOPMENT AND INSTRUMENTATION

X-Ray Spectrography

The improved X-ray spectrograph mount has been completed and is now in use. It permits the sample specimen to be positioned above the X-ray tube in a turret mount which accommodates four samples up to 1.5 inches in diameter. (The ends of slugs or rods of indefinite length can thus be readily analyzed.) As-built drawings and photographs of the completed mount have been made.

Relative precision for the determination of uranium in aluminum-uranium alloy was estimated at ± 6 and ± 2 per cent at concentrations of 0.1 and 1 weight per cent, respectively. From 5 to 100 per cent uranium, the precision was ± 1 per cent. The relative precision for the determination of uranium in uranium dioxide-cryolite was very similar. This method is highly satisfactory from the viewpoint of accuracy and speed.

[redacted]

Coulometry

The recent experimental work on controlled potential coulometry has been extended to explore a technique heretofore referred to as derivative coulometry. This technique is applied to reversibly reducible species in solution by taking a first derivative electronically of the integrated coulometer current with respect to applied potential. The current maximum, therefore, should be directly proportional to the concentration of oxidizable or reducible material.

Several instruments have been constructed to perform the operation, and the extremely high sensitivity of the method was demonstrated by the successful detection of plutonium at a concentration of less than 10^{-6} M. The derivative coulometer technique is technically analogous to derivative polarography, but the former is more sensitive and is expected to be more precise, while having comparable selectivity. Derivative coulometry may make direct determinations of many ions in fuel processing solutions possible without tedious prior treatments or separations. The method may permit the determination of plutonium in the first cycle Purex process waste, although a separation of iron which interferes at high relative concentrations is necessary.

Square Wave Polarography

The polarographic equipment was slightly modified, and square wave polarograms of plutonium at less than 10^{-3} M were successfully obtained on a platinum electrode. Although polarographic work is usually done on a dropping mercury electrode, the metal electrode is of interest because of the possibility of mechanically simplifying in-line analysis instruments.

Alpha Standards

A vacuum metal vaporizer was put into operation, and high quality thin films of any alpha emitter can be formed on smooth surface discs by very simple techniques. Test discs of plutonium on smooth platinum proved to be at least equal in quality to electroplated discs for alpha energy analysis.

Prompt Fission Gamma Counting

The potentialities for plutonium determinations by gamma counting above 2.6 Mev are being explored. Above this energy, hard gammas due to the fission of Pu-240 can be detected without interference from fission products. Using a five inch by five inch crystal of sodium iodide, a counting rate of about 17 c/m/gram plutonium was obtained from a variety of plutonium sources. The method could be used for the estimation of the plutonium content in vessels where the physical form and orientation are uncertain but the Pu-240 content is approximately known.

Analytical Service

Uranium and plutonium mass spectrometry made fuller use of the new thermal ionization spectrometer. Time is saved in two ways: sample preparation is easier and scheduling is simpler because the instrument's zero memory effect permits consecutive

analyses of miscellaneous samples without regard for U-235 content variations. However, when very high precision is required on normal uranium the gas (UF_6) spectrometer can't be beat. Recent Union Carbide analyses of Hanford UO_3 differed from our values by only 0.0004 per cent, absolute (say 0.6840 per cent U-235 vs. 0.6844 per cent).

Numerous, unique chemical measurements were made. Low-level uranium in H_3PO_4--6 per cent HNO_3 was measured by using the flurimeter on hexone-extracted uranium. Aluminum nitrate distribution after solvent extraction was followed in aqueous phases by oxine analyses and in organic phases by aurintricarboxyllic acid color formation. Aluminum in feldspar (cesium source) was measured by leaching the aluminum and weighing its oxine complex. Uranium hold-up in cryolite slag was defined by flurimetric analysis of the uranium leached with nitric acid.

Radiochemical measurements included the first use of uranium burn-up analysis on ceramic fuels. No difficulty was observed in handling several UO_2 samples.

EQUIPMENT AND MATERIALS

Bearing Test Program

An air gage to measure bearing diameter accurately to 0.0001 inch was received. This instrument will increase the accuracy, speed, and reliability for measuring and evaluating bearing wear.

Preliminary data show that the presence of nitrate improves the wear properties of a 17-4 PH stainless steel journal operating against a Rulon* bearing. This combination, running submerged in water at 750 rpm and with 60 psi load, resulted in degeneration of the 17-4 PH journal surface. When the conductivity of the solution was increased by a factor of 100 by the addition of either nitric acid or sodium nitrate, the 17-4PH surface became polished.

Deepwell Turbine Pump Conical Slinger - Deflector Liquid Seal

The slinger cone deflector seal has been operated for 700 hours pumping water at an estimated 100 gallons per minute against a 100 foot head. Although some malfunctioning of the cone has been noted, leakage under these worst case conditions has been only 25 per cent of that noted on similar pumps not employing the cone. Additional studies are contemplated with slightly modified designs in an effort to reduce seal leakage even further.

Corrosion - HNO_3-HF and Titanium

A study of the effect of trace quantities of HF on the corrosion of titanium by boiling 8 M HNO_3 was made at the request of Facilities Engineering Operation, Chemical Processing Department. Special equipment permitting continuous flow of corrodant was used to compensate for any loss of fluoride. In the range 0 to 200 ppm fluoride, there was an approximately linear relationship between the fluoride concentration and the logarithm of the corrosion rates observed. The rates varied from about two mils/mo at zero fluoride to about 300 mils/mo at 200 ppm fluoride.

* Trademark for the Dixon Corporation filled Teflon.

[redacted]

NEW PROCESSES

Anion Exchange Process

Purex Concentration Step. Recent laboratory studies which showed acceptable absorption rates (corresponding to a column capacity of 66 g Pu/l resin at 50 per cent breakthrough) for Permutit SK at 60 C, excellent elution rates at temperatures of 40 C and higher, and chemical stability at least as good as for other 20 to 50 mesh resins, led to selection of Permutit SK over Amberlite IRA-401 for the Purex concentration steps.

Recovery of Pu from Purex 1WW. Column runs with Amberlite IRA-401 and Dowex 21-K at 25 C with synthetic Purex 1WW showed capacities at ten per cent breakthrough (corresponding to recovery of greater than 95 per cent of the feed plutonium) of 0.5 and 1.8 g Pu/l resin for Amberlite IRA-401 and feed concentrations of 2 and 10 mg Pu/liter, and 10 g Pu/l resin for Dowex 21-K and 56 mg Pu/liter feed.

Although low, these capacities are adequate to make application of this process to Purex 1WW economically attractive, particularly since installation of a Purex 1WW anion exchange unit will provide a separate rework facility for off-standard wastes.

Flurex Development

A half-replicate factorial experiment, designed to survey the effects of six cathode compartment operating variables on current efficiency for uranium reduction (yield) and product composition (ideally NH_4UF_5), was completed during the month. Statistical evaluation of the data has been made. Variables studied, listed in the order of their effect on yield, are UO_2^{++} concentration, cathode current density, temperature, NH_4^+ concentration, fluoride concentration, and product density. Slight, but statistically significant, variations in ammonium content of the product were observed as these variables were changed. The data permit estimation of equilibrium cathode composition for an operating cell and show how the variables may be changed to maximize yield.

A similar study of the effects of anode compartment operating variables on anodic corrosion of 347 and 304-L stainless steels is in progress. Data to date show increasing corrosion with increasing fluoride and nitrate concentrations, current density, and temperature. Anodic corrosion of Haynes 25 under expected operating conditions is intolerably high.

Further study of the applicability of membrane evaluation data obtained in "static" tests to operating conditions shows that changes in conductivity and potential are determined by time and temperature of exposure in a particular solution and are not affected by the presence or absence of an applied potential. These observations enhance the usefulness of static test data in predicting membrane performance and life under Flurex operating conditions.

The initial electrical resistance of Permutit 3142 cation membrane under Flurex cell conditions is 5-10 times higher than equilibrium resistance after prolonged use. Exposure of the "as received" membrane for one hour in water at 90 C converts it to the low-resistance condition.

[redacted]

A paper covering development work on the Flurex process has been accepted for presentation at the national American Chemical Society meeting to be held in San Francisco during April, 1958.

PROCESS CONTROL DEVELOPMENT

Assistance to Project-686

The Redox 2BP fluorothene gamma monitor sample cell acquired a high background during a recent column flushing operation. The background activity could not be reduced by additional flushing. The cell was removed for inspection and replaced with a glass cell, which has been performing satisfactorily. Examination of the interior of the fluorothene cell revealed a yellow transparent coating on the cell walls. It is believed that the coating is a product of the dissolution of the core material from the mold. Common reagents and solvents had no noticeable effect on removing this powder nor did ultra sonic cleaning. A mechanical cleaning employing stainless steel balls appears to adequately remove the material without damage to the fluorothene surface.

The vendor supplying these cells has been contacted and specifications and instructions for fabrication have been revised to minimize the formation of this material.

Assistance to the Purex Plutonium Resin Column Controls

Instrumentation associated with the Purex Plutonium Resin Column has performed reasonably well during hot startup. The absorptiometers and conductivity instruments have functioned without difficulty. Electronic troubles with the linear amplifier of the contact alpha counter have kept this instrument out of service. Effort is now being directed to correct this condition.

Assistance to Purex Plant

Installation of a pulse-type gamma monitor on the 100 stream is about 70 per cent complete. The turbo-mixer has been in operation, and laboratory analysis of the 100 stream indicates that about 97 per cent of the gamma activity is I^{131}. If subsequent data confirm these initial findings, it will be necessary to operate the monitor as a two or three channel spectrometer in order to detect ruthenium, and zirconium, in the presence of thirty times as much iodine.

Densitometer for Purex HA Column

Further tests with the prototype densitometer indicate that the unexplained drift reported previously is due largely to actual changes in specific gravity. These specific gravity changes are the result of temperature variation and evaporation of alcohol from the water alcohol mixture used in the tests. TBP in Soltrol is now used in the test runs to minimize the specific gravity changes. The variation due to temperature changes can be compensated for. Satisfactory operation is being achieved in the 0.90 to 1.0 specific gravity range.

A new float is being fabricated to decrease the overall range from 0.94 to 0.98 specific gravity units. If this range can be achieved, the plant model will be so designed.

[redacted]

Magnetic Flowmeter Test

The Foxboro Magnetic Flowmeter (modified for 0-2 gal/min flow) has logged 450 hours of operating time metering UNH solutions with specific gravities ranging from 1.5 to 2.4. The instrumentation of the test loop was altered to permit the magnetic meter to serve as the primary flow control element. After this change control within plus or minus one per cent of chart was obtained. Four magnetic flowmeters have been ordered for further evaluation in a plant test using one of the continuous calciners.

NON-PRODUCTION FUELS REPROCESSING

Mechanical Processing

Three approaches to mechanical processing of non-production fuels are in the preliminary evaluation stage. These include sawing, shearing, and pulverizing. Initially, experimental emphasis will be placed on cut-off sawing. A saw has been obtained and initial testing awaits its installation and the arrival of suitable cutting blades.

Zirflex Process

The solubility of uranium(IV) fluoride in boiling solutions of ammonium fluoride (of approximately six molar total fluoride) containing dissolved zirconium is given by the empirical expression

$$M_{U(IV)} = 6.9 \times 10^{-3} (M_{F^-})^{1.4} + 2.9 \times 10^{-4}$$

where M_{F^-} is the concentration of "free" fluoride defined as the total fluoride concentration minus six times the concentration of dissolved zirconium.

Solubility data at 22 C indicate that uranium losses can be reduced by a factor of three to four by cooling the solution to 22 C prior to discard.

Measured zirconium fluoride solubilities in ammonium fluoride at 100 C and 22 C decreased markedly as the ratio of fluoride to zirconium increased, as expected from the fact that the salt $(NH_4)_3ZrF_7$ is less soluble than the salt $(NH_4)_2ZrF_6$. Solubilities measured at 22 C ranged from 1.19 M zirconium at a fluoride to zirconium ratio of 5.9 to 0.13 M at a fluoride to zirconium ratio of 21. Over a range of fluoride to zirconium ratios from 6.0 to 21 zirconium solubilities at 100 C varied from 3.2 M to 0.34 M.

Addition of ammonium nitrate to the ammonium fluoride appeared to decrease the solubility of both uranium(IV) and zirconium. There was no indication of oxidation of uranium(IV) on addition of ammonium nitrate to ammonium fluoride.

Removal of Chloride from Darex Dissolver Solutions

Engineering Studies. Laboratory data on distillation, boil-down and solvent extraction for chloride removal from Darex process dissolver solutions were calculated

into engineering flowsheet values. Equipment sizes were being developed from these figures. This work is continuing in order to determine the costs of alternate methods for fuel processing.

Solvent Extraction. Studies were continued on the use of chromium(III) ion to aid in scrubbing chloride from organic phases (30 per cent TBP-Shell E-2342) produced by extraction of synthetic Darex dissolver solution. Eight scrub contacts (scrub solution - 3M HNO_3, 0.03 M $Cr(NO_3)_3$, 16 g/l UNH) at an organic/aqueous volume ratio of five reduced organic phase chloride concentration to less than 100 ppmp uranium. Present data indicate a dual scrub combination with chromium(III) nitrate only at the top of the column is preferable to a single scrub of chromium(III) nitrate-nitric acid. Batch extraction, scrub, and strip contacts were made on a synthetic Darex dissolver solution spiked with plutonium(IV) nitrate to Purex IAF level. The plutonium exhibited normal TBP-process extraction and strip behavior.

Volatilization. Work on the direct volatilization of chloride from Darex dissolver solutions will be discontinued for the present following evaluation of ruthenium evolution in the process. A summary report is in preparation. Optimum conditions (from the standpoint of HNO_3 usage and time) found so far involve initial concentration of the solution to a boiling point of about 130 C. Concentrated nitric acid (13-16 M) is then added continuously and volatilized at the same rate as added. The solution is air sparged throughout the process. Chloride content of synthetic Darex dissolver solutions can be reduced from 68 g/l. to about 0.1 g/l. in a total operating time of about 10 hours. Fourteen to twenty moles of HNO_3 per liter of dissolver solution are used. Much of this acid could be used in subsequent dissolution or chloride removal procedures. Persulfate and permanganate were found to accelerate chloride removal, but, because of large amounts required and probable subsequent processing difficulties introduced, their use is not considered promising.

Materials of Construction

Corrosion Studies

HNO_3-HF Systems. The feasibility of a single dissolver for dissolution of both production and non-production fuel elements is under study. The most severe environments (corrosion-wise) considered for this dissolver are HNO_3-HF systems. Accordingly, a search for a material of construction having improved corrosion resistance to these systems is in progress. Preliminary studies on the dissolution of 304-L stainless steel (cladding material) in HNO_3-HF systems established optimum HNO_3 concentration at 0.5 to 1.0 M and that satisfactory dissolution rates can be obtained at HF concentrations as low as 1 M. Corrosion rates for 309 SCb stainless steel, Haynes 25, and Hastelloy F and X alloys in HNO_3-HF systems were obtained. Corrosion rates for 309 SCb and Hastelloy X were prohibitively high. Haynes 25 showed satisfactory resistance to attack when completely annealed. When heated to 1200 F and water quenched, corrosion was increased and "as welded" coupons showed severe attack in areas adjacent to the weld. Hastelloy F has somewhat better resistance than Haynes 25. The samples used showed no sensitization on heat treatment. They were, however, unusually low in carbon content for this alloy (0.01 per cent - specification is 0.08 per cent).

[redacted]

HNO_3-HCl Systems (Darex). In long-term (240 hours) exposures to dilute aqua regia (5M HNO_3-2M HCl) under heat transfer conditions (metal temperature 135 C) corrosion rates of four and 18 mils/mo. were observed for titanium and Haynes 25, respectively.

Non-Metallic Materials

As materials of construction for the Darex system, several materials have been given room temperature static immersion tests. Conventional polyethylene, Super Dylan polyethylene, Marlex 50 polyethylene, Teflon, Kel-F, plasticized polyvinyl chloride, rigid polyvinyl chloride (Boltaron), Hypalon, and CSGBF graphite were tested in 2M HCl - 5M HNO_3. All showed excellent resistance. When these same materials were tested in 1M HCl - 12M HNO_3, the plastic polyvinyl chloride softened slightly but the other samples were essentially unaffected.

Titanium Welding Development

With the initiation of the construction of the 321 Building Darex installation, a program was initiated to develop the required techniques for the welding of titanium. During the month a cover for the dissolver was fabricated utilizing the inert-gas arc-welding process without the use of glove boxes. The resulting welds, although not altogether silvery in appearance, were soft and ductile as evidenced by malleability and scratch tests. They should prove corrosion resistant in this application. The development of techniques for joining pipes to tanks and pipes to pipes is planned in addition to refinements in field welding methods.

