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PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

APRIL 1959

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Compiled by Members of the
PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION
HANFORD LABORATORIES OPERATION

Submitted by: P. F. Gast

May 12, 1959

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By JE Sandy 3-7-94

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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATIONMONTHLY REPORTAPRIL 1959**DECLASSIFIED**FISSIONABLE MATERIALS - 2000 PROGRAMFUELSNuclear Safety in the Fuels Preparation Department

A meeting was held with members of the Fuels Preparation Department to discuss nuclear safety criteria for the design and operation of a co-extrusion plant for the manufacture of NPR fuel elements. The Fuels Preparation Department are now making a study of these criteria and will submit detailed processing requirements at a later date so that the nuclear safety of the process can be analyzed.

Nuclear safety in the co-extrusion of 1.6 percent U-235 enriched uranium was also discussed. Operating procedures have been submitted and will be analyzed for nuclear safety. The project involves the manufacture of 3.5-inch diameter billets at Fernald. These billets are then to be shipped to Hanford for cladding in Zircaloy-2 and copper tubing. They will then be shipped in wooden boxes to Nuclear Metals, Inc., where the billets will be coated with a graphite slurry, heated to 1150-1200°F and then extruded into long tubes of 0.580-inch diameter. The rods will then be cut to about 17-foot lengths, put in wooden boxes and shipped back to Hanford.

REACTORSTUDIES RELATED TO PRESENT PRODUCTION REACTORSLattice Neutron Temperature Study

The first part of this study has been completed and is reported in the January, February, March Nuclear Physics Research Quarterly Report.

Thermal Neutron Flux Spectrum Near a Temperature Discontinuity

The IBM 709 FORTRAN program to obtain numerical results for the analytic solutions to the temperature discontinuity problem has been debugged and checked on two simple cases. This program will perform calculations in all three of the infinite geometries for which analytic solutions have been found--plane, slab, and cylindrical. Although the basic program operated satisfactorily on the check cases, the desirability of several changes, principally in input and output features, has been revealed.

Neutron Energy Spectrum Near a Temperature Discontinuity

The theoretical analysis of the experimental work has been completed on neutron exchange between equilibrium thermal neutron energy distributions near a temperature discontinuity in graphite. The results are at present only in graphic

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form and final evaluation of the precision of the results is not available yet.

Instrumentation

The input address logic and core drive units of the simple computer, using magnetic cores has been tested and debugged. This unit works satisfactorily and only few changes and improvements are foreseen. Work is continuing on the development of core readout register drives and arithmetic units along with inhibit drives for write-in.

The stack effluent gas monitor for the 100-D stack was installed and was operated for two weeks. The detector is a NaI crystal and phototube in a 10-inch diameter hollow aluminum sphere. Gas flow through the sphere is two to three CFM. Several satisfactory spectrum analyses (gamma energy) have been obtained. Viewing only the photopeak portion of I^{131} , the original count contribution was about 250 c/m. After two weeks of operation, this level is now up to about 375 c/m indicating slight contamination within the sphere. None of the gamma energy spectrum analysis data have shown any clearly discernible energy peaks to date. However, we are waiting for a slug rupture to occur to provide us with better data. Some 110 VAC line transient and stack house heat problems have occurred indicating that the counting equipment should be changed to another building if possible. The air temperature in the 105-D stack house was between 110°F and 120°F on April 22, 1959.

A complete five-probe scintillation monitoring and alarm system was designed for the 100 Areas for use on the elevators. The system incorporates five probes cable-connected to the main indicating and recording instrument. Any range can be covered, by high-voltage changes, from a first range of 0-10 mr/hr up to 0-10 r/hr. Two-inch by two-inch terphenyl-in-polyvinyltoluene detectors are used giving an approximately gamma energy independent system above 90 Kev. Each probe has an indicating meter and alarm light and the central station comprises five indicating alarming meter relays and a recorder. The remote probes are set up to be either bracket-mounted on the elevator or hand-held for close work. The incorporated probe meter continuously tells the individual holding the probe what the dose rate is. All range switching is done at the control or central station.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Lattice Measurements for Large Diameter Fuel Elements

The exponential pile program of measurements on lattices using 1.92-inch and 2.5-inch solid fuel elements is now nearing completion.

The material bucklings listed in Table I have been measured this month. Note should be taken that one lattice has a tube and tube fuel assembly. The program now involves the simultaneous measurement of bucklings in two exponential piles.

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<u>Fuel Element</u>	<u>Lattice Spacing</u>	<u>Buckling (10^{-6} cm^{-2})</u>	<u>Volume Ratios</u>		
			<u>Al/U</u>	<u>H₂O/U</u>	<u>C/U</u>
2.50 inch solid	14 9/16 Dry	+ 92	0.185	--	41.58
1.92 inch solid	12 3/8 Dry	+ 108	0.264	--	51.31
2.5 x 2.0 with 1.66 x 1.1	14 9/16 Dry	+ 57	0.487	--	68.46

These buckling values are tentative using an estimated side extrapolation distance, λ , of 1.66 inches and a front-to-rear extrapolation distance of 1.03 inches. Horizontal traverses have been taken to determine the actual λ .

Analysis of several horizontal traverses involving 1.92-inch and 2.50-inch fuel elements has been completed. Final bucklings are shown in Table II. The same front-to-rear λ of 1.03 inches has been used for each lattice. The values of λ tabulated seem to have rather large deviations from pile to pile, although the measurements were made with care.

TABLE IIFINAL BUCKLING VALUES

<u>Fuel Element</u>	<u>Lattice Spacing</u>	<u>Buckling (10^{-6} cm^{-2})</u>	<u>Side to Side λ (inches)</u>	<u>Volume Ratios</u>		
				<u>Al/U</u>	<u>H₂O/U</u>	<u>C/U</u>
1.92	6 3/16 Dry	-400	1.20	0.264	--	11.64
1.92	6 3/16 Wet	-186	1.34	0.264	0.288	11.64
1.92	8 3/8 Dry	+ 67	1.55	0.264	--	22.65
1.92	8 3/8 Wet	+ 65	1.55	0.264	0.288	22.65
2.50	8 3/8 Dry	-199	1.30	0.185	--	12.67
2.50	8 3/8 Wet	- 60	1.55	0.185	0.403	12.67
2.50	10 3/8 Dry	+ 88	1.59	0.185	--	20.31
2.50	10 3/8 Wet	+ 49	1.41	0.185	0.403	20.31
2.50	12 3/8 Dry	+108	1.68	0.185	--	29.58
2.50	12 3/8 Wet	+ 28	1.95	0.185	0.403	29.58
2.50	14 9/16 Wet	- 29	1.29	0.185	0.403	41.58

Coordinated Theoretical - Experimental Program

The direction of previous effort in correlating theory with exponential pile data has been toward using various approximations in microscopic lattice theory. This approach implicitly assumes that the experimental values, as determined by

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the conventional procedure, are correct. The validity of this assumption for heterogeneous lattices, particularly in small exponential assemblies, is being examined.

