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RADIOMETALLURGICAL EXAMINATION OF DIRECT CAST CORE FUEL ELEMENTS, PT-IP-93, (RM-318)

by

R. Teats

November 12, 1959

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RADIOMETALLURGICAL EXAMINATION OF DIRECT CAST CORE FUEL ELEMENTS, PT-IP-93, (RM-318)

INTRODUCTION

Two of the direct cast core I & E fuel elements irradiated in C Reactor under PT-IP-93 were received at the Radiometallurgy Laboratory for examination during July 1959. One of the elements was badly warped and distorted while the other of the same series had remained relatively unchanged. Both pieces had received an average exposure of 689 MWD/T.

SUMMARY AND CONCLUSIONS

Warp and diameter measurements show that the one element had warped approximately .040" and had become distorted in two longitudinal planes at the male end. The distortion planes are at right angles which gives the transverse section a square appearance.

A comparison of the grain size from three positions along the warped element with a section cut from the unwarped element revealed a greater number of large grains in the zones of highest distortion. The maximum size grains, were in the order of 2.5 mm - 3.8 mm vs normal .2 mm. Also prevalent in all sections examined was a columnar type grain structure around the outside periphery. It is evident that the pre-irradiation heat treatment failed to refine the grain size sufficiently to prevent non-uniform growth of this element during irradiation.

No particular damage was found to the canwall or the bonding at the most badly distorted section; however, it was found that the bonding layer was broken completely around the inner spire.

A corrosion pit was noticed in the canwall of the second element that had penetrated 40% of the canwall.

DETAILS

Optical diameter and warp measurements were made on both elements as received. The warp was measured as a deviation from a straight line along one edge of the element. On element #9, the badly distorted piece, a maximum warp of .041" was found in what appeared to be the most severely warped plane. The maximum diameter in this plane was 1.533". Diameter measurements of a transverse section 2" from the male end gave a maximum of 1.521" and a minimum of 1.419". The maximum diameter of a transverse section from the center of the element #9 was 1.485" and at 2" from the female end, the maximum diameter was 1.465". The major non-uniform growth was confined to 4" at the male end of the element.

On element #7 the maximum warp found was .011" and the maximum diameter was 1.479". There was no visible diametral distortion noticed on this piece.

Three transverse sections were removed from element #9: one at 2" from each end and one from the center. After some difficulties, a technique was developed that gave a good cathodic etch of the uranium across the entire diameter. Examination of the macro-etched uranium sections revealed a greater number of larger grains in the highly deformed section.

A section from the male end of element #7 showed only a few large grains. All sections examined had some columnar grains around the outside periphery. The largest uranium grains as scaled from the photomacrographs were of the order of 2.5 mm - 3.8 mm. From the pre-irradiation examination of these cores by R. S. Kemper (1) it was shown that the grain size of the sections nearest the top of the casting was consistently larger than the bottom sections. This would explain the larger grain size found in the male end of the warped element.

The transverse section from the male end of element #9 was examined to determine if there was any damage to the canwall or to the bonding at the point where the maximum distortion had occurred. No particular damage to the canwall or bonding was found; however, it was found that the bonding on the inner spire was broken completely around the inner hole.