Support of Criticality Studies

Homogeneous UNH System. Preliminary studies were made to determine a satisfactory method to prepare a homogeneous mixture of composition equivalent to $UO_2(NO_3)_2.4H_2O$ and to define its handling properties. A suitable material was prepared by (1) dissolution of UO_3 in nitric acid to 60 per cent UNH, (2) concentration to desired H_2O/U ratio of 4(130-135 C boiling temperature), (3) cooling to complete crystallization, and (4) grinding and blending to a uniform mixture.

The preparation of approximately 600 pounds of $UO_2(NO_3)_2.4H_2O$ at 2.10 per cent U^{235} enrichment is in progress. This comprises the material needed for the first part of the full-scale phase of the PCTR criticality experiment to determine K_∞ for several homogeneous systems of enriched uranyl nitrate and water.

REACTOR DEVELOPMENT - 4000 PROGRAM

Zirflex Process

A sample of 1.5 w/o plutonium-aluminum alloy was exposed for 3.5 hours to a boiling solution containing 0.8 M $(NH_4)_2ZrF_6$ and 1.2 M NH_4F. The plutonium content of the boiling solution increased gradually from 0.07 mg Pu/l (at 15 minutes) to 0.16 mg Pu/l (at 3.5 hours). The latter value is lower by a factor of 15 than the result obtained in an earlier experiment employing 6 M NH_4F. A white coating formed on the alloy, but the bulk precipitate which had been seen in the earlier experiment was not observed. Further, the zirconium proved more soluble in the cooled

supernatant than would have been expected from solubility data obtained in the absence of aluminum. It is presumed that complexing of fluoride by dissolved aluminum reduced the free fluoride concentration, thereby increasing the zirconium solubility. This effect will be explored further, particularly the possibility of adding aluminum to the jacket solution to reduce the solubility of uranium(IV).

Exposure of a plutonium-uranium alloy (Pu/U = 1.1×10^{-3}) to boiling solutions of 6 M NH_4F containing various concentrations of dissolved zirconium resulted in a lower relative loss of plutonium than of uranium, as shown by the fact that ratios of plutonium to uranium in the boiling solution were lower than that of the original alloy, ranging from 7×10^{-4} in 6 M NH_4F to 2×10^{-4} in 6 M NH_4F containing 0.86 M zirconium.

Potassium hydroxide metathesis of the uranium(IV) fluoride which precipitated out on cooling the supernatant produced a readily acid-soluble product. Plutonium loss in the metathesis and washing steps was only about 0.01 per cent and the fluoride decontamination factor was about 250, approximately the same as was obtained in earlier metathesis experiments employing uranium(IV) fluoride alone.

Reprocessing of PRP Fuels by Amine Extraction

The extraction of uranium and nitric acid into ten per cent tri-laurylamine-two per cent n-octyl alcohol - Amsco was measured over a range of concentrations since this information is needed for flowsheet design purposes. The extraction coefficients (E_a^o) of both were quite low, compared to plutonium, and decreased with increasing concentration. Disengaging times and specific gravities were also measured. The disengaging times were smaller for aqueous continuous conditions than for organic continuous.

Other experiments showed that no second organic phase was formed when a 50 g/l plutonium solution was contacted with an equal volume of ten per cent tri-laurylamine - ten per cent n-octyl alcohol - Amsco. Aluminum containing feeds, simulating plutonium recovery from Pu-Al alloys, and feeds simulating processing of stainless steel clad fuels also did not give three phase formation.

Pyrochemical Processing

Eight samples of fused uranium(IV) chloride salt solutions prepared by dissolution of UO_2 in excess $KAlCl_4$ were reacted with excess aluminum in air at 770 C. All reaction times were 40 minutes. Partial reduction of the dissolved uranium occurred in every case even though the reaction is not favorable on the basis of available thermodynamic data. The extent of reduction increased with increasing uranium(IV) and aluminum concentration. The largest metal yield was 68 per cent and was found when 0.7 g UO_2, 10.0 g $KAlCl_4$, and 8.0 g Al were used in the experiment. Immediate emphasis is on determination of the reaction mechanism so that conditions for optimizing the metal yield can be found.

A sample of aluminum-165 w/o plutonium was contacted in air with a $KAlCl_4$-UCl_4 salt phase containing eight per cent uranium by weight for 40 minutes at 770 C. About 95 per cent of the plutonium entered the salt phase, and 40 to 60 per cent of the uranium entered the metal phase. The partition noted is signficant and represents an important step in the development of a pyrochemical process.

[redacted]

Aluminum-Plutonium Alloy Preparation

The prototype tilting induction furnace was operated a second time in order to demonstrate mechanical and handling problems to personnel charged with the responsibility for the design of similar equipment to be installed in the Plutonium Fabrication Laboratory. Two kilograms of aluminum-8.25 w/o uranium were prepared in two hours. Two flowsheet modifications were successfully tested; a minimum of cryolite was used such that the dross contained 15 w/o alumina, and the furnace was cooled to 900 C after pouring off the bulk of the salt phase and before pouring the metal, thus insuring a clean phase separation.

Aluminum-Silicon-Plutonium Dissolution Studies

Treatment of both Al-Si-Pu and Al-Si-U alloys with fifty per cent caustic resulted in their rapid disintegration. Upon cooling, the solution from the plutonium alloy formed a solid gel which was solubilized by prolonged contact with nitric acid. The solution from the uranium alloy was diluted 100 per cent with water, and no gel formed. It did, however, form a non-filterable (through a fine stainless steel frit) solid which dissolved in nitric acid to give a viscous colloidal solution which was not coagulated by boiling. The resulting solution was not suitable as a solvent extraction feed.

A document, HW-54819, by E. E. Voiland, has been prepared outlining the separations problems associated with silicon bearing PRP fuels.

Uranium Nitride Preparation

A 150 gram sample of uranium mononitride was prepared and given to Ceramic Fuel Development Operation for preliminary testing as a ceramic fuel material. The X-ray diffraction pattern agreed extremely well with published data for UN.

Mercury - 204 Preparation

A report, HW-54812, by H. T. Hahn, has been written on the production of low cross section mercury-204 for special reactor applications. The report surveys the potential of gas centrifugation, chemical exchange, liquid thermal diffusion, photoexcilation, distillation-diffusion, and barrier diffusion. Distillation-diffusion appears to be the best process for producing 99.5 per cent Hg-204 at a rate of ten kilograms per day.

PRTR Fuel Processing Study

The processing of PRTR fuel for plutonium recovery and recycling was being integrated with the similar work on power and propulsion reactor fuels. Dosage rates from Hot Semiworks load-out vessels were calculated. Similar calculations were made to assist in the evaluation of the radiation problems associated with the plutonium processing in the 234-5 plant where the problems are found to be more severe from the personnel exposure standpoint. Such problems are not entirely the result of the expected power reactor fuel processing program.

[redacted]

BIOLOGY AND MEDICINE - 6000 PROGRAM

Analytical Service

Single flurimetric uranium measurements were found to be as reliable as duplicates. Eliminating duplicates released 1/2 man for other work.

K^{40} in soapstone was calculated from flame photometer measurement of leached potassium. A spiking technique was used to correct for interferences.

At the request of the Industrial Hygiene Operation a rapid method was developed for determining monoisopropylbiphenyl. This compound is being tested as a reactor coolant, and its toxicity on inhalation is being studied. The method is based on a spectrometric measurement of the absorbance at 250 mu of the compound in a solution of 2,2,4-trimethyl pentane and is capable of determining as little as 10^{-9} grams.

Radioisotope Detection

A sample of Columbia River water taken January 21, 1958, from Pasco, Washington, was analyzed for rare earth radioisotopes by the new rare earth isolation and gamma spectrometric methods. Because of instrument failure the Eu^{152} concentration could not be determined, but the values of 9.6×10^{-8}, 3.0×10^{-8}, and 10.0×10^{-8} uc/ml were obtained for La^{140}, Ce^{143}, and Sm^{153}, respectively. Ce^{141} can be determined following a two week decay period. Adoption of these methods on a routine basis will provide five radioistope analyses at about the same cost and manpower requirements now used to obtain a total rare earth group value.

The Ga^{72} procedure developed for reactor effluent water samples was found to be readily adaptable to the larger Columbia River water samples. Analysis of the Ga^{72} in an aliquot of the same (January 21, 1958) sample used for the rare earth analyses showed a Ga^{72} concentration of 2.1×10^{-7} uc/ml.

Studies were renewed this month on modification of the plutonium bioassay procedure to allow analyses on 200 ml samples obtained from on-site sampling. The use of this smaller sample will simplify the chemical isolation of plutonium, but will require greater efficiency of the nuclear track counting procedure now used. Technique for small area electrodeposition shows promise of providing increased efficiency.

Dosimeter Studies

Neopentyl alcohol (2,2-dimethylpropanol) was found to be an outstanding protector in preventing the radiation-induced bleaching of erioglaucine. The large protective effect observed was anticipated from the manner in which protective index values varied with carbon chain structure in alcohols measured previously. The success of this approach suggests that other compounds with large protective indices might be discovered and prove to be capable of protecting living animals from the harmful effects of radiation without toxic chemical effects.

Geology and Hydrology

The Standard Oil Company of California stratigraphic test well on Rattlesnake Hills was abandoned at 8418 feet, still in basalt. The thickness of the basalt series in the Pasco Basin area thus is still in doubt, although the well is more than twice as deep as the next deepest (3616 feet) in the Rattlesnake Hills gas field about ten miles east of the Standard Oil well. Little water and no gas were encountered in the Standard Oil well. Geologic well logs showed no recognizable stratigraphic correlation to the gas field wells, nor could the attitude of the basalt flows in the well be determined.

Sampling data from a large-scale fluorescein tracer test in the region southeast of 200 East Area revealed the presence of the dye in a well 11,500 feet from the dye injection point. The fluorescein appeared in this well 70 days after being injected, representing an average rate of movement of 165 ft/day. The data again confirm the rapid movement of ground water through the glacio-fluviatile gravels of this region and extend the available information on specific rates and directions of ground water movement.

A study of the specific retention capacities of Hanford soils was initiated. Tests were performed and are continuing to evaluate a centrifuge technique for obtaining such data by attempting to establish a gravity-time-specific retention relationship. It was demonstrated that the gravity-time product is not a directly proportional function of specific retention. Initial tests with local Touchet sediments were performed at 1000 gravities for one hour. The 19.6 per cent specific retention by volume resulting from this test represents a field drainage of about 40 days. These results are known to be too high and further tests are needed to determine adequate corrections.

A further modification was found to be necessary in the equation describing unsaturated flow to correct for soil moisture content that does not flow under the impetus of a tension gradient.

Soil Chemistry and Geochemistry

A study was initiated to search for a suitable material for selectively removing cesium from waste solutions. Initial laboratory tests indicated that the cesium mineral pollucite ($Cs_2O.Al_2O_3.4SiO_2.H_2O$) shows great promise for this application. In laboratory column tests with this mineral better than 98 per cent of the cesium was removed from solutions passed through the bed even after the passage of 8.5 column volumes. The presence of 0.15 M sodium ion did not significantly reduce the cesium removal, indicating the great selectivity of the ion replacement mechanism. The addition of 0.5 M cesium ion to the solutions greatly reduced the per cent uptake of cesium. The cesium removed by this mechanism may be recovered from the bed by leaching with dilute nitric acid.

A significant advance was made in understanding the calcite-phosphate-strontium reaction mechanism. Phosphate solutions cause a replacement of calcite by poorly crystallized apatite, as determined by X-ray diffraction analyses. The reaction apparently occurs by the replacement of carbonate ions in the calcite crystal

lattice by phosphate ions from solution and subsequent rearrangement into the apatite crystal. The presence of brushite is apparently a transitory step in the reaction. The mechanism does not depend on the presence of strontium in solution, the strontium removal being incidental during the calcite transition. The alteration proceeds from the surface of the calcite crystals, hence the direct relationship between surface area, apatite formation, and strontium uptake.

Ground Waste Disposal

The effect of temperature on ion exchange in soil columns was further investigated. Columns were tested with Ba, Na, and Al as the saturating ion (Sr is the exchanging ion) to identify the reason for the temperature effect previously reported for columns saturated with magnesium and calcium. Based on data collected at 18° and 58° C there was little or no temperature effect with the barium saturated columns. With sodium saturated columns a more rapid breakthrough of strontium occurred at the lower temperature than at the higher. The reverse influence was found for aluminum saturated columns. These results corroborate the theory of ionic dehydration at elevated temperatures as the mechanism of the observed temperature influence.

Origin of Radioisotopes in Reactor Effluent

Eight samples of sulfuric acid obtained from different batches of acid being used for reactor process water treatment were submitted for arsenic determination. The arsenic content of these samples ranged from 0.01 ppm to 2.0 ppm with an average of 0.9 ppm. Since the maximum amount of acid used in process water treatment is about 12 ppm, the largest amount of arsenic that would probably be introduced into the water with the sulfuric acid is 2.4×10^{-5} ppm. Calculations indicated that about 5×10^{-5} ppm would be required to produce the average As^{76} concentration found in reactor effluent. Thus it may be possible to reduce the As^{76} discharge to the river by utilizing processing acid having a lower arsenic content, but this would not be expected to eliminate it completely.

Field Apparatus Development

A circuit employing thermistors for low liquid flow rates was tested; sensitivity was of the order of one cm per minute (47 feet per day).

Two humidity cells were assembled for possible application in unsaturated flow experiments. The sensing element consisted of methyl cellulose containing lithium chloride held between spiraled wires. For high resistance cells an exponential relation was found between resistance and relative humidity, the resistance changing by a factor of 1000 when relative humidity was changed from 60 to 100 per cent.

L P Bupp

Manager
Chemical Research & Development

LP Bupp:bp

[redacted]

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
F. M. Empson W. J. Lacy	1/6-8/	Union Carbide & Carbon Oak Ridge, Tennessee	To discuss waste disposal problems and soil column work.	JF Honstead JL Nelson CE Linderoth WA Haney DW Pearce RE Brown	Yes
L. J. Haight	1/8/	Johnston Pump Company Pasadena, California	Consultation on pump development.	J Dunn	Yes
R. D. Rowe P. Champman	1/8/	General Machinery Spokane, Washington	Consultation on pump development.	J Dunn	Yes
B. Anderson	1/17/	Chicago Operations Office Chicago, Illinois	Discuss pyrochemical processing at HAPO.	WL Lyon RH Moore OF Hill	Yes
Dale Johnson	1/20/	GE-ANP Idaho Falls, Idaho	Removal of radioactive contaminants from reactor effluents. Discuss problems attendant to clean up of reactor gases.	OF Hill LC Schwendiman	Yes No
G. W. Walpert F. Graf	1/20-22/	Phillips Petroleum Idaho Falls, Idaho	Discuss process equipment.	J Dunn	Yes
F. C. Mikels	1/22/	Ranney Method Western San Francisco, Calif.	Obtain geological and hydrological information, vicinity of Richland.	WH Bierschenk	No
EL Way, Jr. TJ Janus	1/27-28/	Mallory-Sharon Titanium Seattle, Washington	Present talk on titanium Welding products.	RJ Sloat	Yes
[redacted] G. W. Watt	1/20-24/	University of Texas Austin, Texas	Consultation.	LP Bupp OF Hill WH Reas LC Schwendiman	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. P. Bupp W. H. Reas	1/13/	UCRL Berkeley, California	Discuss recovery and chemistry of trans-curium isotopes.	SG Thompson	Yes
	1/14/	APED San Jose, California	Discuss programs of mutual interest.	RB Richards	No
	1/15/	Stanford Research Inst. Palo Alto, California	Inspect radiochemistry cells.	A. O'Donnell	No
	1/16-17/	Atomics International Canoga Park, California	Inspect radiochemistry cells.	EE Motta D Bareis JP Howe	Yes
A. S. Wilson	1/15/	American Institute of Electrical Engineers Wenatchee, Washington	Present Talk.	VJ Fitzgerald	No
D. L. Reid	1/11-16/	ASTM Conference New Orleans, La.	Attend ASTM Committee - D-19 Meeting		Yes
R. J. Sloat	1/13-21/	Northern States Power Milwaukee, Wisconsin Detroit Edison Detroit, Michigan Westinghouse Pittsburgh, Pennsylvania North American Aviation Los Angeles, California General Electric San Jose, California	Consultation on non-production fuel reprocessing.		No
[redacted]	1/15/	Division of Production AEC Washington, D.C.	Discussion on programs required for nuclear safety.	FP Baranowski A Purge	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
A. M. Platt	1/17/	Division of Research & Division of Reactor Development - AEC Washington, D.C.	Attend meeting on trans-uranium products.	H Freeman SG English I Zartman	Yes
D. W. Pearce	1/21-22/	ORNL Oak Ridge, Tennessee	Meet with American Petroleum Institute Committee	W. deLaguna EG Struxness	No
R. W. Perkins	1/27-29/	National Bureau of Standards (AEC) Washington, D.C.	Attend scintillation symposium meeting.	WB Mann	No
	1/30-31/	Savannah River Aiken, South Carolina	Discuss bio-assay procedures.	SM Sanders	Yes
E. T. Merrill	1/29-31/	Phillips Petroleum Co. Idaho Falls, Idaho	Discussions of rare gas processing, MTR Pu fuel element processing, & waste processing - attendance at AEC Conference.	JL Schwennesen F Baranowski and representatives of duPont, Phillips Petroleum, BNL, & Carbide & Carbon Chemical Co.	Yes
		GE - ANP	Review plant design.	KC Vint	Yes

A. Organization and Personnel

Dr. Leo K. Bustad, Manager, Experimental Animal Farm, started a one year's leave of absence this month to continue his post-doctorate studies at the University of Washington with a National Sciences Foundation Fellowship. Dr. W. J. Clarke has been appointed Manager, Experimental Animal Farm, during Dr. Bustad's absence.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Atmospheric Contamination

Concentrations of I^{131} in thyroid glands of jack rabbits were 6 to 20 times less than those observed one year ago. Values were as follow:

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

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

Sample Type	Average μc/g	Trend Factor
Bone	7×10^{-5}	+ 2
Feces	5×10^{-5}	+ 2
Liver	7×10^{-6}	-
Muscle	7×10^{-6}	-

Columbia River Contamination

Sample Type	Collection Site	μc/g wet wt. tissue Average	μc/g wet wt. tissue Maximum	Monthly Trend
Minnows (entire)	Hanford	1×10^{-3}	2×10^{-3}	- 5
Whitefish flesh	Ringold	5×10^{-4}	8×10^{-4}	- 4

[redacted]

The concentration of radioactive contaminants in all aquatic animals decreased during the month because of reduced metabolic rates which were associated with low water temperature.

