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DATE February 3, 1965

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HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

TITLE

MONTHLY RECORD REPORT - JANUARY 1965
RESEARCH AND ENGINEERING OPERATION
IRRADIATION PROCESSING DEPARTMENT

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February 3, 1965

MONTHLY RECORD REPORT

RESEARCH AND ENGINEERING OPERATION
IRRADIATION PROCESSING DEPARTMENT

By

O. H. Greager

January 1965

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TRIPS

Name	Firm & Location	Date	Purpose
OH Greager TW Ambrose R Nilson	AEC Washington, DC	1/14-15/65	Attend ACRS Meeting
OH Greager	GE-APED San Jose, Calif.	1/29/65	Meet with APED personnel regarding information for GETHC

VISITORS

EM Chandler BB Gillies	Atomics International N.American Aviation Canoga Park, Calif.	1/7/65	Discuss NAA-115-1 and NAA-117 tests

ORGANIZATION AND PERSONNEL

	Exempt		Nonexempt		Rotational	
	Dec.	Jan.	Dec.	Jan.	Dec.	Jan.
Management & Administration	3	3	3	3	-	-
Process & Reactor Development	24	24	3	2	1	1
Process Technology	22	21	8	8	0	0
Operational Physics	13	13	3	3	1	1
Testing	20	20	26	28	0	0
	82	81	43	44	2	2

Process & Reactor Development: Barbara W. Armstrong, Secretary, resigned, 1/28/65.

Process Technology: C. G. Hough, Senior Engineer, resigned (transfer to Battelle-Northwest), 1/3/65. J. J. Denahey, MTP Trainee, transferred from CPD, 1/4/65. P. J. Hollifield, Engineer I, transferred to APED, 1/15/65.

Testing: Janice B. Persons, Secretary, rehire, 1/21/65. Maryann L. Sheldon, Secretary, rehire, 1/25/65.

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RESEARCH AND ENGINEERING

PROCESS AND REACTOR DEVELOPMENT

REACTOR FUELS

Depleted Uranium Irradiations

B Reactor. The 104 columns of depleted uranium (0.22 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 plutonium 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. Twelve monitor columns of this test are scheduled for discharge during January 1965. The total plutonium is about 1300 g/T with a 240 content of 12 per cent.

Self-Support Development

Eight columns of self-support fuel elements containing the arch-rail elements were discharged at about 400 MWD/T. Eleven columns of the test remain under irradiation with discharge scheduled for the last week of January 1965. Downstream thermocouple probe measurements on these columns continue to indicate that the arch-rail elements are performing as well as the elements with the bridge-rails.

Thoria Irradiations

All reactor fringe-zone loadings of thoria for the initial program of U-233 production have been completed. Fringe loadings for B, C, D, KE, and KW Reactors are involved. The second half-core loading of KW Reactor was accomplished during the January 4, 1965, outage. The first half-core of thoria elements charged in the KW Reactor during the November 29, 1964, outage is scheduled for discharge during the last week of January 1965.

During the December 30, 1964, outage of the KE Reactor, one column of thoria elements was discharged. This was the final column of the six-ton demonstration test. The elements were charged during the July 12, 1964, outage and had been under irradiation for approximately 128 full-reactor-power days. Elements from this column are being sent to the Radiometallurgy Laboratory for off-gas analysis and to sample for chemical analysis.

