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RL-REA-474 D

April 5, 1965

MONTHLY RECORD REPORT

RESEARCH AND ENGINEERING OPERATION
IRRADIATION PROCESSING DEPARTMENT

By

O. H. Greager

Classification Cancelled and Changed To

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By Authority of RM Mitten

CG-PR-2 4-20-94

By E. Sevely 4-21-94

Verified By [Signature] 4/21/94

MARCH 1965

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TRIPS

<u>Name</u>	<u>Firm & Location</u>	<u>Date</u>	<u>Purpose</u>
WK Woods	GE-TEMPO Santa Barbara, Calif.	3/10/65	Discuss U-233 program
	Atomics International Canoga Park, Calif.	3/11/65	" " "
	General Atomics San Diego, Calif.	3/12/65	" " "
GC Fullmer	US Army Intelligence Fort Holabird, Md.	3/15/65	International Inspection System testing liaison
	US-AEC Div. of Production Washington, D.C.	3/16-18/65	" " "
	US-AEC Div. of Classification - Washington, D.C.	"	Attend Classification Symposium
OH Greager	GE-Atomic Products Div. San Jose, Calif.	3/25-26/65	Nuclear hazards discussions with APD personnel
SS Jones	Washington State Univ. Albrook Hydraulic Lab. Pullman, Wash.	3/29/65	Consult on C and K downcomer models.

VISITORS

NH VanWie WL Kephart	Union Carbide Oak Ridge, Tenn.	3/17-22/65	Discuss Combined Operations Studies
GE McDonald	Lewis Research Center Cleveland, O.	3/18-19/65	Discuss irradiation tests
AD Schwartz	Atomics International Canoga Park, Calif.	3/18-19/65	Discuss irradiation tests

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ORGANIZATION AND PERSONNEL

	<u>Exempt</u>		<u>Nonexempt</u>		<u>Rotational</u>	
	<u>Feb.</u>	<u>Mar.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Feb.</u>	<u>Mar.</u>
Management & Administration	3	3	3	3	0	0
Process & Reactor Development	22	22	2	2	0	0
Process Technology	21	22	8	7	0	0
Operational Physics	13	12	3	3	0	0
Testing	19	19	27	27	0	0
	<u>78</u>	<u>78</u>	<u>43</u>	<u>42</u>	<u>0</u>	<u>0</u>

Process & Reactor Development: Eva C. Kiser, Secretary, deactivated (personal illness), 1/15/65. Virginia R. Smith, Secretary, rehire, 3/1/65.

Process Technology: L. B. Ufkes, Engineer I, transferred from Facilities Engineering, 3/15/65. R. D. Benson, Technician, transferred to NRD, 3/15/65.

Operational Physics: S. M. Skidmore, Engineer II, transferred to APED, 3/26/65.

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RESEARCH AND ENGINEERING

PROCESS AND REACTOR DEVELOPMENT

REACTOR FUELS

Depleted Uranium Irradiations

Examination and measurements of 12 monitor columns of depleted uranium fuel elements from KE Reactor have been completed. The data have been partially analyzed and weight loss observed on the elements, which were discharged at an average exposure of about 760 MWD/T, is minimal — averaging about a quarter of a gram per element. Average weight loss for goal exposure natural uranium element in the K Reactors is about two to three grams. The visual examination revealed no evidence of any moderate or severe corrosion attack on the elements. Unless the dimensional data, which are yet to be analyzed, reveal abnormal behavior of the pieces, there will be no reason to suspect that a fuel failure problem will be encountered during the remainder of the irradiation.

Twelve monitor columns of depleted uranium elements have been discharged, at average exposures of 780 MWD/T, from the B Reactor. Examination and measurement of these elements are now under way. Analysis of these data should be completed in early April.

The status of the depleted uranium as of March 23, 1965, in B and KE Reactors is listed below.

	<u>B Reactor</u>	<u>KE Reactor</u>
Exposure, MWD/T	1040	1120
% Pu-240	15.0	15.5
g/T Pu	1460	1760
No. of Columns	92	78
Goal Exposure, MWD/T	1400	1600

The plutonium inventory is now at about 40 kg with about 15 per cent Pu-240. At 20 per cent Pu-240, the yield should be about 2 kg/ton, or a total of about 50 kg of 20 per cent Pu-240 plutonium.

The reactivity discrepancy reported in previous months in the B Reactor loading has been resolved. The E-D block in B Reactor is heavily splined to permit operation within tube outlet limits in the enrichment; when the reactivity effect of these is considered, the agreement between predicted and observed E-D ratio is good.