Effect of Reactor Effluent on Aquatic Organisms

Chinook salmon eggs were hatched in a 4.0 per cent concentration of reactor effluent and in an equivalent amount of effluent which was varied in concentration from 3.0 per cent to 6.2 per cent to simulate the magnitude of the fluctuation which may occur in the Columbia River when power is produced at Priest Rapids Dam. No adverse effects have been observed in either of the conditions.

Chinook salmon eggs also hatched in a test designed to compare the toxicity of 4.0 per cent effluent from experimental tube No. 4963 of the KE reactor with a like concentration of the gross effluent. No adverse effect is yet evident from either type of effluent.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM AND TOXICITY OF RADIOACTIVE MATERIALS

Phosphorus

At the end of five months, approximately 30 per cent of trout receiving 0.6 μc P^{32}/g body weight each day had died from radiation damage. Isotope feeding to this group was discontinued at the end of the month since most fish no longer accepted food. A reduction in rate of growth has become more apparent in the 0.6 μc and 0.06 μc groups. Analysis of the blood of the 0.6 μc group previously showed the P^{32} to be associated with the albumin component. The albumin fraction is now absent and the P^{32} is in another, as yet unidentified, blood protein. At the 0.06 μc level, the concentration of P^{32} in the soft tissues has remained at about the same level since the third week. On the other hand, a marked increase in the concentration of P^{32} (3 to 5 times previous values) occurred in the hard tissues between the 12 and 16 weeks. The reason for this increase is not clear.

Zinc

Aquaria containing populations of plants and animals were spiked with different concentrations of Zn^{65} to determine the amounts of the isotope that should be used for tracer in future experiments.

Strontium

Effect of time after contamination with Sr^{90} was tested by removing a portion of soil from outdoor plots contaminated four years ago and adding Sr^{85}. Barley grown in this soil showed similar leaf concentration factors for four-year-old Sr^{90} and fresh Sr^{85}. This demonstrated that there is no chemical or physical binding process which has changed availability during the four-year period Sr^{90} was in the field. Since the soil was heated to oven temperatures, biological factors could still exist which would affect the availability of Sr^{90} under field conditions and which would have been overlooked in these tests.

[redacted]

Bean plants were grown in the greenhouse on Cinebar soil contaminated with Sr^{89} and Ca^{45}. The experiment was set up to test additions of calcium in the form of calcium chloride, calcium sulphate, and calcium carbonate, each at two levels: 4,000 and 8,000 pounds calcium per acre. Concentration of both Sr^{89} and Ca^{45} increased as the plant matured. All treatments reduced Sr^{89} concentration in the mature plants. The $CaCl_2$ treatment appeared to stimulate Sr^{89} in the initial harvest which would correspond to the stage of growth in a Neubauer culture. Both the concentration and the anion in combination with calcium were factors in the extent of reduction of Sr^{89} concentration. Chloride was significantly less effective than were carbonate or sulfate, even though the latter two may have been only partially soluble in the soil moisture, the higher level of $CaCl_2$ was extremely toxic to the beans with some toxicity also expressed with the lower level of $CaCl_2$.

One hundred and four rats were started on diets containing from 0.03 to 2.0 per cent calcium. After a conditioning period of 30 days, Sr^{90} and Ca^{45} will be added to the diets and the animals sacrificed at intervals to determine the effect of dietary calcium level and duration of exposure period on the deposition and retention of Sr^{90} and Ca^{45}.

Further analysis of the data from the Sr^{89} lamb-feeding experiment suggests that there is a distinct correlation of skeletal size to calcium content and Sr^{89} uptake for each skeleton. It appears that lambs in the same age, weight and nutritional range vary as to calcium per gram of bone and Sr^{89} uptake in direct relation to skeletal size. Lambs with the larger (heavier) skeletons show the greatest effect of 3 x-calcium enrichment of the food by a decrease of 56 per cent in Sr^{89}:Ca ratio, as compared to the controls, while the smaller skeletons show only an 8 per cent decrease in Sr^{89}:Ca ratio. The data suggest that in future experiments on the assessment of radio-strontium hazard in large animals, an attempt be made to group animals by skeletal density and metabolic rate to insure that data so obtained be extrapolatable among groups.

Iodine

In continuation of the chronic I^{131} feeding experiment in swine, new groups comprising the 1957 offspring were established. The following table shows the I^{131} feeding level, number of animals and nutritional plane of the new groups:

Levels Fed	5 μc	1 μc	Control
No. of Animals	6	6	6
Nutritional Level	85% of Full feed	85% of Full feed	85% of Full feed

[redacted]

The effect of continued low-level I^{131} feeding to sheep is summarized in the following chart of Q/D for the various groups:

	5 μc/day			1.5 μc/day			0.5 μc/day			0.15 μc/day		
	1/57	12/57	1/58	1/57	12/57	1/58	1/57	12/57	1/58	1/57	12/57	1/58
1951-52 Offspring	1.5	1.0	0.9	2.4	2.3	2.4	2.6	2.5	2.4	3.7	2.7	2.9
1954 Offspring				2.2	1.3	1.5	3.5	2.6	2.7			
1955 Offspring				1.8	1.8	1.7	2.6	2.3	2.4	3.5	3.2	3.7

One animal in the 5 μc group continues to show a diminishing avidity for I^{131} during the past year, having a Q/D of 0.9 or less for this period.

Cesium

Observations were continued on the ecosystem of a small pond which was spiked with Cs^{137} last June. The concentration of the isotope remained low at approximately the same values as observed during the previous month.

Plutonium

Following intravenous injection of citrate complexed Pu (IV), retention has been determined in various organs and tissues over periods extending to 42 weeks. Preliminary evaluation of the data revealed somewhat unexpected results. Although a portion of the plutonium deposited in liver and kidney is lost quite rapidly, a substantial fraction is retained with at least as long a half-life as that exhibited by the plutonium in the bone. The half-life of plutonium in the bone appears to be approximately one year. The highest concentrations of plutonium by a factor of approximately 10 are present in bone. Plutonium deposited in the spleen, lung and ovary shows no significant turnover. Excretion data to compare with these retention results are not yet available.

Radioactive Particles

Histological examination of lung tissue from mice intratracheally administered radioactive particles is continuing. Pathological changes appeared to be more numerous in these mice administered dibenz(a,h)anthracene simultaneously with $Pu^{239}O_2$ and $Ru^{106}O_2$ particles.

Preliminary data from inhalation experiments with $Sr^{90}SO_4$ particles indicate the rapid movement of Sr^{90} to the bone. In one mouse killed after 190 hours' exposure to air containing 1×10^{-5} μc $Sr^{90}SO_4$ particles per cc (over a 10-week period), 85 per cent of the total body burden (0.09 μc), was in the bone, 12 per cent in the skin and only 0.5 per cent in the lung. Except for the large per cent in the skin, similar results are being obtained following a single exposure.

The excretion of Pu^{239} by three dogs administered 300 μg $Pu^{239}O_2$ intratracheally can be described by power function equations of the type $Y = at^{-b}$ where Y is the daily rate of excretion in per cent of the administered quantity, a is a constant representing the excretion rate, t is the time after administration in days and b is a constant describing the slope of the logarithmic curve. For the period 2 to 47 days after the administration of plutonium oxide, Y (urine) = $1.7t^{-2.8}$ and Y (feces) = $5t^{-2.1}$.

Gastrointestinal Radiation Injury

Histopathological analyses were completed on 65 rats which had received 12, 15, and 25 mc/kg oral doses of Y^{91}. Results show no damage to the radiosensitive small intestine, but severe damage to the large intestine and cecum. This reversal of the effects noted following x-irradiation is reasonable in view of the much longer retention of the intestinal contents in the cecum and large intestine as compared to the small intestine.

Additional experiments were completed to demonstrate the effect of x-irradiation on nucleic acid synthesis in the gastrointestinal tract as affected by type and extent of exposure. The synthesis of DNA is almost completely inhibited by 1500 r to either the whole body or to the exteriorized intestine. This inhibition was sustained until death, at 3.5 days, of the whole-body exposed animals. In the case of the intestinally exposed animals, recovery of synthetic ability was rapid, especially in regions of the jejunum and colon adjacent to unirradiated tissues. Inhibition of DNA synthesis following abdominal exposure was dose dependent, increasing from 50 per cent inhibition at 600 r to 80 per cent inhibition at 900 r and further increasing by about one per cent for each additional 100 r up to a total dose of 1900 r.

Relative Biological Effectiveness

Carrier-free P^{32}, currently being obtained from Oak Ridge, gives iron dosimeter values approximately half those previously obtained with P^{32} containing carrier phosphorus. Consequently, RBE values appear to be much lower than previously reported. The cause of the change is unknown and it is uncertain whether the present values are the correct ones.

Continued testing confirms the original observation that phosphorus diffuses into the solution in which irradiated cells are suspended. There is evidence that glucose, although not required, increases the diffusion of phosphorus from both irradiated and control cells.

Yeast containing metabolized P^{32} dies off at a slightly faster rate than does yeast containing no metabolized P^{32} but suspended in a P^{32} solution to provide equivalent radiation exposure. Dosimetry is not entirely clear, but the results do suggest a possible transmutation effect.

HA Kornberg
Manager
BIOLOGY OPERATION

HA Kornberg:es

[redacted]

1237818

C. Offsite Visits and HLO Visitors

Name	Dates of Visit	Company or Organization Represented and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
VISITORS TO HAPO						
Science teachers	1/3/58	Spokane schools	Tour facilities	Foster, Davis, Clark	No	100-F, 141, 146-FR
Members of AFSWP	1/7/58	Armed Forces Special Weapons Project	Tour facilities prior to temporary assignments in Biol.	Thompson, Bair, Foster, Davis, Clarke	No	100-F, 108, 141, 146-FR
Members of Columbia River Advisory Group	1/14/58	Northwest Public Health Services and Pollution Control Commission.	Tour facilities	Warner, Foster, Clarke	No	100-F, 108-F, 141, 146-FR
Members of "See It Now" TV show	1/27-30/58	CBS, New York City	Film various phases of Biology research.	Kornberg, Bair, Davis, Foster, Clarke, Case	No	100-F, 108-F, 141, 146-FR
Dr. M. E. Ensminger	1/31/58	Dept. of Animal Sciences, WSC, Pullman, Wash.	Discuss and consult on large animal research.	Clarke	No	100-F, 141
VISITS TO OTHER INSTALLATIONS						
H. A. Kornberg	1/8-13/58	Univ. of Wash., Seattle Div. of Biol. and Med., AEC, Washington, D.C.	Attend conference mtg.	C.L. Dunham P.B. Pearson	No	
W. C. Hanson and R. C. Pendleton	1/8	WSC, Pullman	Discuss ecology.	Dr. Buss and associates.	No	
H. A.Kornberg	1/30-31/58	Univ. of Washington Seattle, Wash.	Present a seminar.	Dr. Edmondson	No	

D. Lectures

a. Papers presented at meetings

None

b. Seminars

January 22, 1958 - R. F. Palmer, "Effect of Dietary Calcium Level on the Chronic Deposition of Sr^{90} and Ca^{45} in Rats"

- J. F. Cline, "The Effect of Added Calcium and Cultural Methods on the Uptake of Radiostrontium by Plants"

January 29, 1958 - W. J. Clarke, "The Effect of the Presence of Calcium Gluconate or Sodium Gluconate on the Deposition of Sr^{89} in Lamb Bone"

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

January 31, 1958 - H. A. Kornberg, "Hanford Biology Research Program" - presented at the University of Washington, Seattle, Wash.

January 18, 1958 - W. C. Hanson, "Studies Involving Wildlife at HAPO" Class at Columbia Basin College.

E. Publications

a. HW Documents

Sullivan, M.F., P.L. Hackett, S. Marks, and R. C. Thompson, "X-Irradiation of the Exteriorized or in situ Intestine of the Rat," Document HW-52896 (UNCLASSIFIED) January 1, 1958.

b. Open Literature

None

[redacted]

[redacted]

OPERATIONS RESEARCH & SYNTHESIS OPERATION
MONTHLY REPORT

January, 1958

ORGANIZATION AND PERSONNEL

There were no significant changes in personnel this month.

OPERATIONS RESEARCH ACTIVITIES

Economic Studies

Planning for the construction of an economic model of HAPO, with particular reference to the work being done at Appliance Park, was continued. Further discussions with Dr. Martin Shubik are planned during February. Work was continued on the series of papers discussing the mathematical formulation of pertinent economic concepts.

Work was continued on the application of learning curve concepts to the prediction of future operating and capital costs. This theory seems to fit the data for plutonium cost very well, but the question arises as to whether or not these curves are unique or a function of the general economy of "growth" industries during this period. In order to check this point similar curves for several other industries are being examined.

Further work was done during the month toward formulating and describing the impact that full adoption of the economic ground rules would have on Hanford. Both plant operation and capital additions have been considered since it is impossible to appropriately evaluate capital additions without simultaneous optimization of plant operations under the prescribed conditions. It is becoming apparent that full use of the ground rules will involve a numerical system of engineering analysis of appreciable magnitude.

Discussions were held during the month with members of the Advance Engineering Operation of the Reactor and Fuels Research and Development Operation concerning the field of application of the plutonium recycle process dictated by economic considerations.

CPD Control Study

A document giving the general scope of the CPD Control Study was issued. The basic process flow diagrams have been brought up to date and verified with the process engineers. Matrices describing all currently feasible transfers into and out of each process vessel have been organized and produced for the Purex, Redox, Recuplex and 234-5 processes. This system permits a concise representation of the process in a form convenient for the examination of the relationships between source data and accountability information.

[redacted]

The collection of operating procedures, vessel instrumentation, overflow volumes, flow rates, analytical requirements and sampling facilities was completed for Redox and Recuplex and is being compiled for Purex and 234-5 This information will also be presented in matrix form. A detailed tabulation of Redox and Purex material transfers is being examined to gain an understanding of the flow of accountability information.

Other

At the request of the Utilities Operation, R & U, the electrical distribution study previously completed by the Operations Research Section is being brought up to date and extended.

Discussions were held with Purchasing and Stores management concerning measuring and the measuring process.

Further discussions were held with IPD Employee Relations personnel in connection with sensitivity survey results.

STATISTICAL AND MATHEMATICAL ACTIVITIES IN SUPPORT OF RESEARCH PROGRAMS

2000 Program - Metallurgy

Further discussions were held with personnel of the Coating and Corrosion Operation concerning a recently completed in-pile experiment to investigate the corrosive properties of M-388 and 1245 aluminum alloys. The current purely multiplicative model for uniform corrosion does not account for the variability in the data from these experiments. A new model treating temperature as the fundamental independent variable was suggested, and an IBM 650 routine for fitting the new model to current data is now being written.

2000 Program - Reactor

For a member of the Physical Metallurgy Operation, Fuels Development Operation, a non-linear partial differential equation which arises in the theory of diffusion was transformed into a linear equation whose solution was easily obtained.

2000 Program - Separations

Work was continued on the determination of confidence limits on the square of the slope parameter in a linear regression scheme. This problem arose in the determination of the buckling of a random dumping of uranium slugs in a bath. Closer examination of the experimental situation revealed a between-experiments variation not accounted for in previous models. As a consequence a new mathematical model was postulated, and confidence intervals for the mathematical expectation of the slope were derived. The results were reported orally to personnel of the Critical Mass Physics Operation.

