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WANL-TME-1077
January 1965

Westinghouse Astronuclear Laboratory

SECTOR SPIGOT COMPRESSIVE LOAD TEST
(At Cryogenic Temperature)
(Title Unclassified)

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Mr. J. L. Dooling
NERVA Subcontract Manager
Rocket Engine Operations - Nuclear
Department 7140
Aerojet-General Corporation
Post Office Box 1947
Sacramento, California

February 24, 1965

Subject: WANL-TME-1077, "Sector Spigot Compressive Load Test," dated
January 1965

Dear Mr. Dooling:

Transmitted herewith are five (5) copies of the subject report. This
report is transmitted for your information.

Respectfully,

Original Signed By

H. F. Faught

H. F. Faught *amw*

Program Manager

NERVA Nuclear Subsystem

Enclosures - 5

cc: R. W. Schroeder, SNPO-C, w/enclosures (3)
B. J. Lowe, SNPO-C/WANL, w/o enclosures
D. Sheppard, AGC/WANL, w/o enclosures

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Astronuclear
WANL-TME-1077
January 1965

(10)

SECTOR SPIGOT COMPRESSIVE LOAD TEST
(At Cryogenic Temperature)
(Title Unclassified)

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Submitted by:
ENGINEERING MECHANICS DEPARTMENT
Westinghouse Electric Corporation
Astronuclear Laboratory
P. O. Box 10864
Pittsburgh, Pennsylvania 15236

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PREPARED BY:

I. N. Kallin

I. N. Kallin

Support Structure & Cryogenic Experiments

APPROVED BY:

N. J. Bifano

N. J. Bifano, Supervisor

Support Structure & Cryogenic Experiments

W. J. Rowan

W. J. Rowan, Manager
Engineering Mechanics

/fep

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N. J. Bifano 2/9/65
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[REDACTED]

LIST OF FIGURES

1. Typical Internal Spigot Cracks from NRX-A1 Reactor Tests (From TME-862)
2. Typical External Spigot Cracks from NRX-A1 Reactor Tests (From TME-862)
3. Sector Spigot Compressive Load Test (EML-58)
4. Test Set Up Showing Cryogenic Bath Container, Tensile Test Machine, and Recorder
5. Laboratory Produced Crack Mode Viewed from Sector Bore
6. External View of Laboratory Produced Crack Mode

[REDACTED]

BACKGROUND

Hoop-type compression loading in the reflector nozzle end support ring is believed to have occurred in the NRX-A1 reactor tests due to transient differential thermal contractions between the support ring and the pressure vessel. After the tests, all the sector spigots were found to be broken (see TME-862 and Figures 1 and 2 of this report). The upper bound diametral spigot contraction and maximum compressive load on the spigot were computed to be about 0.0060 in. and 6,000 lb, respectively.

The objective of this test was to apply the same type of loading to a sector at the cryogenic reactor temperature condition and determine whether the same mode of fracture would occur within the deflection limit imposed in the reactor.

TEST PROCEDURE

An end plate, simulating a portion of the reflector nozzle end support ring, was assembled to a sector with tie bolts (see Figure 3) and the assembly placed in a cryogenic bath container. The tie bolts were torqued finger tight. A deflection transducer was mounted in the bore of the end plate in order to measure diametral contraction in the direction of loading. The cryogenic bath container was placed on the bed of a tensile testing machine and oriented so that compressive loading could be applied to the end plate directly in line with the center of spigot bore (see Figure 4). The container was filled with liquid nitrogen and when the rapid boiling ceased, indicating that the sector and end plate were at -320°F , the load was applied in increments of 50 and 100 lb and the diametral spigot contraction measured at each load increment.

RESULTS

As a load of 4500 lb was being applied to the plate, a loud noise was heard and the deflection transducer jumped from a diametral contraction of 0.0021 to 0.0083 in. The indicated load dropped from 4500 to 3450 lb. Disassembly revealed a large crack in

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the base of the spigot, running about 130° around the spigot under the direction of loading (see Figures 5 and 6). This crack is similar to crack modes found after the NRX-A1 tests (see Figures 1 and 2). The load applied to the spigot by the loading plate was about 3500 lb since the loading plate had a stiffness of 500 lb/0.001 in. and the measured deflection was 0.0021 in.

$$4500 - \frac{0.0021}{0.0010} \times 500 \cong 3500 \text{ lb}$$

The pre-test damage of the spigot which appears in Figures 5 and 6 probably caused some reduction of the failure load but probably did not significantly affect the mode of failure.

CONCLUSIONS

Since a similar mode of fracture was produced within the limits of deflection and load calculated to have occurred in the NRX-A1 sectors, the type of loading applied can be assumed to be the same as that which occurred in the full reactor tests; and the cause of failure proposed for the NRX-A1 spigot fractures, i.e., pressure vessel interference with the reflector, is indeed the right one.

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FIGURE 1

TYPICAL INTERNAL SPIGOT CRACKS
FROM NRX-A1 REACTOR TESTS

(From TME-862)

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FIGURE 2

TYPICAL EXTERNAL SPIGOT CRACKS
FROM NRX-A1 REACTOR TESTS

(From TME-862)

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FIGURE 3

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FIGURE 4

TEST SET UP SHOWING CRYOGENIC BATH CONTAINER,
TENSILE TEST MACHINE, AND RECORDER

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FIGURE 5

LABORATORY PRODUCED CRACK MODE
VIEWED FROM SECTOR BORE

(NOTE: The half-inch chip was a result of damage during manufacturing.)

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FIGURE 6

EXTERNAL VIEW OF
LABORATORY PRODUCED CRACK MODE

(NOTE: The half-inch chip was a result of damage during manufacturing.)

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