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STATUS REPORT OF PRODUCTION TESTS

<u>Test No.</u>	<u>Type Metal</u>	<u>Tubes</u>	<u>Reactor</u>	<u>Goal Exposure</u>	<u>Current Exposure</u>	<u>Remarks</u>
IP-216-A	Normal production natural and enriched fuel elements.	78	All	Normal variable goal.		Provides for monitoring the performance of a sample of all normal production material to assist in development of Quality Index for production fuel. Test is continuous.
IP-669-A	Depleted uranium target elements.	92	B	1400 MWD/T	1040 MWD/T	Irradiation of ten tons of depleted elements for production of 18 w/o Pu-240.
IP-694-A	Depleted uranium target elements.	78	KE	1600 MWD/T	1120 MWD/T	Irradiation of 12 tons of depleted elements for production of 18 w/o Pu-240.
PITA-31	Thorium oxide target elements.	193	KW	175 operating days	114 operating days	Initial loading of thorium elements in fringe zone process tubes for production of clean U-233. Elements charged during September 30, 1964, outage.
PITA-31	Thorium oxide target elements.	166	D	165 operating days	115 operating days	Production of clean U-233. Elements charged during October 19, 1964, outage.
PITA-31	Thorium oxide target elements.	168	B	160 operating days	92 operating days	Production of clean U-233. 140 columns of elements charged during November 14, 1964, outage; 28 columns charged during January 7, 1965, outage.

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STATUS REPORT OF PRODUCTION TESTS (cont'd.)

<u>Test No.</u>	<u>Type Metal</u>	<u>Tubes</u>	<u>Reactor</u>	<u>Goal Exposure</u>	<u>Current Exposure</u>	<u>Remarks</u>
PITA-31	Thorium oxide target elements.	168	C	165 operating days	62 operating days	Production of clean U-233. Elements charged during December 24, 1964, outage.
PITA-31	Thorium oxide target elements.	190	KE	150 operating days	65 operating days	Production of clean U-233. Elements charged during December 31, 1964, outage.
PITA-33	Thorium oxide target elements.	126	KW (core)	47 operating days	44 operating days	Production of clean U-233. First cycle of elements charged during November 29, 1964, outage. Charge-discharge accomplished January 23, 1965.
PITA-33	Thorium oxide target elements.	131	KW (core)	47 operating days	14 operating days	Production of clean U-233. Elements charged during January 4, 1965, outage. Charge-discharge accomplished March 1, 1965.
PITA-34	Thorium oxide target elements.	135	D (core)	35 operating days	18 operating days	Production of clean U-233. Elements charged during February 20, 1965, outage.
PITA-35	Thorium oxide target elements.	95	KE (core)	42 operating days	21 operating days	Production of clean U-233. Elements charged during February 24, 1965, outage.

D-3

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Clean U-233 Program

Six-Ton Test. Last month U-233 and U-232 yields were reported from separations data of the six-ton test. More detailed data are now available from gram samples sent to the Laboratory from these same tests. The U-232/U-233 is consistent with prediction. However, U-233 yields from samples from central thoria elements are higher than predicted or than extracted from the bulk separations data. A peaking of the flux would explain the discrepancy; however, it is not known if there was a flux distribution grossly different from a normal cosine.

Irradiations Status. Central zone E-Q irradiations in the KE and D Reactors have been initiated. No problems were encountered in either of the loadings or initial startups. Some minor loading pattern changes, adding of a few enriched uranium columns near the top E-ring, were accomplished during the first outage of the D Reactor. The changes were made to permit more efficient spline usage.

The reactor irradiations continue to operate satisfactorily from a physics standpoint. The initial criticality in the full E-Q loading in D Reactor was predicted to within one mk, and the reactivity behavior through turn-around to first equilibrium operation has agreed with predictions to within three mk.

Through March 19, six thoria elements had been observed to have "failed" while under irradiation. The first occurred in central zone tube 4653-KW and resulted in a Panellit scram on January 20, 1965. Two elements in this column had actually failed, with approximately 80 per cent of their irradiation period completed. Both elements were severely distorted, with large increases in the cladding diameter being readily evident. No apparent release of the thoria to the effluent occurred.

The third element to fail, also causing a Panellit scram, February 19, 1965, was in fringe zone tube 5881-KE. The element had accumulated about 20 per cent of the scheduled exposure. This element was also severely distorted with a large increase in diameter at the welded end and a "bulge" near the midpoint. This bulged region had apparently been mechanically damaged during discharge such that the cladding had separated, exposing the thoria. No evidence of fission product release during irradiation was observed.

The fourth element failure occurred in central zone process tube 1865-KW. No Panellit scram resulted but a gradually increasing pressure on this tube made it suspect for about a week. Examination of the column after discharge (at approximately 40 per cent of goal exposure) revealed an element which had a four-inch longitudinal crack in the cladding and a general diameter increase. The cladding separation apparently occurred during the irradiation with several "spurious" gamma activity indications being observed.

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Two additional thoria element failures were observed during this period; one at KW Reactor and the other in a fringe tube at KE Reactor.

