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**REACTOR BRANCH MONTHLY REPORT
JANUARY - DECEMBER 1965**

BY: RL PLUM

**ATOMIC ENERGY COMMISSION
HANFORD OPERATIONS OFFICE**

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UNITED STATES GOVERNMENT

Memorandum **DECLASSIFIED**

TO : Files

DATE: February 9, 1965

FROM : R. L. Plum, Chief
Production Reactor Operations Branch

SUBJECT: MONTHLY REPORT - JANUARY 1965

HAN-90620
Report #1

OR:GTO:RGR

This document consists of 2 pages.

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OPERATING EXPERIENCE

Production

Reactor input plutonium production for January was 448.8 KMWDs (98.8 per cent forecast): 268.5 KMWDs (103.8 per cent forecast) at the five smaller reactors and 180.3 (92.2 per cent forecast) at the two K Reactors. A monthly input production record was achieved at F Reactor exceeding the previous small reactor (other than C Reactor) monthly production record by 4.6 per cent.

Efficiency

Over-all time operated efficiency for January was 82.6 per cent: 87.5 per cent at the five smaller reactors and 70.2 per cent at the two K Reactors. A 100 per cent time operated efficiency was achieved at the F Reactor.

Power Levels

Reactor power levels at B were limited by trip-after-instability limits in certain tubes associated with the E-D and E-Q programs. The C Reactor power levels were restricted by graphite limits due to low reactivity resulting from the thorium load. The D Reactor power levels were limited by a bulk outlet water temperature of 95 C early in the month and by tube powers the last third of the month to minimize rupture potential. Power levels at F Reactor were restricted by a bulk outlet water temperature of 95 C, except for several days early in the month when levels were restricted while progressing to new graphite limits authorized by a production test. The H Reactor power levels were limited by the 95 C bulk outlet water temperature limit until late in the month when temperatures on several low flow spline tubes became limiting. Power levels at the two K Reactors were restricted

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Power Levels (Continued)

by the administrative limit of 4400 megawatts.

Ruptures

Eleven failed I&E natural uranium fuel elements were removed from the reactors. Four of the failures were at D Reactor (40 per cent, 48 per cent, 58 per cent and 60 per cent of goal exposure), three were at C (75 per cent, 77 per cent and 78 per cent), two were at H (42 per cent and 64 per cent) and two were at B (95 per cent and 96 per cent). The three C Reactor failures were from end defects in overbore elements. Seven of the normal size failures were side-hot-spots and one was side-unclassified. Eight of the failures, including two overbore, were stuck in process tubes.

MAINTENANCE AND EQUIPMENT EXPERIENCES

Water Leaks

One internal aluminum process tube leak was corrected at KW Reactor.

Tube Replacement

Nine new process tubes were installed: five at D and one each at B, H, KE and KW. The tube installed at KE was zircalloy and it placed a channel in operation that had been a graphite stringer channel.

REACTOR OUTAGES

<u>Date</u> <u>Down</u>	<u>Date</u> <u>Up</u>	<u>Outage</u> <u>Hours</u>	<u>Remarks</u>
<u>B Reactor</u>			
1/7	1/12	116.0	Removal of an I&E natural metal rupture from Tube 1380, charge-discharge and maintenance.
1/31	Still down		Removal of an I&E natural metal rupture from Tube 3973, charge-discharge and miscellaneous maintenance.

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C Reactor

12/31	1/2	37.3	Removal of an I&E 94 metal rupture from Tube 3369.
1/13	1/14	35.5	Removal of an overbore natural metal rupture from Tube 3366.
1/16	1/17	34.4	Removal of an overbore natural metal rupture from Tube 3169.
1/17	1/18	7.4	Removal of overbore natural metal rupture from Tube 3169.

D Reactor

1/2	1/4	35.4	Removal of an I&E natural metal rupture from Tube 2664.
1/13	1/14	38.2	Removal of an I&E natural metal rupture from Tube 2264.
1/15	1/17	31.3	Removal of an I&E natural metal rupture from Tube 1563.
1/19	1/20	35.8	Removal of I&E natural metal rupture from Tube 2661.
1/20	1/20	1.4	Panellit trip when a spline stub blew out of the seal during the splining operation.

F Reactor

No outages.

H Reactor

1/6	1/8	32.9	Removal of an I&E natural metal rupture from Tube 0880.
1/19	1/20	37.0	Removal of an I&E natural metal rupture from Tube 0966, charge-discharge.

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KE Reactor

12/31	1/3	69.0	Low crossheader pressure trip on 1706 single pass tubes 4355 and 4456. Charge-discharge, including the loading of fringe thoria.
1/24	1/28	104.2	Scheduled charge-discharge and miscellaneous maintenance.
1/29	1/30	31.0	High pressure Panellit trip on gauge 1369.

KW Reactor

1/4	1/9	120.4	Charge-discharge, including loading of thoria.
1/9	1/9	2.3	Resistance Temperature Detector repair.
1/12	1/13	37.1	Water leak. Spline tube 5582 was replaced.
1/19	1/21	39.2	High pressure Panellit trip on thoria tube 4653, and miscellaneous maintenance.
1/23	1/25	51.1	Manually scrambled to control process tube outlet temperatures, charge-discharge and maintenance.

RESEARCH AND DEVELOPMENT

Bismuth Irradiation

A production test is being prepared to authorize irradiation of bismuth target elements in C Reactor overbore facility. Fabrication of the bismuth elements has been completed for some time. Special aluminum spacer pieces have been designed which will hold cobalt aluminum wire to obtain flux data. Charging of this test is scheduled for February.

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Generalized Neptunium Production Code

A generalized Np-237 buildup model has been formulated and is now being programmed for the IBM 7090. The program should be versatile enough to compute Np-237 yields for any of the combined operation study cases, including oxide fuel.

Oxide Fuel

The results of speed-of-control calculations for K Reactor with oxide fuel using CLUMSEY indicate that speed-of-control requirements can be satisfied for as much as 3.75 per cent ($\Delta k/k_\infty$) reactivity gain on water loss at 4400 MW power and a 5.0 per cent ($\Delta k/k_\infty$) reactivity gain on water loss at 3000 MW power. It is, therefore, probable that the use of oxide fuel is feasible from a nuclear safety standpoint in the K Reactors without any modification of the lattice. Total control requirements can be met with the use of splines, and perhaps foregoing minimum-outage startups.

PROCESS TECHNOLOGYVertical Safety Rods-Graphite Distortion

Testing of equipment for enlargement of the K Reactor VSR Channels was resumed following the VSR sleeving installation at 105-C Reactor. The modified thermal shield boring machine was completed and is now ready for initial testing.

Testing of the multiple pass VSR channel enlarging equipment was resumed, with current efforts to develop methods to program the cutting heads to avoid cutting into process tube channels in the areas of severe graphite distortion.

Procurement of sleeving material for the 105-K Reactor VSR channels is incomplete. Sufficient material has been received for the initial test; however, the remainder of the order has not been delivered due to purity requirements. The graphite material has a high boron content and is suitable for off-reactor testing but not for in-reactor use.

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Graphite Strength Tests

A series of laboratory tests is being prepared to measure the strength of graphite blocks, keys, and VSR channel liners when subjected to loadings similar to those which are believed to exist in-reactor. The test program is expected to last about one month. The objective of these tests are to measure the magnitude of the forces which may build up within the stack as it distorts until such forces are relieved by failure of the graphite blocks and keys which hold the stack together. The various mockup assemblies will be loaded to failure in a manner believed to exist in-reactor. These tests results, when combined with the present theory of stack distortion mechanisms, should permit a better assessment of the ability of VSR channel lines to withstand internal stack forces.

Higher Graphite Temperature Test

The test which increases the graphite temperature limit from 650 C to 700 C at F Reactor has been in effect for approximately three weeks. Preliminary gas composition data indicate that the observed increase in the reaction rate between graphite and carbon dioxide is well within the limits established for this test. The observed carbon monoxide (product of C-CO₂ reaction) concentration increased from 0.7 per cent before the test to 1.3 per cent indicating approximately a two-fold increase in oxidation rate from the graphite CO₂ reaction. There has been no detectable change in the rate of reaction between graphite and water vapor. The Helium loss rate decreased from about 14,000 cu. ft. per day before the test to about 7,000 cu. ft. per day. This is in reasonable agreement with the expected change.

E-Q Loadings

All reactor fringe loadings are now complete. KW Reactor is now fully loaded as E-Q. The charging of the second half of the core (January 4 outage) and the startup proceeded without incident. The first half-core of thorium elements, charged into KW Reactor during November 29, 1964, were discharged during the January 23 outage. The reactivity of the second half was a little lower than predicted ($\approx 2-3$ mk) but this was possibly caused by water in the pile. The graphite temperature coefficient of the E-Q loading is now

following very closely the predicted behavior. The coefficient is more positive, but the change with exposure is less pronounced than it is with a natural uranium loading. The operating reactivity transient in the half-and-half loading has consistently fallen within $\frac{1}{2}$ mk of the predicted transient. The reactor is more sensitive to oscillation (as predicted), but there is no cycling problem which cannot be corrected with control techniques now available.

The startup procedure following the second half loading was identical to the first except there was no hold at 80 per cent until saturation of short-term transients.

Reactor Deactivation - Placing DR In Standby

The work necessary to place DR in a standby status is proceeding ahead of schedule with 109 shutdown procedures completed of a total of 195. In addition work on the remaining 86 procedures is well advanced. Indications are that shutdown work will be essentially completed by March 1.

The graphite block and the biological shield have reached ambient (room) temperature conditions. Radiation readings at the rear face elevator are about 150 mr per hour.

Effluent Activity Data

The following table shows the average concentrations of five radionuclides from effluent samples taken in December 1964. All units are 10^{-12} curies/cc.

<u>Reactor</u>	<u>As⁷⁶</u>	<u>P³²</u>	<u>Zn⁶⁵</u>	<u>Cr⁵¹</u>	<u>Nd²³⁹</u>
B	140	5.8	3	430	170
C	160	13.3	14	1000	200
D	82	8.3	5	400	100
DR	100	11.5	17	740	150
F	68	7.3	10	370	84
H	72	10.0	4	350	100
KE	38	6.8	8	130	45
KW	38	5.7	8	120	43

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The coolant pH was reduced from 7.0 to 6.6 at KE and KW on December 5, 1964, and December 6, 1964, respectively. There were no other significant changes made in the treatment of reactor coolant during December 1964.

Dose Rates in the DR Reactor Block

Following shutdown of DR Reactor for standby, measurements were made in a process tube to determine the gamma dose rates in the block from front to rear. The highest dose rate was at the end of the gunbarrels. This was 675 R/hr.

Control Studies

Arrangements have been made with CPD for the special scheduling of approximately 260 tons of K reactor fuel through the Purex Plant. This material, which has relatively uniform Pu-240 content quite close to product quality specifications, is being processed following the thorium separations which came immediately after a plant cleanout.

Depleted Uranium Irradiations

B Reactor

The 104 columns of depleted uranium (22 w/o U-235) fuel elements have accumulated an average exposure of 670 MWD/T (about 50 per cent of goal). Discharge of 12 monitor columns of this irradiation will take place during February 1965. The behavior of the depleted uranium has been very close to predictions. The rate of accumulation of exposure is about two per cent greater than anticipated while the depleted uranium tube powers differ by less than three per cent from the expected value. The estimated Pu-240 concentration is 11.7 per cent and the total Pu content is estimated to be 1120 g/T.

KE Reactor

The 90 columns of depleted uranium fuel elements in the central zone of the KE Reactor are now estimated to have an average exposure of 760 MWD/T. The total Pu is about 1300 g/T with a 240 content of 12 per cent.

RUPTURED SLUG TABULATION FOR January 1965

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Tube No.	Date Charged	Date Ruptured	Tube Power (KW)	Concentration MMD/Ton	Assigned Production Loss		Observations
					MMD	Days	
2664 D	12-10-64	1-2-65	1374	211	1382	.76	I&EN Side hot spot
0880 H	12-6-64	1-6-65	1333	264	2084	1.02	I&EN Side hot spot
1380 B	11-14-64	1-7-65	1398	491	891	.47	I&EN Side hot spot
2264 D	12-9-64	1-13-65	1261	290	768	.42	I&EN Side hot spot
3366 C	10-10-64	1-13-65	1598	626	384	.18	I&EN Overbore End Defect
1563 D	12-9-64	1-15-65	1149	319	1132	.62	I&EN Side unclassified
3069 C	10-10-64	1-16-65	1486	615	525	.24	I&EN Overbore End Defect
3169 C	11-9-64	1-17-65	1553	455	742	.34	I&EN Overbore End Defect
2661 D	12-9-64	1-19-65	1321	333	1197	.66	I&EN Side hot spot
0966 H	12-6-64	1-19-65	1345	389	1339	.66	I&EN Side hot spot
3973 B	11-14-64	1-31-65	1245	597	585	.31	I&EN Side hot spot

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Memorandum

TO : Files

DATE: March 9, 1965

FROM : R. L. Plum, Chief *CPD*
PRODUCTION REACTOR OPERATIONS BRANCH

SUBJECT: *for* MONTHLY REPORT - FEBRUARY 1965

HAN-90620
Report #2

OR:GTO:RGR

This document consists of 12

OPERATING EXPERIENCE

Production

Reactor input plutonium for February was 410.5 KMWD'S (96.8% forecast: 205.1 KMWD'S (92.9% forecast) at the five smaller reactors and 205.4 (100.9 forecast) at the two K Reactors.

Efficiency

Over-all time operated efficiency for February was 78.0%: 75.4% at the five smaller reactors and 84.2% at the two K Reactors. Efficiency was below forecast at both the smaller reactors and at the K Reactors due largely to fuel element failures.

Power Levels

Reactor power levels at B Reactor were limited by trip-after-instability limits on tubes operating at higher powers as partial compensation for thorium and depleted uranium loadings. The C Reactor power levels were restricted by graphite limits resulting from low reactivity associated with the thorium load. The D Reactor power levels were restricted by tube power limits internally imposed to minimize rupture potential. The F Reactor power levels were restricted by a bulk outlet water temperature limit of 95 C. Power levels at H Reactor were limited by temperatures on several low flow spline tubes early in the month and later in the month by non-equilibrium caused by low reactivity following a block discharge. Power levels at the two K Reactors were restricted by the administrative limit of 4400 megawatts.

A new record power level (2040 MW) was achieved at F Reactor.

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Ruptures

Seven I&E natural uranium fuel element failures and three failed thoria elements were removed from the reactors. Two of the natural uranium failures were at D Reactor (both at 95% of goal exposure), two were at H (21% and 89%), one was at C (overbore at 11%), one was at F and one was at KE (86% and 27%, respectively). Three of the natural failures were side-hot-spots, two were end defects, one was side-unclassified and one was not examined. The thoria failures, one at KE and two at KW were at 24%, 63% and 63% of goal exposure, respectively. The type of failures has not yet been determined. In addition, two thoria failures, not previously reported, were discharged from one KW Reactor tube last month at 80% of goal exposure.

MAINTENANCE AND EQUIPMENT EXPERIENCES

Water Leaks

Three internal tube leaks and three Van Stone leaks were corrected: the tube leaks were at B, F and H Reactors; two of the Van Stone leaks were at D and one at F Reactor.

Tube Replacement

Twenty-eight aluminum process tubes were installed: nineteen at F, five at D, and two each at B and H.

REACTOR OUTAGES

DATE DOWN	DATE UP	OUTAGES HOURS	REMARKS
<u>B REACTOR</u>			
1-31	2-3	72.0	Removal of an I&E natural metal rupture from tube 3973, charge-discharge and maintenance.
2-25	2-28	85.9	Scheduled charge-discharge.

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C REACTOR

2-2	2-6	87.6	Charge-discharge and miscellaneous maintenance.
2-6	2-6	1.2	Scrammed when a relay in the VSR circuit burned out.
2-15	2-16	39.5	Removal of I&E overbore natural metal rupture from Tube 2967.

D REACTOR

2-10	2-12	51.4	Removal of an I&E natural metal rupture in Tube 2674 and charge-discharge.
2-18	2-24	160.4	Removal of an I&E natural metal rupture from Tube 2067, charge-discharge and maintenance.
2-26	2-27	27.7	Scrammed due to a power failure caused by wet weeds between busses at 190 DR.

F REACTOR

2-1	2-5	105.1	Charge-discharge and maintenance.
2-7	2-9	37.2	Scrammed by Panellit trip. Misc. maintenance work.
2-22	2-24	36.7	Removal of I&E natural metal rupture from Tube 1283. Charge-discharge.

H REACTOR

2-6	2-10	91.5	Removal of I&E natural metal rupture from Tube 0773, and scheduled block charge-discharge.
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H REACTOR (cont.)

2-11	2-12	27.7	Down due to outage caused by a B-metal piece jammed in a ball valve.
2-23	2-25	34.0	Removal of an I&E natural metal rupture from Tube 3280.

KE REACTOR

2-13	2-15	39.3	Removal of I&E natural metal rupture from Tube 3882, and charge-discharge.
2-18	2-20	40.7	Removal of a ruptured thoria piece from Tube 5881. Charge-discharge.

KW REACTOR

2-22	2-28	131.9	Down for scheduled charge-discharge and maintenance. Two ruptured thoria pieces were removed from Tube 3083 and 1865.
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RESEARCH AND DEVELOPMENTPlutonium 238

An effort to isolate and study the important variables in maximizing production of Pu-238 from Neptunium 237 irradiations has resulted in the following information. Spectrum, flux level and irradiation times are all important variables and depending on quality of Pu-238 wanted, the production rates can be varied somewhat. No great spectrum dependence has been found, although the effect of a high neutron temperature and high epithermal flux component are mildly important. Lack of information on the resonance integrals of the isotopes Neptunium 238 and Plutonium 238 puts a limit on the accuracy of the calculations in assessing spectral effects. In the capsule irradiation study to date, the K reactor environment appears to be the most favorable. For example, the expected results for a 5 W% neptunium

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aluminum target are compared with what is believed to be the results of the current Pu-238 program. The K Reactor cases indicate higher quality and smaller losses, but about half the production rate of the current process.

	<u>K REACTOR</u>		<u>CURRENT PROGRAM</u>
Irradiation Time (days)	225	100	90
% Pu 238/cycle	16.4	8.7	16.5
% Np 237 Return/cycle	79.4	90.1	75.0
Quality (%)	86.9	93.2	80.0
Conversion EFF (%)	80.6	89.5	66.0
Fission Losses (%)	1.6	0.34	3.9

The above study assumes production through 1980 from 50 kgs annual Np 237 input.

The optimum combination of spectrum, flux, and irradiation time is still being sought.

Old Reactor Process Channel Enlargement

A study has been completed for enlarging the process channels of the small reactors that will remain in operation. The conclusions reached were that the proposed one-inch channel enlargement provides a program which will result in (1) a net cost savings of approximately \$27,000,000 thru fiscal 1973, (2) the production of an equal quantity of product as planned under current operation coupled with the deactivation of a fourth Hanford production reactor, (3) increased nuclear safety, (4) a significant increase in the capability of the small reactors to manufacture products other than plutonium, and (5) the flexibility for possible future utilization of oxide fuel elements.

Realization of the maximum benefits for this constant plutonium production program occurs through channel enlargement and water plant modifications at B and C Reactors. The reactor power level and conversion efficiency is increased to achieve the same amount of production from two reactors as three small reactors currently provide. Subsequent to the plant modifications, D Reactor could be deactivated with the attendant reduction in operating expenditures.

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Fund requirements for the program accomplishment are estimated at \$9,700,000, including \$7,500,000 expense funds and \$2,200,000 capital funds. Approximately \$2,900,000 of the fund requirement can be provided through diversion of funds from the FY 1966 operating and plant and capital equipment budget. Payout of capital funds would be realized approximately one year after completion of the reactor modification outages. The net cost savings thereafter would approximate \$6,700,000 annually. And the total Hanford plutonium unit cost would be reduced in the order of 3% over the 8-year production period.

The economic analyses were based on the use of metallic uranium fuel elements with no credit included for alternate product formation. Inclusion of alternate product associated economics was avoided primarily to assure that a realistic evaluation of the program benefits was not compromised by arbitrary assumptions of alternate product values. An ultimate determination of alternate product values would, in any case, increase the overall economic benefit.

PROCESS TECHNOLOGY

Depleted Uranium Irradiations

As of mid month the exposures and estimated production in the depleted uranium loadings were:

KE REACTOR	930 MWD/T	13.7% Pu 240	1470 g/T
B REACTOR	810 MWD/T	13 % Pu 240	1260 g/T

There have been no significant operational problems with the KE Reactor E-D loading. However, B reactor is experiencing difficulty maintaining maximum permitted power due to some of the enriched columns running hot in the test block. In addition, the E to D ratio is still staying higher than predicted (2.5 vs 1.6) indicating a discrepancy between the theoretical and observed reactivity match.

Self Support Development

The final 11 columns of self-support fuel elements containing archrail supports have been discharged from the KW Reactor. Examination and measurement of the elements have been completed and analysis of the test results is in progress.

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Clean U-233 Program

Six Ton Test

Preliminary measurements on three samples of the six ton thorium irradiation show yields of 583 to 636 grams U-233 per ton of thorium and 2.48 to 2.72 ppm U-232. These samples appear to be fairly representative, indicating that the calculations were good to $\pm$ 5% of the predicted yield.

