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HANFORD 65142

HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
FEBRUARY 1957

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Operation Managers

March 15, 1957

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

[redacted]

PRELIMINARY REPORT

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TABLE I. HLO-FORCE REPORT AND PERSONNEL STATUS CHANGES

Date February 28, 1957

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	125	93	218	126	94	220	1	1	2	2
Reactor & Fuels Research & Development	139*	92*	231	139	87	226	3*	7	3	2*
Physics & Instrument Research & Development	58	25	83	59	25	84	0	0	1	0
Biology	32	42	74	32	41	73	0	1	0	0
Operations Res. & Syn.	11	3	14	10	3	13	1	1	0	1
Radiation Protection	40	204	244	41	205	246	0	0	1	1
Laboratory Auxiliaries	41**	197**	238	36	201	237	5**	6	0	10**
Financial	15	32	47	15	34	49	0	0	0	2
Employee Relations	13	12	25	13	12	25	0	1	0	1
General	1	1	2	1	1	2	0	0	0	0
TOTAL	475	701	1176	472	703	1175	10	17	7	19
Total excluding Internal Transfers	475	701	1176	472	703	1175	10	15	7	17

* 1 Reassignment from Non-Exempt payroll

** 5 Reassignments from Non-Exempt payroll

Composite Separation Rate -1.530
Separation Rate (based on separations leaving G.E.) - - - - - - - - - - - - - - .680
Controllable Separation Rate - .085

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

Date February 28, 1957

Component	PROMOTIONS			EXEMPT TRANSFERS (2)				NON-EXEMPT TRANSFERS	
				To HLO		From HLO			
	Exempt	Non-Exempt to Exempt	Non-Exempt	From Other HAPO	From Other G.E.	To Other HAPO	To Other G.E.	To HLO	From HLO
Chemical	0	0	1	1	0	0	1(3)	1	0
Reactor & Fuels	7	1	3	1	0	0	2(4)	4	0
Physics & Instr.	0	0	0	0	0	0	0	0	0
Biology	3	0	1	0	0	0	0	0	0
Operations Res. & Syn.	0	0	0	1	0	0	0	0	0
Radiation Protection	0	0	6	0	0	0	0	0	0
Laboratory Aux.	0	5	4	0	0	0	0	2	4
Financial	0	0	2	0	0	0	0	0	1
Employee Relations	0	0	0	0	0	0	0	1	0
TOTAL	10	6	17	3	0	0	3	8	5

(1) Data through 2/28/57
(2) Transfers within HLO not included
(3) M. Seigler to APED
(4) J. R. Morgan & J. W. Lingafelter to APED

SUMMARY

Research and Development

Progress of work generally for product departments was favorable. Some degree of delay occurred when experimental facilities operated by others were not available as early as expected.

The strenuous efforts to bring expenditures to the budget limits began to take effect, but the situation will be a trying one for the balance of the fiscal year.

The Commission was advised of additional areas of research and development activities in which the Laboratories believe that a real contribution can be made. Plans were made to present these items in a formal way for fuller consideration.

1. Reactor and Fuels

   Substantial progress was made by several off-site vendors in developing processes for production of B-D-F-size ribbed and KER-size ribless Zircaloy process tubes. The National Carbon Company has been developing low density (1.2 g/cc) graphite for reactor use. First samples received by HAPO were of satisfactory purity.

   Extended fabrication development programs on hot-pressed I & E and vacuum canned production fuel elements were completed and 250 slug lots of each were prepared for reactor loading.

   Three alternate core designs are under consideration in the fuel element test reactor preliminary design study. Total reactor power now contemplated is 150-200 megawatts. It will be recalled that the AEC plans to make this reactor available for private industry bids.

   Development of improved primary and secondary orifice combinations for use in K reactor fringe zones is virtually completed.

   Preliminary studies indicate that recycling of plutonium is applicable to pressurized and boiling water-type reactors as well as the D_2O types. Estimates of plutonium fuel cycle costs on government financing bases indicate that with current technology plutonium enrichment will be one and one-half to two times as expensive as alternate U-235 enrichment as applied in PWR, EBWR, and SRE reactors. Presently projected research and development programs are designed to achieve competitive situations.

   First irradiation tests of the concentric tube UO_2 fuel element concept were completed.

2. Physics and Instruments

   The limiting enrichment, from a nuclear safety standpoint, of a large mass of uranium metal was calculated to be 5.5%.

An exponential pile was built for reactivity measurements on I and E slugs in a C-Reactor lattice. Buckling measurements were made on 1.4% enriched uranium I and E slugs at two lattice spacings in continuation of work previously reported. Basic data for temperature coefficient calculations were obtained from neutron diffusion length measurements in a heated graphite stack.

Reactivity measurements were made in the PCTR of natural uranium rods of 0.925" diameter at three different lattice spacings. Work was also done on large diameter cored elements and on 7-rod clusters.

Progress was made in correlating existing exponential pile data with reactor lattice theory.

The experiment to determine the safe enrichment limits for UO_3-water mixtures was begun in the PCTR.

The analog computer is being debugged. Circuits were developed to simulate excess power, coolant loss and manual scram for the reactor coolant boilout problem.

A 330 cubic inch plastic scintillator and a 14-inch photomultiplier were studied for application in the Body Monitor. Improvement over the performance of similar scintillators in body monitors at other sites was obtained.

Work was begun on a transistorized Alpha Hand and Shoe Counter. The overall instrument volume will be 20% of the present fourfold counters and detection sensitivity will be 500 d/m.

Work continued on the dual filter alpha air monitor which can be set to alarm at one-twentieth of the previous level.

Several nuclear safety problems were studied including the effect of plutonium buildup in slugs on dissolver safety, specifications for handling 1.6% enriched fuel elements, procedures for casting certain plutonium shapes, and fabrication of plutonium fuel elements for the PRPR.

A design of a zirconium, high pressure, in-reactor tube for the KAPL-120 loop was recommended which will double the flux in the loop and is based upon proven zirconium fabrication techniques.

3. Chemical Research and Development

Investigation of kinetic factors influencing the Purex system included: (1) Effects of non-ionic surfacants on uranium transfer rate; (2) normal butyl tetra hydrofuran behavior as a separations process solvent.

Neptunium is found to be present as Neptunium(V) in the Purex co-decontamination cycle. The (V) form distributes preferentially into the aqueous phase. Reduction to Np(IV) together with high acid and low organic saturation coax the Np into the organic phase. This permits its more convenient recovery.

Basic design features for an organic phase continuous codecontamination cycle extraction column (HA) were provided to CPD.

Dissolution of zirconium in stainless steel equipment appears feasible. Zirconium is attacked by NH_4F, NH_4OH systems at a rate of 0.3 to 0.03 mils/min. Attack on stainless steel is about 1.0 mil/month. The capability of existing separations facilities to process power reactor fuels would be greatly increased by successful integration of this procedure; this could be a significant breakthrough in technology.

Wet chemical measurements for iodine-131 on vegetation samples are subject to a significant loss of iodine. As funds permit a change to routine gamma spectroscopy will be made. Gamma spectrometry has also disclosed the uptake of Zn-65 by animals and persons drinking Columbia River water. The concentration of Zn-65 in Columbia River water in the Tri-City area demonstrably exceeds that near Portland.

Fuel clad with the promising aluminum alloy M-388 will result in effluent water with long-lived Fe-59 concentrations several orders of magnitude above that now observed.

The use of coulometric measurements for plutonium in dissolved irradiated fuel solutions in lieu of present radiochemical assays appears feasible. A marked reduction in the volume of solution (and required shielding) for analytical manipulations is foreseen.

Geological studies have outlined deep basins on the basalt surface. It is conceivable that highly radioactive wastes could be pumped into these depressions without contamination of the mobile ground water.

Conditions for testing the feasibility of cribbing scavenged TBP plant wastes have been defined. Successful demonstration will permit the removal of 10,000,000 gallons of wastes from underground storage tanks.

The surface area of UO_2 was increased 2.5 fold by reoxidation to U_3O_8 and reduction to UO_2 in a fluidized bed system. Previous studies indicate a correlation between large surface area and high density sintered UO_2, needed for oxide fuel elements.

4. Biology

Contamination of plankton in the Columbia River reached the highest values ever recorded--up to 0.1 $\mu c/g$.

Zn^{65} was found in another rat that had been exposed to reactor effluent as drinking water.

Several chemicals were tested for their effectiveness in removing internally deposited plutonium and ruthenium, with negative results. Detectable blood plutonium concentrations in pigs occurred within an hour after they were intratracheally exposed to plutonium nitrate.

No apparent harm resulted from 45 μc I^{131}/day fed to pigs for three months.

Based on turnover studies of ruthenium oxide in lungs of mice, 5×10^{-9} μc $Ru^{106}O_2$/cc air should yield a dose rate of 0.3 rem/week to human lungs; the currently accepted limit is six times greater than this.

A reverse temperature effect of the lethality of radiation on yeast cells was observed. Tritium was more effective at 20 C than at 30 C.

Plants with killed roots absorbed as much or more of several radioactive substances as plants with live roots, further indicating that a passive role taken by plant roots in absorption is important in uptake of many substances, a notion that is contrary to some current theories.

Technical and Other Services

Progress on Operation Pool was satisfactory; cooperation by all product departments was extremely helpful.

Feasibility and scoping studies for the I.P.D. reactor data center were completed, and the task was closed out.

An apparently practical system for matching qualifications, needs, and interests against HAPO-wide opportunities was formulated.

Statistical services and consultation continued at a good professional level and in good volume. One topic of major importance has to do with the tight specifications on final product.

Drinking water in the Pasco-Kennewick systems contains more radioactive material now than has ever been measured at these locations in the past. The average total beta measurement at the Clover Island pumping station for February was 3.2×10^{-6} μc/ml compared to 1.4×10^{-6} μc/ml a year ago.

There was one confirmed case of plutonium deposition during the month. The total number of cases on record to date is 198.

The Columbia River Advisory Group meeting, held February 7-8, was well received.

Radiographic and other testing work on the zirconium process tube program started on a moderately large scale this month in the 221-B Building. The pipe gallery of this building affords a readily accessible, shielded facility in which it is possible to handle the long tubes.

A questionnaire on the services of the Technical Information Operation is rapidly taking shape. It is anticipated that the questionnaire will help in determining a proper level of service as well as providing an indication of performance in the function. Concurrently, a brochure on Technical Information's reference resources and services is being written.

In response to a request from HOO-AEC, Technical Information began selecting a group of reports relating to the separations process for ultimate release by AEC. These include HAPO reports on Redox and Purex, Tasks 1, 2 and 3 in the 234-5 process, and the UO_3 recovery process.

Supporting Functions

The force increased by one to 1176.

The Armed Forces Special Weapons Training Program was concluded on February 15.

The Manager's annual information meeting was held on February 20. Three luncheon information meetings were conducted during the month with a total attendance of 88 exempt personnel.

Thirty-five suggestions were received from Hanford Laboratories employees during February, representing five suggestions submitted per 100 eligible employees.

There was a slight increase in pension and insurance plan participation during the month.

Technical Personnel Placement activities showed recruiting of BS/MS candidates at a favorable level and Ph.D. recruiting somewhat below requirements.

Laboratories personnel worked a total of 185,176 hours with no disabling injuries. The medical treatment frequency for the month was 1.73 compared with 1.53 for the previous month. There were 8 security violation incidents during the month, continuing the unfavorable trend.

Traveling auditors from Accounting Services began their audit of Hanford Laboratories Operation during February.

Tentative budget estimates of personnel by components and assignments were submitted to Contract Administration. Closer estimates are dependent upon decisions as to levels of HAPO research and development and the allocation of the work among HAPO components.

Four favorable FY-1957 budget adjustments in the total amount of $337,500 relieved part of the extreme pressure on the Operation to complete the year without overruns.

H M Parker

Manager
HANFORD LABORATORIES

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Reaction of Uranium with Organic Coolants. Studies of the reaction of uranium metal with organic coolants to form uranium carbide have been reported in recent months. During the month tests were conducted to study the conditions under which the reaction occurs and how it might be controlled. It has been shown that hydrogen pressure in a closed autoclave system has a very strong effect on the rate of reaction between the organic coolant and uranium metal. A bare uranium sample was attacked only after 21 days in monoisopropyl biphenyl at 400 C in a system vented regularly to maintain the total pressure below 200 psig, while a corresponding sample was completely destroyed in seven days in a closed system in which the pressure built up to 750 psig. Uranium metal pieces completely canned in aluminum are perfectly protected, while pieces canned in imperfect (or pre-defected) cans are largely protected. A sample with a 1/16 hole in the can showed no swelling after 28 days in monoisopropyl biphenyl in a vented system at 400 C, while a corresponding piece in a closed system was badly swollen after 17 days.

Eutectic Mixtures of Organic Coolants. French and Epstein(1) of KAPL have suggested that eutectic mixtures of purely aromatic hydrocarbons be used for reactor coolants rather than aromatic compounds with potentially vulnerable aliphatic sidechains (such as monoisopropyl biphenyl). Calculations were made to determine the theoretical vapor compositions and vapor freezing points of these mixtures(2).

These calculations indicate that it is possible to have a mixture of purely aromatic compounds with a freezing point below 25 C whose vapors will be of a composition that will also have a freezing point below room temperature. Such a mixture would not plug gauge lines, etc., as previous mixtures have done.

A program has been started to verify several of the more promising phase diagrams experimentally. Some aromatic compounds are on hand, and others are being purified.

- -

(1) KAPL-M-NEF 1, "Preliminary Consideration of Phase Relations in Systems of Diphenyl and Terphenyls and Other Aromatic Hydrocarbons," N. E. French and L. F. Epstein, 10/15/56, Unclassified.
(2) HW-48427, "Boiling Points, Vapor Compositions and Freezing Points for Some Aromatic Hydrocarbon Mixtures," H. C. Bowen and C. Groot, 2/13/57, (Unclassified).

Effect of Aluminate Ion on Corrosion Rate. Recent experiments have indicated that a basic solution of aluminate ion inhibits the uniform corrosion of aluminum. Laboratory tests and ELMO-9 tests are currently under way to verify this effect. Samples of 1245 aluminum which were exposed for two weeks at 90 C to a solution of 0.25 ppm aluminum of pH 8.9 were corroded to the same extent as samples exposed to neutral distilled water. This corresponds to a 10-fold reduction of the corrosion which normally occurs at pH 8.9.

Effect of pH on Corrosion. Experiments are under way to determine the pH of minimum aluminum corrosion at temperatures up to 350 C. Coupons of aluminum enclosed in six stainless steel tubes containing 0.2 M acetate buffer solutions of pH 3, 4, 5, 6, 7, and 8, and maintained at the desired temperature in an autoclave. At 300 and 280 C, the minimum corrosion occurred at pH 3. The pH 4 solution was only slightly more corrosive. At 250 C, the minimum corrosion occurred at pH 4.

Effect of Galvanic Current on Corrosion of Aluminum. Galvanic acceleration of aluminum corrosion does not exist at 125 C in potable water. Several experiments were conducted in which three coupons of 1245 aluminum were corroded in an autoclave in mixed tap water and distilled water under conditions of low flow. A battery connected across two of the coupons made one of them the anode and the other the cathode with about a one volt drop between them. Exposures were made for various periods of time from two days to five weeks. There was no consistent difference in corrosion between the anode, cathode, and control samples.

Corrosion of M388 and M400 in 363 C Water. Uniform corrosion rates of M388 and M400 aluminum alloys in recent low-flow autoclave tests at 363 C are greater by a factor of two than those in static systems.

Static corrosion tests at 363 C, now in the fifth month at Hanford, indicate that the intergranular corrosion rates for M388 and M400 are 24 and 14 mils/year, respectively.

Detecting Surface Inclusions in Aluminum by Autoclaving. Autoclaving of fuel elements has proven to be a sensitive test for many surface imperfections in the aluminum jacket. The current minimum autoclaving cycle of forty hours delays the information obtained in this test about two days behind the production of the fuel element. This undesirable lag time might be cut down if it could be established that a shorter cycle provides as sensitive a test and as corrosion-resistant a film on the aluminum as the current forty-hour period.

To this end, inclusions of several foreign materials were introduced into aluminum coupons by pressing. These coupons were heat treated, quenched, etched, and autoclaved in a manner similar to process fuel elements. The forty-hour autoclave treatment was interrupted at two, six, and 13 hours and the coupons photographed. A comparison of the various pictures disclosed that the appearance of the inclusions has not changed appreciably in the period 13 to 40 hours. No new inclusions appeared after six hours of autoclaving.

Radiometallurgy Examinations

Post-Irradiation Annealing Studies of Uranium. The investigation of the effects of post-irradiation annealing on irradiated uranium was continued by annealing two samples, having 618 MWD/T exposure, for two hours in the gamma phase region (900°) and then furnace cooling.

A comparison of the pre and post annealing properties revealed that numerous macrocracks were formed in both samples by the annealing and there was a maximum observed change in linear dimensions of two to three percent. The density of the material after annealing was 18.627 g/cc, as compared with 18.860 g/cc for a similar piece of unannealed material, and the hardness decreased from 61.0 to 55.5 $Rockwell_A$.

High Level Examination and Cut-Off Cell (Project CG-682). Authorization of the remaining design funds for Project CG-682 was received on February 1, 1957. The project design is being rescheduled and design completion is expected by June 1957. Previous cell wall thickness calculations indicated that 18-inch thick cast iron walls would reduce the radiation level to 6 mr/hr at the outside of the cell. However, these calculations were found to be in error and at least 22 inches of cast iron shielding will now be required.

Fuel Element Test Reactor - Preliminary Design Studies

Schedule. Preliminary design scoping of a Hanford fuel element test reactor was continued. To complete this work by July 15, the following schedule of completion dates for several phases was established:

Preliminary Engineering Data	March 1
Preliminary Design Scope	May 15
Scope Specifications, Rough Draft	July 1.

Power Level. It has become apparent that the power level of the FETR cannot be higher than 150 to 200 MW if the cost of the reactor does not exceed the amount requested in the budget. Since this reactor would be constructed on a limited budget, special facilities such as small test coolant loops will not be included in the basic reactor design.

Core Design. Three alternate core designs under consideration are:

1. A graphite moderated reactor with 158 tubes arranged on a 10-inch square lattice. The size of the core is approximately 8x8x14 feet. A criss-cross lattice is used with fifty tubes oriented vertically and the remainder horizontally. The active zone length of all tubes is eight feet.
2. A graphite moderated reactor with 156 tubes arranged on a 10-inch square lattice. The size of the core is approximately 10x10x12 feet. This alternate also has a criss-cross lattice with forty-eight vertical channels and the remainder horizontal. The active zone length of all tubes is ten feet.
3. A heavy water moderated central zone with graphite moderated side fringe zones. The core size, number and arrangement of tubes,

and active zone length is the same for this alternate as for (1). Selection of the alternate which will be scoped in detail will be based on an analysis of the construction and operating economics.

Various arrangements for structural support and assembly of moderator, thermal shields, and biological ("B") shields were studied. The accommodation of vertical and horizontal process tubes will utilize four of the six faces of the unit. Preliminary studies indicate the feasibility of separating three of the four faces from the supporting "B" shield frame to permit thermal expansion. Because the fourth or bottom face will serve as supporting member for the moderator, limited movement and control of thermal expansion will be necessary.

Cooling System. Consideration has been given during the past month to the selection of an optimum cooling water supply system for FETR. Planning is necessarily fluid because of the preliminary nature of the reactor. Present plans call for the possibility of single-pass cooling with process water for the entire reactor and an available supply of raw water sufficient to cool most of the reactor by use of liquid-liquid heat exchangers. The actual split between single-pass and recirculation cooling will change with time, depending upon the needs of potential customers. It is thought that few if any recirculation loops will be initially installed unless specific requests are received for them. Future recirculation loops would be supplied by the customer with FETR supplying raw and deionized water for the loop. For purposes of cost estimation the maximum raw water flow from the river has been set at about 30,000 gpm, with about 10,000 gpm of this flow available for process water.

Structure. A preliminary investigation of a containment structure for the FETR was started. Comparative studies will be based on buildings with gross volumes of 1,000,000 cu ft designed to contain a pressure surge of up to 25 psig. Spherical and cylindrical shape buildings will be studied. The structural materials to be considered are steel and concrete or combinations of the two. Preliminary cost figures were developed for a 125-ft diameter Hortonsphere. Based on actual construction costs at an Eastern location, the steel spherical enclosure with concrete footings was estimated to cost approximately $1,200,000.

Lattice Studies. A flux pattern was computed for the FETR on the basis of a 10x10x17 lattice unit design. A buckling of 50 was assigned to the center region. The buckling required from the so-called driver region was found to be zero. The four rectangular faces of the reactor were enriched with U^{235}-Al material, but the ends had no enrichment. This divided the reactor into 27 regions. The average flux was then calculated for each region and from this, the power.

No.	Region	# Uranium or Equiv.	Power MW	Total MW
1	High-flux region- center	4050	36.23	36.23
2	" sides	1400	8.57	17.14
2	" top & bottom	1454	8.90	17.80
4	" edges	493.33	3.02	12.08
2	Driver regions- centers	1320	5.73	11.46
4	" top & bottom	440	1.31	5.24
4	" edges	704	2.09	8.36
8	" corners	146.66	.44	3.52

A total of 111.8 MW, excluding the materials test facilities, is obtained by summing the last column. The fraction of the reactor occupied by enrichment (57%) is considered undesirably high and further studies employing larger core dimensions or D_2O moderation have been initiated.

Calculations were made on buckling of graphite lattices using K-process tubes and 1.336" slugs, enriched uniformly to 0.94% U-235, on a 10" spacing for graphite densities of 1.4, 1.5, 1.6, 1.7, 1.9. These calculations were made with and without graphite stringers surrounding the fuel tubes.

$2/cm^3$ Graphite Density	Without Stringers	With Stringers
1.4	64.8	151.3
1.5	71.3	160.8
1.6	76.7	171.5
1.7	82.6	178.6
1.9		187.2

These buckling values are much too low to solve the problem in view of the required (critical) buckling of 227 for the entire reactor. The utility of 0.94% enriched uranium fuel is considerably improved in lattices with smaller spacing and higher graphite density than those considered so far and is particularly attractive with D_2O moderator in part of the reactor. A report on these results is being prepared.

Basic Metallurgy Studies

Radiation damage to the crystal structure of molybdenum is under investigation by an analysis of the x-ray diffraction lines. Specimens irradiated to various exposure levels up to a maximum of 1.2×10^{20} nvt fast flux reveal increasing broadening of the lines with increasing exposure. The lattice parameters, however, first increase with exposure and then revert to approximately the unirradiated values for maximum exposures. The dimensions of the body centered cubic unit cell increases to a maximum of 0.05 percent above the unirradiated values at exposures of 6.0×10^{19} nvt and then decreases to a value that is 0.004 percent less than unirradiated values for exposures of 1.2×10^{20} nvt. A measurement of all possible interplanar spacings shows that this phenomenon is non-

preferential in nature. This observed shrinkage of the unit cell at high exposures is not readily explained by existing theories on radiation damage. Initial annealing studies are in progress in an attempt to determine the types of damage that have occurred during irradiation by observing the kinetics of the recovery process.

In conjunction with studies in the preparation of high purity uranium, a small charge of high purity electrolytic uranium was fused into an eight-gram button in the NRC vacuum furnace. Analysis of the uranium button indicated an increase in the iron carbon and silicon content compared to the original dendrites. Much of this increase is attributed to the inclusion of "fines" with the large dendrites in the charge and also to the present method of storing and cleaning the electrolytic uranium prior to melting. Further melts will be attempted. Work has been done to eliminate uranyl chloride that may be present in the salt system. Potassium sulfide is added and the following reaction is postulated: $2UO_2Cl_2 + 3K_2S + 4Cl_2$ (gas) $\xrightarrow{\sim 700\ C}$ $2UCl_3 + 6KCl + S$ (gas) $+ 2SO_2$ (gas). This conversion eliminates deposition of uranous oxide at the cathode. Investigation of this process will continue.

The study of reactor induced changes in the microstructure of fissionable and non-fissionable materials is continuing in order to substantiate present hypotheses and theories of radiation damage. Two additional precharacterized and replicated metallographic specimens of uranium irradiated to an approximate burnup of 0.06 and 0.09 percent, respectively, have been replicated. For further comparisons each specimen has been etched by ionic bombardment and replicated. Preparation and analysis of these replicas by optical and electron microscopy are in progress.

Incidental to the study of the diffusion of xenon in silver[1], experimental data became available permitting the calculation of the thermal neutron absorption cross-section for xenon-124. This value is 74 barns based on an experimental half-life of xenon-125 of 19.3 hours at a gamma energy of 0.19 Mev and an average integrated exposure of 1.19×10^{18} nvt. Data and methods of calculation may be seen in HW-48728 (to be published).

New Fuel Element Development

Fuel Element Inspection. Further improvements have been made in the inner tube Frost Test equipment to permit attainment of greater power output. The impedance of the inductor loop was reduced to the ultimate minimum by encasing the fuel element being tested in an internally insulated, externally water-cooled brass tube electrically connected to the bus bar leading to the remote end of the removable inside inductor tube. With this arrangement the sensitivity of the test is increased and the time required in completing each test run is appreciably reduced.

Evaluation of Sylvania I&E Fuel Elements. A shipment of 192 vacuum hot-press canned I&E slug-type fuel elements fabricated by the Sylvania Electric Products Company has been received for testing and evaluation.

To date these elements have been checked for dimensions, surface quality, closure soundness (Dy-Chek), and external Frost Test. Owing to the post-pressing cleaning treatment given these elements at Sylvania, the surfaces are undesirably rough and irregular. Eight OD Frost Test rejects were found and 35 leaky closures as determined by the Dy-Chek test (subject to verification). The Sylvania elements will be turned over to the Testing Methods group, Fuels Preparation Department, for application of such tests as they wish to make, as soon as they are ready to receive them. Thereafter, the elements will be returned to us for continued evaluation tests, including ID Frost Test, cap and base thickness measurement, wall thickness determination, nickel thickness mapping, grain size and orientation tests, and metallographic study of bonding layers and closures.

Wafer-Type Fuel Elements. Twenty-five hot-dip-canned washer-type slugs were tested for internal and external bond quality. The OD Frost Test found two with small voids (about 1/4" diameter) in the outside bonding layer, and two had constrictions in the inner tube which prevented passage of the go-gage. Apparent neck-ins in the outer wall surface were found by destructive examination to be associated with excessive separation of two adjacent wafers during canning. The mechanism of the phenomenon has not been determined.

The eight-inch I&E wafer fuel element that was irradiated in the HAPO fuel element testing facility in the MTR to approximately 800 MWD/T at 70-75 kw/ft has been returned to Hanford. On visual examination of the specimen no unusual effects of the irradiation could be seen. In several places it appears that the wafers have shifted slightly in the transverse plane. However, there is a severe flattened section on the outer edge of one end cap which suggests that the specimen has been dropped from an appreciable height. A blow of sufficient force to flatten the end in the observed manner would probably also be sufficient to cause a shift of the wafers. The rest of the examination will be directed toward determining the nature and degree of any changes that occurred in the specimen as a result of the irradiation.

Cold Closure Canning. The cold closure type of canning is being investigated. Five dummy elements that had been canned by the cold closure technique were sent to Production Machine Company to learn if centerless grinding could be used to finish the outside diameters to a specific dimension with the core remaining concentric with the can outside diameter.

The following observations were made on the pieces:

1. The maximum double-throw warp was 0.001".
2. The maximum diameter variance on a single piece was 0.0005".
3. The maximum diameter variance between two pieces was 0.002".
4. The maximum variance of can wall thickness on a single piece was 0.0029".
5. The core to can concentricity was within 0.0015".

It appears that the centerless grinding technique will provide the required can wall thickness on cold-closure canned fuel elements.

As assistance to the present production process, elements rejected for poor bonds are being hot pressed in order to produce bonding. Preliminary tests using solid fuel element rejects show that voids present in the bonding layer, as indicated by auto-radiographs, are completely bonded after pressing. Further tests will be conducted to learn information on diffusion barrier effectiveness, frangibility and flexibility of technique.

Rod Cluster Fuel Assemblies. Four spring-mounted four-rod cluster fuel elements were pressure drop tested at 1706-KE. They have the lowest pressure drop of any four-rod element tested to date. These fuel elements were also tested for ease of charge and discharge through KER nozzles and tubes. No difficulties were encountered. The design appears sufficiently rugged, but care must be taken to prevent bending the leaf springs backwards while charging. Autoclave tests were made to test the support welds. No serious corrosion attack or lowering of the tear strength was observed after 300 C autoclave exposure.

Zircaloy-2 clad cluster fuel elements are scheduled to be irradiated at KER following the irradiation of two charges of stainless steel clad fuel elements. A Zircaloy-2 clad four-rod cluster containing 0.479-inch diameter natural uranium rods has been built for irradiation at the MTR. A basket which fits the contour of the fuel element is provided to increase coolant velocity. The fuel element has been autoclaved to check weld closure, loaded into the basket and shipped. This irradiation experience will guide the design of the KER fuel charge.

Fuel Designs for Use With Organic Coolant. Materials and methods are being investigated for application to fuel elements for organic loop testing. Cladding materials being considered are aluminum, magnesium, mild steel, and brass. Uranium cores have been clad with each of these materials for testing in ORA 1 (out-of-reactor organic loop). It is hoped that testing may be conducted at 400 C and an initial evaluation of corrosion resistance, mechanical behavior, metallurgical behavior, and the effect of pyrolytic hydrogen in the organic may be obtained. Four test elements have been prepared by sizing and fusion welding the closures, these being unbonded elements. A fifth test element has been prepared by Al-Si dip canning in aluminum and hence is bonded.

Since magnesium appears to be a most desirable cladding material for organic loop fuel elements, bonding studies between magnesium and uranium have been initiated. Uranium has been bonded to magnesium using a ternary Mg-Al-Si alloy. The bond was produced using furnace brazing techniques and chloride flux and appears to be similar to the bond obtained in Al-Si dip canning. Samples are being prepared for bond strength and time-temperature stability testing. The bonding of uranium to iron with the uranium-iron eutectic is also being studied. The extreme brittleness of the bond observed in this system is unfortunate and the bond for this reason is not too promising.