The first four thoria element failures have been sent to the Radiometallurgy Laboratory for destructive examination. Preliminary examination of these elements, along with two "normal" elements, revealed that in two of the failures the oxide had formed into a solid mass, instead of remaining as distinct particles. The oxide in the other failures as well as in the control elements was still in powder form. Investigation of the elements so far has led to one cause of the problem. Pinholes in the closure welds on two of the elements have been observed and a dye penetrant check of a third element revealed several fissures in the weld. The examination confirmed water entry through the closure welds. It is speculated that there is a water-thorium oxide reaction yielding a solid material of increased volume which stresses the cladding to and beyond its ultimate strength resulting in a split-type failure.

Over 500 irradiated thoria elements from the KW Reactor loading have been visually examined in the 105-C Irradiated Fuel Examination Facility, and no evidence of any unusual behavior was observed.

Self-Support Fuel Elements

Analysis of test data from the arch-rail self-support evaluation has been completed with favorable results. No differences were observed in the irradiation behavior of the arch-rail elements as compared to the standard bridge-rail pieces. Fairly large quantities of enriched uranium arch-rail elements have been irradiated in the K Reactor thoria loadings with no apparent difficulty. In view of the favorable results of the arch-rail evaluation program, the use of this support with the KV self-support fuel models is planned.

REACTOR ENGINEERING

Graphite Sleeve Strength Tests

A series of graphite mockup tests has been in progress to measure the strength of VSR keys, blocks, and graphite sleeves under methods of loading similar to that believed to exist in the K Reactors. Following the tests which measured the strength of the individual components, a seven-layer mockup was constructed using K-size blocks, VSR keys, and sleeves. It is expected these tests will be completed within the next few weeks.

VSR Channel Separation Caulking

Development is progressing on caulking of VSR channel separations. Tests are being conducted in a 46-layer mockup to develop tooling and techniques to fill the separations with a graphite paste. Thus far, this approach

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appears to be 100 per cent effective in filling all voids. A production test is being prepared to authorize caulking of one or two channels at C Reactor and in-reactor testing is expected in the next few months.

High Graphite Temperature Test - F Reactor

The initial phase of a testing program at F Reactor to evaluate the effect of higher graphite temperatures with a CO₂ atmosphere has been completed. During the initial phase in which the temperature was increased 50°, the oxidation rate in the bulk of the stack doubled while the rate in the monitor samples increased by a factor of five. The oxidation rate experienced during this test was still within the two per cent per 1000 operating day burnout criteria applied to the Hanford reactors. A production test supplement is being prepared to increase the graphite temperature by an additional 50°.

Reactor Deactivation

Temperatures inside DR Reactor, including graphite and shield temperatures, appear to have achieved equilibrium with the building ambient temperature at approximately 24 C to 27 C. Temperature data will continue to be taken during the remainder of March. It is anticipated that the requirement of cooling the DR stack will be eliminated by the first of April. Except for the irradiated fuel storage basin which remains in service, the lay-away of DR Reactor and water plant is now nearly completed.

Zircaloy Tube Hydriding

During the KW Reactor outage the first week in March, Zircaloy-2 process tubes, Nos. 3065 and 3075, were removed as suspect leakers. Subsequent metallurgical examination of these tubes indicates massive hydriding in the general region extending from the downstream end of the active fuel charge to the rear Van Stone flange. A hydrided layer of from two to four mils thick was observed in this region on the inside of both tubes, with the total hydrogen concentration ranging from approximately 50 ppm at the tube location corresponding to the rear end of the fuel column to approximately 1200 ppm at the rear Van Stone flange.

Tube 3065 is a prototype Allegheny Ludlum tube that was installed in August 1961. Tube 3075 is a Wolverine tube installed in August 1963. The amount of hydriding (approximately four mils) observed at the downstream end was comparable in both tubes.

A program is being developed on a high priority basis to (1) define the extent that hydriding may be occurring on other Zircaloy tubes in both C and K Reactors, (2) to explore the possible mechanisms which could account for the presence of the hydride, and (3) to consider potential remedial action. Two additional tubes have been requested for removal and examination from each of the K Reactors and one tube is scheduled

to be removed from C Reactor. Methods of nondestructive testing for the presence of hydride in-reactor are being explored and include consideration of a high frequency eddy current device and a thermoelectric probe.

Ceramic Balls

One hundred pounds each of 0.025 g/cc Gd_2O_3 and 0.25 g/cc Sm_2O_3 ceramic balls have been obtained for testing purposes. These compositions were selected to minimize burnout costs in case of an inadvertent ball drop. It has been calculated that under current operating conditions the Gd_2O_3 balls can be used in the central channels at K Reactors with the Sm_2O_3 material in the fringe channels. It is estimated that this substitution of ceramic balls for boron-steel balls would reduce burnout cost by a factor of four or five.