STATUS REPORT OF PRODUCTION TESTS

Test No.	Type Metal	Tubes	Reactor	Goal Exposure	Current Exposure	Remarks
IP-216-A	Normal production natural and enriched fuel elements.	97	All	Normal variable goal.		Provides for monitoring the performance of a sample of all normal production material to assist in development of a Quality Index for production fuel. Test is continuous.
IP-669-A	Depleted uranium target elements.	104	B	1400 MWD/T	700 MWD/T	Irradiation of ten tons of depleted elements for production of 18 w/o Pu-240.
IP-694-A	Depleted uranium target elements.	90	KE	1600 MWD/T	725 MWD/T	Irradiation of 12 tons of depleted elements for production of 18 w/o Pu-240.
IP-696-A	I&E self-support fuel.	12	KW	1000 MWD/T	800 MWD/T	Evaluation of arch-rail self-support fuel elements. Test elements discharged during the January 4, 1965, outage.
PITA-31	Thorium oxide target elements.	196	KW	175 operating days	70 operating days	Initial loading of thoria elements in fringe zone process tubes for production of clean U-233. Elements charged during September 30, 1964, outage.
PITA-31	Thorium oxide target elements.	168	D	165 operating days	75 operating days	Production of clean U-233. Elements charged during October 19, 1964, outage.

STATUS REPORT OF PRODUCTION TESTS (cont'd.)

Test No.	Type Metal	Tubes	Reactor	Goal Exposure	Current Exposure	Remarks
PITA-31	Thorium oxide target elements.	168	B	160 operating days	54 operating days	Production of clean U-233. 140 columns of elements charged during November 14, 1964, outage; 28 columns charged during January 7, 1965, outage.
PITA-31	Thorium oxide target elements.	168	C	165 operating days	20 operating days	Production of clean U-233. Elements charged during December 24, 1964, outage.
PITA-31	Thorium oxide target elements.	190	KE	150 operating days	17 operating days	Production of clean U-233. Elements charged during December 31, 1964, outage.
PITA-33	Thorium oxide target elements.	126	KW (core)	47 operating days	36 operating days	Production of clean U-233. Elements charged during November 29, 1964, outage.
PITA-33	Thorium oxide target elements.	131	KW (core)	47 operating days	8 operating days	Production of clean U-233. Elements charged during January 4, 1965, outage.

REACTOR ENGINEERING

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 reaction rate between graphite and carbon dioxide is well within the limits established for this test. The observed carbon monoxide (product of C-CO_2 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 CO_2 reaction. There has been no detectable change in the rate of reaction between graphite and water vapor. The helium loss rate decreased from approximately 14,000 cu ft per day before the test to approximately 7,000 cu ft per day. This is in reasonable agreement with the expected change.

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 approximately one month. The objective of these tests is 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 test results, when combined with the present theory of stack distortion mechanisms, should permit a better assessment of the ability of VSR channel liners to withstand internal stack forces.

Heat Removal Requirements Following Reactor Shutdown

A thorough review has been made of both theoretical estimates and experimental data relating to the heat removal requirements following reactor shutdown. Areas of significant conservatism have been defined and a testing program for refinement of the currently used heat removal curves is outlined.

Reactor Deactivation

DR Reactor, the first scheduled for deactivation, was shut down as planned on December 30, 1964. Fuel discharge was completed within three and one-half to four days after shutdown, and the additional heat load added to the basin from the complete discharge was about 3000 kw, as measured at the completion of the fuel discharge, which is in reasonable agreement with predictions. Process cooling water was completely shut off at midnight January 3, 1965. At that time, the the peak biological shield temperature was about 50 C, peak thermal shield temperature was about 12 C, and peak graphite temperature was about 5 C.

REACTOR PHYSICS

E-Q Loadings

KW Reactor is now fully loaded as E-Q. The charging of the second half of the core and the startup proceeded without incident. The reactivity of the second half was a little lower than predicted (∿ 2-3 mk) but this could be because of water. 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 as compared to a predominantly natural uranium loading. The operating reactivity transient in the half-and-half loading has consistently fallen within 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 for the hold at 80 per cent until saturation of short-term transients.

Test Facility Loss-of-Coolant Protection

As noted last month, loss of coolant to the four KER loops and the three KE snout assemblies would result in an excessive temperature excursion. As a result of this study, solid dummies were charged into the four KER loops and a backflow source of water from #59 crossheader was connected to the side-to-side test channels at both K Reactors. This action will provide protection against water loss in the KER loops and K Reactor test channels.