Irradiation Status

Thorium oxide blankets now exist in B, D, C, KE and KW reactors. The thorium in the first half E-Q core at KW Reactor has been discharged and replaced with fresh thorium. KW is now fully loaded with the E-Q loading. The second half core recharging was scheduled for February 24. Loading of half of the core of KE Reactor with E-Q is planned for an outage near the first of March. Loading of the full core of D Reactor with E-Q has been completed.

The physics behavior of the KE E-Q loading continues to match the predicted values closely. The graphite temperature coefficient is more positive than a normal loading, but the increase in the coefficient with irradiation time is slower. The reactor is more prone to flux cycling due to the more positive net temperature coefficient, but normal control techniques have been able to damp incipient oscillations.

On January 20, 1965, KW Reactor shut down as a result of a Panellit scram on process channel 4653 KW containing thorium elements. Following discharge of the thorium column, visual inspection revealed two elements with distorted cladding. Examination of these elements in the radiometallurgy laboratory revealed that one of the elements had a side bulge greater than 100 mils and the end caps were distorted to a convex shape. Gas samples collected from this element indicate that the quantity of gas given off was approximately 30% greater than observed from previously sampled elements; however, this quantity of gas would not be expected to produce pressures exceeding the yield strength of the can. The possibility of the readsorption of gases evolved during irradiation is being investigated. A pin hole in the weld closure was observed on the second element. Sectioning of the element disclosed that the thorium was no longer in powder form, but had fused into a solid mass, having the consistency of plaster. Further investigation of this piece is planned.

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Reactor Deactivation

Surveillance of graphite moderator and shield temperatures is continuing at the deactivated DR reactor. Approximately one month after removal of coolant flow, the biological shield, thermal shield, and peak graphite temperatures are all about 23 C or ambient temperature. The graphite temperatures continue to increase slightly, but at a continually decreasing rate. The current rate of increase is approximately 0.2 C per day implying a heat generation rate of about 2.5 KW.

Higher Graphite Temperature Test

Production test IP-725, which authorizes an increase in the graphite temperature limit from 650 C to 700 C, has been in effect at F Reactor since January 6. After three weeks of operation at the new limit, the reactor was shut down and the monitor samples were discharged and measured. The oxidation rate of the samples increased from 0.5 to 1%/KOD at the 650 C limit to 3 to 4%/KOD at the 700 C limit. The oxidation rate in the stack however, only doubled as evidence by a two-fold increase in the carbon monoxide concentration in the gas atmosphere. These observations indicate that (1) when the reactor is operating with a 650 C limit the primary cause of stack oxidation is irradiation induced reaction between graphite and CO₂; (2) with a 700 C limit the oxidation rate of the monitor samples is primarily controlled by the thermally induced reaction mechanism, while the bulk of reaction in the stack is still controlled by the radiation induced mechanism; (3) an additional 50 C increase in temperature will probably make a substantially greater change in oxidation rate than did the 50 C increase authorized by the test.

Composite Lattice Measurements

Wet and dry reactivity measurements of various arrangements of fuel and target materials are scheduled during the H reactor deactivation physics tests. The fuel material will be 0.947 and 1.25% enriched uranium; the target material will be thorium, bismuth, and 0.2% depleted uranium. Also, included in the test will be rod shadowing, and relative spline strength measurement. Approval of these tests has been delayed pending notification of the shutdown status of H Reactor.

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Replacement of Horizontal Control Rods C and K Reactors

Testing of a prototype flexible horizontal control rod in the 105 K reactor HCR channel mockup is continuing. Strain gauge measurements showed that highest rod sheath stress occurred at the inner side of the shield step plug under maximum channel distortion conditions. The step plug is being modified to alleviate this condition.

The second inconel sheath, flexible rod prototype is on hand pending installation at 105 KW Reactor for in-reactor testing, now scheduled for early April 1965.

Effluent Acticity Data:

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

<u>Reactor</u>	<u>As⁷⁶</u>		<u>P³²</u>		<u>Zn⁶⁵</u>		<u>Cr⁵¹</u>		<u>Np²³⁹</u>	
	Jan	Feb	Jan	Feb	Jan	Feb	Jan	Feb	Jan	Feb
B	83	88	8.3	9.6	7	13	380	403	67	172
C	98	93	15.5	14.0	20	27	930	972	98	242
D	51	42	12.5	10.6	11	16	410	350	46	91
F	57	44	18.1	10.2	23	24	420	438	44	109
H	48	35	15.0	8.9	9	8	420	334	89	110
KE	22	18	7.0	6.0	8	11	130	138	36	38
KW	24	44	5.5	7.6	8	8	110	145	28	75

Irradiated Fuel Age Monitor

Fabrication of the electronic equipment for irradiated fuel age determination has been completed by Battelle Northwest. In-service testing of the monitoring system is scheduled to begin in March at 105 C Reactor.

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Process Piping Studies

The program to assess the integrity of critical process piping continued. Information received from U.S. Steel indicates that about one-half of the steel in the four 183 C storage tanks was made to American Bureau of Ships standards. No test records have been found by the supplier for the remaining 50% of the plate. In view of this uncertainty, fourteen material samples have been removed randomly from the No. 4 183 C tank. These will be chemically analyzed for carbon, silicon and manganese. Further action will be determined after receipt of analysis results.

Downcomer Capacity Studies

The program to evaluate downcomer flow conditions in each of the reactors intended to remain in operation following deactivation continued. Modification of the former DR model to a C downcomer model is underway at Washington State University. Summary reports concerning the structural analysis of the 105 C and K Reactors downcomers have been received from the General Electric Company Advanced Technology Laboratories. The principle features of these reports was a structural analysis of the strength of the K downcomer approach section. Based on this information, and local analysis, reinforcement of the approach section to permit pressurization appears feasible.

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(Year)
OUTAGES (1965) February

<u>Reason</u>	B	C	D	DR	F	H	KE	KW	Total
Charge-Discharge	75.3	65.8	93.5		51.6	61.0	35.2	75.6	458.0
Maintenance	20.5	30.4	50.7		56.0	44.4	10.5	4.9	217.4
Rupture Removal	-	4.4	13.4		9.7	31.6	18.4	1.1	78.6
Water leak	15.9	-	16.0		30.6	10.1	-	-	6
Water leak					19	2	-	-	72.6
Tube Replacement	4.7	6.6	7.2		21.3	-	-	-	39.8
Project Work	2.7	8.4	-		-	-	12.8	-	23.9
Production Tests	9.7	7.1	13.6		9.8	-	-	11.8	52.0
Standard check	6.3	4.7	7.4		-	5.1	-	38.5	62.0
Standard check									
Rupture Removal									
Miscellaneous	-	0.9	27.7		-	1.0	3.1	-	32.7
Total	135.1	128.3	229.5		179.0	153.2	80.0	131.9	1037.0
Scheduled Outages									
Unscheduled Outages									

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Tube No.	Date Charged	Date Ruptured	Tube Power (KW)	Concentration MWD/Ton	Assigned Production Loss		Observations
					MWD	Days	
0773 H	12-6-64	2-6-65	1311	552	432	.22	I&EN UN
2674 D	12-8-64	2-10-65	1250	535	717	.41	I&EN SH
3882 KE	1-24-65	2-13-65	1615	174	1841	.42	I&E - NS EM
2967 C	2-2-65	2-15-65	1148	85	494	.23	I&ENO EM Rupture Prone
2067 D	12-9-64	2-18-65	1290	578	429	.24	I&E-N SU
1283 F	12-27-64	2-22-65	1394	516	1220	.65	I&E-N SH
328 OH	2-6-64	2-23-65	1385	127	2728	1.42	I&E-N SH
5881 KE	12-31-64	2-18-65		24% of Goal Equil 22	1786	.41	Thoria
1865 KW	1-23-65	2-23-65		63% Equil 52	211	.05	Thoria
3083 KW	1-23-65	2-23-65		63% Equil 47			Thoria

UNITED STATES GOVERNMENT

Memorandum **DECLASSIFIED**

TO : Files

DATE: 7 2 1967

FROM : R. L. Plum, Chief
PRODUCTION REACTOR OPERATIONS BRANCH

SUBJECT: MONTHLY REPORT - MARCH 1965

HAN-90620
Report #3

OR:GTO:JKR

THIS DOCUMENT CONSISTS OF 1 PAGE

CO

OPERATING EXPERIENCE

Production

Reactor input plutonium production for March was 477.7 KMW's (98.9% forecast); 253.5 (98.3% forecast) at the five smaller reactors and 224.2 (99.7% forecast) at the two K Reactors.

Efficiency

Overall time operated efficiency was 84.6%; 84.6% at the five smaller reactors and 84.5% at the two K Reactors. A new operating record was established during March when the seven reactors achieved 9.3 days of continuous operation. The previous record of 8.9 days for eight reactors and for the seven operating reactors was established in February, 1959.

Power Levels

Reactor power levels were limited by trip-after-instability limits on support enrichment tubes for the thoria load at D Reactor and for the thoria and depleted uranium loads at B Reactor. The C Reactor power levels were restricted the first half of the month by graphite limits resulting from low reactivity associated with the thoria load and during the last half of the month by overbore tube powers to minimize rupture potential. The F Reactor power levels were restricted by a bulk outlet water temperature limit of 95°C. Power at the H Reactor was limited by tube powers to control ruptures. The two K Reactor power levels were restricted by the administrative limit of 4400 megawatts.

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Ruptures

Five failed uranium fuel elements (three I&E natural and two I&E enriched) and five failed thorium elements were removed from the reactors. Two of the natural uranium failures were at H; one was a watermix piece at 31% of goal exposure and the other was at 34% of goal exposure. The third natural uranium failure was an overbore element at C Reactor at 52% of goal. The enriched failures, both at B Reactor, were at 75% and 94% of goal exposure. Two of the natural uranium elements were side-hot-spot failures and the failed overbore element was caused by an end defect. One enriched failure was a side-hot-spot and one was a side-unclassified.

The thorium failures, one at C, two at KE, and two at KW, were at 52%, 45%, 9%, 115% and 115% of goal exposure, respectively. One was from a side defect. The failure mechanism of the other four has not yet been established.

MAINTENANCE AND EQUIPMENT EXPERIENCESWater Leaks

Two internal tube leaks were corrected at F and KW Reactors. Six Van Stone leaks were corrected, two each at D and F Reactors and one each at H and KW Reactors.

Tube Replacement

Three zirconium and seven aluminum tubes were installed: the zirconium tubes were installed at KW Reactor, two each of the aluminum tubes were installed at D, F and H Reactors and one at KW Reactor.

REACTOR OUTAGES

DATE DOWN	DATE UP	OUTAGES HOURS	REMARKS
<u>B REACTOR</u>			
3-3	3-5	36.9	Scrammed due to faulty bypass switch on zone temperature monitoring system.
3-11	3-12	38.1	Removal of I&E enriched metal rupture from tube 2760. Charge-discharge.
3-25	3-28	57.8	Removal of an I&E enriched uranium rupture from tube 3988. Charge-discharge and maint.

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REACTOR OUTAGES - Cont.

C REACTOR

3-1	3-4	71.0	Scheduled charge-discharge and miscellaneous maintenance.
3-4	3-4	.9	Scrammed due to a defective Panellit gauge on tube 0379.
3-6	3-7	33.7	Panellit trip on overbore tube 4472.
3-7	3-7	.4	Scrammed when flux monitor trip settings were not properly changed during power rise.
3-14	3-15	37.6	Removal of an I&E normal uranium overbore rupture from tube 3266. Charge-discharge.
3-25	3-27	39.5	Removal of a thoria rupture from tube 0172.

D REACTOR

3-7	3-9	31.3	Down due to high pressure on thoria tubes 0173 and 4673.
3-25	3-26	32.2	Scrammed when a temperature map indicated temperature in tube 3070 above the TAI limits.
3-26	3-26	.3	Panellit trip.
3-26	3-26	.4	Panellit trip.

F REACTOR

3-8	3-11	74.8	Scheduled charge-discharge. Leak testing.
3-29	3-31	39.3	Panellit trip caused by a leak in tube 1273.
3-31	3-31	2.7	Panellit trip while inserting a spline in tube 1382.

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REACTOR OUTAGES - Cont.

H REACTOR

3-3	3-4	33.0	Removal of an I&E normal uranium rupture from tube 1476.
3-4	3-5	14.5	Removal of an I&E normal rupture from tube 3385.
3-7	3-8	29.5	Down due to excessive water collection.

KE REACTOR

3-1	3-5	102.2	Removal of thoria rupture from tube 3098, charge-discharge and maintenance.
3-31	Still down		Scheduled charge-discharge. Removal of thoria rupture from tube 5885.

KW REACTOR

3-1	3-4	81.6	Panellit trip. Leak testing. Removal of two zirconium tubes, 3075 and 3065.
3-5	3-5	.7	Panellit trip caused by an oscillating gauge on thoria tube 2669.
3-29	3-30	42.0	Removal of thoria element ruptures from tubes 1853 and 4265.
3-31	3-31	.5	Panellit trip.

RESEARCH AND DEVELOPMENT

Pu-238

Calculation of Pu-238 production from irradiating Np-237 has continued. Optimization of the process has been completed for three Pu-238 qualities. The pertinent numbers are given below for K Reactor operation, bulk

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Pu-238 - cont.

limited year around.

<u>Quality:</u>	<u>70%</u>	<u>80%</u>	<u>90%</u>
α = % Pu-238/cycle	21.1	16.9	9.06
β = % Np-237	58.4	75.6	89.0
$\frac{\alpha}{1-\beta}$ = Conversion Eff	50.7	69.3%	82.3%

<u>Fission Losses/cycle:</u>	<u>11.2%</u>	<u>3.0%</u>	<u>0.7%</u>
Irradiation time	477 days	246 days	101 days
Cycle time	716 days	427 days	246 days

Production through 1980:

50 kg Np annual input	285 kg	405 kg	403 kg
Np remaining 1980	138 kg	165 kg	260 kg

The conversion efficiencies reported here are lower than those reported last month. The reason for this is the latest calculations assume a 580 b cross section for Pu-238 (based on a 1962 measurement) whereas the earlier work used the older value of 400 b (1956 measurement). The cycle times are based on 80 per cent reactor operating efficiencies and 120 days for the out-of-reactor cycle time (cooling, separating, and fabricating).

Uncooled Horizontal Control Rods

Substantial progress has been made upon the design of an uncooled horizontal control rod suitable for use in the Hanford production reactors.

Sheath material tests on 19-9DL and Inconel 600 have passed the 5000 hour point with both materials still resisting deterioration satisfactorily. Composite samples of dysprosium oxide-nickel (Dy_2O_3-Ni) clad in 19-9DL and Inconel 600 have completed 1450 hours of test in a simulated reactor environment with no detrimental effects indicated. Samples of each of these are also being irradiated in a test hole at KW Reactor.

Uncooled Horizontal Control Rods - Cont.

A comprehensive analysis of nuclear characteristics, concentration requirements and induced radioactivity for high purity (99% +) Dy_2O_3 and boron carbide in nickel and aluminum oxide matrices for use as a neutron absorber in an uncooled HCR are also being made. Recent information shows promise that the moderate-purity Dy_2O_3 may offer most of the nuclear attractions of high purity Dy_2O_3 but at a cost much more comparable to that of boron carbide.

PROCESS TECHNOLOGYDepleted Uranium Irradiations

Examination and measurement of 12 monitor columns of 760 MWD/t depleted uranium fuel elements from KE Reactors have been completed. The data have been partially analyzed and weight loss observed on the elements is minimal - averaging about a quarter of a gram per element. Average weight loss for a natural uranium element at goal exposure 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.

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

	<u>B</u>	<u>KE</u>
Exposure, MWD/T	1040	1120
% Pu-240	15	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% Pu-240. At 20% Pu-240, the yield should be about 2 kg/ton, or a total of about 50 kg of 20% Pu-240 plutonium.

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Depleted Uranium Irradiations - Cont.

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 the splines is considered, the agreement between predicted and observed E-D ratio is good.

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 ratio is consistent with prediction, but U-233 yields from samples from the central thoria elements are higher than predicted or than from the bulk separations data. A peaking of the flux would explain the discrepancy, but it is not known if there was a flux distribution grossly different from a normal cosine.

There have been ten in-reactor failures of thoria target elements since production charging was initiated on September 29, 1964; 6 at KW, 3 at KE and 1 at C Reactor. Cause of failures of the elements examined has been found to be water penetration through small pinhole defects in the fuel element weld end closure and subsequent reaction between thoria (ThO_2) and water to form thoria hydrate, which has expanded and caused deformation and/or rupture of the fuel jacket.

Previous information, which indicated that the thoria fired in the range of 1050 C was nonreactive, appears to be invalid. Recommendations now are that the material should be fired at 1150 C for four hours to produce nonreactive oxide. The present closure method for the thoria element can be improved so as to preclude water penetration.

About 30 tons of thoria fired in the questionable temperature range remain to be canned. To meet charging schedules, it will not be possible to refire this material; however, the weld integrity will be improved by taking the following actions:

- a). Helium leak test all welds.
- b). Backfill with helium and test.
- c). Demonstrate radiograph feasibility and implement.
- d). Improve lighting at visual weld inspection station, brush welds prior to inspection, use magnification to examine welds, and double weld inspect.
- e). Improve the bubble tester integrity.
- f). Autoclaving, 40 hours at 175 C.

Six-Ton Test - Cont.

In addition to the above acceptance tests and procedures, development programs aimed at improving the welding process are also under way. Techniques being considered include double cap welding, double can welding, welding of evacuated cans or welding in a vacuum, cold formed closure with subsequent welding, and electron beam welding.

Vertical Safety Rods and Graphite Distortion

The off-reactor mockup testing program to evaluate the effects of VSR channel sleeving upon graphite stack keying has been completed. The following conclusions were reached as a result of these tests:

1. The strength of regular grade reactor graphite sleeves is greater than that of the stack and adjoining vertical keys. Upon loading of the stack model to simulate the loads applied as a result of continued stack distortion, the vertical keys and/or filler blocks were found to fail in shear or flexure before the sleeves would fail in crushing.
2. Sleeve installation will reduce the degree of channel curvature across the slip plane and distribute the slip-plane load across several layers of the graphite stack.
3. No sudden or catastrophic collapse of VSR channel sleeves would be anticipated on key failure.
4. Both of the current graphite distortion stack force theories are validated in part, thus providing a basis for a decision regarding the ultimate application of sleeving to portions of the 105-C and K Reactors.
5. One of the principal benefits from sleeving would be in preventing the loss of 3X system poison balls into known stack voids in the more severely distorted VSR channels.

These observations are being included in a review of the future direction of the VSR sleeving program and its on-reactor application.

During this period, work has continued on the development of equipment in support of the sleeving program with the status as follows:

All major pieces of the K Reactor biological shield enlargement equipment have been fabricated and are currently awaiting final mockup testing. Fabrication of the multiple-pass thermal shield boring machine was completed and initial cutting tests were conducted in the laboratory mockup.

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Vertical Safety Rods and Graphite Distortion - Cont.

Testing of the multiple-pass graphite channel enlargement equipment is nearing completion with several alternate cutter arrangements to reduce possible process tube losses are now being evaluated.

Temporary Repair - Installed RTDs

The increasing failure rate of RTD assemblies on the rear face of the K Reactors has necessitated the initiation of on-reactor repair by the injection of air-cured silicone elastomer into the cavity of the electrical connector. The technique has proved partially successful in the past and it does extend the life of the installed RTD for some months. Other techniques of temporary repair are also being evaluated.

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 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 effects 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°.

Zircaloy Tube Hydriding

During the KW Reactor outage the first week in March, zircaloy-2 process tubes were removed from channels 3065 and 3075 as leakers. Subsequent metallurgical examination of these indicated substantial hydriding in

Zircaloy Tube Hydriding - Cont.

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, circumferentially uniform, 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 observed at the downstream end was comparable in both tubes.

A program is being developed on a 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 0.025g/cc Gd_2O_3 and 0.25g/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 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.

Replacement of Horizontal Control Rods - C&K Reactors

All fabrication and test work in preparation for the installation of a prototype flexible Inconel sheathed HCR in Channel No. 2 at 105 KW Reactor has been completed. The installation of this prototype will be undertaken at the next available outage. This HCR channel was modified during January to accept the prototype HCR by the removal of the track blocks and installation of flat spacer plates. The existing style round rod has operated satisfactorily in the channel since that time.

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Irradiated Fuel Age Monitor

Initial testing of the completed fuel-age monitoring system has been completed using the original probe shielding head and tube. This equipment will be used to avoid inadvertent shipments of "green" fuel to the separation plants. Test results have been good and no obstacles are foreseen which would prevent complete success of the equipment. Additional testing is underway to achieve the optimum size of collimating hole and other factors in order to reduce the time presently required for age determination.

Gas Studies - All Reactors

The review of current operating procedures and techniques was continued in support of the program to reduce helium loss. Procedures for operation of the purge system and driers were reviewed and updated, and techniques to repair deteriorating shield seals were developed. A limited on-reactor test of application of air curing silicone rubber was conducted at D Reactor, and test results were encouraging. Additional testing is planned as reactor outage time becomes available.

Reactor Plant Deactivation

The 105-DR Building was locked on March 10, 1965. Closure of this building essentially completed the physical layaway of the DR facilities except for a few miscellaneous small jobs and completion of the cleanup of the 190 storage tanks. Work on the latter has been temporarily postponed pending improved weather to enhance atmospheric drying. Appropriate signs have been provided to indicate facility status.

