AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 1

DECLASSIFIED

HW-65977
Page 1

DISTRIBUTION

1-2. AEC-HOO: Att: AT Gifford	29. RE Hall
3. AEC-HOO: ATT: PM Midkiff	30. AK Hardin
4. FW Albaugh	31. PC Jerman
5. WK Alexander	32. WK Kratzer
6. GS Allison	33. GA Last
7. TW Ambrose	34. CG Lewis
8. JA Ayres	35. GL Madsen
9. LV Barker	36. NR Miller
10. RS Bell	37. JE Minor
11. WA Blanton	38. SL Nelson
12. RW Bown	39. R Nilson
13. JH Brown	40. WA Oldham
14. JJ Cadwell	41. RL Olsen
15. RL Call	42. GF Owsley
16. AC Callen	43. CA Priode/WG Albert
17. MA Clinton	44. T Prudich
18. WA Crossman	45. RW Reid
19. FE Dearing	46. RJ Shields
20. TL Deobald	47. RD Shimer
21. RL Dickeman	48. WR Smit
22. DR Dickinson	49. HG Spencer
23. JM Fouts	50. JT Stringer
24. FC Franklin	51. JW Talbott
25. GC Fuller	52. RE Trumble
26. SM Gill	53. FW Van Wornor
27. SM Graves	54. EE Weyerts
28. OH Greager	55. FW Woodfield
	56. HM Woods
	57. 300 Files
	58. Record Copy COPY 1 OF 1, SERIES MA

Classification Cancelled and Changed To

DECLASSIFIED

By Authority of CG-PR-2

RM Jbn 1-25-94

By Cheryl Miley 4-20-94

Verified By J. K. Harrison 4-20-94

This document consists of
5 pages.

This document classified by

W. Ambrose

July 13, 1960

IRRADIATION SUMMARY REPORT - PT-IP-288-A, EVALUATION OF SEVEN ROD CLUSTER ELEMENTS WITH MODIFIED END CLOSURES

INTRODUCTION

The objective of this report is to summarize all in-reactor operating data associated with PT-288-A. (1) This document will serve as a ready reference to the irradiation history of the fuel elements, and will record any anomalies encountered in the performance of this test.

- (1) HW-62416, "Production Test IP-288-A, Evaluation of Seven-Rod Cluster Elements with Modified end Closures", W. K. Kratzer, October 16, 1959 (SECRET).

DECLASSIFIED

DECLASSIFIED

HW-65977

Page 2

SUMMARY

The seven seven-rod cluster elements irradiated in this test operated at a charge power of approximately 530 KW. The maximum surface temperature of the downstream fuel element was greater than 300°C while uranium core temperatures were approximately 430°C. Element power was approximately 75 KW/element or rod specific powers of 13 KW/ft of uranium. The above condition incurred 70% of the operating experience. High power and high temperature operation occurred in about 10% of the operating experience and 7% of the operation occurred at high power and low temperature.

DISCUSSION

The hot-headed end closure⁽²⁾ on coextruded Zircaloy-2 jacketed fuel rods provides a closure technique in which the uranium fuel rod is bonded over most of the end and two welds are employed between the uranium and the coolant. In contrast, the current end closure technique utilizes an unbonded end cap and a single weld. The purpose of this test was to provide initial irradiation of fuel element rods using the hot-headed closure technique. The test was charged on October 13, 1959, and discharged on May 14, 1960. This report summarizes the irradiation history of this test.

TEST DETAILS

1. Fuel Elements

The fuel elements consisted of seven 0.593 inch diameter rods with 0.020 inch Zircaloy-2 jackets. The rods were supported at the ends with spark machined Zircaloy-2 spiders arranged in a cluster with 0.071 inch clearance between rods. The uranium length is 11.3 inches per rod yielding a fabricated fuel element over-all length of 12.0 inches.

2. Loading

The loading consisted of thirty eight-inch spacer elements downstream of the seven seven-rod cluster elements, with sixteen eight-inch spacer elements upstream. The actual position of the elements appears in Appendix I. The cluster elements were irradiated in the high temperature recirculating KBR Loop-3.

OPERATING CONDITIONS

The coolant was pressurized water of pH between 4.5 - 11.0 at a normal operating flow of 60 gpm and a normal pressure of 1600 psig. The desired operating conditions were requested in Figure I of the original test document⁽¹⁾.

The following data are presented in tabulated form for sake of clarity. The data for only fuel element numbers 1, 4, and 7 appear, as the charge was centered in the reactor and little error will be incurred in interpolating between these points. Appendix II presents the general operating conditions of the entire charge.

Appendix III tabulates the most frequently occurring (mode) operating conditions of the test elements. Since 20% of the operating history was nonequilibrium or

(2) HW-61233, "A Process for Nuclear Fuel Element End Closures", G. S. Allison et al., June 23, 1959 (CONFIDENTIAL-UNDOCUMENTED).