4000 Program - PRP

Further analysis was done on new data from a Ceramic Fuels Development Operation UO_2 capsule irradiation experiment to determine the dependency of fission gas activity on packing density, enrichment, neutron flux, exposure time and surface area. The use of accurate data on the average neutron flux for each capsule as a concomitant variable in a covariance analysis yielded results which correlate much better with current theory than those from the previous analysis based on two arbitrary neutron flux levels.

6000 Program - Biology

Experimental data on the deposition of Sr-89 in lambs were re-analyzed with a view to determining the statistical significance of various factors, including specifically the gluconate ion of sodium and calcium compounds. The results of the investigation were reported to interested personnel of the Experimental Animal Farm Operation.

Experimental data on the intratracheal administration of Pu to dogs were statistically analyzed for the Pharmacology Operation. Estimates of the rates of fecal and urinary excretion were obtained and reported orally to interested persons. Excretion data from an inhalation turn-over experiment with mice are also being analyzed for the Pharmacology Operation.

Work was continued on a generalized mathematical model of migration to describe the transition of radioactive tracer particles from region to region within an experimental animal.

At the request of the Aquatic Biology Operation, work has begun on the statistical analysis of data from miscellaneous fish tests.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR THE PRODUCT DEPARTMENTS

Process Control - Fuels Preparation Department

A discussion of plans to be used in the acceptance sampling of I and E fuel elements rejected by the Penetration Tester was given in a letter to T. D. Naylor, "Sampling Plans for Penetration Tester Rejects," 1-28-58. A double sampling scheme was proposed as a possible means of reducing necessary sample sizes, and criteria for proper choice of lot size were included. It was emphasized that experimentation currently under way, which is designed to test the efficiency of the instrument, would be helpful in testing the validity of the assumptions underlying the proposed sampling plans.

Further training sessions on techniques and principles of statistical quality control were conducted for Quality Control technicians and engineers as requested. The dangers of over control of a process and the need for a process capability study were vividly demonstrated. Preliminary groundwork has been laid for conducting such a process capability study.

Experimentation has been designed to evaluate the effects on certain reject rates of using reclaimed M-388 aluminum in the canning process. Considerable savings can be affected if it is found that the effects are not deleterious.

[redacted]

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

Data from the non-enriched portions of production test IP-30-A were analyzed to determine the hole size for cored slugs optimum with respect to irradiation effects on warp, diameter change, and/or breaking strength. This test represented the first successfully completed Latin Square arrangement for treatments in a production test and the resulting data analysis will be valuable in designing future tests in that several variables previously ignored could be evaluated by means of this design. (HW-54596 RD, "Analysis of Data from Production Test IP-30-A: Determination of Optimum Cored Slug Hole Size," 1-20-58.)

The analysis of data from Production Test PT-610-60 MT is almost complete. This test was designed to determine the relative dimensional stability of slugs machined from vertically heat treated rods having various quench treatments. Five different treatments, including a standard, were involved, and a Latin Square design was used. A report will be issued in February.

Profilometer Study - Irradiation Processing Department

A profilometer has been installed in the C-Basin to measure warp, diameter, ellipticity, and length of irradiated fuel elements. Brass standards have been measured by this profilometer in a series of runs in order to evaluate its precision and accuracy. The resulting data are currently being analyzed.

Rupture Studies - Irradiation Processing Department

In connection with rupture studies, it is of interest to estimate how many tubes in a given pile have one or more slugs operating above a given power level. Using randomly selected weasel data, which yielded the power factors for the maximum powered slug in each tube, it was possible to estimate the number of tubes whose maximum powered slug would be expected to have a power factor F with α% confidence. Curves were prepared for different combinations of values (F, α).

Two sets of curves useful in designing and analyzing run-to-rupture tests were prepared as requested. One set gives the upper limit of the rupture rate at exposure $\underline{x}$ as a function of $\underline{x}$ for different confidence levels, given that 4 tubes are exposed to exposure G without a rupture. The other is useful in determining to what exposure $\underline{n}$ tubes must be irradiated without a rupture in order to demonstrate a given improvement over a second set of $\underline{n}$ tubes which are discharged after having sustained one rupture at exposure $\overline{E}$.

Radiation Exposure Study - Chemical Processing Department

Statistical assistance is being given in connection with a radiation exposure study in "Z" plant. Historical data have been studied in order to determine the effects of pile exposure on certain radiation measurements. Data from a sampling program to evaluate the effects of moving across the various tasks within the "Z" plant will be analyzed to determine how accurately one can predict exposures based on certain input data.

[redacted]

Final Product Specifications - Chemical Processing Department

Tolerance statements are being prepared for weapons parts which were shipped to Los Alamos during the fourth quarter of the calendar year 1958. The statements demonstrate the conformity of the product quality to specifications.

Other

Appropriate methods of inverting a complex power series were discussed with a member of the Research Engineering Operation, IPD.

Consultation services have been provided Redox personnel on the feasibility of using a curve based on recent production vs. production cost data as a basis of comparison with a so-called "bogey curve" which is used as a goal criterion.

Questions arising in the analysis of data from a fractional experiment were answered for personnel of the Redox Analytical Control Laboratories.

OTHER STATISTICAL AND MATHEMATICAL ACTIVITIES

Activities for other Operations

An investigation was made of the uncertainties associated with plutonium yields and U-235 consumption estimated as functions of megawatt days and tonnage. Alternate formulas for estimating the variance were developed. This was done in connection with a requested study of the proposed tube by tube accounting system. (HW-54692 RD, "Comments on Tube by Tube Accounting," 1-24-58.)

Work has been completed on calibrations for the C-1 and E-12 tanks of the Redox plant. (HW-54554, "Statistical Analysis of the C-1 and E-12 Tank Calibration Data.") The calibrations agree with previous calibrations to the extent that little light is shed on recent shortages in the UNH storage area.

Discussions were held with the Industrial Medical Operation concerning the analysis of the genetic effect of x-ray radiation on the population of Richland.

Activities within HLO

Assistance was given to the Reactor Lattice Physics Operation in setting up the format for a computational routine to evaluate a least squares regression line and provide estimates of its precision.

Further statistical work was done for the Spectrochemical Analysis Operation concerning the precision and accuracy of their monthly production U-235 composite estimate. Data from receiver analyses are being correlated with September, October, and November HAPO data to determine whether or not there is a consistent bias between the two methods.

Work was initiated for the Spectrochemical Analysis Operation on a precision and accuracy study of their new method of isotopic analysis based on thermal emission mass spectroscopy.

[redacted]

Discussions were held with the Radiological Chemical Analysis Operation concerning the precision of their fluorophotometer. Specifically, the effect of duplicate analyses on precision was discussed.

An evaluation of the 1957 minor injury experience for HLO and FPD was initiated for the respective Employee Relations Operations with the hope of determining a realistic goal for reduction of minor injuries in the next year.

The Radiological Development Operation requested assistance in calibrating their new pulse method of reading pencil dosimeters. Some data from field and laboratory studies have been analyzed, and suggestions were made concerning the direction of future investigations.

In connection with the environmental monitoring study, further work was done on determining the relative precisions of the wet chemistry and the gamma spectroscopy methods of assaying vegetation I-131 content. The results of this evaluation are in line with the factor of three previously mentioned by the Analytical Chemistry Operation.

Statistical and Mathematical Research and Development

The study of stationary time series was continued.

OFFSITE VISITS AND VISITORS.

Dr. Arnold Fritch, Dr. Kuan Sun and Charles C. Thomas of the Westinghouse Electric Corporation visited the Operations Research & Synthesis Operation on 1-29-58 for discussions connected with Operation Pool.

W. H. Bloodworth of the Operations Research and Synthesis Consulting Service visited on January 21 and 22 for consultation on operations research problems.

There were no offsite visits during the month.

Carl A. Bennett

Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

CAB:jbk

[redacted]

RADIATION PROTECTION OPERATION
MONTHLY REPORT - JANUARY, 1958

A. ORGANIZATION AND PERSONNEL

Organization

No significant organization changes occurred.

Force Summary	12-31-57	1-31-58
Exempt	44	43
Nonexempt	152	123
Total	196	166

B. ACTIVITIES

Radiation Monitoring

Routine surveys for customers located in the reactor areas indicated no unusual conditions except for minor amounts of particulate contamination in the 100-B Patrol Headquarters which was attributed to the recent contamination status of the 107-C tank.

Excessive concentration of plutonium air contamination occurred in the 231 building from a spread of plutonium contamination of undetermined cause.

Normal radiation work was accomplished in Hanford Laboratories facilities in the 300 Area. Exposure rates ranged up to 5 r/hour.

Conferences were held with AEC-HOO and the U. S. Army to discuss mutual aid in emergencies and radiological training for a new military component. Other discussions were held on retraining AEC couriers, the course for offsite monitoring teams to be given at Idaho Falls and HOO-HAPO emergency plans.

A detailed report of Radiation Monitoring is contained in HW-54844.

Regional Monitoring

The average weekly emission of I^{131} was 6 curies. The average for the last year was 7 curies. Iodine-131 deposition on local vegetation decreased to a more normal level of one-third that measured in December.

Raw water analyses at 100-F and Pasco showed 9.6% and 3.0% respectively of the continuous occupational MPC_{GI}. A study, currently in progress, indicated that the effect of a line break of the 100-KE and 100-KW effluent lines would cause excessive contamination of the 100-D Area drinking water. A summary report of this study will be issued in February.

A detailed report of waste disposal monitoring is contained in HW-54836.

Exposure Evaluation and Records

Four cases of plutonium deposition, all appearing to be less than 10% of the MPL, were confirmed during the month. One case had potential for substantial deposition and involved a process operator who was sprayed with a plutonium solution resulting in nasal smears up to 40,000 d/m Pu and loose facial contamination in excess of 40,000 d/m.

A total of 216 confirmed plutonium cases is on record, including a total of 18 cases which occurred in 1957. Several cases still pend confirmation.

Four technical overexposures occurred. Two were whole body exposures and involved a maximum whole body dose of 745 mrads including 115 mr. Two were localized exposures and involved a maximum dose of 3.6 rads to the hands.

Work was started in Chemical Research and Development on procedures for determining plutonium and fission products in bioassay samples with the objective of on-plant sampling.

Radiological Development

Reproducibility was improved in the densitometer measurements made on badge film by increasing the aperture size of the densitometer and collimating the light on both sides of the film. Equipment modifications were scheduled. Testing of the Eastman Personal Monitoring Film Type II continued for both fading and consistency of product.

As a result of HAPO interest in protective clothing specifications, AEC-HOO has initiated a survey of other atomic installation clothing specification activities. Very little work in this area appears to have been done at other sites.

Additional data collected with the low-level pencil reading device were very encouraging for application in regional measurements. Pencils were placed at various house locations in surrounding communities to obtain background measurements.

Development of methods for field use in estimating surface dose rates was active. Work also progressed on the fabrication and testing of the double moderator neutron dose rate meters.

Calibrations

Modifications on the calibration wells were completed. This puts both wells in good operating condition. Field user groups were surveyed for portable instrument requirements. There will probably be no need for additional instruments for the next two years.

The preparation of field check sources was completed. This added service to field groups will provide a complete set of identical sources for use in checking the operability of portable instruments.

Radiological Consultation

Several discussions were held on the tabulation of dose to the gonads during diagnostic examinations at the Kadlec Hospital. Factors were selected for application to the gonad dose of the fetus, and procedures to be followed in calculating the effective genetic dose were designed. Supplemental measurements of the gonad dose

following recent changes in procedures including better coning of the machines and the use of faster film were scheduled.

An Emergency Handbook draft prepared by a Subcommittee of the National Committee on Radiation Protection and Measurements was reviewed and comments were made.

Radiological Disaster Studies

The calculations on dispersion and deposition of radioactive materials from a reactor accident were extended to provide plots of the areas exposed to given levels. These curves supplement the previously issued curves on distances involved and permit the rapid estimation of the area contaminated to a given level. Separate curves were obtained for gross fission products and halogens.

The limits used in estimating lethal conditions as well as other damaging conditions to individuals exposed to a cloud from a reactor accident were reviewed and new limits derived. It was found that the limits for damage of this nature were dependent upon the wind velocity and to some extent upon the meteorological conditions because of the assumed variation in rate of deposition from the cloud and the consequent change in total body irradiation from the material deposited on the ground.

Columbia River Studies

The annual Columbia River Advisory Group meeting was conducted January 14-16, and included a tour of the project, a lecture at the Plutonium Recycle Test Reactor model, and talks on radioactivity, heat, and other pollution of the Columbia River.

C. EMPLOYEE RELATIONS

Safety and Security

There were six medical treatment injuries for a frequency of 1.89. No security violations occurred.

Suggestions

Three suggestions were submitted by RPO personnel. Eight suggestions were received in RPO for evaluation, and evaluations on seven suggestions were completed.

Relations

The scheduled ROF of thirty clerical employees in the Exposure Evaluation and Records Operation was completed without incident.

Negotiations with the Regional Monitors continued without significant progress.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
H. C. Clare E. F. Eldridge C. M. Everts, Jr. K. H. Spies E. C. Jensen Roger James A. T. Neale W. W. Saxton	1/14,15, 16/58	Columbia River Advisory Group	Attend annual meeting.	AR Keene and Staff	Yes	105-KE:100-K 325:300
S. W. Cavender D. J. Corkhill G. R. Farmer R. A. Hoffman F. W. Lanard C. E. Nelson J. R. Snoga C. F. Tedford G. W. Werner	1/1958	USA USAF USA USAF USA USPHS USAF USN USN	Attend training courses.	AR Keene and Staff	Yes	300 Area

VISITS TO OTHER INSTALLATIONS

J. W. Healy	1/6,7, 8/58	British Atomic Energy Authority Harwell, England	Member of study team on Windscale incident.	Members of the British Atomic Energy Authority	Yes	

REGIONAL MONITORING

The general findings are summarized in the following:

Sample Type and Location	Activity Type	Average Activity Density µc/cc	Trend* Factor
Drinking Water and Related Materials			
Benton City Water Co. Well	alpha	1.0×10^{-8}	--
100 Areas	beta	$(0.02 \text{ to } 2.1) \times 10^{-5}$	--
200 Areas	beta	$(2.9 \text{ to } 6.5) \times 10^{-6}$	--
Pasco, Kennewick, McNary Dam	beta	$(0.05 \text{ to } 7.4) \times 10^{-6}$	--
Backwash Solids - Pasco Filter Plant	beta	1.7 µc/gm	+3
Backwash Liquids - Pasco Filter Plant	beta	7.4×10^{-6}	+2
Anthracite, Sand Filter - Pasco Filter Plant	beta	6.9×10^{-4} µc/gm	--
Other Waters and Related Materials			
200 West Wells	beta	$< 2 \times 10^{-7}$ to 2.4×10^{-3}	--
200 East Wells	beta	$< 2 \times 10^{-7}$ to 5.1×10^{-2}	--
Wells Near 200 Areas	beta	$< 2 \times 10^{-7}$ to 1.6×10^{-6}	--
Outlying Wells	beta	$(< 2.0 \text{ to } 2.5) \times 10^{-7}$	--
Columbia River - Hanford Ferry	beta	5.9×10^{-5}	--
Columbia River - Below Reactors	beta	3.7×10^{-5}	--
Columbia River - Paterson to McNary	beta	8.5×10^{-7}	--
Columbia River - Mud	beta	$(0.2 \text{ to } 2.9) \times 10^{-4}$	--
Raw Water - Operating Areas	beta	$(0.01 \text{ to } 4.8) \times 10^{-5}$	--
Reactor Effluent Retention Basins to River	beta	20,000 to 59,000 µc/sec/reactor	--
		$(0.5 \text{ to } 1.2) \times 10^{-2}$	--
Reactor Effluent Retention Basins to River	alpha	< 0.04 µc/sec/reactor	--
		$< 5 \times 10^{-9}$	--
I-131 in Farm Wastes to River	I-131	2.2×10^{-7}	-3
I-131 in Columbia River - Hanford	I-131	1.5×10^{-7}	--

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

Sample Type and Location	Activity Type	Average Activity Density μc/cc	Trend* Factor
Atmospheric Pollution			
Gross Alpha Emitters	alpha	$(< 0.2$ to $3.8) \times 10^{-15}$	--
Gross Dose Rate - Separations Areas	beta-gamma	0.4 to 2.5 mrad/day	--
Gross Dose Rate - Residential Areas	beta-gamma	0.3 to 1.6 mrad/day	--
Active Particles - Separations Areas	beta	$(0.03$ to $1.6) \times 10^{-11}$	+40
I-131 Separations Areas	I-131	$(1.9$ to $3.7) \times 10^{-13}$	-5
I-131 Separations Stacks	I-131	0.8 curie/day	--
Ruthenium - Separations Stacks	Ru-103-106	0.01 curie/day	--
Active Particles - Wash., Idaho, Ore., Mont.	--	0.02 to 0.07 ptle/m^3	+2
Active Particles - Project	--	0.004 to 0.34 ptle/m^3	+10
Vegetation			
Environs of Separations Areas	I-131	5.1×10^{-6} μc/gm	-3
Residential Areas	I-131	2.3×10^{-6} μc/gm	-3
Eastern Washington and Oregon	I-131	$< 1.5 \times 10^{-6}$ μc/gm	--
Fission Products Less I-131 Wash. and Ore.	beta	9.1×10^{-5} μc/gm	--
Alpha Emitters - Separations Areas	alpha	$(0.5$ to $9.9) \times 10^{-6}$ μc/gm	+3