Currently, periodic engineering inspections are under way to determine the extent of future routine surveillance.

At H Area, considerable planning activity is under way evaluating specific manpower needs and schedules and incorporating the extensive reactor testing program into the overall deactivation schedule.

The H Reactor deactivation procedures are essentially complete on the basis of abandonment, but with the 105 metal storage basin being retained. A limited number of procedure manuals have been issued, and orientation and planning meetings with Manufacturing personnel have been started.

Reactor Plant Deactivation - Cont.

Because of the increasingly compressed schedule between the H and F deactivation shutdowns, every effort is being made to resolve F Area preshutdown planning needs while also completing the actual H Area deactivation programs plans. F Area procedures are about 80% completed on the abandonment basis.

Effluent Activity Data:

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

<u>Reactor</u>	<u>P³²</u>	<u>As⁷⁶</u>	<u>Cr⁵¹</u>	<u>Np²³⁷</u>	<u>Zn⁶⁵</u>
B	10.9	94	470	165	16
C	13.1	122	880	245	31
D	10.4	47	230	75	13
F	28.6	135	350	160	24
H	10.7	66	330	95	8
KE	8.2	34	140	50	13
KW	8.0	74	150	95	13

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RUPTURED SLUG TABULATION FOR MARCH 1965

Tube No.	Date Charged	Date Ruptured	Tube Power (KW)	Concentration MWD/Ton	Assigned Production Loss		Observations
					MWD	Days	
1476 H	2/6/65	3/3/65	1397	189	2990	1.58	I&E - Normal Mixer Side-hot spot
3385 H	2/6/65	3/4/65	1331	205	1388	.73	I&E - N Side-hot/spot
2760 B	12/13/64	3/11/65	1385	761	2024	1.09	I&E - E Bumper Side unclassified
3266 C	1/16/65	3/14/65	1489	413	507	.23	I&E - NOverbore End mechanical defect
3988 B	1/31/65	3/25/65	1334	572	661	.36	I&E - E Side-hot spot
3098 KE	12/31/64	3/1/65		Equiv. 20	6084	1.39	Thoria
0172 C	12/18/64	3/25/65		Equiv. 33	536	.25	Thoria Side defect
4265 KW	1/23/65	3/29/65		Equiv. 110	1397	.33	Thoria
1853 KW	1/23/65	3/29/65		Equiv. 109	1397	.33	Thoria

Thoria

.49

Equiv. 39 2153

12/31/64 3/31/65

5885 KE

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(Year)
OUTAGES (1965) MARCH

Reason	B	C	D	DR	F	H	KE	KW	Total
Charge-Discharge	52.4	82.1	19.4		34.3	5.0	50.6	10.7	254.5
Maintenance	8.4	59.1	25.8		55.6	2.0	20.3	4.6	175.8
Rupture Removal	25.9	10.1				45.5	32.1	6.1	119.7
Leak Testing			17.5		18.3	20.5		68.5	124.8
Tube Replacement		7.3			3.0			17.1	27.4
Project Work	0	0	0		0	0	0	0	0
Production Tests	2.0	17.3			4.1	4.0	2.9	4.0	34.3
Standard check	7.2	4.2	.5					0.7	12.6
Rupture Suspects									
Miscellaneous	36.9	3.0	1.1		1.5			13.1	55.6
Total	132.8	183.1	64.3		116.8	77.0	105.9	124.8	804.7
Scheduled Outages									
Unscheduled Outages									

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UNITED STATES GOVERNMENT

Memorandum

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TO : Files

DATE: May 12, 1965

FROM : R. L. Plum, Chief
PRODUCTION REACTOR OPERATIONS BRANCH

SUBJECT: MONTHLY REPORT - APRIL 1965

HAN-90620
Report #4

OR:GTO:JPT

THIS DOCUMENT CONSISTS OF 11 PAGES

OPERATING EXPERIENCE

Production

Reactor input plutonium production for April was 414.1 KMWDs (93.2% forecast): 231.5 (99.6% forecast) at the five smaller reactors and 182.6 (86.3% forecast) at the two K Reactors.

Efficiency

Overall time operated efficiency was 82.1%: 86.3% at the five smaller reactors and 72.1% at the two K Reactors.

Power Levels

Reactor power levels were limited by trip-after-instability limits on support enrichment tubes for the thoria load at D Reactor and for the thoria and depleted uranium loads at B Reactor. C Reactor power levels were limited by a bulk outlet water temperature limit of 95 C the first half of the month and by graphite temperatures the last half of the month. F Reactor power levels were limited by a bulk outlet water temperature limit of 95 C. Power levels at H Reactor were held below normal to minimize rupture potential as the reactor approached deactivation (April 21). Power levels at the K Reactors were restricted by the administrative limit of 4400 megawatts.

Ruptures

Three failed uranium fuel elements, two I&E enriched and one I&E natural, were removed from the reactors. The two enriched failures, at KE and KW, were self-support elements at 69% and 75% of goal exposure, respectively. Both elements failed because of end defects. The natural failure, at H Reactor, was a side-hot-spot at 80% of goal exposure.

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MAINTENANCE AND EQUIPMENT EXPERIENCES

Water Leaks

One internal tube leak was corrected at F Reactor.

Tube Replacement

Two Zircaloy and five aluminum tubes were installed. Two aluminum tubes were installed at D and one each at C, F and KE. The two Zircaloy tubes were installed at KE.

REACTOR OUTAGES

DATE DOWN	DATE UP	OUTAGES HOURS	REMARKS
<u>B REACTOR</u>			
4/27	Still down		Scheduled charge-discharge.
<u>C REACTOR</u>			
4/12	4/15	66.3	Scheduled charge-discharge. Zirconium tube 3679 was split and removed, and ribbed aluminum tube installed in channel.
4/15	4/16	18.6	Manually scrammed due to loss of cooling water pressure on HCR No. 14.
<u>D REACTOR</u>			
4/1	4/5	103.4	Panellit trip when spline cap insert seal on tube 3864 failed. Scheduled charge-discharge and miscellaneous maint.
4/6	4/7	25.6	Shut down due to heat cycle.
<u>F REACTOR</u>			
4/8	4/10	40.5	Water leak. Charge-discharge.
4/15	4/17	50.6	Scheduled charge-discharge.

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REACTOR OUTAGES - Cont.

H REACTOR

4/4	4/5	32.0	Removal of an I&E natural metal rupture from tube 2886.
4/13	4/14	29.1	Shut down due to a heat cycle.
4/21			Shut down as first step in the deactivation.

KE REACTOR

3/31	4/3	54.9	Removal of a thoria rupture from tube 5885.
4/3	4/3	6.8	Removal of an I&E enriched metal rupture from tube 3263.
4/9	4/14	136.5	Scheduled charge-discharge and maint..
4/14	4/14	1.9	Scrammed due to faulty RTD.
4/15	4/16	34.0	Scrammed by a Beckman trip.

KW REACTOR

4/1	4/6	127.8	Panellit trip. Charge-discharge and miscellaneous maintenance.
4/8	4/10	42.6	Removal of I&E enriched metal rupture from tube 3451.

RESEARCH AND DEVELOPMENT

UO₂ Irradiation

Before oxide fuel elements can be used at Hanford, a major effort will be required to demonstrate the aluminum clad oxide fuel concept by irradiation testing. A small scale exploratory irradiation testing effort has been started to evaluate the feasibility of using oxide fuels in the Hanford reactors. The test involves the irradiation in a K Reactor of two columns of oxide fuel elements, one using compacted oxide and one using sintered oxide. Enrichment levels of 1.3 per cent were calculated to provide

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UO₂ Irradiation - cont.

specific powers typical of those expected in full production loadings. This test will provide preliminary engineering data for oxide fuels to check out design calculations, give an indication of the irradiation behavior of aluminum clad oxide fuels in typical Hanford geometries, and provide an indication of limiting phenomena to guide oxide fuel development studies.

Overbore Bismuth Test

The column of bismuth elements in the C Reactor overbore facility has now accumulated approximately 29 days of operating exposure. Fabrication of improved bismuth elements capable of withstanding greater axial loading has been delayed by difficulty in producing leakproof welds and by lack of manpower for reworking leaky pieces. It is expected that a mixed uranium-bismuth charge will be charged within the next three weeks.

Higher Graphite Temperature

A program is being initiated to investigate the problems associated with prolonged operation at graphite temperatures in the order of 1000 C. Included in this study will be such problem areas as atmosphere requirements, oxidation rates, changes in distortion rates and compatibility with proposed distortion corrective measures, oxidation and temperature monitoring, safety implications and modifications to existing equipment and operating procedures. This study is expected to take one to two years and require both laboratory and in-reactor testing.

Thoria Recycle

Thorium nitrate from CPD was delivered to Battelle-Northwest where a few pounds were spray calcined. The resulting thoria powder is over ten times as active with gamma radiation as the initial feed thoria used in the present target elements. Fission products appear to be contributing the major portion of the gamma activity. An analysis made at the Redox laboratory showed the Th-228 to be at 60 per cent of secular equilibrium while both Pa-233 and Th-234 have decayed to an insignificant level. CPD indicated that process specifications on the quantity of fission products in the thorium nitrate would reduce the activity by a factor of 10 to 15, which should make the fission product gamma contribution nearly negligible.

Pocket Radiation Alarm Devices

Forty-two modified Chalk River type pocket dose alarms have been completed and calibrated by the Calibrations Unit of Battelle Northwest. Five units have been released to Radiation Practices Engineering, Manufacturing Section, for preliminary field evaluation.

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Dose Rate Telemetry

Progress of the design and fabrication of the prototype dose rate telemetry system is proceeding slower than scheduled. Final design and procurement are approximately 50 per cent complete. Engineering personnel are currently visiting the vendor's plant to witness tests and review design.

Uncooled Horizontal Control Rods

Development work by General Electric's Nuclear Material and Propulsion Operation (NMPO) on the uncooled HCR concept is progressing satisfactorily. The shape of the rod has been resolved to a 3-1/8 inch by 7/8 inch rectangular cross-section. Current studies indicate that a segment length of about 40 inches can be utilized without excessive stresses.

Assembly of a test facility to test the proposed hinge joint at temperature is in progress at NMPO. Current plans include fabrication of a full size "dummy" rod to mechanically test the assembly in the HCR channel mockup at the 189-D laboratory.

Preliminary results from a study of the nuclear aspects of the uncooled HCR are favorable for the use of dysprosium oxide-nickel cermet as a neutron absorber. The concentration of dysprosium required is sufficiently low to permit consideration of moderate purity (80% to 85%), less expensive dysprosium oxide. The nuclear longevity of such a "poison" material appears to be more than adequate.

HTR Facility Modifications

It has been proposed to modify the Hanford Test Reactor (HTR) to provide a test zone with a 7 x 7 lattice unit supercell. In addition, the test zone would be centered in the reactor and the basic fuel loading geometry changed.

Additional work on this proposal has been suspended as a result of significant reductions in the cost estimates for running the experiments at the High Temperature Lattice Test Reactors (HTLTR). In view of this reduction, it is not considered economical to modify the HTR to accept the supercell.

PROCESS TECHNOLOGYVertical Safety Rods - Graphite Distortion

The off reactor mockup testing of the various pieces of equipment required to enlarge the openings through the 105-K Reactor thermal and biological

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Vertical Safety Rods - Graphite Distortion - Cont.

shields and graphite for VSR sleeving installation has continued. The tooling required to enlarge the shield openings has been designed, fabricated and tested, and all but the thermal shield plate cutter have proven satisfactory in mockup trials.

Work has continued in the development of tools and procedures for caulking of in-reactor graphite stack voids which surround most VSR channels as an alternate method of preventing the migration of 3 X system balls into the stack. A field channel demonstration of this method in the 195-D Test Tower mockup was successfully completed from a depth of 31 feet to the bottom of the channel.

Replacement of Horizontal Control Rods - C&K Reactors

Test installation of a prototypic flexible, cooled HCR in channel No. 2-105 KW Reactor has been postponed until late May or early June. Results obtained to date from laboratory testing of the prototype are satisfactory.

K Reactor Coolant Backup System

Evaluation of the adequacy of the 100-K emergency coolant backup system has continued. Preliminary results of the recent trip-out test at 100 K indicate that the flow capacity of the system is somewhat less than in previously performed tests, indicating that corrosion product buildup has continued, and as a result the flow available has been reduced. Based on this preliminary information, action has been initiated to obtain a contract for cleaning of the cross-tie line in late summer of this year.

Downcomer Repair - 105-C

The 105-C far downcomer has been restored to service subsequent to completion of repairs and reinforcement. Data obtained from strain gauges installed within the downcomer to determine stresses in the downcomer liner are undergoing evaluation.

Process Piping Study

The program to assess the integrity of critical process piping has continued during the month. A total of 42 material samples have been removed from the bottom two courses of tanks at 183-C and sent to U. S. Steel for chemical analysis. U. S. Steel has continued their search for records which might identify the type of steel utilized in the fabrication of the tanks, but has not transmitted any useful information to date. Analysis of the data from strain gauges attached to the tanks has not been completed.

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Reactor Plant Deactivation

Atmospheric drying of the 190-DR storage tanks has progressed satisfactorily and final cleanup of the tanks is underway.

H Reactor was shut down as scheduled on April 21, 1965. Both the reactor physics measurement program and the planned deactivation work are progressing on schedule.

Deactivation planning for F Area continues on schedule. Shutdown manuals have been issued, although several procedures are delayed pending development of the testing program and a decision on the status of the 105 basin. Orientation and planning meetings with manufacturing personnel at F Area are underway.

Depleted Uranium Irradiation

KE Reactor

Analysis of the dimensional behavior of the depleted elements discharged from the KE Reactor at about one-half goal exposure reveals satisfactory stability. Diameter changes are less than experienced on normal production elements, but average element warp is higher than that experienced with standard production elements. This difference in warp should not adversely affect performance of the fuel. These data, together with the good corrosion behavior, indicate that the depleted elements should attain full goal exposure without usual operational difficulty. The 78 depleted uranium columns currently under irradiation have accumulated an average exposure of approximately 1330 MWD/T. The established goal exposure, based on 18 w/o Pu-240 concentration, is 1600 MWD/T.

B Reactor

Examination and measurements have been completed on 12 monitor columns of depleted uranium fuel discharged at average exposures of 780 MWD/T. The visual and weight loss data indicate good behavior of the elements. No moderate or severe corrosion attack was observed on any of the elements. It appears now that the remaining depleted columns will attain the scheduled goal exposure without operational problems. The 92 columns of elements currently under irradiation have accumulated an average exposure of approximately 1200 MWD/T.

Clean U-233 Program

Irradiation Status

Ten thoria elements have failed thus far, with the program approximately 60% completed. The recent failures support earlier observations that the failures are associated with weld integrity. Water entering through weld

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~~SECRET~~Irradiation Status - Cont.

integrity. Water entering through weld defects has been associated with all failures to date. Recent closure inspection techniques remain to be proven by in-reactor experience, since only small quantities of this material have been irradiated so far. Several apparently defective elements have been found by the helium leak detector in Production Fuels after having passed through the "standard" inspection. Consideration is being given to increasing the can wall thickness to 90 mils for the continuing fringe thorium loading. This change is expected to improve the weld closure integrity.

To detect the presence of failed thorium elements, arrangements were made to have crossheader samples of effluent water analyzed at the Redox laboratory. Samples of water taken from a header containing a suspect thorium element rupture at KW Reactor were analyzed on the spot using a multichannel analyzer. The gamma scan indicated that Krypton-85 and 87 were the two principal nuclides of higher concentrations in samples from suspect cross-headers.

Increase Graphite Temperature Limit

The test to further increase temperature limits at F Reactor was initiated on April 12. The test will remain in effect until F Reactor is shut down.

Reactor Flow Limits

A review has been completed of the flow capacity of the effluent system at all reactors, i.e., the line extending from the downcomers to the retention basins. Based on the calculated pressure drop to the effluent lines, the calculated pressure at the bottom of the downcomer, and the calculated water level in the downcomer, it is concluded that modest flow increases for B, C, and D Reactors can be made without exceeding the downcomer hydraulic capacity. To confirm these calculations, water level height and bottom of downcomer pressure data will be obtained at the time flow increases are made.

Zircaloy Hydriding

To date, four Zircaloy process tubes have been removed from KW Reactor, two from KE Reactor and one from C Reactor. All tubes examined to date indicate significant hydriding with the maximum observed at the downstream end of the process tube. There has been no indication of hydriding in that portion extending from the front Van Stone flange to downstream to the end of the active fuel section. There is a preliminary indication that the Zircaloy "inserts" in the rear nozzles may provide a useful index of the degree of hydriding present in the companion process tube.

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Zircaloy Hydriding - Cont.

A sample of 24 "inserts" has been removed from KE Reactor for examination. Programs have been initiated to explore the possible mechanisms which would account for the presence of hydride and to determine the effect hydriding has on the mechanical properties of the Zircaloy tubes. Methods for reconditioning the Zircaloy tubes, including methods for hydride removal and applying a protective film are being evaluated.

Gas Studies

Coating of rear face omega seals with an air curing silicone rubber sealant was accomplished at D Reactor on April 3 and 4. The current application technique proved more time consuming than had been anticipated, and the effort was terminated upon completion of five seals. Evaluation of this repair method cannot be accomplished until all omega seals have been coated; however, the current gas leakage at D Reactor has improved approximately 25%. Additional sealing will be accomplished as outage time becomes available.

Channel Enlargement

Preliminary testing of graphite and cast iron drilling equipment is progressing satisfactorily. Preliminary tests in rudimentary mock-ups indicate that current drilling equipment has sufficient power and reliability to permit both channel enlargement and shield drilling to a size which will permit installation of a one-inch oversized tube. Preparations are continuing for an off-reactor demonstration of this equipment early in May. Planning is proceeding for the on-reactor drilling of a limited number of channels at F Reactor early in July.

Effluent Activity Data:

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

<u>Reactor</u>	<u>P32</u>	<u>As76</u>	<u>Cr51</u>	<u>Np239</u>	<u>Zn65</u>
B	14.1	143	450	188	16
C	17.3	134	960	265	29
D	10.1	55	220	77	21
F	34.8	129	250	177	11
H	8.3	54	300	104	3
KE	9.7	57	110	46	13
KW	11.6	107	120	86	

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APRIL 1965

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(Year)
OUTAGES (1965) APRIL

Reason	B	C	D	DR	H	KE	KW	Total
Charge-Discharge	55.9	44.2	33.6	-	53.0	0	82.8	355.4
Maintenance	29.1	29.2	80.2		17.6	7.0	54.4	236.0
Rupture Removal	0	0	0	-	0	30.0	17.4	67.4
Leak Testing	0	0	0	-	15.8	0	0	15.8
Tube Replacement	2.9	4.5	0	-	3.7	0	35.9	47.0
Project Work	0	0	0	-	0	0	8.3	8.3
Production Tests	3.5	6.9	0	-	1.0	0	10.8	40.6
Standard	0.7	1.9	0	-	0	0	14.6	44.8
XXXXXXXXXXXXXXXXXXXX								
Rupture Suspects								
Miscellaneous	0	0.3	15.2	-	0	24.1	6.2	45.8
Total	92.1	87.0	129.0	-	91.1	61.1	230.4	861.1
Scheduled Outages								
Unscheduled Outages								

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UNITED STATES GOVERNMENT

Memorandum **DECLASSIFIED**

TO : Files

FROM : R. L. Plum, Chief
PRODUCTION REACTOR OPERATIONS BRANCH

SUBJECT: MONTHLY REPORT - MAY 1965

OR:GTO:RGR

DATE: June 7, 1965

HAN-90620
Report #5

THIS DOCUMENT CONTAINS NEITHER RECOMMENDATIONS NOR

OPERATING EXPERIENCE

Production

Reactor input plutonium production for May was 381.3 KMWDs (98.0% forecast): 165.7 (95.0 forecast) at the four smaller reactors and 215.6 (100.5%) at the two K Reactors.

Efficiency

Overall time operated efficiency was 75.0%: 72.3% at the four smaller reactors and 80.3% at the two K Reactors.

Power Levels

Reactor power levels at B Reactor were limited by trip-after-instability tube temperature limits on support enrichment tubes for the thorium and depleted loads early in the month and by the 95 C bulk outlet water temperature limit the last half of the month. The C Reactor power levels were limited by an internally imposed administrative limit (due to broken splines in several tubes) until the last week when the 95 C bulk outlet water temperature became limiting. Power levels at the D Reactor were limited by trip-after-instability tube temperature limits on thorium associated enrichment tubes. The F Reactor power levels were limited by the 95 C bulk outlet water temperature limits and the two K Reactors by the administrative limit.

Ruptures

Six failed uranium fuel elements, three natural and three enriched, and seven failed thorium elements were removed from the reactors. The three natural uranium failures, two at B and one at C, were at 81%, 36% (bumpered) and 86% (overbore) of goal exposure, respectively.

GROUP I

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Ruptures - cont.

The enriched failures, two at C and one at KE, were at 71, 41 and 47% of goal exposure. Three of the thoria failures were at C Reactor and four were at KW. The goal exposure (equivalent MWDs) for five of the thoria failures ranged from 75 to 88%. The exposure of two, found after discharge and with no tube identity, is not known.