DECLASSIFIED

HW-65977
Page 3

low temperature operation, the mean operating condition of the entire test has little actual meaning. The data presented in Appendix III is essentially the mean of the equilibrium operation. Approximately 70% of the operating time occurred at these conditions.

Appendix IV illustrates the test conditions at the highest power and temperature operation observed for a significant period. Approximately 10% of the operating experience occurred at or above the conditions listed.

The initial thirteen days of operation occurred at high power and low temperature. Appendix V includes the data for a representative case for this condition. The remaining 13% of the operating experience occurred during startup.

Limits of Errors in the Presented Data

A Cosine flux distribution was assumed for this calculation.

The power splits are known to be within $\pm 5\%$ of the calculated values. Approximately ± 10 to $\pm 20\%$ error is expected in the thermodynamic calculations and a comparable error is suggested for the thermohydraulic calculations. All indications point to an over-all value of $\pm 20\%$ for the largest expected error.

Unusual Operating Conditions

1. The initial thirteen days of operation occurred at high power and low temperature in order to evaluate the oxygen content of the loop. During this time the coolant had a low pH value.
2. At the conclusion of 1) LiOH was added to increase the pH to approximately 10.
3. On November 16, 1959, the outlet temperature thermocouple housing failed causing rapid depressurization of the loop.
4. During the residence period of this test the reactor was scrammed eleven times and the loop was on process water seven times.

W. K. Kratzer
Reactor Fuels
Process & Reactor Development
Research and Engineering Section
IRRADIATION PROCESSING DEPARTMENT

D. W. Peacock
Reactor Fuels
Process & Reactor Development
Research and Engineering Section
IRRADIATION PROCESSING DEPARTMENT

WKE:DWP:gb

DECLASSIFIED

Page 4

APPENDIX I

Fuel Element Position and Identification

Fuel Element number	1	2	3	4	5	6	7
Distance from End of Active Zone (inches)	208	194	182	170	158	146	134
Fuel Element Identification	U-1 W-10 W-6 T-2 U-6 R-7 K-7	E-5 W-2 W-5 U-7 L-4 W-3 T-3	X-2 X03 U-8 M-2 R-9 R-5 D-3	U-2 X-5 B-7 U-3 K-8 T-1 D-3	D-1 D06 B-6 S-4 K-6 C-2 U-9	C-4 S-2 X-7 M-6 K-2 K-5 U-7	M-7 U-4 T-4 U-8 W-2 C-5 U-5

APPENDIX II

General Operating Data

Charge Date 10-30-59 HAPO Charge Date 5513
Discharge Date 5-14-60 HAPO Discharge Date 5710
Days in Reactor 197
Days of equilibrium operation at temperature
(outlet temperature greater than 200°C) 156
Days of non-equilibrium and or low temperature operation 41
Tube Exposure 2174 MWD/T
Element Exposure
Fuel Element 1 2111 MWD/T
Fuel Element 4 2215 MWD/T
Fuel Element 7 2111 MWD/T

APPENDICES III, IV, V

Operating Conditions

	<u>Appendix III</u> <u>Normal Operating Conditions</u>			<u>Appendix IV</u> <u>High Power - High Temp. Case</u>			<u>Appendix V</u> <u>High Power-Low Temp. Case</u>		
) Tube Power (KW)	577			648			629		
) Power from the graphite (KW)	47			48			94		
) Charge Power (KW)	530			600			535		
) Mass Flow (lbs/hr)	27,500			27,600			29,800		
) Outlet Temperature (°C)	270			268			96		
) Inlet Temperature (°C)	230			223			54		
	<u>Fuel Element Number</u>			<u>Fuel Element Number</u>			<u>Fuel Element Number</u>		
	<u>1</u>	<u>2</u>	<u>7</u>	<u>1</u>	<u>4</u>	<u>7</u>	<u>1</u>	<u>4</u>	<u>7</u>
) Element Power (KW)	73.5	77.0	73.5	83.2	87.3	83.2	73.4	77.2	73.4
) Rod Specific Power (KW/ft of U)	10.8	11.4	10.8	12.6	13.3	12.6	10.9	11.5	10.9
) Heat Flux (BTU's/hr-ft ²)	253,000	265,000	253,000	287,000	301,000	287,000	256,000	268,000	256,000
) Local Water Temp. of the limiting channel *(°C)	238	265	290	232	272	291	63	90	117
) Fuel Element Surface Temp. of the limiting channel (°C)	259	286	310	256	296	313	101	123	144
) Uranium core temperature (°C)	382	416	433	400	447	457	225	254	268

*The inner surface of an outer rod.

DATE

FILMED

9 / 23 / 94

END