Ball 3X Replacement

Steel chain is being considered as holddown control in the production reactors where it is impossible or undesirable to insert vertical safety rods or ball shot. The reactivity effect of a short length (12 links) of plain steel chain, which had been annealed in 40 mesh boron carbide in helium atmosphere at 1800 F for 24 hours, was compared against the reactivity effect of a similar length of untreated chain in the Hanford Test Reactor. From calculations based on this and previous measurements, the relative worth of the treated chain as compared to a standard ball mixture in a four-inch square channel would be approximately 70 per cent. This may be compared to a measured relative worth of 50 per cent for an untreated chain (as compared to the steel ball mixture).

In-Core Flux Monitors

A supplement to Production Test IP-440-F was prepared and is now being routed for signatures, which will permit the continuation of testing of in-core chambers. Work is also directed to obtaining performance information regarding the 105-N in-core system and traveling wire flux monitor. The information will provide a background for establishing IPD installation needs.

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RADIOLOGICAL ENGINEERING

Radiation Control Experience

The following table, summarizing the 1964 radiation exposure experience for critical IPD classifications, is based on incomplete data. The final data processing run for 1964 personnel exposure will be made about February 1, 1965.

Classification	Total Dose	No. of Employees	Average Dose/ Employee	Maximum Dose	No. of Employees over 3 R
Radiation Monitors	188978 mR	69	2739 mR	3161 mR	7
Processing Operators	568201	214	2655	3248	10
Pipefitters	205851	85	2422	3048	1
Millwrights	167534	72	2327	3017	1

In addition, two exempt employees received doses in excess of 3 R. The maximum was 3088 mR.

Radiation Occurrences

	Distribution by Reactor and Component								
	B	C	D	DR	F	H	KE	KW	Totals
Processing		1	2	1	1				5
Maintenance		1		1					2
Research and Engineering		1							1
Totals	0	2	2	1	1	0	0	0	6

Vertical columns do not necessarily add up to indicated totals because, in some cases, a radiation occurrence is chargeable to more than one component.

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/ml.

SECRET
[redacted]

Reactor	As-76	P-32	Zn-65	Cr-51	Np-239
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

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.

Radiation Standard, Controls and Procedures

Thirty-one revised Radiation Control Standards were sent to the Production Sections for comment. These Standards are titled "Radiation Controls" in preparation for document HW-45674 REV, "Manual of Radiation Standard, Controls and Procedures," which is to replace HW-45674, "Radiation Control Standards and Procedures."

Dose Rates in the DR Reactor Block

Following shutdown of the 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 right at the end of the gunbarrels. This was 675 R/hr.

PROCESS TECHNOLOGY

PROCESS STANDARDS

HW-46000 B, Process Standards - Reactor

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

Process Standard A-050 - "Panellit System Control"

The standard was revised to provide specifications for adjusting a limited number of Panellit gauges beyond the pressure range used for calibrating the gauge.

Process Standard C-020 - "Power Level Monitoring"

The requirement for audible annunciation on insertion of reserve poison was deleted.

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

The power level where the first temperature map is required was raised. New methods for alternate monitoring of tubes with faulty temperature sensors were added.

HW-46000 D and H, Process Standards - Reactor

One standard was revised for each of these two reactors. The revision was to C-020, "Power Level Monitoring," and is identical to HW-46000 B above.

HW-46000 K, Process Standards - Reactor

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

Process Standard A-050 - "Panellit System Control"

The revision was identical to that made for HW-46000 B above.

Process Standard C-020 - "Power Level Monitoring"

The revision required withholding insertable poison during charge-discharge operations, provided specifications for shutdown flux monitoring, deleted references to hot and secondary cold startups, and required management approval for reactor startup if criticality prediction is in error by more than 50 cmk.