The making and testing of bonds between magnesium and uranium was started as a forerunner to the possible use of magnesium canned fuel elements in organic cooled loops. A bond between uranium and magnesium was made by two methods. One method involved hot pressing in a vacuum at 450 to 500 C using Al-Si foil as an intermediate bonding material. Specimens were bonded using 0.010" thick Al-Si foil; but, as expected, the compound layers were extremely thick. A bond between a magnesium and a uranium plate was made by dip coating the uranium with a thin Al-Si compound layer. The uranium and a magnesium plate were sandwiched together, sheathed in Cu, evacuated and hot rolled at 400 C. This procedure causes bonding; however, the strength and quality of the bond has not been determined.

Indentation testing of magnesium and selected magnesium alloys as a function of time at temperature is being conducted as a measure of their creep characteristics. The results of these tests to date indicate that magnesium alloys are no better than pure magnesium for use as spiders, ribs, supporting projections, etc., in the temperature range of 350-450 C. If the stresses in magnesium supporting pieces are held to below several hundred psi, and this should not be difficult, distortion due to creep should not be a problem.

Heat Transfer in Unbonded Elements. The contact coefficient of a Hanford size uranium fuel element clad unbonded in 347 stainless steel was measured at a low simulated power of 2.3 kw/ft. The fuel element contains a central cavity that is filled with molten Wood's metal. The Wood's metal is used to transfer heat from a specially designed immersion calrod heater to the fuel element. In this particular test maximum power was limited by voltage available from the high current power supply. Typical results at maximum power gave a contact coefficient value of 1000 btu/hr/ft/^{o}F. This value is very low and would result in high temperature drops across the interface. Attempts to increase the power and thereby improve the accuracy of the contact coefficient measurements are under way.

Stress Analyses. A general method for calculating the thermal stresses in infinite length cylindrical reactor fuel elements, HW-46125, has been described in previous reports of this series. The initial calculations for several cases were tried during this month. Difficulties were encountered in obtaining the numerical results; thus the following alterations were made in order to improve the method of numerical analysis: (1) the number of radial increments used in the solution were decreased by a factor of two by using multiple point integration formulae. This change halved the machine time used for each iteration. (2) A logical circuit was introduced into the calculation of the strain hardening coefficient in order to assure the convergence of this calculation. This circuit had to be used because the variations of this factor gave numbers beyond the range of the IBM 650 machine. This difficulty is due to the form of the stress-strain relations and should not be present after the initial increment is calculated.

Self-supported Fuel Elements. Projections attached to fuel elements are designed to support fuel elements concentrically in a process tube. Three different fuel element types with supports are now being evaluated. These include supports attached to standard "F" canned fuel elements, supports attached to KER 1.8-inch diameter wafer fuel elements, and M388 jacketed fuel elements for KER. Twenty-eight M388 jacketed fuel elements with supports are ready for charging and a continuing program is now set up to make possibly 200 more of this type of fuel element.

Hot Press and Vaccum Canned Fuel Elements. The work on these alternate canning methods for production fuel elements has been completed and the elements produced are ready for testing in reactors.

Comparison of Bond Strengths. Comparative bond strengths and bond strength uniformity were determined on three different canning process products -- hot-press, dip, and vacuum. Studs machined from 2S aluminum rod were welded onto the side of the fuel element with a Graham Stud Welder in order to test the strength of the bond. The first samples tested were hot-press bonds that yielded true strength data since the can well immediately surrounding the stud was removed by a radial cut. These bond strengths were consistently between 10,000 and 14,000 psi. Because the dip and vacuum bonds were either too fragile or inconsistent and, consequently, some bonds fell apart, no radial cuts were made around the studs. Hence, the bond strengths observed varied in magnitude from 6000-16,000 psi on dip-canned elements and 6000-15,000 psi on vacuum canned elements.

Welding Development. A welding process has been developed which makes controlled fusion welding in a high vacuum possible. This equipment consists of a heated tungsten cathode designed to give off a large supply of electrons, a high voltage supply from 3000 to 15,000 volts to accelerate the electrons to the target, and a focusing system which forms the electrons into a beam with the focus point at the target. The beam of electrons striking the target, or in this case the two parts to be fusion welded, heat the area to be welded to the melting point and the two parts are fused together. By moving the parts to be welded at the correct speed beneath the electron beam, a complete closure can be made between the parts to be joined. Zircaloy-2 end caps have been welded into 1/2 inch diameter, 0.045 inch wall Zircaloy-2 cans with this process. Other materials can be joined with this process, but to date very little work has been done on other materials. A complete vacuum system and welding unit is now being assembled by Fuels Fabrication Development to more completely evaluate this process.

In the investigation of the roto-arc welding process it was developed that the installation of a current-slope-time control unit has provided close control over the welding cycle variables. This added instrumentation has enabled reproducible results to be obtained and allows for the determination of the parameters of the system. The added control has been responsible for an increase from five to approximately 70 percent of acceptable welds on Al-Si dipped cans. Three weld surfaces can be

produced, a domed surface similar to that produced by C. C. Stone at Argonne National Laboratories, a weld bead similar to that produced by the heli-arc process with a dull surface, and a weld bead with a clean surface similar to that of the heli-arc process. Weld bead surfaces can be controlled by proper spacing of the electrode and by control of the current decay time. Surface treatment of the element such as by buffing with a wire brush or degreasing had little effect on the weld quality. Cap thickness appeared to be fairly critical as the thinner caps produced a hotter weld zone with more Al-Si contamination. Contamination of Al-Si in the weld bead can be reduced by widening the weld zone or by forming a step in the can at the braze layer. Preheating the element to be welded at a lower power level appears to reduce the contamination. Power in the range of 86-87 kilowatt-seconds must be supplied to produce a weld of acceptable quality.

Matrix Fuel Element Development. Additional attempts to fabricate U-Mg fuel material by swaging have been made. In the latest trial an appropriate amount of Mg was surrounded by uniform iron shot in an evacuated iron can. Hot swaging at 400 C to about 20% total reduction caused the end of the iron can to be pushed out and the can to split. The iron shot was found to be embedded in the central Mg rod, but the shot had become bridged in a circular pattern. As a result the central portion of the material was solid Mg and the outer portion, being solidly bridged iron shot, caused the iron can to split.

Coaxial Fuel Element Development. The irradiation of a coaxial fuel element specimen in the HAPO fuel element testing facility in the MTR was begun January 11, and completed January 27, after one reactor cycle. The specimen parameters had been selected so that the inner uranium tube would operate in the low gamma phase and the outer tube would operate in the alpha phase, based on ex-reactor measurements of the uranium-uranium interface thermal conductance with no load. The specimen was returned to Hanford during the month. The examination, which will begin next month, should provide an estimate of the maximum temperature that was reached during operation. Thus, the interface conductance can be estimated and the information used to plan a second irradiation. The examination is planned to include determination of dimensional changes.

Insulated Fuel Elements. Three cored insulated uranium fuel elements have been operating in a KW through-hole for over a month without incident. Power of these elements is about 40 kw/ft and current exposure is in excess of 150 MWD/T. The dummy charge and test assembly which was irradiated in the KW through-hole prior to the loading of the uranium fuel elements has been received at the Radiometallurgy facility. Post-irradiation examination is scheduled for the determination of any unusual corrosion or mechanical damage suffered during irradiation or at discharge.

MTR Fuel Test Facility. The cored thermocouple fuel element with two internal thermocouples for the measurement of temperature, power, and flux asymmetry in the MTR test position has completed its exposure and has been returned to the HAPO Radiometallurgy facility. The thermocouples indicated about one percent temperature difference between the

inner surface of the cored uranium adjacent to the reactor center and the surface away from the center. Post-irradiation examination of this thermocouple piece will be made to study the thermocouple's condition and position.

2. REACTOR PROGRAM

Coolant Systems Development

Single Pass Coolant Development. A standard fuel element being exposed to pH 6.0 process water in a 1706-KE tube ruptured and caused an outage of the KE Reactor. Examination of the rupture showed it to be a core failure and not related to any corrosion effects. Corrosion data from previous 1706 tube discharges indicate that rates in pH 6.5 process water are about one-half those in normal pH 7.0 water; there is some evidence that aluminum corrosion rates at pH 6.0 are higher than at 6.5, although still below 7.0.

Evaluation of M388 aluminum cladding for regular production fuel elements continued. Four tubes of slugs in H Reactor for corrosion evaluation reached an average exposure of 650 MWD/T.

Pressurized Water Technology. Three simulated fuel element rupture tests were conducted using prototype KER fuel elements and tube geometry. One test used a massive uranium, I&E (Cow) slug with collapsible rails. After 6-3/4 hours exposure at 200 C, the pin-holed slug stuck in the tube and required 9000 psi for discharge. Two wafered (Elephant) slugs having 3/16 inch wafers were tested. The first ruptured after 1-1/2 hours at 280 C; it was not stuck in the tube. The second rupture occurred after 3-1/2 hours at 240 C. A portion of this slug remained in the tube and could not be removed by hand.

Additional data were obtained on aluminum corrosion at elevated temperatures. After 1500 hours at 300 C, M388 alloy exhibited a corrosion rate of 0.2 mil per month in phosphate inhibited water at pH 4.5. At 150 C, pH 3.5, a rate of 0.01 mil per month was observed. Further confirmation was obtained showing that a high aluminum surface-to-water volume ratio has an inhibiting effect on corrosion.

The sampling and analytical requirements for all pressurized water systems in 1706 Building were reviewed and evaluated. An improved system was installed in each KER loop to permit remote sampling. Specialized equipment for continuous analysis of hydrogen concentration and for detection of "crud" concentration was put into operation to enable evaluation of the equipment for reactor applications. In addition, comprehensive chemical and radiochemical analytical requirements and schedules for all coolant system test facilities were developed and placed in effect.

KER Program. Shakedown operation of the KER systems continued. Two of the loops are now considered ready for in-reactor operation, and this step is scheduled to occur at the next reactor outage. An analysis has been completed to determine optimum initial tube charging pattern based

on the heat generation distribution, available pressure drop, and the overall KER program objectives.

Organic Coolant Technology. A summary report was prepared which presents pertinent available technology on organic coolants. Application to a typical plutonium production reactor is discussed. A report has been submitted for comments by interested organizations.

Gas Coolant Technology. Preliminary evaluation of gas coolant systems for Hanford reactors has been initiated. Many of the problems involved are associated with material compatibility and component performance in high temperature gas systems. The experimental investigation of these problems appears to be a logical step towards broadening the base of reactor technology at Hanford. To this end, a budget study of a small gas coolant test facility was prepared, and a review of the available literature is under way.

Thermal and Hydraulic Studies

K Reactor Re-orificing Studies. Development testing of primary and secondary orifice combinations for use in re-orificing the K reactor fringe zones was substantially completed. This work is aimed at identifying practical dual orifice geometries substantially free from cavitation and which result in a substantial decrease in Panellit gage pressure following failure of front pigtail or nozzle cap. Desirable geometries utilize a long barrel secondary orifice which dissipates more energy through friction and less through kinetic energy effects associated with orifice jets.

Flow Hazard Simulation Studies. Analysis has been completed of transient tests simulating the response of an H Pile size process tube system at 1000 KW and 120 C outlet water temperature to sudden partial throttling to 40, 60, and 80 percent of initial flow. As indicated in the descriptive report issued, shutdowns free from serious harm to the reactor would result at this power over the range of flow reductions even if present Panellit protection limits were relaxed. A preliminary test was performed to determine the transient response of an individual process tube system to a step power increase sufficient to initiate flow instability. It was found that low flow rates (50 percent of initial) occurred about fifteen seconds following a step power increase of 64 percent (from 750 KW to 1250 KW) and that a Panellit trip would have resulted within about five seconds following the tube power increase.

Slug Cooling Anomalies. Analytical work was completed and a report issued concerning the temperature distributions within solid slugs subjected to a serious but localized surface cooling anomaly. From these studies it appears that past anomalies by assuming localized areas of perfect insulation may have led to overly pessimistic prediction of maximum jacket temperatures.

PURITY OF LOW DENSITY GRAPHITE

Bar No.	Purity (dih)*	Density (g/cc)
1 & 2	+0.890	1.23
3 & 4	+0.940	1.24
5 & 6	+0.939	1.22
7 & 8	+0.944	1.23
9 & 10	+0.910	1.24
11 & 12	+0.894	1.23
13 & 14	+0.906	1.22
15 & 16	+0.876	1.22
17 & 18	+0.958	1.21

* "Delta In-Hours," compared to a CSO graphite bar employed as a reference standard.

Graphite Surface Measurements. Adsorption, desorption, and x-ray measurements have been completed on three of a series of four virgin CSF graphite samples oxidized to various extents. The results of these measurements are tabulated below. For comparison, previously reported results on CSF graphite samples irradiated at 350 to 450 C are also presented. The major peaks in the pore size distribution are listed in order of decreasing intensity.

Sample	Percent Oxidation	Exposure in MWD/CT	Surface Area in m^2/gm	Pore Radii in Å	Lc in Å
61-66	0	0	0.20	20, 140	465
61-16	5.04	0	0.47	160, 17	520
61-77	11.35	0	1.23	15, 290, 70, 180	530
90-206	0	0	0.27	190	460
90-11	-	4494	1.14	20, 120	260

These tests show that oxidation rapidly increases the surface area. It also increases the average crystallite size as a result of preferential oxidation of the smaller crystallites. Although the results of pore size calculations are not conclusive, in general it appears that oxidation results primarily in an enlargement of existing pores. The reappearance of very small pores after 11.35 percent oxidation is probably the result of increasing the availability of previously unavailable internal void volume. In contrast, high temperature irradiation, while increasing the surface area, results in a smaller average crystallite size and smaller pore radii as a consequence of crystallite breakup. Crystallite breakup also accounts for the increase in surface area, since many small particles will have a much larger surface area than a few large particles.

The results, to date, demonstrate that a previously proposed method of determining the extent of oxidation of the graphite moderator (HW-33738) is not valid, for it cannot be determined to what extent the surface area was increased by oxidation and to what extent by high temperature irradiation.

Radiation Effects on Plastics and Elastomers. Two reports have been issued on the effects of radiation on plastics and elastomers. HW-47577 describes the effect of dose rate on plastics over the range 10^4 to 10^7 r/hr. HW-48732 contains the effect of stress during irradiation in air and in a vacuum.

Structural Materials Development

Substantial progress was made by several vendors in developing processes applicable to production of B-D-F size ribbed Zircaloy process tubes. Two approximately 20 feet long lengths of B-D-F size ribbed Zircaloy-3 process tubes were produced this month by Allegheny Ludlum Steel Corporation. The tubes reportedly were sound and free of rib or wall defects, and with the exception of wall eccentricity, were to dimensional tolerances. The successful fabrication of the two lengths indicates that the procedures developed by Allegheny Ludlum for extruding and tube reducing ribbed tubes should be satisfactory. In addition to the above, material for eleven tubes has been processed through the second tube reducing operation without difficulty. Studies are being conducted to modify Allegheny's process to decrease the variation in wall thickness and to reduce costs.

Seven short lengths of ribbed Zircaloy-2 process tubing were fabricated by Superior Tube Company using the technique of double tube reducing extruded tube blanks. The lengths of the tubes produced ranged from 12 feet to 16 feet. An inspection of the tubes that was made by Superior personnel, using a boroscope and penetrant dye techniques, indicated no readily detectable material failures had occurred. No Zircaloy-3 tube blanks were processed because of the inability to insert the first stage tube reducing mandrels into the extruded blanks. In addition to minor operating problems which remain to be solved, a serious rash of mandrel breakage incidents must be explained and eliminated. Solutions to these problems will probably require a new mandrel design.

The fabrication of ribbed strip by Sciaky Brothers for Order HW-77934 was completed this month. Approximately 200 feet of unalloyed zirconium and 225 feet of Zircaloy-2 ribbed strip were produced by seam welding techniques. Metallographic examination of the joint between the rib and strip revealed a sound weld structure, except at the extreme edges of the rib. The ribbed strip will subsequently be roll formed and welded into tubing by Trent Tube Company.

Approximately 50 feet of B-D-F size zirconium and Zircaloy process tubing, welded by the New Rochelle Tool Company on Order H7K-24881, has been evaluated. The "Thermatool" welding process used by New Rochelle appears to be a satisfactory method for welding long lengths of Zircaloy tubing. Metallographic examination of welded tube joints revealed that the welding process produces an extremely narrow weld and heat-affected zone. Analysis of tensile testing results indicates that the weld and base material of Thermatool welded zirconium tubes have equivalent yield and tensile strengths.

Two 50-ft ribless KER size, Zircaloy-2 process tubes and four short lengths were fabricated by Bridgeport Brass Company with apparently good results. No drop in hydrostatic pressure was observed in a three-minute hydrostatic test at 1800 psi. A preliminary examination of the outside surface of the tubes by Bridgeport personnel did not indicate the presence of cracks, tears, or material defects.

An apparatus has been designed for vacuum degassing and for controlled hydrogenation of zirconium tensile specimens. The glass construction is an estimated 70 percent complete. A suitable furnace and quartz combustion tube remain to be set up before outgassing of the apparatus and trial hydrogenations can commence.

Tests to measure the secondary creep rates and total deformation from primary creep of Zircaloy-2 and 3 and M-257 and 6063 aluminum alloys are in progress or were initiated at Battelle Memorial Institute and the University of California. Results from initial tests have been received; however, several months of testing will be required before firm comparisons can be made between these alloys.

Zircaloy-2 Tube Specimens from H Loop. Metallographic examination of the center sections of a Zircaloy-2 process tube from the H Loop Facility was completed. Microscopic examination revealed the metal to be 70 to 80 percent cold worked, but no other unusual conditions were observed. Chemical analyses, which are partially completed, show the hydrogen content in two samples 196 inches and 297 inches from the rear van stone flanges to be 25 and 32 ppm, respectively.

B. WEAPONS - 3000 PROGRAM

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

C. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Fuels

Radiographs of the first PRP plutonium-aluminum castings for the PCTR tests indicated internal voids due to shrinkage upon cooling. Ten castings were recast using a tapered mold and a different mold heating arrangement to eliminate the shrinkage problem. Radiographs of the reprocessed rods show only two reject rods out of the seventy-eight that were cast. The good rods from the first pour have been machined and machining has commenced on the reruns.

The canning and closure techniques for these fuel elements have been modified and successful welding techniques for canned closures have been determined. Machining and leak testing of the welded tubing is in progress.

Experimentation with the bonding of the foil caps to the test assembly tube ends and the forming and bonding of the 1, 3-5, and 5-mil thick aluminum jacketing for the Pu-Al alloy monitoring wafers is continuing.

Planning is under way for the irradiation testing of capsules containing Pu-Al alloy fuel material and mixed crystals of PuO_2 and UO_2. These first irradiations will be conducted in the MTR and the first Pu-Al capsules are scheduled to begin irradiation on 5/1/57. The 234-5 Chemical Development group has started work on producing mixed crystal oxides for this program and the Plutonium Fuels group is planning on installing the minimum amount of equipment required for the fabrication of oxides.

Extrusion is being considered as a method of fabricating the fuel materials for the PRP reactor. A 50-ton capacity, developmental extrusion press is being assembled for these studies and will be used for the investigation of extrusion constants, temperature variables, ratios, and extrusion speeds.

UO_2 Fuels Development

Four 17-inch lengths of Zircaloy-2 tubing have been supplied for the PRP-PCTR fuel elements. These tubes were made by swaging 0.625" OD x 0.050" wall thickness, Zircaloy-2 tubing down to 0.562" OD with a 0.030" wall.

Four Zircaloy-2 clad UO_2 fuel elements were made as part of an experimental study. Both hot and cold swaging techniques were tried. A detailed report of this study is being written.

Equipment installation and barricade construction preparatory to isostatic pressing of UO_2 in the basement of 325 Building was completed. Assembly of the components has begun. Dies for pressing UO_2 tubes and rods were fabricated.

A process was developed by which approximately 350 pounds of 0.504-inch diameter uranium oxide pellets 0.5 to 1.1 inches long were cold-pressed, sintered and ground to size for testing in the PCTR. The pellets were prepared from Mallinckrodt normal uranium oxide and Mallinckrodt special ceramic-grade uranium oxide. Satisfactory pellets having average densities of 92 percent of the theoretical density of uranium oxide were prepared from both oxides. The density of each pellet was determined from its weight and length using a densitometer designed and constructed especially for this purpose.

Ceramic Fuels Development Operation will provide uranium oxide fuel elements for PCTR tests planned in support of the Plutonium Recycle Program. Rod-type elements are being fabricated for cluster tests. One hundred thirty-three outer buffer rods (34-1/8 inches length), thirty-eight end buffer rods (8-3/8 inches length), nineteen sealed and five demountable test rods (16-3/8 inches length) are currently in final assembly and testing stages.

Extrusion is being investigated as an alternate method of fabricating UO_2 fuel elements. Previously, UO_2 rods have been fabricated with densities over 90 percent using both Mallinckrodt AEC-grade and ceramic-grade powders although internal cracking had seriously hampered the sintering of the ceramic-grade material. During the past month additional ceramic-grade material has been extruded and sintered with considerably improved results. Densities over 94 percent of theoretical have been obtained. Lengths up to 18 inches have been sintered, although slight warpage has prevented the grinding of such lengths. Extrusion of ceramic-grade UO_2 appears promising because of resulting high sintering rates and sintered densities although the results to date have not always been reproducible because of the varying characteristics of this material from lot to lot. Additional work is planned to further determine the feasibility of extruding ceramic-grade UO_2.

Two internally and externally cooled UO_2 fuel test elements have been discharged from the MTR following cycle 82. This completes the first successful irradiation of massive UO_2 in this geometry. The irradiation test was conducted as part of the program for design, fabrication, and evaluation of nested tubular fuel elements for the PRPR. The two test elements produced an average power of 50 kilowatts per foot. This represents an average power density of 10.2 kilowatts per pound of UO_2. Because of the flux asymmetry existing in the GEH-4 facility, the true power density of the hotter element was over 11 kilowatts per pound of UO_2. These figures may be compared with a normal maximum power density of 8.6 kilowatts per pound UO_2 calculated for the nested tubular fuel element in the PRPR.

One purposely defected internally and externally cooled fuel element has been assembled. The element consists of a UO_2 core, 1.410 inches OD, 0.475 inch ID, 4.0 inches long, clad in Zircaloy-2 having an inner wall thickness of 0.035 inch and an outer wall thickness of 0.020 inch. A 0.014-inch diameter hole was drilled through the outer wall at about the midpoint. The element was thoroughly waterlogged, autoclaved, and shipped to the MTR in a water-filled container. Reactor Safeguards Committee approval has been obtained for insertion into the GEH-4 facility, presumably during cycle 84 (March 11, 1957). This experiment is in support of the PRP fuel element evaluation program. The purpose of the irradiation is to determine the effect of rapid reactor startup on a defective UO_2 fuel element. The MTR will be rapidly raised in steps of 10 megawatts power generation to at least 20 megawatts. The calculated maximum UO_2 core temperature at 20 megawatts is 1000 C. The duration of the experiment (approximately one hour) will be determined by the capacity of the radioactive waste tank of the GEH-4 facility. Facilities for performing experiments of longer duration will not be available until the ETR loops are in operation.

A Zircaloy-2 capsule containing UO_2 and having a controlled gap between UO_2 and cladding varying between 0.001 inch and 0.011 inch was irradiated in the MTR during cycle 81. The estimated effect of these clearances was to cause maximum core temperatures of 1400 C and 2800 C in regions of 0.006 inch and 0.011 inch gap, respectively, when irradiated at the requested unperturbed flux, 1.65×10^{14}. The actual flux was found to exceed this by about 20 percent. The capsule was sectioned at the point calculated to have operated at the highest core temperature. A central zone of recrystallized UO_2 was observed surrounding an axial void of approximately 0.020-inch diameter. Such voids are caused by relocation of UO_2 toward the cooler zone at temperatures near melting. These results show our methods of core temperature calculation to be effective, though somewhat conservative.

Mechanical Equipment Development

The complete mechanical development program for the PRPR has been scoped. Preliminary scoping is under way for the test facilities required to carry out this program.

Following notice from Advance Engineering Operation that the PRPR process tube inlet assembly design is firm, preliminary steps have been taken to initiate the fabrication and testing of these components. Fabrication of the test sections will begin in early March when suitable zirconium tubing arrives on-site. The required testing will be carried out in ELMO-7.

In order to assemble the process tube inlet connections, high torque requirements will be necessary to insure that the gas seal and flared tubing are leak-tight. A recommendation was made to flatten the opposite sides of the inlet fitting to provide a wrench hold as the process tube is not supported at the inlet end and is not keyed against rotation at any location. Plans are under way for the development of the workable tools for making the process tubing connections using mockups of the reactor inlet and outlet faces.

Detailed design of the components of the PRPR one tube prototype facility continued during the month. Comments were transmitted to Construction Engineering Operation personnel on the facility's instrumentation pressurizer, heaters, heat exchangers, and make-up tank. The flow rate of the facility has been increased from 100 to 150 gpm to simulate the increased flow to the actual reactor tubes.

The preparation of the drawings and specifications for the process tube test shaft for the 314 Building have been completed. All drawings have been received for HLO approval.

Structural Materials Development

Zirconium Tubing. The Chase Brass and Copper Company has begun fabrication of four prototype PRP process tubes; however, it now appears that an April delivery is more realistic than the previous estimate of March 1957. Allegheny Ludlum has proposed an alternate method of fabrication

that will include forming the tapered bottom end as an integral step in the process. Action will be taken on this proposal when a firm price quotation is received.

Experimental work at HAPO has demonstrated the feasibility of forming small diameter thin walled tubing by drawing strip through a suitably designed die, welding and sizing. Calculations reveal that tubing up to 1/2-inch diameter by 0.030-inch wall can be fabricated using the 2000-pound draw bench.

Shim Control Bead Chain. Approximately 30 feet of Zircaloy-2 bead chain was satisfactorily fabricated by Auto-Swage Products, Inc. The dimensions of the beads were about 1/4" diameter by 0.018" wall thickness. The work was performed to investigate the feasibility of fabricating 3/4" diameter bead chain with a bead wall thickness of 0.050" from a zirconium-hafnium alloy. The 3/4" zirconium-hafnium alloy bead chain has been proposed as a shim control for the PRP reactor. Tensile tests on a sample of the 1/4" chain indicated that a breaking strength of 98 pounds could be obtained with the dumbbell and bead design that was utilized.

Plutonium Fuel Cycle Analyses

Recycle Applicability. The preliminary study of the applicability of recycling plutonium to different reactor designs has been completed and a report is being prepared. It is concluded that Plutonium Recycle can be applied to pressurized water and boiling water type reactors. Calculations are based on the evolution of equal amounts of heat generated in a given reactor whether enriched with uarnium-235 or plutonium. When applied to thermal reactors this assumption approximates equal reactivities for both types of enrichment. The high enrichment levels of small diameter sodium-cooled, graphite-moderated reactors such as SRE appear to require too high a conversion ratio to operate successfully with the plutonium recycle concept. Larger sodium-cooled types may be feasible.

Recycle Costs. Fuel cycle costs were estimated for the PWR, EBWR, and SRE reactors of the AEC reactor development program. If the cost of plutonium is assumed to be only the cost of purifying, alloying, and jacketing the cores, then the fuel cycle costs using current technology for plutonium enrichment are estimated to be between 1.5 and two times the cost of uranium-235 enrichment. Technological improvements in plutonium fuel element fabrication expected before 1960 as a result of current research and development should reduce plutonium fuel costs by at least a factor of two.

Use of Stainless Steel with Recycle. Calculations on the relative neutron economy of stainless steel for use in jacketing and process tube material have been completed. Results indicate that its use in thermal reactors is definitely restricted. The following fuel element types were considered: cluster, solid cylinder and inverted cluster. In general, the inverted cluster appears to be the most attractive on an economic basis. A report on this study will be issued shortly.

Experimental Reactor Design

Calandria and Reflector. Three different schemes of calandria design have been drawn and prints issued for comment. The second scheme, which is presently favored, calls for a liquid type reflector which is

[redacted]

or heavy water. This scheme also brings the top gas balance lines down through the reflector tank, the dump chamber, and the bottom shield in a nearly straight line connection to the heavy water storage tank. This arrangement should provide a minimum scram or moderator dump time. Details of the calandria and reflector design are being drawn on the basis of this scheme.

Reactor Piping. New jumper layouts for the 85-tube reactor are shown in the revised drawings SK-1-6121 and SK-1-6130, and the new tube numbering diagram is given on SK-1-6141. Although total D_2O flow is less in the 85-tube reactor, the flow per tube is greater. A restudy of piping sizes indicates that it is desirable to increase jumper size from 1-1/2" OD to 1-3/4" OD, which can be accommodated with the eight-inch lattice spacing. A 10" pipe will be used for the ring header. Inlet piping and valves will remain 1-1/2" pipe. Maximum D_2O velocity

In the new concept only a single shielding cover will be required. This method uses a non-rising cask which will be lower in cost than the rising model. Considerable uncertainty exists as to the shielding characteristics of this arrangement during discharge of fuel elements into the water pit. This question is being investigated further.

Control and Safety Systems. A sample length of 1/4" diameter bead chain fabricated of zirconium metal was received and was tested for tensile strength. The chain failed at 85 pounds force.

Recent re-evaluations of the zirconium-hafnium bead chain have shown that a chain of this type could not be made sufficiently "black" to neutrons and that it would be subject to excessive burnout. This fact coupled with the weakness of the zirconium chain has led to curtailment of further development of the bead chain type of shim.

A new type shim control is being designed which will utilize a rare earth, probably gadolinium, as poison material. The poison will be jacketed in stainless steel or other metal and will be in the form of short, hollow cylinders or beads with an outside diameter of 3/4 inch. These beads will be strung on and fastened to a length of small diameter metallic cable to make shim elements of the required length. Extensions of bare cable at either end of the element will be wound on a hoist drum for moving the shim through the reactor core.