Experimental work on the effect of void channels on the diffusion area has recently been summarized in Power Reactor Technology 2 14 (1959), with the conclusion that measurements on graphite assemblies confirm the theory of D. J. Behrens. For the case of neutron streaming perpendicular to the channels, an alternative diffusion theory expression obtained previously (Monthly Report, May 1958) has been used to obtain the values of $(L/L_0)^2$ diffusion in the following table. The subscript o refers to the solid graphite; homogeneous refers to the case of void dimensions small compared to a mean free path in the graphite, so that a simple density correction is sufficient. In the expression due to Behrens, r/λ is the ratio of hydraulic diameter of the void to graphite mean free path, and $Q = 1.33$ for a circular cross section and 1.49 for a square.

Experiment	A. P. Schmitt, et al, Second Geneva Conference, A/Conf. 15/P/1191	L. Seren ANS Meeting Dec. 1958 Paper 3.6
Void Cross Section	Circular, 7 cm. diameter	Square, 11.38 cm. sides
$O = \frac{\text{void volume}}{\text{graphite volume}}$	.106	.333
$(L/L_0)_{\text{homogeneous}}^2 = (1 + \phi)^2$	1.223	1.78
$(L/L_0)_{\text{diffusion}}^2 = (1 + \phi)(1 + 2\phi)$	1.340	2.22*
$(L/L_0)_{\text{Behrens}}^2 = 1 + 2\phi(1 + \frac{3}{8} Q \frac{r}{\lambda})$	1.353	2.33
$(L/L_0)_{\text{experimental}}^2$	1.393 $\pm$.045	2.26

* Calculated for a circular cross section; the actual square cross section should lead to a slightly higher value.

It should be emphasized that the agreement of the diffusion result with experiment is of questionable significance since the derivation does not apply to the case of a void region. However, it suggests that the diffusion expression may be valid over a wider range than its derivation would indicate.

NPR Lattice Measurements

Bids have been received on the graphite to be used in the exponential pile which will be loaded with NPR fuel elements.

Intercalibration of Graphite Purity

The moderating effect correction to the PCTR graphite absorption cross section measurement is still uncertain. Isotopic analyses of two samples of the D₂O

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used in determining the correction are now available, but the results of the analyses are confusing and appear to be in error in some manner. Another D₂O sample will be analyzed to eliminate this difficulty.

A document describing this program in some detail has been prepared for publication in the open literature and will be submitted after all the results are final.

Mechanism of Graphite Damage

The measurement of the energy loss in thin foils required measuring a small difference between two large numbers. The stability of the system required for this is being checked again. An attempt is being made to measure the heat increment of the foil directly so that the difference measurement may be avoided. The Wheatstone bridge used for temperature measurement was rearranged to improve the response time at the expense of some loss in sensitivity.

Computational Programs and Services

The Exponential Data program has now been checked out and is operational. The P-3 subroutine for the IPD lattice parameter calculation program is nearly complete, the most difficult part having been debugged.

a. Least Squares Program (Linear Regression Only)

The code will handle any regression problem which is reducible to linear form. For example, $y = a x^2 + b$ is linear if the variable x^2 is evaluated and entered as, say, z . Exponential regression analysis is handled with a single "statement" of "do take logarithms." In all cases the code will do a weighted regression analysis using specified weights only. The output gives constants of the linear expression and their errors. One case specifies the confidence level of the solution by stating the students "t" test parameter f_{n-2}, α .

b. EXPOG Program

This is a special code written specifically for evaluation of a thermal activity function in the graphite core of the PCTR. It does however have wide application. The general form of the calculated expression is

$$y = A e^{\alpha x} + B e^{\beta x} + C e^{\gamma x} + D e^{\delta x} + E x^2 + F x + G.$$

All constants A, B, . . . , α , β , . . . , etc. are to be specified and, of course, may be zero. The code evaluates the function y for integral values of x. The range of the independent variable x may be specified.

c. NEUTHERM Program

The code was written to solve the matrix of the coefficients of the solutions to a set of four simultaneous plane diffusion equations for a two region, two thermal group problem. It calculates the thermal activity of a 1/v detector in both regions, compares the calculated curve with a corresponding experimental curve point by point to obtain the residual sum of

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squares of the fit, and repeats the solution a specified number of times. The repeating of the solution is an iteration process on a coupling coefficient between the original differential equations. The interval of iteration is specified initially and thereafter is reduced by a factor of 10 as necessary to obtain the minimum residual sum of squares or until the specified number of iterations has been performed. The output is the input, the final iteration, and the flux curve or all iterations and flux curves, as specified. This code was written by R. A. Cahoon of IPD.

d. Multi-Thermal Neutron Group Diffusion Program

Attempts have been made to develop a program capable of dealing with one fast group and two thermal groups, using a three-group program, $F_3^{(1)}$, as a basis. The FORTRAN listing for F_3 is given in (1). Attempts to run test cases, using a deck as punched from the document listing have been unsuccessful, so this approach was dropped.

e. A Program for Analyzing PCTR Data

Descriptions of portions of the proposed program are being circulated to physicists using the PCTR. Subjects covered include:

1. Foil data analysis
2. Reactivity data analysis
3. Thermal absorption cross sections to be used in calculating k_{∞} and f .
4. Corrections for resonance absorption effects upon thermal traverses.
5. Computation of errors associated with all of the above.
6. Computation of the error in k_{∞} due to spectral mismatch.

The above have been written as individual subroutines. The input format in all cases has been kept as simple as possible. Remaining work involves figuring out a simple way of calculating average fluxes for the several regions in a cell and specifying the layout of the main program which ties all the subroutines together. Virtually no actual programming has been done.

STUDIES RELATED TO SEPARATIONS PLANTS

Critical Hazards Specifications

Nuclear Safety in Hanford Laboratories

A rough draft of general nuclear safety specifications was prepared.

Specifications have been issued for Critical Mass Physics governing the storage and handling of U²³⁵-Al alloy fuel elements, 1.44 percent and 1.6 percent U²³⁵ enriched I. and E. fuel elements, and 3.0 percent U²³⁵ enriched fuel elements.

(1) Keppler, J. G., and Orr, W. L., "Three Group Neutron Diffusion Calculation (Program F_3 -IBM 704)," XDC-58-7-18.

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At the request of the Plutonium Metallurgy Operation, a study has been made of the nuclear safety in storage and shipping of 7 percent Pu (by weight) - Al alloy fuels. These elements are one-inch diameter rods, five feet-two inches long. Each rod contains about 90 grams Pu. These fuel elements are being sent by air express to Savannah River. It was determined that an array of boxes containing a total of 168 of these elements would be safe under the following conditions:

- (1) Each box would contain 12 rods spaced on four-inch centers in three rows of four rods each.
- (2) The 12 rods are centered in a box whose cross section is 24 inches by 36 inches.

It is believed that these storage and shipping criteria have a safety factor of at least two.

E-Metal Program

Two meetings were held with members of the AEC-HOO to discuss the E-Metal Program, particularly the analysis made by PIRDO of the random loading of the E-Metal dissolver.