RADIOLOGICAL ENGINEERING

Radiation Control Experience

The following table summarizes the radiation exposure experience for critical IPD classifications through nine weeks of the 1965 badge year:

<u>Classification</u>	<u>Total Dose</u>	<u>No. of Employees</u>	<u>Average Dose/Employee</u>	<u>Extrapolated Year End Average</u>
Radiation Monitors	36820 mR	65	566 mR	3334 mR
Processing Operators	108210	217	499	2939
Pipefitters	20600	82	251	1480
Millwrights	19200	72	267	1575

Radiation Occurrences

	<u>B</u>	<u>C</u>	<u>D</u>	<u>F</u>	<u>H</u>	<u>KE</u>	<u>KW</u>	<u>Totals</u>
Processing				2		1		3
Maintenance	<u>1</u>	<u>-</u>	<u>1</u>	<u>-</u>	<u>-</u>	<u>1</u>	<u>1</u>	<u>4</u>
IPD Totals	1	0	1	2	0	2	1	7
Outside Department						1		1

Effluent Activity Data

The following table shows the average concentrations of five radionuclides from effluent samples taken in February 1965. All units are 10^{-12} curies/ml.

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<u>Reactor</u>	<u>As-76</u>	<u>P-32</u>	<u>Zn-65</u>	<u>Cr-51</u>	<u>Np-239</u>
B	88	9.6	13	410	180
C	93	14.0	27	990	240
D	42	10.6	16	320	85
F	44	10.2	24	440	120
H	35	8.9	8	330	110
KE	18	6.0	11	140	40
KW	44	7.6	8	150	75

Treatment of coolant at the KW Reactor was modified on February 1, 1965, when the liquid alum addition was reduced from a relatively high fixed rate to a lower variable rate, i.e., a minimum rate to maintain better than standard clarity. There were no other significant changes made in the treatment of reactor coolant during February 1965.

Thoria Target Elements Surface Contamination

It has been determined that the present contamination check on the outside surfaces of thoria elements is adequate, and installation of equipment to provide detection of lower concentrations is unnecessary. The radiological effect of concern was the potential increase in river pollution as a result of thoria coolant disposal. Effluent samples from both the K Reactors indicate the current coolant has essentially the same radio-nuclides and in about the same concentration as before the thoria loading.

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PROCESS TECHNOLOGY

PROCESS STANDARDS

HW-46000 B, Process Standards - Reactor

One revised standard was issued during the report period. This was:

Process Standard C-050 - "Process Tube Temperature Monitoring"

The standard was revised to include requirements for operation of the zone temperature monitor system in the No. 1 safety circuit.

HW-46000 D, Process Standards - Reactor

Two revised standards were issued during the report period. These were:

Process Standard D-030 - "Process Tube Replacement and Stuck Fuel Element Removal"

The standard was revised to include specifications for zirconium tube installation and thorium column pushing forces. Specifications related to reuse of tubes and broaching tools, formerly contained in HW-41000, "Process Equipment Standards," were transferred to D-030.

Process Standard B-010 - "Gas Composition, Pressure, and Flow"

The standard was completely revised to provide a limit structure design to exclude air entry into the reactor gas atmosphere after reactor startup. Specifications on O_2 and N_2 concentrations, inlet and outlet dewpoints, gas pressure, gas flow, and monitoring instrumentation were provided.

HW-46000 K, Process Standards - Reactor

Two revised standards were issued during the report period. These were:

Process Standard A-070 - "Thermal and Biological Shield Cooling Water"

Following failure of a portion of the thermocouples in the bottom thermal shield, the high temperature limit was respecified for the remaining couples to limit the temperature gradient across the concrete pad below the shield.

Process Standard D-030 - "Process Tube Replacement and Stuck Fuel Element Removal"

This revision was essentially identical to the revision for HW-46000 D above.

HW-27155 Rev. 1, Process Standards - Water Plant

One revised standard was issued during the report period. This was:

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Process Standard 190-B-010 - "Process Water Piping"

The standard was reissued to accommodate the provisions of 190-B-060, "Process Water Sectionalizing Valves." 190-B-060 was deleted. Specifications were added to provide for sectionalizing the process water system upstream of the 190 process water pumps.

HW-41000 - Process Equipment Standards

Three deletion notices were issued during the report period. These were:

- D-060 - "Reactor Confinement System"
- Gen-010 - "Design Change"
- A-020 - "Panellit Gauges"

The specifications of these standards were deleted, transferred to Process Standards - Reactor, or to Equipment Maintenance Standards, as deemed appropriate.

PROCESS CHANGE AUTHORIZATIONS

Nine Process Change Authorizations were issued during the report period. These were:

PCA #5-9 - "Outage Flux Monitoring - C Reactor"

Authorization was granted to remove both subcritical flux monitors from service for one hour during a reactor outage to accommodate relocation of the low level period meter as specified in Design Change No. 944. Conditions to be met during the period were specified in the Process Change Authorization.

PCA #5-10 - "Smoothbore Zirconium Tube Dummy Charge - C Reactor"

The process change authorized the use of solid aluminum dummy slugs in place of self-supported dummy slugs in zirconium process tube 3679. The solid aluminum nonself-support dummies were to provide additional pressure drop for adequate pressure gauge operation for an operating period preceding removal of tube 3679 from the reactor. The tube did not contain a fissionable charge.

