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September 1964

MASTER

OUTER REFLECTOR SECTOR LENGTH VARIATION TEST (EML-45)

(Title Unclassified)

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Astronuclear Laboratory
Westinghouse Electric Corporation

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1.0 SUMMARY

Stresses developed in the nozzle and dome end support rings as a result of tightening the tie bolts during reactor assembly were found to be relatively low. Although the magnitude of these stresses was affected by the differences in the lengths of adjacent sectors, they were not excessive for length variations as large as 0.020 in. The maximum stress for this condition was only 11,800 psi compared with a yield strength of 95,000 psi for the titanium support ring.

2.0 INTRODUCTION

The outer reflector sectors are "sandwiched" between the nozzle end and dome end support rings as shown in Figure 1. Since the sectors butt against the faces of the rings and are clamped between them under tie bolt tension loads, any mismatch between adjacent sectors results in bending stresses in the rings when the tie bolts are tightened.

To insure against high stresses developing in the support rings during the tie bolt tightening operation, sector length variation has heretofore been limited, by tolerances specified on the manufacturing drawings, to 0.0005 in. for any twelve sectors which make up any one reactor.

3.0 PURPOSE OF TEST

Since the sector length matching problem is both costly and troublesome, this test was conducted to determine if sectors with greater variations in their lengths could be used without developing excessively high stresses in the support rings.

4.0 CONCLUSIONS

Sector length variations as great as 0.020 in. can exist between adjacent sectors without causing excessively high assembly stresses in either the nozzle or dome end support rings. Consequently the extremely close tolerance of 0.0005 in. which has been specified for matching the lengths of the twelve sectors which make up the outer reflector of any one reactor can be increased to some less exacting tolerance.

5.0 RECOMMENDATIONS

Although strain measurements indicated that more than 0.020 in. of variation can exist in the lengths of adjacent sectors without causing excessive assembly stresses in the support rings, a 0.005 in. tolerance is recommended for practical reasons. The primary reason is that this tolerance (+0.003 to -0.002 in.) can be met in standard milling operations without difficulty. A second reason for this recommendation is that it is conservative enough to allow for higher stresses which can occur in areas of high stress concentration which could not be instrumented. These include the edges of the holes of the support rings.

6.0 GENERAL TEST DESCRIPTION

The reactor support system assembly is shown in Figure 1. This assembly was supported on a test stand (not shown) at four equally spaced support points on the nozzle end flange of the pressure vessel. Strain gages were mounted on the nozzle end and dome end support rings at the locations shown in Figures 2 and 3.

The sectors which were used in the test were equal in length within 0.002 in. but were made of aluminum because of the prohibitive cost of beryllium. All other test parts were specification grade components. In order to determine the effect of 0.010 and 0.020 in. sector length variations, shims were inserted between the nozzle end ring and two sectors spaced 180° apart in the assembly shown in Figure 1. Hydraulic tie bolt tensioning tools were used to apply the design preload of 10,000 lb to each of the tie bolts. The tie bolt nuts were then "snugged up" tight to maintain the proper preload and the tensioning device was removed. Two instrumented tie bolts, previously calibrated for load versus strain in the tie bolt, were used to verify the preloads. Strains in these bolts and the support rings were measured with standard resistance bridge strain measuring equipment.

7.0 TEST RESULTS

The data obtained in these tests consisted of strains measured at 22 locations on each support ring. These locations are shown in Figures 2 and 3. The stresses produced by the thicker shim (0.020) are shown in Table I.

All the measured strains were well below the material yield properties and showed a wide margin of safety for the support rings.

TABLE I
NOZZLE AND DOME END RING STRESSES
(Azimuth 285°)

NOZZLE END RING

<u>Gage Number</u>	<u>Stress With 0.020 Shims (lb/in.²)</u>
1	1,488
2	- 589
3	- 883
4	0
5	2,247
6	11,800
7	11,377
8	2,945
9	2,325
10	9,532
11	9,300

DOME END RING

12	4,960
13	1,581
14	2,945
15	7,130
16	4,960
17	2,170
18	1,240
19	4,030
20	4,495
21	3,952
22	- 2,170

* SEE FIGURE 2 FOR GAGE LOCATIONS ON NOZZLE END RING
 AND FIGURE 3 FOR GAGE LOCATIONS ON Z-RING

FIGURE 1
 REACTOR SUPPORT SYSTEM

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NOTES:

1. View looking toward dome end of support system.
2. Strain gages indicated by symbol ■.

FIGURE 2

STRAIN GAGE LOCATIONS
NOZZLE END SUPPORT RING
(FULL SCALE)

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FIGURE 3
 STRAIN GAGE LOCATIONS
 DOME END SUPPORT (Z-RING) FLANGE
 (FULL SCALE)