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POST IRRADIATION EXAMINATION
OF ELLIPTICAL FUEL ELEMENT
(RM-416)

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W. J. Gruber

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W. J. Gruber

March 1, 1961

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POST IRRADIATION EXAMINATION OF ELLIPTICAL FUEL ELEMENT

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INTRODUCTION

During the post-irradiation measuring of fuel elements from PT-IP-262A by Component Testing Operation, Irradiation Processing Department, one element exhibited 0.069 inch of diametric ellipticity. The element had been fabricated from natural uranium, clad in X-8001 aluminum alloy, and was internally and externally cooled during irradiation. The element was selected for detailed examination to determine the cause of the distortion and was transferred to the Radiometallurgy Laboratory in January, 1961.

Fuel Element History:

Lot and Fuel Type	●	KL-465-D
Tube - Reactor	●	3582-D
Series and Piece Number	●	50U - #12
Date Charged	-	May 13, 1960
Date Discharged	-	November 12, 1960
Average Tube Exposure	●	1246 MWD/T

SUMMARY AND CONCLUSIONS

Growth in the radial direction over the total length in one quadrant of the fuel was the cause of the distortion. Maximum ellipticity of the uranium was 0.037 inch. Corrosion of the cladding corresponding to the minor axis of ellipticity made the distortion appear more severe.

The uranium had grown away from the spire braze layer over a three-inch length in the central portion of the element and at the point of maximum ellipticity approximately 110° of the angular distance around the spire contained a gap.

Grains in the uranium were larger in the area adjacent to the spire gap than in the remainder of the piece. Two possible causes are:

1. A pocket of large grained, oriented uranium existed in the element when it was canned.
2. Oriented uranium caused growth which separated the bond. The uranium insulated by the gap became hot enough that localized grain growth occurred.

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DETAILS

The element was photographed as received and visually examined (Figure I). The distortion was visible to the eye. Corrosion on one side of the element opposite the ribs was the only other abnormal feature observed.

The element was sectioned at the maximum point of ellipticity, three-fourths inch from the midpoint in the male half of the piece. A wafer was removed downstream and a longitudinal section upstream from the initial section. Another wafer was removed one inch from the female end for comparison.

The maximum ellipticity of the uranium was 0.037 inch. There was 0.012 inch of ellipticity in the uranium one inch from the female end. The major and minor axes of ellipticity in the element nearly corresponded with diameters through the ribs. A complete list of measurements may be seen in Table I. Diameter measurements were made with a telescope and cathetometer. A Filar eyepiece was used with the metallograph to measure cladding thicknesses and the gap between the spire and fuel.

Additional sections were made to determine the extent of the spire-uranium gap. The gap terminated at approximately two and one-half inches from the male end and three and one-half inches from the female end.

The two measured wafers and the longitudinal section were cathodically etched (Figure II). Large grains were observed in the area adjacent to the gap. Part of the bond layer was seen on the inner surface of the uranium at the gap which showed that spire and fuel were bonded at fabrication.

W. J. Gruber, Engineer
Radiometallurgy Laboratory
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TABLE I

A. Diameters of section through maximum ellipticity:

	Canwall OD	Uranium OD	Uranium ID	Spire and ALS1 OD	Spire ID
D1	1.484	1.393	.448	.433	.327
D2	1.430	1.356	.419	.419	.317

The minimum cladding thickness was 25.4 mils in the area of corrosion. Nominal cladding thickness in the remainder was 39 mils. The nominal gap between the spire and uranium was 15 mils with a maximum of 25 mils.

B. Diameters of section one inch from female end:

	Canwall OD	Uranium OD	Uranium ID	Spire ID
D1	1.457	1.369	.431	.327
D2	1.449	1.356	.425	.324

Nominal cladding thickness was 40 mils.

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FIGURE I

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A1760
Top of the element opposite the ribs.

.7x

A1759
Side of the element. One rib mark can be seen. Lines indicate where sections were made.

.7x

A1909

1.75x

Wafer from area of maximum ellipticity. The photograph is oriented so that the top and bottom are in perspective. The gap where the fuel "grew" away from the spire is plainly visible.

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FIGURE II

A1935

1.75x

A2042

1.3x

Cathodically etched sections in the area of maximum ellipticity. The line references the longitudinal section.

A2137

3.2x

Cathodically etched section one inch from female end

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AIM

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