Design is under way on an in-line dump valve which is compatible with the latest schemes for calandria design. This valve is a modified poppet type with an eight-inch diameter seat. The valve is held closed by a solenoid surrounding the valve stem. Upon deenergizing of the solenoid the valve will be opened by the force applied by the differential gas pressure existing across the seat. An opening spring is included to assure rapid action of the valve. An extension of the valve stem below the seat fits into a dashpot mechanism which will limit valve travel and protect against mechanical shock.

Arrangements are being made to have analyses of the reactor controller characteristics performed on the GEDA analog computer.

Reactor Instrumentation. The design criteria for the reactor radiation instrumentation system and the activity monitor instrumentation system have been prepared in rough draft form. Schematic diagrams of these two systems have been brought up to date to agree with the criteria.

Reactor Shielding. A new set of drawings is being prepared to delineate details of the primary and secondary shields. These additional drawings incorporate changes associated with a reduction in reactor size and the use of a water reflector instead of graphite. However, the fundamental concepts presented in the original design have been retained.

A preliminary calculation of the heat load indicates that about 275 gpm will be required to cool the top and bottom primary shields and the side thermal shields. Due to the relatively small flow of cooling water required, a once-through system probably will be adequate utilizing

partially treated water. In addition to piping, the system will require a pump capable of delivering the above flow under a head of about 100 feet of water or about 10 HP.

Building Ventilation. Five scope drawings of the process and service area ventilation have been prepared. Estimates have been prepared for two methods of ventilating the process area. One method uses 100% fresh air for the process area ventilation. In the other method, air from the reactor hall is utilized to cool and ventilate the cells below grade. The air from the reactor hall will be cooled by a refrigeration system in order to maintain the proper temperature in the cells.

Electrical System. Revisions have been made to the one-line electrical diagram and to the written criteria for the PRPR electrical installations. Detailed design has begun on essential components prior to the preparation of a substation procurement specification.

Design Tests. The following design tests were prepared during the month:

PR-10 Primary Loop Mock-Up

Requests evaluation of the ability of the primary coolant loop to remove reactor heat under varying conditions.

PR-60 Resistance Temperature Detectors Test

Requests testing and evaluation of various designs of temperature detectors.

Reactor Physics

Fuel Cycle Studies. Material and reactivity balance calculations for plutonium recycle fuel cycles are continuing. Numerical values for the average isotopic composition of the fuel and enrichment for fuel cycle times of from 100 to 800 days (1250-10,000 MWD/T) in PRPR have been obtained.

Lattice Studies. A revised version of HW-46679 is completed. This incorporates the newest lattice parameters for the PRP and includes P3 calculations performed on the IBM 650. Lattice enrichment and H_2O cooling are also discussed.

Favorable comparison has been made between the results from a two-region P3 calculation and the measured flux in UO_2-graphite lattices. Some scatter of the measured points may be corrected when the detectors are calibrated next week.

A P3 calculation was performed on a 19-rod NPD cluster fuel element with a plutonium-aluminum rod substituted for the central UO_2 rod and matched to give the same heat generation as the adjacent uranium. Results show a slightly smaller flux depression in the Pu rod than with UO_2 in this position. However, the effect on the thermal utilization of the cell is negligible as one would expect.

Reactor Kinetics. The kinetic study is complete and the final drawings of the solutions are finished.

Reactor Controls. Evaluation of the shim control requirements of approximately 20 mk per element with no cooling required indicates that the most satisfactory absorbing materials are the oxides of samarium, europium, and gadolinium. The last of these appears to be the most economical. The required amount of Gd_2O_3 is approximately 1.5 grams/cm of the control element or about 12 kg for the entire system, which includes a burnout allowance of one year exposure time.

Reactor Core Modification. The increase of lattice spacing to eight inches and decreases of tank dimensions to seven feet ID were analyzed in report HW-48119, "Basis of PRPR Core Modification Proposals." This report contains a discussion of the incentives for the change in lattice spacing and a comparison of the physics of the reactor before and after the proposed change. This comparison was based upon highly approximate methods and the results currently being obtained (P3 method) are significantly different in detail, but the overall comparison of the two cases is not substantially altered.

Reactor Operations Studies

Emergency Steam. In addition to the normal review and assistance in scoping, negotiations were carried out with Fuels Preparation Department to optimize the emergency back-up systems for the PRPR. Some economies may be possible by cooperating with FPD by PRPR taking over the emergency electrical generation for the 300 Area while the 300 Area provides an emergency supply of steam to the PRP Reactor.

D. CUSTOMER WORK

Anodizing

The anodizing and autoclaving equipment was operated on production test material without incident. The scale of operation has not been sufficient to test the capacity of the anodizing and auxiliary equipment for any extended period, but it has been functionally tested and appears to be quite satisfactory.

An aluminum tube, 1.3" ID x 16-1/2' long, and a spline, 3/8" x 16-1/2' long, were anodized at the request of the Irradiations Processing Department. The spline was suspended in the tube and made the anode and the tube the cathode to anodize the spline. An aluminum rod was then suspended through the tube and the tube was made the anode. The operation was successful and it is possible that the same techniques could be applied on similar items between 25 and 30 feet long.

Radiometallurgy Service

KE Reactor Slug Failures. The examination of Failure 739 from tube 4573-KE was completed. Metallographic examination of a third wafer taken 3/4 inch from the cap end of the uranium revealed that the core of the slug was heated

above the beta phase transformation temperature over its entire length. Dimensional measurements of the beta phase zone in each wafer revealed that the size of this zone gradually decreased from a maximum diameter of 0.76" at the center of the hot spot area to a minimum diameter of 0.64". In all cases the maximum and minimum distances between the edge of the beta phase zone and edge of the uranium were diametrically opposed, with the minimum distance lying on the hot spot side. The shape and orientation of the phase zone and the hot spot area on the slug jacket indicate that overheating resulted from the slug being forced against the process tube. The gradual reduction in size of the beta phase zone away from the hot spot could be attributed to the warp of the slug (estimated 50 to 60 mils).

Examination of a Pump Shaft From Redox. Metallurgical examination of the 304 SS pump shaft from D-14 tank in Redox is complete. No mechanical damage or heat effects to the shaft were evident.

An analysis of the deposit on the shaft revealed that the major metal constituents were Al, Cr, Fe, and Pb with minor and trace quantities of Ca, Cu, Mg, Mn, Mo, Ni, Si, Sn, Ti, and V. The presence of so large a quantity of lead cannot be explained at this time. The x-ray analysis for determination of the compounds present in the deposit is in process.

Metallography Service

Two Edison resistance thermometers which failed in service in KE Reactor were received from IPD to determine the cause of the failures. Each stem had broken off immediately adjacent to a point where the stem protrudes from an adapter and thence into the process tube coolant stream. Several deep scratches and severe abrasion caused by the metal-to-metal contact between the adapter and stem were observed at the area of failure. The fractures of each stem appeared to be fatigue type failures although the cross-sections of the stems were so small that positive identification of fatigue failures was extremely difficult. Perhaps of equal significance and possibly contributing to the failures was the poor surface condition on the interior of the stems. Numerous microfissures were observed, any of which could have propagated through the stem cross-section during service. An acid pickle subsequent to the fabrication process could have caused such a poor surface condition and the microfissures of the type observed.

A program that will involve a considerable amount of metallographic service is presently under way in the 306 Laboratory. This work, which is being initiated by the Fuels Development Operation, consists of an investigation to establish the time-temperature curve for the beta to alpha transformation in uranium. An early completion date of the program is expected.

Samples Processed During the Month:

Total Samples Processed:	253
Photographs:	
Micrographs	148
Macrographs	173
Total	321

Service to Savannah River Plant

A request has been received from Savannah River for 100 canned Pu-Al flux monitoring wafers and one Pu-Al slug. Delivery on this request is April 1, 1957, and design and development work has commenced.

F W Albaugh

Manager, Reactor and Fuels Research
and Development

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JF Fletcher RL Reynolds	2/10-13	duPont Company Savannah River Plant Augusta, Ga.	Securing information concerning reactor instrumentation & control applying to PRPR	JN Wilson	Yes
NG Wittenbrock	2/18-19	Natl. Reactor Test Station (MTR & ETR) Arco, Idaho	Technical discussions of test reactor operation	DC King	Yes
TT Claudson	2/11-22	ORNL Oak Ridge, Tenn.	Document review project sponsored by AEC	HF Carroll	Yes
DR Green	2/25-28	ORNL Oak Ridge, Tenn.	" " "	HF Carroll	Yes
DC Kaulitz	2/18/19	Phillips Petroleum Idaho Falls, Ida.	Discuss ETR experimental facilities	R Nertney AS Richardson R Neidner (GE)	Yes
R Harrington	2/25	Union Carbide & Carbon Corp., New York City	Attend ASTM Comm. Mtg. on radiation effects on matls., and visit with plastics & rubber manufacturers	Mr. Sinnott	No
	2/26	Enjay Co.,N.Y.C. Rubber & Plastics Compounding Co., N.Y.C.		Mr. Haworth Mr. Sacerdote	No
	2/27	ASTM Comm. Mtg., Roanoke, Va.		DS Balentine	No
	2/28	duPont Co., Wilmington, Del.		JS Rugg JP Mann	No No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
LG Merker ID Thomas	2/12-14	LASL Los Alamos, N.M.	Attend plutonium metallurgy information meeting	RD Baker	Yes

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
John Mead	2/5-8	No. American Phillips Mt. Vernon, N.Y.	Repair electron microscope	TK Bierlein	No	300, 326
MJ Sanderson R Pennington	2/14-15	APED, San Jose, Calif.	Discuss fuel element problems	FW Albaugh JJ Cadwell SH Bush JE Minor EA Evans WP Wallace	Yes	300, 326 325, 306
Malcolm McEwen	2/15	Monsanto Chemical Co. St. Louis, Mo.	Discuss organic coolant technology	JM Atwood	Yes	100-K, 105-KE; 100-D, 189-D
WR Holman	2/26-27	American-Standard Redwood City, Calif.	Discuss UO_2 fuel elements	JJ Cadwell EA Evans	Yes	300, 326, 325, 303
SR Nixon	2/26-27	American-Standard Redwood City, Calif.	Discuss boiling heat transfer problems	LH McEwen	Yes	100-D, 189-D

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

FEBRUARY 1957

FISSIONABLE MATERIALS - 2000 PROGRAM

METALLURGY

Critical Conditions for Metallic Uranium

A calculation has been performed to ascertain the critical enrichment of an infinite mass of uranium metal. The value obtained, 5.5%, agrees with other estimates of this quantity.

Fuel Element Test Reactor

Criteria for test conditions for the fuel element test reactor are being prepared. Assistance has also been given in the preliminary scoping of the reactor core and its auxiliary components. Suggestions for this reactor were obtained from personnel from other AEC sites.

Instrumentation

The design was completed of an experimental model slit camera and fabrication was started. This is an optical instrument which allows the cylindrical surface of a fuel element to be photographically unrolled to produce a flat photograph. This permits the examination of the entire surface at one time. Another application of the same principle would provide a flat photograph of the internal surface of an I and E fuel element.

Development was started on a microscope for observing the microstructure of the object at the focus of a solar furnace. This microscope should ideally provide 250 X magnification with no lens closer to the solar furnace focus than eight inches. A laboratory model employing parts from a commercial projector with a 50 X magnification was demonstrated. A two-color pyrometer for determining the temperature of the object at the focus is also under development.

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION PILES

Control Rod Strengths as a Function of Temperature and Exposure

A theoretical study has been made of the change of control rod strength as a function of neutron temperature and reactor exposure. The variation is greatest with temperature in the unexposed case. For K-pile, a single horizontal rod increases in worth ca. 33% between a green room temperature pile condition and a green, graphite at 700° C, pile condition (pile dry).

Buckling Measurements for I and E Slugs in C Lattice

A small exponential pile (~4' x 5' x 6') was built with an 8-3/8" lattice spacing for use with C-pile process tubing and I and E fuel elements. The buckling will be measured and the results compared to that for a solid-fuel element. The quantity of prime interest is the difference between the wet-dry buckling values for the I and E fuel element as compared to the solid element, since large numbers of the I and E elements are being loaded in C-pile. This measurement should confirm, and possibly provide more accurate values than were obtained in the PCTR.

Buckling Measurements, 1.4% Enriched Uranium

Buckling measurements were continued in the small (~4' x 4' x 6'), graphite, exponential piles with enriched-uranium loadings. The uranium enrichment was 1.44% by weight U-235. The uranium consisted of canned I and E elements having dimensions of 1.47" O.D., 0.37" I.D.; the bare slug size was 1.37" O.D., 0.48" I.D. The lattices measured this month are given below:

Buckling of 1.44% Enriched Uranium

Lattice Spacing	Al/U	C/U	Cooling Annuli Condition	H_2O/U	Buckling (10^{-6} cm^{-2})
7-11/16"	0.598	82.2	Wet	0.351	630
9-3/8"	0.598	123.9	Dry	-	532
			Wet	0.351	494

The above ratios are the atom ratios for the cell. These new lattice spacings of 7-11/16" and 9-3/8" are being measured to establish the wet-dry crossover point more accurately.

Variation of Graphite Diffusion Length with Temperature

The temperature was increased from 400 to 600° C in the graphite stack being used for the high temperature diffusion length experiment. Measurements were taken at 450, 500, 550, and 600° C. The graphite was then permitted to cool and the diffusion length measured at 500, 400, 300, and 200° C to check on the results which were obtained while the graphite was being heated; the pile has now cooled to about 100° C. The diffusion lengths obtained while the pile was cooling are in essential agreement with those as measured when the pile was being heated; however, there is a tendency for the "cooling" values to be slightly less as can be seen in the following tabulation.

Temperature	Heating	Cooling	Calculated
200° C	59.0* cm.	58.5 cm.	59.2 cm.
300	62.2*	61.7	62.2
400	65.2*	64.4	65.0
450	65.9		
500	67.1	67.1	67.4
550	68.6		
600	69.0		69.6

* These values were reported previously and are given here to facilitate a comparison between the "heating" and "cooling" values.

The measured diffusion lengths continue to be in agreement with the calculated values assuming a 1/v absorption cross section for graphite and a constant transport mean free path.

STUDIES RELATED TO FUTURE PRODUCTION PILES

k_{∞} Measurements with 0.925" Fuel Elements

Reactivity measurements were taken in the PCTR with 0.925" diameter, natural uranium rods in graphite lattices. These rods were canned in aluminum and placed in 1.22" O.D., dry, process tubes. Three lattice spacings were used, these were: 5-5/8, 6-1/2, and 7-1/2 inches; four to five different buffer-rod arrangements were used at each lattice spacing. The analysis of the data, which will yield the infinite multiplication factor for these lattices, has not yet been completed; the k_{∞} values will be reported at a later date. Since buckling measurements have been taken in the exponential piles with similar type fuel assemblies, it will be possible to combine the buckling and k_{∞} measurements to give information on the migration area, or Fermi age for these lattices.

Lattice Parameters for Large Diameter Cored Fuel Elements

Four different irradiations were made in the PCTR to determine the lattice parameters (ϵ, f, p, and conversion ratio) of large cored, natural uranium fuel elements. These measurements are summarized below:

Fuel Element	Lattice	Coolant
1.93" O.D., 0.75" I.D.	8-3/8"	I and E (Water)
1.68" O.D., 0.75" I.D.	7-1/2"	Core (dry), External Annulus (Water)
1.93" O.D., 0.75" I.D.	8-3/8"	None
1.68" O.D., 0.75" I.D.	7-1/2"	None

The analysis of the data from these irradiations has not yet been completed.

Measurement of Lattice Parameters of Seven-Rod Cluster

As a part of the determination of the thermal utilization of the natural uranium cluster rod fuel assembly (seven 0.5 inch diameter rods in a 1.93 inch I. D. process tube), the average flux ratio $\phi H_2O/\phi_u$ was determined to be 1.68 in the 7.5 inch lattice; the H_2O/U volume ratio in this fuel assembly is 0.85.

The flux ratio was obtained from reactivity coefficient measurements using dilute H_3BO_3 and thin copper foil. An error analysis has not been completed for the above flux ratio.

In an effort to fabricate a countable foil type 1/v detector to supplement BF_3 counters, crystalline NaF has been investigated. Satisfactory 1/4" diameter by 5/8" long cylinders have been successfully cast. The cylinders are multiple crystals with many partial fractures, and hence they are rather fragile. The first set of six cylinders has been calibrated by activation with a total variation of 0.2%.

A desirable feature of NaF is its melting temperature of $> 900^\circ$ C which would make this material suitable for neutron flux measurements at high temperatures.

Correlation of Exponential Measurements with Theory

Since the P_3 programs have become available for the determination of thermal disadvantage factors of fuel elements, an attempt is being made to find a consistent set of parameters which will allow material bucklings to be calculated over a wider range of fuel elements than is now possible.

Correlation was attempted with measured bucklings for 0.925", 1.175", 1.36", and 1.66" solid, natural uranium, fuel elements along with the 1.66" O.D., 0.81" I.D., and 1.66" O.D., 1.10" I.D., natural uranium, fuel elements. The analysis with this series of fuel elements results in two sets of parameters instead of the expected single set. The Volkoff-Rumsey method for calculation of thermal utilization was used in the above analysis and could be the source of the difficulty because the neutron flux is assumed to be constant across the air gap between the fuel element and the moderator. More accurate values of f are now being calculated by the P_3 program on the 702 computer.

Thermal Utilization Calculations

The three region P_3 program for the 702 computer has been completed and is in use. The four and five region programs are in final stages of "debug" and are expected to be in operation early in March.

A difference exists in the results obtained from the 650 program and the 702 program for the P_3 solution to the transport equation. It is believed that the difficulty exists in the Bessel function routine for the 650. This routine is not as accurate as the one utilized in the 702 program. A series of test cases is being prepared to investigate the seriousness of the error.

A recipe has been developed for selecting, and incorporating, proton effective masses into P_3 calculations.

Work reported by the Russians at Geneva on excess absorption factors has been refined through elimination of several previously made assumptions. These results will be significant when applied to analysis of large lattice cell exponential experiments.

Other Theoretical Work

Theoretical curves have been obtained from the small source theory analysis of the PCTR which have the same qualitative shape as the experimental curves.

The inverse flux problem has been set up as a Fredholm integral equation of the first kind. The inverse flux problem concerns itself with ascertaining the fuel distribution which presents a stipulated reactor flux pattern. This is useful for flattening flux distributions. The integral equation is solved by fitting its kernel with a polynomial (a 650 program is available for this fitting).

Crystal Spectrometer

The installation of the neutron beam cutoff and collimation system on the crystal spectrometer at 105-DR was completed during the Project CG-558 outage. Airborne contamination in the reactor building following startup has made it impossible to start testing of this new installation.

Millimicrosecond Time Analyzer

The time analyzer loops have been completed. A fast scaling circuit was fabricated for manual single channel recording. A run was made of the time coincidence curve of two cascade gamma rays from Co^{60}. This curve had a width of 1.6 millimicroseconds which is attributable to the statistics of the detector systems. Further testing of this system must await the arrival of the 256 channel analyzer.

PCTR Operation

Operation of the Physical Constants Testing Reactor continued routinely during the month. One unscheduled shutdown occurred due to faulty operation.

Reactor improvement items provided during the month included: The installation of a fence around the 305 and 305-B Buildings to permit temporary isolation of the buildings from the 303 Area. By isolating the 305 Buildings from the 303 Area, non-Q-cleared personnel can be taken on tour through the reactor buildings.

The 305-B Building safety regulations were revised to limit the number of personnel in the control rooms of the PCTR and the TTR to four during reactor operation.

TTR Operation

The upper 5 inches of the fuel tubes were filled with graphite plugs which were waterproofed. The resulting increase in reactivity caused the fuel inventory to be reduced by 20 fuel disks or 44.6 gms. The fuel inventory now stands at 2.7 Kg, which gives an excess reactivity of 33 cents.

New water with 100 ppm sodium bichromate was placed in the fuel tubes. No contamination could be detected in the water that was removed.

Copper and bare gold traverses were made through the TTR and some points on a cadmium-covered gold traverse were taken.

No effects due to bubble formation have been detected for some time. No bubbles have appeared in the sample fuel assembly used as a monitor.

One unscheduled scram caused by Ch. 2 level trip occurred.

SEPARATIONS

Criticality Equipment for Enriched Uranium Salts

The first part of the initial phase of the criticality experiment (measurement of k_{oo} for enriched $UO_3.H_2O$ mixtures) was completed in the PCTR. In the first phase of the experiment the H/U atomic ratio was held fixed at about 4.4; measurements were taken with core enrichments of 0.8, 1.0, 1.2, and 1.4 percent by weight U-235; enrichments of 1.0 and 1.4 percent were used in the buffer region. The results (by interpolation) indicate that for the H/U ratio of about 4.4, the U-235 enrichment for which $k_{\infty} = 1$ is about 1.16 percent. The preliminary results given here are subject to further analysis and revision because of the following reasons:

(1) During the k_{∞} measurements, the buffer regions were not thick enough to provide complete matching of the neutron spectra.

(2) Results of mass spectrographic analysis of the batch enrichments have not been received and thus nominal values were used for the calculations.

(3) The interpolation technique introduces uncertainties.

In the second phase of the experiment two different enrichments will be used and the H/U atomic ratio will be varied; enrichments of 1.00% and 1.15% and with H/U ratios ranging from 4 to 10 are now being prepared by Chemical Research and Development personnel.

Critical Mass Facility

With the deletion of the critical mass laboratory from the FY-58 construction budget, other approaches toward initiating criticality studies are being considered in more detail. These approaches are based upon the expenditure of a minimum amount of money to initiate work and will involve a scope and program much reduced from that of the original proposal.

The first of these approaches calls for the use of the head end of the 221-T Building (bismuth-phosphate separations plant now on a standby basis). The head end is an area in the main canyon originally intended for experimental separations studies. This area was seldom used. The location would provide adequate containment and protection to personnel in the event of a burst of a critical assembly. The pipe, operating, and electrical galleries, immediately outside the head end, would provide adequate space for control rooms, offices, and laboratories. This plant is currently maintained on a standby operating basis. It is quite probable, however, that it may be put on a mothball status. In that event, special provisions would have to be made for certain utilities and air conditioning of the head end. The cost of making these provisions, which is not fully known at this time, appears to be the major difficulty in using this location.

A second approach being studied consists primarily of an experimental facility similar to that used in the former P-11 studies. A reactor station in a containment structure would be set up at an appropriate site. The control station and adjunct facilities would then be located at a distance from the reactor station sufficient to provide protection to personnel from bursts.

A feasibility report with approximate costs, advantages, and disadvantages of each system is being prepared.

Plutonium Mass Spectrometer Consultation

Further consultation has been provided to the Chemical Instrumentation's project of converting a gas analyzing mass spectrometer for use as a plutonium analyzer.

Magnetic Balance

The electronic system is completed and testing and calibration of the system are continuing.

Neutron Age Measurements

Arrangements were made for the fabrication at Oak Ridge of the beryllium spheres for the photoneutron sources.

INSTRUMENTATION AND CONTROL

Analog Computer Operation and Maintenance

A large number of minor malfunctions in various components of the computer have been experienced. Considerable time was spent in investigating these malfunctions in order to gain experience in maintenance procedure and to report to Goodyear Aircraft. Although there are a large number of trouble-causing items, they are minor in nature and Goodyear Aircraft will make all necessary repairs and replacements to Hanford's satisfaction.

Reactor Boil-out Problem

Computer circuits were developed to simulate excess power, coolant loss and manual scram conditions. Performance of these circuits was very good.

Trouble in the form of excessive signal pick-up was experienced in the computer circuits for Xenon and reactor kinetic simulation. Modification of these circuits will be necessary.

Components Research and Development

Fabrication was started on an experimental detecting system which will be utilized in determining the gamma and X-ray detection low energy threshold. The technique under investigation involves the introduction of a signal component which allows cross correlation detection.

REACTOR DEVELOPMENT - 4000 PROGRAM

STUDIES RELATED TO THE PLUTONIUM RECYCLE PROGRAM

PRPR Lattice Measurements

The aluminum tank (calandria) for the heavy water test core for a 7-inch lattice for PCTR measurements has been received from the shops. The calandria has been pressure-tested for leaks and is ready for installation in the PCTR. A safety system has been designed for possible loss of heavy water which has a sensitivity of 100 ml of D_2O or a drop of D_2O temperature of 1° C. The D_2O, which is scheduled to arrive March 1, has been reported to have a tritium impurity of 30 to 35 millicuries per liter. The system has been designed to be safe for concentrations of tritium about 1000 times greater.

BIOLOGY AND MEDICINE - 6000 PROGRAM

BIOPHYSICS RESEARCH

Atmospheric Physics

A revaluation of the calibration of the fluorescent pigment used as a tracer material in atmospheric diffusion studies was undertaken in order to reduce the uncertainty of the estimate of the number of elementary particles per gram of pigment. In the course of this work it was found that a faulty laboratory technique for diluting the calibration samples had caused previous estimates to be consistently too large by approximately one order of magnitude. A complete recalibration, using correct dilution techniques, yielded a value of $4.48 \pm 0.28 \times 10^{10}$ particles/gram (confidence assessed at the 95% level) versus the value of $7.60 \pm 1.36 \times 10^{11}$ reported previously.

Installation of labeled six-foot metal stakes at 100-foot intervals from 400 to 2500 feet from the Metecrology Tower and at five-degree intervals of azimuth from north through southwest clockwise around the Tower was begun. This grid of sampling points was chosen for the initial diffusion experiments using various levels on the Tower to simulate elevated point sources. Extension of the grid to distances up to one mile from the Tower in the easterly and

southerly quadrants is feasible and has been planned to coincide with the expansion of the diffusion program and additions to the sampling equipment.

The extensive studies of diffusion in stable atmospheres and the relation of diffusion parameters for this atmospheric condition to meteorological parameters were continued and a comprehensive report on this subject was essentially complete at month's end. In the sixteen cases studied, the peak (axial) concentration at 300 m downwind from the source varied from 16.8×10^{-1} to 0.63×10^{-1} mg/m^3 for a source strength of one gram/second. These values, appropriate for an observer fixed on the azimuth of the average wind direction, illustrate the variability of the diffusion processes within the stable case.

DOSIMETRY

A 330-cubic inch plastic scintillator and a 14-inch photomultiplier were studied to see if they could be applied to Body Monitor measurements. Mineral oil was used to provide temporary optical coupling between the scintillator and the tube. The operating potentials of the photomultiplier shield and first dynode were varied until conditions of optimum pulse height with minimum noise were found. The counter was partially shielded with two inches of lead; background was reduced to one-third the unshielded value. Greater reductions are certainly possible. 280 Kev gamma rays from a Hg^{203} source could be detected efficiently. This represents an improvement over the performance of similar scintillators in body monitors at other sites and means that it may be a useful adjunct to our Body Monitor. A test of the scintillator was made by fastening envelopes containing Cs^{137} sources (about 1 μc) or blanks to the backs of members of the group and then counting them through their chests for one minute. All sources were detected and measured within a factor of two; one blank was erroneously reported as containing 0.2 μc.

The Van de Graaf accelerator operated with only routine maintenance during the month.

The moderated detector neutron fluxmeter was calibrated against the long counter with $C^{12}(d,n)$ and D(d,n) sources. Disagreement by as much as 30% was found with earlier work with (alpha, n) sources. The reason for the disagreement is not yet known. The problem of using (d,n) sources has become very great because of the background of D(d,n) neutrons. The ion source is aging rapidly and stable operation with mass-two deuterium is becoming increasingly difficult.

The difficulties reported last month with gases adsorbed on the walls of graphite chambers used for X-ray measurements are still being studied. Careful repetition of the nitrogen flushing experiment and extension to other X-ray energies indicated that argon was not the chief source of trouble. The experimental results are consistent with nitrogen itself being strongly adsorbed on the graphite. The pressure extrapolation chamber was fixed so the system could be heated to drive off adsorbed gases. Heating to 50° C produced no effect; higher temperatures will be tried. Measurements of W for nitrogen relative to W for air were made and good agreement found with values in the literature.

A small aluminum ionization chamber was made to be used in determining W with the calibrated Co^{60} source. The chamber was found to obey inverse square law which indicates that room scattering and chamber size effects are negligible. Leakage

characteristics were satisfactory. A preliminary value for air of W = 33.8 ev/ip was obtained; corrections for wall absorption and the Fermi polarization effect must yet be made. Values of the Compton energy absorption coefficient for carbon, nitrogen, oxygen, aluminum, argon, iron and lead were computed by IBM machine at 0.01 Mev intervals from 0.01 to 10 Mev for use in this work.

Measurements were made to determine the dose received by a film badge when it is calibrated with uranium beta rays. The depth dose was measured with an extrapolation chamber for 16 to 290 mg/cm^2 of polyethylene. The emulsions in the badge are at depths of 64 and 94 mg/cm^2. The average dose to the two emulsions is 146 mrad/hr.

INSTRUMENTATION

Experimental work on a transistorized Alpha Hand and Shoe Counter was started. The instrument will be completely transistorized except for the multiplier phototubes used to detect alpha particle caused scintillations from ZnS phosphor screens. The instrument will be approximately four cubic feet in volume with register readout indicators and it will use separate cable connected shoe probes. Detection sensitivity will be approximately 500 d/m. The transistor amplifiers and register drive circuits are under development. The overall instrument volume will be approximately one-fifth the size of the present four-fold counters.

Experimental work was continued on the Dual Filter Alpha Air Monitor with the following comparison data being obtained. The dual filter instrument was set to alarm at three times the Radon-Thoron background, or 500 MPC of plutonium alpha in three minutes. This represents an alarm sensitivity 20 times better than the single filter instrument which alarmed on 10,000 MPC in three minutes.

Modifications to the circuitry for the Stack Effluent Monitor were completed. The modifications were undertaken to aid in calibration and maintenance of the equipment.

Experimental work was started on a scintillation portable fast neutron dose-rate meter. The instrument will utilize the n,p reaction using polyethylene material and attached ZnS phosphor.