The natural metal bumpered failure was from mechanical damage and the overbore from an end defect; the other natural uranium failure and the three enriched failures were from side-hot-spots. All seven of the thoria failures were from end defects.

MAINTENANCE AND EQUIPMENT EXPERIENCESWater Leaks

Three internal process tube leaks and six Van Stone flange leaks were corrected.

Tube Replacement

Thirteen aluminum process tubes were installed; one at F, two at B and ten at D Reactor.

REACTOR OUTAGES

DATE DOWN	DATE UP	OUTAGES HOURS	REMARKS
<u>B REACTOR</u>			
4/27	5/1	104.7	Scheduled charge-discharge.
5/1	5/1	.9	Panellit trip.
5/20	5/23	54.8	Removal of an I&E natural metal rupture from tube 3962. Charge-discharge.
5/24	5/25	34.7	Removal of an I&E natural metal rupture from tube 1077.
5/26	5/29	63.9	Panellit trip. Charge-discharge.

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REACTOR OUTAGES - cont.

C REACTOR

5/8	5/11	78.8	Removal of an I&E natural overbore rupture from tube 2863. Charge-discharge.
5/11	5/11	7.2	Failure of the HCR water PRV to control pressure.
5/11	5/11	.8	Scrammed manually when a high trip on the HCR water supply was experienced during adjustments on the HCR water PRV.
5/12	5/13	30.2	Removal of two thoria ruptures from tubes 1196 and 2396. Miscellaneous maintenance.
5/14	5/14	3.4	Removal of thoria rupture from tube 3496.
5/16	5/19	82.0	Removal of an I&E E metal rupture from tube 3074. Charge-discharge.
5/26	5/27	34.5	Removal of an I&E enriched metal rupture from tube 2360. Miscellaneous maintenance work.

D REACTOR

5/3	5/4	41.4	Loss of electrical power to the HCRs, caused by a loose connector in the electrical equipment room. Charge-discharge.
5/18	5/30	278.8	Scheduled charge-discharge and maintenance.
5/30	5/30	2.0	Discharge of metal from tubes 1973 and 1176.
5/31	5/31	10.3	Discharge of metal from tube 2378.

F REACTOR

5/3	5/4	38.1	Outage caused by a water leak. Tube 1464 was replaced.
5/4	5/5	.6	Panellit trip.
5/5	5/5	1.2	Scrammed due to difficulty in moving HCRs.
5/19	5/20	43.3	Panellit trip. Removal of tubes 0993 and 0678 due to rear Van Stone leaks.

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REACTOR OUTAGES - cont.

KE REACTOR

5/9	5/11	14.6	Removal of an I&E enriched rupture from tube 2582. Charge-discharge and RTD work.
5/20	5/25	108.5	Scheduled charge-discharge and maintenance.

KW REACTOR

5/3	5/8	98.3	Panelit trip. Four thoria failures were discharged, one each from tubes 3553 and 4971. Other two are unknown. Charge-discharge and RTD work.
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PROCESS TECHNOLOGY

Depleted Uranium Irradiations

The status and calculated yields of the E-D load as of May 19, 1965 was:

	<u>B Reactor</u>	<u>KE Reactor</u>
Exposure MWD/T	1410	1560
% Pu-240	17.9	17.8
g/T	1760	1980
No. of columns	92	75
Tons Depleted	10.7	10.8
Kg Pu	18.8	21.4
Kg Pu-240	3.36	3.81

Both reactors have essentially reached their goal, that is, they have produced a total of more than 25 Kg of plutonium containing at least 18% Pu-240. These loadings will continue to operate, however, until ruptures occur in the depleted fuel or October 1965, whichever is first. By October the status should be as follows:

	<u>B Reactor</u>	<u>KE Reactor</u>
Exposure, MWD/T	2050	2500
g/T	2150	2550
% Pu-240	21.5 ±	21.5 ±
Kg Plutonium	20.5	24.0

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DECLASSIFIEDDepleted Uranium Irradiations - cont.

Three depleted uranium monitor columns were discharged from KE Reactor during the May 9 outage at an exposure of approximately 1500 MWD/T. Measurement and examination of these elements have been scheduled in the 105-C Irradiated Fuel Examination Facility. Discharge at exposure intervals of monitor columns from both B and KE Reactors has been scheduled. This monitoring of fuel element behavior will permit evaluation of the loadings for identification of potential fuel performance problems.

The supercell test at H Reactor after shutdown showed a green E-D ratio of 3.167 to be slightly more reactive than green natural uranium. The calculated ratio was 3.09 for B Reactor. A ratio of 3.05 was used because it allowed a uniform E-metal distribution. Based on these preliminary analyses of the H Reactor tests, the calculation of the material ratios was confirmed experimentally to within 2.5 percent for the cold, clean green reactor.

Thoria Irradiations

The final loading of thoria to complete the 140 Kg order of clean U-233 is scheduled into KE Reactor about the first of June. Nearly 54 tons of irradiated thoria elements have been discharged to date. In late June the first of the fringe tube loadings is scheduled for discharge. During the month seven thoria failures occurred - all seemingly the result of end weld deficiencies. All of these pieces had been charged into the reactor by late February before helium leak inspection was adopted.

Increased Graphite Temperature Limit Test - F Reactor

An increase in the graphite temperature limit to 750 C has been in effect at F Reactor since April 12; however, the desired temperature has not yet been attained. The combination of slow rate of temperature increase, shutdowns, and high biological shield temperature has thus far prevented taking full advantage of the relaxed limit. To achieve the desired temperature of 750 C, the carbon dioxide concentration has been increased to almost 100 percent.

VSR Channel Caulking

A production test authorizing the caulking with a graphite-sugar paste of cracks in one or two VSR channels at C Reactor is being routed for signature. All equipment is in place, and it is anticipated that the caulking operation will be performed during the next one or two outages.

Vertical Safety Rods - Graphite Distortion

The testing of the equipment required for enlarging VSR channels prior to sleeving at a 105-K Reactor continues. The Hanford designed shield boring equipment has been completed and checked out with off-reactor tests. Final mockup testing of vendor produced shield boring equipment is scheduled for June. Satisfactory testing of the biological and thermal shield plate cutters has been accomplished on the mockup.

Preparations are being made for the initial K Reactor VSR boring test during an extended outage tentatively scheduled for mid-July. Current estimates indicate that at least two outages will be required to complete boring and sleeving the prototypic channel.

Replacement of Horizontal Control Rods - C&K Reactors

All planned laboratory tests on the flexible cooled horizontal control rod prior to on-reactor testing have been completed with all results being satisfactory. The most notable test result was the highest measured force required to move the rod. This was 260 pounds with the channel mockup distorted to simulate 10 years additional graphite distortion at K Reactor. Insertion force for the existing rods currently runs about 700 pounds in some of the most distorted channels. The laboratory test rod will be inspected with fluorescent penetrant and pressure tested to assure its soundness prior to in-reactor release.

Irradiated Fuel Age Monitor

Design-development, fabrication, and testing are complete for the prototype device to determine the age of irradiated fuel elements prior to shipment to CPD, in order to insure proper decay of radioactivity. Action has been initiated to provide four additional monitors so that there will be a monitor in each of the operating reactors.

Functional testing of the prototype has been performed satisfactorily. The accuracy of the instrument has been demonstrated to be within $\pm 10\%$ of the true age regardless of whether the metal is fringe, central zone, or enriched.

Process Piping Study

The program to assess the integrity of critical process piping has continued during the month. The final samples to be removed for metallurgical examination were taken from the main process pump suction and discharge line in the 190-B Annex. Charpy and tensile test specimens have been prepared from the material removed and have been sent to the laboratory for physical testing. Radiographic examination of 190-B Annex process pump by-pass piping has indicated no evidence of cavitation in the lines.

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Process Piping Study - cont.

Material samples from all 183-C storage tanks have been chemically analyzed. Results of the analysis reveal a satisfactory low carbon content and indicate that the tank material in the lower two courses of all four tanks is of a better quality as regards brittle fracture susceptibility than was originally believed.

Zirconium Process Tube Investigation

Studies and development work have been initiated to determine techniques of renovating zircalloy tubing which has an internal hydride layer and protecting the renovated tube from further hydriding while in service. Preliminary efforts have resulted in a technique of removing the hydrided layer by means of brasive blasting.

Investigation of various techniques to accurately detect hydriding in Zircalloy-II is continuing. Several concepts have been investigated, but to date none have proved successful. Study effort will continue.

Process Channel Enlargement

The demonstration program for process channel enlargement at F Reactor is on schedule. The demonstration will be carried out in July after F shutdown with about 12 channels to be overbored. Development and testing of machining equipment are essentially completed.

Reactor Plant Deactivation

190-DR storage tanks have been dried out and laid away. Discharged metal is scheduled for shipment during this summer. Except for shipment of irradiated fuel, shutdown work for DR is complete.

Physics tests at H were completed on May 5 with fuel discharge completed on May 5. Flow through the pile was stopped on May 6. Shutdown work for 105 and 190 H is about 75% complete. Earth backfill of the 107 Retention Basin was completed on May 26.

Deactivation procedures and planning on basis of abandonment are completed for F Area.

Effluent Activity Data

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

Reactor	As-76	P-32	Zn-65	Cr-51	Np-239
B	175	15.9	13	160	350
C	225	18.6	23	250	860
D	110	10.6	22	105	270
F	135	22.3	20	185	330
KE	44	8.9	12	65	135
KW	146	9.7	10	135	185

RESEARCH & DEVELOPMENTUranium Oxide - In-Reactor Testing

Battelle-Northwest is fabricating two uranium oxide fuel columns of 20 elements each for irradiation in the K Reactors. One column will be comprised of sintered oxide fuel elements having approximately 94% theoretical density. The fuel columns for the other column will be compacted and have approximately 87% theoretical density. An enrichment of 1.3% will be used in both cases to simulate specific fuel power under a full reactor oxide loading.

Uncooled HCRs

The design of a full size "dummy" uncooled HCR has been completed and fabrication started. This dummy rod will be tested in the 189-D Laboratory HCR channel mockup to demonstrate the mechanics of the basic design and to gather information on stresses in the articulated joint and rod sections at various stages of operation. The fabrication of a fixture to cyclic test the articulated joint at temperature is also underway.

In-Reactor testing of composite samples of the dysprosium-oxide-nickel cermet poison material encased in 19-9DL and Inconel 600 is proceeding satisfactorily at 105-KW Reactor. The samples have been in test for two months and all data points continue to function. Initial efforts to coextrude the cermet in an inconel sheath have been quite encouraging. The technique will be pursued further because it offers a possibility of reducing rod fabrication costs compared to assembling and autoclaving the separate components.

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RUPTURED SLUG TABULATION FOR MAY, 1965

Tube No.	Date Charged	Date Ruptured	Tube Power (KW)	Concentration MWD/Ton	Assigned - Production Loss		Observations
					MWD	Days	
2063C	2/15/65	5/8	1396	686	243	.12	I&ENO End defect.
2582 KE	4/9/65	5/9	1881	372	660	.15	I&EE Side hot spot.
3074 C	4/12/65	5/16	1548	301	5911	2.88	I&EE Side hot spot.
3962 B	3/25/65	5/20	1247	496	129	.06	I&EN Side hot spot.
1077 B	4/27/65	5/24	1329	214	1042	.58	I&ENB Side mech. damage.
2360 C	4/12/65	5/26	1477	469	296	.14	I&EE Side hot spot.
4971 KW	2/22/65	5/3	225	713	472	.11	Thoria End defect.
3553 KW	2/22/65	5/3	217	713	397	.09	Thoria End defect.
Unknown KW	2/22/65	5/3	-	-	)		" 2 ruptures end defect.
1196 C	12/18/64	5/12	042	783	) 532	.26	" end defect
2396 C	12/18/64	5/12	063	783	)		" "
3496 C	12/16/64	5/14	042	783	348	.17	" "

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OUTAGES (1965) MAY

Reason

	B	C	D	DR	F	H	KE	KW	Total
Charge-Discharge	89.0	86.3	152.3		7.8		81.6	32.9	449.9
Maintenance	43.3	38.3	137.1		25.6		65.0	1.3	312.6
Rupture Removal	12.4	74.8					3.4	4.4	95.0
Leak Testing			6.8		33.2			11.7	51.7
Tube Replacement	3.0	12.2	11.8				1.2	7.5	35.7
Project Work	-	-	-	-	-	-	-	-	-
Production Tests	9.0	3.2			16.0		12.4	11.4	52.0
Standard check for xxxxxxxx	8.2	25.1	1.0				16.4	29.1	79.8
Rupture Suspects									
Miscellaneous		.4	23.5		.6		15.1		39.6
Total	166.9	240.3	332.5		83.2		195.1	98.3	1116.3
Scheduled Outages									
Unscheduled Outages									

UNITED STATES GOVERNMENT

Memorandum

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TO : Files

DATE: July 14, 1965

FROM : R. L. Plum, Chief
PRODUCTION REACTOR OPERATIONS BRANCH

SUBJECT: MONTHLY REPORT - JUNE 1965

HAN-90620
Report #6

OR:GTO:JKR

THIS DOCUMENT CONTAINS [REDACTED]

OPERATING EXPERIENCE

Production

Reactor input plutonium production for June was 394.3 KMWDs (110.4% of forecast): 191.3 (132.3% forecast) at the four smaller reactors, 203.0 (95.7% forecast) at the two K Reactors.

Efficiency

Overall time operated efficiency was 85.5%: 88.5% at the four smaller reactors and 79.2% at the two K Reactors.

Power Levels

Reactor power levels at B Reactor were limited by trip-after-instability tube temperature limits on support enrichment tubes for the thorium and depleted loads the first half of the month, and by the 95 C bulk outlet water temperature limit the last half of the month. C and D Reactor power levels were limited by the 95 C bulk outlet water temperature limit and F Reactor by tube power limits to minimize rupture potential during the approach to deactivation. Power levels at the K Reactors were limited by the administrative limit until late in the month when the bulk outlet water temperature (95 C) became limiting.

Ruptures

Two failed enriched uranium fuel elements and two failed thorium elements were removed from the reactors. The enriched failures, at C and KE Reactors, were at 111% and 70% of goal exposure, respectively. The C failure was a side-hot-spot and the KE failure (self-support) was a side defect. The thorium failures, at C and KW Reactors, were caused by end defects. The C failure was at 106% of goal exposure (equivalent MWDs) and the KW failure was at 92%.

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EQUIPMENT EXPERIENCES

Tube Replacement

Three process tubes were replaced, two at KW and one at B. The two tubes replaced at KW were zirconium.

Water Leaks

Two water leaks, one tube and one VanStone, were corrected at B Reactor.

REACTOR OUTAGES

DATE DOWN	DATE UP	OUTAGES HOURS	REMARKS
<u>B REACTOR</u>			
6/9	6/11	41.2	Water leak. Leak testing and maintenance.
6/30	Still down		Scheduled charge-discharge.
<u>C REACTOR</u>			
6/17	6/21	13.7	Removal of an I&E-94 metal rupture from tube 3077. Charge-discharge and maintenance.
6/21	6/21	3.6	Panellit trip.
6/23	6/25	32.6	Removal of a thoria rupture from tube 0358. Miscellaneous maintenance.
<u>D REACTOR</u>			
6/29	Still down		Panellit trip when a spline being inserted into tube 2582 blew out of the spline seal.
<u>F REACTOR</u>			
6/19	6/21	44.2	Scrammed due to power loss to the HCRs caused by a burned out coil on the No. 8 rod brake solenoid.

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REACTOR OUTAGES - Cont.

F REACTOR - Cont.

6/22	6/23	37.7	Panellit trip due to a broken rear pigtail adapter on tube 3889.
6/25			Manually scrambled for temperature control due to the malfunction of the spline coiler. Remained down on deactivation.

KE REACTOR

6/23	6/29	111.3	Removal of an I&E-94 metal rupture from tube 3380. Scheduled charge-discharge and maintenance.
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KW REACTOR

6/1	6/5	118.5	Charge-discharge and maintenance.
6/5	6/5	.6	Panellit trip
6/6	6/6	.5	Panellit trip
6/6	6/6	.5	Panellit trip
6/6	6/6	2.4	Panellit trip
6/6	6/6	.5	Panellit trip
6/6	6/6	.6	Panellit trip
6/26	6/28	40.9	Removal of a thoria rupture from tube 4168.

PROCESS TECHNOLOGY

Depleted Uranium Irradiation

The status of the E-D load as of June 18, 1965 is as follows:

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	<u>B Reactor</u>	<u>KE Reactor</u>
Exposure, MWD/T	1575	1775
% Pu-240	20.0	20.4
Kg/T	1.8	2.1
No. of Columns	92	75
Tons Depleted	10.7	10.8
Kg Pu	19.3	22.2

The extended operation appears to be going smoothly, and the relatively high graphite temperature coefficient of reactivity calculated for the E-D has now been noticed at B Reactor.

Supplements to the authorizing documents are being prepared to allow an extension of the irradiation time to produce 25 Wt % Pu-240. One depleted element failure in each loading prior to obtaining the desired exposure would, however, terminate the irradiation. Examination of three columns of elements, discharged from KE Reactor at an exposure of 1500 MWD/T, revealed that the elements are behaving very well.

The downstream elements of the columns have started to film, but no evidence of even moderate corrosion attack was observed.

Thoria Irradiations

The sharply reduced thoria element failures indicates that increased examination and testing instituted in March have been effective. All thoria elements for the initial program have been charged. The central zone irradiations will be completed by the first week of July, and fringe loadings will be discharged by August 1, 1965.

Increased Graphite Temperature Limit Test - F Reactor

The desired graphite temperature of 750 C in the F test was maintained only a relatively short time. Apparent improvement in graphite thermal conductivity and reduced power level has prevented maximum graphite temperatures from exceeding much above 700 C during the past month. Oxidation rates are not significantly different from those in the initial phase of the testing program when the temperature limit was increased from 650 to 700 C. Despite the fact that graphite temperatures could not be maintained as high as desired, preliminary results indicate that an increase in graphite temperature beyond the present limit is feasible from the standpoint of graphite oxidation with a CO₂ atmosphere. In addition, no significant increase in the reaction between graphite and water vapor has been detected during the three-month period the test has been in effect.

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Zircaloy Hydriding

Analysis of zircaloy nozzle inserts removed from KE Reactor has been completed. The total hydrogen content varied from 86 to 570 ppm. Process tubes from two of the channels, from which these nozzle inserts came, were also removed for hydride evaluation, with the following results:

<u>Tube No.</u>	<u>Max. Tube H2 Concentration</u>	<u>Nozzle Insert H2 Concentration</u>
2169 KE	361 PPM	175 PPM
4372 KE	740 PPM	139 PPM

These data indicate no correlation between the hydrogen content of the nozzle inserts and the process tubes. Examination of 24 more nozzle inserts is planned before drawing any final conclusions. Zircaloy coupons with various surface conditions are being exposed in KE Reactor process tubes to obtain further information on the conditions resulting in process tube hydriding in the reactor environment. The first coupon holder was removed after approximately five weeks exposure. The following table lists the results:

<u>Number of Coupons</u>	<u>Coupon Material & Surface Conditions</u>	<u>Results</u>
2	Annealed zircaloy-2 sheet, vapor blasted one side; etched one side.	Hydride case about one mil thick on both sides.
2	As above, except zircaloy-4.	Same results.
2	K tube material-as-received on inside - vapor blasted outside.	Same results.
2	K tube material - etched both sides.	Some hydriding along edges where scraped by sample holder.
2	K tube material - etched and auto-claved both sides.	No hydride found.
2	K tube material - etched and air oxidized at 500 C for ten minutes.	Hydride case about one mil thick on both sides.
3	K tube material - etched and anodized - 100 volts in KOH.	Same results.

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Additional coupon holders have been prepared. Stainless steel will be used to determine if the galvanic couple between zircaloy and aluminum is a factor in the rate of hydriding. Stainless steel is cathodic to zircaloy, whereas aluminum is anodic.

Ex-reactor exposure of samples in process water shows similar results, except that no evidence of hydriding of etched samples was found. A test has been run to determine if self-support fuel elements would damage an autoclave film. The equivalent of six charges was pushed through an autoclaved K reactor process tube and it was found that most of the oxide film was removed along the bottom of the tube. This would indicate that simple autoclaving will not be adequate to give long term protection.

Zirconium Process Tube Investigation

Efforts to develop a non-destructive system to detect hydriding in zirconium process tubes are continuing. Two approaches tried to date, a one megacycle/second eddy current technique and a direct resistance measurement of the tube wall, have been unsuccessful. Investigation of additional concepts has been started. In addition to the detection of zirconium hydride non-destructively, a program of in-reactor tube renovation or repair is being pursued. It has been concluded that the hydride layer can be removed mechanically and investigations are underway to develop techniques for establishing a non-reacting interior surface in the tube. Tube samples with various coatings of ceramic and metallic materials flame-sprayed on the surface are undergoing test to determine their ability to inhibit hydride formation.

Effluent Activity Data

The table below shows the average concentrations of five radionuclides from effluent samples in June 1965. All units are 10^{-12} curies per milliliter.