AEC-HOO Nuclear Safety Consulting

A meeting was held with a member of the Separations Branch, AEC, regarding nuclear safety in the shipment of a proposed weapon model. When a firm production schedule is made, a formal request for a nuclear safety shipping specification will be made.

Plutonium Critical Mass Laboratory

Invitation for bids, No. AT (45-1) - 1446, for construction of the Critical Mass Laboratory Facilities, 200-East Area, was issued by the AEC on April 8; bid opening was scheduled for May 6.

At the request of the Commission a concrete block structure was substituted in lieu of the 40 x 80 ft. metal excess Army mess hall which was to have been used for the control building. An addendum to invitation to bid was issued asking interested bidders to bid on this basis and extending bid opening date to May 20.

Radiation Levels for a Potential Criticality Incident at the Hanford Critical Mass Laboratory

A detailed calculation of radiation levels at various points at the proposed Hanford Plutonium Critical Mass Facility has been performed based upon a maximum burst of 3×10^{18} fissions. The purpose of this calculation was to confirm the prediction contained in HW-57603, dated September 30, 1958, "Preliminary Hazards Study of the Hanford Plutonium Critical Mass Laboratory," that "the reactor room walls and ceiling are of such thickness that the radiation dose to personnel in areas outside the reactor room to which access is permitted will be less than 100 mrem for a burst as large as 3×10^{18} fissions."

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The γ radiation was divided into four energy groups. The direct doses calculated are tabulated below.

<u>Location</u>	<u>Distance From Center of Reactor Room</u>	<u>Dose in mr</u>				<u>Total</u>
		<u>Group I (1 Mev)</u>	<u>Group II (2 Mev)</u>	<u>Group III (4 Mev)</u>	<u>Group IV (6 Mev)</u>	
Mixing Room	33 ft.	0.000073	0.0382	0.866	1.103	2.007
Control Room	66	0.000016	0.00896	0.212	0.270	0.491

The skyshine contributions were also calculated and are tabulated below:

<u>Location</u>	<u>Distance From Center of Reactor Room</u>	<u>Dose in mr (γ skyshine)</u>				<u>Total</u>
		<u>Group I (1 Mev)</u>	<u>Group II (2 Mev)</u>	<u>Group III (4 Mev)</u>	<u>Group IV (6 Mev)</u>	
Mixing Room	33 ft.	0.237	0.255	0.307	0.049	0.848
Control Room	66	0.248	0.268	0.332	0.051	0.899

<u>Location</u>	<u>Total γ Dose (mr)</u>
Mixing Room	2.86
Control Room	1.39

The neutron contribution to the total dose is less than 0.3 mrem, and hence is not presented with the foregoing. The calculations for both the neutron and gamma attenuation are based upon a multiple scattering calculation, and self-shielding by the source is neglected, thus lending a further degree of conservatism to the results.

Criticality Studies in Support of Processing Power Reactor Fuels

A series of experiments was initiated for the purpose of evaluating the extrapolation lengths of the water reflected heterogeneous lattices. These experiments were made with 3.063 percent enriched uranium rods of 0.300-inch diameter and 8 inches in length. Four of these elements placed in a lucite tube of 0.028-inch wall thickness constituted a fuel rod (32 inches in length).

Lattices of these rods in water were supported on a 3/4-inch thick aluminum plate. Four 1/2-gram RaBe sources were placed just below the aluminum plate so that sufficient flux would be available to irradiate 1/4-inch diameter, 0.005-inch thick gold foils. The loadings were taken to about 94 percent of critical. Horizontal neutron flux traverses were taken with both gold foils and BF₃ proportional counters. The flux traverse points were fitted by a least squares analysis to a J_0 function of the form $J_0(\alpha r)$, where α is the square root of the radial buckling and r is the true radial distance from the central axis of the lattice where the flux was measured. From this fit the extrapolated radius can be calculated. The difference between the extrapolated radius and the true radius is the extrapolation length. The preliminary results of these measure-

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ments are given as follows:

<u>Lattice Spacing</u>	<u>H₂O/U Volume Ratio</u>	<u>Extrapolation Length</u>	
		<u>BF₃ Measurement</u>	<u>Au Foil Measurement</u>
0.700 inch	5.00	6.2 cm.	6.1 cm.
0.800 inch	6.84	6.5 cm.	6.3 cm.

The critical masses for these 32-inch high loadings were also determined and measured bucklings compared with earlier calculations from 16-inch high loadings. The results are given as follows:

<u>Lattice Spacing</u>	<u>H₂O/U (Volume Ratio)</u>	<u>Measured Critical Mass (32-inch High Cylinder)</u>	<u>Measured Buckling (32-inch High)</u>	<u>Calculated Buckling (16-inch High)</u>
0.700 inch	5.00	355 lbs.	$14,599 \times 10^{-6} \text{ cm}^{-2}$	$14,778 \times 10^{-6} \text{ cm}^{-2}$
0.800 inch	6.84	312 lbs.	$13,262 \times 10^{-6} \text{ cm}^{-2}$	$13,383 \times 10^{-6} \text{ cm}^{-2}$

An extrapolation length of 6.5 cm was used in the buckling calculations.

Experiments were continued to determine reasons for the discrepancy between k_{∞} measurements involving polyethylene (CH₂) and water moderation for 3 percent U-235 enriched UO₃-moderator mixtures having the same effective H/U ratios. It was suspected that disagreement results either from improper care in the handling of the water moderated samples before analysis for water content or a possible difference in the resonance escape probability between the polyethylene and water-moderated systems at the low H/U ratios investigated.

The following experiments were performed to clear up this discrepancy.

- A measurement of k_{∞} for a polyethylene pellet (1/8-inch diameter sphere) moderated system at a nominal H/U = 4.
- A measurement of k_{∞} for a polyethylene powder moderated system at a nominal H/U = 4.
- A measurement of k_{∞} for a water moderated system at a nominal H/U = 4.
- A measurement of the resonance escape probability in the polyethylene pellet and water moderated systems.
- A measurement of k_{∞} for a water moderated system at a nominal H/U = 6.5.

The first three experiments (a-c) were conducted at an H/U = 4 since a large discrepancy between k_{∞} measurements of polyethylene- and water-moderated systems were found in earlier experiments. The experiment at an H/U = 6.5 was done to check a k_{∞} measurement near the maximum. The UO₃-H₂O mixture was prepared by adding a known weight of water to the UO₃ and mixing. Earlier mixtures were prepared by adding the H₂O to the oxide by means of steam. This mix-

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ture is now being analyzed for water content.

Preliminary calculations indicate that the k_{∞} measurements for polyethylene and water moderated fuels are in agreement. Further analyses of these data, as well as the resonance escape probability, are being carried out.