PCA #5-11 - "Confinement System, Iodine Monitor Bypassing - C Reactor"

Following failure of the iodine monitor, authorization was granted to extend the eight-hour time limit specified in the standard for returning the instrument to service. A four-hour time extension was required to install a spare instrument.

PCA #5-12 - "Ball 3X Hopper Inspection - F Reactor"

The process change authorized a reduction in the number of hoppers tested from seven to three. The reduction was based on good results from previous inspections. Additional requirements to be met during the testing were specified in the process change.

PCA #5-13 - "Foundation Temperature - KW Reactor"

Water in the moderator and fringe fuel loadings resulted in lower than normal shield and foundation temperature. The process change authorized operation with foundation temperature 6 C below normal. The cooling flow to the bottom biological shield was stopped until the foundation temperature reached the minimum specified temperature.

PCA #5-14 - "Irradiated Fuel Shipment - H Reactor"

The process change authorized shipment of three tubes of fuel elements from H to C Reactor for examination of the fuel. Limits on cask loading, cooling water, and shipping time were specified.

PCA #5-15 - "Panellit Gauge Rolling Limit - KE Reactor"

Authorization was granted to re-range process tube pressure monitor gauges 15 psi beyond the limit specified in the standards. The gauges were monitoring thoria charges and the high trip was shown to be reliable.

PCA #5-16 - "Panellit Gauge Rolling Limit - B Reactor"

The process change is essentially identical to PCA #5-15 for K above.

PCA #5-17 - "Process Tube Annunciator Trip Setting - KE Reactor"

The process change waived the high temperature annunciator trip on thoria tubes. Because of low annulus boiling limits on thoria tubes high in the reactor, it was not possible to set the trips on these tubes at the calculated values. Uranium charges surrounding the thoria, with temperature high-trip annunciators set as required by standards, were deemed sufficient to warn of flux distortions which might cause excessive thoria tube temperatures.

MEMORANDUM OF PROCESS STANDARDS RELAXATION

Two memorandums were issued during the report period. These were:

Memorandum #5-1M - "Deactivation of Raw Water Backup to DR Reactor"

The memorandum authorized removal of the raw water system coolant backup to DR provided either a water system or gas system could be activated within 48 hours which would be capable of removing at least 8 kw of distributed heat from the DR graphite.

Memorandum #5-2M - "Zone Temperature Monitor System"

The memorandum was issued to document a scheduled placement of the zone temperature monitor system in the No. 1 safety circuit at B Reactor.

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AUDITING

During the report period, one engineer audited conformance to Process Standards by making 18 inspections at each reactor.

FUEL FAILURE EXPERIENCE

Production Fuel

<u>Failure Date</u>	<u>Tube Number</u>	<u>Lot Number</u>	<u>Type of Material</u>	<u>Tube power at Failure (kw)</u>	<u>Exposure MWD/T</u>	<u>Type Failure</u>
3/3/65	1476-H	KD-096-A	I&E N	1397	189	SH
3/4/65	3385-H	KZ-235-A	I&E N	1331	205	SH
3/11/65	2760-B	KY-725-Q	I&E EB(0.94%)	1385	761	SU
3/14/65	3266-C	CP-003-M	I&E NS	1489	413	EM
3/25/65	3988-B	CY-039-A	I&E E (0.94%)	1334	572	SH

Target Fuel

<u>Failure Date</u>	<u>Tube Number</u>	<u>Lot Number</u>	<u>Type of Material</u>	<u>Tube Power at Failure (kw)</u>	<u>Per Cent of Goal</u>	<u>Type Failure</u>
3/1/65	3098-KE	TC-2650	Solid Thoria	23	29	*
3/25/65	0172-C	TC-1650	Solid Thoria	56	52	SM
3/29/65	4265-KW		Solid Thoria		115	*
3/29/65	1853-KW	TK-4440	Solid Thoria		115	SM
3/31/65	5885-KE		Solid Thoria		45	*

Following is the failure classifications of thoria failures sustained in the months of January and February.

<u>Tube Number</u>	<u>Date Failed</u>	<u>Type Failure</u>
4653-KW	1/19/65	EM, SM (two failures in this tube)
5881-KE	2/18/65	EM
1865-KW	2/22/65	SM
3083-KW	2/22/65	SM

* As yet the failure mechanism has not been established.

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Legend

I&E N - This is the symbol for internally and externally cooled production reactor fuel elements of natural uranium. The fuel is irradiated in ribbed process tubes.

I&E NS - This is the symbol for internally and externally cooled production reactor fuel elements of natural uranium which have projections welded to the fuel element jacket. The fuel is irradiated in ribless process tubes.

I&E E - This is the symbol for internally and externally cooled production reactor fuel elements with uranium cores enriched in U-235. The fuel is irradiated in ribbed process tubes. The weight per cent U-235 in the core material is stated.