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

The revision required process tube temperature monitor trips to be set below the annulus boiling limit or the TAI limit, whichever is lower, rather than the previously specified "nearest 5 C incremental setting above the annulus boiling limit."

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

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

Process Standard 183-A-020 - "pH Control"

The pH range was revised to conform to the authorization contained in "Memorandum of Process Standards Relaxation No. 4-9M." Statements concerning approved chemicals and addition points were deleted since the information is contained in 183-A-030.

HW-41000 - Process Equipment Standards

One deletion notice was issued during the report period and authorized deletion of pages 2, 3, 4, and 5 of Process Equipment Standard A-010. The specifications were deleted and transferred to Process Standards - Reactor, or to Equipment Maintenance Standards as deemed appropriate.

PROCESS CHANGE AUTHORIZATIONS

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

PCA #4-103 - "Graphite Temperature Limits - C Reactor"

Authorization was given to operate approximately 40 C above the graphite temperature high limit for approximately 24 hours.

PCA #4-104 - "Seismoscope Circuit Modifications - B Reactor"

The Process Change authorized minor modifications to seismoscope circuitry to damp electrical "noise."

PCA #4-105 - "Graphite Temperature Limits - C Reactor"

The Process Change authorized operation up to 15 C above the graphite temperature high limit provided the restrictions of the PCA were met.

PCA #5-1 - "Reactor Discharge Completed Before Five Days - DR Reactor"

The specification which required that DR Reactor not be discharged in less than five days was reduced to three days. Alternate restrictions on discharging requirements were specified.

PCA #5-2 - "Confinement Fog Spray System - C Reactor"

The Process Change authorized removal of the fog spray system from service for a two-hour period during a reactor shutdown to permit tie-in of a one-inch line for use as a basin hydraulic floor sweep.

 [redacted]

PCA #5-3 - "Fissionable Material Charge in Tube 3369-C - C Reactor"

The Process Change authorized a fissionable material charge in process tube 3369-C following removal of a stuck charge which required 6500 pounds of force. Visual inspection, hydrostatic pressure tests, and probolog data indicated the tube to be satisfactory.

MEMORANDUM OF PROCESS STANDARDS RELAXATION

One memorandum was issued during the report period. This was "Supplement C to Memorandum No. 4-2M, Zone Temperature Monitor Reliability." The memorandum extended the date to January 27, 1965, for placement of the zone temperature monitor in the B Reactor safety circuit.

AUDITING

During the report period, one engineer audited conformance to Process Standards on all Processing Operations' shifts by making ten inspections at each reactor.

FUEL FAILURE EXPERIENCE

Failure Date	Tube Number	Lot Number	Type of Material	Tube Power at Failure (kw)	Exposure MWD/T	Type Failure
1/2/65	2664-D	KZ-179-C	I&E N	1374	211	SH
1/6/65	0880-H	KZ-186-A	I&E N	1333	264	SH
1/7/65	1380-B	CZ-079-C	I&E N	1398	491	SH
1/13/65	3366-C	CP-808-M	I&E NS	1598	626	EM
1/13/65	2264-D	KZ-175-A	I&E N	1261	290	SH
1/15/65	1563-D	KZ-179-C	I&E N	1149	319	SU
1/16/65	3069-C	CP-808-M	I&E NS	1486	615	EM
1/17/65	3169-C	KP-031-M	I&E NS	1553	455	EM
1/19/65	2661-D	KZ-157-A	I&E N	1321	333	SH
1/19/65	0966-H	KZ-160-A	I&E N	1345	389	SH
1/31/65	3973-B	CZ-079-C	I&E N	1245	597	SH

Legend

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

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

[redacted]

First Character

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

Second Character

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

OPERATIONAL PHYSICS OPERATION

PILE PHYSICS PLANT ASSISTANCE

Five of the production reactors operated at maximum power levels determined by bulk outlet temperature limits or external administrative limits; three (B, D, and DR) operated under internal administrative tube power limits. Operation with mixed loadings (E-D and/or F-Q) at several of the reactors has resulted in expected decreases in reactor flattening as measured by the number of effective central tubes (ECT), but actual flattening efficiency (ratio of ECT to number of active tubes) has remained close to the previous year's average. Nonequilibrium losses were somewhat higher than during the previous month, due largely to an increased frequency of shutdowns from nonequilibrium conditions.