<u>Reactor</u>	<u>p32</u>	<u>As⁷⁶</u>	<u>Np²³⁹</u>	<u>Cr⁵¹</u>	<u>Zn⁶⁵</u>
B	10.7	145	140	330	9.2
C	8.3	205	240	1020	26.6
D	6.3	50	90	240	18.7
F	11.0	85	160	340	21.4
KE	7.2	42	55	140	10.0
KW	5.6	68	80	150	10.9

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Vertical Safety Rods - Graphite Distortion

The initial on-reactor test of VSR channel caulking, with a granular graphite-sugar-water slurry, has been successfully completed. Periodic inspections of this channel will be made to evaluate the durability of the caulking under normal stack movement and distortion shifting. VSR channel caulking has the potential for reducing the amount of graphite stack voids, which currently offer ball retention space in the event of a ball 3X drop.

Replacement of Horizontal Control Rods - C and K Reactors

A prototype of the flexible-cooled HCR has been installed in No. 2 HCR channel at 105-KW Reactor for in-reactor testing. Rough in-pile calibration of the test rod indicated that the control strength was approximately 125 per cent of that for the normal rods. More precise measurements of control strength will be made as operating conditions permit. Instrumentation was also installed for use in the measurement of induced radioactivity in the test rod. Operating experience with this prototype HCR has been satisfactory to date.

Process Piping Study

The program to assess the integrity of critical process piping has continued throughout the month. Results of Charpy impact testing of samples from 190-B primary coolant piping were recently received from the testing laboratory. Samples removed from 190-B Annex pump discharge piping revealed exceptionally high impact resistance indicating a very low susceptibility to brittle fracture. The results of tensile tests were very satisfactory. Samples removed from pump suction piping (low pressure) yielded relatively low impact resistance. The relatively low pressure rating of the suction piping reduces its susceptibility to brittle fracture.

Continued investigation of the 183-C storage tank material indicates that, although test results have indicated a lower than anticipated susceptibility to brittle fracture, some measure of protection must still be provided for the tanks during periods of critical low temperatures. The protection may be afforded either by a reduction of pressure head in the tanks during low temperature periods or insulating against such low temperatures.

Offsite Radioactive Material Shipping Casks

The preliminary design of a shipping cask and buffer-container, which will meet proposed ICC regulations and revisions to AEC Manual, Chapter 0529, has been completed. Detail design of the cask and its protective container has been initiated.

Reactor Plant Deactivation

Deactivation at 100-H Area is progressing ahead of schedule with the 105-H and 190-H essentially shut down. An exception is the metal storage area where no further work is planned until all metal has been shipped. Deactivation work at 181, 182, and 183-H is about one-third done with the remainder being delayed by the need to maintain area sanitary and filtered water requirements until certain work covered by the construction project is completed. Through a special process arrangement covering the reactor backup water system, it was possible to shut down the H boiler house about one month ahead of schedule. This has permitted expediting deactivation to the extent that all work at 184-H is nearing completion at month-end.

F Area was shut down on June 25, with the deactivation work to proceed on the basis of plant abandonment. However, no shutdown work will be done which would prevent a start-up over the course of the next two years. Deactivation procedures on this basis have been prepared and orientation of field forces completed. All planned special test procedures have been developed and issued and the over-all deactivation work schedule has been established. Current planning includes trans-shipment to DR of the metal discharged from 105-F.

Some deactivation work has been completed at F Area, including one of the 184-F boilers and about 50% of the building heating systems in the power area. With the actual shutdown occurring on June 25, discharge of the 100-F Reactor fuel load was complete at month-end.

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1965 - June 1965

ACTOR OUTAGES

D	DR	F	H	KE	KW	TOTAL
13.5				99.0	81.5	300.8
15.4		81.9		24.8	11.7	151.4
				5.2	22.2	37.5
						26.1
					1.9	3.4
				4.3	11.4	22.3
2.2				2.0	32.8	64.8
					3.2	3.5
31.1		81.9		135.3	164.7	609.8

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June 1965

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UNITED STATES GOVERNMENT

Memorandum

HANFORD CODE C65

TO : Files

DATE: August 9, 1965

FROM : R. L. Plum, Chief
PRODUCTION REACTOR OPERATIONS BRANCH

SUBJECT: MONTHLY REPORT - JULY 1965

HAN-90620
Report #7

OR:GTO:RGR

OPERATING EXPERIENCE

Production

Reactor input plutonium production for July was 332.8 KMWDs (97.2% forecast): 125.8 (92.4% forecast) at the three smaller reactors and 207.0 (100.3% forecast) at the two K Reactors.

Efficiency

Overall time operated efficiency was 77.5%: 76.7% at the three smaller reactors and 78.6% at the two K Reactors.

Power Levels

Reactor power levels at all reactors were limited by the bulk outlet water temperature limit of 95 C.

Ruptures

Three failed enriched uranium fuel elements, three failed natural uranium fuel elements and one thoria failure were removed from the reactors. The enriched failures, one at C and two at KW, were at 98%, 47% and 57% of goal exposure, respectively. The natural failures, at B, C (overbore), and D, failed at 31%, 105%, and 71% of goal exposure, respectively. The thoria failure at C Reactor failed at 114% of goal exposure (equivalent MWDs) because of an end defect.

The three enriched failures were caused by side-hot-spots. One natural uranium failure was caused by a side-hot-spot, one by side mechanical damage (at 31% of goal exposure) and one (overbore) by an end cap failure.

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MAINTENANCE AND EQUIPMENT EXPERIENCES

Water Leaks

Three internal process tube leaks and three Van Stone flange leaks were corrected, two of each at D and one of each at B.

Tube Replacement

Twenty-eight aluminum process tubes were installed: 13 at D, 10 at C, and 5 at B. Two zirconium process tubes were installed at KW Reactor.

REACTOR OUTAGES

<u>DATE DOWN</u>	<u>DATE UP</u>	<u>OUTAGES HOURS</u>	<u>REMARKS</u>
<u>B REACTOR</u>			
6/30	7/4	90.3	Scheduled charge-discharge and maintenance.
7/11	7/12	38.7	Removal of a stuck I&E natural metal rupture from tube 3293.
<u>C REACTOR</u>			
7/1	7/2	35.5	Manually scrambled when an HCR water supply annunciator could not be reset within 10 seconds. The HCR pressure control was found to be insensitive to pressure changes.
7/2	7/2	.3	Panellit trip on tube 3389.
7/6	7/7	33.9	Shut down due to water leak. Miscellaneous maintenance.
7/8	7/9	33.3	Low pressure Panellit trip on tube 4675. The trip was caused by the tube pulling apart.
7/19	7/22	52.7	Removal of a stuck I&E enriched metal rupture from tube 2782. Miscellaneous maintenance.
7/28	Still down		Removal of an overbore natural metal rupture from tube 3264 and a thorium rupture from tube 3855. Charge-discharge and tube replacement.

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REACTOR OUTAGES - Cont.

<u>DATE DOWN</u>	<u>DATE UP</u>	<u>OUTAGES HOURS</u>	<u>REMARKS</u>
<u>D REACTOR</u>			
6/29	7/1	46.7	Panellit trip. Charge-discharge and maintenance.
7/1	7/1	1.8	Panellit trip.
7/16	7/21	121.1	Removal of an I&E natural metal rupture from tube 2668. Charge-discharge and maintenance.
7/22	7/22	2.7	Panellit trip on tube 0174 caused by foreign material partially plugging the orifice screen.
7/22	7/22	.9	Scrammed due to loss of power to six of the eight primary pumps at 190 Bldg. caused when the 230 kv bus tie breaker opened during critical "W" operation and removed power from two of the three transformer banks.
<u>KE REACTOR</u>			
7/30	Still down		Scrammed due to a low pressure trip on KER single pass tubes. Charge-discharge.
<u>KW REACTOR</u>			
7/5	7/15	228.7	Removal of an I&E enriched metal rupture from tube 4558. Charge-discharge and scheduled outage work.
7/15	7/15	1.6	Panellit trip on tube 0271 caused by an upstream plugging.
7/15	7/15	1.7	Manually scrambled due to faulty RTDs.
7/22	7/24	36.8	Removal of an I&E enriched metal rupture from tube 2964. Charge-discharge.
7/31	Still down		Shut down when the No. 3 boiler at 165-KW became damaged to the extent that it had to be removed from service.

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RESEARCH AND DEVELOPMENT

C-Overbore Bismuth Test

The bismuth charge was discharged from an overbored channel in C Reactor on July 6, 1965, after about 99 days of full power operation. The mixed charge (uranium alternated with bismuth pieces) was discharged July 29.

Uranium Oxide Irradiations

Battelle-Northwest is fabricating two columns of oxide fuel elements for irradiation in a K Reactor to obtain preliminary oxide fuel design data applicable to the Hanford reactors. Poor canning yields have been experienced to date primarily because of problems in obtaining satisfactory final closures. These canning problems are expected to delay the irradiation test by one month.

Plutonium-Aluminum Irradiations

The irradiation of a few plutonium-aluminum fuel elements is planned in B Reactor. Initially, graphite temperature data will be obtained in a short-term irradiation of a single column containing two Pu-Al fuel elements. Assuming satisfactory results from this column, two additional columns, each containing six elements, will be charged for irradiation for up to 18 months. The test is expected to begin during August.

PRODUCTION TECHNOLOGY

Depleted Uranium Irradiations

The status of the E-D loads at B and KE reactors as of July 20, 1965, is as follows:

	<u>B Reactor</u>	<u>KE Reactor</u>
Exposure MWD/T	1760	2025
% Pu-240	21.2	21.5
Kg/ton	1.9	2.2

The depleted uranium irradiations are continuing without difficulty. No indications of potential problems have been observed. Supplements to the authorizing documents have been issued to allow extension of the irradiation to produce 25 Wt.% Pu-240. Analysis of dimensional change data from the

three depleted uranium columns discharged from KE Reactor at 1500 MWD/T show that the outside diameters are increasing with exposure while the average warp has decreased from previously observed values. This behavior is consistent with that of standard fuel elements. Additional monitor columns are scheduled for discharge in early August.

Thoria Irradiations

The thoria rupture which occurred in tube 4168 KW on June 26, 1965, was from a lot which had received additional inspection during manufacture and is the only one which has occurred in the 24,000 thoria elements produced under the tighter inspection criteria. All central-zone thoria loadings have been discharged. Recharging of the fringe tubes in all reactors with thoria loadings has been completed.

Zircaloy Process Tube Hydriding

Seventeen additional nozzle inserts were removed from the KE Reactor and analyzed for hydrogen. The total hydrogen content varied from 29 to 332 ppm, compared to a range of 86-570 ppm obtained from the first 24 nozzle inserts removed from KE. No correlation between the hydrogen content of the nozzle inserts and process tubes has been determined at present.

The high-frequency, eddy-current hydride detector was tested on four tubes in the KW Reactor on July 9, 1965. The readings obtained appeared meaningful and were reproducible. Two of the tubes were removed for hydrogen analysis to further evaluate the detector.

Laboratory investigation of the hydriding problem now shows that the probable cause is galvanic corrosion resulting from a couple between the zircaloy tube and the material used in the aluminum alloy dummy elements downstream of the fuel charge. All the severe hydriding observed to date has been in this area of the tubes. The alloying constituents of 6063 are Cu, Mn, and Mg. The dummy material, aluminum alloy 6063, apparently behaves differently from the fuel jacketing, alloy X8001, and it is now believed that the hydriding problem can be greatly alleviated or eliminated by a change in dummy specification.

F Reactor Storage Basin Test

The F Reactor storage basin heat generation test was successfully conducted as planned. The main water supply to the basin was shut off about six days and fourteen hours after shutdown. During the 24-hour test period, the basin temperature rose linearly at a rate of about 0.8 C per hour. This corresponds to a heat generation rate of 3740 KW. A flow of approximately 500 gpm was returned to the basin on July 3. The ΔT measured was 28 C; this corresponds to a measured heat generation rate of about 3680 KW. From theoretical heat decay data the heat generation rate of the fuel in the basin is estimated at 3900 KW.

The test clearly showed that neither significant channeling nor stratification occurs in the basin at the conditions tested. Essentially no variation in temperature was noted front-to-rear, side-to-side, or top-to-bottom in the

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basin with zero and 500 gpm coolant flow rates. At a flow rate of 1200 gpm imposed just prior to turning off the water, it appeared that a difference of 2-3 C existed between the top and bottom of the basin with the coldest temperature at the bottom.

An apparent basin leak rate of 120 gph was found from a level drop below the lowest weir while the water was shut off. Order of magnitude calculations indicate that a significant portion of this would have been due to evaporation.

Effluent Activity Data

The table shows the average concentrations of five radionuclides from effluent samples in July, 1965. All units are 10^{-12} curies per milliliter.

<u>Reactor</u>	<u>As-76</u>	<u>P-32</u>	<u>Zn-65</u>	<u>Cr-51</u>	<u>Np-239</u>
B	113	8.4	7.2	300	100
C	170	6.1	No results	960	155
D	57	3.3	11.5	220	70
KE	53	6.4	5.5	130	45
KW	119	5.4	8.8	146	100

F Reactor Confinement System Tests

Confinement system tests were performed in association with the deactivation of the F Reactor. On July 10, 1965, the first of the tests was made using iodine-128 as a tracer. The iodine-128 was injected into the supply air stream for the discharge area. "May-pack" samples for determining the iodine concentration in air were set up to sample air from several locations in the exhaust duct. Analysis showed a 99.4 per cent efficiency for retention of I-128 between the discharge area and the outlet of the charcoal filters. Much of this efficiency was due to plate-out in the exhaust system. This test will be rerun to verify results.

Repeat of the above test with the fog spray activated showed complete removal of iodine in the discharge area.

On July 16 a test was performed to investigate the potential of foam to trap noble gases and halogens. About 14.5 curies of argon-41 were released in the work area and 138 curies of iodine-128 were released into the supply air to the discharge area. A 45,000 cfm foam generator installed in the confinement system from which the filters had been removed just upstream of the reactor stack was activated at the same time the tracers were released and was operated for about 10 minutes.

The Atmospheric Physics group of BNL lofted a 35-pound lift, blimp-type balloon above the stack which supported a hose for sampling air from the stack plume just above the foam as it was released. This sampled air

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was pumped into a Kanne Chamber located in the ground-level stack instrument shack. The chamber showed background reading while the foam was released. After the foam generation ceased, the Kanne Chamber showed an abrupt rise in reading and slowly returned to background. This is a good indication that the radioactive tracers were well encapsulated in the foam during its release.

Additional tests are scheduled.

Vertical Safety Rods - Graphite Distortion

KE Reactor is scheduled to accomplish all or part of the first VSR channel enlargement at a K Reactor during the outage of August 9, 1965. A graphite sleeve will then be installed to restore the integrity of the channel for Ball 3X use. Testing has shown standard nuclear grade polycrystalline graphite to be satisfactory for this purpose and future sleeving will be done with excess N Reactor graphite.

Replacement of Horizontal Control Rods - C and K Reactors

The flexible cooled HCR installed in No. 2 channel at KW Reactor for testing has operated satisfactorily for a month. The rod has been operated in a normal manner for this rod position the entire period; i.e., inserted about 60 per cent to 65 per cent of full travel. The first set of measurements of induced radioactivity have just been obtained. Preliminary interpretation of the data shows the level to be similar to that from an aluminum rod at this time. Routine activity level measurements are planned as part of these tests.

The flat inconel control rod heat transfer test has begun with definition of the heat transfer characteristics of the rod. This method of refinement of earlier estimates of rod temperature capability was chosen because in-reactor sheath temperature measurements would have been impractical.

100-K Reactor Coolant Backup

The evaluation of the adequacy of the 100-K emergency coolant backup system has continued. Work has been initiated to review the integrity and reliability of the 100-K Area service water system and its interarea cross-tie connection for possible use as a supplemental water supply to the 100-K Area last ditch coolant system. Design has been completed for installation of flow tubes to permit measuring the flow contribution to the coolant backup system from the service water system. Design has begun on a raw water feed and bleed system to replace the present service water feed and bleed system used for maintaining temperature control in the stagnant water crosstie lines. The use of raw water with its higher pH may curtail the pitting corrosion rate in the crosstie lines.

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Process Channel Enlargement

On July 13 the on-reactor demonstration of one-inch process channel enlargement was successfully completed at F Reactor. An average cycle time of 1.78 hours per channel for the test work was achieved. Equipment performance and cutting rates exceeded preliminary estimates.

Examination of the channels prior to and following enlargement indicated little, if any, graphite damage caused by the machining operation.

Reactor Plant Deactivation

At H Area, deactivation work was completed at the 190 and 184 Buildings. In the 105 Building, all work has been completed except for deactivation of the metal storage basin equipment now planned for late summer when all metal has been shipped. Little additional work was done during the month at 181, 182, and 183-H where minimum operation is required to supply water until project work is completed.

At F Area the metal discharge was completed and cooling water to the 105-F Reactor discontinued on July 1. Engineering tests have been completed. The overall deactivation program at F Area is progressing slightly ahead of schedule.

Although the IPD requirements for steam in F Area ended on July 26, 1965, operation of one boiler must be continued until the package boiler being installed to supply Battelle Northwest needs is completed.

Field planning for the proposed Press Tour is continuing. The planning, although informal at this time, involves a redirection of certain deactivation efforts and delays in others.

RUPTURE SLUG TABULATION FOR JULY 1965

Tube No.	Date Charged	Date Ruptured	Tube Power (KW)	Concentration MWD/Ton	Assigned Production Loss		Observations
					MWD	Days	
4558 KW	6-1-65	7-5-65	1443	404	609	.15	I&E - E Side Hot spot.
3293 B	5-26-65	7-11-65	759	223	2226	1.30	I&E-N Side mechanical damage
2668 D	5-18-65	7-16-65		429	89	.05	I&E-N Side hot spot
2782 C	5-8-65	7-19-65	1411	761	617	.34	I&E-E Side hot spot
2964 KW	6-1-65	7-22-65	1728	485	2146	.52	I&E-E Side hot spot
3264 C	3-25-65	7-28-65	1205	839	1613	.88	I&E-NO EM(overbore) End defect
3853 C	12-18-64	7-28-65	112	1086	72	.04	Thoria end defect

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STOR OUTAGES

D	DR	F	H	KE	KW	TOTAL
55.7				19.2	175.7	369.8
22.7				4.1	18.3	90.6
7.4				0	17.6	83.4
14.9				0	0	115.3
9.8				0	25.4	69.0
0				0	4.9	4.9
17.0				7.2	2.0	27.8
4.9				1.0	31.8	49.1
9.8				6.4	4.9	28.0
142.2				37.9	280.6	837.9

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UNITED STATES GOVERNMENT

Memorandum

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TO : Files

DATE: September 13, 1965

FROM : R. L. Plum, Chief
Production Reactor Operations Branch

THIS DOCUMENT CONSISTS OF PAGES

SUBJECT: MONTHLY REPORT - AUGUST 1965

HANFORD CODE C65

HAN-90620

Report #8

OR:GTO:RGR

OPERATING EXPERIENCE

Production

Reactor input plutonium production for August was 327.1 KMWDs (97.2% of forecast): 135.6 KMWD (102.5% of forecast) at the three smaller reactors and 191.5 KMWD (93.9% of forecast) at the two K reactors.

Efficiency

Overall time operated efficiency was 79.7%: 82.1% at the three smaller reactors and 76.0% at the two K reactors.

Power Levels

Reactor power levels at all reactors were limited by a bulk outlet water temperature limit of 95 C.

Ruptures

Two failed natural uranium and two failed enriched uranium fuel elements were removed from the reactors. The natural uranium failures were overbore hot die sized elements with water quench cores at C Reactor; one was a hole defect at 25% of goal exposure and the other a side corrosion failure at 69% of goal exposure. Only about 20 tubes of water quench core elements now remain out of a total of 62 tubes in the block. A total of 51 hot die size fueled tubes and 11 AlSi canned element tubes now make up the 62 tube block. Eight of the AlSi canned element tubes will be discharged within two months; two of the remaining three AlSi tubes charged this month have a 5 month residence time to goal. The AlSi canned, overbore inventory now consists of three short charge (19 pieces) tubes plus spares. The two enriched failures at D Reactor failed at 19% and 26% of goal exposure. The first was caused by an end defect on a bumper element. The other was from side groove corrosion on a hot-die-sized, run-to-rupture element charged on a production test.

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MAINTENANCE AND EQUIPMENT EXPERIENCES

Water Leaks

Three internal process tube leaks were corrected at C Reactor. One Van Stone leak was corrected at both B and C Reactors.

Tube Replacement

Sixteen aluminum process tubes were installed: ten at B and six at D Reactor.

REACTOR OUTAGES

<u>Date</u> <u>Down</u>	<u>Date</u> <u>Up</u>	<u>Outage</u> <u>Hours</u>	<u>Remarks</u>
<u>B REACTOR</u>			
8/2	8/7	117.3	Scheduled charge-discharge. Leak testing and maintenance.
<u>C REACTOR</u>			
7/28	8/2	118.9	Charge-discharge and maintenance.
8/15	8/17	40.8	Removal of an I&E natural overbore metal rupture from tube 3067.
8/21	8/23	33.1	Removal of an I&E natural overbore rupture from tube 2865. Miscellaneous maintenance.
<u>D REACTOR</u>			
8/5	8/9	75.9	Scheduled charge-discharge and maintenance.
8/9	8/9	4.0	Venturi changes on four tubes.
8/24	8/26	39.4	Scrammed by a Panellit trip when a spline cap seal failed on tube 1286. Charge-discharge and maintenance.
8/26	8/26	.9	Panellit trip.
8/26	8/26	.6	Panellit trip.