Criticality Calculations for Correlating Theory with Experimental Data

The study of the critical parameters for homogeneous systems of slightly enriched uranium fuel and moderator was continued. In the March Monthly Report theoretical calculations of k_{∞} for slightly enriched U-235 fuels and water were reported that were in good agreement with experiment. Neutron ages for these homogeneous mixtures were calculated according to the following equation:

$$\tau = \frac{\tau_0}{\left[\frac{\rho_M}{\rho_{M_0}} + \frac{\Sigma_{sl}^F}{\Sigma_{sl}^M} \right] \left[\frac{\rho_M}{\rho_{M_0}} + \frac{\Sigma_{tr}^F}{\Sigma_{tr}^M} \right]}$$

where

τ_0 = neutron age of the pure moderator

τ = neutron age of the system

ρ_M = density of moderator in system

ρ_{M_0} = density of pure moderator.

The superscripts F and M represent fuel and moderator, respectively, while Σ_{sl} and Σ_{tr} represent macroscopic slowing down and transport cross sections, respectively. The slowing down cross section is the sum of the inelastic scattering cross section and macroscopic slowing down power. The neutron age of pure light water was taken as 27 cm² as the use of this value for neutron age in a wide range of solution concentrations for highly enriched U-235 in light water resulted in critical mass calculations that were in good agreement with experiment.

Calculated critical parameters for homogeneous mixtures of UF_4 in paraffin were made and compared with experimental results. In these experiments the U-235 content was two percent of the total uranium. It was assumed that the neutron age of a pure moderator varied inversely as the product of the slowing down power and the transport cross section. Assuming water to have an age of 27 cm², paraffin would have an age of 17.6 cm². Had 32.29 cm² been assumed as the age of water, the corresponding age for paraffin would be 21.06 cm². This compares with 20.90 cm² using a modified age method and an IBM 704 multigroup program. The paraffin reflected extrapolation length was calculated to be 6.38 cm (assuming it to be inversely proportional to the transport cross section and that for a water reflector equal to 8 cm). Critical mass calculations using this method give results for paraffin reflected cylinders (diameters of 25-50 inches) that are 88-96 percent of experimental values at an H/U²³⁵

of 195. It is not clear from the report which cylinders were paraffin reflected and which were plexiglass. Critical mass calculations for homogeneous systems at an H/U²³⁵ of 294 in cylinders 25-50 inches in diameter were 106-112 percent of the experimental values if the experimental cylinders were paraffin reflected. If the experiments were conducted with plexiglass reflectors, the calculated critical masses are from 90-100 percent of experimental values.

It was not possible to make critical mass calculations for other H/U ratios for paraffin moderated systems as the relationship between H/U and uranium density is not available at this time. However, a study of homogeneous mixtures of UO₃ and water (two percent U-235 content) was made and critical masses evaluated. The minimum critical mass for water reflected systems of this material was calculated to be 5.9 kg U-235. This compares with an estimated experimental minimum critical mass for paraffin moderated and reflected systems of 4.0 kg U-235. It is reasonable to expect that the paraffin moderated systems will have smaller minimum critical masses, because the neutron age is so much smaller in paraffin than in water.

The theory was applied to homogeneous systems of 4.9 percent U-235 enriched uranium (U₃O₈) in glycerol tristearate and UO₂F₂ solutions in water. Good agreement between theory and experiment were obtained (within 5-10 percent of experimental values). It is interesting to note that for these systems the uranium concentrations were always less than 2.2 gm U/cc. Under these conditions the minimum critical mass was about 2.0 kg U-235 and the minimum critical cylinder diameter about 12 inches. However, the uranium concentration of interest in processing UO₃-water mixtures may be as high as 4.3 gm U/cc. Under these conditions the minimum critical mass is calculated to be 1.6 kg U-235 and the minimum critical cylinder diameter is calculated to be about 10 inches.

Miscellaneous Experiments for Nuclear Safety Specifications

1. Exponential Measurements with 1.25 Percent Enriched Uranium

The exponential experiments with the 1.25 percent U-235 enriched I. and E. fuel elements (1.336-inch O.D., 0.500-inch I.D.) were completed. The fuel rods consisted of six elements, each 7.5 inches in length, positioned in an aluminum tube of 1.402-inch O.D. with a 0.028-inch wall thickness. An aluminum tube filled with water was placed in the central hole for the wet core measurement. These tubes were 0.492-inch O.D. with a 0.020-inch wall thickness. The following buckling was determined this month:

<u>Lattice Spacing</u>	<u>H₂O/U (By Volume)</u>	<u>Buckling (Fuel Core Wet)</u>
1.85 inches	1.31	$4650 \times 10^{-6} \text{ cm}^{-2}$

A complete report on the 1.25 percent enriched fuel measurements is being made in the January, February, and March 1959, Nuclear Physics Research Quarterly Report, HW-60220.

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Neutron Age Measurements

Analysis of the monoenergetic age measurement is virtually complete. Most of the effort in the past month has been devoted to estimating the accuracy of the measured ages.

Two of the numbers reported last month have been changed. The age from a small source in kerosene contained an error in the position scale, and should read 14.15 cm^2 instead of 13.98 cm^2 . The lower limit quoted for the age from a small source in water has been judged to be unrealistic. The current value for this age is $14.29 \pm 0.23 \text{ cm}^2$.

The matrices used to determine the first-collision-approximation fits to the asymptotic flux distributions have been inverted, using an IBM 709 FORTRAN program. The inverse matrices have been used to determine the statistical precision of the asymptotic fits. It appears that the tails contribute about half of the overall variance in the ages. The balance of the variance comes principally from uncertainty in extrapolating to a point source. The extrapolation used is substantially larger than the largest value allowed theoretically. The final values of the age are $14.0 \pm 0.2 \text{ cm}^2$ in water and $14.1 \pm 0.2 \text{ cm}^2$ in kerosene.

The thermal migration areas have been computed as $22.0 \pm 0.4 \text{ cm}^2$ in water and $21.1 \pm 0.4 \text{ cm}^2$ in kerosene. The former gives a diffusion length $L = 2.79 \pm 0.07 \text{ cm}$ in water. The current "best" value from ANL-5800 is $2.75 \pm 0.02 \text{ cm}$, but the best Russian value is $2.69 \pm 0.02 \text{ cm}$.

Calculation of the source spectrum is still in progress.

Mass Spectrometer for Plutonium Analyses

Progress toward putting the mass spectrometer for this program into operation has been confined to altering the electronic instrumentation according to the final design of the components of the other mass spectrometer. Efforts to fabricate successfully a kovar-to-glass seal for the source vacuum interlock are awaiting the firing of the kovar metal according to a special firing schedule.

Theoretical Critical Mass Studies

A report, HW-60255, on the leakage of neutrons from subcritical plutonium solutions, has been written and is in the reproduction stage. Some of the results of this report were described qualitatively in the Monthly Report for February. In the linear time variation of reactivity problem, an analytical approximation has been made which neglects the prompt neutron lifetime. The solution of the resulting first order differential equation indicates that the effect of a geometrical buckling change accompanying the linear change in reactivity is small for values of parameters of current interest. An analog computer formulation of this problem is also being investigated. The principal defect in an earlier numerical integration by digital computer is now attributed to an improper formulation of the problem. The acquisition of information on computational methods in critical mass problems continues.