The circuitry tracings and parts list for the Radiotelemetering Remote Data Stations have been essentially completed. The Radiotelemetering System will incorporate a central station, repeater station and twenty remote data stations. Information on radiation levels, wind parameters, and temperature will be transmitted automatically from each data station through the repeater station and then to the central station for recording and analyzing. Each data station is a separate self-contained automatic detection and radio transmitting and receiving unit.

The Water Velocity Indicator for use in plant wells by the Geochemical and Geophysical Research Operation was assembled. Some laboratory tests have been completed and more are contemplated before field tests are undertaken. The instrument will detect the direction and speed of underground water flow when the probe is placed in the flow.

Evaluation tests were completed on the use of RK-61 subminiature thyratrons for

use in miniature high voltage supplies. Accuracy and calibration tests were completed on a Jordan Remote Air Monitoring System, and evaluation tests were started on metal-wall halogen-quenched GM tubes. Field tests were started on the Nemo fast and slow neutron detector and on miniature hearing-aid-type headphones.

CUSTOMER WORK

PROCESS TECHNOLOGY

Nuclear Safety Problems

A variety of nuclear safety problems were studied during the month. Among these were treatments of long-term reactivity gains on slug dissolver safety, and fabrication considerations involved in the preparation of plutonium fuel elements for the PRP.

Additional manufacturing specifications were also prepared for 1.6% enriched fuel elements.

Assistance was granted the Plutonium Metallurgy Operation in establishing procedures for pouring the Robin B casting.

Design of Shipping Cask

Calculations were made of the shielding requirements for a high level cask for fuel elements irradiated in the ETR. A provision for thermal cooling of the fuel elements was recommended.

KAPL-120 Loop Design

A design for a zirconium, high pressure, in-pile tube for the KAPL-120 loop has been recommended to KAPL. Preliminary calculations show that this design will approximately double the flux in the loop and thus double the exposure capacity of the loop. Whereas other designs have been made using zirconium which would enhance the flux by an equivalent amount, they have all required that development work on zirconium fabrication be done. This design is based upon known and proven fabrication techniques.

OTHER

Weather Forecasting

Type of Forecast	Number Made	% Reliability
8-Hour Production	84	84.5
24-Hour General	56	76.4
Special	70	81.4

Summary of the Weather

Temperatures during February varied between 65 on the 26th and -1 on the 2nd. Below normal temperatures predominated, however, and the over-all monthly average of 34.1 was 1.4° below normal.

The precipitation total of 0.23 inches was only about one-third the normal amount for February. There were high winds on the 24th with peak gusts 59 mph at 50 feet and 77 mph at 400 feet. During most of the time, however, speeds were light.

Columbia River Level Forecasts

Conferences with U. S. Weather Bureau and Soil Conservation Service personnel were held in Portland, Oregon, in preparation for Columbia River level forecasts for the 1957 high-water period. Due to only an average snowfall over the Columbia watershed the potential for any appreciable flooding of the Columbia during 1957 is held to be essentially nil. In fact, primary concern is directed toward a potential water shortage.

Optical Shop

The routine work in the Optical Shop included the repair of three crane periscope heads, a discharge area periscope, a microscope, and four cameras; and the fabrication of microscope brackets, lens mounts, lens extension for a motion picture camera, and glass bearings.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H. W. Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
M. L. Barad	Feb. 13	Air Force, Cambridge Research Center Boston, Mass.	Confer on meteorological problems and instruments.	GR Hilst PF Gast HM Parker	No	200-W: 622 300: 328, 3760

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
G. R. Hilst	Jan. 31	Travelers Insurance Co. Hartford, Conn.	Confer on problems of weather forecasting by statistical techniques.	TF Malone	No
G. R. Hilst	Feb. 1	Univ. of Chicago Chicago, Ill.	Confer on problems in atmospheric diffusion.	HR Byers	No
D. J. Donahue G. W. Stuart	Feb. 1-2	Am. Phys. Soc. Meeting New York, N. Y.	Recruiting. Present a paper and recruiting.		No
D. J. Donahue	Feb. 4	Atomics International Canoga Park, Calif.	Discuss reactor and lattice physics.	RA Laubenstein	Yes
E. J. Seppi	Feb. 11-24	Oak Ridge Nat. Lab. Oak Ridge, Tenn.	Declassification Program.	HF Carroll	Yes
E. J. Seppi	Feb. 25-26	Brookhaven Nat. Lab. Upton, N. Y.	Discuss neutron cross sections.	VL Sailor	Yes

VISITS TO OTHER INSTALLATIONS (CONT'D)

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. A. Berberet	Feb. 18-19	Phillips Petroleum Co. NRTS, Arco, Idaho	Discuss test reactor operations.	A. S. Richardson	Yes
D. E. Jenne	Feb. 18	U. S. Weather Bureau Portland, Oregon	Discuss problems of Columbia River level forecasts.	A. J. Polos	No
D. E. Jenne	Feb. 19	Soil Conservation Service Portland, Oregon	Discuss problems of Columbia River level forecasts.	R. T. Beaumont	No
D. A. Kottwitz	Feb. 25-28	Oak Ridge Nat. Lab. Oak Ridge, Tenn.	Declassification Program.	H. F. Carroll	Yes
J. A. Berberet	Feb. 27	Reed College Portland, Oregon	Recruiting Ph.D.'s	Dr. Scott	No

Chemical Research & Development Operation

ORGANIZATION AND PERSONNEL

John P. Keiser, Engineer II, transferred to Reactor and Fuels Research and Development.

Manfred Siegler, Engineer I, transferred to APED at San Jose, California.

Lucille A. Holden, Steno-Typist, resigned.

O. H. Pilkey, Jr., Engineering Assistant, was added to the force.

L. R. Duncan, Chemist II, transferred in from Chemical Processing Department.

Rozella M. Ogden, Laboratory Assistant, transferred in from Fuels Processing Department.

TECHNICAL ACTIVITIES

2000 PROGRAM - PRODUCTION OF FISSIONABLE MATERIAL

IRRADIATION PROCESSES

Reactor Effluent Studies - Automatic Analyzing Monitor

Exhaust ducting for removing fumes and vapor from the evaporation hoods on the monitor was designed to permit variable control of flow rates through the individual hoods. Several experiments were conducted to evaluate optimum conditions of air flow, air temperature, and placing of the radiant heater over the sample dish. It was determined that with the commercial 200-watt radiant over-head heater, and the 600-watt air preheater delivering 2.5 cfm air at 600 F, smooth evaporation of two cc per minute could be obtained. This rate will be adequate for the largest sample anticipated, 100 cc each hour.

The one day half-life isotope interfering with the P^{32} measurement previously reported to be I^{133} was confirmed by Analytical Chemistry to be W^{187}. At month's end experiments were underway to evaluate a modified procedure for the P^{32} stream which would remove the interfering W^{187} and Cr^{51} in addition to As^{76}. The additional steps require a second Dowex-50 column and a final slurrying with WO_3 after removal of As^{76}. The use of nitric acid to replace hydrochloric acid in the modified procedure should be a definite improvement from the corrosion standpoint, although the added complexity will pose added maintenance and reliability problems.

Modification of the Weston recorder was accomplished with a new motor and gear train. The recorder action is thereby slowed to a degree that permits the recorder to pulse out through the toothed-wheel analog to digital converter at a rate within the acceptance rate of the Streeter-Amet printer. Full scale recorder reading can be pulsed out in a minimum time of six seconds.

The circuit for the Cu^{64} coincidence measurement was tested. An output pulse from the circuit of 8 ms duration operates the appropriate relay in the Streeter-Amet printer.

The 100-channel pulse height analyzer was received during the month. It will be used to assist calibration of the analyzing monitor and to aid in the general study of reactor effluent composition. An engineer spent three days at the manufacturer's plant (RIDL) in Chicago attending orientation sessions on the theory, operation, care, and maintenance of the instrument.

Routine Monitoring

Routine monitoring of As-76 in reactor effluent cooling water is being accomplished by means of direct counting through suitable absorbers. The method was developed by Analytical Chemistry. Operator time is reduced by a factor of three with no change in accuracy. Compared to the former standard method requiring chemical separation, counting results were 7 per cent higher as found by Radiological Chemical Analysis. Adoption of a similar method for P-32 is being withheld. Compared to the existing method results are 16 per cent higher and are delayed 12 days to permit decay of short-lived isotopes.

Radiological Chemical Analysis confirmed standard beta counting of Zn-65. Gamma spectrometer results diverged by less than 10 per cent from beta counting values.

Radiation Protection requested composition analysis of Turco, a possible reactor cooling water additive for reducing reactor rear face personnel exposure. Infrared analysis and emission spectrography were utilized to establish the presence of sodium chloride, sulfamic acid, ammonium bifluoride, and an aromatic wetting agent. Quantitative analyses are in process.

Analytical Service

A coulometric plutonium analytical method is being evaluated for general use. Immediate application is the direct analysis of I&E dissolver solution. Plutonium standard solution gave precision and accuracy of $\pm$ 1 per cent which meets IPD needs.

New analytical services in support of organic pile coolant studies consisted of pour point and cloud point measurements provided on a routine basis.

SEPARATIONS PROCESSES

PUREX

HA Column Studies

Work continued on the development of a satisfactory cartridge for organic phase continuous operation in the Purex Plant HA Column scrub section. The failure to achieve alternate phase inversions ("zebra effect") without using plastic plates for organic coalescence shifted the emphasis to the utilization of a short stainless steel cartridge section (about 5-ft. high in the plant column) immediately above the feed point and a mixed stainless steel and plastic cartridge section for the remainder. It is expected that the decontamination obtained in the all stainless steel section will be sufficient to insure satisfactory life for the plastic plates.

The studies were conducted in a three-inch-diameter glass pulse column with a nine-foot-high scrub section. Both Purex Flowsheet HW No. 3 and Purex Plant Flowsheet No. IIA were used.

Highlights of the studies include:

1. In the mixed cartridge section the use of stainless steel plates having 0.08-inch-diameter holes and 21 per cent free area gave the best aqueous coalescense, i.e., a finer dispersion and coalescence obtainable over a wider frequency range.

2. The order of decreasing ability of plastic materials to achieve organic coalescence was found to be linear polyethylene, polyethylene, and fluorothene.

3. The use of plastic plates at the top of the cartridge markedly decreased aqueous entrainment into the top disengaging section.

4. A cartridge consisting of alternate groups of four stainless steel sieve plates and two fluorothene sieve plates (all on one inch spacing) gave chloride HTU values of 1.6 and 2.0 feet at volume velocities equivalent to plant capacity factors of 1.8 and 3.6, respectively. These HTU values are 15 to 20 per cent lower than obtained when using a cartridge containing alternate groups of two stainless steel and two fluorothene sieve plates.

5. Nozzle plates appear unattractive for the all stainless steel section immediately above the feed point. For reasons not yet defined, it was not possible to obtain a stable "zebra effect" when the nozzle plate section operated with the organic phase continuous.

Interface Control

A float-type interface level detector using a standard rotameter coil and armature, coupled to a stainless steel float is installed and operating in a glass column in the 321 Building. The device has been in operation for two weeks and controls the bottom interface level to within ± 1/2 inch of the set point, where the density difference of the two phases is about 0.2. Based on these observations, a second float-type interface detector is being designed for installation and testing on a jumper for use in the Purex Plant IA Column. The approximate 0.1 density difference of the two phases at the top of this column will provide a severe test of the suitability of this type interface detector for plant use.

Interfacial Transfer Rates

Most of the difficulties apparently stemming from surface-active impurities in the solvent and in uranyl nitrate appear to have been solved, and reproducible results are now being obtained. Considering the extraction of uranyl nitrate into TBP-Amsco as a process first-order in uranyl nitrate (an assumption which appears valid over at least the first half of the transfer process), results of recent measurements can be summarized as follows.

1. Extraction rates from 0.48 molar uranyl nitrate solution varied only slightly as the TBP concentration was varied from 10 per cent to 40 per cent. Values for the first-order rate constant for the extraction process were 0.0074,

0.0078, 0.0084, and 0.0085 min^{-1}, respectively, for 10, 20, 30, and 40 per cent TBP. The rate of extraction of uranyl nitrate out of a solution 0.75 molar in uranyl nitrate and 2.4 molar in nitric acid was more sensitive to TBP concentration but still considerably less than first-order in TBP. Values for the first-order rate constant for the extraction process were 0.0029, 0.0041, and 0.0055 min^{-1}, for 10, 20, and 30 per cent TBP, respectively.

2. Addition of an aqueous soluble non-ionic surfactant to a concentration of 100 ppm lowered the rate constant for uranium extraction by a factor of four.

3. The rate of extraction of uranyl nitrate from 0.48 molar uranyl nitrate solution into 30 per cent TBP in Amsco proved much more sensitive to the stirring rate of the aqueous phase than to that of the organic phase. The rate constants ranged from 0.0027 min^{-1} to 0.023 min^{-1} as the aqueous stirring rate was increased from 50 to 120 RPM, with the organic stirred at a constant rate of 80 RPM. By contrast, the measured rate constants were 0.0029, 0.0046, 0.0046 and 0.0048 min^{-1} for organic phase stirring rates of 50, 80, 110, and 112 RPM, respectively, with the aqueous phase stirred at 80 RPM. Under the conditions of these measurements, therefore, it appears that diffusion in the aqueous phase may constitute one of the major limitations on the rate at which uranyl nitrate transfers from aqueous to organic phases.

Solvent Properties of 2-n-Butyltetrahydrofuran

Cyclic ethers are currently undergoing examination to determine their potential as solvents for processing irradiated uranium. The first of this class of compounds which has received attention is 2-n-butyltetrahydrofuran. The solvent capability of this compound for uranyl nitrate has been examined, and the data are summarized in the accompanying table. Distribution data for tracer zirconium is included also, as a measure of the decontamination potential of this solvent. Results obtained in parallel measurements with hexone and 30 per cent TBP in a hydrocarbon diluent are included.

As a solvent, n-butyltetrahydrofuran is apparently competitive with hexone in ANN-salted systems in both uranium extraction power and decontamination capability for zirconium, but appears inferior on both counts to 30 per cent TBP in nitric acid salted systems.

It is planned to study the stability of BTF towards nitric acid and its decontamination capability for gross fission products.

Solvent Properties of 2-n-Butyltetrahydrofuran ("BTF")

Comparison with Hexone[a]

BTF				Hexone			
M HNO_3	$E_a^o(U)$	$E_a^o(Zr)$	$\frac{E_a^o(U)}{E_a^o(Zr)}$	M HNO_3	$E_a^o(U)$	$E_a^o(Zr)$	$\frac{E_a^o(U)}{E_a^o(Zr)}$
- 0.14	1.25	0.00011	11,400	- 0.14	0.86	0.00023	3,740
0.03	1.93	0.0027	1,080	0.02	1.26	0.0050	252
0.11	1.38 (?)	0.0046	300 (?)	0.09	1.36	0.0074	184
0.22	2.05	0.0080	256	0.16	1.03 (?)	0.018	57
0.36	2.4	0.014	17	0.32	1.31	0.028	47

(a) Aqueous solution 1.0 M ANN and initially 0.2 M UNH.

Comparison with 30% TBP

M HNO_3	$E_a^o(U)$	$E_a^o(Zr)$	$\frac{E_a^o(U)}{E_a^o(Zr)}$	M HNO_3	$E_a^o(U)$[b]	$E_a^o(Zr)$	$\frac{E_a^o(U)}{E_a^o(Zr)}$
1.6	0.30	0.002	150	1	7	0.017	410
2.4	0.92	0.0085	108	2	18	0.058	310
3.75	1.20	0.025	48	3	31	0.16	194
4.8	1.60	0.048	34	4	35	0.40	88
5.6	2.4	0.066	36	5	40	0.84	48

(b) Data for dilute uranium region taken from HW-31000, Figure IV - 14.

Tri-iso-butyl Phosphate as Purex Extractant

Tri-iso-butyl phosphate (Eastman Chemical Products) was studied as an extractant in the Purex process. Batch equilibrations were made simulating the partition cycle (IA and IB feed points and IC stripping). Uranium distribution ratios were, in all cases, nearly identical to those obtained when using tri-n-butyl phosphate (TBP) as extractant. Also, IA feed point distribution ratios for Pu, gross gamma, Zr-Nb, Ru, and Ce were approximately the same with the two extractants. Under IB feed point conditions, Pu E_a^o was greater by a factor of four for TBP than for tri-isobutyl phosphate (0.0077 vs. 0.0018).

When the concentration of uranium in an organic phase 30 per cent in tri-iso-butyl phosphate exceeded 0.27 M, a yellow, crystalline solid formed. Probable composition of the solid (from uranium analysis) is $UO_2(NO_3)_2.2TIBP$. Uranium saturation in 30 per cent TBP is ca. 0.52 M and Purex HAP and IAP (extraction column product streams) exceed 0.35 M in uranium. Tri-iso-butyl phosphate does not appear attractive as an alternate for TBP in the Purex process because of the limited solubility of uranium in it.

Ion Exchange Studies

Attempts to operate the 321 Building moving-bed ion-exchange contactor with new Dowex-50 20-to-50 mesh resin were unsuccessful because of excessive resistance to liquid flow which developed in the XA Column and prevented pumping feed to the column. An hydraulic classifier which allowed a water flow of up to 500 ml./min. in a 2-inch-diameter pipe removed about 0.2 ml./hr. of fines from the unit. Microscopic inspection of the resin indicated that the removal rate was not as fast as the fines formation rate. No further work is planned with the coarse resin since it does not appear attractive for plant use.

Performance tests of the instrumentation to control the acid-water interface in the 321 Building plutonium resin column, "C" Column section, are complete. The nitric acid concentration at the probe is determined with the following precisions over the indicated concentration ranges:

0.1 to 1.0 g/l $\pm$ 2%
1.0 to 10.0 g/l $\pm$ 2%
10.0 to 100.0 g/l $\pm$ 10%

An alternate probe installed into a well on the slip water outlet line indicates that this position may be a more desirable control point. Controlling from this position, the slip water overflow volume increased about 5 per cent for the same average acid concentration and the deviation of the slip water volume per cycle was reduced by a factor of ten.

During the course of these tests it was found that the manufacturer of the conductivity probes had used silver solder to hold the carbon electrodes in place. The probes were reworked and installed with press-fitted electrodes and have now operated satisfactorily for ten days.

NEW PROCESSES

Dissolution of IPR Fuel Elements

Work on this problem during the report period has been concentrated on study of the dissolution of zircalloy-2 by ammonium fluoride solutions. The results to date confirm the previously reported observation that substitution of ammonium fluoride for hydrofluoric acid permits dissolution of zircalloy-2 at adequate rates at pH values as high as 9.5. Participation of ammonium ion in the reaction is indicated by the following.

1. Instantaneous dissolution rates with one molar ammonium fluoride (pH = 6.5) ranged from 0.3 mils/min to 0.03 mils/min as the zirconium concentration increased from nil to 0.17 molar. By contrast, the dissolution rate with one molar potassium fluoride (adjusted to a pH of 6.4 by addition of hydrochloric acid) was only 0.003 mils/min.

2. The rate of dissolution in ammonium fluoride solutions is increased significantly by addition of ammonium chloride although ammonium chloride solutions alone do not appear to attack zircalloy-2.

Exposure of uranium metal to boiling four molar ammonium fluoride or a boiling mixture four molar in ammonium fluoride and four molar in ammonium hydroxide (pH = 9.6) for two hours resulted in formation of a green coating on the metal (presumably UF_4 or $UF_4 \cdot NH_4F$). The coating plus any uranium which dissolved amounted to about 1.4 per cent of the total uranium in the experiment employing ammonium fluoride and about 1.7 per cent of the total uranium in the experiment employing the mixture of ammonium fluoride and ammonium hydroxide. After cooling the supernatant liquids from both experiments appeared water-white.

Addition of ethylene diamine tetra-acetic acid ("Versene") to a concentration of one molar in a mixture one molar in ammonium fluoride and three molar in ammonium hydroxide allowed dissolution to continue at a significant rate past the mole ratio of ca. six moles of fluoride per mole of zirconium at which the dissolution generally ceases with ammonium fluoride alone.

Experiments are planned to define more closely the effect of fluoride, ammonium, and hydrogen ions on zircalloy-2 dissolution, and to determine the feasibility of selectively dissolving zircalloy-2 jackets off uranium by use of ammonium fluoride mixtures.

Continuous Metal Dissolution

Eleven runs in the 2-inch-diameter by 12-foot-high continuous tower dissolver were completed. Although a variety of operating conditions were used, including different acid and reflux rates and reflux, feed, and air entry points, dissolving rates of only 50-75 per cent of those obtained in a continuous pot dissolver (HW-42666) were achieved.

FLUREX DEVELOPMENT

Anodic corrosion of platinum. Measurements of the anodic corrosion of platinum in nitric acid were extended to nitric acid concentrations as high as 3.9 M.

Decreased corrosion with increased nitric acid strength, as reported previously, was confirmed. The corrosion rates varied, in parabolic fashion, from 0.021 mg./amp. hour at 0.15 M HNO_3 to nondetectable weight loss (24 hour run at 7.5 amps./in.^{2}) at 3.9 M HNO_3. Similar studies with gold as anode showed increased corrosion with increased acid concentration in the range 0.15 to 0.45; corrosion rates were prohibitively high in this range.

Resistance of Flurex Cell Components. Resistance of various cation and anion exchange membranes was measured by a "difference" technique. The resistance of an appropriate solution in a conductivity cell was measured. A membrane, pre-equilibrated to 2 M UNH if cation exchanger or 4 M HNO_3 if anion exchanger, was inserted between the electrodes and the cell resistance was measured again. Resistance of the membrane was taken as the difference in the two measurements. Anion exchange membrane resistance as a function of external solution composition is shown in the following table.

External Solution	Resistance of One Thickness of Membrane, Ohms/Cm.^{2}	
	Permutit 3148 (8.0 mils)	Nalfilm 2 (3.4 mils)
0.5 M HNO_3	12.5	65.1
0.1 M HNO_3	20.6	71.2
0.5 M HNO_3	12.6	55.7
1.0 M HNO_3	6.9	49.0
0.5 M UNH	31.0	94.0
0.10 M UNH	28.0	80.0
0.50 M UNH	19.0	82.0
1.00 M UNH	32.0	123.0
2.00 M UNH	108.0	801.0

Similar values for cation exchange membranes in contact with UNH solutions of varying composition are as follows:

External Solution	Resistance of One Thickness of Membrane, Ohms/Cm.^{2}		
	Permutit 3142	Nalfilm 1	Ionics CR-61
0.5 M UNH	736	84	154
0.1 M UNH	588	77	113
0.50 M UNH	369	67	36
1.00 M UNH	305	54	21
1.97 M UNH	304	179	24

Specific resistance of UNH solutions of concentrations possibly applicable as Flurex feed was measured. These range from 105 ohm cm. at 0.005 M UNH to ca. 11 ohm cm. at 2 M UNH. Similarly, specific resistance of possible catholyte solutions (0.2 M UO_2F_2, 0.05 M NH_4F, varying HF concentration) varied almost linearly from 9 ohm cm. at 3 M HF to 36 ohm cm. at 0.5 M HF. Specific resistance of HNO_3 solutions (anolyte) ranged from ca. 4 ohm cm. at 1 M to 53 at 0.05 M. With these data, voltage drop across a Flurex cell may be estimated for a wide variety of operating conditions. Trial calculations indicate relatively high cell voltages and point to the necessity of optimizing cell design to minimize power loss.

WASTE TREATMENT AND FISSION PRODUCT RECOVERY

Cesium Packaging Flowsheets

A calcination-leaching process was reported last month for converting cesium zinc ferrocyanide precipitates to cesium chloride. Further work has now been done to determine whether the same treatment would be applicable to nickel ferrocyanide or ferri ferrocyanide precipitates, since it may prove desirable in some cases to employ these materials rather than cesium zinc ferrocyanide in the recovery of cesium from certain wastes. This may be the case if it is desired to process Purex HAW directly or if the iron and aluminum concentrations in 1WW are excessive. In the calcination experiments, it was observed that both the nickel ferrocyanide and ferri ferrocyanide spattered badly when heated to 300 to 550 C. Overall cesium recoveries after leaching were very poor and averaged less than 10 per cent. However, the calcination-chlorination and wet chemistry processes handled nickel ferrocyanide and ferricyanide without difficulty.

It has been thought that calcination of cesium zinc ferrocyanide may result in conversion of a portion, at least, of the cesium to the cyanide rather than the oxide. While this is of little consequence if the product is packaged as the chloride, it is a matter of concern if the "oxide" is packaged directly since the cyanide would probably undergo radiation induced decomposition with gradual pressure build-up. A leach solution was accordingly analyzed for cyanide. The result was negative and indicated that the cyanide content was less than one part in 200,000.

The wet chemistry flowsheet which was reported recently for converting cesium zinc ferrocyanide to cesium chloride utilizes a sulfide precipitation to remove zinc and iron and an anion exchange step to remove sulfate. Both of these are rather time consuming and may, also, be subject to radiation decomposition difficulties. An alternate scheme was devised and tested this month which appears to have many advantages. This involves dissolution in sulfuric acid, as before, followed by electrolysis in a mercury cathode cell to remove iron and zinc. It has also been found possible to remove the sulfate by precipitation with lead (added as lead nitrate) and to remove the excess lead electrolytically along with the iron and zinc. Alternately, the sulfate can be removed by stoichiometric precipitation with barium, the end point being determined conductiometrically.

In other experiments with the wet chemical process, it was found that the chloride form of the Dowex-1 anion resin can be substituted for the hydroxide form and that it can be re-generated more readily, thereby reducing overall time cycles. The fission product decontamination factors across the wet chemical packaging process were also determined and were found to be 160 for zirconium-niobium, 18 for ruthenium, 9 for cerium, and >1000 for plutonium. Since substantial decontamination is also obtained in the cesium zinc ferrocyanide recovery operation, the final cesium chloride product will be of very high radiochemical purity.

Neptunium Recovery

Three Mini (miniature mixer settler) runs were completed during the month. These simulated the HA Purex column and represented tests of flowsheets based on previously reported batch extraction data. The first run simulated the HW #3 flowsheet (1.35 M U, 2 M HNO_3 feed, 3 M HNO_3 scrub) and was run at about 65 per cent

uranium saturation. At steady state, most (about 90 per cent) of the neptunium was eliminated in the HAW, as expected. The second run was identical to the first except that 0.1 M ferrous sulfamate was added to the feed to reduce the neptunium to the extractable (IV) state. In this case, about 90 per cent of the neptunium was extracted and was found in the uranium product. The third run employed a high acid - low saturation flowsheet (1.35 M U, 4 M HNO_3 feed, 3 M HNO_3 scrub, 60 per cent uranium saturation) and was designed to force neptunium(V) over with the uranium (and plutonium). Although steady state was not attained and only 54 per cent of the neptunium was found in the uranium product, it was estimated that about 95 per cent would have been forced through after the nitric acid had refluxed up to steady state concentration.

The above results indicate the practicality of two methods for recovering the neptunium: (1) high acid, HA, IA, IB operation with eventual recovery of the neptunium from the low acid IIDW, or (2) operation of a conventional HA with recovery of neptunium from the HAW by solvent extraction after reduction to the (IV) state with ferrous sulfamate. The first scheme has the disadvantage that decontamination will be somewhat compromised and the second that additional columns are required. A third scheme, currently undergoing batch testing, would have neither of these drawbacks. It is based on differences in the rates of oxidation of neptunium and plutonium. Thus preliminary experiments show that the neptunium (IV) is oxidized very slowly by nitrite, whereas the plutonium(III) to (IV) oxidation is very nearly instantaneous. Similarly the oxidation of neptunium(V) to (VI) by dichromate was found to be rapid ($t_{\frac{1}{2}} < 1$ minute) whereas the dichromate oxidation of plutonium(IV) is slow (at room temperature). It should be possible with these, or some other suitable oxidant, to extract both the plutonium and neptunium in the HA and 1A columns. Testing of these ideas is proceeding.

The ion exchange characteristics of neptunium are also under investigation as an alternate means of recovery or of isolation. A preliminary experiment with neptunium(IV) gave a distribution coefficient of 2.5×10^4 for adsorption on Dowex-1 from 7 M nitric acid. Twenty-four hours were required to attain this equilibrium value at room temperature. It is planned to cover a range of acidities from 4 M to 8 M nitric acid in the case of neptunium(IV) and to investigate the behavior of the (V) and (VI) states as well.

Cesium Isolation and Packaging

Efforts expended on developing the isolation and packaging prototype were aimed at producing the first Engineering Flowsheet by May 1, 1957. Basic assumptions include: (1) feed material will be an aqueous slurry of zinc cesium ferrocyanide, (2) the final product will be cesium chloride, (3) instantaneous capacity will be adequate for processing 4 Kg of cesium per eight hour shift, and (4) the product will be packaged in bulk form. The capacity assumption is tentative and may change before the flowsheet is completed.

In support of design of the prototype cesium packaging unit, information on centrifugation, filtration, and settling of $Cs_2ZnFe(CN)_6$ is being obtained. When precipitated from simulated IWW (procedure proposed by Chemical Research Operation) the solid volume after centrifuging (one hour at ca. 600 x G) is about 0.04 per cent corresponding to 0.54 M in $Cs_2ZnFe(CN)_6$. If precipitated at higher cesium content (4.3×10^{-3} M vs. 4.3×10^{-4} M in IWW), the solid agglomerates more rapidly and is more bulky after centrifugation (0.2 M). Thus preparation of the solid for

study by precipitation at higher cesium concentration to avoid large solution volumes is not valid due to different characteristics of the solid.

$Cs_2ZnFe(CN)_6$ is precipitated from simulated IWW and centrifuged is readily suspended in two or three volumes of water to give a slurry which can be pumped through a 1/4 inch line. Dilution of the slurry with water tends to peptize the solid. At a water to centrifuged solid volume ratio of 15, the solid filtered readily on F porosity sintered glass (4-5.5 microns). At a water to solid ratio of 50, some solid passed an F porosity filter. Digestion at elevated temperature as well as the addition of ammonium salts to maintain ionic strength counteract the peptization.

Semiworks Waste Self-Concentrator

The waste tank contents continued to concentrate during the first week of the month. A total of 124 liters of condensate were collected and cribbed, reducing the liquid level in the tank to approximately 13 feet. This corresponds to 30 per cent of the original volume charged to the tank.