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<u>Date Down</u>	<u>Date Up</u>	<u>Outage Hours</u>	<u>Remarks</u>
<u>D REACTOR (Cont.)</u>			
8/27	8/28	23.9	Removal of an I&E enriched bumpered rupture from tube 3389.
8/29	8/31	36.7	Removal of a hot die size, I&E enriched rupture from tube 1365. Leak testing and maintenance.

KE REACTOR

7/30	8/1	50.9	Low pressure trip on KER single pass tubes.
8/1	8/1	.5	Panellit trip caused by an oscillating gage on thoria tube 1398.
8/8	8/14	129.3	Charge-discharge and cleaning of the cross-tie system. Miscellaneous maintenance.
8/14	8/14	.7	Unexplained Panellit trip.
8/17	8/19	36.4	Scrammed by a high trip on KER single pass tube 3050. Miscellaneous maintenance.

KW REACTOR

7/31	8/1	36.5	Outage caused by loss of No. 3 boiler at 165-KW.
8/8	8/12	94.9	Shut down for scheduled charge-discharge and cleaning of the cross-tie system. Miscellaneous maintenance.
8/13	8/14	26.6	Shut down due to a water leak.
8/14	8/14	.9	Panellit trip.
8/15	8/17	33.0	Panellit trip. Miscellaneous maintenance.

RESEARCH AND DEVELOPMENT - EXISTING REACTORS

Uranium Oxide Fuel Program

Fabrication of oxide elements is now underway. One fuel column (20 elements) of the vibration compacted elements has been completed. About ten of the higher density sintered pellet elements have been assembled. Up to four fuel

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September 13, 1965

columns of 20 elements each are scheduled to be charged into KW Reactor during the mid-September outage.

Welding of the compacted elements is still a problem. Some steps have been taken to prevent contamination of the closure region, and completion of the elements is not expected to be delayed as a result of closure trouble. All of the elements produced have been helium leak-checked and the welds radiographed.

Bismuth Test

The mixed charge of bismuth elements alternated with uranium pieces was discharged from C Reactor on July 30 without difficulty. This completes the irradiation phase of the polonium production test in overbore geometry.

Ribbed Zircaloy Tubes

The three full-length K-size Zircaloy process tubes being fabricated by electron beam techniques have been completed.

High Temperature Graphite Test

Data from the high temperature graphite temperature test at F Reactor are presently being analyzed. Preliminary conclusions indicate that a temperature limit increase of about 50 C is technically feasible; however, a different philosophy of oxidation limit administration will probably be necessary.

Pu-Thoria Physics Testing

Dry reactivity and flux distribution measurements of 6 w/o Pu in aluminum and thoria in a 1:1 supercell arrangement have been completed in the PCTR; the data are being analyzed. The wet tests have been scheduled for September.

PROCESS TECHNOLOGY

Reactor Characteristics

Physics calculations of the reactor improvements in the use of hot-die-sized fuel have been made. The differences given below are based on the present AlSi fuel.

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	<u>Small Reactors</u>	<u>K Reactors</u>
Positive Void Coefficient	10% reduction	30% reduction
Positive Graphite Temperature Coefficient	No change	No change
Negative Doppler Coefficient	2% more negative	3.6% more negative
Cold, Clean K	No change	No change
Gratuitous Np Production	3.5% gain	5% gain
Weight per Foot	6.6% heavier	8.6% heavier
Pu Conversion	1% gain	1% gain

The 30% reduction in the void coefficient in the K reactors is significant as it will make it easier to obtain future goals in increasing specific fuel powers and thus strengthen the K reactors flexibility for non-defense products.

Depleted Uranium Irradiations

The irradiation of depleted uranium fuel columns is continuing without difficulty. During the report period, the monitor columns of depleted elements were discharged from both the B and KE loadings.

Examination and measurement of these columns was completed. The results are reported below. A total of 15 monitor columns has been discharged from B Reactor and 18 from KE.

The current status of the E-D loads is as follows:

	<u>B Reactor</u>	<u>KE Reactor</u>
Exposure, MWD/T	1960	2230
% Pu-240	22.5	22.6
Kilogram/ton	2.0	2.3

The authorized goal exposure for the elements is 2500 MWD/T. Continuation of the irradiation beyond this exposure is anticipated, but will be terminated with one depleted fuel failure at that reactor.

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Reactor Effluent Flow and Temperature Limits

Additional experimental results have been obtained at shutdown coolant flows ranging from 63,000 to 203,000 gpm and at operating bulk outlet temperatures ranging from 73 to 95 C with flows up to 210,000 gpm. The effluent line pressure drop was found to agree closely with calculations at 15 C. At 95 C there was no indication of the anticipated pressurization effects of the release of air and vapor in the effluent system.

Pressure measurements taken at the downcomer orifice plate showed a significant change in downcomer channel flow distribution between cold and hot full flow conditions.

There was a decrease in flow through the lower four channels and a corresponding increase in the flow through channels seven through ten. This effect is believed to be caused by cavitation at the channel openings which tends to limit the downcomer flow capacity. The effect of temperature surging upon this condition is unknown but may cause approach box pressures above the steady-state saturation pressure values.

A program for strengthening of the approach boxes at both KW and KE is being undertaken.

Resistance Temperature Detectors

Response characteristics tests have shown that the immersion RTD's exhibit a pure time constant of about 1.5 seconds. New strap-on RTD's respond to a temperature change with about a 1.5 second time constant for the first 60-70 per cent of the change but then exhibit a time constant of 10-30 seconds for the remainder of the change to saturation. The measured response of strap-on RTD's after several months' exposure on reactor was somewhat lower - about a 1.5 second time constant to 40-50 per cent of the change and an average time constant of about one minute for the remainder of the change to saturation.

Considerable study has been made to determine the effect of strap-on RTD characteristics on zone temperature monitor and linear rate-of-rise limits. New strap-on RTD's (properly installed) will not cause significant reduction in the linear rate-of-rise limits because the initial response of the strap-on RTD is equal to that of an immersion RTD. The limit reduction is larger for the zone temperature monitor because the delay in saturation of the strap-on RTD causes several degrees error in the indicated coolant temperature.

KE Prototype VSR Channel Enlargement

During the August outage at KE Reactor, the prototype VSR channel enlargement equipment on-reactor testing was initiated on VSR channel 49. The biological shield and thermal shield were enlarged and the top two feet of the graphite packing blocks were reamed, preparatory to graphite sleeving. At this point the following step would have been entry of the reamer into the tube pattern, with some tube removal work probable. The anticipated end of the scheduled outage would not permit such a block of work to be undertaken, so work was terminated. The results are now being evaluated. Preliminary data indicate that the equipment performed within the expected time-operating cycles as established during the mockup testing phase. During the enlargement of the shield opening, considerable time was expended in inspection and evaluation of the various cutting operations. The principal objective of the test was attained - that of demonstrating the on-reactor operation of much of the new concept tooling required to enlarge the channel.

Test completion including sleeve installation is scheduled for September.

Channel Caulking

VSR channel 17 at C Reactor, caulked in June, has been inspected visually and movies were taken through the borescope for evaluation. The last film is still being processed. Visual examination showed a large amount of fallout from the narrower cracks especially the zone where the caulking operation was interrupted and then restarted with additional water. One former 1-1/2 inch wide void was still completely filled and apparently quite solid. As a result of these examinations, the caulking plans have been revised to specify a smaller (about 1/8 inch) particle size and the use of thin sugar syrup instead of water for washing the chain and vibrator hose during their removal from the channel.

The production test for caulking the first K channel will begin with tests in the 195-D Test Tower early in September.

Zircaloy Process Tube Hydriding

It has been demonstrated in the laboratory that Zircaloy, when electrically coupled to aluminum will hydride in stirred process water at 90 C. Under the same conditions, samples which are not electrically coupled did not hydride. It was further demonstrated that zircaloy samples coupled to 6063-T6 aluminum absorbed about three times as much hydrogen as those coupled to 8001. These data add support to the theory that hydriding is a galvanic phenomenon. Also, they help to explain why hydriding is peculiar to the rear of the tubes since the K self-supports are canned in 8001 whereas 6063 is used for dummies.

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Effluent Activity Data

The following table shows the average concentration of five radionuclides from effluent samples in August, 1965. All units are 10^{-12} curies per milliliter.

<u>Reactor</u>	<u>As-76</u>	<u>P-32</u>	<u>Zn-65</u>	<u>Cr-51</u>	<u>Np-239</u>
B	131	7.5	4.8	350	87
C	186	7.2	10.0	1070	170
D	51	2.0	9.3	210	60
KE	54	7.1	7.8	130	53
KW	161	7.1	3.9	140	82

F Reactor Confinement System Tests

Further tests were run at the deactivated F Reactor to determine the cleanup of iodine and noble gases by fog spray. A fog spray system with five nozzles was installed in the tunnel upstream of the filters in the filter building. The length of tunnel subjected to fog was about 30 feet. About 100 curies of I-128 were released just upstream of the fog spray in the tunnel. With an air flow of 900 linear feet per minute, 11.7 per cent of the iodine released penetrated the fog spray.

Another test was run in which about 100 curies of I-128 were released on two occasions into the discharge area. The first release was with the fog spray turned off, and 14.6 per cent of the iodine released reached the inlet of the filters. The second release was with the fog spray on in the discharge area and only about 0.02 per cent of the iodine reached the inlet to the filters.

Two tests were also run to determine the washout of noble gases by the fog spray system set up in the filter building tunnel. One involved the release of Argon-41 and the other the release of ten curies of Krypton-85. In both cases the fog spray had little effect on penetration.

100 K Coolant Backup

Results of the mechanical cleaning operation performed early in August are satisfactory. Removal of the corrosion product buildup in the system has restored full system capacity. A raw water injection system has been designed by means of which it is expected that corrosion in the future will occur at a reduced rate. If successful, the raw water injection system will minimize the need for periodic cleaning.

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Reactor Deactivation

The F and H end of the export water line was converted to fire and sanitary water use on August 25. The facilities remaining in use in F and H areas will now be supplied with water from D area.

The package steam boilers were placed in operation in F area on August 19 for supplying steam to the biology facilities. The 184-F Boiler House was shut down on that same date.

Deactivation work in all areas, DR, F, and H, is complete with the exception of the work in the 181 and 182 Buildings which was delayed pending the conversion of the export water line for sanitary water use.

About 66 per cent of the irradiated metal was shipped from F area and almost 50 per cent of the H metal at the end of the month.

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REACTOR OUTAGES

	B	C	D
Charge-discharge	63.6	21.1	79.4
Maintenance	5.1	25.8	19.4
Rupture removal		35.6	15.9
Water leak	15.4		39.5
Tube replacement	24.9		3.6
Project work			
Production tests	1.8		16.8
Standard check	6.8	5.7	5.3
Miscellaneous		12.1	1.5
Total	117.3	100.3	181.4

UNITED STATES GOVERNMENT

Memorandum **DECLASSIFIED**

TO : Files

DATE: October 13, 1965

FROM : R. L. Plum, Chief
Production Reactor Operations Branch

HANFORD CODE 77-3

THIS DOCUMENT CONSISTS OF 10 PAGES

SUBJECT: MONTHLY REPORT FOR SEPTEMBER, 1965

HAN-90620

Report #9

OR:GTO:RGR

OPERATING EXPERIENCE

Production

Reactor input plutonium production for September was 321.0 KMWDs (100.8% forecast); 132.9 (111.5% forecast) at the three smaller reactors and 188.1 (94.5% forecast) at the two K Reactors.

Efficiency

Overall time operated efficiency for September was 79.6%: 82.8% at the three smaller reactors and 74.8% at the two K Reactors.

Power Levels

Power levels at all reactors were limited by a bulk outlet water temperature limit of 95 C.

Ruptures

Three failed natural uranium, two failed enriched uranium fuel elements and one failed thoria element were removed from the reactors. Two of the natural uranium failures were hot-die-sized overbore elements at C Reactor; the other natural failure was at B Reactor. The overbore elements failed at 71% and 82% of goal exposure. The other natural metal failure was at 79% of goal exposure. The two enriched failures, at C and D Reactors, failed at 75% and 32% of goal exposure, respectively. The thoria element failed at 17% of goal exposure (equivalent MWDs) at KE Reactor. The overbore elements were side ledge corrosion and side unclassified failures. The other natural metal failure was a side unclassified failure. The two enriched failures were from a side hot spot and from side groove corrosion. The thoria failure has not yet been examined.

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MAINTENANCE AND EQUIPMENT EXPERIENCESWater Leaks

Three internal process tube leaks and three Van Stone flange leaks were corrected at D Reactor.

Tube Replacement

Fourteen aluminum process tubes were installed: six each at B and D Reactors and one each at C and KE.

REACTOR OUTAGES

<u>Date Down</u>	<u>Date Up</u>	<u>Outage Hours</u>	<u>Remarks</u>
<u>B REACTOR</u>			
9/7	9/11	97.3	Scheduled charge-discharge and miscellaneous maintenance.
9/30	Still down		Removal of an I&E natural metal rupture from tube 4077. Charge-discharge.
<u>C REACTOR</u>			
9/11	9/15	84.0	Removal of a hot-die-sized overbore natural metal rupture from tube 3269. Charge-discharge and maintenance.
9/16	9/18	32.2	Panel lit trip on tube 3681. Miscellaneous maintenance work.
9/22	9/23	38.1	Removal of a hot-die-sized overbore natural metal rupture from tube 1464.
9/26	9/28	32.3	Removal of a stuck I&E enriched metal rupture from tube 3988.
<u>D REACTOR</u>			
9/7	9/8	34.0	Removal of a hot-die-sized enriched metal rupture from tube 1367. Leak testing and miscellaneous maintenance.
9/22	9/24	35.3	Water leak. Leak testing and maintenance.

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REACTOR OUTAGES (CONT.)

<u>Date Down</u>	<u>Date Up</u>	<u>Outage Hours</u>	<u>Remarks</u>
<u>KE REACTOR</u>			
9/13	9/20	174.3	Removal of a thoria failure from tube 2898. Charge-discharge and scheduled maintenance.
9/20	9/20	0.5	Excessive oscillation on Panellit gauge 5871.
9/20	9/20	1.1	Repair of faulty RTD on tube 2169.
<u>KW REACTOR</u>			
9/20	9/28	187.1	Scheduled charge-discharge and modification to the downcomer approach box.
9/28	9/28	0.6	Panellit trip.

RESEARCH AND DEVELOPMENT - PRODUCTION REACTORS

Ribbed Zircaloy Process Tubes

The three full-length ribbed zircaloy process tubes fabricated by Electron Beam techniques have been received at the White Bluffs tube shop and are being evaluated.

Uranium Oxide Program

Additional enriched uranium oxide for blending with natural uranium was released in August. This additional quantity of oxide is sufficient for fabrication of three columns of fuel elements for irradiation tests. Welding problems have delayed completion of the elements, so that the test could not be charged during the mid-September outage at KW Reactor as originally planned.

Plutonium-Aluminum Irradiations

The initial charge of two plutonium-aluminum alloy fuel elements was placed in B Reactor on September 7. These fuel elements are being used to evaluate

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the effect of the lower density and higher specific power upon graphite temperature and are the forerunners of more tests.

Neptunium Irradiation Tests

Battelle-Northwest is currently making trial runs to develop a satisfactory method for canning neptunium oxide for irradiation in a K Reactor. No particular problems are being experienced in these runs, and they expect to have twelve target elements available for charging during an October outage at one of the K Reactors.

Dose Rate Telemetry

The prototype dose rate telemetry equipment has been installed in KE Reactor and utilized in a two-day field test during a recent outage. No major deficiencies were noted in the equipment during this test program. Following the successful completion of the tests the equipment was returned to the laboratory for additional bench testing.

PROCESS TECHNOLOGY

E-D Load

The E-D loads continue to run smoothly. Although production calculations are not exact for the present exposures, the current predictions are as follows:

	<u>K Reactor</u>	<u>B Reactor</u>
Exposure, MWD/T	2500	2110
% 240	26.0	27.4
Kg/t Pu	2.3	2.0
Tons Depleted in Test	10.4	10.5

Hot-Die-Size Fuel Program

Production Test IP-781, comparing hot die size (HDS) with AlSi fuel using .947 per cent enriched uranium in smooth O3E geometry, sustained two failures in HDS columns during August and September at exposures of 420 MWD/T and 485 MWD/T. Both failures were the result of severe groove corrosion and occurred in fuel columns charged into new process tubes. A water leak was associated with the second failure, but the cause of the leak was not determined. Examination of several production enriched metal columns (AlSi) discharged at goal exposure showed evidence of only very mild groove corrosion. In view of the more severe groove corrosion observed on HDS pieces compared to AlSi canned material examined to date, the failures have been designated as fabrication process related. A third HDS, process-related failure will result in the discharge of the HDS portion of the test.

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Longer Fuel Program

Ten fuel columns containing ten-inch enriched uranium elements were charged into D Reactor during the August 24, 1965 outage under Production Test IP-693. This test will evaluate oil-quenched cores. The fuel columns of the test are now estimated to have an average exposure of 180 MWD/T, with goal exposure at 800 MWD/T.

Resistance Temperature Detector Tests

Response tests were made on six strap-on RTDs removed from B Reactor after several months' service. The tests showed reduced response times compared to new conditions; however, in four instances, the responses could be improved by shimming under the clamps. However, a potential maintenance problem was pointed up in that the placement of the shim on the clamping mechanism can interfere with the proper closing of the clamp and, in so doing, cause a very slow response of the RTD.

The conclusion drawn from recent analog studies of new strap-on RTDs is that high temperature limits could be essentially the same as those for immersion RTDs. However, those strap-on RTDs which become loose exhibit poor response characteristics and would require fairly strict trip limits or require reductions in the allowable reactivity insertion rates for control rods. However, if the zone temperature monitor trip system is used in conjunction with a linear rate protection system, the poorer response of strap-on RTDs can be tolerated without a reduction in HCR speeds. The principal protection in this dual system would come from the linear rate system.

Vertical Safety Rods - Graphite Distortion

The sleeving of VSR channel No. 49 in 105-KE Reactor was successfully completed September 15. Following the biological and thermal shield boring, which was accomplished during the August outage, the graphite channel was enlarged and high strength graphite sleeves satisfactorily installed. The graphite cutting rates achieved were the highest ever attained, averaging 4-1/3 feet per hour over 8-1/2 hours. The channel cut was essentially as predicted from mock-up tests and traverse data. Process tube channel 5787 was exposed and penetrated approximately one-third of its diameter. The process tube in channel 5588 was exposed but not damaged. A full length stack of sleeves was installed, and the VSR was returned to normal service. Further analysis of the channel enlargement will be completed when the borescope movies and traverse data, which were taken after the sleeving was completed, are available. Except for continuing evaluation, the planned prototype on-reactor sleeving of VSR channels at the K Reactors has been satisfactorily completed.

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Irradiated Fuel Age Monitor

With the successful completion of the prototype irradiated fuel age monitor, the program has been expanded to provide identical equipment for each of the operating reactors. This equipment will provide assurance that all irradiated fuel will be properly aged prior to shipment to chemical separations plants. Design of the additional equipment has been completed and fabrication is in progress. The program has also been extended to determine suitability of this particular equipment for use in determining age of irradiated thorium elements, as well as uranium fuels.

Downcomer Modifications

The study to determine limiting capabilities of reactor effluent downcomer systems has continued throughout the month. Hydraulic testing of the 105-C downcomer model at the R. L. Albrook Laboratory has been completed and the final report is being reviewed.

Construction of the K downcomer model has been completed and initial tests are in progress. The K Reactor downcomers are being modified to support the coolant flow increase which will result from the use of fuel elements with arch rails. The modifications include strengthening the approach boxes to yield an allowable steady-state operating pressure of 10 psig and transient pressure surges to 15 psig, and opening the orifice plate to permit a 10,000 gpm effluent coolant flow increase without an increase in the downcomer water levels.

Columbia River Hydrology

As has been the practice in recent years, a river cooling program was effected during the summer of 1965 to achieve reduction in reactor coolant water temperature. Cooling of the river was effected through controlled discharge from Grand Coulee Dam during the period August 9 to September 8, 1965. On September 8, Columbia River in-flow to Lake Roosevelt had reduced to a value equal to generation and pumping requirements, and no further cooling effect could be realized. Normal river temperatures at this time, however, are declining normally due to cooler weather. Preliminary data evaluation indicates that results of the program were significant. An average reduction of up to 2°C in temperature was realized in spite of lower inventory of cold water available in Lake Roosevelt and the higher than normal river temperatures encountered at the start of the program. A final report of the program is in preparation.

Zirconium Tube Investigations

Evaluation of hydriding of Zircaloy-II process tubes continued during the month. Metallographic equipment has been received and it is now possible to

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quickly process metallurgical samples. Evaluation of in-reactor samples continued.

The first set of zircaloy coupons exposed in stainless steel holders was analyzed. There were no signs of hydride needles in any of the coupons, and vacuum analyses showed no hydrogen pickup. These data further substantiate the theory that the basic driving force in the hydriding process is the galvanic couple between the zircaloy tube and the aluminum dummies.

A new series of "bench" tests has been initiated to evaluate surface finishes and various treatments. Development efforts have continued toward the prototype sandblasting and flame spraying approach, in the eventuality of on-reactor demonstrations.

