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By Authority of RM-6tenCG-PR-2, 3-10-94By C. E. Savelly 4-1-94Verified By D. K. Hanson 4-15-94EXAMINATION OF RUPTURE FROM 1372-H (RM 454)INTRODUCTION

A production fuel element which failed in tube 1372-H on March 12, 1962 at 263 MWD/T exposure was transferred to the Radiometallurgy Laboratory for examination to determine the cause of failure. The fuel geometry was O III N-B and the parent Lot was KZ-135 D.

SUMMARY AND CONCLUSIONS

The failure was the result of mechanical damage to the cladding and cap at the male end prior to irradiation. A scrape or gouge at the male end reduced the cladding thickness drastically so that water entry to the uranium occurred after an incubation period of operation. Fabrication was not a factor in the failure as the male weld was found to be in good condition when metallurgically examined.

DETAILS

The element as received may be seen in Figure I. The mechanical damage on the cap in line with the rupture cavity was plainly visible. The formation of aluminum oxide over the marred surface indicated that the damage occurred prior to irradiation. The cladding was missing from over the rupture cavity and the fragments attached to the edge of the cap were extremely thin. It is possible that the entire cladding thickness was removed by the mechanical damage prior to or during charging. A diagonal split in the uranium emanating from the cavity isolated a small section of the fuel at the male end (see as received photos). Subsequent examination indicated that the split was the result of internal stress caused by the formation of voluminous uranium-water reaction product. Negligible corrosion of the cladding and supports was noted. The surface of the internal annulus was visually examined with a macroscopic viewer. The spire has partially parted in tension along the crack in the fuel indicating a good spire bond. No

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evidence of corrosion or other damage was observed in the remainder of the spire surface.

The element was sectioned to remove the cap. The rupture cavity extended into the uranium nearly to the spire.

The cap was cleaned in nitric acid and the weld was examined visually. No defects were seen. The cap was ground until the weld metal was removed and there were no voids in the Al-Si under the weld. The mechanical damage can be clearly seen in the photographs of the cap after sectioning and cleaning.

W. J. Gruber, Engineer
Radiometallurgy Laboratory

WJ Gruber/lhl

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FIGURE I

B 764 Rupture Cavity and Split

0.6X

B 766 Side Opposite the Rupture

0.6X

B 842 Oblique View of Element

1X

Note the mechanical damage to the cap in the oblique view.

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FIGURE II

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B1109

2X

B 1398

2X

Photograph at left shows the cap after cleaning to remove the film.

The photograph at the right shows a cross section of the cap just under the weld. Note that there are no voids or pin holes in the Al-Si.

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