On February 5, the calrod heaters, used to compensate for tank heat losses, were shut off and the tank was allowed to cool. This permitted piping and instrumentation changes in the condensate drain system. Instrumentation was also installed for an emergency quench system which will drown the waste tank in the event the vapor load should ever exceed the condenser capacity.

Disposal to Ground

Laboratory experiments were conducted to investigate the possibility of disposal of UO_3 Plant uranium wastes to the ground. Tank C-2 waste at pH 1.6 containing 0.085 lbs U/gal was used for the laboratory experiments. The addition of sodium hydroxide to the waste removed uranium very effectively from the solution by precipitation. The concentration of uranium remaining in solution at pH 4.2 was 0.037 lbs/gal while at pH 5.0 it had dropped to 3.6×10^{-4} and at pH 7.6, 9.2×10^{-6} lbs/gal. Addition of caustic to neutralize the acidity and retention of the sludge in a holdup tank would be a feasible method of producing effluent containing insufficient uranium to be of radiological importance. The addition of sodium hydroxide to adjust to below the precipitation point ($\sim$pH 3-4) produced the best conditions for removal of the uranium from solution by soil adsorption. Distribution coefficients for such effluent were >40, indicating that disposal based on the adsorption of uranium by soil may be possible under carefully controlled conditions.

Soil column experiments were conducted to determine the capacity of the A-8 crib for A-farm condensate waste. The results of a radiochemical analysis for 10 radioisotopes in the A-8 waste indicated that Sr^{90}, at a concentration of 1.5×10^{-5} uc/ml, would be the limiting radioisotope in disposal to the ground. The capacity of the A-8 crib, which was estimated from the soil column breakthrough curve for Sr^{90}, was about 13 column volumes of A-8 waste based on a Sr^{90} concentration in the waste of 1.5×10^{-5} uc/ml. Experiments were planned to obtain a similar estimate for higher concentrations of Sr^{90}. Using a total capacity for the crib of 13 column volumes, approximately two-thirds of the total crib capacity remained as of December 1, 1956.

A document was drafted which recommends the crib disposal of a large fraction of in-farm scavenged waste supernates. It is estimated that some ten million gallons of presently tanked wastes can be discharged to the 216-BC cribsite if adequate cesium and strontium soil adsorption is demonstrated, Co^{60} concentration is reduced to less than 4×10^{-4} uc/cc (MPC), and other defined requirements are met. It is expected that the test disposal will yield valuable data relating to stratification and dispersion of wastes in ground water, aquifer characteristics in the disposal area, and ground water movement.

Approximately 550,000 gallons of TBP scavenged supernate was discharged to the 216-BC-6 crib. This waste demonstrated satisfactory strontium and cesium soil adsorption characteristics and contained Co^{60} at 0.7 MPC. It is the first batch of waste to be sent to the cribsite as part of the above-described high Co^{60} waste "use test" in this area.

Total beta emitters in cooling water recently routed to the new Redox swamp were found to be slightly below the recommended swamp disposal limit. The activity is believed to be due to wash-out of contamination previously deposited in the lines. Increased crib life should result from the cooling water segregation and re-routing.

Arrangements were made for isotopic analysis of the contact condenser effluent from the recently installed vacuum acid fractionator in Purex plant. The large volume discharged (300 gpm) may result in short crib life unless it can be shown that surface disposal can be achieved or the contact condenser replaced with a surface condenser. Data to be obtained will assist in determining the most promising solution.

Observation Wells

The movement of radioactive contamination in the ground water north from T-Plant waste disposal sites has reached a point 4000 feet northeast of the 241-T Area. Significant nitrate ion concentrations have been found in wells as far north as Gable Butte. The rate of movement of this material has significantly increased as predicted due to the decreasing ground water level beneath the T-swamp.

Ground water samples from wells located southeast of 200 East Area contained significant concentrations of nitrate ion. This material may be explained as residual material remaining from previous contamination of the region, seepage of high-density wastes beneath the Purex mound that apparently blocks the movement of ground water from the 200 East Area, or an undetected stream of high nitrate waste from the Purex Plant that is incorporated into the Purex mound. No radioactive material has thus far been detected in the wells, although further to the west significant concentrations of radioactive contamination have been detected moving slowly southward around the west edge of the Purex mound. The possibility of seepage of high salt waste beneath a ground water mound has been qualitatively demonstrated in laboratory models.

A series of special sampling tests is being conducted in monitoring wells in the 200 East Area. The wells are located 2500-3000 feet south of the BY cribs and monitor the movement of contamination from this site. The sampling tests involve simultaneously collecting representative samples from different depths in the ground water. Very marked concentration differences have been found at different levels in some of these wells. In one well in particular a striking increase in

the concentration of radioactive material was found in the lower levels of the ground water. The bottom 15 feet of the well is drilled in a uniform bed of fine sand. Within the horizon the radioactive material concentration near the bottom is as much as 500 times that found in the ground water near the top of the bed.

The Purex mound appears to have essentially stabilized under the continuous discharge of about 7 x 10^6 gal. of cooling water per day to the Purex swamp. The elevation of the mound has increased only 0.1 foot since December. Somewhat more significant changes continue to occur in the size of the 200 West mound. The southern portion continues its slow rise, while the northern portion continues to show a significant subsidence. The elevation of the ground water beneath the T-Plant has decreased a total of 1.15 feet since December.

Special Geological Studies

The apparent downward migration of some high salt wastes in the ground waters beneath 200 East Area could be a combination of structural and stratigraphic control of the ground water movement (in the most permeable bed and down the dip) with at least some mass settling of those wastes toward the basalt "floor." Movement of the wastes is in a highly permeable aquifer of the lowermost Ringold formation, entrance to which was gained where the upwarped Ringold sediments were eroded and truncated prior to burial beneath later fluviatile sediments. Two clay beds elsewhere overlie the aquifer but were locally removed by erosion to form a window into the lower aquifer through which the waters moved. Movement is toward one of several deep basins in the top of the basalt bedrock -- basins which bottom at or below sea level and from which preliminary evidence suggests the exchange of water with shallower ground waters may be extremely slow. It is hoped that geophysical seismic techniques will trace the clay and silt beds capping the aquifer and similarly define the form of the basin in the basalt such that necessary monitoring wells can be most advantageously located. The depth to basalt in these locations (400 to 800 feet) precludes the routine use of slow and laborious churn drilling techniques for the determination of the structures at these depths.

At month's end the Atomic Energy Commission was preparing to negotiate with Geophysical Services, Inc. of Dallas, Texas for the planned two to three month geophysical seismic evaluation survey. Final awarding of the contract may be delayed by budget limitations.

Process Development

Batch equilibrium tests were conducted to investigate the possibility of using cation exchange resins as a method for removing the "critical" radioisotopes from low activity, low salt, condensate wastes. Radiochemical analyses of A-8 waste (Purex tank farm condensate) indicated that Sr^{90} probably would be the limiting radioisotope in its disposal. Accordingly, distribution coefficients were measured for Sr^{90} in A-8 waste for five different resins. The measured distribution coefficients started at about 2100 with Amberlite IRC-50 and increased in the order Duolite C-25, Amberlite IRC-50, Amberlite IR-100, Amberlite IR-120, to approximately 10,400 for Duolite C-3. These distribution coefficients indicated a relatively high affinity of all of the resins for Sr^{90}. Experiments were planned to determine the capacity of a Duolite C-3 resin column for Sr^{90} in A-8 waste, since the feasibility of using resins to decontaminate A-8 waste is dependent to a large extent on the ability of the resins to compete on an economic basis with the present method of disposal to underground cribs.

The investigation of the mechanism of the reactions of ruthenium with silica and alumina surfaces was continued. A series of experiments in which ruthenium tetraoxide solutions was equilibrated with activated alumina indicated that reproducibility of the results was a function of the contamination of the alumina surface rather than the time of equilibrium. A longer outgassing period at higher temperature was proposed as a corrective measure.

Gelling of Wastes - Field Work

The program for field work was scheduled for the approaching spring and summer and tentative selection was made of sites and equipment to conduct the test.

INSTRUMENT DEVELOPMENT

Iodine Monitor

Additional gamma energy spectra of Purex "C" Cell dissolver off-gas were obtained in an attempt to identify the 0.5 mev. gamma emitter previously observed during metal dissolution under conditions requiring the most sensitive setting on the monitor to observe the iodine activity. The "C" Cell dissolver heel was removed in early February and the dissolver loaded with fresh metal. Gamma energy scans were then obtained as this metal was dejacketed and dissolved. During dejacketing there was no activity above background at any energy level. During metal dissolution, peaks were observed at 0.36 and 0.50 mev. An air purge of the sample cell would immediately lower these peaks by factors of 1.5 and 10, respectively, i.e., to background, confirming that both contributors were in the off-gas and not appreciably adhering to the sample cell walls. These observations strengthen the conclusion that the 0.5 mev. emitter is Kr^{85}.

Contact Alpha Counter

A contact alpha counter cell employing a small phosphor area in the central portion of the open cell has been laboratory tested. With Task I supernate solutions it was confirmed that satisfactory counting rates for low activity streams (0.24 g/l) could be obtained after passage of high activity streams (6 g/l) without flushing between samples. One acid flush (1 M HNO_3) returned the counting rate to background.

Photometer Development

Efforts to standardize the flow cell have shown that two types of cells will be required, one for sample streams containing little or no air (Redox samples), and one, a self-degassing unit, for sample streams containing an appreciable percentage of air (Purex air lift assisted samples).

The ruggedness and tube-to-tube reproducibility of the 1P-42 phototube has been improved by casting the tube in the shell of an An series amphenol line connector. The phototube assembly fabricated in this manner serves as a rugged detector that is easily installed and replaced.

The sensitivity of the photometer to dichromate has been improved by using an interference filter that passes light with a wave length of 510 millimicrons, in place of the previously used 490 millimicrons filter.

EQUIPMENT DEVELOPMENT

Titanium Tube Heat Exchanger Prototype

Testing of the titanium tube heat exchanger was completed. The tests consisted of thermal cycling and boiling of concentrated nitric acid. Weekly dye penetrant examination and pressure testing of both the shell and tube sides did not disclose any cracks or leaks. The unit was also tested for leaks with the helium leak detector. No leaks were found. The unit is now available for in-plant prototype testing.

Deepwell Turbine Pumps, Redox F-1 Tank

The deepwell turbine pumps installed in the Redox F-1 tank (Redox Flowsheet No. 5 LAFS solution, feed to the extraction column of the partition cycle) have failed after 3 to 75 days operation during the past ten months. Recent seal studies failed to develop any cause for the failures. As a follow up, a pump equipped with glass bearings was put on test pumping simulated LAFS solution. Within ten minutes severe foaming was apparent. The foam extended about eight feet above the surface of the liquid and was expelled from the vessel vent. Although presence of foam in the Redox F-1 tank has not been demonstrated, foaming in the F-2 concentrator, which precedes the F-1 tank, does give trouble unless a foam depressant is added.

The addition of 100 times the amount of "Nonisol" (a foam depressant) used in the plant F-2 concentrator did not eliminate foaming of the simulated LAFS solution. Several variables remain to be examined before it can be concluded that foaming and not seal failure is the primary problem in the F-1 tank. At this time, it appears that foaming may exist. This coupled with poor sealing of the tank openings, agitator, pump, etc., would explain the leakage observed from the F-1 tank.

Redox D-14 Pump

A deepwell turbine pump which failed because of shaft seizure at the liquid throttle bushing has been dismantled by Chemical Processing Department personnel. A section of the shaft that operated in the liquid throttle bushing has been examined macroscopically, microscopically, and spectrographically by Radiometallurgy personnel. Minor corrosion of the stainless steel and faint scratches on the surface were noted. The foreign material that had built up on the shaft contained more than one per cent lead as well as elements contained in solution in proportion with the solution content.

Aveco Three-way Packless Valves, Air Operated

The valves purchased for the Purex Plant moving-bed ion-exchange contactor have given trouble during operability tests. The top works (air operators) fabricated at HAPO contained weak duck-reinforced neoprene diaphragms. In some cases, this did not seal on the periphery. A phonograph finish on the sealing faces of the operator body corrected the latter.

In addition, the bodies fabricated by AVECO contained three potential stainless to stainless contact areas. These proved to be troublesome when galling occurred.

By making one of the surfaces of plastic (Polyethylene, Kel-F, etc.) this source of trouble should be eliminated. A valve modified to eliminate all known causes of malfunction is on test and operating satisfactory. The remaining valves are now being modified.

Continuous Calciner Rotary Feeder Valve

A vane-type rotor (Drawing SK-2-43229) with 5-mil-thick Elgiloy (Elgin Watch Company) vanes was fabricated for the 3-inch experimental rotary valve, K-Cell, 224-UA Building. Installation is awaiting shutdown of the K-Cell calciner.

The solid-body stainless steel rotor continues to operate satisfactorily with 10-mil radial clearance, except for plugging of the inlet by lumps of uranium trioxide, which presumably form in the collection bin due to water vapor. The valve body was altered to change to inlet opening from a one-by-two inch slot to a 2-inch-diameter hole. No plugging has been reported since startup February 19.

Slug Handling

A reciprocating slug feeder, which was built to develop data required for designing equipment to feed randomly-dumped cylindrical slugs from a vertical hopper, operated at 90 to 70 per cent efficiencies (slugs delivered vs. tube strokes) with a slug to tube diameter ratio of about 0.6, 5 to 10 tube stroke/minute using 1-1/4 inch diameter x 8-inch long slugs. In comparison, the efficiency was above 95 per cent with a diameter ratio of 0.55. Studies of nonjamming hopper geometries and optimum diameter ratios will continue.

Materials of Construction

Polystyrene. Amphenol connector insulators were tested by static immersion at room temperature in Purex HAX and 2.2 M nitric acid. After 42 days immersion, there was no dimension change in either sample. In HAX, the material increased 0.25 per cent in weight. Several internal cracks were noted. The material yellowed slightly in the nitric acid.

Color-Plast. A gasket and shim material manufactured by General Gasket, Incorporated, was tested by static immersion at room temperature for 30 days in various solutions. The results are tabulated below:

Solution	Results
60% Nitric Acid	Failed - 3 hours
50% Caustic Soda	Swelled 100% - lost strength
Carbon Tetrachloride	No Change
Recuplex CAX	Hardened, failed
Purex HAX	Hardened, failed
Hexone	Swelled 30% - softened
Distilled Water	No Change.

A sample of this material was bolted between flanges. The bolts were torqued to 35 foot pounds. After 30 days the bolt torque was 32 foot pounds and there was no measurable change in the thickness of the material.

Mylar. A polyester film manufactured by the duPont Company was tested by static immersion at room temperature for 28 days. The results are tabulated below:

Solution	Results
60% Nitric Acid	Failed - no strength
50% Caustic Soda	Dissolved - 12 days
Carbon Tetrachloride	No Change
Purex HAX	No Change
Hexone	No Change
Distilled Water	No Change.

Tygon. A Hills-McCanna valve diaphragm, purchased for use in the Purex Plant was tested by static immersion at room temperature for 28 days. The original hardness of the diaphragm was 70 durometer "A".

Solution	Dimension Change, %	Final Hardness
60% Nitric Acid	- 6	100
50% Caustic Soda	0	70
Carbon Tetrachloride	- 10	92
Recuplex CAX	0	70
Purex HAX	- 6	92
Hexone	Failed after 8 hours	
Distilled Water	- 6	70.

Corrosion Studies

Iodide Inhibition of Corrosion. It has been reported (GEL Report No. 57-GL-30, C. E. Michelson) that the presence of iodide ion may greatly reduce corrosion of stainless steels by HCl, HF, and H_2SO_4. A series of exposures of 304 L and 347 stainless steels and A-55 titanium was made to 20 per cent HNO_3-3 per cent HF and to 0.5, 6, 12, and 18 M H_2SO_4 with and without 0.1 M iodide. The tests were made at atmospheric boiling temperature. No significant reduction in corrosion due to iodide ion was observed. The presence of iodide appear to accelerate corrosion of titanium in HNO_3-HF solution.

UO_3 CONVERSION

UO_3 Studies

Further reaction characteristics of the oxides of uranium were studied by observing the course of reaction of an oxide bed open to a reactant gas at the upper surface only. Two significant observations were made:

1. As reaction proceeds, a dark blue band, probably U_4O_9, forms and moves down the tube, forming an interface between the initial material and the reaction product. The band formed whether UO_2 was being oxidized with oxygen or U_3O_8 was being reduced with hydrogen.

2. The reduction of UO_3 to UO_2 at temperatures above decomposition point of the former apparently does not begin until the entire bed has been converted to U_3O_8.

Apparently oxygen produced in the low portion of the bed inhibits the reaction, either by displacing hydrogen or by reoxidizing UO_2 if it is formed.

This effect pointed up a noticeable difference in samples of pot calcined and continuous calcined powders. Under comparable conditions, UO_2 appeared in the pot-calcined powder eleven minutes after hydrogen flow was begun; with the continuously calcined material, twenty-seven minutes elapsed, thus indicating another mechanism possibly responsible for the difference in behavior of the two types of UO_3.

HOT SEMIWORKS MAINTENANCE ACTIVITIES

The major portion of the stainless steel floor work in A Cell was completed. Inspection, testing, and wall-cover-skirt (a secondary seal to prevent leakage of hot solution under the floor) work is now starting.

Replacement of Teflon with Teflon Flexitallic gaskets is 85 per cent completed. Welding of process lines is 65 per cent completed. The over-all maintenance effort required to place the semiworks in standby condition is 65 to 70 per cent finished.

In B Cell, eight out of nine pulsers have now been installed with graphite pistons. B Cell work is 90 per cent completed.

On February 25, the shift schedule at the Hot Semiworks was changed from "days-and-swing" to "straight days". The remaining work will be completed on this basis.

4000 PROGRAM - REACTOR DEVELOPMENT

Purification of Plutonium from PRPR Fuels

Studies have been initiated to explore the feasibility of recovering and purifying plutonium from PRPR fuels by solvent extraction with solutions of thenoyl trifluoracetone ("TTA").

Study of the literature together with experimental studies completed during the report period disclose the following factors which must be considered in designing a flowsheet for this operation.

1. The solubility of the plutonium(IV) TTA complex in benzene is low (0.012 M). In order to avoid precipitation of the plutonium complex and still maintain a small scale and low solvent inventory in the extraction step it is necessary to hold the TTA concentration in the solvent to something less than 0.05 molar.

2. The efficiency of extraction of plutonium(IV) is improved by reduced acidity. An acidity of 0.2 M HNO_3 or less is then desirable in the uranium-containing feed to the extraction step.

3. Plutonium must be adjusted to Pu(IV) to assure satisfactory extraction. Reduction with ferrous sulfamate followed by addition of nitrite may be used to adjust the oxidation state of the plutonium but has the disadvantage that ferric ion forms a fairly stable complex (stability constant of about 3×10^3) with TTA and thus hinders plutonium extraction by depleting the TTA.

4. Rates of transfer are slow for both the extraction step and the stripping step, especially the latter. The rate of stripping depends not only on efficiency of agitation and temperature but is quite sensitive to acidity and TTA concentration. With fairly vigorous agitation, times of the order of two hours may be required to strip more than 99 per cent of the plutonium into 0.50 M HNO_3, 0.03 M Fe^{++}. The time cycle for the stripping operation may be reduced by a factor of four or five (and made about equal to the time cycle for a suitable extraction step) by stripping into 3 M HNO_3, 0.03 M Fe^{++} instead of 0.5 M HNO_3, 0.03 M Fe^{++}. Under this condition a concentration factor of about five can be effected without significantly decreased decontamination or increased waste loss, and semi-continuous equipment of small scale is feasible.

5. Gamma decontamination in a batch TTA cycle appears to be limited by zirconium and niobium. Zirconium is the most readily extracted species in the feed and should in theory be readily separated by stripping plutonium as plutonium(III) out of a TTA extract and into a low acid aqueous phase out of which zirconium would be highly extractable. However, the kinetics of the plutonium stripping operation allow sufficient time for growth of appreciable amounts of niobium, which follows plutonium in the stripping step. Over and above this effect, however, conditions necessary for extraction of greater than 99 per cent of the plutonium(IV) result in extraction of about three per cent of the niobium. If the plutonium stripping operation is expedited by increasing the acidity then both niobium and zirconium follow plutonium to an appreciable extent in both the extraction and stripping steps. Gamma decontamination factors have ranged from 80 to 300 for single batch cycles employing stripping into 0.5 M HNO_3. A gamma decontamination factor of 50 to 100 appears feasible with a shorter time cycle by stripping into 3 M nitric acid.

The simplest overall aqueous processing scheme presently envisioned for PRPR fuels would employ a single batch cycle of TTA extraction to separate plutonium from uranium and to remove the bulk of the fission products (gamma df in the range 50 to 100). The product from this step would then be processed through an anion exchange step in which hopefully a high degree of purification could be accomplished.

It is planned to test this concept in the near future. A major area of uncertainty in the TTA extraction cycle is the radiation stability of TTA, a topic scheduled for experimental investigation in the near future.

Impregnated Graphite Fuel Element

Scouting work has begun with the goal of developing a readily processed plutonium bearing graphite fuel material. The most promising approach to date involves the evacuation of a machined pile graphite shape, immersion in a uranyl nitrate solution (a stand-in for plutonium nitrate), application of atmospheric pressure, draining, rinsing, drying, and heating to convert the absorbed uranyl salt to oxide. A loading of 220 mg U/cc was obtained by this technique, and no dimensional distortion was observed in the 3/8 inch cylinders used either during impregnations or after heating to 600 C. Uranium was leached from impregnated graphite, which had been heated to 600 C, by concentrated nitric acid, but at present the extent of recovery is unknown. The simple operations employed in this procedure, the fact that forming or machining may be done on pure uncontaminated graphite, and the attainment of concentration in the 200 mg U/cc range are all very encouraging findings.

UO_2 Improvement Studies - Ceramic Fuels

In the development of ceramic fuels, variation in the Mallinckrodt AEC-grade UO_2 has resulted in an ultimate UO_2 fuel material varying in density from 85 to 95 per cent of the theoretical value. Experience in the Ceramic Fuel Development Operation has shown a correlation between surface area and good sintering characteristics, i.e., high densities. In general, if the surface area of the UO_2 is in the range 1 to 3 m^2/g, a satisfactory density is achieved. Previously reported work (HW-47943 C), on HAPO UO_3 product, has shown that UO_2 which undergoes oxidation to U_3O_8 followed by reduction again to UO_2 develops increased surface area which is believed due to the disruption of aggregates. Initial tests with AEC grade material disclosed similar behavior; the surface area increasing from 0.65 m^2/g to 1.58 m^2/g when the powder was oxidized at 500 C and reduced again at 650 C in a tube furnace. Since it is possible that the aggregates exhibiting low surface area are responsible for the lower densities of the sintered UO_2, 35 pounds of AEC grade UO_2 is being subjected to an oxidation-reduction cycle in a fluidized bed reactor to determine whether this procedure will produce a uniform product capable of forming a high density fuel material.

D_2O - Purification

The study of methods for light water removal from heavy water in the PRPR system was completed. A rough draft report covering the comparison of the distillation and electrolytic methods was prepared. The economic features of this study are shown to be as follows:

Method	Project Cost	Out of Pocket Annual Savings	Payout Period
Distillation	$100,000	$ 83,700	1.19 years
Electrolysis	$132,500	$114,000	1.16 years

The study of the separations plant and facilities required for the PRPR program was continued. The scope for the feed cell and related equipment was completed. Flowsheets for the remainder of the separations facility were well along toward completion.

6000 PROGRAM - BIOLOGY AND MEDICINE

On February 8 new programming was started for calculating environmental monitoring data. Costs were reduced 40 per cent. The change was made possible with the installation of an improved memory circuit in the IBM 702 computer.

Effective February 23 routine I-131 vegetation values were increased by a factor of three. Examinations continued to show that the separation method recovers only one-third of I-131 on vegetation. Chemical Research and Analytical Laboratories will redetermine the factor each month or at slightly longer intervals to insure sufficient iodine activity for valid comparative measurements.

Zn^{65} Analysis

The gamma emitting isotope content of two employees was determined by multichannel gamma spectrometry. In addition to K^{40}, which is a naturally occurring radioisotope,

and Cs^{137}, which is present in all personnel as a result of bomb debris contamination of food materials, about 5000 d/m of Zn^{65} was measured in one of the men. This man is apparently exposed to Zn^{65} contamination through the sanitary water at 100-F Area which is derived from the Columbia River and is contaminated by the reactor effluent water from reactors farther up the river. Samples of both raw and sanitary water were analyzed for nine isotopes by multichannel gamma spectrometry and beta absorption counting. The results are tabulated below together with similar values for raw river water at Clover Island in Kennewick.

The concentration of Zn^{65} in the sanitary water at F Area is roughly the same as at D and H Areas and the Columbia River at Kennewick, and about four times that of the Columbia River at Portland. This means that by total body counting Zn^{65} will probably be detected in all persons in F, D, and H Areas, and in all persons downstream using Columbia River water under conditions where Zn^{65} is not specially removed by the water treatment process.

TABLE II

ANALYSIS OF RAW AND SANITARY WATER

Sample		Radioisotope (in units of $\mu c/ml \times 10^{-8}$)								
Location	Type	Na^{24}	P^{32}	Sc^{46}	Cr^{51}	Cu^{64}	Zn^{65}	As^{76}	Ba^{140}	Np^{239}
183 KW	Raw	2.7	1.6	--	16	5.4	0.7	10	--	5.7
	Sanitary	2.1	4.9	--	99	7.7	4.1	18	--	4.2
183 KE	Raw	0.87	1.8	--	12	1.6	0.7	0	--	4.3
	Sanitary	0.44	1.7	--	6.4	8.1	2.1	0	--	5.7
183 D	Raw	141	7.5	1.3	88	179	4.3	90	--	90
	Sanitary	106	1.4	0.18	91	41	7.0	8.7	--	103
183 H	Raw	317	13	1.4	186	320	17	195	16	250
	Sanitary	143	4.4	1.2	656	33	14	11	9.2	308
183 F	Raw	350	18	2.5	354	376	16	222	38	313
	Sanitary	240	3.5	1.2	365	70	15	12	12	327
200 W	Sanitary	0.08	--	--	45	2.9	--	6.5	--	1.0
Columbia River (Clover Island)		106	12	1.1	304	100	10.7	--	--	232

Reactor Effluent Studies

Fe^{59} was determined in selected cross-header water samples taken from H reactor. Samples taken from a header containing one-half tube load of M-388 clad slugs showed an Fe^{59} activity from two to three times that observed on samples taken from an adjacent header containing regular slugs. This suggests that for a full load of M-388 clad slugs the Fe^{59} concentration in the reactor effluent water might be increased to as much as two to three hundred times the present value of about 1×10^{6} $\mu c/ml$.

Dosimetry

The radiation-protective action of three alcohols, ethanol, isopropanol, and t-butanol was compared by means of their effects on the radiation-induced decomposition of erioglaucine in dilute aqueous solution. Although these alcohols were tested previously, the new measurements were made with much purer reagents, and the results were analyzed statistically to ascertain the degree of confidence to place in them. The results were interpreted in terms of a mechanism involving competition between erioglaucine and its decomposition product and the alcohols and their decomposition products for HO_2 radicals produced by the irradiation of the water which makes up the bulk of the solution. The competitive steps in this mechanism were assumed to involve simple second order reactions, and the measure of the degree of protection was taken as the ratio of the rate constant for the alcohol-radical reaction to the rate constant for the erioglaucine-radical reaction. The higher this ratio the more effective the protector, and the values for the three alcohols were:

Ethanol	0.125 ± 0.010
Isopropanol	0.098 ± 0.013
t-butanol	0.026 ± 0.012

Since the rate constants themselves are independent of concentration of protector, the validity of the mechanism is tested by the variation of the above ratios with protector concentration. These ratios were found to be constant over the concentration range of 1×10^{-5} to 5×10^{-4} M alcohol within the 95 per cent confidence limits given above, lending support to the mechanism proposed.

Geochemical and Geophysical Research

Continuing regional geological studies have outlined deep basins on the surface of the basalt; several aquifers within the lowermost Ringold formation are similarly downwarped with the basalt and are overlain by two clay beds, aggregating up to more than several hundred feet in thickness. Laterally these clay beds apparently thicken still more and this results at least locally in the pinching out of the aquifers. Very incomplete data suggest a slow exchange of water in these aquifers with the shallower ground waters and thus the potential storage of selected wastes in these horizons by displacement of the existing water there. Disposal by such methods is similar to the "disposal-at-great-depth" concept but at shallower depths (up to 800 feet) which would simplify the monitoring well requirements and the determination of the inadequately known geologic conditions.

Mineralogical determinations by the U.S. Geological Survey on selected samples from various local strata disclosed significant differences that may be useful in stratigraphic determinations as well as in predicting the effects on waste solutions. Specifically the samples of post-Ringold sediments (fluviatile gravels, Palouse soil, Touchet sediments) contained less montmorillonite but more kaolinite, chlorite, quartz and feldspar than the Ringold sediments, which were similarly lower in montmorillonite but higher in quartz, kaolinite, chlorite and feldspar than the Ellensburg sediments. The ion-exchange capacity was also shown to be rather directly related to the montmorillonite content of the samples.

The silt and clay bed 100 feet beneath 200 West Area was further verified to be a wind deposited soil equivalent to the Palouse on the basis of high quartz,

calcite, mica and chlorite content. It's exchange capacity is accordingly low. The differentiation of the post-basalt sediments into the currently used divisions, in turn based on the concept of a deformed Ringold formation, was validated.

The U.S. Geological Survey, owing to the need for wells at the 216-BC site, are 600 feet behind schedule on the CA-700 project (FY-1957 work). A continuous rate of 550 feet per month is necessary to complete their part of the project by July 1, 1957.

Geology and Hydrology

A more sensitive analytical procedure for fluorescein in ground water was developed by others and was applied to the analysis of samples of ground water collected in August and September, 1956, during a ground water tracer test southeast of 200 East Area. On the basis of these analyses, fluorescein was detected in a well 8800 feet SSW of the well spiked with fluorescein dye 28 days after injecting it into the ground water. The observed movement represents an average velocity through this region of 350 ft/day. A 95 per cent confidence is ascribed to the analytical results.