Reactor Plant Deactivation

At F Area, metal shipment was completed on September 11, 1965. Deactivation of all major F buildings and facilities has been completed except for the 105-F Building where the metal storage and transfer area equipment work is now underway. Some electrical switching, the deactivation of the 1704-F and 1707-FA Buildings and some burial ground cleanup remain to be completed.

At H Area, the regular metal shipment was completed on September 14, 1965. Due to the current process material needs in CPD and the storage problems in the operating reactors, it was decided to trans-ship the enriched metal from 105-H to 105-DR. This trans-shipment was completed on September 25, 1965.

Deactivation of all H Area major facilities has been completed except for the 105-H Building where the metal storage and transfer area equipment deactivation is now underway. Certain electrical switching work and some burial ground cleanup work remain to be completed.

A drawdown test of the 105-F metal storage basin and transfer area was successfully completed. The test had the objective of determining wall contamination and floor radiation. After some washdown of the basin walls, it was concluded that no serious problems should be encountered with partial or complete dirt-filling. Currently, no deactivation work on the actual basin is planned; and the basins in the three deactivated areas will be retained in a wet condition. The results of the tests also indicate that partial water fill can be used with reasonable variance in the water elevations between refillings.

Field work incidental to the equipment listing is essentially completed at F Area and has been started at H and DR Areas.

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October 13, 1965

Effluent Activity Data

September, 1965, effluent water samples. Average concentrations are in 10^{-12} Ci/ml.

<u>Reactor</u>	<u>As⁷⁶</u>	<u>P³²</u>	<u>Zn⁶⁵</u>	<u>Cr⁵¹</u>	<u>Np²³⁹</u>
B	109	8.8	7.4	410	92
C	125	6.6	18.9	1340	158
D	51	3.1	5.7	263	54
KE	32	6.7	7.0	122	32
KW	250	13.2	5.7	175	148

No significant changes were made in the treatment of reactor effluent during the month.

Gas Studies - All Reactors

The molecular sieve desiccant installed in No. 4 dryer at C Reactor has been performing very satisfactorily. It has been picking up 23 to 25 gallons of water between -80 dew point and -30 dew point, and the instrumentation installed with it has proved valuable in following the regeneration progress of the drying cycle. Steam leaks in the K Reactor dryers have proved more difficult to repair than had been anticipated. Consideration is being given to changing the internal configuration of one of the KE dryers to accommodate a molecular sieve, which could be done rather easily and would require enough less desiccant to amortize the cost.

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RUPTURED SILUX TUBULATION FOR SEPTEMBER, 1965

Tube No.	Date Charged	Date Ruptured	Tube Power (KW)	Concentration MWD/Ton	Assigned Production Loss		Observations
					MWD	Days	
1367D	7-16-65	9-7-65	1234	485	1364	.80	I&E E HDS Side groove corrosion
3269C	6-17-65	9-11-65	1313	568	555	.29	I&E NO HDS Side ledge corrosion
1454C	6-17-65	9-22-65	1470	654	1265	.66	I&E NO HDS Side unclassified
3988C	7-28-65	9-26-65	1282	569	2123	1.10	I&E E Side hot spot
4077B	8-2-65	9-30-65	1161	455	1447	.83	I&E N Side unclassified
2898 KE	8-9-65	9-13-65	40		1445	.34	Thoria

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RE.

B	
62.5	
9.9	
3.0	
26.5	
7.8	
6.8	
116.5	

Charge-discharge

Maintenance

Rupture removal

Water leak

Tube replacement

Project work

Production tests

Standard check

Miscellaneous

Total

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UNITED STATES GOVERNMENT

Memorandum

TO : Files

FROM : R. L. Plum, Chief
Production Reactor Operations Branch

SUBJECT: MONTHLY REPORT FOR OCTOBER 1965

DATE: November 8, 1965

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HAN-90620
Report #10

OR:GTO:RGR

OPERATING EXPERIENCE

Production

Reactor input plutonium production for October was 348.2 KMWDs (82.9% forecast): 116.9 (79.3% forecast) at the three smaller reactors and 231.3 (86.3% forecast) at the two K Reactors.

Efficiency

Overall time operated efficiency for October was 77.0%: 70.3% at the three smaller reactors and 87.0% at the two K Reactors. Low efficiency at the smaller reactors resulted largely from the extension of a scheduled outage at C Reactor and fuel element failures at D Reactor.

Power levels

Power levels at the three smaller reactors were limited by a bulk outlet water temperature limit of 95 C. The K Reactor power levels were restricted by the 95 C bulk outlet water temperature limit until mid-month, when the administrative limit of 4400 megawatts became limiting.

Ruptures

Four failed enriched uranium, one failed natural uranium and one failed thoria elements were removed from the reactors. Three of the enriched failures, at D Reactor, were charged on run-to-rupture Production Test IP-781, "Comparison Between HDS and Al-Si Fuel." One failure was from HDS fuel at 58% of goal exposure and two were from Al-Si fuel at 58% and 69% of goal exposure. The HDS element was a side failure, one Al-Si failure was from side groove corrosion, and the cause of the other Al-Si failure is currently unknown. The other enriched element failed at B Reactor, because of a hole defect, at 89% of goal exposure. The natural metal failure and the thoria failure were at KE Reactor. The natural metal

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was at 53% of goal exposure and the thoria failure was at 38% (equivalent MWds) of goal; both failures were from end defects.

MAINTENANCE AND EQUIPMENT EXPERIENCES

Tube Leaks

Two Van Stone flange leaks were corrected at D Reactor.

Tube Replacement

Eighteen aluminum tubes were replaced, seven at B, six at D and five at C Reactors. Four zirconium tubes were replaced at the K Reactors, two at each reactor.

REACTOR OUTAGES

<u>DATE</u> <u>DOWN</u>	<u>DATE</u> <u>UP</u>	<u>OUTAGE</u> <u>HOURS</u>	<u>REMARKS</u>
<u>B REACTOR</u>			
9/30	10/3	85.1	Removal of an I&E natural metal rupture from tube 4077. Charge-discharge and maintenance.
10/13	10/14	43.2	Removal of an I&E enriched metal rupture from tube 4474. Miscellaneous maintenance.
<u>C REACTOR</u>			
10/9	10/24	372.0	Scheduled maintenance and charge-discharge.
10/28	10/30	36.2	Unexplained Panellit trip on overbore tube 3264.
10/30	10/30	1.9	Low pressure Panellit trip on overbore tube 3168.
<u>D REACTOR</u>			
10/10	10/13	77.0	Removal of I&E E hot-die-sized rupture in tube 1570. Miscellaneous maintenance work. Charge-discharge.

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REACTOR OUTAGES (Cont.)

<u>DATE DOWN</u>	<u>DATE UP</u>	<u>OUTAGE HOURS</u>	<u>REMARKS</u>
10/18	10/19	32.4	Removal of an I&E enriched metal rupture from tube 1568. Leak testing and miscellaneous maintenance work.
10/19	10/19	2.2	Panellit trip caused by a faulty spline seal.
10/25	10/26	34.6	Removal of an I&E E metal rupture from tube 1370. Charge-discharge and maintenance.

KE REACTOR

10/21	10/26	109.9	Removal of a failed thoria element from tube 5852. Scheduled charge-discharge and maintenance.
10/26	10/26	.6	Scrammed by personnel error during a routine check of the safety circuit on a side-to-side test hole.
10/26	10/26	2.7	Panellit trip on tube 0668.
10/26	10/26	5.9	Shut down due to oscillation on Panellit gage 0668.
10/26	10/27	16.2	Removal of an I&E natural metal rupture from tube 4376.

KW REACTOR

10/19	10/21	55.2	Panellit trip. Charge-discharge and scheduled maintenance.
10/21	10/21	2.7	Insufficient control rod for turnaround.

RESEARCH AND DEVELOPMENT

Uranium Oxide Program

Fabrication of three columns of uranium oxide fuel for irradiation in KW Reactor has been completed by Battelle. The test is expected to begin in late November.

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Plutonium Fuel Tests

Phase I of the Pu-Al tests was completed. The purpose of the first testing phase was to determine the increase in graphite temperature next to the low density Pu-Al fuel. The graphite temperatures were found to increase only 30 C above normal. The second phase of the Pu fuel program consists of two test columns (of six pieces each) which will be used to develop isotope buildup data. After 20 days of irradiation, no change in fuel power has been observed; the initial powers were 20 per cent lower than predicted.

Neptunium Irradiation Tests

It is planned to irradiate twelve NpO_2 -aluminum target elements in KW Reactor beginning in late November. Fabrication of the target elements was completed near the end of October.

To predict dose rates which will be encountered in handling the Np-237 elements being prepared, a set of measurements was made with a radiation meter on the NpO_2 prior to canning. The dose rate at contact with the oxide was 4.7 R/hr. The Np had been separated nine days before, putting it at 25 per cent of equilibrium with its first daughter Pa-233, which is the principal dose contributor.

Polonium-210

Calorimetric measurements to determine the polonium content in the overbore bismuth elements have been completed. Values obtained correspond to theoretical calculations used in past production studies. The measured peak Wescott flux in the process channel containing all bismuth was 1.35×10^{14} and 1.20×10^{14} in the process channel containing a striped loading of bismuth and fuel elements. Polonium values obtained for these flux values were 12 grams polonium per ton of bismuth for 92 days' irradiation at a flux of 1.35×10^{14} and 7 grams of polonium per ton of bismuth for 56 days at a flux of 1.20×10^{14} . These values are 30 days after reactor discharge.

Columbia River Studies

The half-plant test at D Reactor to determine the effects of adding 20 ppm SiO_2 to process coolant continued. During September, the silicate reduced the concentrations of P-32 and As-76 by factors of 3 and 5, respectively. This is the best improvement seen to date.

In early August, the alum feed rate at KW Reactor was reduced to 6 ppm on a test basis. By month end, the feed rate had been reduced to 3 ppm and

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operations continued at that feed rate through September and early October. The concentrations of P-32 and As-76 increased by factors of 2 and 8, respectively, as compared to KE Reactor (16-18 ppm alum). Accordingly, the alum feed rate at KW Reactor was increased to 6 ppm on October 15.

PROCESS TECHNOLOGY

Thoria

Full E-Q core loadings will be charged into KE and KW Reactors during November. It has been suggested that the initial thoria load remain in the reactor for the entire irradiation period, rather than recharging the thoria at mid-point. The U-233 yield would be essentially the same, near 55 kg, and the U-232 contamination level would reach 7.5 ppm instead of 4.0 ppm. Twenty-five columns of thoria have been irradiated to this exposure at KE without failure or excessive tube outlet temperature. This proposal would reduce outage time required for the U-233 production and would save about 35 tons of thoria.

Vertical Safety Rods - Graphite Distortion

During a recent outage at 105-C Reactor, four VSR channels, No. 56, 57, 58 and 59, were successfully enlarged and sleeves installed. Performance of the prototype boring equipment was satisfactory with the enlargement of channel No. 58 accomplished in eight hours. Based on the results of this outage, no additional improvements in the 105-C Reactor boring equipment are anticipated.

The design of modification to the prototype 105-K Reactor boring equipment is under way. This work is being performed in support of the fabrication of the additional biological and thermal shield boring machines which will be required in the 105-K Reactor sleeving program.

Ball 3X Entry - C & K Reactors

Studies of methods of coping with the anticipated Ball 3X bellows problem at the 105-C and K Reactors are being performed by the Vitro Engineering Company. This problem will result from continued contraction of the reactor's graphite stack which supports the thermal shield. This contraction will ultimately cause rupture of the bellows between the biological and thermal shields which are a part of the Ball 3X system entry into the reactor, with a resultant loss of 3X system integrity. Vitro's studies are directed toward establishing more economical methods of coping with this problem than the external 3X hoppers and step plugs of the types utilized at 105-B and D Reactors. Laboratory tests are under way to establish the feasibility of inserting flexible metal tubing through the ball hoppers and the delay in

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Ball 3X drop time due to the reduction in flow area. Pending a determination of the increase in Ball 3X drop time, the feasibility of this method is not fully resolved.

165-K Boiler Control System

As a result of the 165 KW boiler incident, an intensive study has been undertaken to evaluate performance of the automatic flame failure detection and re-ignition system and to determine methods of improving reliability of this system.

Two new flame monitors, differing in principle from those presently in use, have been procured and installed on one boiler for purposes of testing. The new monitors will detect both pilot and main flames but are less susceptible to false signals than the present detectors. The present system also requires separate detection equipment for pilot and main flames. An evaluation of the overall boiler control system is also under way to determine feasibility of improving the reliability of this system.

E-D Load

The E-D test loadings continued to run smoothly. The mid-October status is shown below.

	<u>K Reactor</u>	<u>B Reactor</u>
Exposure, MWD/T	2700	2250
% Pu 240	25.5	24.5
Kg Pu per ton U	2.7	2.3
Tons Depleted U	10	10

At the request of the Commission, the KE test load was discharged; the B load will also be discharged at the next B Reactor outage. One depleted column will be kept under irradiation in each reactor to obtain physics data at maximum exposures. The goal exposure for these two columns is 4,000 MWD/T; the 240 isotope concentration at that exposure will be about 30 per cent.

Hot-Die-Sized Fuel Program

The third hot-die-sized and first AlSi fuel failures occurred in PT-781 at exposures of 874 and 870 MWD/T, respectively. The remaining HDS fuel columns were discharged as specified in the production test. The recent and current comparative HDS - AlSi irradiation tests are biased against the HDS elements because of their weight differences. The HDS elements in the small reactors produces about 8% more power than an AlSi element in the same neutron flux; and, since the coolant flow is the same in both cases, the HDS elements are exposed to hotter water and suffer higher corrosion rates. In a full-reactor test of HDS elements, this would not be the case, as the flux would be reduced to maintain the same reactor power as at present.

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Effluent Activity Data

October 1965 Effluent Water Samples
Average Concentration, 10^{-12} Ci/ml

<u>Reactor</u>	<u>As-76</u>	<u>P-32</u>	<u>Zn-65</u>	<u>Cr-51</u>	<u>Np-239</u>
B	305	12.0	3.1	450	160
C	135	8.5	6.6	1120	160
D	65	5.1	4.4	440	95
KE	50	7.0	2.5	130	35
KW	370	16.4	3.3	185	170

Reactor Deactivation

As of November 1, all deactivation work was complete with the exception of the DR storage basin, which will contain irradiated fuel until about March 1966.

During the month both the F and H irradiated metal storage basins were pumped down to a water level of about 3-1/2 feet. The basin walls were hosed down as the water level dropped, and it was found that no significant radiation levels existed with the water at the low level. The basins were refilled with water. Some activity remains in the sludge on the floors of the basins which will be considerably reduced through decay over the next several years.

Preparation of the equipment and material lists for the shutdown plants is continuing and will be completed in about six weeks.

The deactivation group which has been responsible for the planning and scheduling of the plant shutdowns was disbanded at the end of October.

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RUPTURED SLUG TABULATION FOR OCTOBER 1965

Tube No.	Date Charged	Date Ruptured	Tube Power (KW)	Concentration MMD/Ton	Assigned Production Loss		Observations
					MMD	Days	
1570 D	7-16-65	10-10-65	1247	874	2577	1.50	I&E E HDS Side not examined
4474 B	5-24-65	10-13-65	720	801	976	.56	I&E E Hole defect
1568 D	7-16-65	10-18-65	1208	871	1819	1.06	I&E E ALSi Side groove corrosion
1370 D	7-16-65	10-25-65	1214	1038	228	.13	I&E E ALSi Unknown
4376 KE	9-13-65	10-26-65	1656	346	3118	.73	I&E N End defect
5852 KE	8-9-65	10-21-65	65	346	1421	.33	Thoria End defect

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Charge-discharge

Maintenance

Rupture removal

Water leak

Tube replacement

Project work

Production tests

Standard check

Miscellaneous

Total

REACTOR OUTAGES (Hour)			
	B	C	
	40.6	61.8	1
	22.0	296.6	2
	26.7	0	
	0	0	1
	13.3	16.0	1
	0	0	
	1.8	0	7
	4.7	10.5	
	0	25.2	
	109.1	410.1	14

UNITED STATES GOVERNMENT

Memorandum

TO : Files

FROM : R. L. Plum, Chief
Production Reactor Operations Branch
Production Reactor Division

SUBJECT: MONTHLY REPORT FOR NOVEMBER 1965

DATE: December 8, 1965

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THIS DOCUMENT CONSISTS OF 11 PAGES
OF 11 PAGES SERIES

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Report #11

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OPERATING EXPERIENCE

Production

Reactor input plutonium production for November was 301.6 KMWDs (91.2% forecast): 122.7 (95.5% forecast) at the three small reactors and 178.9 (88.4% forecast) at the two K Reactors.

Efficiency

Overall time operated efficiency was 69.7%: 68.7% at the three small reactors and 71.3% at the two K Reactors.

There were 15 reactor outages during November. Two were scheduled outages for the charge-discharge of fuel at B and D Reactors. The D Reactor continued the outage for the modification of rear face hardware. The charge-discharge of fuel was achieved at C, KE and KW Reactors including the loading of a thoria core at KW, during outages initiated by failed fuel elements. Thirteen of the November outages were unscheduled. Seven were for the removal of failed fuel elements and six were caused by reactor scrams.

Power Levels

Power levels at the three small reactors were limited by a bulk outlet water temperature limit of 95 C. The K Reactor power levels were restricted by the administrative limit of 4400 megawatts.

Ruptures

Eight failed fuel elements, five natural uranium and three enriched uranium, were removed from the reactors. The natural metal failures, two at KE Reactor and one each at B, C, and KW, ranged from 44 to 168% of goal exposure. The B Reactor failure was a bumper element and one KE failure was a self-support element. Two of the enriched failures were at KW Reactor (both in

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one tube) and one was at C Reactor. The two KW failures, at four per cent of goal exposure, and several other suspected failed elements from this tube charge are being inspected to determine the cause of failure at this low exposure. The enriched failure at C Reactor was at 60 per cent of goal exposure.

MAINTENANCE AND EQUIPMENT EXPERIENCES

Water Leaks

One process tube water leak was corrected at D Reactor.

Tube Replacement

Thirty-two aluminum process tubes were installed: 28 at D, two at B and one each at C and KW Reactors. One zirconium process tube was installed at KW Reactor.

REACTOR OUTAGES

<u>Date Down</u>	<u>Date Up</u>	<u>Outage Hours</u>	<u>Remarks</u>
<u>B REACTOR</u>			
11/2	11/5	71.8	Scheduled charge-discharge and maintenance.
11/18	11/21	79.2	Removal of an I&E natural metal rupture from tube 1585. Charge-discharge and maintenance.
<u>C REACTOR</u>			
11/22	11/24	55.0	Removal of an I&E natural metal rupture from tube 2889. Charge-discharge and miscellaneous maintenance.
11/26	11/28	34.4	Removal of an I&E enriched metal rupture from tube 2783. Miscellaneous maintenance.
<u>D REACTOR</u>			
11/4	11/20	398.7	Scheduled charge-discharge and the modification of rear face hardware. Miscellaneous maintenance work and leak testing.

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REACTOR OUTAGES (Continued)

<u>Date</u> <u>Down</u>	<u>Date</u> <u>Up</u>	<u>Outage</u> <u>Hours</u>	<u>Remarks</u>
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D REACTOR (Continued)

11/29	11/30	35.7	Panellit trip.
-------	-------	------	----------------

11/30	Still down		Panellit trip.
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KE REACTOR

11/9	11/11	41.5	Panellit trip. Charge-discharge and main- tenance.
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11/11	11/11	2.7	Removal of an I&E natural metal rupture from tube 4384.
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11/11	11/11	1.2	Panellit trip.
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11/11	11/11	2.6	Panellit trip.
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11/21	11/25	84.2	Removal of an I&E natural metal rupture from tube 0761. Charge-discharge and maintenance work.
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KW REACTOR

11/3	11/5	46.2	Panellit trip. Charge-discharge.
------	------	------	----------------------------------

11/14	11/22	198.0	Removal of an I&E natural metal rupture from tube 2970. Scheduled charge-discharge and maintenance work.
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11/26	11/27	37.2	Removal of an I&E enriched rupture from tube 1053. Charge-discharge.
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PROCESS TECHNOLOGY

Hot-Die-Size Fuel Program

The irradiation test, designed to determine the in-reactor performance of HDS fuel relative to Al-Si fuel, has been completed in D Reactor.

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Three HDS fuel failures occurred at exposures of 405, 450, and 874 MWD/T, respectively. The HDS portion of the test was discharged following the third failure in accordance with the provisions of the test. Two Al-Si failures occurred at 870 and 1025 MWD/T, respectively.

Statistically, the results indicate an even chance that the HDS fuel failure rate due to groove corrosion is 1.43 times that of Al-Si fuel. This difference is explainable, at least in part, by the fact that the HDS fuel generates 6 per cent to 8 per cent more power due to their greater uranium content.

Fuel elements in both the HDS and Al-Si fuel failure columns showed heavy groove corrosion, and all failures occurred in new tubes.

Graphite Oxidation

One of the more significant results from the analysis of the high graphite temperatures test performed at F Reactor is the conclusion that, to date, the principal cause of oxidation of the stack graphite with carbon dioxide has been radiation rather than graphite temperature. Analyses of reactor data show that graphite oxidation has been proportional to reactor power level rather than increasing exponentially as would be expected if the reaction were solely dependent on temperature. During the test at F Reactor, an exponential increase in oxidation was observed only after the temperature had been increased beyond the current temperature limit of 650 C.

