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EXPOSURE OVERBORE ELEMENTS
(RM 410)

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POST IRRADIATION EXAMINATION OF LOW
EXPOSURE OVERBORE ELEMENTS
(RM 410)

by

W. J. Gruber

Radiometallurgy Laboratory
Materials Development Operation
REACTOR AND FUELS RESEARCH AND DEVELOPMENT

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POST IRRADIATION EXAMINATION OF LOW
EXPOSURE OVERBORE ELEMENTS
(RM 410)

INTRODUCTION

Two overbore dingot elements with low exposures were submitted to the Radiometallurgy Laboratory for examination to aid in determining the irradiation behavior of overbore elements.

Fuel Element Histories

Production Test	PT-IP-381-A	PT-IP-381-A
Tube and Reactor	0954-C	1494-B
Lot and Fuel Type	WX-001-A	WX-001-A
Series & Piece #	97W-17	96W-18
Date Charged	1/17/61	1/17/61
Date Discharged	4/30/61	2/25/61
Exposure	402 MWD/T	168 MWD/T

SUMMARY AND CONCLUSIONS

The uranium OD increased about 20 mils in 97W-17 and 12 mils in 96W-18. The ID did not change.

Remaining cladding thicknesses of 97W-17 were 37 mils minimum and 41 mils maximum external, and 42 mils minimum and 44 mils maximum internal, exclusive of Al Si.

Remaining cladding thicknesses of 96W-18 were 35 mils minimum and 43 mils maximum external, and 36 mils minimum and 45 mils maximum internal, exclusive of Al Si.

Metallographic examination disclosed small grains to a depth of about 10 mils on the internal surface of the uranium in both elements.

The spire bond in 97W-17 was cracked completely around the spire.

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DETAILS

The elements were visually examined and photographed (Figure I). Both elements appeared to be in excellent condition. About one fourth of the external surface film was gone, indicating that corrosion may have occurred. The film on the piece with higher exposure was much darker.

Initially a wafer was sectioned from the midpoint of piece #96W-18 and the OD of the cladding, OD of the fuel, ID of the fuel, and ID of the spire were obtained. When this data was relayed to IPD personnel it was requested that micrometer measurements be taken of the ends of #96W-17 and at three points along the length of #97W-17. The micrometer readings appear in Table I.

An additional wafer was sectioned from piece 96W-18 between the male end and the midpoint, and one wafer was sectioned from the midpoint of #96W-17. Lines indicating where sections were made have been drawn in Figure I.

The cladding OD, uranium OD, uranium ID, and spire ID of each wafer were measured optically along perpendicular diameters and appear in Table I and are correct to ± 0.003 inch. For reference the wafers from piece 96W-18 were prefixed A and the wafer from 97W-17 was prefixed B.

The external and internal cladding and Al-Si thicknesses were measured by using a Filar eyepiece in the remote metallograph and appear in Table III.

The wafer from the midpoint of each element was cathodically etched and examined (Figure II). The internal surface metal was extremely fine grained to a depth of about 10 mils and the compound layer in the spire Al-Si of 97W-17 was cracked completely around the spire (Figure III). The external bond in 97W-17 and both the internal and external bond in 96W-18 were in good condition.

W. J. Gruber
W. J. Gruber, Engineer
Radiometallurgy Laboratory

WJG/nat

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TABLE I

DIAMETER MEASUREMENTS OF ELEMENTS AS RECEIVED

Measurements were made 45° apart with an in-cell micrometer to obtain four diameter readings around the periphery at each location.

PIECE 97W-17

	0°	45°	90°	135°
3/4" From Male End	2.003	2.004	2.004	2.003
Midpoint	2.004	2.005	2.004	2.004
3/4" From Female End	2.004	2.004	2.003	2.003

PIECE 96W-18

	0°	45°	90°	135°
3/4" From Male End	2.001	2.002	2.003	2.003
Midpoint	*2.005		*2.004	
3/4" From Female End	2.003	2.003	2.002	2.002

PRE IRRADIATION MEASUREMENTS

	Piece 97W-17		Piece 96W-18	
	Maximum	Minimum	Maximum	Minimum
3/4" From Male End	1.987	1.982	1.990	1.984
Midpoint	1.991	1.986	1.992	1.989
3/4" From Female End	1.991	1.989	1.994	1.990

*Optical measurements from a wafer from the midpoint of piece #96W-18

TABLE II
CLADDING AND FUEL DIAMETERS

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WAFER NUMBER	DIAMETER	CLADDING OD	URANIUM OD	URANIUM ID	SAFE ID
A-2	0° 90°	2.005 2.004	1.896 1.901	.456 .457	.341 .342
A-3	0° 90°	2.005 2.004	1.898 1.868	.453 .457	.346 .347
B-1	0° 90°	2.006 2.003	1.905 1.902	.455 .456	.347 .346
(1)		(2)	1.883 $\pm .001$ - .002	0.452 $\pm .004$	.339 $\pm .003$
1. Pre Irradiation Specifications from H-3-7350, Rev 9 2. Refer to Table I for pre-irradiation cladding OD					

TABLE III
CLADDING AND AL-SI THICKNESSES $\times 10^{-3}$ INCHES

WAFER NUMBER	EXTERNAL CLADDING (1)		INTERNAL CLADDING (1)		EXTERNAL Al - Si		INTERNAL Al - Si	
	Max	Min	Max	Min	Max	Min	Max	Min
A-2	43.1	36.0	45.3	36.6	15.0	9.0	23.4	3.5
A-3	41.6	34.4	41.6	35.6	19.1	9.78	21.6	6.7
B-1	41.5	36.7	44.0	42.3	15.0	6.5	18.0	3.2

1. Readings do not include Al-Si

FIGURE I

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FUEL ELEMENTS AS RECEIVED
PIECE 97W-17

A 3763

0.6X

A3762

Side Opposite A 3763

0.6X

PIECE # 96W-18

A 3756

0.5X

A 3755

Side Opposite A 3756

0.5X

The lines indicate where sections were made and the wafers have been indexed

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FIGURE II
ETCHED WAFERS

97W-17
2X

A 4265

96W-18
2X

A 3974

The area at the upper right is the result of the cathodic etch not completely covering the surface

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FIGURE III
METALLOGRAPHY

A 3998 96W-18 250X
Fine grain in U at Internal Surface

A 4280 97W-17 250X
Typical appearance of cracked
spire bond

A 3992 96W-18 250X

A 4278 97W-17 250X

Typical structure of the uranium cathodically etched
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