Soil Chemistry

Previous work on the removal of Ce isotopes by Hanford soils is being reviewed and supplemented. The removal of Ce by soils differs from the removal of Sr and Cs in that it appears to be almost independent of the cation exchange capacity of the soils. The removal exhibits a very marked dependence on pH, exceeding 97 per cent for all soils tested when the pH is greater than 4.1 and for a wide range of Ce concentrations. It is hypothesized that the removal results from a precipitation of the cerium at higher pH followed by filtration on the soil.

Mineralogical analyses of the clay fraction of Hanford soil samples is of value in developing basic information for predicting disposal site capacities and identifying geologic strata. Initial tests to evaluate clay mineral composition were started. Preliminary results indicated that the material of less than 1 micron size is primarily montmorillinite. This may indicate the presence of zeolites in the finest fraction of this particular soil.

Initial experimental data indicated that Turco 4306 B (a decontaminating agent) inhibited the adsorption by soil of Sr^{90} in Uranium Recovery Plant scavenged waste and probably even desorbed some of the Sr^{90} from sludge that was associated with the waste. Experiments were planned to obtain more information regarding the effect of this agent on sludge and particularly on 107 Basin sludge which will be contacted by reactor effluent containing this agent following its use to decontaminate the rear face of the reactors.

The measurement of equilibrium distribution coefficients for Cs^{137} and Sr^{90} in a mixture of distilled water and a standard soil gave values of 50.5 ± 5.7 for Sr^{90} and 460.2 ± 40.2 for Cs^{137} at an equilibrium pH of 8.3. These values will be used as a standard to evaluate the adsorption characteristics of Cs^{137} and Sr^{90} in various waste solutions.

Gelling of Wastes

Gel formed by reacting sodium aluminate with sodium silicate was dried to constant weight at 105 C, the loss in weight corresponded to about 34 moles of H_2O per mole

[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 & Buildings Visited
Wm. E. Froemming	2/6-7,13/	U.S. Air Force	Participant in AFSWP Training Program	DW Rhodes HL Brandt KC Knoll LC Schwendiman WN Koop WA Haney HG Rieck JR Raymond	Yes	222-U, 200-W; 325, 300 Area
C. R. McFarland	2/14/	Knolls Atomic Power Laboratory, Schenectady, N.Y.	Discussion of information concerning KAPL-31 and general analytical data.	R Ko DM Robertson FE Holt HJ Anderson	No	325, 300 Area
R. D. Pierce G. Winder E. K. Burkholder	2/18-20/	Babcock & Wilcox Co. Lynchburg, Va.	Review chemical, mechanical & process features of separations plants & R&D efforts.	CA Rohrmann HE Hanthorn	Yes	325, 326, 327, 306, 300 Area
			Discuss remote mechanical handling techniques.	OF Hill RJ Sloat JG Bradley RE Burns	Yes	326, 300 Area; 222-S, 200-W
J. L. Culbertson	2/20/57	Dept. of Chemistry State College of Washington, Pullman, Wash.	To consult with Mr. Ewing regarding thesis work for a PhD degree.	RE Ewing	No	329, 300
R. D. Rowe	2/20/	General Machinery Co. Spokane, Washington	Pump consultations.	AE Smith J Dunn	Yes	3706, 300
H. B. Coates Dr. Baczuoski	2/20-22/	Blaw-Knox Company Pittsburgh, Pa.	Review separation processes & Development items.	CA Rohrmann	Yes	326, 300
			Consultation on chemical processing.	MT Walling	Yes	325, [redacted]

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Buildings Visited
K. L. Rohde	2/26-28/	Phillips Petroleum Idaho Falls, Idaho	Consultation on equipment and process problems.	OF Hill RJ Sloat RG Geier AE Smith	Yes	326, 328, 300 Area
			Discussions on ruthenium & zirconium chemistry & acid recovery.	MT Walling LL Burger AS Wilson WH Reas	Yes	325, 300
H. B. Coates Dr. Baczuoski	2/20-22/	Blaw-Knox Company Pittsburgh, Pa.	Purex Process and related technology.	RJ Sloat GJ Alkire AE Smith RG Geier	Yes	326, 300; 2704-C, 200-E

VISITS TO OTHER INSTALLATIONS

H. T. Norton	2/2-5/	General Electric Philadelphia, Pa.	Computer discussions.	CK Schoults Mr. Friehm E Fullenwilder	No	
W. W. Marshall	2/8-28/	Oak Ridge National Lab. Oak Ridge, Tennessee	Participation in Oak Ridge AEC Document Declassification Program and technical consultation & inspection of facilities.	C Feldman	Yes	
E. W. Christopherson	2/18/	Pacific Lutheran College Tacoma, Washington	Recruiting of personnel.		No	
A. E. Smith	2/19/	Whitman College & Walla Walla College Walla Walla, Wash.	Recruiting of personnel		No	
H. G. Rieck	2/20-23/	Radiation Instrument Development Laboratory Chicago, Illinois	Attend orientation sessions in theory, use & maintenance of 100-channel pulse height analyzer.	LJ Harzer Jay Wolf	No	

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Buildings Visited
R. W. Wirta	2/25-26/	Los Alamos Scientific Laboratory, Los Alamos, N. M.	Consult on RaLa equipment & equipment developments - application to fission product development.	John Schulte RD Baker	Yes	
	2/27-28/	Idaho Falls Operation Office, Idaho Falls, Idaho	Consult on RaLa equipment & equipment developments - application to fission product development.	JL Schwennesen	Yes	

BIOLOGY OPERATION MONTHLY REPORT - FEBRUARY 1957

A. Organization and Personnel

No major or significant items relating to personnel changes or personnel activities occurred during February 1957.

B. Technical Activities

4. Biology and Medicine - 6000 Program

BIOLOGICAL MONITORING

Samples of terrestrial and aquatic organisms are routinely collected and assayed for radioactive contaminants released to the atmosphere, impoundments, and the Columbia River.

Atmospheric Contamination

Concentrations of I^{131} in the thyroid glands of rabbits are tabulated below in decreasing order:

Collection Site	$\mu c\ I^{131}/g$ thyroid Average	$\mu c\ I^{131}/g$ thyroid Maximum	Trend Factor
1 mile SE of Redox	5×10^{-2}	7×10^{-2}	-
West of 200 West Area	1×10^{-2}	2×10^{-2}	- 3
Meteorology Tower	6×10^{-3}	1×10^{-2}	-
East of 200 East Area	5×10^{-3}	9×10^{-3}	- 2
4 miles SW of Redox	3×10^{-3}	6×10^{-3}	- 7
Prosser Barricade	2×10^{-3}	5×10^{-3}	- 4
100-B Area	1×10^{-3}	2×10^{-3}	- 4
6 miles SE of Redox	5×10^{-3}	1×10^{-2}	- *
Route 2S, mile 3	3×10^{-3}	4×10^{-3}	- *
Wahluke Slope, ENE	1×10^{-3}	1×10^{-3}	- 3*
Wahluke Slope, N	6×10^{-4}	1×10^{-3}	- 3*

* The last four trend factors compare values with December rather than January because corresponding collections are made bimonthly.

Contamination levels are twice those of one year ago.

Fallout debris, presumably of off-Plant origin, was present in rabbit tissues and feces in the following concentrations:

Sample Type	μc FP's/g sample Average	Trend Factor
Bone	3×10^{-5}	-
Feces	5×10^{-5}	-
Liver	6×10^{-6}	-

Swamp Contamination

Fission products were present in tissues of migrant waterfowl at the 221-U swamp in the following concentrations:

Sample Type	μc FP's/g tissue Average	Maximum	Trend Factor
Coots			
Bone	1×10^{-3}	1×10^{-3}	+ 3*
Soft tissue	6×10^{-4}	7×10^{-4}	+ 2*
Diving ducks			
Bone	1×10^{-3}	2×10^{-3}	+ 2
Soft tissue	8×10^{-4}	1×10^{-3}	-
Puddle ducks			
Bone	2×10^{-3}	5×10^{-3}	+ 4
Soft tissue	4×10^{-4}	1×10^{-3}	-

* Trend factors for coot tissues are compared with December values rather than January, because coots were not frequenting the swamp at that time.

Current contamination of bone is one-tenth that of February 1956; soft tissue contamination is one-third of 1956 values.

Columbia River Contamination

The contamination levels for beta emitters in representative aquatic forms and in waterfowl for February are shown in the following table. With the exception of plankton, virtually all of the activity is from P^{32}.

Sample Type	Collection Site	μc beta emitters/g tissue Average	Maximum	Trend Factor
Plankton	Hanford	8×10^{-2}	1×10^{-1}	+ 2
Caddis larvae	"	4×10^{-3}	5×10^{-3}	-
Minnows	"	6×10^{-4}	2×10^{-3}	- 2
Whitefish*	"	4×10^{-5}	7×10^{-5}	- 5
	Priest Rapids	7×10^{-6}	3×10^{-5}	+ 2
	Ringold	(Not sampled this month)		
Diving ducks*	Hanford	2×10^{-3}	4×10^{-3}	-
Puddle ducks*	"	5×10^{-4}	8×10^{-4}	-
Gulls*	"	8×10^{-5}	2×10^{-4}	-
Mergansers*	"	4×10^{-5}	7×10^{-5}	- 3
Herons*	"	3×10^{-5}	3×10^{-5}	- 3

* Values are for flesh. Concentrations in bone are about ten times higher for fish and three times higher for waterfowl.

The concentration of radioactive materials in plankton has usually been at near the maximum for the year during February. The level reached this month is the highest ever recorded, however. The usual seasonal decline occurred in other river organisms. The apparent increase above background for whitefish at Priest Rapids resulted from the presence of a few individuals which had moved upriver from the project. The contamination level in small fish collected below the reactors and in waterfowl was about three times greater than one year ago. The level in whitefish was about the same as one year ago.

Effects of Reactor Effluent on Aquatic Organisms

Fingerling-size (one-year-old) whitefish have been unaffected by reactor effluent in concentrations as high as 8 per cent, while winter temperatures have prevailed. Survival of chinook salmon fry was not affected by exposure to 4 per cent strength effluent from the 105-KE reactor.

Survival of whitefish eggs has been substantially reduced at temperatures 2 C and 3 C above the average for the Columbia River.

"Turco", a commercial compound containing fluoride, which is under consideration as a decontaminant for reactor tubing, was tested for acute toxicity to young salmon. The fish tolerated 75 ppm of the commercial compound for 7 hours, but died within a few minutes at a concentration of 750 ppm. The fish readily detected a concentration of about 200 ppm and avoided the solution.

Analyses of algae and diatoms which were scraped from rocks after exposure to effluent containing debris from a ruptured fuel element indicated the presence of about equal amounts of rare earths, Sr^{89-90}, and P^{32}, and much smaller quantities of Cs^{137}, Zr^{95}-Nb^{95}, and Ru^{106}.

METABOLISM AND TOXICITY OF RADIOACTIVE MATERIALS

Reactor Effluent

Presence of Zn^{65} in rats continuously maintained on 30-fold concentrated reactor effluent for 347 days was confirmed by analyses of a second rat. The average Zn^{65} content of bone was $6.2\ 10^{-4}$ μc per gram. This figure is in close agreement with the concentration which would be predicted from the estimated Zn^{65} concentration in reactor effluent and reasonable assumptions of metabolic parameters.

In continuing studies of P^{32} absorption from reactor effluent, groups of rats were fed P^{32} added to the effluent before and after concentration, P^{32} added to unconcentrated effluent, and P^{32} in ordinary water. The bone deposition of P^{32} from these various solutions was not significantly different, indicating quite clearly that absorption of P^{32} is not appreciably affected by the presence of reactor effluent or by the process of concentration. Preliminary results suggest that the low P^{32} absorption indicated by P^{32} buildup in the animals maintained for one year on concentrated reactor effluent may have been due to the advanced age of the animals by the end of the experiment. P^{32} absorption and deposition in bone of year-old rats was 4.7 per cent of administered doses which is lower by a factor of 3 than P^{32} bone deposition measured in young animals, but still higher by a factor of 2 to 3 than the apparent absorption in the chronic reactor effluent feeding experiment.

Plutonium

Epinephrine administered intravenously was shown to be without effect on the deposition in liver of simultaneously administered plutonium.

Thirty rats were injected with plutonium intraperitoneally, and will be held for studies on the removal of plutonium by chronic treatment with EDTA, zirconium citrate, and combinations of the two. Progress was made on the determination of the best experimental conditions for studying the removal of plutonium from the lung by intrapulmonary EDTA administration.

The radiochemical analysis results on the blood from the three miniature pigs intratracheally injected with a soluble plutonium solution showed that plutonium was detectable within one hour after administration. Peak blood concentrations were obtained at about seven hours after dosing and represented 0.06 per cent of the administered dose in the blood. One hour after the dose, about 10^{-5} per cent was in the blood.

Ruthenium

Cortisone, growth hormone, and EDTA were shown to be without statistically significant effect on the deposition of Ru^{106} in liver.

Iodine

No change in thyroid function has been observed in any of the groups of swine fed I^{131} daily for over three months. During this period of time the thyroid glands of the group fed 45 μc/day were exposed to an estimated 7,000 rads.

In a short-term tracer study designed to test the applicability of the swine scintillation detector for sheep thyroid monitoring, a 100 μc tracer dose was administered to each of three lambs. The earliest time at which I^{131} was detected in the thyroid was one hour after feeding. The thyroid uptake for the entire course of the tracer dose was readily detected using the scintillation detector.

Frequent determinations made on blood concentrations showed that I^{131} was detectable one-half hour after feeding. The effective half-life for I^{131} in the blood after the first day was about seven days, although day to day values showed considerable variation.

Just before sacrifice another 100 μc tracer dose was administered in order to furnish conversion-factor data for future in vivo thyroid monitoring. Values found by the scintillation detector agreed with radiochemical analysis values to within 4 per cent.

Radioactive Particles

Inhalation by mice of $Ru^{106}O_2$ aerosol resulted in retention of 12 per cent in the lung and 67 per cent in the gut immediately after exposure. These values agree remarkably well with those assumed by the International Commission on Radiological Protection for insoluble particles.

Based on these data and 400-day pulmonary turnover of intratracheally administered $Ru^{106}O_2$ to mice, the concentration of $Ru^{106}O_2$ (particle size 0.01 - 3 microns) in air that at equilibrium will result in an average dose rate of 0.3 rem/week to the lung is 5×10^{-9} μc/cc and to the lower large intestine is 1.8×10^{-8} μc/cc. This extrapolation of data from mouse to man is on the basis of a difference in organ weight and does not allow for differences in physiology.

Preliminary experiments employing a new vertical exposure chamber have been completed, testing two types of particle aspirators and the introduction of $Ru^{106}O_2$ dust with a pistol. Because of the apparent success of this type chamber, fabrication of an identical one and a new glove box for plutonium exposures is being completed.

Investigation of a questionable but consistent initial fluctuation in lung burden after exposure to radioactive aerosols was continued with the exposure of sixty-eight BAF_1 mice to 25 μc $Ru^{106}O_2$ dust. The mice were "scanned" in the mouse counter and sacrificed periodically for radiochemical analysis of lungs and other organs.

[redacted] [redacted]

Twenty-eight mice exposed approximately one year ago to $Ru^{106}O_2$ as a hydrosol were sacrificed and their lungs submitted for histological examination.

Gastrointestinal Radiation Injury

Further studies on the effect of intestinal irradiation on red cell uptake of Fe^{59} indicate a depression of about 25 per cent six days after exposure of the gut to 1,500 r of X-ray. During this period loss of Fe^{59} into the feces is markedly in excess of control values, probably due to intestinal hemmorhage resulting from the acute damage evident histologically in the intestinal tract during this period. Beta irradiation of the tract from intragastrically administered Y^{91} showed no effect on iron uptake, although the dose of Y^{91} fed was of comparable lethality to the 1500 r X-ray.

A study was initiated to determine the effect of intestinal irradiation on the metabolism of the gut per se. The respiration of various segments of the tract is being determined after exposure of the abdomen to X-ray.

Relative Biological Effectiveness

At comparable total doses delivered by tritium, the viability of yeast grown at 30 C was less reduced than that grown at 20 C. The dose required for a 90 per cent reduction in viability at 30 C was 30,000 rads as compared to 20,000 required to give comparable reduction at 20 C. Back mutation rates appeared to be unaffected by temperature, although the results were somewhat erratic. These unusual observations are to be re-tested.

To reduce secondary radiations, cultures and dosimeter solutions were contained in lusteroid tubes during experiments using X rays. Both inhibition of micro-organism growth and abnormally high dosimeter values were consistently obtained when lusteroid tubes were used. Initial tests with Teflon and polyptyrene show no effects such as found with lusteroid. When tubes of these materials become available, the X-ray exposures will be repeated.

Glass beads have been coated with palladium by vacuum spattering in preparation for treatment with polonium. It is hoped that these coated beads will serve as alpha radiation sources in RBE studies.

Genetic Effects of Metabolized Radioisotopes

Barium sulfate labelled with S^{35} was adsorbed by yeast and subsequently dried. Both before and after drying, less than 10 per cent of the sulfate could be removed. In an initial experiment comparing mutation effects of adsorbed S^{35} and metabolized S^{35}, the amounts taken up by the yeast were not consistent with previous experiments and thus comparable levels could not be studied. In addition, viability was appreciably lower than previously found and the tests will have to be repeated.

[redacted] [redacted]

Uptake of Radioactive Substances by Growing Plants

The uptake of radioactive iodine, phosphorus, and strontium by plants with roots killed with hot water was compared with uptake into intact plants. In each case the amount taken up was greater in the plants with dead roots.

Growing bean plants in the presence of both potassium thiocyanate and I^{131}, as compared to growth in I^{131} alone, gave no apparent difference in the form of iodine in the plants. Autoradiographic results show that essentially all of the I^{131} in the plant is in the inorganic form. No evidence of I^{131} binding to tyrosine has been found.

HA Kornberg

Manager
BIOLOGY OPERATION

HA Kornberg:es

Offsite Visits and HLO Visitors

Name	Dates	Company Represented or Visited	Reason for Visit	Personnel Contacted	Access to Restricted Data
Visits to Hanford Works					
Dr. Paul B. Sears	2/2/57	Professor, Yale Univ., New Haven, Conn.	Discuss ecological problems and present a seminar.	H.A. Kornberg and staff.	No
Visits to other Installations					
H. A. Kornberg	2/11-2/13/57	AEC, Washington, D.C.	Attend Bio-Medical Program Directors Mtg.	Dr. C.L. Dunham and staff	Yes
W. J. Clarke	2/13/57	Washington State College, Pullman, Washington	Regarding special steer to be irradiated.	Dr. Klavano	No

D. Lectures

a. Papers presented at meetings

L. K. Bustad, February 27, 1957 - "Application of Isotopes in Agriculture", Research Staff of Irrigation Experimental Station, Prosser, Washington.

b. Seminars

Dr. Paul B. Sears, Yale University, presented a discussion on ecology. (February 4, 1957)

D. G. Watson, February 26, 1957 - "The Concentration of Radioisotopes in Columbia River White Fish"

E. Publications

None

F. AFSWP Training Projects

Two Armed Forces officers completed a research orientation that included the following:

1. Whole-body radiation of excess ram lamb utilizing the GE Maxitron.

2. Skin exposure of excess ewe lamb to Van de Graaff accelerator electrons.

3. Plutonium metabolism in miniature pigs.

4. I^{131} metabolism, instrumentation, pathology, and radiochemical analysis.

OPERATIONS RESEARCH AND SYNTHESIS OPERATION
MONTHLY REPORT

February, 1957

ORGANIZATION AND PERSONNEL

D. F. Shepard was transferred to the Operations Research and Synthesis Operation from the Research and Engineering Operation, Chemical Processing Department effective 2-1-57. Mr. Shepard will be associated with the Industrial Statistics function.

A talk on "Statistics in Experimentation" was given by J. L. Jaech to the personnel of Naval Research Reserve Company 13-2 on January 29, 1957.

P. M. Thompson spoke to the Richland Lion's Club on February 5 on the "Potentialities of Research in Management Science."

OPERATIONS RESEARCH ACTIVITIES

Reactor Data

The final presentation of the feasibility and scoping study for the Irradiation Processing Department reactor data center was made to IPD personnel early this month. With the exception of normal consultation, activity in this area has been terminated.

Economics Studies

Significantly less time was spent on studies in this area due to the impact of Operation Pool. In particular, little time was spent following up on the intriguing subject of learning curves as a tool in explaining and predicting both cumulative and unit production costs and values.

Responsibility for the study of appropriate HAPO motivations in line with AEC objectives was partially re-assigned and continued, particularly in the area of mathematical models of economic behavior.

The study of suggested AEC ground rules as they affect both project justification and operating practices was revised to include the latest budget and production information and will be issued early in March for consideration by appropriate managers.

Personnel Data

Work continued on the problem of matching in some optimum fashion the qualifications of an individual, as well as his needs and interests, with the plant-wide opportunities available. A system that may be useful in dealing with this problem has been formulated and the practical aspects of its use are now under consideration.

Investigation of Problem Areas

The scoping of possible operations research assistance in the area of measurements was continued. An outline of the basic philosophy of measurements is beginning to take form. A progress report outlining the thinking to date and indicating possible further approaches will be compiled during March.

Attendance at the planning meetings instituted by the Radiation Protection Operation to review the entire Regional Monitoring program was continued. Since this review itself is still in the scoping stage it has not been possible to determine as yet the extent to which operations research assistance will be of value.

STATISTICAL AND MATHEMATICAL ACTIVITIES IN SUPPORT OF RESEARCH PROGRAMS

2000 Program - Metallurgy

A final report was issued in connection with the diffusion problem dealing with the penetration of alsi into uranium and uranium into alsi in bonded couples. This report contained a complete discussion of the statistical methodology used to estimate the maximum penetrations within each couple. Data collection has begun on a similar problem in which aluminum alloy M-388 is being considered rather than alsi.

During the last several months a statistical evaluation of data contained in ORNL-681, "The Corrosion of 356 Aluminum in Simulated Cooling Water for the Proposed Materials Testing Reactor," has been carried out by Operations Research and Synthesis Operation personnel. This evaluation provided guidance to the Coating and Corrosion Operation in designing several recent experiments to explore further the effects recorded in this document. Data from these experiments are currently being analyzed.

In connection with the experimental determination of the accuracy of the uranium assay stamped on certain test slugs, discussions were held to determine how statistical techniques, in conjunction with an appropriately designed experiment, could increase the overall experimental precision. A design to handle the five test slugs currently being assayed was suggested to F. E. Holt in an unclassified letter, "Experimental Design - Percent Uranium Content of Test Slugs," dated February 25, 1957.

Mathematical consultation was provided a member of Fuels Design, Fuels Development Operation, on the subject of the differential geometry of surfaces which have been subjected to inextensible deformations. This discipline finds frequent application in the stress and strain analysis of materials which must endure conditions in the interior of a reactor.

2000 Program - Reactor

The investigation, begun in January, of the statistical properties of various alternative methods of estimating K_∞, the coefficient of fast neutron multiplication, from cadmium ratio data was concluded this month. Results and relative merits of the different estimators were reported to D. J. Donahue in an unclassified letter, "Estimation Schemes Related to K_∞ Measurements," dated Feb. 26, 1957.

[redacted] [redacted]

3000 Program - 234-5 Weapons

Mathematical consultation was completed on a study initiated by members of the Plutonium Metallurgy Operation. The object of the study was the design and analysis of the two surfaces of a mold for molten metal. Paramount in the design were three conflicting objectives; (a) simplicity of design, (b) minimization of the total volume, and (c) provision for an adequate free-flow surface for the advancing fluid. Three designs were discussed and are now being subjected to further study.

6000 Program - Biological Research

Work continued on the program to evaluate experimental error in biological experimentation. Further discussions were held with interested personnel concerning the possible errors that might arise within the framework of the present procedure for counting a radioactive source. Sample-dilute-count data analysis also continued in February.

Many experiments performed by Biology Operation personnel using live animals as subjects follow the general double dose pattern. The first dose might be an injection of radioactive Pu, and the second dose a treatment injection. Each of the two doses can be administered on either a "fixed" or a "variable" schedule. "Fixed" means all animals receive the same dose by weight (or by volume). "Variable" means the amount of the dose is a function of the animal, usually being a certain percentage of the animal's weight. There is no uniformity among the biologists as to which of the four possible double dose schedules is used. Data from a test experiment involving all four schedules is currently being analyzed to determine whether the experimental findings from one schedule can reasonably be used to predict results from a second schedule.

Analysis of an intratrachael hydrosol experiment on mice was completed and the results were sent to L. A. Temple of the Biology Operation in an unclassified letter, "Statistical Analysis of the Intratrachael Hydrosol Experiment," dated February 28, 1957. A "turnover curve" expressing the weekly retention of a given dose of Ru^{106} in mice was determined. The tissue distribution of the remaining radioactivity was also found. Confidence intervals were given on the mean percentages for each organ or type of tissue.

Statistical analysis was performed for Biology Operation personnel on data from a pilot study investigation of possible antidotes for excessive internal ruthenium deposition in rats. The results of the analysis, including recommendations as to which treatments might most profitably be investigated further, were reported to B. Kawin in an unclassified letter, "Statistical Analysis - Possible Antidotes for Ru Radiation in Rats," dated February 6, 1957. The large measurement error in data on total recovery of Ru obtained in this experiment again indicates the need for a systematic study of measurement techniques and instruments used by the research biologists.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR PRODUCT DEPARTMENTS

Fuel Preparations Department

Personnel of the Quality Audit Section requested assistance in designing appropriate monthly Quality Report forms. It was felt that the type of report form now in use for various quality characteristics could be improved. Consideration was given to the level of supervision receiving the report, type of information most beneficial to that level, and labor involved in the preparation of the report. In a subsequent letter to T. D. Naylor, "Proposed Method of Reporting Various Quality Characteristics," dated February 21, 1957, a suggested method was outlined based on the principles of statistical control charts.

A project to evaluate the importance of various inspection stations and determine an optimum sampling frequency at each station has been undertaken. Recommendations and assistance to Quality Audit personnel have been given in this direction. Further assistance in developing the proper type of statistical control for operational uses and in the proper subgrouping of samples is being given.

Consultations were held with interested personnel in connection with the design of appropriate controlled experiments to evaluate the effect of slug insertion rate on residual can wall thickness at various temperatures of the alsi canning solution. Results of these experiments have been very gratifying and further experimentation is continuing in this area.

Data submitted by personnel of the Materials Engineering Operation are being analyzed to see whether the type of ingot (Mallinckrodt or Fernald), the rod location, and slug location within a rod have a significant effect on any of several yield variables.

Informal training sessions in basic statistical quality control and other statistical techniques are being continued for personnel of the Quality Audit Section These sessions afford operation personnel an opportunity to become familiar with the services performed by the Statistics group.

An analysis of analytical data was made to determine the precision and accuracy of certain measuring instruments used in chemical analyses. Biases, relative errors, and variances were calculated. Analysis of variance techniques were used to find desired within sample variances. Results were sent to G. F. Yost in an unclassified letter, "Precision and Accuracy Studies," on February 27, 1957.

Irradiation Processing Department

The frequency with which tube factors should be computed from temperature maps is being studied as an aspect of the data processing program. The data used were taken from the KE Tube Data Reports for a series of tests conducted during the summer of 1955. Consideration will be given to the accuracy of the measurements which are used in the computations, the fluctuations which exist, and the various uses of temperature maps.

A preliminary investigation of the data thus far submitted from the production test dealing with the effects of pile variables on slug distortion has been made. One important objective is to re-evaluate the standard warp relationship currently in use.

[redacted]

Exposures at discharge or rupture for the tubes in the recently completed I & E run to rupture test were submitted by Process and Reactor Development Operation personnel. Using these data, a table was prepared which gave the significance level as a function of the assumed ratio of rupture rates between standard and I & E slugs.

In a series of experiments performed several months ago, the accuracy and precision of the 105-C Basin balance used for weighing slugs had been determined. In view of appreciable biases, which were a function of the true weight, and considerable scatter even after bias corrections were made, it was recommended that the balance not be used until adjustments were made and a re-assessment of its accuracy and precision were determined. Such adjustments were subsequently made, and the original experiment was recently repeated by personnel of the Component Testing Operation. The resulting data were submitted and analyzed, with the results reported in an unclassified letter to T. L. Deobald, February 21, 1957, "Accuracy and Precision of the 105-C Balance."

Several rupture studies are being planned by Process Technology Operation personnel. These will include 1956 data. In this connection, simplified approximate tube exposures have been calculated for all tubes discharged during 1956. In order to determine the accuracy of these approximations, random samples were drawn from each month and area and compared with available production scheduling exposures. It appears that appreciable biases exist in some month-area combinations, but the consistent grouping of individual values about the average biases should permit the application of bias correction factors such that the approximations can be utilized. These bias factors are presently being determined.

Assistance had previously been given personnel of the Process Technology Operation on the statistical aspects of a technique for using past pile rupture experience to adjust outlet water temperature levels. Since this dealt with probability statements about the numbers of ruptures adjusted to 100% efficiency, common outlet water temperature, and common pile rupture index, the resulting probability statements were not exact. Suggestions for improving on the accuracy of such statements were submitted in a rough draft to H. G. Spencer.

In evaluating the safety of a mechanism or system of mechanisms associated with a reactor, some estimate of the reliability (percentage of times that the mechanism would respond in an emergency) of the safety devices must be obtained. For some mechanisms, an experimental estimate of the reliability can be found, but many trials have to be run in order to estimate the reliability with any degree of confidence. Discussions were held during the month with personnel of the Process Technology Operation on this general subject of reliability, and a table was prepared showing the uncertainty in the estimated reliability as a function of the number of independent trials performed.

Data evaluation has started for the work sampling study currently being conducted in the K areas by Industrial Engineering Operation. Preliminary analysis should indicate how long the study must continue to insure that sample data is representative of the overall work picture of the trades involved.