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Criticality Alarms

The two experimental nuclear incident alarm monitors or dose-rate indicating and alarming monitors have now been tested using the two-transistor amplifier for about two months continuously with a maximum error due to drift of 2.5%. All source checks (daily) have shown reading and alarm errors to be approximately the same (2.5%). The instrument can be used for metering and alarm work with stable operation from one mr/hr up to ten r/hr. The instruments are exceedingly simple and reliable.

A gamma dose-rate analysis of the background in Purex is being made. The backgrounds are being checked where the nuclear incident alarm systems will be placed.

NEUTRON CROSS SECTION PROGRAM

Absolute Fission Cross Section of U^{235}

The study of experimental errors in the U^{235} absolute fission cross section measurement has been continued. The diameter of the uranium deposited area of the U^{235} fission foil used in the experiment was redetermined using a traveling microscope. The area of the foil obtained from these measurements was (0.85 ± 0.32) percent larger than the area previously assigned from the reported size of the mask used in preparing the foil at KAPL.

Slow Neutron Scattering Cross Sections

The energy spectra of neutrons scattered from water of incident energy 0.184 ev was measured for scattering angles of 5 and 45 degrees. No experimental data have been obtained since the middle of April because of the extended reactor outage.

The observed angular distributions of elastically scattered (bound atom) neutrons for the incident energies investigated of 0.095 ev, 0.141 ev, and 0.184 ev are apparently the same within experimental uncertainty. This is a theoretically unanticipated effect and might be a result of the method of analysis. The effect of the finite energy resolution of the analyzer has not been taken into account and the method of subtraction of the gas scattering background has not been carefully investigated.

A FORTRAN program has been initiated to calculate the theoretically expected hard sphere gas scattering energy spectra. The results of these calculations are being used to determine to what precision the gas scattering component of the observed neutron scattering from water can be approximated by this simple model.

Subthreshold Fission

No data have been taken on this program during the month. A sample of several milligrams of Pa^{231} was received through the courtesy of the Phillips Petroleum Company, MTR, Neutron Cross Section group, for subthreshold fission measurements. This sample joins samples already on hand of U^{234} , U^{236} , and U^{238} awaiting preparation as deposited foils for fission cross-section measurements.

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Slow Neutron Fission Cross Section - Pu²⁴¹

The radiation problem which existed at 105-DR and caused the loss of at least two months operating time of the crystal spectrometer has now been ascribed to an improperly shielded test hole on the X-2 level operated by an IPD engineering group. The additional dose rate caused by the crystal spectrometer neutron beam on the X-1 level has been determined to be well below tolerance except within a few feet of the spectrometer shielding. No further efforts have been made to cause the spectrometer beam to be turned off with the exception of two days early in the month. Useful data were obtained on the Pu²⁴¹ fission cross section about 50 percent of the month. The lost time was caused by spectrometer instrumentation malfunction and reactor outage.

The fission resonance at about 0.26 ev in Pu²⁴¹ obtained with this supposedly high purity sample is observed to differ by as much as twenty percent in shape in the wings of the resonance from the variation deduced in earlier measurements with a sample of lower isotopic purity. The investigation of this energy region is not complete and further analysis of the data is necessary to determine if the shape difference is real.

The energy region from 1 to 20 ev has been measured with an energy resolution about three times better than previously used in the Hanford measurements of Pu²⁴¹ fission cross section but still not adequate to perform a shape analysis of resonances above about 3 ev. Slightly more structure was observed than is revealed in the latest BNL-325 cross section compilation in the region of 4 to 12 ev. In addition, two small apparent resonances were found at about 1.6 ev and 2.4 ev. The resonance at 1.6 ev is rather remarkably small with a peak cross section of about 10 barns.

Fast Neutron Spectra

The new model of the vernier chronotron has been tested in the laboratory and has been installed at the Van de Graaff. The testing of the resolution, sensitivity, etc. of the complete system for time-of-flight studies is in progress.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Correlation of Data on D₂O Moderated Cluster Lattices

This work is now complete. A report is to be issued.

Low Exposure Plutonium Lattices

Fabrication of the special graphite pieces for the 10 1/2-inch, 8 3/8-inch, and 6 1/2-inch lattices is about 75% complete. It is planned to assemble these lattices in a mockup (without fuel) to guarantee compatibility of components before assembly in the PCTR.

Instrumentation designed to reduce PCTR time required to level fluxes along the longitudinal axis has been fabricated. This consists of a dual channel BF₃

traversing device; one channel uses an enriched BF_3 tube cadmium covered, the second channel uses a natural BF_3 tube bare. They are moved simultaneously, one above the central fuel column, the other below. Simultaneous measurements of total and epi-cadmium $1/v$ fluxes at a longitudinal position are made possible. The tubes are intercalibrated beforehand in the Sigma pile. This system should make possible optimum flux leveling in a strange lattice with the maximum expenditure of about one shift of PCTR time.

PCTR Experiments

Further work on the problem of highly self-shielded Pu fuel rods has consisted of making cell calculations on clusters consisting of 0.0625 inch dia. and 0.125 inch dia. Pu rods which are 65-90 w/o Pu. These are not yet complete.

Instrumentation

A variable wedge was fabricated for the diameter measurement unit of the profilometer. The unit has been assembled and tested. Preliminary tests indicated excessive spherical aberration, lens effect, and chromatic aberration. The addition of a film of oil between the spherical surfaces of the variable wedge to a large extent corrected all defects except chromatic aberration which has been eliminated by use of a filter. Tests of the unit with these changes indicated that diameters can be measured with a $\pm .001$ -inch accuracy. The unit was demonstrated. A correction of a small focusing effect is still required and will be made this month. Drawings and a description of the print-out system are being prepared for distribution to possible vendors for cost estimation.

Calculation of thermal conductivity values for samples of graphite and UO_2 gave values in agreement with data from National Carbon Company for graphite but the values for UO_2 are higher than data reported by BMI. The difference is due to the variation of thermal conductivity with temperature. A method of successive approximations which takes this variation into account is being used to calculate more correct values of UO_2 thermal conductivity.

GAS COOLED REACTOR PROGRAM

Lattice Parameter Measurements

Analysis of the data obtained in the PCTR to obtain k_{∞} and β is underway.

The additional fuel needed for a 16-column loading of the PCTR has been received and preparations are being made for the control rod experiment.

Variation in Doppler Coefficient with S/M Ratio

Fabrication of the mockup assembly is nearly complete. Testing will begin with arrival of the induction heater. Bids have been received on the heater, ranging from \$4400 to \$7500. No award has been made as yet.

It was found necessary to coat the stainless steel jackets of the thermocouples with molybdenum by flame spraying to prevent their failure due to forma-

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tion of an iron-uranium eutectic at elevated temperatures ($\sim 700^{\circ}\text{C}$).

A 12-point Brown recorder has been modified to have a full scale linear span of 5 millivolts and 15 overlapping ranges, to cover the range from 0 to 60 millivolts ($\sim 0-1000^{\circ}\text{C}$ for iron-constantan) with an estimated accuracy of 0.0125 millivolts ($\sim 0.2^{\circ}\text{C}$).