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

RADIATION MONITORING	Hanford Laboratories	Minor & Major Construction	Others	Jan.	Year to Date
Special Work Permits	1617	47	187	1851	1,851
Routine and Special Surveys	946	32	206	1184	1,184
Air Samples	1756	2	219	1977	1,977
Skin Contamination	0	0	1	1	1
*Class II Radiation Incidents	0	0	0	0	0
**Class II Radiation Incidents	0	0	4	4	4

EXPOSURE EVALUATION AND RECORDS

Gamma Pencils	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
January	67,064	47	9	3
1958 to Date	67,064	47	9	3

Beta-Gamma Film Badges

	Badges Processed	Readings 100-300 mrads	Readings 300-500 mrads	Readings Over 500 mrads	Lost Readings	Average Dose Per Film Packet mrad(ow)	mr(s)
January	23,695	770	27	17	42	3.54	8.76
1958 to Date	23,695	770	27	17	42	3.54	8.76

Slow Neutron Pencils

	Pencils Processed	Paired Readings 4-12 mrem	Paired Readings Over 12 mrem	Lost Readings
January	3,940	40	3	0
1958 to Date	3,940	40	3	0

Fast Neutron Film Badges	Badges Processed	Readings Above 50 mrem	Lost Readings
January	1,123	6	2
1958 to Date	1,123	6	2

Bioassay		January	1958 to Date
Plutonium:	Samples Assayed	1,312	1,312
	Results above 2.2×10^{-8} μc/sample	48	48
Fission Product:	Samples Assayed	1,350	1,350
	Results above 3.1×10^{-5} μc FP/sample	1	1
Uranium:	Samples Assayed	368	368

*HLO Radiation Monitoring Customers
**Other Plant Components

Uranium Analyses	Following Exposure Units of 10^{-9} µc U/cc			Following Period of No Exposure Units of 10^{-9} µc U/cc		
Sample Description	Maximum	Average	Number Samples	Maximum	Average	Number Samples
Fuels Preparation	15.8	4.41	42	10.8	2.78	39
Hanford Laboratories	72.5	10.1	18	11.9	2.98	19
Chemical Processing	61.4	9.49	105	39.1	4.95	91
Chemical Processing*	24.4	9.22	15	39.7	15.9	4
Special Incidents	0	0	0	--	--	--
Random	11.3	12.7	35	--	--	--

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

Tritium Analyses	January	1958 to Date
Samples Assayed	0	0
Thyroid Checks		
Checks Taken	5	5
Checks Indicating .01 µc	0	0
Hand Checks - Alpha	45,177	45,177
- Beta-Gamma	39,266	39,266

CALIBRATIONS

Portable Instruments	Number of Units Calibrated January	1958 to Date
CP Meter	1,012	1,012
Juno	340	340
GM	1,387	1,387
Other	210	210
Total	2,949	2,949
Personnel Meters		
Badge Film	1,080	1,080
Pencils	832	832
Other	395	395
Total	2,307	2,307
Miscellaneous Special Services	1,339	1,339
Total Number of Calibrations	6,595	6,595

A. R. Keene, Manager
RADIATION PROTECTION

ARK:bh

1237834

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - JANUARY, 1958

GENERAL

Safety performance of the Operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 3.36 per cent which is substantially above December experience but well within established control limits.

The absenteeism rate was 3.26 per cent, an increase of about 0.29 per cent above December experience. This rate is below the expected rate.

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

There were no grievances filed during the month.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 12,920 hours. The total shop work backlog is 23,237 hours of which 40% is required in the current month, with the remainder distributed over a six month period. Overtime worked during the month was 1.7% (294 hours) of the total available hours.

Distribution of time was as follows:

	Man Hours	% of Total
Fuels Preparation Department	1701	13.2
Irradiation Processing Department	1568	12.1
Chemical Processing Department	763	5.9
Hanford Laboratories Operation	8703	67.3
Construction Engineering Operation	46	.4
Miscellaneous	139	1.1

Customer demands for service remained firm in all components with the total backlog of work increasing approximately 15%. Overtime work increased over the previous month but remains at what is considered a nominal level.

Safety and security performance was considered satisfactory with no major violations. The minor injury rate was average for the operation.

The absenteeism rate increased from 2.49% for the previous month to 2.97% for the current month. This increase seems to be mainly attributable to the prevalence of a form of flu.

TECHNICAL INFORMATION OPERATION

On January 1, control of the 234-5 Comprehensive Data Sheets was transferred to the SS Accountability Operation, Relations & Utilities. The move resulted from a suggestion by an employee of Technical Information.

The plan to reduce the clerical work force in Technical Information by two persons was carried out during the month. One General Clerk A received a downgrade in the process, "bumping" a General Clerk B in the Employee Relations Operation. The latter then moved into a General Clerk C opening in Technical Information.

A systematic review of all the clerical positions in Technical Information was begun. The Technical Information Manager, Supervisors, and the Specialist, Technical Information Procedures, meet weekly with the Wage Administration representative to review the jobs. The Office Procedures Specialist from HLO's Financial Operation is also providing counsel. The aim is to compare Technical Information jobs with one another and with representative "bench mark" jobs in other Departments and Operations.

The Employee Relations Specialist is interviewing all personnel in Technical Information to gather further information on the attitude survey conducted last September. All Supervisors have been interviewed, intereviews are proceeding with the exempt non-supervisory staff, and arrangements have been completed for him to meet with the non-exempt employees in groups of five or six. Results of the interviews will be used to improve the climate of the Operation.

The Office Procedures Specialist in Financial Operation has thoroughly investigated the possibility of combining classified document delivery with the plant mail runs, as suggested by Relations & Utilities Operation, and concluded that it is not practical. The possibility of having Classified Files messengers handle the Registered Delivery for the plant was also investigated and deemed impractical. The present arrangements appear to be the most efficient.

There were a number of developments in the Classification-Declassification field during the month:

(1) The HOO Classification Committee met on December 30 to review HW-54095, "Proposed Hanford Production Reactor Supplement to OC-DOC-44 and Proposed Revisions to OC-DOC-45 and OC-DOC-48". Certain changes in these documents were recommended.

(2) On January 29th a revised Hanford Classification Guide was completed and forwarded to the HOO Classification Committee for review. The Guide was prepared by a HAPO task force specifically designated for this assignment. HW-55000 is an extensive revision of the original Guide. Most of the difficulties encountered with the first Guide resulted from the detailed topical breakdown. This approach tended to obscure the basic classification policies and made sound classification judgments difficult. For this reason, the intent of the classification policies as they apply to Hanford was given a great deal of attention. After the intent was agreed upon, the revised Guide was written to logically reflect this intent. It is believed that most of the disadvantages associated with the original Guide have been eliminated.

1237836

Another feature of the revised Guide is the inclusion of a section which would permit many of the research and development activities of the Laboratories to be handled as unclassified. In the past, the work of the Laboratories has been classified because of its direct relationship to the Hanford production process.

(3) HW-54095 Rev. 1, which incorporated suggestions made by the HOO Classification Committee, plus other changes found necessary during the preparation of the revised Hanford Classification Guide, was forwarded with the Guide for review by the Classification Committee.

(4) Comments were prepared for GE-AEC Security on a proposed HAN supplement to AEC Manual Chapter 2801 (not yet received) relating to the control of documents containing Atomic Weapon Data. Comments primarily urged elimination of the distinction between Atomic Weapon Data reports and Atomic Weapon Data documents.

A Files messenger returning from 700 Area failed to stop quickly enough to avoid hitting another government car driven by an HLO employee. Damage to the messenger's car was $75.00; to the other car, $25.00. The messenger should have stopped to report the accident to Richland police, but since he had a large number of classified documents in his possession and the Files vault was to be locked in 15 minutes, he proceeded to the 300 Area and reported to Patrol there.

The annual inventory of SECRET Research and Development reports was completed. Results reported to G.E. Security are as follows:

(1) There are 12,137 accountable copies of which 380 are Atomic Weapon Data reports and 11,757 are Research and Development reports.

(2) Twenty-seven copies are unaccounted for. All of these were listed as missing on previous annual inventories. None of them is an Atomic Weapon Data report.

The inventory of Files' holding was resumed despite the fact that lists are not yet available from Data Processing. In the interim, documents are being checked against the File Record Cards, which are the basic inventory record.

Data Processing plans to prepare the master document accountability tape on the weekend of February 1 and 2. Files Operators have finished keypunching the two month's backlog of source data referred to in the November report. It was necessary to work 46 overtime hours to complete the job, since there were 37,640 cards backlogged. These cards were sent to Data Processing for incorporation into the master tape.

Security has given permission for the projectionist from Acquisition & Cataloging to carry classified films to showings. This new procedure replaces the old system of charging the film to the individual in charge of the showing and delivering it to him via Files messenger. Under the old system, the film was in transit

more than it was in use, and close scheduling (and maximum utilization of the films) was difficult. The projectionist will make certain that those viewing the film have proper access authorization.

As indicated last month, Commission regulations now require that a bill be prepared for all unclassified reports shipped by Technical Information to the Office of Technical Services, U. S. Department of Commerce (the AEC's sales outlet for unclassified reports). The first billing was made this month. The charge for 100 copies came to $11.45 ($5.75 for page costs and $5.70 for mailing), an amount hardly worth the time required to prepare the necessary forms and take the packages down to the Central Mail room for weighing. The page cost figures used -- $00.25 per page of the report--do not begin to pay for the actual expense of the report.

RADIOGRAPHIC TESTING OPERATION

Activity for the Radiographic Testing Operation remained at a high level for January. A record number of tests was made and even more significant was the large increase in the amount of material examined. A total of 2807 tests were made of which 740 were radiographic exposures (including x-ray and gamma-ray) and 2067 were supplementary tests. The supplementary tests consisted of work with dye penetrant, dimensional checking, eddy current, and ultrasonics. The feet of material examined was up over 9000, about a four-fold increase over last year's average. Work was done for 17 different organizational components representing all of the operating departments and service operations. A total of 22 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 16 different occasions for advice and information regarding general testing theory and applications.

Details of work accomplished are as follows:

A. Construction

No work related to construction projects was done during this month.

B. Fabrication

Field work was completed on the L-Cell Package being fabricated for Purex. This work was a major project that extended some ten months, being started in April of 1957. The fabrication was not only large in physical size (40 feet high by 20 feet square) but also in the amount of welding which was necessary to examine. A total of 600 weld seams were radiographed involving pipe size varying from 1/2 inch O.D. to 8 inches O.D. To examine this number of seams over 1400 radiographic exposures were made. About half of this number were made on the structure itself.

C. Maintenance

In the straight maintenance category two jobs were done. One involved evaluation of possible damage to a locomotive center ring and eye, a support member attaching the locomotive body to the wheel trucks. This particular part had been bent during maintenance of the locomotive and it was necessary to straighten it. No damage was found that was associated with the straightening, but some questionable areas were discovered originating from the fabrication processes used in making the part. Also examined was a damaged heat exchanger that had been subjected to excessive temperatures and pressure. The vessel had failed by splitting and the extent of damage was determined to be extensive. This failure was interesting in that it demonstrated the mode of failure of an over-stressed pressure vessel. In addition to the original crack which occurred in a longitudinally welded seam, additional transverse cracks were discovered in the associated girth weld.

In the preventative maintenance category some additional work was done on detecting the extent of possible stress corrosion damage to stainless steel pigtails. Additional units were examined and suspect pieces selected for sectioning to correlate eddy current results. To determine the condition of copper tube heat exchangers at the condensate return header, trial radiographs were made. Clear pictures were obtained showing the construction features and the internal wall condition. On the one heat exchanger examined no appreciable corrosion was evident though build-ups of scale and calcium and magnesium salts could be detected.

Only one job was concerned with the safety aspects of maintenance. This was continuation of the work on the autoclaves in the 303 Area. All of the autoclaves are being examined in at least one location and others are being more completely examined where visual evidence indicates doubtful quality.

D. Qualifications and Certifications

A small number of welders qualification coupons were examined to determine conformance with applicable codes. These coupons included both stainless steel and aluminum weldments.

E. As-Received Material

Work was continued on the program for Stores involving the radiographic examination of longitudinally welded stainless steel pipe. Initial work was done on 3 and 4 inch schedule 40 stainless steel pipe and the results indicated about a 50 per cent rejection rate on the material. The pipe was suitably marked and sorted for proper identification and storage. Some of the smaller sizes in stock are now being examined.

For the PRTR fuel fabrication program tubing stock of different materials were examined. Carbon steel, stainless steel, and zirconium alloy tubing used in the fuel element assemblies was evaluated for integrity as jacket material.

F. Assistance in Research and Development

A large amount of the Research and Development assistance work was associated with problems relating to various fuel element configurations. Included were uranium oxide ceramic elements, PRTR fuel elements, and MTR fuel plates. Most of the work with uranium oxide wafer assemblies was concerned with the integrity of closures. For the PRTR work two areas were investigated: Aluminum castings with various amounts of plutonium were examined in efforts aimed at establishing satisfactory casting practices; the other was the direct casting of core materials into cladding tubes. For the MTR fuel plate work, a number of trial plates were examined in addition to experimental heats of different plutonium percentages for manufacture of the core slugs.

Development work associated with the successful fabrication of tubular products continued to occupy a major portion of the Radiographic Testing Operation's time. Carbon steel, stainless steel and zirconium tubing, made by various fabrication processes and by various suppliers, were examined for integrity and dimensional tolerances. Both BDF and KER sized process tubing were also examined. Extensive analysis was made of eight BDF sized zirconium tubes for possible use in a trial tubing. No serious difficulties were found in the tubing other than considerable wall thickness variations and eccentricity. Though the tubing was found to be within tolerances, the eccentric condition did not permit entry of the tubes in the graphite blocks. Further development work is being done to alleviate this condition.

A large amount of miscellaneous work was also done on various materials and assemblies. Zirconium figured in two of these jobs. One was the examination of zirconium butt welds in tubing and the other, the examination of cast and machined zirconium end pieces for PRTR fuel element closures. Interesting samples of stainless steel welds were examined containing tungsten inclusions that had been partially attacked in the Huey test. This work was done to establish if the presence of tungsten caused acclerated corrosion. Miscellaneous assemblies examined included an in-pile heater, various thermocouple constructions, and NaK covered zirconium, thorium and uranium specimens for pile irradiation.

Testing Statistics

Component	No. of Tests	Ft. of Weld or Material	No. of Pieces	Description
A. Chemical Processing Department	207	49-1/2	115	SS process vessels and piping.
B. Construction Engineering Operation	8	2	7	SS and Al welder qualification coupons.
C. Fuels Preparation Department	4	5	4	CS pressure vessels.
D. Hanford Laboratories Operation	2397	8357-1/2	481	CS, SS, and Zr tubing PRTR, UO_2, and MTR fuel elements. CS pressure vessel, Cu heat exchanger KER and BDF process tubing. Misc. materials and assemblies.
E. Irradiation Processing Department	74	185	1	Zr process tube.
F. Relations & Utilities Operation	117	573	35	SS welded pipe. Locomotive springs.
Totals	2807	9172	643	

FACILITIES ENGINEERING OPERATION

Project Activity

The progress of project work during the month is summarized on the attached report. HLO has 15 authorized Plant Acquisition or Equipment Projects. Six proposals for new projects are awaiting AEC action (excepting PRP activities).

Engineering Services

Following is the status of engineering service work:

Title	Status
Contaminated Waste Chute, 327 Building	Job about 90% complete; should be completed the first week of February.
Thermal Expansion Layout	Because of shortage of funds, sponsor requests deferment to FY 1959.
Impact Tester	As above.
Hot Miscroscope	As above.
Vacuum Air Sampling System, 108-F Building	Project proposal written; deferred until FY 1959.
Hood Repair and Relocation, 329 Building	Work complete.
Whole Body Animal Counting Room, 141-F Building	Work complete.
Breathing Air Installation, 141-FS Building	Tests for satisfactory operation with masks were successful. Defective parts found in leaking trap are being replaced by vendor. Final acceptance expected after these are installed.
Correct Leaking Pump Seals in Plating Laboratory, 306 Building	Mechanical Seals have been received and Adapter Flanges made in Technical Shops. Installation to be complete by February 1, 1958.
Correct Noisy Heating Coil in 3760 Building	Modifications have corrected the trouble, as the noise has not recurred.
Budget Item B-75916, Additions to the Radiometallurgy Building	Project proposal being prepared.
Alterations to Room 313, 3706 Building	Work pending.
Eight Station Intercom System, 326 Building	Cost estimate has been made.