Chemical Processing Department

Considerable steel corrosion data have been accumulated as a consequence of the acceptance sampling tests routinely run on samples from steel shipments. Personnel of the Facilities Engineering Operation have requested that these data be analyzed to evaluate certain variables (shippers, steel geometries, impurity content, etc.). I is hoped that by determining which variables appreciably affect corrosion, the quality of the steel being used can be improved. These analyses will be performed using IBM equipment. Personnel in the Data Processing Operation have been contacted, and estimates of cost and completion dates have been obtained and forwarded to the interested parties.

The Research and Engineering Operation is interested in the determination of

[redacted]

An abstract of a paper to be considered for presentation at the annual AEC Accountability Meeting in Washington, D. C. in June has been submitted as requested. The paper by K. B. Stewart entitled, "An Optimum Sampling Technique," deals with the determination of the sample sizes at various points in a system of streams in order to best determine the amount of uranium transferred. The criterion used is that the variance of the total estimate be a minimum subject to a fixed cost constraint.

Several more sets of data have been analyzed with the assistance of the IBM equipment in connection with the problem of relating isotopic concentrations in the reactor basin to certain pile variables. The latest attempts were restricted to individual piles and water treatments, but the resulting lack of data combined with the large amount of scatter led to generally negative results.

A paper was prepared in conjunction with C. Groot and H. C. Bowen of the Reactor and Fuels Research and Development Operation for distribution to plant personnel concerned with corrosion work, and subsequent submission for publication in a corrosion journal. This paper points out the necessity for transformations in analyzing corrosion data in particular, and resulted from an experiment recently conducted by Groot and Bowen which strikingly illustrated this point.

Bias correction equations were developed for 1/2" cored slugs at the request of personnel of the SS Accountability Operation, Relations and Utilities. The equations correct predicted amount of Pu formation and U^{235} depletion, which, based on average MWD figures, would be slightly biased.

Data submitted by Spectrochemical Analysis Operation were analyzed to determine the types and magnitudes of errors present in routine measurement techniques. Several methods of averaging experimental results were investigated and their relative precisions estimated. The results of the statistical study were reported to E. J. Anderson in an unclassified letter, "Error Analysis - Fe Concentration Data," dated February 7, 1957.

Chemical Instrumentation Operation personnel use the fission count method to estimate percent Pu^{240} in an unknown. The method estimates the unknown percentage as a rational function of four independent counting rates. Confidence intervals constructed for this estimate were reported to F. P. Brauer in an unclassified letter, "Confidence Interval Procedures for Fission Count Method of Determining Percent Pu^{240}, " dated January 31, 1957.

Discussions were held with interested parties concerning the feasibility of installing a sequential decisions procedure to govern bioassay film strip reading. Various sequential plans are currently being considered.

Regressions studies of the present salaries of various groups of HLO employees were completed. Final results were given to R. D. Tillson on February 19, 1957. A new study was begun on salaries predicted for January 1, 1958.

An analysis was made for Electrical Systems Planning, Relations and Utilities Operation of the forces due to the wind on an ice-encrusted standard utility pole. Further computations were made as to the amount of guying needed to meet the required safety codes, under various assumptions as to the degree of pole deterioration.

OFFSITE PROJECTS

Routine release calculations in connection with Project Bluenose were continued.

Work on Operation Pool is progressing satisfactorily. Progress during the month can be summarized as follows:

1. Special Agreement No. 21 to the Prime Contract was signed by the Commission authorizing the program.

2. Through lengthy discussions, a basic outline of the study and its objectives, and the contemplated nature of the final report to be prepared, have been formulated. This outline was discussed with, and additional information obtained from, those responsible for the parallel study at Oak Ridge and from the designated consultants at Savannah River. This phase of the study should be completed early in March.

3. Studies of the existing Hanford situation in such areas as accountability, instrumentation, and physical security have been requested from FPD, IPD, CPD, HLO and the SS Accountability Operations. In order to give appropriate direction and forestall redundancy, detailed personal discussions were held with the personnel assigned to these studies. These discussions were completed during the two-week period ending February 22, and it is anticipated the results of most of these studies will be available by March 8 to 15.

OFFSITE VISITS

W. R. Lewis and J. B. Work spent the week of February 25 through March 1 visiting the K-25 and Savannah River plants in connection with Operation Pool.

W. L. Nicholson participated in BA/MA recruiting on the University of Oregon campus on February 18, 1957, and visited the Mathematics and Statistics Departments of Oregon State College on February 19.

Carl A. Bennett

Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

CAB:jbk

[redacted]

RADIATION PROTECTION OPERATION MONTHLY REPORT - FEBRUARY, 1957

A. ORGANIZATION AND PERSONNEL

Organization

No significant change in organization occurred.

Force Summary	1-31-57	2-28-57
Exempt	41	41
Nonexempt	205	204
Total	246	245

B. ACTIVITIES

Radiation Monitoring

Scheduled work on the front face at 105-DR was completed at an average body dose rate of 5 mr/hour. Radiation levels from open tubes during nozzle replacement ranged to 800 mr/hour at 30 inches and contamination to 2 rads/hour including 100 mr/hour was noted on the nozzles. The field dose rate in the C-elevator pit was 10 to 30 mr/hour, but particles were found which gave readings to 10.5 rads/hour including 500 mr/hour before being shielded with lead bricks.

Prior to the major outage at 105-D, TC water lines were installed in the valve pit, riser tunnels and the C-elevator pit. At the latter location the average body dose rate was 100 mr/hour due to gross particle contamination which ranged to 6.3 rads/hour uncorrected for source size. After decontamination, the average dose rate in the pit was 10 to 25 mr/hour. Major shutdown work at 105-D commenced February 12.

Biology Research has tried two methods for forming the aerosol of ruthenium-106 particles to which mice are exposed. A ruthenium hydrosol was used to create a fine mist in the sealed cylinder containing the mice. Later, capsules containing a fine powder as the carrier for the particles were fired from an air pistol. The maximum hand dosage rate encountered during preparation of the capsules was 2 rads/hour including 50 mr/hour at 4 inches.

Samples were removed from the 305-B experimental pile on three different occasions with a maximum body dosage rate of 4.5 r/hour between the reactor faces. Most work can be accomplished in radiation fields of 2 r/hour.

The Richland Crash Alarm System failed during routine test. Repairs were instituted, and the system re-tested satisfactorily.

Regional Monitoring

The daily average emission of I^{131} was 1.7 curies compared to 1.1 curies during January. The maximum daily measurement was 6.6 curies which originated from Redox between January 30 and 31. The maximum total emission during any seven-day period was 19 curies of which 18.9 curies were released from Redox.

Test wells drilled around the A-8 crib show increases in beta emitter activity by factors of 2 to 9 with a maximum concentration of 1.6×10^{-3} μc/ml in well 299-E25-5.

Drinking water in the Pasco-Kennewick systems contains more radioactive material now than has ever been measured at these locations in the past. The average total beta measurement at the Clover Island pumping station for February was 3.2×10^{-6} μc/ml compared to 1.4×10^{-6} μc/ml a year ago. An upward trend has been noted since June. The increase is partially caused by less dilution in the river and partially by a continual increase in power level.

Exposure Evaluation and Records

There was one confirmed case of plutonium deposition during the month. Detection of this case by routine sampling was first made in 1956; thus, the corrected total is 37 for that year. The total number of cases on record to date is 198.

No radiation incidents involving exposure above permissible limits were reported.

A shipment of 702.8 ounces of silver backs (stainless steel strips attached) and silver inserts was sent to the San Francisco Mint for reclaiming. Loss due to steel and impurities was 39.1 ounces. The value of the resulting fine silver was $539.90.

Calibrations

Permission has been given to Radiological Physics to transfer the Sigma Pile from the 3745 building to the Positive Ion Accelerator building. Routine calibrations will still be performed with the facility; however, much greater utility of the Sigma Pile in experimental work will be realized by the transfer.

In addition to the routine calibration work on the 2 Mev accelerator, some special irradiations were made. These consisted of large beta doses given to localized skin areas of a sheep for the experimental animal farm.

The simple modification to the 17 dose rate integrators was completed, the acceptance tests completed and the units sent to the field. Acceptance test results revealed that the units performed well within the limits established.

In accordance with OPG 08.2.1, a classification of radiation monitoring instruments and a classification list was prepared and issued to all monitoring managers.

Radiological Development

Progress was made on the conversion of film badge information to electronic data processing. The audit of master record information was continued. The number of master records determined to be in error was found to be about normal for a program of this magnitude. A new instruction assembly was completed and testing was initiated. This assembly was prepared to consolidate program corrections and additions to the program conceived subsequent to the initial instruction assembly. Development of operating procedures for the guidance of the Exposure Records personnel progressed to the detail outline stage. Consideration of bioassay for conversion to electronic data processing methods was initiated. The economies and resultant benefits of processing these data are less obvious than for film badge data, largely because of the smaller volume of data to be processed.

By agreement with the vendor of the plastic coated gloves mentioned in last month's report, a total of 3502 pairs of gloves was returned for replacement. An initial replacement order of 48 dozen pairs was received and accepted with the following stipulations: Should the gloves prove unsatisfactory, the cost of the entire replacement lot will be refunded; if approved, the remainder of the order will be filled. Approximately 400 pairs of replacement gloves were dispersed to various representative facilities for actual field use and consumer evaluation. In conjunction, straight laundry tests will be conducted. As a result of these actions and through considerable personal contact, the mounting dissent among user components was quelled and the situation has returned to normal.

Nine resistance thermometers from the 100-K Area were decontaminated with a Turco 4306-B solution and ultrasonic agitation. Contamination levels to 5000 c/m were reduced to less than 100 c/m in two washings of approximately two minutes each. Conventional chemical decontamination methods on other resistance thermometers were not satisfactory.

Fabrication of the beta source jig was completed. After calibration of the system, the uranium source with appropriate absorbers will be used for calibration of GM's. Sufficient shielding was included in the beta source jig to allow GM calibration to proceed while other work is in progress such as X-ray operation.

Radiological Consultation

Recommendations were made for a study of the distribution of radiation dose over the body of workers engaged in normal monitoring activities. This program has been started with a group of people in Radiation Monitoring Operation using film badges distributed at key locations on the person. It is hoped that this pilot study will provide sufficient evidence to indicate the advisability and need for a major program of routinely estimating the distribution of exposure over the body.

Consultations on the advisability of applying the new gamma ray spectrophotometry techniques to the analyses of reactor effluent and river water samples have been made. Such procedures are now being tested in the Analytical Laboratory for the reactor effluent water, and plans were being made at the end of the month to extend these studies to at least one river sample per week at Pasco. Such a study will permit evaluation of the biological significance of the radioactive materials in the river directly at the point of use without the inaccuracies caused by assumptions needed in extrapolating reactor effluent samples downstream to the point of use. A major difficulty in the complete acceptance of this program is apparently the lack of equipment in the Analytical Laboratory.

Procedures for the calculations of the biological significance of reactor effluents were reviewed with Regional Monitoring personnel. Present procedures are as previously outlined in Hanford reports and are based on the extrapolation of results from the effluent basins downstream in the river. These calculations are to be made on a routine basis by Regional Monitoring so that necessary information on the approach to permissible limits is continuously available. Uncertainties and errors in this method of calculation were pointed out and the need for accelerating the procurement and analysis of samples from the river for the purpose of estimating the biological significance were emphasized. It is hoped that the present methods of interpretation will be used only for a few months until adequate analytical procedures and data are available for the river samples.

Major effort was resumed on the second draft revision of NBS Handbook 42, now that the NCRP statement is available on accumulated dose and population dose limitations.

Radiological Disaster Studies

Comments on "Reactor Disaster Studies", which was circulated to Chemical Effluents Technology Operation have been received. The draft will continue circulation to other interested groups in Hanford Laboratories.

Columbia River Studies

The Columbia River Advisory Group meeting held February 7-8, 1957, was well received.

Mineral constituents in Columbia River water at 100-F Area for the period October, November, December, 1956, were reported to the Washington State Pollution Control Commission. Analytical data for these serial reports are obtained from the 190-A Analytical Laboratory, Irradiation Processing Department.

Significant Reports Issued

HW-46726	Radioactive Contamination in the Hanford Environs for the Period July, August, September, 1956	BV Andersen, JK Soldat, MW McConiga
HW-47784	Basis for IPD Radioanalytical Laboratory	WN Koop, HV Clukey
HW-47941	Special Filters-Samples of Hanford Process Effluent Gasses	JK Soldat
HW-48469	Minutes of the Columbia River Advisory Group Meeting, February 7-8, 1957	HV Clukey

A detailed report of radiation monitoring is contained in document HW-48817.

A detailed report of waste disposal monitoring is contained in HW-48826.

C. EMPLOYEE RELATIONS

Safety

One medical treatment injury occurred for an injury frequency of 0.26.

Security

No security violations occurred.

Suggestions

Radiation Protection personnel submitted a total of 10 suggestions in February. Six employees were awarded a total of $30. Eleven suggestions were evaluated in February and eight suggestions remain to be evaluated.

Training

A protective clothing display and tour guide service were provided for the high school student visitors entertained at HAPO during February.

One class was conducted with the AFSWP training program on Practical Applications of Statistics on February 5, 1957. A seminar on February 5, 1957, was held with the same group on the subject of Bioassay.

Relations

No beneficial moves were made in February.

No grievances were submitted during the month of February.

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 W. W. Saxton C. M. Everts, Jr. K. H. Spies E. C. Jensen Roger James	2/7-8/57	Columbia River Advisory Group	Regular meeting of CRAG and tour of 100-K Area.	JW Healy HV Clukey JW Vanderbeek	Yes	100-K 300:325

VISITS TO OTHER INSTALLATIONS

J. W. Healy	2/11-12/57	AEC Washington, D. C.	Attend meeting of Biomedical Directors of the AEC Division of Biology and Medicine	Dr. C Dunham	Yes	
J. W. Healy	2/13/57	Naval Research Lab. Washington, D. C.	Obtain information on new glass dosimeters.	---	No	
J. W. Healy	2/14/57	Argonne National Lab. Lemont, Illinois	Discuss body monitor and applied protection problems.	Dr. J Rose Dr. L Marinelli	No	
J. W. Healy	2/25-27/57	Union Carbide Nuclear Company Oak Ridge, Tennessee	Operation Pool	Logam B. Emlett A deLaGarza HC Patton	Yes	
J. W. Healy	2/28-29/3/1/57	duPont Company Aiken, South Carolina	Operation Pool	IM Arnett	Yes	

REGIONAL MONITORING

The general findings are summarized in the following:

Sample Type and Location	Activity Type	Average Activity Density /uc/ml	Trend* Factor
Drinking Water and Related Materials			
Benton City Water Co. Well	alpha	1.1×10^{-8}	--
Richland Wells	alpha	$<5 \times 10^{-9}$	--
100 Areas	beta	$(0.08 \text{ to } 7.3) \times 10^{-6}$	--
200 Areas	beta	$(0.8 \text{ to } 1.1) \times 10^{-7}$	--
Pasco, Kennewick, McNary Dam	beta	$(<0.05 \text{ to } 3.2) \times 10^{-6}$	--
Backwash Solids - Pasco Filter Plant	beta	2.1×10^{-1} /uc/gm	+2
Backwash Liquids - Pasco Filter Plant	beta	3.6×10^{-6}	--
Anthracite, Sand Filter - Pasco Filter Plant	beta	3.1×10^{-4} /uc/gm	+2
Other Waters and Related Materials			
200 West Wells	beta	$<1 \times 10^{-7}$ to 1.2×10^{-2}	--
200 East Wells	beta	$<1 \times 10^{-7}$ to 3.2×10^{-2}	+2
Wells Near 200 Areas	beta	$<1 \times 10^{-7}$ to 6.0×10^{-7}	-3
100 and 100 Wells	beta	$<1 \times 10^{-7}$ to 1.6×10^{-3}	+2
Outlying Wells	beta	$<1 \times 10^{-7}$	--
Columbia River - Hanford Ferry	beta	$4.[illegible] \times 10^{-5}$	--
Columbia River - Below Reactors	beta	2.8×10^{-5}	--
Columbia River - Paterson to McNary	beta	9.8×10^{-7}	--
Columbia River - Shore Mud	beta	$(0.2 \text{ to } 5.5) \times 10^{-4}$	+3
Raw Water - Operating Areas	beta	$(0.00[illegible] \text{ to } 2.2) \times 10^{-5}$	--
Reactor Effluent Retention Basins to River	beta	1,000 to [illegible],000 /uc/sec/reactor	--
		$(2.0 \text{ to } 7.1) \times 10^{-5}$	--
Reactor Effluent Retention Basins to River	alpha	<0.04 uc/sec/reactor	--
		$<5 \times 10^{-9}$	--

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

Sample Type and Location	Activity Type	Average Activity Density μc/ml	Trend* Factor
Other Waters and Related Materials (contd)			
I-131 in Farm Wastes to River	I-131	59 μc/day	--
I-131 in Columbia River - Hanford	I-131	8.0×10^{-7}	--
300 Area Pond Inlet	alpha	1.0×10^{-7}	--
		5.1×10^{-7}	--
Atmospheric Pollution			
Gross Alpha Emitters	alpha	$(<4 \text{ to } 9.5) \times 10^{-15}$	--
Gross Dose Rate - Separations Areas	beta-gamma	1.0 to 15 mrad/day	+2
Gross Dose Rate - Residential Areas	beta-gamma	0.4 to 3.6 mrad/day	--
Active Particles - Separations Areas	beta	$(1.3 \text{ to } 5 \text{ ; } \times 10^{-13}$	--
I-131 Separations Areas	I-131	$(1.0 \text{ to } 2.9) \times 10^{-13}$	-2
I-131 Separations Stacks	I-131	1.7 curies/day	--
Ruthenium - Separations Stacks	Ru-103-106	<0.02 curie/day	--
Active Particles - Wash., Idaho, Ore., Mont.	--	0.004 to 0.04 ptle/m^3	--
Active Particles - Project	--	0.001 to 0.035 ptle/m^3	--
Vegetation			
Environs of Separations Areas	I-131	$(0.3 \text{ to } 1.5) \times 10^{-5}$ μc/gm	-3
Residential Areas	I-131	$(<3 \text{ to } 4.3) \times 10^{-6}$ μc/gm	-3
Eastern Washington and Oregon	I-131	$< 3 \times 10^{-6}$ μc/gm	-2
Non-Volatile Beta Emitters Wash. and Ore.	beta	$(0.12 \text{ to } 3.7) \times 10^{-4}$ μc/gm	--
Alpha Emitters - Separations Areas	alpha	$(0.1 \text{ to } 1.1) \times 10^{-9}$ μc/gm	--

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

RADIATION MONITORING	Hanford Laboratories	Construction Engineering	Others	February Total	1957 To Date
Special Work Permits	1,373	684	258	2,315	4,883
Radiation Surveys	1,691	993	280	2,964	5,261
Air Samples	2,142	79	78	2,299	4,213
Skin Contamination Cases	13	9	0	22	36
*Class II Radiation Incidents	0	0	0	0	0
**Class II Radiation Incidents	0	0	0	0	0

EXPOSURE RECORDS

Gamma Pencils	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
February	271,890	9	22	10
1957 to Date	557,682	19	30	20

Beta-Gamma Film Badges

	Badges Processed	Readings 100-300 mrads	Readings 300-500 mrads	Readings Over 500 mrads	Lost Readings	Average Dose Per Film Packet mrad(ow)	Average Dose Per Film Packet mr(s)
February	52,431	408	14	8	64	1.33	2.67
1957 to Date	106,849	1,075	33	12	122	1.33	2.67

Slow Neutron Pencils

	Pencils Processed	Paired Readings 4-12 mrem	Paired Readings Over 12 mrem	Lost Readings
February	2,054	20	4	0
1957 to Date	4,848	51	16	2

Fast Neutron Film Badges

	Badges Processed	Readings Above 50 mrem	Lost Readings
February	1,076	0	0
1957 to Date	1,923	0	0

Bioassay

	February	1957 to Date
Plutonium: Samples Assayed	1,472	2,461
Results above 2.2×10^{-8} µc/sample	51	76
Fission Product: Samples Assayed	1,580	2,706
Results above 3.1×10^{-5} µc FP/sample	3	3
Uranium: Samples Assayed	418	810

*Radiation Monitoring Operation Customers
**Total Plant

Uranium Analyses

Sample Description	Following Exposure Units of 10^{-9} µc U/cc Maximum	Average	Number Samples	Following Period of No Exposure Units of 10^{-9} µc U/cc Maximum	Average	Number Samples
Fuels Preparation	5.74	1.26	124	8.51	1.45	22
Hanford Laboratories	9.40	3.41	15	3.28	1.51	12
CPD - Finished Products Uranium Reduction	9.40	2.46	134	8.77	2.02	77
Special Incidents	0.63	0.32	5	--	--	--
Random	0.76	0.76	2	--	--	--

Tritium Analyses	February	1957 to Date
Samples Assayed	0	1

Thyroid Checks		
Checks Taken	26	127
Checks Indicating .01 µc	0	0

Hand Checks		
Checks Taken - alpha	58,666	111,079
- beta gamma	53,783	103,434

CALIBRATIONS

Portable Instrument Calibration	Number of Units Calibrated February	1957 to Date
CP Meter	1,086	2,120
Juno	394	772
GM	1,453	2,853
Other	182	360
Total	3,115	6,105

Personnel Meters		
Badge Film	2,460	4,950
Pencils	3,196	5,266
Other	154	403
Total	5,810	10,619
Miscellaneous Special Services	160	445
Total Number of Calibrations	9,085	17,169

A. J. Stevens
Acting Manager
RADIATION PROTECTION

LABORATORY AUXILIARIES OPERATION MONTHLY REPORT - FEBRUARY, 1957

General

Safety performance of the Operation as indicated by the Minor Injury Frequency Rate was within the control limits previously established. However, the rate was almost double the January record and indicates a need for investigative and possibly corrective action.

Security performance improved with only one violation reported. It is hoped that this reflects a downward trend resulting from our efforts in this direction.

The absenteeism rate for all employees was up to a rate of 3.55 from the January rate of 2.49. This rate is not unusually high for the Operation but improvement is expected.

Facilities Engineering Operation

The preparation of the FY 1959 and Revisions to FY 1958 Plant Acquisition and Construction Budget is continuing on schedule. All necessary study work has been performed and data is being compiled for summary and inclusion in the budget data sheets.

Project activities are continuing, using Construction Engineering Operation services for the performance of the majority of this work. Hanford Laboratories Operation has projects underway with authorized funds in the amount of approximately $1,600,000. The total cost of these projects is approximately $3,200,000 excluding PRPR. Other HLO projects presently in project proposal preparation or submittal stage approximate an order of magnitude of $10,700,000. These include the Effluent Engineering Test Facility, Biology Controlled Activity Water System, Critical Mass Laboratory, Metallurgical Development Facility, Ventilation Improvements in 222-U Building, Plutonium Metallurgy Facility Expansion and Plutonium Fabrication Pilot Plant. Continuing efforts are being made to establish realistic schedules and costs. Project activity during the month and project status is included in the schedule attached.

The Drafting and Design function produced approximately 195 drawings, using a total of 2463 productive man hours or approximately 13 man hours per drawing. This work was devoted primarily to drafting requests of other HLO components. The backlog of work has decreased. No doubt efforts by engineers to reduce costs have resulted in more thorough analysis and resultant design drafting efforts are more effectual in meeting the required end results.

A summary of the Material Requisitioning and Standardization function is as follows:

Requisitions and Alterations Issued this Month	- 7
Total Estimated Costs of these Requisitions	- $540,000*
Total Requisitions Processed to Date	- 27
Bid Reviews Completed this Month	- 3

Engineering work is being performed to result in repairs to buildings which were damaged due to the winter freeze-up and to forestall reoccurrence. Engineering

*Includes Zirconium Requisitions.

studies are also being made to correct building heating system inadequacies.

An office equipment forecast was made for budget purposes. One air monitoring station was removed from our properties and transferred to Salvage.

Three jobs are in progress using CEO for engineering services. These include Breathing Air Equipment Installation in 141-FS Building, Formaldehyde Ventilation in 146-FR Building, and tank heaters and building electrical adjustment work in 146-FR Building. Also, study work is progressing on modifications to the heating and ventilating systems in 747, 3706, 326 and 328 Buildings. Fuels Preparation Department is conducting a study on corrective measures for additional heat in 3707-C Building.

Steps are being taken to economize as much as possible on the Landlord budget. Control of costs under the present system, wherein FPD renders the majority of service, appears to be adequate; however, a detailed analysis of all costs and accounting is being made with the assistance of the Financial Operation. A detailed plan is being formulated for the landlord activities mainly with respect to control of budgeted expenditures.

Laboratories Administration Operation

Twenty-three additional Organization and Policy Guides were issued. A total of 120 have been issued and 43 are in draft form or ready for duplicating and distribution.

The following contracts were entered into in February:

Consultant Agreement No. CA-153	P. E. Church
Consultant Agreement No. CA-154	R. E. Zirkle
Consultant Agreement No. CA-155	J. L. Powell
Design, Development and Research Contract No. DDR-11	Allegheny Ludlum Steel Corp.

An extension of Consultant Agreement No. CA-138 with M. E. Ensminger was requested.

Assignments involving five automotive vehicles were made to improve transportation operations. Two requests for auxiliary equipment were filed with Transportation and Maintenance Operation.

A report on Columbia River Studies for the period from February 16, 1956 to September 1, 1956, was given to the Columbia River Advisory Group, meeting here on February 7, 1957.

Radiographic Testing Operation

Testing operations this month almost duplicated last month's activity. A total of 984 tests were made as compared to a total of 983 last month. Of the total number, 276 tests were radiographic exposures, and the remaining 706 were supplementary tests. The supplementary tests included penetrant, magnetic particle, ultrasonic, and eddy current tests. Work was done for 13 different organizational components.

A three-shift operation was started in the middle of the month. This change was made possible by individual assignment of the operation's three technicians. On-the-job training and the increased experience of the operators made such assignment feasible. Better service at a reduced cost should result. Available time for radiation work will be doubled by using the graveyard shift, and greater operator efficiency has already been demonstrated.

Following up upon the rejection of a questionable crane rigging ring last month, four steel plates (from which new rings were to be cut) were examined. Radiography, ultrasonic, and magnetic particle testing showed the material to be sound and the material was released for shop fabrication. The examination of material before fabrication is desirable both from the standpoint of money saved (rejection of fabricated items avoided and fabrication costs saved) and in the ease and greater confidence of testing.

Work in connection with Project 558 still continues, both in the shop and in the field. Field work has now been extended to almost all areas; D, DR, F, and H. Good field results in radiographing pipe welds in place through both walls have been achieved.

A small amount of pressure vessel and Class I vessel work was done. A stainless steel vessel job was completed for the 200-E shops, and work on the H-4 oxidizer is still continuing. A pressure regulating storage tank was radiographed for the 100-F Area.

Final testing of the experimental titanium heat exchanger for Chemical Development was completed. This fabrication was a good example of desirable practice for developmental work. In addition to checking the material stocks before fabrication, checks were also made after major fabrication steps and after accelerated service testing.

Radiographic examination of thermocouples is proving to be a very practical way of assuring serviceability of these necessary adjuncts to in-pile and other experimental work. In addition to the normal work done along these lines, successful radiographs were made this month of two irradiated thermocouples reading 4 R on contact. The short, intense exposure of the x-ray beam makes such pictures possible.

Work on the zirconium process tube program started in earnest this month with the occupation of part of the 221-B building in the 200-E Area. The pipe gallery of this building affords a readily accessible, shielded facility in which it is possible to handle the long tubes. Radiographic, eddy current, and ultrasonic testing has been started, with penetrant, boroscoping, pressure testing, triboelectric, thermoelectric, and eccentricity testing to follow.

Considerable work was done for the Plutonium Metallurgy Operation in connection with the development of zirconium and aluminum tubing of special sizes, and with aluminum castings.

Two large ultrasonic tests were completed this month. One involved zirconium test pieces for coolant system studies. These pieces were examined for flaws that might initiate failure in proofing tests. The other, directly opposite, was completion of the thickness measurement of a series of vessels in the 100-F Area. All of the results were calculated and tabulated for study and reference.

Customer	No. of Tests	Feet of Weld	No. of Pieces	Descriptions
Radiographic Tests				
Construction Engineering Operation	52	22	36	Carbon and stainless steel pipe and plates.
Hanford Laboratories Operation	122	73	43	Titanium, zirconium & aluminum tubing & miscellaneous materials.
Chemical Processing Department	22	8	4	Stainless steel pipe & vessel welds.
Irradiation Processing Department	276	160	108	Carbon steel pipe welds.
Dye Penetrant				
Construction Engineering Operation	48	64	2	Process vessel welds.
Hanford Laboratories Operation	48	6	4	Titanium heat exchanger welds.
Ultrasonic				
Construction Engineering Operation	164	5	4	Crane rings.
Hanford Laboratories Operation	119	15	14	Zirconium process tubes.
Irradiation Processing Department	34	5	5	Zirconium process tubes.
Magnetic Particle				
Construction Engineering Operation	81	4	3	Crane rings.
Eddy Current				
Hanford Laboratories Operation	214	227	31	Zirconium tubing.
Total	984	479	169	

Technical Shops Operation

Total productive time for the month was 12,466 hours. The total shop work backlog is 22,342 hours with 80% scheduled to be completed in 60 days. The remaining 20% consists of major items scheduled over a six month period. Overtime worked during the month was 3.3% (543 hours) of the total available hours.