Approximately one month's operation with the first half-core E-Q (enriched uranium-thoria) loading in the KW Reactor has been completed, with close agreement between theoretical and observed physics parameters. Initial observations with the full core (the second half was charged in early January) indicate continued good agreement.

The radial enrichment ring was moved outward at the B Reactor in an effort to improve flattening efficiency in the E-D and E-Q loadings now under irradiation. Preliminary observations indicate an increase of about two per cent in level in spite of a further potential two per cent decrease with completion of the fringe blanket loading.

The DR Reactor was shut down as scheduled on 12-30-64 as the lead reactor in the deactivation program. The shutdown and subsequent discharge were uneventful.

SUMMARY OF OPERATIONAL DATA OF PHYSICS INTEREST
FOR THE MONTH OF JANUARY 1965

Reactor	B	C	D	DR	F	H	KE	KW
ECT in January (1)	1360	1445	1490	1485	1490	1485	2425	2065
12-Month Average ECT	1445	1575	1490	1505	1485	1510	2455	2385
Recording Time:								
From:	12-17	12-17	12-17	12-18	12-17	12-17	12-17	12-16
To:	1-20	1-19	1-21	1-18	1-20	1-20	1-21	1-20

(1) Effective Central Tubes: This value is defined as pile power level divided by the average power of the ten most productive tubes in the reactor. A general decline in ECT has resulted from introduction of many nonuranium core and fringe loadings and the consequent decrease in number of active tubes. However, flattening efficiency, which is approximately the quotient of ECT and number of fuel columns, has remained fairly constant.

B Reactor - C. E. Hughey

Maximum power level was restricted by individual tube temperatures to about five per cent below the maximum allowed by the bulk outlet temperature limit; the power deficit was attributable to a sharp reduction in reactor flattening (Effective Central Tubes) occurring as a natural consequence of the recently charged fringe thoria loading. Corrective measures recommended by Pile Physics and instituted in mid-January included a modification to the equilibrium rod configuration and an extension of the flattened zone by relocation of the radial enrichment ring. Reactor potential has improved by about two per cent over that of December, and startup efficiency has improved by roughly 0.25 equilibrium day. At this rate, it appears that the cost of the prematurely discharged fuel will be repaid after roughly one month of operation; however, rate of return should be considerably accelerated in subsequent runs after operation experience allows optimum flux trimming. Similar but smaller changes are being proposed to aid in reducing the fuel rupture potential, as rupture frequency during recent weeks has been high.

C Reactor - J. R. Heald

A fringe thoria loading (PITA-31) was charged early in the report period; subsequent operation, although at the bulk outlet temperature limit, was marked by a seven per cent reduction in the number of Effective Central Tubes. The loss in ECT is a predictable consequence of the effective decrease in reactor size due to the fringe blanket. Operation throughout the report period was marked by several shutdowns, some due to fuel element ruptures in the overbored zone; despite this preponderance of nonequilibrium operation, average startup losses for the month were about 25 per cent less than the previous year's average. Calibration checks on the graphite stringer temperature recorder disclosed a general nonconservative bias, resulting in false temperature readings as much as 45 degrees below the true temperature. The problem was subsequently corrected before the next startup.

D Reactor - R. L. Miller

As a measure to counteract a recent increase in rupture frequency, an administrative tube power limit was imposed, which restricted power level to about ten per cent below normal (bulk outlet) maximum; flattening efficiency remained at the past year's average value. Spline insertion problems aggravated by a high nonequilibrium shutdown frequency resulted in an increase in average startup losses.