Title	Status
Preliminary Scoping and Estimating for Crane Improvements, 327 Building	Various systems are being investigated.
Replacement of Sump Pump, 329 Building	A check was made through the BP File for spare part data on the existing pumps. These are obtainable and are being ordered.

Design and Drafting Services

Cesium Isolation and Packaging - revised scope drawings showing a change in the packaging unit will be issued at end of month.

Drawings are being produced for relocating Elmo No. 3 Test Loop from 3706 to 185-D Building. Work will include a new design of the test section, and enclosure and extension of related utilities.

Fluid Mechanics Test Assembly - this is a mock-up of an experimental process tube for obtaining heat transfer information.

14 Ton Cask Cart - this cart will be used for transfer of casks containing irradiated samples in 327 Building.

Maintenance and Building Engineering Services

The Report Editing group of Technical Information was moved from 328 to 3760 Building. Minor rearrangements in 328 Building were made by Facilities Engineering.

The installation of the propane storage tank has been delayed awaiting valves.

Building 3707-C will be altered in order to better utilize existing space. Plans are presently being drawn for this change.

The rearrangement of the periodical routing and bindery operations is progressing with the approval of the appropriation request for additional stacks. The purchase requisition has been submitted. When the stacks are received the library collection can be rearranged. The planned stack arrangement will provide adequate space for the new periodical routing room.

Engineering Requests have been issued to:

(a) Prepare project proposal to increase electrical capacity - 328 Bldg.
(b) Recommend filter for vacuum exhaust - 325 Bldg.
(c) Recommend sound and temperature control - key punch room, 3760 Bldg.

A brief comparison of HLO building operations costs with those of buildings in Philadelphia was issued this month.

An engineering study of the foundation settlement of 141-N Building was completed, and action is being taken for correction.

A Plant and Equipment Transfer document was initiated which recommended the transfer of Building 2708-E from HLO to CPD. This building was acquired during reorganization. Its use to HLO is for storage of well drilling samples. Further use by HLO is not expected nor is maintenance warranted without major repairs.

The budget for Landlord function of Biology Operation required that certain economies be made. This was accomplished at possible expense of planned maintenance activities with only minimal preventative maintenance work allowed. This economy measure does not affect Janitorial Services or utilities.

The Hanford Laboratories Office and Equipment Budget work sheets for FY 1960 and Revised FY 1959 were distributed for forecast estimates.

The procurement and installation of the Shielded Cave in the 325 Building (AR-57-HL2-47) is as follows: Expenditures and commitments on 1-26-58 were $20,693; balance left is $637. Work is estimated to be 99% complete. Hot runs are scheduled for week of February 3.

Survey and Inspection of Pressure Vessels - is estimated to be 74% complete. Thickness measurements and final calculations to determine safe operating pressures are remaining items of work.

R. H. Scott held a meeting on January 23 for inquiry of a ruptured pressure vessel at 189-D. He will issue a report of the accident which will include recommended action.

LABORATORIES ADMINISTRATION & TECHNICAL LIAISON

Two new Organization and Policy Guides were issued. Timely revisions were issued on specific sections of eight existing guides. OPG No. 02.3.1, Approval Authorizations, has been revised and expanded.

Contract No. SA-40 with State College of Washington for acquisition of swine was signed and Consultant Agreement No. CA-178 with Dr. Raymond E. Zirkle for services was processed for renewal for another year. A new contract is being negotiated with Dr. Franklin I. Badgely of the Department of Meteorology and Climatology, University of Washington, for consulting services. Dr. E. J. Ordal of University of Washington was approached to enter into a consultant contract to serve the Biology Operation.

Assistance-to-Hanford authorization No. ATH-HLO-2-58 was approved for a dynamic study of a solvent extraction system by General Engineering Laboratory for Chemical Research and Development Operation. Another authorization with the Metallurgy and Ceramics Research Department is being considered for services for Physics and Instrument Research and Development Operation.

The close-out of a purchase order with KAPL for BF_3 counters was reviewed again and additional steps taken to arrange for final payment.

One request for a pickup truck was made to Transporation and Maintenance Operation for immediate assignment to Biology Operation. Further, the budget for FY-1960 and revision of budget for FY-1959 for automotive and heavy mobile equipment not included in construction projects were submitted.

Manager
LABORATORY AUXILIARIES

JL Boyd:lt

UNCLASSIFIED

MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-54760
January, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
General Plant Projects - FY 1956		Reactor &		$ 140,000*	100	67	5-23-56	As	9-28-56
AEC-2-23X-56-L-2		Fuels	$ 132,000	4-4-57	100	84	12-7-56	Completed	5-1-58 *
CG-664	350°C Flow Loop - 314 Building	REMARKS: The ½" globe valves and 2" gate valves have been received and welded into the loop. Pressure transmitters are installed. Electrical work will be complete by 2-14-58. Canned rotor pump failed in motor bearings during second performance test. The third test will be made the week of 2-3-58. Expediting moved shipping date of instrument panel to 2-7-58.							
	Engineer: R. W. Dascenzo	*Includes $350 transferred equipment. *Directive Completion Date.							
General Plant Projects - FY 1957		Radiation		$ 150,000	100	N.S.	2-18-57		12-19-57
AEC-23-57-N-2		Protection	$ 150,000	2-4-57	100	0	4-1-58*	10-1-58*	10-1-58*
CA-658	Shielded Personnel Monitoring Station - 747 Building	REMARKS: The AEC has submitted a revision to the project proposal asking that the physical completion date be changed to 12-31-58. The invitations to bid for construction of the facility were issued. Bid opening is set for February 12, 1958. The bid assembly called for completion 300 days after start of construction. It is felt this is too long. A letter was transmitted to the Commission requesting the construction period be limited to a maximum of 240 days. *Estimated construction dates.							
	Engineer: D. S. Jackson								
		Reactor &		$ 135,000	100	99	10-3-56		1-25-57
		Fuels	$ 110,000	5-2-57	100	99	5-2-57	1-3-58	3-15-58*
CG-680	Corrosion Testing Facilities - 314 Building	REMARKS: Beneficial use was obtained on 1-3-58. The F.A. Lohse Fixed Price Contract was completed on 1-27-58. Construction Operation completed their work on 1-23-58. The only work that remains to be done is transfer and installation of a stainless steel hood and stone sink started on 1-29-58 by Plant Forces. Indications are that an underrun of $20,000 to $25,000 will exist upon completion of the project.							
	Engineer: R. W. Dascenzo	*Directive Completion Date.							
		Chemical		$ 122,000	100	100	11-8-56	As Wells	1-15-57
		Research	$ 122,000	6-27-57	100	100	10-24-56	Completed	2-1-58**
CA-700	Geological and Hydrological Wells - FY 1957	REMARKS: USGS 100% complete. Fourteen wells, 5419 feet of hole.* Fixed Price Contractor - Twenty-three wells complete, 7329 feet of hole. All Fixed Price Contract work was completed on January 31, 1958. The only work remaining to be done is locating and determination of elevation by GE Field Survey crews. *One well formerly shown in the USGS totals for this project was drilled as a part of Project CG-648, Rev. 1. **Directive Completion Date.							
	Engineer: D. S. Jackson								
		Biology		$ 20,000	100	100	3-11-57		6-20-57
		Research	$ 20,000	2-11-57	100	100	7-16-57	10-1-57	1-15-58*
CA-728	High Level Exposure Facility Addition - 141-H Building	REMARKS: Project was accepted November 19, 1957. Financial Closing Notice is being prepared.							
	Engineer: J. T. Lloyd	*Directive Completion Date.							

MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

DEL

USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
Chemical Research	$ 73,000	$ 73,000 3-12-57	100 100	63 87	4-23-57 7-15-57	2-15-58	5-28-57 9-15-58*

REMARKS: A preliminary inspection of the fixed price contractor's work was held on January 22, 1958. A few items of work remain to be completed, such as; cleanup and work on the steam control system. The CPFF construction contractor resumed work on 1-20-58 and has cut one hole in the roof for the exhaust ductwork from one hood. Work is also progressing on the exhaust system on the roof. A representative from Johnson Service Company was requested to look at the controls on the refrigeration

REMARKS: (CG-729 Continued) unit and make recommendations as to what instruments need replacing and cost of replacement. It is now planned, due to humidity control relocation on the counting units, to use this unit as a standard air washer type of unit.

*Directive Completion Date, however, it is contemplated this project will be physically complete on 5-1-58.

Reactor & Fuels	$ 295,000	$ 295,000 5-10-57	100 100	82 86	5-14-57 6-10-57	As Completed	10-1-57 6-15-58*

REMARKS: Lump Sum work is 100% complete. Final inspection was made on 1-24-58. There were two minor exceptions; (1) one electrical outlet in each of two rooms and (2) anchoring of lockers and benches. Architectural work by CEO forces is complete except for repairing and painting a wall after removal of hood in room 41. Design Change No. 4 was approved for four additional new items of work. Exhaust system is 60 % complete, piping 85%, power 50 %, lighting 50% and alarm system 90% complete.

REMARKS: (CG-733 Continued) Some of the percentages given remain unchanged due to the increased amount of work.

*Directive Completion Date.

Biology Research	$ 19,900	$ 19,900 6-27-57	100 100	100 100	1-2-57 7-22-57	1-15-58	4-11-57 1-21-58*

REMARKS: This project is complete. The Physical Completion Notice is being prepared.

This project will no longer be included in this report.

*Date project was actually complete.

MONTHLY PROJECT REPORT

HW-5476 DEL

UNCLASSIFIED — HANFORD LABORATORIES OPERATION — January, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
General Plant Projects - FY 1958 AEC-2-23-58-L		Chemical Research	$ 77,000	None to date / None to date	To be est / 0	To be est / 0	1* / 7*	12*	4* / 13*
CG-781	Coolant Radio Analysis Laboratory Addition - 1706-KE	REMARKS: This will probably be the last time this project will be reported as the Manager of Chemical Research has requested that this project be canceled. It is planned that another organization will carry out the analytical work contemplated for this enlarged facility.							
	Engineer: R. W. Dascenzo	*Months after authorization.							
CG-760	Expansion of the 3745-B Facility	Physics & Instr.	$ 193,000	None to date / None to date	To be est / 0	To be est / 0	1* / 9*	16*	6* / 16*
		REMARKS: The project proposal was approved by the General Manager and submitted to the AEC-HOO Review Board 1-23-58. The Commission is returning the proposal to HLO for further justification.							
	Engineer: R. C. Ingersoll	*Months after authorization.							
CA-765	Additions to the 314 Building	Reactor & Fuels	$ 46,000	$ 6,800* / 10-3-57	100* / 100*	To be est / 0	10-14-57 / 4-20-58	10-4-58	3-4-58 / 11-15-58**
		REMARKS: The Architect-Engineer, Carson and Moe, have submitted preliminary drawings which have been reviewed by the General Electric Company and returned. **Directive Completion Date.							
	Engineer: A. W. Hervin	*GE Company portion only, including only design criteria and preliminary design.							
CA-769	Additions to the 622 Building	Physics & Instr.	$ 80,000	None to date / None to date	0 / 0	0 / 0	None est / None est	None est	None est / None est
		REMARKS: Project Proposal awaiting AEC approval.							
	Engineer: J. T. Lloyd								
CA-778	Expansion of the 305-B Building	Physics & Instr.	$ 55,000	$ 55,000 / 12-11-57	To be est / 0	To be est / 0	3-15-58 / 7-1-58	10-15-58	6-15-58 / 10-15-58*
		REMARKS: Design Criteria is being prepared and is estimated to be 50% complete.							
	Engineer: R. C. Ingersoll	*Directive Completion Date.							

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-54760 DEL

January, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
		Chemical Research	$ 63,000	None to date / None to date	0 / 0	0 / 0	None est / None est	None est	None est / None est
CG-779	Alterations to the 321 Building Engineer: J. T. Lloyd	REMARKS: The project proposal was transmitted to AEC-HOO on 10-17-57. The request was forwarded to AEC Washington on 12-3-57.							
IR-232	Repair Damage and Additions to Heating System - 747 Building Engineer: J. T. Lloyd	Lab.		$ 15,000	100	100	7-1-57		8-12-57
		Aux.	$ 13,850	8-29-57	100	100	10-24-57	11-15-57	12-26-57*
		REMARKS: Inspection and acceptance was made on 12-26-57. All exceptions were were completed and Final Acceptance papers were signed by GE on 1-16-58. This project will no longer be included in this report. *Actual Physical Completion Date.							
IR-234	Storm Windows and Sun Shades - 326 Building Engineer: J. T. Lloyd			$ 14,000	100	100	8-1-57	As	11-15-57
		HLO	$ 14,550	10-31-57	100	100	12-3-57	Completed	1-17-58*
		REMARKS: All work with no exceptions was completed on day of final inspection (January 17, 1958). The AEC is preparing a modification to the contract. Physical Completion Notice will be prepared by the AEC. *Actual Physical Completion Date.							
Equipment Not Included In Construction Projects - Program Class 2900		Reactor & Fuels	$ 103,500	$ 120,000	100	100	5-1-56		4-1-57
				2-7-57	100	100*	6-1-57	12-20-57	9-30-57**
CG-620	Vacuum Furnace Engineer: R. C. Ingersoll	REMARKS: *An exception exists on the centrifugal casting mechanism. This is being taken up with the manufacturer. Use of the main portion of the equipment is not restricted, however, and is available to HLO. This project is physically complete, with the above exception, has been accepted from the contractor and will no longer be carried in this report. **Actual Physical Completion Date.							
CG-660	Modifications and Additions to the Metallographic Cell - 327 Building Engineer: D. S. Jackson	Reactor & Fuels	$ 135,000	$ 135,000	100	100	3-27-57		4-1-57
				3-15-57	100	97	5-14-57	2-15-58	3-15-58
		REMARKS: The project completion date was extended to March 15, 1958. The Metallograph was received and is currently being installed.							

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

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
CG-661	Additional Heat Generation Facility - 189-D Building Engineer: A. W. Hervin	Reactor & Fuels	$ 664,000	$ 664,000 9-18-57	30 39	0 0	12-6-56 1-15-59	9-30-59	11-1-58 8-31-59*
		REMARKS: Specification HWS-6189 for the Direct Current Power Supply has been modified to include silicon junctions as well as germanium junctions for the rectifier assembly. The silicon unit may be air or water cooled and the protective system shall be equal to the protective system specified for the germanium rectifiers. Due to this alternate, the bid opening has been extended to February 5, 1958. *Directive Completion Date.							
CG-672	Monochromatic Neutron Beam Facility - 105-KE Building Engineer: H. Radow	Physics & Instr.	$ 195,000	$ 195,000 3-7-57	100 100	40 40	5-21-56 11-1-57	5-1-58	10-1-57 5-1-58*
		REMARKS: Spectrometer components have been assembled in place and floor deflection checked with the test weights with satisfactory results. Paraffining is nearing completion. The last item of procurement has been shipped. *Directive Completion Date.							
CA-681	Hanford Equipment in the ETR Engineer: H. Radow	Reactor & Fuels	$1,200,000	$ 900,000 8-12-57	100 100	0 0	9-17-56 2-15-58	12-1-58	5-29-57 12-15-58*
		REMARKS: A new schedule date for the start of installation by Phillips has not yet been received from the Commission. Informal indications are that this will be April 1, 1958. A tentative construction schedule is being prepared by CEO as a basis for establishing Phillips position in this regard. *Directive Completion Date.							
CG-682	High Level Cut-Off and Examination Cell - 327 Building Engineer: A. W. Hervin	Reactor & Fuels	$ 430,000	$ 430,000 8-20-57	100 100	0 0	7-18-56 4-15-58*	10-1-58	6-26-57 10-1-58**
		REMARKS: The following items of equipment have been received; motor control plug-in compartment, micro-microameter, HM Chamber, ultrasonic transducers, and seven miscellaneous plugs. The two manipulator plug assemblies are nearing completion in the vendor's shop. The vendor for the cut-off saw has approximately 40% of the detail parts in progress. His material suppliers are meeting delivery dates. It may be possible to ship 4-15-58, this is one month ahead of the original promised							
		REMARKS: (CG-682 Continued) shipping date. The vendor for the high level examination cell (promised shipping date 3-15-58) received eleven of the meehanite castings from his material supplier. The remaining castings have been promised the first part of February. Machining of the castings was started on January 20, 1958. The vendor for the shipping cask (promised shipping date 4-17-58) has received most of the materials for this job. Machining has been started on several pieces and							

DEL

MONTHLY PROJECT REPORT

HW-54760
January, 1958

UNCLASSIFIED

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.

REMARKS: (CG-682 Continued) work is progressing on the shafts, top plug, casing for the top plug, and some of the bottom cover parts. The welding of the formed heads to the shell of the casks has started. Work on other items of material by vendors is in progress. The bids on the Hanford Master Slave Manipulator Model #3 were received on January 30, 1958 and are currently being reviewed. *A meeting was held with CEO to discuss the start of construction and the preparations necessary

REMARKS: (CG-682 Continued) by both Construction Operation and Radiometallurgy personnel. As most of the material deliveries are scheduled for shipment the last part of March or the first part of April, it was deemed impractical to start construction on March 1, 1958.
**Directive Completion Date.