Theoretical PCTR Studies

The small source theory critical condition for an infinite array consisting of one control rod for each fuel rod has been found and has been related to the criticality condition for fuel rods only. The condition has been employed to predict the thermal utilization for a sample case. The result is $f = 0.38$ as compared to $f = 0.92$ for the same system with no control. Based on physical arguments regarding relative absorption rates in a cell, this result appears reasonable. The method is now being extended to the GCR lattice which consists of one control rod for each nine fuel rods and requires the solution of a 4×4 determinant. The elements of this determinant are now being evaluated numerically.

TEST REACTOR OPERATIONS

Operation of the PCTR continued routinely during the month. There was one unscheduled shutdown due to electronic failure. The initial experiment for the gas cooled reactor program was completed as was another series of runs to measure k_{∞} of 3 percent enriched $\text{UO}_3\text{-H}_2\text{O}$ mixtures.

Work orders were written for the fabrication of equipment needed for the k_{∞} measurements using 7 element clusters of 1.007 percent enriched uranium. As built drawings of the traverse device were prepared and a work order issued for fabrication of a second unit. This will allow simultaneous bare and cadmium traverses.

The reproducibility of positioning the moving face was checked by making five successive period measurements. After each one, the rods were dropped and the face opened one inch. The reproducibility was within the error due to the rod drop (std. deviation 0.007 cents).

PCTR

The preliminary Project Proposal for the Full Scale PCTR, CGH-832, has been forwarded to Washington AEC with local Commission approval. Preliminary work on the Reactor Hazards Study has been initiated.

BIOLOGY AND MEDICINE - 6000 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

Essentially all of the R and D effort in this Operation was expended in the preparation and arrangement of physical equipment for the forthcoming dispersion experiments. These preparations are on or ahead of schedule.

The erection of the towers for vertical air sampling was approximately 90 percent complete at month's end. The completion date for this work was scheduled for May 8, 1959. A major injury was sustained by a construction worker on April 22, when an 18-foot section of tower fell over as another six-foot section was being lifted into place.

The assembly of 487 gasoline-driven vacuum pumps was completed by Transportation employees, and the testing, adjustment, and installation of this equipment at the field locations were begun. Two of the four automatic pigment counters were completed and accepted. New sources for the other two are being fabricated. Delivery of disposable filter holders and filters was assured and 14 pulse-type drum samplers were received from the U. S. Army Chemical Corps on a loan basis.

The visible preparations for these experiments, such as the erection of towers, assembly of pumps, etc., were photographed by the Photography Operation as part of an overall documentation of the experiments. The Air Force has dubbed this project, "Operation Greenglow," an official Air Force nickname. We have not used this designation.

DOSIMETRY

The basic trouble with the live-timer of the 256-channel analyzer in the Shielded Personnel Monitoring Station was found and corrected. Minimum maintenance was required during the month.

Tests of the resolution obtained for the large NaI crystal with a uniform array of six 3" photomultiplier tubes or five such tubes in a circle gave definitely poorer results than a circular array of six tubes. One more photomultiplier, a 10" EMI tube, remains to be tested.

Tests were made of our ability to standardize gamma ray sources by using theoretical photofractions and efficiencies at known distances. Results were very good. The accuracy was certainly better than 5% and usually better than 2%. Tests by this method of six sources obtained on the plant uncovered errors in the values of three of them and cast doubt on a fourth.

It was found that a box made of lead-plywood sheets such as used in X-ray shielding was quite effective in reducing the background of low energy pulses on the big NaI crystal. Many of these low energy rays result from the slowing down of higher energy gamma rays in the iron of the shield. The shielding was effective even though there was some small radioactivity detectable in it; the radioactivity could very well have been in the adhesive used to bond the lead and the plywood. It seems desirable to line the interior of the iron room with a 1/8 inch thick sheet of lead that tests show to be low in radioactivity. This has been done at other whole body counters.

The large NaI crystal was calibrated by the one meter arc method for natural body Cs^{137} and K^{40} for three subjects. The accuracy was about 20%, which is sufficient for the present. A calibration for Zn^{65} was obtained through the cooperation of a visitor with a known body burden of the isotope.

A subject injured in a glove box explosion was studied for plutonium contamination. Both cuts and burns were involved. Surgery had been performed prior

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to our examination with the result that two cuts had been combined into a single wound. There was (1.0 ± 0.2) mpc of plutonium in the wound. The excised flesh contained (0.39 ± 0.06) mpc. An examination of the whole side of the face and neck with a $4\frac{1}{2}$ inch by 1 mm NaI crystal indicated less than 2 mpc present. A second man involved in the same incident was examined for plutonium in the lungs; none was detected.

The positive ion accelerator operated satisfactorily during the month. The use of the new stapled belt has improved the stability of the machine. Sparking has developed near 2 Mev. It may be due to small iron fragments released inside the accelerator from wearing of the staples. The X-ray warning device and interlock system were completed and put into use.

Advantage was taken of the new stability of the accelerator to restudy some characteristics of the $\text{Be}(d,n)$ and $\text{D}(d,n)$ reactions with the double moderator. For the latter reaction the results indicated that the angular distribution was not the same for two different targets and that the deuterium gas is probably not uniformly distributed in the titanium metal of the target.

The system for counting neutrons from radioactive sources was automated and further measurements made on plutonium oxalate, plutonium nitrate, and several RaBe sources to obtain statistically better data.

An automatic system for gamma ray counting was put into use. Na^{24} in samples of effluent water was counted several times a week to calibrate the system and to test its stability. Stability was good.

In studies of the use of pencil ion chambers for low dose measurements it was found that electrical discharge of the chambers equivalent to 1 mr dose could be measured to better than 1% accuracy if the measurement was made immediately after discharge. If the chamber were exposed to 1 mr of gamma radiation, however, only 5% accuracy could be achieved. Only 5% accuracy could be achieved with the electrical discharge method if the chambers were allowed to sit for the same length of time required for the gamma ray exposure. It is suspected that slow drifts in the charging voltage cause the decrease in accuracy. Use of a stable 6 volt battery resulted in somewhat better accuracy.

INSTRUMENTATION

The scintillation, transistorized combined alpha-beta-gamma band and shoe counter is still in satisfactory continuous operation in the 329 Building. The instrument has been source-checked twice a day for almost two months with no recalibration or maintenance work found to be necessary. Personnel acceptance of the instrument has been gratifying. The instrument indicates about twice background for a 500 d/m Pu^{239} source distributed over a four-inch by eight-inch area, and it indicates two to three times normal background for a similarly distributed 15 millimicrocurie Ra D-E-F source. The total individual counting time is 15 seconds since the probes simultaneously detect the indicated types of radiation. The alpha information is separated electronically from the beta-gamma information and the two are then separately indicated.