A block of about 100 tubes was shortened by four pieces per tube in an effort to reduce rupture frequency; other measures being contemplated include reversion to a downstream-oriented equilibrium rod configuration (contingent upon substantiating observations from very recent axial flux traverses).

[redacted]

DR Reactor - S. M. Skidmore

Terminal shutdown of DR Reactor occurred as per schedule on 12-30-64. The last six weeks of operation included a 31-day span of continuous operation followed by a final 10-day period interrupted twice by fuel element ruptures and aggravated by a sizable process tube leak; the stack was dried by operation prior to final shutdown, however. As might be expected, operating efficiency during the final report period was slightly lower than measured during the previous year, and both startup and flattening efficiency showed a small decrease. Final discharge was completed on 1-3-65, and reactor process water was valved off on 1-4-65.

F Reactor - G. C. Masche/S. M. Skidmore

Operation during the report period was nearly continuous; flattening and startup efficiency remained very near the previous yearly average. A problem of slight localized changes in coolant pressures encountered during the startup of January 2 did not cause noticeable effects on reactivity at the time nor during subsequent repeated coolant purging. A production test (PT IP-725) for operation with elevated graphite temperatures (up to a stringer temperature of 790 C) was instituted with no observed adverse effects; initial observations indicate that the accompanying reactivity increase is of the order of 1-mk as expected.

H Reactor - G. C. Masche/J. R. Langton

Operating continuity during the report period was fair. Splining techniques are being tailored to minimize downstream flux peaking and thus reduce rupture potential. Recent flattening efficiency has been about one per cent lower than the average during the previous core loading, which was the first natural uranium loading since termination of the E-N program.

KE Reactor - G. D. Baston

Operation was nearly continuous during the report period. Despite the local flux-depressing effects of the large E-D (enriched uranium/depleted uranium - PT IP-694A) block, ECT remained relatively high; the month-average value of 2425 ECT is within one per cent of the previous, pre-E-D year's average. Startup losses have been sharply reduced by complete exploitation of poison splines to facilitate turnaround; the average startup loss during the last two startups was less than half the average for the preceding 20 startups. The exposure of the depleted uranium in the E-D block is now about 50 per cent goal; current ratio of E columns to D columns is about 1.8:1.0, down from an initial ratio of 2.7:1.0.

KW Reactor - R. A. Dieterich

A shutdown to replace a weakened pigtail terminated a three-week operating period only eight hours before scheduled shutdown. Operation during that time was marked by smooth operation at full power with half of the central zone charged with the E-Q mixed loading (PITA-33). Operating reactivity

[redacted]

during the entire run was within one milli-k of the predicted excess. During the ensuing five-day outage, the second half-core was charged; startup was then achieved with a full central zone E-Q loading on 1-9-65. Initial observations indicate agreement to within two milli-k for the full core, which is quite satisfactory. Flux distribution control with the full core, as expected, has been more demanding than equivalent operation with the standard natural uranium loading, due to a larger graphite temperature coefficient of reactivity; however, the reactor is expected to be no less stable than has been successfully operated during high exposure cycles in the past, and little or no production loss should result after experience is gained from two or three operating runs. Rate of rise to equilibrium is temporarily being restricted to allow more complete definition of temperature effects and evaluation of reactor flux balance before reaching full level.

