AIIM

Association for Information and Image Management
1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

HW-70520

Cover Sheet for a Hanford Historical Document Released for Public Availability

Released 1994

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

DECLASSIFIED

[redacted]
(C[redacted]ICATION)

DOCUMENT NO. HW-70520

SERIES AND COPY NO. [redacted]

DATE May 29, 1961

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

[redacted]

TITLE

RADIOCHEMISTRY FOR THE RUPTURE OF A ZIRCALOY-2 CLAD URANIUM FUEL ELEMENT IN KER-2.

☐ OTHER OFFICIAL CLASSIFIED INFORMATION

THIS MATERIAL CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U. S. C., SECS. 793 AND 794, THE TRANSMISSION OR REVELATION OF WHICH IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

AUTHOR

T. F. Demmitt

CIRCULATING COPY
RECEIVED 100D AREA
AUG [illegible] 1961
RETURN TO

[redacted]

ROUTE TO:	PAYROLL NO.	LOCATION	FILES ROUTE DATE	SIGNATURE AND DATE
T. F. Demmitt	21398	04K	AUG [illegible]	Demmitt 6/2/66

DECLASSIFIED

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

-3195-MS (7 - 55) A.E.C.-G.E.-RICHLAND, WASH.

[redacted]
(CLASSIFICATION)

[redacted]

[redacted]

DECLASSIFIED

HW-

This document classified

by JA Ayres

This document [illegible]

of 5 pages. [redacted]

DISTRIBUTION:

1. FW Albaugh
2. JA Ayres
3. LV Barker
4. JH Brown
5. RL Call
6. AC Callen
7. TF Demmitt
8. DR Dickinson
9. TW Evans
10. JW Green
11. RB Hall
12. NT Hildreth
13. WK Kratzer
14. CG Lewis
15. NR Miller
16. SL Nelson - TM Hall
17. WA Oldham
18. LD Perrigo
19. RE Trumble
20. FW Woodfield
21. 300 File
22. Record Center

May 29, 1961

RADIOCHEMISTRY FOR THE RUPTURE OF A ZIRCALOY-2
CLAD URANIUM FUEL ELEMENT IN KER-2

T. F. Demmitt

Classification Cancelled and Changed To
DECLASSIFIED
By Authority of C G - PR-2,
W A Snyder, 3-1-94.
By Jerri Maley, 3-9-94.
Verified By DK Hanson, 3-21-94

[redacted]

MASTER

[redacted]

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

RADIOCHEMISTRY FOR THE RUPTURE OF A ZIRCALOY-2 CLAD URANIUM FUEL ELEMENT IN KER-2

INTRODUCTION

During the 1600-2400 shift on August 7, 1960, the delayed neutron monitor on KER Loop 2 indicated a high coolant activity level. Sympathetic responses were also observed on the Loop 1, 3 and 4 monitors. This indicated a possible fuel element failure in Loop 2 and the KE Reactor began shutdown operations immediately.

The purpose of this report is to summarize the events pertinent to this reactor outage and to discuss the results obtained from coolant and coupon samples taken from Loop 2 after shutdown.

SUMMARY AND CONCLUSIONS

Samples were taken from the KER Loop 2 system for radiochemical analysis after the reactor was shut down. Coolant samples were taken from the loop emergency storage tank, and coupons were removed from the mockup tube for examination. The fission product concentrations in the coolant were much higher than those observed under normal operating conditions. Examination of the coupon samples indicated the presence of Np^{239}, Ru^{106} and $Zr\text{-}Nb^{95}$. These results definitely indicate that a rupture occurred in this system on August 7, 1960.

The fuel elements discharged from the loop were examined visually in the KE viewing pit. This examination did not reveal any noticeable rupture; however, a rod and two defected tube elements could not be removed from their external sleeves. Since these elements had received only a three-day exposure there was not much reason to examine them in detail. The rupture was therefore never really located. It was assumed that at least one of the elements stuck in the external sleeve had ruptured.

DISCUSSION

The fuel elements discharged on August 7, 1960, were charged in Loop 2 on August 4, 1960. The elements included in this charge were two 16-inch defected, unalloyed single tubes for rupture testing in the ETR; two 18-inch unalloyed single tubes with brazed end closures; one 9-inch 7-rod cluster and one 16-inch single rod containing small samples for rupture tests. These elements along with some coupon holders, perfs and spacers comprised the charge authorized by Production Test orders PT-IP-309-A, PT-IP-309-A, Supplement A, PT-IP-309-A, Supplement B, and PT-IP-315-A. The chronology of operation pertinent to this fuel element failure is discussed below. The following information was taken directly from "Rupture Report R-60-6", by W. A. Oldham, Coolant Testing Unit, IPD.