Preliminary examination of the economics associated with increased graphite temperature indicates that an increase of about 50 C is justifiable. Since the test results indicate that this is also technically feasible, a production test similar to the F test will be prepared to increase the graphite temperature limit 50 C at B, D and possibly C Reactors.

Improved HCR Design

One of two prototype aluminum rods has been tested in the laboratory to determine hydraulic and physical characteristics, and thermocouples have been installed on the outer sheath, in preparation for measuring sheath temperatures during in-reactor testing. This rod has been installed at D Reactor for in-reactor testing. The rod is performing satisfactorily regarding sheath temperatures and coolant outlet temperatures.

The outer sheath on the second prototype was damaged in attempting to install thermocouples for in-reactor testing. A new sheath for the damaged rod has been ordered. The rod can be salvaged for a minor cost.

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Process Channel Enlargement

A response to an RLO request for current information on various approaches to process channel enlargement is being prepared. The document will propose that full-scale engineering and development effort be undertaken at once, and the effort for a fuel test block of 44 tubes be initiated this fiscal year. The accumulation of materials and the scheduling of outages for one "complete" 1500 tube outage at each reactor was proposed within a \$2,000,000 annual incremental cost.

Boiler Controls - 165-K

Preliminary testing of new flame detection and reignition equipment has been completed on a prototype basis on Boiler No. 1 at KE Reactor. Results of the testing show that the new equipment in conjunction with minor control system modifications and improved power supply units will provide the desired reliability for the flame failure detection, purge, and reignition functions. The tests have also indicated, however, some basic deficiencies in the combustion control and firing equipment which are causing unnecessary flame-outs during various conditions of firing. Further investigation is under way to isolate these deficiencies and to recommend appropriate corrective action.

Steam Boiler Repair, 165-KW Building

Repair is 90 per cent complete. All steel plates are in place and 50 per cent of the seams are welded.

Zirconium Process Tube Hydriding

Five additional zircaloy tubes have been removed from the K Reactors for analysis. The hydride analysis results available at this time indicate a uniform hydride case layer of approximately 3 mils thickness near the rear Van Stone flange of tube 3181 KE, and some hydrogen pickup was observed at scratch locations in tube 4372-KE. This tube had been autoclaved prior to installation.

Analyses of the zircaloy coupons removed from a stainless steel holder exposed for three months agree very well with those from the stainless steel holder with one month exposure. There was no significant pickup of hydrogen in either case. Under similar times and conditions, coupons in 6063 aluminum holders consistently pick up hydrogen, particularly coupons with sandblasted surfaces.

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Reactor Last Ditch Cooling

As a result of the shutdown of the F, H and DR Reactors and the installation of a diesel-powered emergency cooling system for the B and C Reactor, major changes have been made in the export system which will continue to provide backup coolant to the D Reactor. The effect of these changes on the export system pressure transients resulting from loss of electric-powered export pumps at 100 B is being investigated in a series of tests. The preliminary results indicate some small increase in the initial pressure down-surge following electric-power trip out, and a marked decrease in the pressure surging as the lines refill up to the 200 East and West reservoirs. The decreased pressure surging observed at the end of these tests may be attributed to the fact that the modified system uses two instead of four steam pumps to supply emergency export system coolant flow, that bypass lines with orifices have been installed at the 200 reservoir, and that the 200-Area cone valves were partially open during the tests.

Recommendations concerning operation of the export system to control pressure transients following loss of BPA power will be made following completion of the testing program and analysis of the test results.

Effluent Activity Data

The table below shows the average concentrations of five radionuclides in reactor effluent water samples taken during November, 1965. All units are 10^{-12} curies/cc.

<u>Reactor</u>	<u>As⁷⁶</u>	<u>P32</u>	<u>Zn⁶⁵</u>	<u>Cr⁵¹</u>	<u>Np²³⁹</u>
B	275	16.0	3.1	410	130
C	140	10.0	21.0	900	140
D	75	5.5	--	230	55
KE	60	7.8	3.9	135	40
KW	275	12.8	3.5	150	140

Tamper-Proof Seal for IAEA

The test mockup has been shipped to the Army Intelligence Center accompanied by a letter outlining ground rules for the "tampering" tests to be performed by the Center. They will attempt to gain entry to the mockup, remove the safing, and then replace the entire assembly. If they feel they have accomplished this without the tampering being detectable, the mockup will be returned here for our evaluation.

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Linear Power Rate-of-Rise Instrumentation - 105-KE and Three Small Reactors

Vendor procurement problems continue to delay the completion of electronic equipment.

Resistance temperature detectors were installed on pile in 105-D.

High Speed Scanning System for Temperature Monitoring:

K₂ Reactor

Fabrication of the temperature monitor board assembly was completed by the J. A. Jones Construction Company on November 18, 1965, and shipped to Astrodata, Incorporated, on November 22, 1965, for use in high speed scanner testing.

Construction of the cooling air plenum has started in the 105-KE Building, and procurement of equipment has started.

KW Reactor

Revision 2 of the Project Proposal requesting an extension in time to complete the project was approved informally on November 22, 1965.

The KW high speed scanner was started on a six-month acceptance test on October 14, 1965, and removed from this on November 7. It was again started November 9 after temporary corrections to the scanner circuits to eliminate calibration drift of approximately 0.8 C per 10 day period. Spare parts required in the above repairs, and requested June 15, 1965, are still unavailable.

RTD and Leadwire Replacement - 105-KE and KW Process Tube Temperature Monitoring System

The vendor has found that the internal addition of a small amount of desiccant to the RTD assembly eliminates the low resistance to ground problem. Production has restarted.

RESEARCH AND DEVELOPMENT

Uranium Oxide

Three columns of 1.3 w/o enriched uranium oxide fuel elements have been charged at KE Reactor.

Plutonium Fuel Tests

The average exposure accumulated by fuel adjacent to the two test columns of plutonium-aluminum fuel elements is about 310 MWD/T. Both test columns

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initially operated at about 80 per cent of the predicted power (adjusted for difference in adjacent tube power). Neither tube decreased appreciably in specific power during the first 32 days of operation.

Neptunium Irradiation Tests

Eleven of the twelve neptunium target elements being fabricated for irradiation testing swelled following heating to outgas the elements prior to making final closure. The reason for this behavior is being determined and recovery procedures are under study. This unexpected development will delay the irradiation test, which was scheduled to begin in November.

Production-Related Studies

The thoria being charged into the two K Reactors has a lower density and a lower high-cross-section contaminant level than anticipated. The actual density is about 7.2 g/cc rather than 7.5 g/cc and the gadolinium content is down to less than 1 ppm from 2.5 ppm. This will cause the excess reactivity to be about 3.5 mk higher than predicted, which will require some adjustments in the loading pattern.

The depleted blocks at both B and KE Reactors (with the exception of tubes 3186B and 4055KE) have been discharged. Estimated production data are as follows:

	<u>B</u>	<u>KE</u>
Tons depleted U discharged	10.3	10.1
Average discharge exposure, MWD/T	2475	2700
Yield, Kg Pu/Ton	2.305	2.740
% Pu-239	70.5	67.7
% Pu-240	25.0	26.0
% Pu-241	4.5	5.4
% Pu-242	1.0	1.2

One depleted uranium fuel column remains under irradiation at each reactor. A goal exposure of 4000 MWD/T has been established for these columns.

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RUPTURED SLUG TABULATION FOR NOVEMBER 1965

Tube No.	Date Charged	Date Ruptured	Tube Power (KW)	Concen- tration MWD/Ton	Assigned Production Loss		Observations
					MWD	Days	
1585-B	8-2-65	11-18-65	1270	900	175	.08	I&E-N side groove corrosion
2783-C	11-9-65	11-26-65	1491	433	535	.25	I&E-E side hot spot
2889-C	10-9-65	11-22-65	1368	289	1656	.76	I&E-N side hot spot
4384-KE	9-13-65	11-11-65	1764	507	626	.15	I&E-N end defect
(2 rupt.) 1053-KW	11-14-65	11-26-65	1705	37	969	.24	I&E-E (2 ruptures) Hole: unclassified
2970-KW	9-20-65	11-14-65	1761	486	9633	2.35	I&E-N Unknown not examined
0761-KE	9-13-65	11-21-65	1728	589	353	.08	I&E-N side: unclassified

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OUTAGES (Hours)

C	D	KE	KW	TOTAL
4.6	71.5	100.0	161.3	443.7
7.1	280.4	15.4	36.6	374.0
2.8	--	4.7	58.1	84.6
.	15.7	---	---	33.9
3.2	34.4	---	---	50.2
1.6	---	---	---	4.6
1.2	12.0	0.5	12.9	37.0
1.8	15.7	8.0	9.8	38.3
.1	5.4	3.8	2.7	23.0
.4	435.1	132.4	281.4	1089.3

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Memorandum

TO : Files

FROM : R. L. Plum, Chief *[Signature]*
Production Reactor Operations Branch
Production Reactor Division

SUBJECT: MONTHLY REPORT FOR DECEMBER 1965

DATE: January 12, 1966

HANFORD CODE *C.6.5*

THIS DOCUMENT CONTAINS *7* PAGES

HAN-90620
Report #12

OR:GTO:RGR

OPERATING EXPERIENCE

Production

Reactor input plutonium production for December was 366.1 KMWDs (101.7% forecast): 153.8 (97.7% forecast) at the three small reactors and 212.3 (104.9% forecast) at the two K Reactors. Input production records were achieved at the B and D Reactors exceeding their previous records established in November 1963 and March 1964, respectively.

Efficiency

Overall time operated efficiency was 80.2%: 81.4% at the three small reactors and 78.4% at the two K Reactors.

There were 12 reactor outages during December. Two were scheduled outages for the charge-discharge of fuel at B and KE Reactors. The charge-discharge of fuel was achieved at other reactors during unscheduled outages. Ten of the December outages were unscheduled. Five were for the removal of failed fuel and thoria elements, three were caused by reactor scrams, one was for reactor water leak testing and one was for the correction of a leaking front face connector.

Power Levels

Reactor power level records of 2370 megawatts at C Reactor and 2105 megawatts at D were achieved exceeding the records of March, 1964 by 5 and 50 megawatts, respectively. Power levels at the three small reactors were limited by a bulk outlet water temperature limit of 95 C. The K Reactor power levels were restricted by the administrative limit of 4400 megawatts.

Ruptures

Four failed fuel elements, three natural uranium and one enriched uranium, and one failed thoria element were removed from the reactors. Two of the

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natural uranium elements were side-hot-spot failures at C and KW Reactors at 88 per cent and 92 per cent of goal exposure, respectively. The third natural uranium failure was from side groove corrosion on an overbore element at C Reactor with 93 per cent of goal exposure. The enriched element, a side-hot-spot failure at C Reactor, was at 54 per cent of goal exposure. The thorium element, at KW Reactor failed at 46 per cent of goal exposure (equivalent MWDs) because of mechanical damage.

MAINTENANCE AND EQUIPMENT EXPERIENCES

Water Leaks

At the KW Reactor excessive water collection was experienced from the reactor atmosphere late in the month indicating a process tube leak. The entire reactor was leak tested with no leaks found by month's end. There were no process tube leaks at the other reactors.

Tube Replacement

Six aluminum process tubes were installed: three at C, two at D and one at KW.

REACTOR OUTAGES

<u>Date</u> <u>Down</u>	<u>Date</u> <u>Up</u>	<u>Outage</u> <u>Hours</u>	<u>Remarks</u>
<u>B REACTOR</u>			
12/13	12/17	101.2	Scheduled charge-discharge and maintenance.
<u>C REACTOR</u>			
12/2	12/6	85.1	Removal of an I&E enriched rupture from tube 4281. Charge-discharge and maintenance.
12/8	12/9	34.2	Panellit trip.
12/14	12/16	41.0	Outage caused by a leaking front connector. Charge-discharge.
12/23	12/25	42.5	Removal of an I&E natural metal rupture from tube 1378.
12/28	12/30	65.9	Removal of an I&E natural metal overbore rupture from tube 4466. Charge-discharge.
12/30	12/30	2.0	Panellit trip on tube 1059.

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REACTOR OUTAGES (Continued)

<u>Date Down</u>	<u>Date Up</u>	<u>Outage Hours</u>	<u>Remarks</u>
<u>D REACTOR</u>			
11/30	12/1	3.0	Panellit trip.
12/15	12/16	43.4	Panellit trip on tube 4458. Charge-discharge.
<u>KE REACTOR</u>			
12/2	12/6	97.6	Scheduled charge-discharge and miscellaneous maintenance.
12/30	Still Down		Removal of a failed thoria element from tube 274.
<u>KW REACTOR</u>			
12/5	12/8	75.6	Removal of an I&E natural metal rupture from tube 3579, and leak testing.
12/18	12/23	114.2	Water leak testing. Charge-discharge.

RESEARCH AND DEVELOPMENT

Neptunium Irradiation Tests

The swelling of the neptunium targets which was seen during their fabrication following heating to 450 C has been determined to be caused by the release of gases entrapped in the target cores during compaction. It has been found feasible to recover the target cores by machining off the existing aluminum jackets and recanning the cores. The first recanned target did not swell when heated, but subsequent targets did. It is now planned to recan the targets and outgas at a lower temperature. It is expected that the targets will be ready for reactor charging in February.

Uncooled Horizontal Control Rods

Information received from Battelle Northwest and sample examination of a 19-9DL clad, dysprosium oxide-nickel cermet sample irradiated for seven months in KW Reactor indicates no apparent damage. A similar sample with Inconel 600 sheath material is still undergoing irradiation in KW Reactor.

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PROCESS TECHNOLOGY

Hot-Die-Sized Fuel Program

Preliminary examination of C Basin measurements of fuel elements from the D-Reactor run-to-rupture test indicates the following:

1. The average cladding weight loss of the AlSi fuel elements was about twice that of the hot-die-sized fuel elements.
2. The average frequency of fuel elements from the higher exposure tubes showing primary groove and ledge corrosion was about 37 per cent for the hot-die-sized fuel and about 32 per cent for the AlSi fuel.
3. Some of the AlSi columns appear to have been more severely attacked than any of the hot-die-sized columns.
4. Two high exposure AlSi fuel columns showed low frequency and low severity of corrosion, whereas all hot-die-sized fuel columns had at least one fuel element with severe groove corrosion.

These observations do not explain the higher rupture rate observed in the HDS fuel elements in the test. Their significance must await evaluation until data are obtained on dimensional behavior.

Zircaloy Process Tube Hydriding

The evaluation of the five tubes removed from K Reactors continues. Hot vacuum extraction analyses for hydrogen content have given the following maximum readings:

<u>Tube No.</u>	<u>Length of Exposure</u>	<u>Max. total Hydrogen, ppm</u>	<u>Max. Base Metal Hydrogen, ppm</u>
3074-KW	7 mo.	648	22
3667-KW	30 mo.	209	54
2048-KW	26 mo.	202	42
4372-KE	6 mo.	65	--
3181-KE	24 mo.	1162	91

There is a large variation (200-1200 ppm) in the amount of hydrogen absorbed by different tubes under supposedly identical conditions. The reason for this is still unknown.

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The data obtained to date indicate that the base metal hydrogen content increases linearly with time for a given case layer content, and that it diffuses into the base metal from the case layer. It appears now that the case layer formation is dependent on chemical, electrical, and physical conditions on the tube surface, while the base metal content is controlled by diffusion from the case layer.

A number of studies are being carried out in support of the K Reactor process tube zirconium hydriding investigation. Among current activities are the following:

Hydride Removal - Metallurgical samples have been inserted in the KE Reactor. The samples will expose coupons with various surface treatments. Sandblasted samples will be evaluated against control samples for the buildup of the detrimental case. Sandblasted surfaces will also be treated with heat and a chemical etch to determine if the supposedly sensitive surface of the sandblasted metal is desensitized by the treatments. Samples of metal sprayed surfaces with the surface scored with aluminum, to repeat an earlier test on reducing the galvanic couple, are included among the coupons.

Dummy Fuel Spacers - The development of a new downstream fuel column spacer has been initiated. The present aluminum spacers are suspect as providing the anode for hydriding the process tubes. A new spacer design approximately forty inches in length is under consideration. It is initially being procured in an aluminum alloy, but will lend itself to coating evaluation and the many other parameters such as handling, pickup, decontamination, storage, and alternate materials.

An aluminum dummy assembly designed to determine source impedances and current available in a zirconium process tube from a reactor rear face nozzle and part way in towards the fuel has been installed in KE Reactor. This assembly will be utilized to verify the suspected presence of galvanic currents between the dummy column and process tube. To date conclusive data from the assembly are not available, but initial current readings are substantially higher than those obtained in off-reactor tests.

Effluent Activity Data

The table below shows the average concentrations of five radionuclides in reactor effluent water samples taken during December, 1965. All units are in 10^{-12} curies per milliliter.

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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	220	17.7	6	116	420
C	124	11.6	12	126	840
D	95	7.0	8	70	298
KE	50	7.0	7	29	121
KW	234	9.6	4	109	127

Shield Protection Poison

A preliminary analysis of fringe poison loadings required to protect the reactor biological shields has been completed. These loadings reduce shield temperatures by approximately 35 per cent and correspondingly reduce shield deterioration rates. It is estimated that leakage through the side and top shields will increase by roughly a factor of two over the next five years if fringe poison loadings are used. The corresponding increase without shield poison would be approximately a factor of 25 in the shield leakage rate. In the past the fringe poison loadings have produced .25 Kg of tritium per year - an equivalent loading of thoria would produce 13 Kg/year of U-233. It is anticipated that more complete coverage, including some fringe poison at the two K Reactors, may be required in the future. Expected requirements indicate that such loadings would result in production of roughly 1.2 Kg/year of tritium or 42 Kg/year of U-233, which is approximately 45 per cent of the production from full blanket loadings at the five affected reactors.

Graphite Distortion - K Reactors

Technical assistance is continuing to the VSR channel sleeving program at the K Reactors. The enlargement of two additional VSR channels at KE Reactor has been undertaken. In VSR channel No. 58, the biological shield enlargement was completed and the thermal shield enlargement partially completed. A component failure in the prototype thermal shield boring machine drive mechanism precluded completion of the operation. In VSR channel No. 40, the biological shield enlargement was stopped due to encountering an unexpected interfering shroud ring left from initial reactor construction. The enlargement and sleeving of the channels will be completed at the next available outage, when production quality thermal and biological shield boring equipment will be utilized. The current prototype equipment will then be utilized for backup purposes.

Evaluations have been made of the sleeves installed in VSR channel No. 49 in KE Reactor earlier this year. The sleeve column is in satisfactory condition except for minor cracking of three sleeves in the upper portion of the reactor. Based on available information, it has been concluded that this cracking was caused by improper adjustment of the sleeve insertion tool. These cracks are not considered to be detrimental to sleeve utilization, and there are no plans for replacement of the cracked sleeves pending further monitoring of the channel.

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An improved two-inch borescope with modified lens and light source has been used on the upper portions of four outer VSR channels at KW Reactor to gather data on channel blockage. Only three borescope sections were available at that time, and blockages were found to be high in the one channel in which good pictures have been processed.

Horizontal Control Rod Improvement Program

Routine monitoring of the prototype flexible cooled HCR (Inconel Sheath - B_4C -Al cermet) installed in No. 2 position at KW Reactor has continued. The prototype flat aluminum HCR (extruded aluminum sheath - B_4C powder poison) installed in No. 2 position at D Reactor has also been routinely monitored. The control strength of the new aluminum rod has been found to be approximately 85 per cent of the existing rods, which is within process requirements. Both of the prototype HCRs have continued to function satisfactorily with no problem noted with either rod.

Immersion RTDs

Testing has been completed on nine sample lots of immersion RTDs which were received from the vendor. These RTDs contained 100 mg. of molecular sieve material, which had been added as a desiccant for correction of the moisture problem previously encountered with these units. Testing under irradiation, vibration, heat cycling, and heat soaking did not appreciably affect the performance characteristics of the samples. Based on the results of the tests, it has been concluded that the addition of a desiccant to the RTDs provides an acceptable solution to the moisture problem previously encountered. Production of immersion RTDs has been resumed utilizing this technique.

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RUPTURED SLUG TABULATION FOR DECEMBER 1965

Tube No.	Date Charged	Date Ruptured	Tube Power (KW)	Concentration MWD/Ton	Assigned Production Loss		Observations
					MWD	Days	
4281 C	10-9-65	12-2-65	1408	456	1961	.91	I&EE Side Hot Spot
3579 KW	9-20-65	12-5-65	1707	601	809	.19	I&EN Side Hot Spot
1378 C	10-9-65	12-23-65	1493	541	1451	.67	I&EN Side Hot Spot
4466 C	6-17-65	12-28-65	1557	745	232	.11	I&EN Overbore Side Groove Corrosion
4274 KE	11-21-65	12-30-65	187	467	1592	.36	Thoria End Mechanical Damage

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REACTOR OUTAGES (Hou

	B	C	
Charge-discharge	40.2	127.9	
Maintenance	50.4	78.9	
Rupture removal		36.3	
Water leak			
Tube replacement	6.8	16.0	
Project work			
Production tests		0.5	
Standard check	1.8	17.9	
Miscellaneous	2.0	51.1	
Total	101.2	268.6	4

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