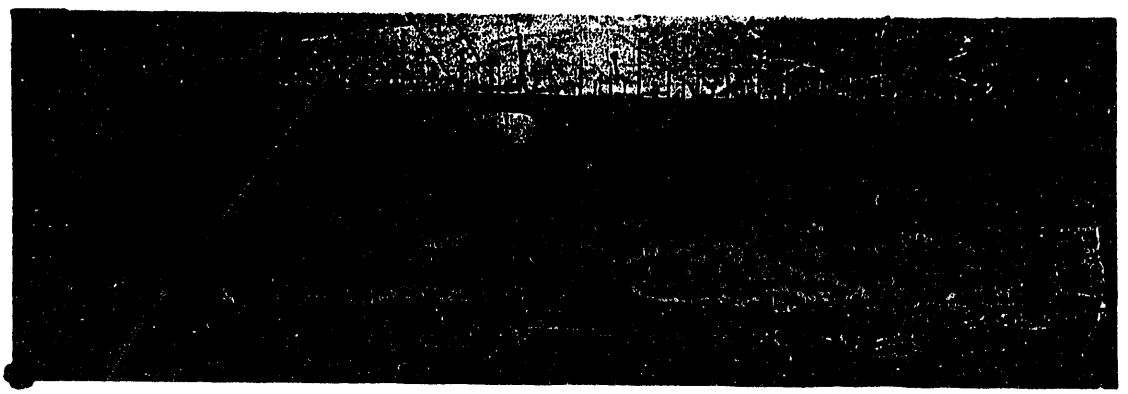
During the examination a small corrosion pit was noticed in the canwall of element #7. The pit was surrounded with a halo which resembled very closely the inclusion type corrosion attack which is often found after the autoclave test. A transverse cut was made through the pit and examination showed that the corrosion had penetrated 40% of the canwall thickness.

(1) Reference: HW-58554 - Metallurgical Examination of Direct Cast I & E Fuel Cores

R. Teats

R. Teats Engineer
Radiometallurgy Laboratory
MATERIALS DEVELOPMENT OPERATION

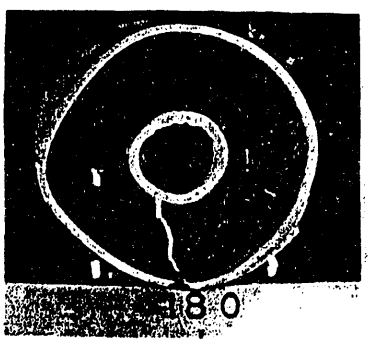
Neg. #12299 2/3X
Element #7



Neg. #12289 2/3X
Element #9

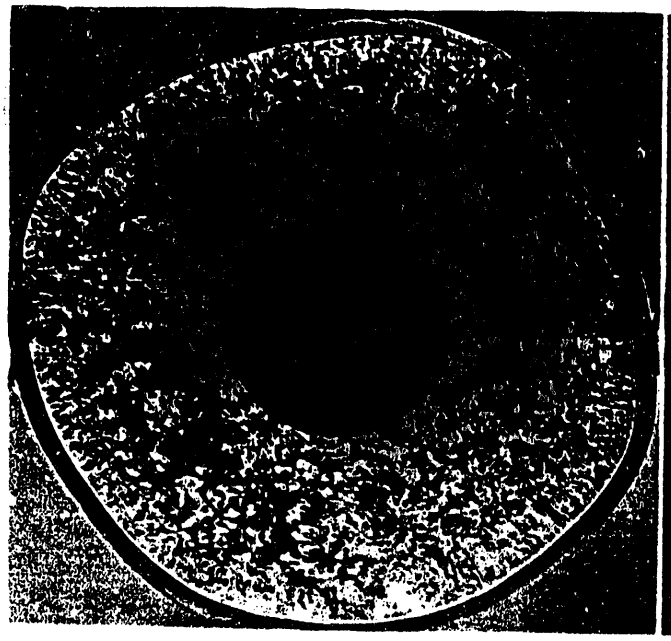
[redacted] as Received. [redacted] Element [redacted] from Right End [redacted]

[redacted] section at 9" from [redacted] end of Element #9.