First Character

S	Side	Failure occurred on the side of the fuel element.
E	End	Failure occurred at the end of the fuel element.

Second Character

H	Hot-Spot	Failure caused by accelerated high temperature corrosion attack.
U	Unclassified	No other character logically applies to the failure.
M	Defect	Failure caused by a defect in fuel fabrication.

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OPERATIONAL PHYSICSPILE PHYSICS PLANT ASSISTANCE

Despite several unscheduled outages early in the report period, operating continuity was generally high; during the ten-day period from March 15 to 25, all seven reactors operated without interruption. An expected general decline in ECT (number of Effective Central Tubes) has accompanied irradiation of the various mixed loadings (E-D and E-Q), but the normal level of flattening efficiency has been maintained within the flattened zone.

Operating experience with the full E-Q core at the KW Reactor has continued to closely parallel expectations; full pile reactivity, temperature transients, and flattening efficiency have been very close to predicted values. Agreement between calculated and observed effects at the D and KE Reactors has been within 4 mk at both reactors.

Flattening efficiency at the B Reactor has increased as expected, with an ECT increase approaching nine per cent compared to that prior to the recent enrichment ring relocation.

SUMMARY OF OPERATIONAL DATA OF PHYSICS INTEREST
FOR THE MONTH OF MARCH, 1965

Reactor	B	C	D	F	H	KE	KW
ECT in March (1)	1430	1480	1290	1510	1465	2258	2000
12-Month Average ECT	1430	1555	1490	1490	1505	2445	2320
Equilibrium Scram Time (2)	22	25	19	16-18	35	30	30
Recording Time:							
From:	2-16	2-16	2-17	2-17	2-16	2-16	2-17
To:	3-19	3-21	3-22	3-23	3-22	3-23	3-23

- (1) Effective Central Tubes: This value is defined as pile power level divided by the average power of the ten most productive tubes in the reactor.
- (2) This is defined as the maximum time which could elapse between scram and half-up and still permit a successful scram recovery using hot startup procedures. Equilibrium scram recoveries are not attempted at any of the reactors, and hot startup procedures are no longer authorized.

B Reactor - J. R. Langton

Operating continuity has been good during the report period, and reactor flattening has been considerably improved by a planned E-ring relocation; a maximum of 1460 ECT has been achieved, and maximum level has been increased by 4-5 per cent. Nonequilibrium (startup) losses have increased slightly, partly as a normal consequence of higher equilibrium levels.

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C Reactor - J. R. Heald

Several unscheduled outages interrupted operating continuity, but flattening and startup efficiency were maintained close to the previous year's average. A slight reduction in ECT followed loading changes intended to relieve temperature peaking in the surrounding lower-flow annular region, and maximum tube outlet temperatures were reduced four degrees or more.

D Reactor - R. L. Miller

Several short, unscheduled outages followed the charging of the initial cycle of the core E-Q loading, but operation was continuous from 3-9-65 to 3-25-65. Observed reactivity with the E-Q core was always within 3-4 mk of predicted, with agreement to within 1 mk toward the end of the run. Some minor loading changes were made after the initial startup in an effort to improve flattening, and additional changes are planned for further improving flattening. Startup losses were somewhat higher than normal, due to a more conservative approach with the new loading plus minor instrumentation difficulties.

F Reactor - S. M. Skidmore

Good operating continuity and excellent flattening efficiency prevailed during the report period. Startup losses were higher than the previous year's average, due to spline insertion problems at turnaround.

H Reactor - C. E. Hughey/G. C. Masche

Although several outages interrupted operation early in the report period, operating continuity subsequent to the startup of March 8 has been good. Average ECT was slightly below the year's average, but it steadily improved over the report period. Startup losses were considerably reduced, although part of the "improvement" was due to the lower equilibrium levels allowed under a prevailing tube power limit. Flux traverses taken shortly after the third fuel element rupture in a two-week period indicated a favorable flux distribution in the vicinity of the ruptures (axial peak located four slug lengths upstream). The production test for reactor physics experimentation prior to deactivation was completed on Duplimat and signature routing initiated.

KE Reactor - G. D. Baston

Consistent flattening efficiency has been maintained following charging of the initial half of the E-Q half-core loading (E-D remains in the upper part of the KE core), and operating continuity has been quite good. Total Control compensation is currently required for "minimum" outages, due to the high basic reactivity accompanying the E-Q core and prevailing high residual exposures in both E-metal and natural uranium.

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KW Reactor - R. A. Dieterich

Operating continuity was good, and operating control fairly stable with the E-Q core charge complete. Flattening efficiency was at almost exactly the predicted value, with average ECT about 2000. Operation at the normal 4400 MW limit was thus feasible with tube outlet temperatures at or below expected maximum values. Number 2 HCR, which is scheduled for replacement with a flexible prototype Inconel rod during the next outage, was calibrated during a startup; the calibration will be repeated after replacement is complete, thus allowing a direct comparison of strength for the two rod types.