Distribution of time was as follows:

	Man Hours	% of Total
Fuels Preparation Department	1269	10.1
Irradiation Processing Department	1996	16.0
Chemical Processing Department	962	7.7
Hanford Laboratories Operation	7972	63.8
Construction Engineering Operation	173	1.4
Miscellaneous	94	1.0

Customer demands for service remained firm in all components of the operation. The optical shop completed the overhaul of the 105-DR discharge area periscope. A sizeable order was received for replacement pyrex glass bearings used in chemical pumps in Chemical Processing Department production areas. These bearings must be individually ground to fit the pump shaft and the bearing housing. Work continued in the electronic shop on the fabrication of in-line monitoring instrumentation authorized in Project CG-686. The 306 Building machine shop was engaged primarily in the fuel fabrication field with emphasis on the finishing of ceramic fuel elements. Several jobs were completed in the graphite machining facility, the largest being an order for 80 full size blocks to be used in a laboratory reactor experiment. In the 328 Building machine shops work is progressing on the pressurized magazine reactor charging machine. The coating facility had an interesting application for Dow Corning Company's # R-671 Silicone Resin. This material was applied over a coating of Shell Epon # 828 to give a hard, impervious, glossy finish on deflection shingles used in conjunction with outlet nozzles on the production reactors. It is expected that shingles so equipped will retain a minimum of contamination.

Total personnel in the operation as of 2-28-57 was 102 with open requisitions for 6 machinist journeyman. Two of the machinist requisitions are to replace men who will accept transfers to fill openings in the 200 Area, and one to replace a journeyman who will accept a transfer to fill an opening in Fuels Preparation - 300 Area. The remaining three requisitions will be used to bring the operation up to full strength.

Work has commenced on the electronic shop ceiling and is expected to be completed in 30 days.

The noise abatement study for the main shop and the quartz room in the glass shop has been completed and turned over to Facilities Engineering for estimating and inclusion in the FY-1958 construction budget.

The lighting survey for 328 Building has been completed and also turned over to Facilities Engineering for checking and possible acquisition of funds.

Technical Information Operation

A questionnaire on the services of the Technical Information Operation is rapidly taking shape. Statistical help is being supplied by Operations Research. It is anticipated that the questionnaire will help in determining a proper level of service as well as providing an indication of performance in the function. Concurrently a brochure on Technical Information's reference resources and services is being written.

In response to an oral request from HOO-AEC (since confirmed in writing), Technical Information began selecting a group of reports relating to the separations process. These include HAPO reports on Redox and Purex, Tasks 1, 2 and 3 in the 234-5 process, and the UO_3 recovery process. Reports on waste disposal, corrosion problems, and construction costs will be included, as well as engineering drawings covering design and construction. Approximately 800 reports were reviewed. Of these, 190 have already been released to the Civilian Application Program. Approximately 350 reports were withheld because they (1) contain production information, (2) contain Atomic Weapon Data or (3) are not applicable for use in the program. A listing of periodic reports on separations processes was also prepared. Of the 138 reports on this list, 75 have already been released to CAP. Technical Information Service Extension has copies of all but 4 of these periodic reports.

A twice-daily mail service between all Classified Files offices was started on February 25th. The run was established as a result of outer area demand for improved service. No additional personnel or vehicles are required.

The annual inventory of SECRET Research & Development reports required by the AEC was completed February 26. An unofficial tally of the results showed 5,480 titles were inventoried, with a total of 13,542 accountable copies. Of the total, 204 copies were Atomic Weapon Data reports. Despite three new losses this year, the total number of unaccounted-for Research & Development reports was reduced from 34 on the 1955 inventory to 30 on the 1956 inventory. This was because 7 copies shown on the 1955 inventory were downgraded from SECRET to CONFIDENTIAL, and therefore did not appear on the 1956 inventory. All Atomic Weapon Data reports were accounted for.

Most February inventories of field holdings were satisfactory, although a few discrepancies were brought to light toward the end of the month. Apparently some Files transactions are not arranged in proper sequence on the tape. For example, a document which appeared on the February inventory list had been returned, cleared through Files and the transaction confirmed on the August 10, 1956 historical list. Another problem concerns "lost records." On February 13, for instance, some FRC's and routings were processed through 702. A few days later when some of the same documents were cleared, the clearing bounced with the reason "No Record." Data Processing is working on these problems.

A meeting was held with the AEC regarding their Directive HA-21H1-045 on the temporary loan of GE documents to HOO personnel. It was agreed that GE would charge documents to HOO Responsibility Stations rather than to individuals. This resulted in the deletion of 330 AEC names from Files' Address Access list and the addition of 16 new codes representing the 16 Responsibility Stations. An inventory list of all charges to AEC personnel was run, and with the aid of L. E. Speer of AEC Mail and Files the appropriate Stations were determined. A total of 517 documents were cleared and recharged under the new system.

HAN-64777, "Interpretation of Atomic Weapon Definition in GM-172" was received from the AEC, Washington, D. C. HOO and HAPO are authorized to use this document as a temporary guide for the identification of Atomic Weapon Data. The Guide is similar to HW-36713, Rev. 1, prepared at Hanford by the Supervisor, Document Classification-Declassification in June, 1955 and approved for local use at that time by HOO.

Work Load Statistics

	January	February
Documents routed and discharged	33,693	27,283
Documents issued	17,132	12,710
Documents destroyed	6,474	6,175
Reports abstracted	219	236
Formal R & D reports issued	23	25
Document classification changes	624	521
Books circulated	2,149	2,237
Periodicals circulated	12,203	10,707
Volumes added to the collection	326	353

Manager,
LABORATORY AUXILIARIES

JL Boyd:po

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-48741

FEBRUARY 1957

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, AEC-2-23X-56-L-2		Reactor & Fuels	$140,000	$120,000 / 5-11-56	100 / 100	0 / 2	5-23-56 / 12-7-56	As Completed	3-28-56 / 8-1-57**
CG-664	350° C Flow Loop - 314 Bldg.	REMARKS: A revised proj. prop. is being approved in HLO requesting changes in methods of work performance, schedules and total project funds. Proposed method of work is for procurement by G.E. forces and fabrication and installation by Constr. Operation. The firm estimates that have been obtained using this method indicate cost savings and improved schedules as compared to offsite procurement of a package 350° C Flow Loop. **Lump sum Contractor installed deionizer completed 1-31-57.							
General Plant Projects - FY 1957, AEC 2-23-57-N-2		Radiation Protection	$150,000	$150,000 / 2-4-57	Not Schd. / 0	Not Schd / 0	2-18-57 / 7-30-57		6-1-57 / 12-31-57
CA-658	Shielded Personnel Monitoring Station (747 Building Addition)	REMARKS: Method of steel procurement not yet decided. Work Authority Number CA-658 (1) authorized G.E. $5,000 to perform minimum scoping, prepare design criteria for an A-E contract, preliminary and final acceptance and field inspection. Work Authority CA-658 (2) authorized G.E. and additional $1,000 to provide preliminary design of the monitoring cell.							
CG-580	Corrosion Testing Facilities - 314 Building	Reactor & Fuels	$140,000**	$29,500* / 9-24-56	100 / 100	Not Schd / Not Schd	10-3-56 / 3-20-57*	11-28-58*	1-25-57 / 1-20-58
		REMARKS: Design is completed on schedule: A revised project proposal is being prepared requesting construction funds. A final project cost estimate based on complete design, will be utilized in the revised project proposal. * Interim authorization only for design and procurement. **Total $171,000 includes $31,000 capital equipment transfer.							
CA-685	Alterations to Buildings 325 and 326	HLO	$23,000	$23,000 / 10-4-56	100* / 100*	0 / 0	10-1-56 / 4-9-57		11-14-56** / 8-15-57
		REMARKS: 325 Building - Otis Elevator Company performing design & fabrication for 325 elevator. To be completed by June 1957. Work to start about 5-17-57 and to be completed by 7-4-57. 326 Building - Contract 1172 awarded Patton and Hill for $8,261. Notice to proceed issued 1-18-57. Field work expected to start by mid-March. Contract completion date: 5-17-57. *G.E. portion of design only. **Actual date.							
CA-700	Geological and Hydrological Wells	Chemical Research	$137,000	$137,000 / 10-24-56	100 / 100	4 / 8	11-8-56 / 10-24-56	As Wells are compld.	1-15-57 / 12-10-57
		REMARKS: USGS Wells USGS crews resumed drilling on this project. Two drilling rigs are currently drilling wells at the BX Tank Farm site in 200-E area and at Z facility in 200-W Area. Fixed Price Wells Invitations to bid and bid assemblies issued.							

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.
CA-728	High Level Exposure Facility Addition - 141-H Building	Biology Research	$26,000	$26,000 / 2-11-57	NS / 0	NS / 0	3-11-57 / 9-15-57	12-11-57	7-15-57 / 1-11-58
		REMARKS: Directive AEC 103 dated 2-11-57. Work Authority CA-728 (1) authorized G.E. $2,000 to perform preliminary scope, prepare design criteria, review A-E drawings, perform field inspection, evaluate property, perform final acceptance and as builts. Detail design will be performed by L.S. Architect-Engineer.							
CG-729	Ventilation System Improvements 222-U Building	Chemical Research	$73,000	Pending / Pending	0 / 0	0 / 0	6 wks.* / 10 mo.*	15 mo.*	3 mo.* / 18 mo.*
		REMARKS: Awaiting project proposal approved by Washington - AEC. *After authorization.							
B-5776	Effluent Engineering Test Facility	Chemical Research	$125,000*	Pending / Pending	0 / 0	0 / 0	To be est. / To be est.	To be est.	To be est. / To be est.
		REMARKS: Preparation of project proposal resumed. *Order of magnitude estimate only. Project Cost Estimate currently being prepared.							
CG-733	Plutonium Metallurgy Facility Expansion	Research & Fuels	$295,000	None to date / None to date	Not Schd. / *	Not Sch. / *	1 mo.** / 1 mo.**	As compl.	4½ mo.** / 13 mo.**
		REMARKS: This project has been approved by General Electric Co. HAPO, and was transmitted 1-25-57 to AEC (HOO) for approval. * To be established. **After authorization.							
	Biology Controlled Activity Water System - 100-F Area	Biology Research	$15,000*	Pending / Pending	0 / 0	0 / 0	To be est. / To be est.	To be est.	To be est. / To be est.
		REMARKS: Project proposal being prepared. *Order of magnitude estimate only.							

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 / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	*PROJECT COMP. DATE DESIGN / CONST.
Equipment Not Included in Construction Projects		Reactor & Fuels	$131,000	$120,000 2-7-57	97 60**	0 0	5-1-56 6-1-57	8-31-57	4-1-57 9-30-57
CG-620	Melt Plant Modifications - 306 Bldg.* *New Title - Vacuum Furnace	REMARKS: Installation design has been delayed due to lack of vendors shop drawings. Repeated expediting by phone, telegrams, letters and personal calls has not effected receipt of complete information. The directive for Revision 2 of the project proposal was received this month. An alteration to the purchase order for the centrifugal casting was mailed to the vendor. Present indication design will meet **Behind schedule due to vendor information/. completion date.							
Equipment Not Included in Construction Projects		Reactor & Fuels	$147,000	$135,000 3-15-56	81 95	Not Schd. Not Std.	3-27-56 Undet. *		4-1-57 9-30-57
CG-660	Modifications and Additions to Metallographic Cell - 327 Bldg.	REMARKS: Detailed cell design has been routed for comments. A revised project proposal requesting an extension of completion dates is currently being routed through HLO for approvals. *Project Proposal starting date 12-29-56.							
CG-661	Additional Heat Generation Facility - 189-D Bldg.	Reactor & Fuels	$700,000	$22,400* 11-13-56	Not Schd.** 8	Not Sch.** Not Auth.	12-6-56* Not Est.	*	To be est. To be est.
		REMARKS: Information has been received from suppliers of the required equipment and is being transmitted to drafting. Methods of design are being reanalyzed in light of this information. New cost estimates have been obtained and a decision will be made as to continue design utilizing germanium rectifiers or motor generators. *Interim authorization for preliminary design only.**To be est. March 11.							
CG-672	Monochromatic Neutron Beam Facility - 105-KE Bldg.	Physics & Instr.	$195,000	$112,000 5-1-56	100 100	Not Sch. Not Std.	5-21-56 Undet.	5-15-57*	10-1-56 6-30-57
		REMARKS: *A revised project proposal for additional funds and an extension of the completion date was approved by HAPO and transmitted to AEC on February 19, 1957. An order has been placed with the Puget Sound Naval Shipyard for a spectrometer casting for $29,950.							
CG-681	Hanford Equipment in the ETR	Reactor & Fuels	$1,200,000	600,000* 2-8-57	75 83	Not Sch. Not Std.	9-17-56 Not est.	*	5-29-57 8-15-58
		REMARKS: A directive was received in Feb. from AEC for additional funds and establishing a completion date. Design is on schedule. As a result of negotiations this month. Phillips Petroleum and I.O.O.-AEC have requested that G.E. perform all procurement. Requisitions for engineered equipment and materials are being prepared by G.E. *G.E. 550,000, AEC $50,000 for partial procurement and complete design.							

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-49741

FEBRUARY 1957

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-682	High Level Cut Off and Examination Cell - 327 Bldg.	Reactor & Fuels	$355,000	$30,500* / 2-1-57*	** / 58	0 / 0	7-18-56 / 6-57	*	6-26-57 / Not est.
		REMARKS: *Directive HW-390 Modification 1 authorized G.E. an increase in design funds for the rescoped cell. Interim authorization for design only. **Schedule being revised.							
CA-695	Radio Telemetering Network	Physics & Instr.	$89,000	$89,000 / 1-10-57	N.S. / 0	N.S. / 0	2-21-57 / 7-25-57	4-15-58	4-25-57 / 5-15-58
		REMARKS: Preparation of design criteria started. Design, fabrication, and installation to be performed by a fixed price contractor.							
New Construction - FY 1958		Physics & Instr.	$2,000,000	None to date / None to date	Not Sch. / 0	Not Sch. / 0	1 mo.** / *	*	* / *
CG-731	Critical Mass Laboratory	REMARKS: The project proposal for advance engineering funds in the amount of $60,000 was transferred to AEC in January 1957. * To be established. ** After authorization.							
None	Metallurgical Development Facility	Reactor & Fuels	$4,200,000	None to date / None to date	Not Sch. / 0	Not Sch. / 0	** / **	**	** / **
		REMARKS: Project Proposal undergoing approvals in HLO for a request of $60,000 in funds. * For scoping and initiation of detailed design. **To be established.							
B-5848	Plutonium Fabrication Pilot Plant	Reactor & Fuels	***$4,275,000	None to date / None to date	Not Sch. / Not Sch.	Not Sch. / Not Sch.	** / **	**	** / **
		REMARKS: Project Proposal is being prepared to request funds in the amount of $100,000.* *For scope design only. **To be established after scope work. ***Order of magnitude estimate.							

LABORATORY AUXILIARIES MONTHLY REPORT
FEBRUARY, 1957

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 & Bldgs. Visited
M. J. Sanderson R. T. Pennington	2/14,15	General Electric, APED, San Jose	Discuss fuel element development and reactor design concepts.	R. W. Benoliel	Yes	713, 700 762, 700 326, 300
G. Winders E. Burkholder R. D. Pierce	2/18-20	Babcock & Wilcox, New York, N. Y.	To discuss philosophy of plant design and techniques of remote operation and maintenance.	R. W. Benoliel	Yes	3760, 300
H. C. Clare	2/7/57	Public Health Service, Portland	Columbia River Advisory Group Meeting	R. E. Rostenbach	Yes	325, 300
E. C. Jensen	"	St. Dept. of Health Seattle 4, Wn.	" " "	"	"	" "
R. James	"	St. Dept. of Health Spokane, Wn.	" " "	"	"	" "
C. M. Everts, Jr.	"	Oregon St. Board of Health, Portland	" " "	"	"	" "
K. H. Spies	"	Oregon St. Board of Health, Portland	" " "	"	"	" "
E. F. Eldridge	"	Pollution Control Comm., St. of Wash. Olympia, Wn.	" " "	"	"	" "
W. W. Saxton	"	Pollution Control Comm., St. of Wash. Olympia, Wn.	" " "	"	"	" "

VISITS TO OTHER INSTALLATIONS

None

General

On February 28 the staff of the Hanford Laboratories Operation totalled 1176, including 475 exempt and 701 non-exempt employees. Of the total exempt personnel there were 415 with college degrees, including 398 technical degrees as follows:

BS	MS	PhD
201	102	95

In addition there were 36 non-exempt employees with degrees.

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

Personnel Development and Communications

The Key Personnel Appraisal procedure was established in conjunction with the Key Personnel Inventory. The preparation of initial records on HLO personnel will be performed during the coming ten months.

The Armed Forces Special Weapons Project training program was concluded on February 15. Comments received from the 17 participants indicate that the HLO training course fulfilled its intended purpose.

Thirteen HLO exempt employees attended the "Management Orientation" program conducted by Relations and Utilities.

Seven machinist trainees from Technical Shops Operation will participate in the Craft Training Program being conducted by Fuels Preparation Department. Three welders have been scheduled to attend a two-week welding school conducted by Construction Engineering Operation.

At month's end 27 Technical Graduates and 22 Technician Trainees were assigned within Hanford Laboratories.

Eight technical papers, signed articles and speeches were processed during the month.

The Manager's annual information meeting was held on February 20. In addition three management luncheon meetings were held during the month with a total of 88 exempt personnel in attendance.

Personnel Practices

Suggestions - At the February meeting of the Suggestion Board, 14 suggestions were reviewed and 12 were adopted. Nine of the suggestions represented intangible savings and 3 represented savings totalling $1213.74. A total of $205.00 was granted in awards.

During February, 35 suggestions were received from Hanford Laboratories employees representing 5 suggestions submitted per 100 eligible employees.

Selective Service - All of the military survey questionnaires have been re-

Personnel Practices (continued)

turned, the results tabulated and HLO records brought up to date. There are currently 204 employees subject to military service of which 78 are reservists or National Guard members and 106 are non-veterans.

Benefit - - Hanford Laboratories Operation participation in the employee benefit plans is as follows:

	Feb.	Jan.
Pension Plan	97.6	97.5
Insurance Plan	99.4	99.2
Savings & Stock Bonus Plan	58.7	58.9
Savings Plan	8.1	8.2

Placement and Records - At the end of the month there were 8 openings remaining uncommitted. All other openings are either on a "hold" basis or have been committed by arrangements for transfers.

Current openings include one secretary "B", one General Clerk "C", two Draftsmen and four Machinists.

During the month Hanford Laboratories Operation transferred 5 non-exempt employees to other components and 8 employees transferred into HLO from other components.

Fifteen attendance recognition awards were issued during the month including two one-year, five two-year, four three-year, two four-year and two five-year awards.

Thirteen service recognition pins were issued during the month including nine five-year and four ten-year pins.

Technical Personnel Placement

Technical personnel placement activities are summarized in Table III.

Four HLO employees participated in the campus BS/MS recruiting conducted by Relations and Utilities. There was no active campus PhD recruiting conducted during the month.

The recruiting of new graduates at the BS and MS levels (Relations and Utilities) is progressing favorably in view of the intensive competition being encountered on the campuses. It is expected that total acceptances will under-run estimated requirements for the Technical Graduate program. However these requirements are believed to be somewhat unrealistic.

Six professors have accepted Summer Program offers for assignment within the Laboratories and will be reporting during June. Included in this number are two metallurgists, two mechanical engineers, one chemical engineer and one chemist.

Technical Personnel Placement (continued)

The status of exempt transfers is summarized in Table IV. An increase in transfer requests was noted during the month with five new requests and two cases reactivated.

Union Relations

Two grievances were received during the month of February. Both were presented by Radiation Monitor Journeymen. In each case the Step I answer was not acceptable and Step II answers have been given to these grievances.

The grievances processed since September 1, 1956 now total 17 and are summarized in Table V.

Salary and Wage Administration

The addition of a secretary to the staff of Salary and Wage Administration brought that group up to authorized strength.

The audit of exempt salary positions in accordance with the Company Salary Administration Plan was undertaken by the Specialist, Salary Administration. The program will cover a minimum of 50 per cent of all HLO positions to be completed by the end of calendar year 1957.

A discussion of current appraisals appears to be going on schedule. At month's end, 325 individual appraisals of the 470 odd total have been forwarded for insertion in Salary files.

George Devereaux, Flight Propulsion Laboratory Department, AGT Division, visited Hanford on February 27-28 for salary reconciliation work. The meeting proved very fruitfull with 21 positions reconciled out of 27 discussed.

The revised Secretarial Plan was approved by the Atomic Energy Commission to be effective January 28, 1957. Basic ground rules and formal plan was forwarded to all managers and supervisors during the month. The Specialist, Wage Administration will be responsible for integrating all HLO secretaries into the new plan.

Health and Safety

In February, Laboratories personnel worked a total of 185,176 employee hours with no disabling injuries. There were 32 medical treatment injuries with a frequency of 1.73 as compared to 1.83 for the previous month. The frequency for the year to date is 1.61.

An injury required hospital treatment but caused no disability when an employee of Technical Shops caught his thumb in a milling machine.

Of the first 200 medical examinations scheduled this year for Hanford Laboratories Operation personnel, 84% were completed.

Security

There were 8 security violation incidents processed making the 1957 total 21 to date. To keep the HLO total below the year's ceiling of 82, an average of 6 or less per month must be maintained for the remaining 10 months.

Manager
Employee Relations

T.G. Marshall:vf

TABLE III. EMPLOYMENT - TECHNICAL PERSONNEL STATUS

I. Employment

Non-Exempt Employment Status	Jan.	Feb.
Requisitions		
At end of month	49	39
Cancelled	2	1
Received during month	21	10
Filled during month	22	19
Candidates Considered		
Total applications	31	16
Total Transfer Request from other at HAPO	10	7
Total Interviewed	7	5

Non-Exempt Transfer Requests	Jan.	Feb.
Transfer Cases		
Active Cases at end of month	41	43
Cancelled	3	1
New during month	12	6
Transfer effected	7	3
Planned Transfers		
Effective during month	4	2

II. Technical Personnel Placement

PhD Recruiting

	Cases Considered	VISITS TO RICHLAND: Extended	Visited	To Visit	Open Invite.	OFFERS: * Extended	* Accepted	* Open	On The Roll
Engineering:									
Chemical	53	28	3	13	6	2	-	2	-
Electrical	16	7	-	2	5	1	-	1	-
Mechanical	14	7	2	-	4	2	1	-	-
Metallurgical	36	22	4	3	12	4	1	1	-
Civil	2	-	-	-	-	-	-	-	-
Science:									
Chemistry	187	72	8	32	18	8	1	4	1
Physics	203	99	10	26	47	11	3	5	2
Math-Stat.	36	12	-	2	7	-	-	-	-
Other	33	10	5	2	2	4	3	-	-
DVM	2	1	1	-	-	1	1	-	1
TOTAL	561	258	33	80	101	33	10	13	4

*Includes 13 carry overs with 5 acceptances not on the roll as of 9/1/56 and 8 open offers at that time

BS/MS Experienced Recruiting

	Cases Considered	VISITS TO RICHLAND: Extended	Visited	To Visit	Open Invite.	OFFERS: Extended	Accepted	Open	On The Roll
Engineering:									
Chemical	13	7	4	-	1	-	-	-	-
Electrical	15	10	2	2	3	1	1	-	1
Mechanical	16	13	7	2	1	3	1	1	1
Industrial	4	2	2	-	1	2	1	1	1
Metallurgical	10	7	2	2	1	2	2	-	1
Ceramic	3	3	3	-	-	3	1	2	1
Other	7	3	1	-	1	-	-	-	-
Science:									
Chemistry	18	5	1	-	1	1	-	-	-
Physics	8	5	3	1	-	2	1	-	-
Math-Stat.	4	3	3	-	-	3	2	1	2
Other	17	1	1	-	-	-	-	-	-
TOTAL	115	59	29	7	9	17	9	5	7

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IV. Exempt Transfer Cases

		Feb.	Jan.
Active cases at end of month		20	19
Total Cases since 9/1/56		55	50
(Includes those initiated prior to 9/1/56)			
Initiated by employee	39		35
Initiated by management*	16		15
New cases during month		5	2
Initiated by employee	4		1
Initiated by management*	1		1
Cases re-activated during month		2	0
Cases closed during month		6	6
Transfers effected: Within HLO	1		1
Within HAPO	0		1
Other G.E.	3		2
Requests withdrawn	2		0
Terminated	0		2

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

V. Union Relations

Grievances Processed - September 1, 1956 to date.

Total processed 17 (includes 1 non-unit grievance)

Step I

Pending Step I Answer	0
Answered Satisfactorily*	7
Pending time limit	1

Step II

Pending Step II Discussion	0
Pending Step II Answer	3
Answered	
Satisfactorily**	6
Unsatisfactorily	0
Applied for Arbitration	0

*Step I grievances which Council indicated a desire to discuss at Step II but 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.

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company or organization represented & address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
George Devereaux	2/27 & 2/28/57	General Electric Co. New York, New York	Salary reconciliations	H. A. Paulsen	No	703
C. H. Griffin	2/4/57	General Electric Co. New York, New York	Consultations on Personnel Practices	A. P. Hudspeth A. H. Brandt	No	W-10
	2/6/57			D.C. Fleckenstein J.B. Thompson R.H. Scott	No	3703

VISITS TO OTHER INSTALLATIONS

None were conducted by Employee Relations personnel during February.

FINANCIAL OPERATION MONTHLY REPORT
February, 1957

Compiled by Members of the
FINANCIAL OPERATION
HANFORD LABORATORIES OPERATION

Activities

General

Traveling auditors from Accounting Services began their audit of Hanford Laboratories Operation during February.

General Accounting Operation

A summary of AEC Manual revisions and additions received in January was issued to HLO Level 2 and 3 managers. Similar summaries will be issued each month in the future.

Overtime control limits for the current quarter were established by the Manager - Hanford Laboratories, based on forecasts by Level 3 managers.

A physical inventory of Melt Plant facilities was taken February 4, 1957 in connection with the proposed transfer to Plant and Equipment Not Used or Currently Useful. Subsequent plans provide for possible transfer of part of the facilities to Chemical Processing Department.

Responsibility for control and pricing of declarations of excess issued by Hanford Laboratories was transferred from Relations and Utilities Operation.

S. B. Gire, Business Graduate on rotational training, transferred from work on general books and expense accounts to work on property accounting.

Cost Accounting Operation

Tentative budget estimates of personnel by components and assignments for periods through June 30, 1959 were submitted by Level 3 components, reviewed by the Manager - Hanford Laboratories, and submitted to Contract Administration. More firm estimates are dependent upon decisions as to levels of HAPO research and development and the allocation of the work among HAPO components.

The following FY 1957 budget adjustments have been made since the Midyear Budget Review:

1. Increase of $72,500 (from $805,000 to $877,500) in budget for Plutonium Recycle Program research and development.

2. Transfer of $100,000 from Irradiation Processing Department for services associated with zirconium procurement.

3. Transfer of $90,000 from Chemical Processing Department for fabrication of production models and related activities associated with the 3000 Program.

4. Transfer of $75,000 from Fuels Processing Department for research and development.

Personnel Accounting Operation

A cost of living pay increase for most non-exempt employees, effective January 26, 1957, was reflected in pay checks delivered February 8, 1957. The increase represented 1.18% of base pay and isolation rates and will increase annual pay approximately $33,000.

Auditing

The Specialist - Auditing continued to assist the traveling auditors from Accounting Services, on a loaned basis.

Office Procedures

A systems study of Cost Accounting Operation by the Specialist - Office Procedures was nearly completed at month-end. Procedures assistance was provided to Personnel Development and Communication in a study of a record file system for personnel inventory data.

Payroll Statistics

Changes during month	Total	Exempt	Non-Exempt
Employees on payroll at beginning of month	1 175	472	703
Additions and transfers in	19	4	15
Removals and transfers out	(18)	(6)	(12)
Transfers from weekly to monthly payroll-net	-0-	5	(5)
Employees on payroll at end of month	1 176	475	701

Gross payroll paid	February	January
Exempt	$341 513	$333 128
Non-exempt	274 496	265 556
	$616 009	$598 684

Overtime payments		
Exempt	$ 4 282	$ 4 043
Non-exempt	10 557	8 162
	$ 14 839	$ 12 205

Insurance claims paid

	February Number	February Amount	January Number	January Amount
Employee				
Life	-0-		-0-	
Weekly sickness and accident	15	$1 255	19	$2 408
Comprehensive medical	65	5 115	62	8 174
Dependents				
Comprehensive medical	154	9 928	83	5 558
	234	$16 298	164	$16 140

Good Neighbor Fund

	February	January
Number participating	807	826
Percent participating	68.6%	70.3%

Other Statistics

Cash advances and travel expenses

Advances outstanding at beginning		$11 538		$10 793
Advances issued - by checks	38	6 298	34	6 044
- by cash	18	2 190	41	6 821
- air travel order		2 793		7 040
		22 819		30 698
Less:				
Expense vouchers processed				
Travel expense accounts	33	8 394	50	12 874
Other (movement of household goods, conference expense, etc.)	25	570	14	263
Refunds of advances	29	3 380	42	5 538
Billing to and from HAPO components - Net		603		485
		12 947		19 160
Advances outstanding at close	31	$ 9 872	32	$11 538
Ages of advances outstanding				
15 days or less	29	$ 9 352	26	$ 8 126
16 - 30 days	2	520	6	3 412
		$ 9 872		$11 538

Project proposals and appropriation requests

	Project proposals	Appropriation requests
On hand beginning of month	-	-
Received	1	6
	1	6

Project proposals and appropriation requests (Cont.)

	Project proposals	Appropriation requests
Recommended for approval	1	5
Returned for rewrite	-	1
	1	6
On hand at close of month	-	-
Appropriation requests receiving final approval during month		
Number		10
Amount		$35 156

J. P. Holmes

J. P. Holmes:bb
3-11-57

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. H. Kleinpeter	High Viscosity Fluid for Use in Radiation Fields
H. G. Rieck L. C. Schwendiman	An Automatic Isotope Analyzing Monitor
J. L. Hepworth R. L. Moore	An Electrolytic Process of Application in the Packaging of Radiocesium
J. C. Sheppard	Processes for Neptunium Recovery
A. S. Wilson	Control of Ruthenium in Separations Processes
E. C. Watts	High-Volume Aspirator for Conveying Radioactive Liquids
R. H. Sommerville	Crank Case Drain Plug Oil Heater
L. F. Kocher	Mechanized Film Badge Processing
F. L. Rising	The Application of Clock or Timer Movements as Operating Time Indicators for Use in Portable Instruments

H. M. Parker

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BATE NUMBER

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INADVERTENTLY SKIPPED