PROCESS PHYSICS STUDIES

Reactivity and Control Studies

Planning for a physics test program in connection with reactor deactivation is proceeding. A comprehensive production test is largely completed in rough draft form which will be routed in the near future for comment. It is intended that the reactor be discharged by rows from the bottom and top until a critical slab is obtained. Geometry effects of enrichment, control configurations, and the fringe poison blanket will be investigated. Bucklings characteristic of the cold "ripe" loading and "green" uranium will also be observed. A 25-tube block "supercell" in the center of the critical size slab will be used for reactivity-matching measurements of fuel and target combinations of interest to diversification planning. The test program is being proposed for the H Reactor rather than F in order to permit its completion within the current fiscal year, to provide more rod and test hole flexibility for special instrumentation and measurements, and to avoid conflicts with engineering tests planned for the F Reactor which may increase corrosion and rupture potential. The tests are being planned to be consistent with the intent of existing AEC "operating limits," thereby precluding the necessity for extensive hazards analyses and reviews.

Survey studies carried out during the report period on total control requirements included the investigation of utilizing weaker poisons in the Ball 3X system. Such an approach would appear quite feasible with current loadings in combination with use of chain controls in distorted channels, but the greater water loss effect with oxide fuels would appear to require stronger control columns.

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 thoria separations which came immediately after a plant cleanout.

[redacted]

Product Related Studies

The fringe loadings for the E-Q program have all been charged in the five continuing reactors. The C Reactor fringe was loaded late in December, the KE Reactor fringe early in January, and the final quarter of the B Reactor fringe was loaded in early January. Because higher fluxes were required for special irradiations in test holes 0065 at KE and KW, the columns adjacent to those holes have been loaded with E-metal rather than thoria. The second half of the KW core was successfully loaded early in January. PITA's are in preparation for production of the additional 30 kg's of U-233 authorized last month. This material is to be produced in two thoria cycles, supported by one E-metal cycle, in the D Reactor core and the bottom half of the KE Reactor core.

The E-D loadings in the top half of the B and KE Reactors are approximately half through their cycle. As of mid-January the E to D ratios in the B Reactor were approximately 2.3 actual compared to 1.7 predicted theoretically, and at the KE Reactor 1.9 actual compared to 2.1 predicted. Current exposures of the two loadings are in the range of 700 MWD/T. Enrichment replacement charges are being shortened in both loadings in order to avoid limiting tubes.

[redacted]

TESTING

PLANT ASSISTANCE - IPD

Corrosion Testing Facilities

TF-20 - Testing continued to determine the cause of resistance temperature detector corrosion and the effect of various coatings in preventing corrosion. Operating conditions are 120 C, 9.5 gpm and pH 6.6

Irradiated Process Tube Measurement

Wall Thickness Gauge (eddy-current type) - WTG

Reactor	No. of Tubes	Report No.	Document No.
F	65	1	RL-REA-361
B	56	2	RL-REA-466
Total	121		

Ex-Reactor Visual, Weight and Micrometer Measurement

Reactor	No. of Tubes	Tube Samples Measured	Reason Examined
D	2	41	Rupture Leaker

Critical Reactor Component Examination

On-Reactor Examination of all Front Flexible Connectors

Reactor	Date Examined	No. of Connectors with 7 or More Broken Strands
F	12-29-64	None
KW	1-4-65	6
KW (58-28 row)	1-13-65	4
B	1-18-65	None

Front Flexible Connectors Examined at 108-B

Reactor	No. of Connectors	Reason Examined
F	4	1 Leaker, 3 Reliability Program
B	5	3 Leakers, 1 Thirteen Broken Strands, 1 Suspect Damage

The six remaining snap rings on front tube sleeves on KW Reactor were examined on 12-30-64.

Zircaloy Tube Examination

The inlet and outlet flanges on Zircaloy tubes 2168 and 2169 KW were inspected as requested in PT IP-175 using the Zyglo dye check method. The inspection revealed a small blemish on the inlet flange of 2168.

Pressure Monitor System Programs

In-board Bourdon coil examination	7,228	
Non-leaking coils	7,227	(99.99%)
-average rate past two years		(99.9%)
Gauges receiving failure analysis	23	
Gauges received from Central Maintenance and examined	378	
-acceptance rate	359	(95%)
-previous month		(97%)

One gauge was removed during operation from the KE Reactor pressure monitor panel due to a Bourdon coil leak. A failure analysis confirmed the leak on the inside cap-to-plug soldered overlay.