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
CA-695	Radio Telemetering Network Engineer: J. T. Lloyd	Physics & Instr.	$ 89,000	$ 89,000 1-10-57	100 100	Not Sched Not Sched	2-22-57 7-25-57	7-15-58	5-27-57 1-1-59*
		REMARKS: Our prototype unit was shipped to the contractor. The RCA quote on the repeater station has not been received. Quotes were received on wind transducers and radiation chambers with cables of about $13,900 and $2,600 respectively. The pre-production model of the data station is scheduled for delivery about March 17, 1958. *Present Directive Completion Date is 5-15-58.							
CG-758	Ceramic Fuels Development Press and Furnace Additions Engineer: R. C. Ingersoll	Reactor & Fuels	$200,000	$ 200,000 8-1-57	90 90	0 0	8-22-57 1-20-58	As Completed	2-28-58* 10-1-58**
		REMARKS: Contract for furnace installation awarded to Grant Construction Company. Notice to proceed issued 1-15-58 and signed 1-17-58. Barring complications, shipment of furnace is expected during the week of 2-3-58. *Original design completion date changed from 2-1-58 due to delay in receipt of vendor information on press. **Directive Completion Date.							
CG-785	In-Reactor Studies Equipment - 105-KW Building Engineer: H. Radow	Reactor & Fuels	$ 15,000*	To be est. To be est.	0 0	0 0	To be est To be est	To be est.	To be est To be est
		REMARKS: The project proposal was submitted to the Commission on December 23, 1957. It is has not yet been acted upon by the AEC Review Board. *For preliminary design only.							

UNCLASSIFIED

MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-54760 DEL

January, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
IR-231	Badgehouse Alterations for Self-Service - 100 and 200 Areas Engineer: D. S. Jackson	Radiation Protection	$ 15,000	$ 18,500 8-29-57	100 100	N.S. 99	7-1-57 12-2-57	12-20-57	9-15-57 2-14-58
		REMARKS: All racks are in use. All building alterations are completed. Minor alterations to the badge racks and clean up of exceptions remain to be performed.							
New Construction - FY 1958									
CG-731	Critical Mass Laboratory Engineer: R. W. Dascenzo	Physics & Instr.	$1,800,000	None to date None to date	To be est 0	To be est 0	None est None est	As Completed	None est None est
		REMARKS: To date authorized funds have not been received from the AEC on the project proposal request of $175,000 for total design.							
CA-744	Metallurgical Development Facility Engineer: R. W. Dascenzo	Reactor & Fuels	$2,600,000	None to date None to date	To be est 0	To be est 0	None est None est	As Completed	None est None est
		REMARKS: A revised project proposal is being prepared.							
CA-749	High Level Radiochemistry Facility Engineer: R. W. Dascenzo	Chemical Research	$1,070,000	$ 20,000* 9-27-57	100** 100**	To be est 0	7-11-57 5-1-58***	7-1-59***	6-1-58*** 6-1-59***
		REMARKS: The design criteria has been approved by the AEC. Additional preliminary design has been completed on the cell partition doors, liquid transfer hood, cell doors and the interior of the cell. Authorized funds for the total project have not been received to date. *Interim Authority. **Preliminary Design. ***Estimated.							
		REMARKS:							

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H.W. Personnel Contacted	Access to Restricted Data	Areas & Buildings Visited
Spokane Teachers	1-3-58	Spokane public and private schools	Learn about technical information facilities.	CG Stevenson	No	3760 Bldg. 300 Area
L. H. East A. H. Doud I. G. McChesney	1-16,17-1958	Rochester Gas & Electric Corp. Rochester, N.Y.	To acquire general background relating to atomic power generation.	HM Parker FW Albaugh RW Benoliel & others	Yes	325, 326, 327, 306, 305-B, 3760 Bldgs. 300 Area 231 Bldg., 200-West Area
John S. Burns Dirk Verhagen	1-13-58	Van Water & Rogers Seattle, Washington	To discuss shielding materials and solvents.	RW Benoliel EA Evans LL Burger	No	325 Bldg. 300 Area
Sheldon Dunning	1-15-58	Amercoat Corp. Seattle, Washington	Discussion on painting and coatings.	LJ Lucas	No	328 Bldg. 300 Area

VISITS TO OTHER INSTALLATIONS

None

EMPLOYEE RELATIONS OPERATION MONTHLY REPORT

UNCLASSIFIED

HW-54760 -Del

GENERAL

On January 31, 1958 the staff of the Hanford Laboratories Operation totalled 1125, including 506 exempt and 619 nonexempt employees. Of the total exempt employees there were 439 with college degrees including 421 technical degrees as follows:

BS	MS	PhD
221	103	97

In addition, there were 36 nonexempt employees with college degrees.

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

PERSONNEL DEVELOPMENT AND COMMUNICATIONS

Nine members of the Armed Forces Special Weapons Project started a six-weeks' training program in radiation protection on January 6, 1958.

The AEC has approved our proposal for the 1958 Summer Institute. C A. Rohrmann will represent HLO at the selection committee to be held in Washington, D C. in February.

Preliminary planning for the 1958 AEC Radiological Physics Fellowship Training Program is being carried out by a member of the Radiation Protection Operation.

Twenty-one Technical Graduates and seven Technician Trainees were on assignment within HLO at month's end.

Sixteen employees attended Written Communications, 10 employees completed Understanding People, 5 managers attended R&U's Management Conference on Communications, and 3 employees completed the Engineering Data Processing Course.

Eight HLO employees participated in the January Area Tour for Women. This was the final tour of R&U's program. All interested HLO women employees were given an opportunity to take these tours.

A tour of HLO facilities was arranged for 40 Spokane high school science teachers.

Arrangements were made for a visit of HLO facilities by a four-man crew assigned to Edward R. Murrow's "See It Now" show.

One manager's luncheon was held for 27 exempt employees.

Thirty-one technical papers and articles were processed for publication during the report period.

PERSONNEL PRACTICES

One Calibrator B in lack of work status was placed as a Counting Room Assistant with the Analytical Laboratories.

One Serviceman was removed from HLO rolls as a result of seniority bumping.

Twenty-eight Personnel Meter Clerks were laid off, and one was placed in HLO.

One General Clerk A in Technical Information accepted a downgrade to a General Clerk B in lieu of layoff. The General Clerk B displaced accepted a downgrade to a General Clerk C.

Two transfer requests were received during the month of January. The reasons given for the requests were as follows: One - desire a change and one - a job more in line with her interests.

Three one-year, one four-year, two six-year, and one eight-year Attendance Awards were issued during the month of January.

Service Recognition	5 Years	10 Years	15 Years	20 Years	25 Years	Total
Pins issued this month	8	14	-	-	-	22
Total pins out	467	251	1	2	1	722

At the January Suggestion Board meeting 12 suggestions were reviewed and 10 were approved for awards totalling $175. Since the HAPO suggestion budget has not yet been approved, all payments of awards will be withheld pending receipt of such approval from the Commission.

Hanford Laboratories participation in the Employee Benefit Plans as of January 31, 1958, is listed below:

	Dec. 1957	Jan. 1958
Insurance	99.5	99.6
Pension Plan	98.3	98.4
Savings & Stock Bonus	60.3	60.6
Savings Plan	7.7	7.5

Military status of HLO employees is as follows:

STATUS

Reservists	Non-Technical Other than 1A	Technical	Non-Technical 1A	*Critical	TOTAL
Standby	12	31	0	0	43
Ready	15	20	6	1	42
Total	27	51	6	1	85
Non-Veterans	27	39	21	43	130
TOTAL	54	90	27	44	215

*Refers to those employees for whom deferments are currently being requested.

Deferment Requests Pending	6
Deferments Denied, Appealed and Pending	0
Deferments Pending at Presidential Appeal Level	0

UNION RELATIONS

At a meeting held with Union representatives on January 28, the Company refused the Council's proposal of a "Y" type seniority arrangement for the Radiation Monitors and the Regional Monitors on the basis that it would not benefit either the Company or the Union. Our original proposal was offered of separate seniority groups with a terminal date of June 30, 1958, at which time they would merge as one seniority group. The Council is now considering this offer.

The Company has agreed on a list of names to be used for the selection of an arbitrator in connection with the A. R. Maki arbitration case, and the names of these people will be submitted to the Council for their consideration. Mr. T. G. Marshall has been named as a representative on the arbitration committee. This case will probably come to arbitration in the near future.

Six grievances were received during the month of January--all are jurisdictional grievances regarding misassignment of work. One grievance is from the Biology Operation, one in Physics and Instrument Research and Development, two in Chemical Research and Development, and two in Reactor and Fuels.

The grievances processed by this Operation since January 1, 1957 now total 29. This number includes one non-unit grievance. The following is a breakdown as to the status of these grievances.

Step I

Answered satisfactorily*	12
Pending time limit	2

Step II

Pending Step II discussion	1
Pending Step II answer	2
Answered	
Satisfactorily**	11
Pending time limit	1
Applied for arbitration	1

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

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

TECHNICAL PERSONNEL PLACEMENT

During the month eight PhD candidates visited Richland for employment interviews; three offers were extended; and six rejections were received.

PhD - HLO - 9/1/57 to date

		Offers				
Cases Considered	Visited	Extended	Accepted	Open	Rejected	On the Roll
434	31	30	8	6	16	9

1237856

Offer totals included 14 offers extended during the last recruiting season which were open on September 1, 1957.

Offers accepted do not include seven acceptances received during the last recruiting season from people who were not on our payroll on September 1. Four of the seven carry-over acceptances have reported on the roll to date.

A summary of PhD recruiting statistics appears in Table III.

No experienced BS/MS recruiting was conducted during the month of January. A summary of this activity since September 1, 1957 is as follows:

		Offers				
Cases Considered	Visited	Extended	Accepted	Open	Rejected	On the Roll
66	7	6	2	1	3	3

Two people reported on the roll during September as a result of offers accepted prior to September 1, 1957.

A summary of BS/MS experienced recruiting appears in Table III.

During the month one Technical Graduate was placed on permanent assignment within HLO.

During the month seven new requests for transfer were received. Two cases were closed, one by termination and one withdrawn.

Exempt transfer statistics appear in Table IV.

The attrition of exempt personnel for HLO for January:

Transfers	3
Terminations and deactivates	2

SALARY AND WAGE ADMINISTRATION

Following approval of the 1958 salary review by the HAPO General Manager, a detailed statistical analysis of the proposed salary action versus appraisal distribution was completed and forwarded to the HLO level 2 and 3 managers.

The Salary Distribution Data report for the fourth quarter of calendar year 1957 was completed and forwarded to HOO-AEC via Relations and Utilities.

A revised organization directory of HLO exempt personnel as of January 1, 1958 was completed and distributed during the month.

The following position changes were made during the month:

Positions Added	5
Position Titles Changed	2
Position Levels Changed	3
Position Guide Revisions	4

The coordinated HAPO-wide study of semitechnical jobs undertaken last month is proceeding satisfactorily. A preliminary report setting forth recommended changes will be forwarded to the HAPO Employee Relations managers for their review by March 1. Twenty-three nonexempt jobs were audited during the month and as a result, a number of revisions of job write-ups were initiated.

HEALTH AND SAFETY

During January, Laboratories personnel worked a total of 200,384 hours with no disabling injuries. Since September 1, 1956, a total of 3,207,628 hours have been completed with no disabling injuries.

There were 32 medical treatment injuries giving a frequency of 1.60 as compared to 1.77 last month.

There were no fire incidents reported.

Two unusual incidents were recorded:

> Failure of a weld in a code pressure vessel resulted from excessive temperature when a gas pocket formed in the dome of the vessel. A report of investigation is in preparation.
>
> Two Government vehicles driven by Laboratories employees collided in Richland with a total damage of $97.50.

There were seven security violations reported in January.

Consultations were had with and approvals were given to 18 operations on 28 problems.

In addition, consultation was held with a local physician on handling and application of an organic coolant in allergy tests.

Medical examination appointments for HLO employees were 95% fulfilled in January. The three employees not examined in 1957 also reported for examinations.

Supervision was informed of one new medical work restriction, four continuations, and one discontinuation.

Security Operation was assisted in establishing a program of monthly "Infractor Schools" designed to assist employees having security violations to examine reasons for and means of achieving better security performance.

ATTITUDE SURVEY

An analysis of the Attitude Survey scores for significant questions was completed and discussions initiated with the Laboratory Auxiliaries Operation. The first discussion was with the level 3 manager, and subsequent meetings were held with him and each of his level 4's. As a result of the discussions with the level 4's, it was determined that additional discussions should be conducted with the Technical Information Operation. The analysis has been discussed with each of the level 5 supervisors in Technical Information and with six of the nine individual contributors. Detailed notes of the comments made in all of the discussion periods have been made for study and summary.

It is significant to note that enough time has elapsed since the Attitude Survey that most people have forgotten exactly why certain attitudes were expressed as they were. More knowledge about the validity of "aged" attitude survey scores would help in the analysis.

T G Marshall

Manager
Employee Relations

TG Marshall:tr

TABLE III. EMPLOYMENT - TECHNICAL PERSONNEL STATUS

I. Employment

Non-Exempt Employment Status	Dec.	Jan.
Requisitions		
At end of month	7	11
Cancelled	0	0
Received during month	5	10
Filled during month	2	6
Candidates Considered		
Total Applications	52	21
Total Transfer Requests from other at HAPO	4	4

Non-Exempt Transfer Requests	Dec.	Jan.
Transfer Requests		
Active cases at end of month	45	43
Cancelled	10	3
New during month	5	2
Transfers Effected	4	1
Planned Transfers		
Effective during month	0	0

II. Technical Personnel Placement

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

		VISITS TO RICHLAND				OFFERS			On
	Cases Considered	Extended	Visited	To Visit	Open Invite.	Extended*	Accepted	Open	The Roll
Engineering:									
Chemical	51	21	3	7	3	5	1	2	0
Electrical	16	4	0	2	1	2	0	0	0
Mechanical	28	9	2	4	1	2	0	0	0
Met-Ceramics	46	23	6	5	7	4	0	1	1
Other	6	2	0	1	1	0	0	0	0
Science:									
Chemistry	205	33	10	11	5	9	4	2	4
Physics	188	76	9	21	28	7	2	1	1
Math-Statistics	28	3	0	1	2	0	0	0	1
Other	26	4	1	2	0	1	1	0	2
TOTALS	594	175	31	54	48	30	8	6	9

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

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

		VISITS TO RICHLAND				OFFERS			On
	Cases Considered	Extended	Visited	To Visit	Open Invite.	Extended	Accepted	Open	The Roll
Engineering:									
Chemical	6	2	1	-	-	-	-	-	-
Electrical	6	1	1	-	-	-	-	-	-
Mechanical	10	4	3	-	-	2	-	-	-
Met-Ceramics	5	1	1	-	-	1	1	-	-
Other	12	-	-	-	-	1	1	-	1
Science:									
Chemistry	10	-	-	-	-	-	-	-	2
Physics	5	-	-	-	-	2	-	1	-
Math-Statistics	1	1	1	-	-	-	-	-	-
Other	11	-	-	-	-	-	-	-	-
TOTALS	66	9	7	0	0	6	2	1	3

TABLE IV. Exempt Transfer Cases

			January	Total
Active cases at beginning of month			23	
New cases:	Initiated by employee		2	2
	Initiated by management*		5	5
Cases reactivated			30	
Cases closed:	Transfers:	Within HLO		
		Within HAPO		
		Other G.E.		
	Withdrawn		1	1
	Terminated		1	1
			28	2
Active cases at end of month			28	28

Total cases - January 1, 1958 to date (includes 23 cases initiated prior to and active on 1/1/58) 30

Initiated by employee	12
Initiated by management*	18

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

TABLE V. Union Relations

Grievances Processed - January 1, 1957 to date

Total Processed 29 (includes 1 non-unit grievance)

Step I

Answered satisfactorily*	12
Pending time limit	2

Step II

Pending Step II discussion	1
Pending Step II answer	2
Answered	
Satisfactorily**	11
Pending time limit	1
Applied for arbitration	1

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

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

FINANCIAL OPERATION MONTHLY REPORT

Personnel

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

General Accounting Operation

The final draft of a revision to HAPO OPG 05.2 covering plant acquisition and construction was reviewed. In submitting comments to Contract Accounting a recommendation was included that we retain the original copy of Appropriation Requests rather than submit them to Property Management as we have done in the past.

Assistance was rendered HLO components in the preparation of approval and agreement letters covering participation in the affairs of a national committee of the American Standards Association and the fabrication of Pu Al Fuel Elements for the MTR at Arco.

As a result of a request received from SS Accountability, forecasts of requirements for diversion of nuclear materials inside production channels covering the fourth quarter of FY 1958 and the first quarter of FY 1959 were prepared and submitted to them for consolidation on a HAPO-wide basis. Also at the request of the SS Accountability Operation, schedules were prepared to assist HOO-AEC in the conduct of Survey 15, Part II.