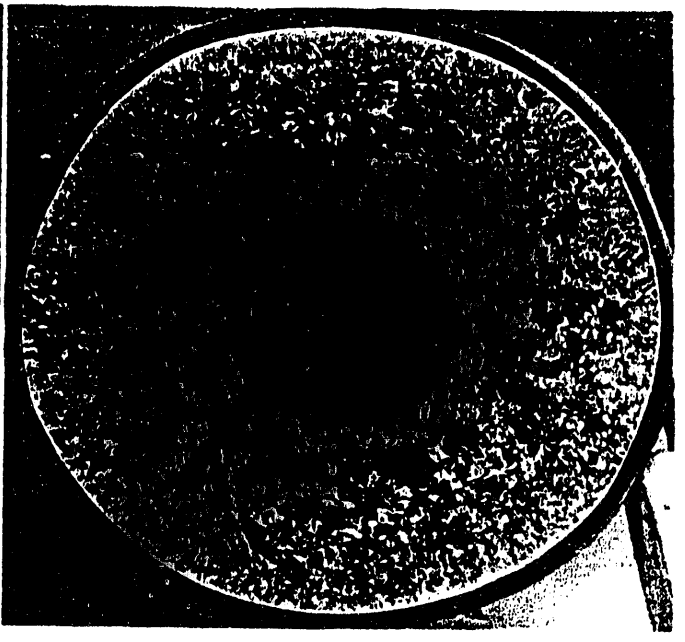


Neg. #12333 Actual Size

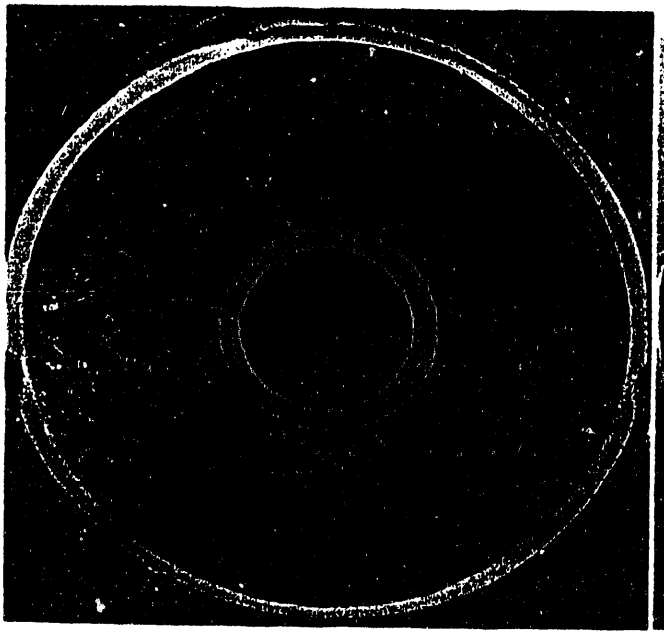
UNCLASSIFIED



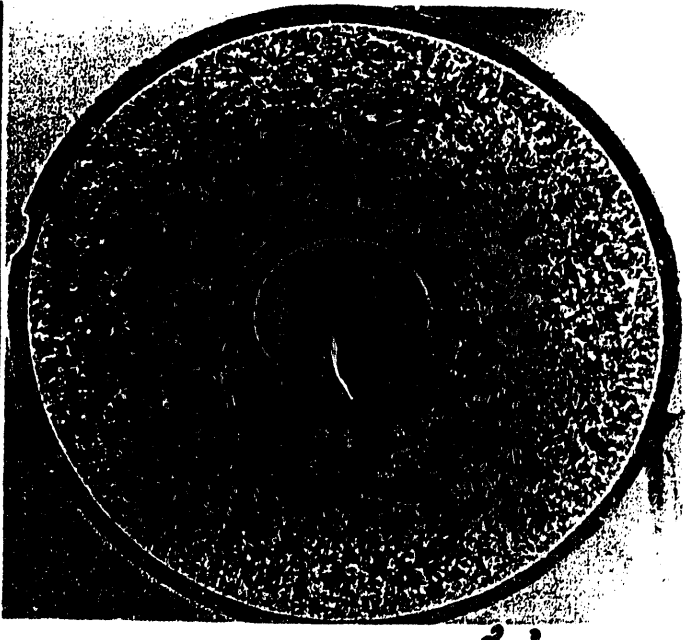
Neg. #12099 2.3X
Transverse section from male end of element #9.



Neg. #13100 2.3X
Transverse section from center of element #9.



Neg. #12776 2.3X
Transverse section from female end of element #9.



Neg. #13153 2.3X
Transverse section from male end of element #7.

DATE
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10/27/94
END