Two final model scintillation transistorized slow and fast neutron count-rate and dose-rate meters and two final model scintillation transistorized alpha-

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beta-gamma meters have been completed and tested satisfactorily. The neutron portable meter replaces, in one instrument, both the old BF₃ meters and the "Neuts." The alpha-beta-gamma meters, in one instrument, replaces the old scintillation alpha "poppies" and the standard GM's. In all cases, the performance of the new instruments is superior to the old types.

The composite transistor circuit board tester for all of our various plug-in type, modular construction transistor circuits has been completed and tested satisfactorily. This testing device will enable any technician to check the plug-in boards in a go, no-go type test. All of the transistor circuits for portable and fixed instruments which we have developed can be tested. Several new stable transistor oscillators of various pulse repetition rates were developed and tested. These will be used to drive the other circuits being checked in the transistor tester. The transistor plug-in circuits that can be tested include amplifiers, multivibrators, binaries, count-rate meters, and register-driving types.

The pinhole camera was evaluated this month. The best results were obtained by using Eastman-type kk X-ray film for the radiation picture and Royal Pan (ASA 200) film for the daylight picture. An exposure of 300 mr from a point source at the face of the camera was necessary to produce satisfactory results. The camera was demonstrated by placing a Co⁶⁰ bug inside of an aluminum tube and photographs made. After the film had been processed, the radiation film was laid on top of the photograph to locate the source. An attempt to improve the sensitivity by inserting a terphenyl crystal in the film holder and laying Royal Pan (ASA 800) on the crystal was not successful.

The Radiotelemetry Central Station equipment has now been tested and is ready for delivery to and installation at the 622 (Meteorology) Building. RCA engineers are changing receiving and transmitting antenna positions of equipment on Rattlesnake Mountain to attempt alleviation of interference problems. The Aerovane wind direction detector at the Yakima Barricade has ruined its bearings and will be replaced, in total, by the manufacturer. Some trouble has been experienced with the Benton City data station from cattle damaging the unit. The AEC is engaged in a study of methods to alleviate the condition.

The four zinc sulfide particle counters were assembled and tested this month. Two of the alpha sources received were not satisfactory because of the high background. The sources were prepared identically but at different times. The reason for this background on two of the sources is unexplainable. The two units which are satisfactory have been delivered to the field.

An instrument for automatically counting dust particles in air has been developed. The instrument consists of a vacuum source to draw air through a pipe which is used as an impactor, a lucite disc covered with a triboluminescent pigment (pigment 3336-U. S. Radium), a photomultiplier tube, amplifier, scaler or count-rate meter and a high-voltage supply. In operation, dust is impacted onto the pigment that is attached to the disc. The dust particles striking the pigment causes it to scintillate. The scintillations are viewed by the phototube which changes them into electrical pulses that are amplified and recorded. Size separation can be accomplished by adjusting the space between the impactor and the deposited pigment.

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The investigation of determining the efficiencies of various light pipes continued.

Consultation was rendered to the Process Control Development Operation concerning the use of terphenyl-in-polyvinyltoluene detectors for Pu²³⁹ alpha detection in acid-flowing process lines for Purex. The terphenyl type is to be tried as a replacement for a very thin Teflon-covered zinc-sulfide alpha detector which has not stood up to use in the acid fluid.

WASHINGTON DESIGNATED PROGRAM

The mass spectrometer for this program is now operated on a part-time basis (about 30 percent of available time) as an analytical service to the program. For this service the alternate ion detection system consisting of the electron multiplier, vibrating reed electrometer, and Brown recorder is being used. The remainder of the time is being used to study experimental effects of importance to the types of samples encountered in this program and toward putting the ion counting detection system into reliable operation.

CUSTOMER WORK

Analog Computing

The problem load for the Analog Computer is building up to the point where a considerable back-log has accumulated. The problems waiting for machine time are (1) Hazards re-runs for PRTR, (2) Frequency response for PRTR, (3) Primary loop frequency response for NPR, (4) Pump coast down for NPR, (5) Heat exchanger frequency response for NPR, (6) Primary loop plus heat exchanger for NPR, (7) Boilout curves for existing reactors, (8) Boilout with the effect of meltdown of lithium poison, (9) Flux distribution with various pile loading effects, and (10) Log simulator for reactor kinetics (theoretical physics).

The Goodyear Computer has been in operation almost steadily for the last month with a gradual loss in capacity due to loose connections, bad potentiometers, etc. It is estimated that the computer will have to go down for an overhaul before some of the larger of the above-mentioned problems can go on.

The new replacement coefficient potentiometers have been received and twenty-four have been installed. The remaining thirty-six will be installed during May.

Replacements for the intercept potentiometers on the diode function generators have been ordered. May 15 is the tentative delivery date.

Work has been started on the design of a better slope switch-potentiometer combination for the diode function generators and the components have been placed on order.

The order for the new computer was placed on April 20, 1959, with Beckman Instruments, Inc. The delivery date is six months, which would mean October 20 before the new computer arrives.

The new Brush 8-Channel Recorder has been received. All necessary wiring has been completed and the recorder is now in service. The Sanborn recorder is to

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be removed from service and completely overhauled at the earliest opportunity.

A study is being made into the feasibility of either building or purchasing a Magnetic Tape Type Transport Lag Simulator. Several vendors have been contacted and more will be contacted in the next couple of weeks.

A one-hour talk, followed by a demonstration and discussion period, was given to the Design groups in CEO on May 4. The talk covered the basis of analog computers and their applications.

The NPR Primary Loop (Four Section Temperature Model) Frequency Response runs are approximately 90% complete. A few runs are still to be made using a positive water temperature coefficient.

Pump coastdown curves for the NPR are now being studied on the computer.

Report No. HW-60026, "Multi-Region Simulation of Xenon Poisoning in the PRTR," has been issued.

Constants necessary to make a new hazards analysis on the PRTR have been received.

A request for Primary Coolant Transient Analysis for the PRTR was received April 24. Special equipment needed for this study has delayed its solution. Four transport lag simulators are needed to solve the problem. Arrangements are being made to obtain three of these from the Los Angeles Computer Center for a 30-day loan.

Curves depicting the response of a power rate meter after different power level ramps were recorded. The kinetics part of the problem included the constants from a natural uranium loading.

Using equations and constants from HW-32346, "Solutions of the Pile Kinetic Equations When the Reactivity is a Linear Function of Time: I," a solution was attempted on the analog computer. The computer overloaded before prompt critical was reached and, since the interest was in the shape of the curve just preceding prompt critical, a new approach seemed necessary. The log simulator which plots the log of the power level versus time has been programmed and is awaiting computer time.

Weather Forecasting and Meteorology Service

The first Columbia River crest forecast was issued on April 21, 1959. Expected crest heights are nearly equivalent to or slightly in excess of those observed in 1958. The forecasts for the 100 Areas and Richland are as follows (these forecasts will be amended as later information becomes available):

	<u>Peak Stage (Feet above MSL)</u>			
	<u>100-B</u>	<u>100-D</u>	<u>100-F</u>	<u>Richland</u>
1959 Forecast	405.5-408.5	394.0-397.0	381.0-384.0	348.5-352.5
1958 Observed	406.2	395.0	381.8	349.2

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The River is expected to crest in late May or early June, but probably before the 1938-1952 average crest date of June 7.

