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WANL-TME-951
September 1964

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DOME END OUTER REFLECTOR SUPPORT RING
COLLAPSING PRESSURE TEST (EML-12)
(Title Unclassified)

Astronuclear Laboratory
Westinghouse Electric Corporation

OCT 26 1964

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SPECIAL REREVIEW FINAL DETERMINATION	Reviewer	Class.	Date
	TR	U	4-12-82
Class: <u>U</u>			

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1.0 SUMMARY

A static pressure test was performed to determine the capability of the NRX-A2 dome end outer reflector support ring (Z-ring), shown in Figure 1, to withstand the collapsing pressure anticipated at the 100% power, 100% flow operating condition (45 psi) without developing excessive stresses or deflections. A pressure twice as high as the anticipated maximum collapsing pressure was applied on the outside surface of the cylindrical portion of the ring. Elastic instability of the test specimen was not observed, and the stresses obtained agree with calculated values.

2.0 INTRODUCTION

For the Z-ring, which is a "short" thin cylinder as determined by the ratio of the diameter to the length and thickness, end conditions have a major effect on the radial buckling pressure. As uncertainties exist in the analytical determination of the buckling strength of such a structure, an external pressure test of the ring was performed with the other reactor components that could influence the end conditions assembled to the ring.

3.0 TEST DESCRIPTION

The Z-ring was installed within the simulated pressure vessel of the axial load test fixture as shown in Figure 2. "O" ring seals were used at each end of the cavity between the Z-ring and pressure vessel to permit pressurization of the cavity. The other reactor support system components were assembled to the Z-ring to reproduce the ring end support conditions in the reactor.

A safety cylinder was installed within the Z-ring as shown in Figures 2 and 4 to prevent damage of the ring if premature buckling occurred, and an alarm system was wired so that it would be activated if the Z-ring wall buckled and made contact with the "back-up" cylinder. The annular cavity was then filled with hydraulic fluid and pressure applied with a hydraulic pump. The maximum test pressure of 90 psi was applied in increments, and the resulting strains and deflections of the Z-ring were measured. Figure 5 shows the test fixture and recording instrumentation used during the performance of the test.

The Z-ring was instrumented with 42 strain gages and 4 deflection measuring dial gages. The strain gages were located in the areas shown in Figure 3. A photograph showing some of the gages mounted on the Z-ring is shown in Figure 6. A 50 channel digital type scanner unit was used to obtain the strain measurements. The strain gages were exercised by applying loads to the specimen prior to making actual test measurements to relieve initial installation strains. Strain gage data reduction was accomplished with a special computer program described in WANL-TME-685, utilizing the 7090 computer. The dial gages were mounted on the "back-up" cylinder, as shown in Figure 4, to measure radial deflections of the Z-ring cylinder.

4.0 RESULTS

The Z-ring met the external pressure load requirements of 100% power, 100% flow operation conditions. All the stresses and deflections measured were well within the allowable design values. Considerable stress and deflection data was obtained which substantiated analytically determined values, and additional data was obtained in many areas where accurate values could not be readily

obtained by analytical methods. All the stress and deflection data obtained under the maximum test pressure are presented in Tables I and II.

A lighter weight Z-ring as well as the other NRX-A2 support system components were also found to be capable of withstanding the full power, full flow axial static loads in tests performed in CY 1963 and reported internally in EE-3470 and EE-3512.

TABLE I
 STRESSES AT MAXIMUM TEST PRESSURE
 (90 psi)

Location (Ref. Figure 3)				
View..	Angle θ°	Dimension (in.)	Direction	Stress (psi)
B-B	$18^\circ 45'$	3/4	Axial	-4000
"	$198^\circ 45'$	"	"	-4100
"	30°	"	"	-1400
"	210°	"	"	-1600
"	$18^\circ 45'$	1-1/4	"	- 900 (1)
"	$198^\circ 45'$	"	"	-2200
"	$18^\circ 45'$	1-3/4	"	-1000
"	$198^\circ 45'$	"	"	-1000
"	$18^\circ 45'$	7-15/16	"	- 200
"	$198^\circ 45'$	"	"	- 100
"	$18^\circ 45'$	5/8	"	-5500
"	$198^\circ 45'$	"	"	-3900
"	0°	"	"	-3900
"	180°	"	"	-5000
"	$18^\circ 45'$	1-1/8	"	-2300
"	$198^\circ 45'$	"	"	-1700
"	$18^\circ 45'$	1-5/8	"	- 400
"	$198^\circ 45'$	"	"	500
"	$18^\circ 45'$	3/4	Circumferential	-3100
"	$198^\circ 45'$	"	"	-3200
"	30°	"	"	-4700
"	210°	"	"	-5000
"	$18^\circ 45'$	1-1/4	"	-2900 (2)

- (1) This stress is substantially lower than the stress measured at the corresponding stress point 180° away from it because the axial strain gage in the right-angle gage assembly shorted out.
- (2) This stress is less than the stress measured at the corresponding stress point 180° away from it because the axial strain gage in the right-angle gage assembly shorted out.

TABLE I (Continued)

Location (Ref. Figure 3)				
<u>View</u>	<u>Angle θ°</u>	<u>Dimension (in.)</u>	<u>Direction</u>	<u>Stress (psi)</u>
B-B	198°45'	1-1/4	Circumferential	-3400
"	18°45'	1-3/4	"	-4000
"	198°45'	"	"	-4000
"	18°45'	7-15/16	"	-8800
"	198°45'	"	"	-8700
"	18°45'	5/8	"	-2200
"	198°45'	"	"	-2000
"	0°	"	"	-2700
"	180°	"	"	-2400
"	18°45'	1-1/8	"	-2600
"	198°45'	"	"	-2400
"	18°45'	1-5/8	"	-3200
"	198°45'	"	"	-2900
C-C	16°45'	----	Radial	-6500
"	196°45'	----	"	-5100
"	18°45'	----	"	-4200
"	198°45'	----	"	-3700
"	20°45'	----	"	-2800
"	200°45'	----	"	-2900

TABLE II
RADIAL DEFLECTIONS AT MAXIMUM TEST PRESSURE
(90 psi)

<u>Dial Gage</u>	<u>Location¹ (Angle θ)²</u>	<u>Inward Radial Deflection (Inch)</u>
1	0	.015
2	90°	.012
3	180°	.014
4	270°	.011

1. All the dial gages were located axially 9.2 in. from the outside surface of the nozzle end flange.
2. See Figure 3.

DOM E END OUTER REFLECTOR SUPPORT (Z-RING)

FIGURE 1

TEST FIXTURE
(SCHEMATIC)
FIGURE 2

STRAIN INSTRUMENTED AREAS OF Z-RING

FIGURE 3

DEFLECTION GAGE INSTRUMENTATION
WITH SAFETY CYLINDER

FIGURE 4

TEST FIXTURE AND
RECORDING INSTRUMENTATION

FIGURE 5

STRAIN GAGE INSTRUMENTATION

FIGURE 6