Twenty-three spare gauges were recertified for D Reactor as more than six months had elapsed since previous certification.

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

Reactor	Tube or Channel	Motion Picture Record	Purpose*
C	4491	No	2
C	3491	No	2
C	3168	No	2
C	2691	No	2
KW	HCR#2	Yes	1
KW	2168	No	2
B	4375	No	2

*1 - Assisting Maintenance in installing blocks and liners
*2 - Routine inspection

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

Reactor	Tube or Channel	Comparison to Previous Data
C	4674	Down .04 at 21' since 1/64
KW	HCR#2	Down 1.1 at 34' since 2/64

[redacted]

[redacted]

[redacted]

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

Reactor	No. of Tubes
KE	5
B	17
C	8

TESTING AND IRRADIATION SERVICES - OTHER DEPARTMENTS AND CONTRACTORS

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

Reactor	Test Hole	Facility	Request No.	No. of Samples	Material-Purpose
KW	3C	Bare Channel	HAPO 177	4	Graphite (irradiation damage)
DR		Process Channel	HAPO 098	10	Graphite (irradiation damage)
KE	2D	Quickie	HAPO 172	3	Water (water chemical studies)
KE	2D	Quickie	HAPO 184	37	Washington Designated Program
F	ETH	Quickie	HAPO 219	12	Strontium (isotope production)
KW	4C	Snout	HAPO 243	6	Reactor materials (fast neutron damage study)
KE	2D	Quickie	HAPO 254	1	Water (water chemical studies)
KW	2A	Quickie	HAPO 254	10	Water (water chemical studies)
DR		PCCF	HAPO 254	2	Water (water chemical studies)
KW	2B	Snout	HAPO 263	1	Neutron detector (neutron detector evaluation)
DR		PCCF	HAPO 271	1	Depleted uranium (isotope production)
KW	4B	Snout	HAPO 273	1	Wave guide (neutron detector development)
DR		PCCF	HAPO 316	1	Antimony-beryllium (neutron source)
KW	2A	Quickie	HAPO 321	2	Urine (activation analysis)
KW	2A	Magazine	HAPO 119	37	Graphite (irradiation damage)
		Gamma*	HAPO 326	2	Pollycrete (radiation damage)

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

Ex-Reactor Pressurized Water Loops

TF-1 - A corrosion test to determine the effects of very high oxygen content deionized water on the corrosion of carbon steels, austenitic stainless steels and ferritic stainless steels was initiated. A test section was installed in the loop containing rear face graphite cooling system components from NPR. Modifications to TF-1 facility included an injection facility to add chemicals to the loop during operation and a sampling system involving two sampling pumps to take high oxygen content water samples. Operating conditions are 148 F, 135 psig, pH 10.0 ± 0.2

[redacted]

using lithium-hydroxide-regenerated ion column, and oxygen content 20 to 60 ppm.

TF-3 - Testing continued to provide long term corrosion data at N Reactor alternate primary coolant water conditions. Operating conditions are 560 F, 1350 psig, and pH 10.0 adjusted with lithium hydroxide.

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

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

Three NPR valves were removed from the system to be examined for ammonia stress corrosion cracking of the bronze components.

Legend

NIN1 - N Reactor, inner tube, natural, first model
KSE3 - KER loops, single tube, enriched, third model

TF-17 - Testing to determine stress corrosion cracking of 17-4 PH stainless steel in water and steam at N Reactor conditions was terminated. A new test was started to determine the corrosion rates of 27 alloys in pH 9.0 boiling water adjusted with ammonium hydroxide. Operating conditions are 85 psig and 140 F.

Borescoping - Tube 1987 in N Reactor was borescoped to monitor inner surface condition.

O. H. Greager
Manager, Research and Engineering

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DATE
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10/12/94

END