> "The loop was operating at 253 C, 1600 psi and 60 gpm flow. A process radiation alarm on KER-2 was received at 7:02 PM with the delayed neutron instrument scalar on the 250 counts/second range. The activity continued to increase to 40 per cent of scale and at 7:11 PM the range was changed to the 500 counts/second range on all four loops. The activity continued to increase until the scram occurred at 7:27 PM and the depressurization

[redacted]

cycle began. The strainer activity increased from 80 mr/hr before the indication to 300 mr/hr at the time of the scram. Sympathetic responses of the delayed neutron monitors on the other three loops were noted."

The fuel elements were then discharged into the KE basin. The coolant discharged from the loop with the fuel elements was not noticeably discolored. Visual inspection of the elements in the KE basin did not reveal any noticeable rupture. A rod and the two defected tube elements could not be removed from their external sleeves, however. Since these elements had received only a three-day exposure there was not much reason to examine them in detail. It was assumed that at least one of the elements stuck in the external sleeves had ruptured although the actual rupture was never really located.

Coolant Analyses

A coolant sample was drawn from the Loop 2 emergency storage tank approximately 35 minutes after depressurization was completed. The sample was subjected to radiochemical analysis to determine fission product concentrations. Since the loop coolant is diluted by a factor of at least 3 during the depressurization operation, the measured activity loadings should be considerably lower than the actual coolant loadings prior to depressurization. In addition some settling of particulate matter probably also occurred before the sample was taken. This would further reduce the solution activity prior to sampling.

Table I contains a summary of the radiochemical analysis data obtained from this sample along with data for a sample drawn from KER-4 during normal operation. The KER-4 sample was taken directly from the recirculating coolant so these analytical results are not subject to the dilution and settling effects previously discussed for the rupture sample. The KER-4 data are used as a base point since data are not available from KER-2. Loops 2 and 4 are similar systems and operate under comparable conditions.

The data in Table I were calculated to a reference time of 4 hours after the rupture occurred. This reference time is arbitrary and was selected for convenience only.

TABLE I

Radioanalysis Data For Coolant Samples

Isotope	Rupture Sample Activity (uuc/ml)	Normal Coolant Activity* (uuc/ml)
I_{total}	6,000	-
I^{131}	2,100	39
Np^{239}	950	interference
$Zr\text{-}Nb^{95}$	2,800	10
Sr^{89-90}	10,000	-
As^{76}	2,850	430
Co^{60}	19	8

* Data obtained from KER-4 courtesy of L. D. Perrigo, CSDO.

Comparison of the data in Table I shows that the fission product activity loading in the rupture sample was much higher than that normally encountered in a similar system under comparable operating conditions.

The fission products observed in the coolant during normal operation are presumed to be due primarily to fissioning and recoil of the products of the uranium impurity in the Zircaloy-2 tubes, and diffusion from the fuel elements to the coolant.

Coupon Samples

Coupons removed from the mockup tube after depressurization showed the presence on Np^{239}, Ru^{106} and $Zr\text{-}Nb^{95}$. Complete analytical data are not available at this time

Loop Radiation Levels

High activity levels were encountered in the Loop 2 components following reactor shutdown. A comparison of some of these levels with those observed during normal operation is shown in Table II.

[redacted]

DECLASSIFIED

HW-70520

TABLE II

KER Loop 2 Component Activity Levels

Component	Normal	8:00 PM	12:10 AM	9:00 AM
	(All Readings in mr/hr)			
Emergency Storage Tank	10	1500 (max)	1500 (max)	50 (avg.)
Dump Valve	35	250	150	100
Cell Background	5	20	20	17
Pump Strainer	15	110	50	35

ACKNOWLEDGEMENTS

The assistance of the Purex and Redox Analytical Operations in analyzing the samples is gratefully acknowledged. The KER-2 loop is operated by Coolant Testing Unit, IPD.

T. F. Demmitt / m.f.

Thomas F. Demmitt
Coolant Systems Development Operation
HANFORD LABORATORIES OPERATION

TFD:mf

[redacted]

DATE
FILMED
6 / 14 / 94

END