At the request of Contract Accounting and as a result of exceptions taken by HOO-AEC to certain practices in connection with expenditures for subscriptions to books and periodicals, discussions were held with Technical Information Operation to determine whether or not their practices were in conformance with those of other library operations. As a result of these discussions, Contract Accounting was informed that these practices were normal and it was suggested that this information be forwarded to HOO-AEC with a suggestion that this fact be taken into consideration in certifying expenditures of HAPO year-end closings.

Appropriation requests receiving final approval during the month included:

58-HL7-40	Vacuum Annealing Furnace Facility	$10,000
58-HL7-41	Hydrogen Sintering Furnace	4,500
58-HL7-42	Power Tube-Flaring Machine	2,100
58-HL2-42	Manipulators	6,700
58-HL5-44	Multipoint Temperature Recorder	2,200
58-HL3-45	Library Stacks	4,500
58-HL2-46	Temperature Indicating Recorder	1,710
58-HL3-47	Eddy Current Testing Device	4,000
58-HL7-48	Swaging Machine	10,400
58-HL7-49	Special Contour Machine	56,000
58-HL5-50	Wind Instruments	21,500

A revised financial plan for HAPO will be received shortly allocating HLO an additional $35,000 for 2000 Program equipment to cover a portion of the cost of Vacuum Creep Testing Units ($38,000).

A budget call letter was submitted to all level 3 and interested level 4 managers on January 22, 1958 for submission of requirement for Equipment Not Included in Construction Projects for FY 1960 and revision of FY 1959 budget. This letter included a format to be used and points to be considered in preparing their budget.

Budget studies are in the process of being prepared and reviewed for major equipment and construction projects.

Budgeted funds in the amount of $200 have been transferred from Financial Operation to Operations Research and Synthesis Operation for attendance at meetings of professional and trade societies during FY 1958.

It has been determined that the over-accrual of approximately $100,000 for continuity of service during 1957 resulting primarily from reduced pension costs and tax credits, will be credited to cost during the remainder of FY 1958.

The remaining funds available for attendance at off-site training courses and seminars during FY 1958 have been allocated to level 3 components. This allocation will be reflected in the report for the month of February.

A recommended allocation of the CY 1958 budget for charges against the fee has been submitted to the Manager - HLO. Preliminary estimates indicate the funds for conference and other will provide for approximately the same level of spending as last year. The variation budget provides for approximately twice the average daily variation incurred during last year and will be allocated to level 3 components based on their estimates of number of travel days during 1958.

Our proposed revision to the present "Travel Order, Reservation Request and Cash Advance Receipt" has been accepted by all other HAPO components. Steps are being taken to have the revised form placed in stores stock upon depletion of the supply of present forms.

As a result of Traffic Operation's discontinuing the service of providing transportation after December 15, 1957, travel advances now include funds for employees to purchase transportation on a cash basis. The increased demands for cash are reflected in the cash working fund as follows:

	Cash Advances		
	Number	Amount	Average Amount
October, November & December 1957	139	$15,170	$109
January 1958	51	13,392	262

Quarterly inventory reports for the quarter ending December 31, 1957 were received from all HLO custodians of Reactor and Other Special Materials and reconciled with Property Accounting stock control records. All reports were found to be in agreement with Property Accounting records. A comparison of the December 31, 1957 total ($693,797) with that of September 30, 1957 ($871,955) shows a decrease of $178,158, principally due to the transfer of zirconium to IPD for use on their Contracts DDR-28 and DDR-32 and their purchase orders HA-58-888-1339 and H8K-888-50696.

Custodian Accountability Cards for uninstalled cataloged equipment in the custody of Reactor and Fuels Research and Development Operation and Chemical Research and Development Operation were reviewed and distributed to Property Control Custodians. With the issuance of these cards new Custodian Accountability Cards have been issued for all HLO uninstalled cataloged equipment (8,717 items) on the 702 magnetic tape. New Custodian Accountability Cards will be issued on a current basis.

In connection with the annual physical inventory of uninstalled cataloged equipment, Missing Plant and Equipment Reports have been received from Radiation Protection Operation and Laboratory Auxiliaries Operation, valued at $1,205 and $101 respectively. Upon receipt of all Missing Plant and Equipment Reports, one Property Disposal Request will be prepared for all HLO missing equipment.

A special report - Annual Industrial Fire Program and Experience - was prepared for Contract Accounting showing the replacement value of facilities and equipment assigned to HLO, including underground installation and open-sided structures, at December 31, 1957. The value of plant and equipment on HLO records was $33,052,218 compared to a replacement value of $39,898,876. This reflected an increase of $6,846,658 over the original purchase price. The index used in reflecting replacement value was furnished by Contract Accounting from the Building Cost Index published by Smith, Hinckman, and Geyels.

Building 2708-E, 200-E Area will be transferred to CPD in February 1958 for use by 200-East General Maintenance Operation. Arrangements have been made for HLO to rent warehouse space from CPD to store Regional Monitoring soil samples now stored in the 2708-E Building.

The standard service life of portable radiation monitoring instruments was changed from 10 years to 5 years with Commission approval. This was accomplished by reclassifying portable radiation monitoring instruments from Health Instruments to Special Radiation Instruments, Apparatus and Accessories. The request for change in service life by Instruments Standards, HLO, was due to:

1. In such a rapidly advancing technology as electronics, obsolescence occurs at a much faster rate than in more stable industries.

2. The extensive use that the pool instruments receive here at HAPO results in more rapid deterioration of the equipment than a ten-year life will accomodate.

The change in service life resulted in an increase of $2,650 in our monthly depreciation and an adjustment of $74,898 will be made to the reserve account in June when the annual review of HLO composite depreciation rates is made.

Cost Accounting Operation

A new Financial Plan for FY 1958 was received from HOO-AEC during January. A letter was sent to HLO management informing them of the amounts included. The Plan was essentially the same as the Midyear Review (for operating costs) as it applies to HLO with the exception of the Plutonium Recycle Test Program which was $563,000 less than that requested in the Midyear Review.

Funds allocated to HLO from the Product Departments for R & D Programs have been adjusted during January as follows:

IPD - Additional New Production Reactor funds

Reactor & Fuels R & D	$130 000
Physics & Instrument R & D	10 000
	$140 000

FPD - Additional New Production Reactor funds

Reactor & Fuels R & D	$ 75 000

CPD - Adjustments in programs as follows:

	Midyear Review	New Allocation	Increase (Decrease)
Chemical Research & Development			
Separations Development	$1 502 000	$1 456 000	$(46 000)
Non-Production Reactor Fuels Reprocessing	530 000	510 000	(20 000)
Nuclear Materials Management		29 000	29 000
New Production Reactor		13 000	13 000
Reactor & Fuels R & D - Weapons Development	86 000	83 000	(3 000)
	$2 118 000	$2 091 000	$(27 000)

Preparation of the FY 1959 Revised Budget and FY 1960 Annual Budget has begun. The "call letter" has been transmitted to HLO management for the required information. Forms, comparison data, salary averages and other basic information are now being prepared.

Hanford Laboratories will allocate General Overhead cost to Research and Development - New Production Reactor in accordance with the policy established by IPD whereby accounting rules which govern distribution of overhead will in general follow project-type procedures. Only the additional General Overhead cost incurred by Hanford Laboratories as direct result of this program will be charged. This consists of purchasing and receiving costs approximately 6.5% and 2.5%, respectively, on the purchase price of direct orders and contracts. Individual orders or contracts in excess of $25,000 (if any) will receive 1.5% for purchasing cost and 2.5% receiving cost when applicable.

Three new work identification codes were established during the month as follows:

Code .52 - Research & Development - IPD - NPR
Code .61 - Research & Development - CPD - NPR
Code .64 - Research & Development - CPD - Nuclear Materials Management

Considerable time has been spent with management of Laboratory Auxiliaries in preparing a calendar year 1957 cost base for purposes of measuring calendar year 1958 progress toward achieving a 9% cost reduction by December 31, 1958 in the Technical Information Operation. This has been a difficult job due to reorganization within the Technical Information Operation last September. In

addition, salaries were escalated for cost-of-living increases and Buildings and Utilities costs were corrected to present basis. These cost indexes have been established for each level five operation and will be shown on operating reports each month with comparisons made to annualized calendar year-to-date costs.

Detailed listings of equipment expenditures for the first six months as well as commitments and in-process items as of December 31, 1957 were issued to each level three operation to assist them in their planning and control of expenditures within budget funds.

Personnel Accounting Operation

Salary Review listings were returned to Personnel Accounting indicating recommended merit and promotional increases with effective dates December 31, 1957 through December 31, 1958. Each listing sheet was approved by the individual authorized to approve salary changes. An analyses of the Review was prepared and forwarded to level 2 and level 3 Managers on January 22. Salary Review increases for December 1, 1957 and January 1, 1958 were reflected in salary payments made in the month of January.

In accordance with Pension Instructions No. 12 - Report of Employees' Contribution Cards Year 1957, IBM cards forwarded from Schenectady covering each individual participating in the Pension Plan were key punched to reflect individual employees' contribution to the Plan during 1957. Transfers in, transfers out, refunds and retired employees tabulations were certified as being correct with our records and a reconciliation of the Pension Plan prepared. The individual cards and Pension Reconciliation were air mailed to Company Employees Trusts Accounting on January 31, 1958.

In accordance with instructions relative to reporting under the requirements for filing State Income tax returns covering payments made by the General Electric Company during the year of 1957, returns were filed with the State of Idaho, Oregon and California within due dates required for filing such returns.

Instructions were received from Schenectady relative to the preparation of the annual Federal Tax return of Employers under the Federal Unemployment Tax Act for the year 1957. Attached to the instructions were three exhibits which required completing as follows:

(1) Analysis of Total Wages Paid
(2) State Summary of Wages
(3) Annual Return Under Federal Unemployment Tax Act Calendar Year 1957 Summary

Total wages reported on analysis of total wages on (1) above amounted to $7,812,663. Wages subject to Federal Unemployment Tax, (3) above, amounted to $3,616,906. Total taxable wages reported for the State of Washington on (2) above amounted to $3,613,906 and total reported for the State of Idaho amounted to $3,000. These reports were prepared and forwarded to Schenectady on January 31.

Withholding tax statements (Form W-2 for 1957) were delivered on January 16 to employees of HLO. During the year, including active and inactive employees, 1,368 forms were prepared. Gross wages paid to these employees amounted to $7,812,663. Income tax withheld from this payment amounted to $1,097,753.

Social security tax withheld amounted to $111,255.

IBM cards were prepared on forms furnished by State of Washington Unemployment Compensation Department to indicate State taxable applicable to each individual paid by HLO during 1957. These cards plus listing sheets as requested were mailed to Employment Security Department, Olympia, Washington on January 30.

As a result of another rise in the cost of living index during the fourth quarter calendar year 1957, a .59% increase in the base rates of most non-exempt employees was effective January 27, 1958. The increase will be reflected in weekly salary checks to be delivered February 7, 1958. Based on the hourly based rates of non-exempt employees, week ending 1-12-58, this increase would increase the non-exempt annual payroll approximately $14,887. The exempt annual payroll would be increased approximately $346 due to an increase in area differential payments.

Procedures

The study concerning suggested consolidation of plant delivery service by Classified Files and area mail forces was completed and recommendations submitted. It was determined that the increased possibilities of operating errors and loss of security controls outweighed the limited benefits of such a consolidation; it was recommended that consideration for this proposal be dropped. A further suggestion made concerning the possibility of Files' messengers taking over all registered deliveries within areas was considered by both plant mail and Files supervision. Results of discussions held showed that this plan also was not feasible at this time.

An investigation is being made of the current and potential needs of work addresses to be included in the main personnel source file records maintained by Data Processing Operation R&UO. Some interest in these records has been expressed; we are now awaiting more firm estimates of the costs of maintaining these data.

A demonstration meeting was held with representatives of IBM to view the new #8200 Time Punch. This time recorder performs an additional step in automatic data handling in that it delivers punched cards ready for data processing. The potential possibilities of these machines are excellent in certain applications; whether they are feasible for our specific use is uncertain, however, and is being studied.

A suggestion was made to Data Processing Operation concerning the using of reproducible masters routinely as one copy of output from the IBM printers. Coincident with the planned development of Ozalid equipment to handle continuous forms, this method appears to offer considerable time savings in handling information being printed as output from programs on the computer.

Final evaluations were made of a proposal made by Data Processing for mechanizing absence accounting using EDPM equipment. Though the proposal designed by this group was, in part, in answer to a specific request made by us in August 1957, the finished program was considerably more extensive than we had requested and proved to be too costly to use. This is an unfortunate example of the need for better integration of the wishes of Data Processing and its customers.

Auditing

The Cost Accounting audit report and the General Accounts audit follow-up were completed as of December 31, 1957. Field work on the Administrative Services audit is nearly complete. The report will be issued in January.

Measurements

Assistance was given in establishing Hanford Laboratories goals for 1958. A narrative summarizing measurement status and indicating the direction of future efforts was prepared in rought draft form.

Payroll Statistics

Number of HLO Employees Changes During Month	Total	Exempt	Non-Exempt
Employees on Payroll at Beginning of Month	1 158	507	651
Additions and Transfers in	10	5	5
Removals and Transfers Out	(43)	(6)	(37)
Transfers from Exempt to Non-Exempt	-	-	-
Employees on Payroll at End of Month	1 125	506	619

Overtime Payments During Month	January	December
Exempt	$1 232	$1 966
Non-Exempt (five weeks in January)	4 528	2 773
Total	$5 760	$4 739

Gross Payroll Paid During Month		
Exempt	$385 017	$377 188
Non-Exempt (five weeks in January)	327 500	270 768
Total	$712 517	$647 956

Annual Going Rate of Payroll		
Exempt	$4 566 220	$4 507 108
Non-Exempt	3 371 446	3 466 721
Total	$7 937 666	$7 973 829

Average Hourly Base Rate		
Exempt	$4.2469	$4.1675
Non-Exempt	$2.4837	$2.4411

Participation in Employee Benefit Plans at Month End	Number Participating January	Number Participating December	Percent Participating January	Percent Participating December
Pension Plan	1 121	1 120	98.4	98.3
Insurance Plan				
Personal Coverage	1 172	1 183	99.6	99.5
Dependent Coverage	733	731		
U.S. Savings Bonds				
Stock Bonus Plan	682	698	60.6	60.3
Savings Plan	84	89	7.5	7.7

Insurance Claims Employee Benefits	January Number	January Amount	December Number	December Amount
Life Insurance	0	$ 0	0	$ 0
Weekly Sickness & Accident	13	973	9	596
Comprehensive Medical	102	6 943	55	5 251
Dependent Benefits				
Comprehensive Medical	127	9 722	77	8 293
Total	242	$17 638	141	$14 140

Good Neighbor Fund

	January	December
Number participating	722	753
Percent participating	64.2	65.0

Other Statistics

Travel

	No.	January	No.	December
Accounts Outstanding at beginning		$ 7 043		$21 548
Charges:				
Cash issued - by checks	32	8 124	25	5 714
- by currency	51	13 392	32	3 259
Transportation		-0-		7 080
Other - (Billings from other GE Components, moving expense, etc.)		2 555		2 854
		31 114		40 455
Less:				
Expense vouchers processed				
Travel expense accounts	23	5 832	94	25 540
Other (moving expenses, conference expense, etc.)	9	675	38	2 867
Refund of advances	44	3 765	62	5 768
Billings to and from HAPO Components-Net		(229)		(763)
		10 043		33 412
Accounts Outstanding at Close	56	$21 071	20	$ 7 043
Ages of accounts outstanding				
15 days or less	50	$18 346	14	$ 5 462
16 - 30 days	4	2 485	6	1 581
More than 30 days	2	240		-0-
		$21 071		$ 7 043

Schedule of Non-Reimbursable Expenditures	January	December
Travel and Living Expense Variation	$ 105	$ (51)
Conference Expense and Other	-0-	916
	$ 105	$ 865

Activity in Cash Working Fund		
Balance beginning of period	$5 000	$3 000
Increase of Fund	-0-	2 000
Cash disbursements	(13 392)	(3 257)
Replenishments to Fund	13 392	3 257
	$5 000	$5 000

W. Sale
February 11, 1958

INVENTIONS OR DISCOVERIES

All persons engaged in work that might reasonably be expected to result in inventions or discoveries advise that, to the best of their knowledge and belief, no inventions or discoveries were made in the course of their work during the period covered by this report except as listed below. Such persons further advise that, for the period therein covered by this report, notebook records, if any, kept in the course of their work have been examined for possible inventions or discoveries.

INVENTOR	TITLE OF INVENTION OR DISCOVERY
J. J. Cadwell and F. B. Quinlan	Flexible Cluster Fuel Element Support
R. H. Moore	Use of CCl_4 as an Oxidant in the $KAlCl_4$ System.
E. J. Middlebrough	"Mixing Blade"