<u>Type of Forecast</u>	<u>Number Made</u>	<u>% Reliability</u>
8-Hour Production	90	88.4
24-Hour General	60	82.1
Special	136	87.5

April was the windiest month in more than 14 years of record at the Hanford Meteorology Station. The average speed of 11.1 mph compares with 10.7 mph in June of 1949, which previously was the windiest month of record.

Instrumentation

A count-rate system is being developed for checking the thickness of the zirconium cladding around the uranium fuel element for FPD. The probe is a scintillation type employed terphenyl in polyvinyltoluene for beta-gamma detection. The crystal, light pipe, and shield are being fabricated for evaluation.

A complete, fair-cost estimate was prepared concerning the alpha-only scintillation transistorized hand counter. The estimate was necessary because offsite fabrication bids are being obtained for the fabrication of twelve of the units. The fair-cost estimate, excluding the profit factor, was found to be \$2,300 each in lots of one only. In lots of twelve required, the estimate would be reduced by about 10% per unit.

Design and fabrication work was started for conversion of the vertical lead pig beta-gamma shelf counters from mica-window GM tube use to a scintillation detector using a phototube and terphenyl in polyvinyltoluene. The very fragile mica-window tubes which cost about \$200 for replacement will then be eliminated.

A radiation warning device design was completed for Facilities Engineering Operation, HLO. The instrument is to monitor above a water-filled tank containing 15,000 curies of Cobalt 60. The instrument has a minimum alarm sensitivity of five mr/hr, and the alarm point may be varied to 100 mr/hr or greater. The detector is a two-inch by one-inch NI(Tl) crystal with a 6655A multiplier phototube. The alarm circuit is activated by a meter relay which measures the multiplier phototube anode current.

Acceptance tests were continued on eight Victoreen remote area monitoring systems with a total of 65 channels and a Riggs (one channel) remote area monitor. Acceptance tests were completed on 47 HAP0 GM's.

Optical

Work was completed on the modified Slit Camera for 105-C Fuel Inspection Facility. The camera has been delivered and the customer is installing and testing the camera at 105-C.

Design drawings have been completed for a remotely operated TV scanning system to be used in the six-inch diameter access holes on the rear shield wall of the reactors. Fabrication of the unit is about 80% complete.

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The routine Optical Shop Work during this period includes 400 manhours work of which 35-3/4% was for Spare Parts (Stores), 19-1/2% was for IPD, 15% for CPD and 29-3/4% for HLO. During the month, O. K. Selle left to work in Technical Shops. Work performed included:

1. Completion of parts for PRTR profilometer components.
2. Polishing three lead glass bricks.
3. Fabrication of 20 glass bearings.
4. Fabrication of parts for TV scanner.
5. Service to 327 Building microscopes.
6. Fabrication of a second scratch depth microscope.
7. Evaporation plating of gold on wire loops.
8. Fabrication of a lamp projection and photocell detector mounting for R. C. Clark.
9. Fabrication of a pyroceram bearing.

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
J. E. Sperry	4/16	Brush Instruments Seattle, Wash.	Discuss recorders.	HH Burley WD Cameron GR Taylor	No	300: 326
Lt.Col. B. Pusin	4/16-17	Air Force Tinker Field, Okla.	Install rawinsonde equipment.	GR Hilst	No	200-W:622F 200-E
W. B. Lewis	4/24	Phillips Petroleum Idaho Falls, Idaho	Discuss nuclear safety problems.	ED Clayton JE Faulkner	No	300: 326
A. C. Hughes	4/30	Hawker-Siddeley Nuclear Power Co., Limited Slough, England	Discuss application of PCTR techniques in Argonaut Type Reactors.	JE Faulkner RE Heineman	No	300: 326 305-B

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
C. R. Lagergren	4/1-2	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Mass spectrometer - consulting.	A. E. Cameron	Yes
A. L. Ruiz	4/1-2	Schenectady, N. Y.	Attend Symposium on Reliability.	--	No
W. C. Roesch	4/2-3	Univ. of Washington Seattle, Wash.	To teach AEC Fellowship Class.	Faculty and Students.	No
N. Ketzlach	4/5-9	Nuclear Congress Cleveland, Ohio	Present a paper at Nuclear Congress.	--	No

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. E. Wood	4/9	Univ. of Washington Seattle, Wash.	Present a talk.	--	No
I. T. Myers	4/9-10	Univ. of Washington Seattle, Wash.	To teach AEC Fellowship Class.	Faculty and Students.	No
N. Ketzlach	4/10	ANP Dept. (G.E.) Evendale, Ohio	Discuss critical mass experiments.	C. C. Gamertsfelder	Yes
L. V. Zuerner	4/10-11	Knolls Atomic Power Laboratories Schenectady, N. Y.	Discuss health instrumentation.	L. Cherubin	No
	4/13	Brookhaven Nat'l Lab. Long Island, N. Y.	Discuss health instrumentation.	F. P. Cowan	No
	4/16-17	Argonne Nat'l Labs. Lemont, Ill.	Discuss health instrumentation.	J. R. Novak	No
R. A. Harvey	4/9-10 4/16-17	Univ. of Washington Seattle, Wash.	Assist in teaching EE 510.	Prof. Eastman	No
J. E. Faulkner	4/15	Univ. of California Los Angeles, Calif.	Recruiting.	--	No
	4/16-17	California Tech. Pasadena, Calif.	Recruiting.	--	No
W. C. Roesch	4/16-17 4/23-24 4/28-29	Univ. of Washington Seattle, Wash. U. S. Atomic Energy Commission Washington, D. C.	To teach AEC Fellowship Class. Project Tutor Meeting.	Faculty and Students D. Gale	No Yes
	4/30	Nat'l Bur. of Standards Washington, D. C.	ICRU Committee on Quantities and Units	H. O. Wyckoff L. S. Taylor	No

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
P. F. Gast	4/20-21	Univ. of California Berkeley, Calif.	Recruiting.	--	No
	4/22	Stanford Univ. Palo Alto, Calif.	Recruiting.	--	No
	4/23	G-E Vallecitos Lab. Pleasanton, Calif.	Discuss business of Standards Committee N6.	W. J. Ozeroff	No
R. A. Harvey	4/20-24	Chalk River Ontario, Canada	Attend Sixth Tripartite Instrumentation Conference.	Conf. Members	Yes
R. C. McCall	4/29-30	Am. Physical Society Washington, D. C.	Attend meeting.	--	No
C. R. Lagergren	4/29	Knolls Atomic Power Lab. Schenectady, N. Y.	Consulting on Wash. Designated Program.	T. L. Collins	Yes
	4/30	Am. Physical Society Washington, D. C.	Attend APS meeting.	--	No
D. G. Foster E. D. Clayton	4/30	Am. Physical Society	Attend APS meeting.	--	No
I. T. Myers	4/30	Univ. of Washington Seattle, Wash.	Teach AEC Fellowship Class.	Faculty and Students	No

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