PROCESS PHYSICS STUDIESReactivity and Control Studies

The comprehensive H Reactor deactivation physics test program has been reviewed in rough draft form with interested organizations, and the production test document is now being circulated in final form for authorization. The tentative date for starting the tests, based on exposure of the H loading, is between April 15 and 20.

Basic computer studies have been carried out to permit the establishment of an easily auditable enrichment loading restriction. Such a restriction will permit Process Standards and Operating personnel to quickly spot check against gross loading errors sufficient to cause criticality in the shutdown wet reactor. Application of this method will be analogous to the more restrictive administration of total control for the dry reactor case, but will not require the amount of detailed calculation and referencing needed by the pile physicist for the latter.

Work is continuing on yield prediction normalization studies in order that the current bias factor of an intended one-half per cent be removed by the end of this fiscal year. The actual adjustment required to achieve this normalization will be somewhat less than one-half per cent for natural uranium and somewhat over one-half per cent for plutonium produced in E-metal.

Production-Related Studies

Thoria (E-Q) loadings are progressing in the fringes of the five continuing reactors and in the cores of the KW, KE and D Reactors. Cyclic replacement of one-half of the thoria columns in the K cores and all of the thoria in the D core is scheduled to take place during April.

The E-D (enriched-depleted) loadings at the B and KE Reactors proceeded without incident during the report period. Both of these partial core loadings have achieved exposures in excess of 1000 MWD/T. The predicted E-D ratio at both reactors is less than 2 to 1 at the current exposures. The actual ratio was slightly over 2 to 1 at B and 1.6 to 1 at KE at the end of the report period.

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Startup losses in February, 1965, averaged approximately 0.30 effective day per startup for all IPD production reactors compared to approximately 0.23 in February, 1964. The current startup efficiency, reflecting slightly greater conservatism with the mixed loadings and some insertion problems with the new spline caps, has still been reasonably good.

Reactor Fundamentals Training

A third programmed learning text on pile physics, Book III - Variations in Pile Reactivity, has been largely completed in rough draft form. Reactor Processing Certification personnel have been taking part in the editing and publishing of this series.

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TESTING

PLANT ASSISTANCE - IPD

Corrosion Testing Facilities

TF-20 - Testing began March 26 to evaluate the effects of surface treatment on zirconium hydride formation in low temperature systems. Testing continued to determine the cause of resistance temperature detector corrosion and the effect of various coatings to prevent corrosion. The operating conditions will continue unchanged, 120 C, 9.5 gpm and pH 6.6.

Irradiated Process Tube Measurement

Wall Thickness Gauge (eddy-current type - WTG)

<u>Reactor</u>	<u>No. of Tubes Measured</u>	<u>Report No.</u>	<u>Document No.</u>
D	104	6	RL-REA-704
B	31	7	RL-REA-734
C	92	8	RL-REA-787
F	52	9	RL-REA-804
Total	279		

Ex-Reactor Visual, Weight and Micrometer Measurements

<u>Reactor</u>	<u>No. of Tubes Measured</u>	<u>Tube Samples Measured</u>	<u>Reason Examined</u>
KE	1	40	corrosion studies of aluminum tubes at K Reactor
H	1	42	leaker

Zircaloy leaker tubes 3065 KW and 3075 KW were reassembled in the basin as to location in the reactor. A total of fourteen samples were obtained from both tubes and labeled for shipment to Pacific Northwest Laboratory for analysis.

Critical Reactor Component Examination

Ninety per cent of the measurements and dye-penetrant tests have been completed on the 10 front face tube assemblies received from DR Reactor.

Pressure Monitor System Programs

In-board Bourdon coil examination	7328	
Non-leaking coils	7327	(99.9%)
-average rate past two years		(99.9%)

Gauges receiving failure analysis

35

Gauges received from Central Maintenance
and examined

-acceptance rate

531*

501*

(94.4%)

-previous month

(93.4%)

*This includes 322 gauges that were re-processed following re-calibration at 250 psi midscale. Total number of gauges actually certified is then 853 for the month. The K Reactors have requested that all gauges processed for use in the K Pressure Monitor Systems be certified at a 250 psi midscale pressure, to accommodate the various loadings currently in use.

Borescoping Activities - In-reactor channels and tubes were examined with the borescope as follows:

<u>Reactor</u>	<u>Channel</u>	<u>Motion Picture Record</u>	<u>Purpose*</u>
KW	HCR # 5	No	2
KW	HCR #12	No	2
KW	VSR #23	No	2
KW	VSR #34	No	2
KW	VSR #46	No	2
KW	3065	No	1
KW	3075	No	1
KE	VSR #43	No	2
KE	HCR #19	No	2
KE	HCR #12	No	2
KE	VSR #23	No	2
KE	VSR #46	No	2
KE	3098	No	1
C	VSR #26	Yes	2
C	VSR #17	Yes	2

*1 - Routine maintenance support

2 - VSR-HCR channel problem

Spline Traverses - Front-to-rear flux distribution data were taken as follows:

<u>Reactor</u>	<u>No. of Tubes</u>
KW	8
KE	9
H	9
D	8

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Vertical Bowing Measurements - Vertical displacement measurements were taken as follows:

<u>Reactor</u>	<u>Channel</u>	<u>Comparison to Previous Data</u>
KW	Y-2	Down .92" at 24' since May 1964

Horizontal Bowing Measurements - Horizontal displacement measurements were taken as follows:

<u>Reactor</u>	<u>Tube</u>	<u>Comparison to Previous Data</u>
C	3459	No previous data
C	3289	No previous data
B	3589	No previous data
B	3558	No previous data

Note: C Reactor data were taken during February but were not reported until calibration of equipment accuracy was verified on a mockup

TESTING AND IRRADIATION SERVICES - OTHER DEPARTMENTS, CONTRACTORS

Irradiations - Non Loop - Routine sample irradiations were handled as follows:

<u>Reactor</u>	<u>Test Hole</u>	<u>Facility</u>	<u>Request Number</u>	<u>No. of Samples</u>	<u>Material-Purpose</u>
C		Process Channel	HAP0-098	40	Graphite (burnout rate determination)
KW		Process Channel	HAP0-098	22	Graphite (burnout rate determination)
KW	2A	Magazine	HAP0-119	37	Graphite (irradiation damage)
KE,	2D,	Quickie	HAP0-172	10	Effluent water (water chemical studies)
KW	2A				
C	B	Bare Channel	HAP0-177	8	Graphite (irradiation damage)
KW	3C	Bare Channel	HAP0-177	7	Graphite (irradiation damage)
KE	3C	Bare Channel	HAP0-177	1	Graphite (irradiation damage)
KW,	2A,	Quickie	HAP0-184	76	Washington Designated Program
KE	2D				
KW	4C	Snout	HAP0-243	11	Tensile specimens (fast neutron damage)
KE	2D	Quickie	HAP0-252	1	Arsenic (tracer isotope)
KW,	2A	Quickie	HAP0-254	11	Various (activation analysis)
KE	2D				
KW	2A	Quickie	HAP0-316	1	Antimony (isotope production)
KW	2B	Snout	HAP0-263	1	Neutron detector (development)
KE	2D	Quickie	HAP0-324	1	Methane (gamma flux measure)
KW	2B	Snout	HAP0-306	1	UO ₂ (confinement study)
C	Y	Neutron Beam	HAP0-325	31	Boron-concrete (dispersion check)
KW	4B	Bare Channel	HAP0-329	2	Dysprosium (uncooled control rod damage study)

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Reactor	Test Hole	Facility	Request Number	No. of Samples	Materials-Purpose
B		Process Tube	ORNL-184	36	Be ₃ N ₂ (C ¹⁴ production for ORNL)
KW	2C,	General Purpose	HAPO-236	2	Tensile specimens (creep rate study)
	3D				
KW	3865	General Purpose	HAPO-304	1	Uranium (swelling capsule)
B		Process Tube	HAPO-303	45	Uranium (swelling capsule)
KW	3674	General Purpose	NAA-123	1	Nuclear heating experiment
		*Gamma	HAPO-320	5	RTD's (damage study)

*Gamma irradiation facility located in Building 105-KE storage basin

Ex-Reactor Pressurized Water Loops

TF-1 - Testing continued to determine the corrosion rates of carbon steels in low ammoniated water. Operating conditions are 82 C, 135 psig, and pH 10.0 adjusted with ammonium hydroxide.

TF-3 - Testing continued to provide long term corrosion data at N Reactor alternate primary coolant water conditions. Operating conditions are 293 C, 1350 psig, and pH 10.0 adjusted with lithium hydroxide.

TF-7 - Corrosion and equipment testing continued. Operating conditions are 1125 psig, 277 C, pH 10.0 adjusted with ammonium hydroxide. The test sections contain the following materials:

1. PRTR fuel element for fretting corrosion
2. Two dummy fuel elements, two NIN1 fuel elements and coupons for ALK-15 crevice corrosion tests
3. A metallic spiral-wound, asbestos filled gasket for caustic corrosion cracking
4. Special NPR type inner fuel elements for fretting corrosion
5. One KSE3 fuel element for uniform corrosion testing
6. Two coupon holders for film buildup studies
7. One Zr-2 specimen for caustic attack testing

Legend

NIN1 - N Reactor, inner tube, natural, first model

KSE3 - KER loops, single tube, enriched, third model

TF-17 - Testing was continued to determine the corrosion rates of approximately 20 alloys in pH 9.0 boiling water adjusted with ammonium hydroxide. Operating conditions are 78 C and 85 psig.

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Borescoping - N Reactor - Traverse channel L-4 was examined with the bore-scope and a motion picture record obtained to determine its condition and to provide data to be used in the design of distortion measurement equipment.

O. H. Greager
Manager, Research and Engineering

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DATE

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9/16/94

END