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SUBJECT: Metallographic Examination of L6Z-114
In-Pile Autoclave Pins

TO: A. R. Olsen

MASTER

FROM: A. E. Richt

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Intra-Laboratory Correspondence
OAK RIDGE NATIONAL LABORATORY
Solid State Division

To: A. R. Olsen

Date: February 5, 1958

From: A. E. Richt

Subject: Metallographic Examination of L6Z-114
In-Pile Autoclave Pins

Introduction

During the examination of the pins from in-pile autoclave L6Z-114, it was noted that each of the double-notched pins exhibited areas of increased corrosion while the exact duplicate single-notched pins did not. A request for metallographic examination was made to determine if structural variations between the single and double notched pins might be responsible for the variation in corrosive susceptibility.

The pins identified as L6Z-114 S, L6Z-114 SM, L6Z-114 M, and L6Z-114 MM were fabricated from HRP No. 1202 Zircaloy-2 stock. The "S" and "SS" pins were exposed in the as-machined condition, the "M" and "MM" pins were pickled before exposure. The pins identified as L6Z-114 L and L6Z-114 LM were fabricated from HRP No. 56, a Zr-1.5% Sn-15% Nb alloy. Fabrication and heat treatment for these pins was not specified. All pins were exposed for 150 hours at 250°C and 16 hours at 280°C in a 0.17 m UO_2SO_4 , 0.02 m CuSO_4 , 0.1 m HNO_3 solution. Weight loss data for these pins was not reported.

Results

The typical appearance of the surfaces of the four Zircaloy-2 pins is shown in Figs. 1 and 2. Figure 3 shows the structure of the

specimens more clearly at a higher magnification. As can be seen in the photographs, some structural variation was noted between the two pairs in that the "S" specimens show some evidence of cold work near the exterior surface (as noted by the marked twinning in this region), whereas the "M" specimens do not. The surface of the "M" specimen also showed evidence of very slight surface roughening whereas the surface of the "S" was relatively smooth with a slight undulating characteristic. Pin L6Z-114 S showed no evidence of corrosive attack, the surface having a slight undulating characteristic with no evidence of corrosive pitting. Pin L6Z-114 SM had essentially the same characteristics with the exception of slight ($< \frac{1}{2}$ mil) pitting noted near the cut end. Pin L6Z-114 M exhibited a relatively even surface with evidence of very slight surface roughening. The surface of pin L6Z-114 MM showed slightly greater roughening except for the rounded tip, which was very smooth.

The typical appearance of the surface of pin L6Z-114 L is shown in Fig. 4. The surface was smooth, showing a very few scattered pits of less than $\frac{1}{2}$ mil depth along the sides of the pins. Pin L6Z-114 LM showed severe pitting of over 4 mils in depth for a distance of approximately $\frac{1}{4}$ inch from the cut end, as shown in Fig. 5. The structure of these pins is shown in Figs. 6 and 7. Although there is some difference in the amount of the stringered phase between the two specimens, the nature and type of corrosive attack noted does not appear to be dependent upon this variation.

Summary

Although a slight structural variation between the two pairs of Zircaloy-2 pins was noted, both pins of anyone pair were essentially

identical in structure and thus the noted difference in corrosive attack cannot be attributed to this factor. This slight variation in structure (i.e. - evidence of cold-work near the exterior surface and surface characteristics) can probably be attributed to the fabrication procedure (i.e. - machined vs. machined and pickled). The Zr-1.5% Sn-15% Nb pins varied slightly in the amount of a stringered second phase present but the type of corrosive attack noted did not seem dependent upon this variation.

TABLE I

Summary of Metallographic Results - L6Z-114 Pins

Pin No.	Surface Appearance
L6Z-114 S	Smooth, undulating - no pitting noted.
L6Z-114 SM	Smooth, undulating - $< \frac{1}{4}$ mil pits near cut end.
L6Z-114 M	Even, very slight surface roughening.
L6Z-114 MM	Slight general surface roughening except for rounded tip which was very smooth.
L6Z-114 L	Smooth, even - a very few $< \frac{1}{4}$ mil deep pits on sides.
L6Z-114 LM	Heavily pitted to over 4 mils near cut end - a few shallow pits on rounded end.

RMG 2072

Pin L6Z-1145

250X

RMG 2073

Pin L6Z-114 SM

250X

Fig. 1

RMG 2074

Pin L6Z-114 M

250X

RMG 2075

Pin L6Z-114 MM

250X

Fig. 2

RMG 2976 L6Z-114 S 500X

RMG 2077 L6Z-114 SM 500X

RMG 2078 L6Z-114 M 500X

RMG 2079 L6Z-114 MM 500X

Fig. 3

Structure of L6Z-114 Autoclave Zircaloy-2 Pins

RMG 2080

Fig. 4

250X

Pin L6Z-114 L

RMG 2081

Fig. 5

250X

Pin L6Z-114 LM

RMG 2082

Fig. 6

250X

Pin L6Z-1114 L (End)

RMG 2083

Fig. 7

250X

Pin L6Z-1114 LM (End)