~~CONFIDENTIAL~~
~~RESTRICTED DATA~~

COPY NO. 2

SNPO-C
Astronuclear

WANL-TME-867

September 1964

MASTER

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

FINAL REPORT

EML-26

NOZZLE INTERFACE SEAL TEST - MECHANICAL LOADING AND SEAL LEAKAGE
(Title Unclassified)

(31)

Westinghouse Electric Corporation
Astronuclear Laboratory
P. O. Box 10864
Pittsburgh 36, Pennsylvania 15236

Classification cancelled (or changed to _____)

by authority of _____

H.F.C. TIC, date SEP 11 1973

SPECIAL REVIEW FINAL DETERMINATION	Reviewers	Class.	D.L's
	<u>JRP</u>	<u>U</u>	<u>5-4-82</u>
Class: <u>U</u>			

PREPARED BY:

W.G. Parker

W. G. Parker

Core Components and Thermal Experiments

APPROVED BY:

E.A. Watjen

E. A. Watjen, Supervisor

Core Components and Thermal Experiments

W.J. Rowan

W. J. Rowan, Manager

Engineering Mechanics

H.S. McCreary

H. S. McCreary, Manager

Experimental Engineering

W.G. Roman

W. G. Roman, Manager

Reactor Engineering, NERVA Project

~~Excluded from automatic downgrading
and Declassification~~

~~INFORMATION CATEGORY~~

~~Confidential Restricted Data~~

~~Authorized Classifier Date~~

/als

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
A

DISTRIBUTION OF THIS DOCUMENT UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~Atomic Energy, 1954~~

WANL-TME-867

TABLE OF CONTENTS

	<u>PAGE</u>
1.0 SUMMARY	1
2.0 INTRODUCTION	2
3.0 CONCLUSIONS AND RECOMMENDATIONS	4
4.0 DATA ANALYSIS	5
5.0 TEST DESCRIPTION	9
6.0 REFERENCES	10
7.0 APPENDIX A	11
8.0 APPENDIX B	14
9.0 TEST PARAMETERS	16

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~

LIST OF ILLUSTRATIONS

		<u>Page</u>
Figure 1	Nozzle Interface Seal Leakage Rate Test - Nitrogen Gas Environment	17
Figure 2	Nozzle Interface Seal Leakage Rate Test - Hydrogen Gas Environment	18
Figure 3	Nozzle Interface Seal Mechanical Load Test - Seal Deflection Versus Axial Load	19
Figure 4	Nozzle Interface Seal Mechanical Load Test	20
Figure 5	Nozzle Interface Seal Mechanical Load Test (Radial Strain Versus Applied Load)	21
Figure 6	Nozzle Interface Seal Mechanical Load Test (Radial Strain Versus Applied Load)	22
Figure 7	Nozzle Interface Seal Strain Gage Locations	23
Figure 8	Test Pressure Vessel and Associated Equipment for Pressurization of Inner Reflector Cylinder	24
Figure 9	Nozzle Interface Seal Test - Test Assembly	25
Figure 10	Nozzle Interface Seal Test (Weight Positions)	26
Table 1	Nozzle Interface Seal Leakage Rate	27
Table 2	Nozzle Interface Seal Mechanical Load Tests (Axial Load Versus Seal Strain)	28
Table 3	Nozzle Interface Seal Mechanical Load Tests (Axial Load Versus Axial Deflection)	29
Table 4	Nozzle Interface Seal (Seal Width and Thickness Variation at Various Circumferential Positions)	30

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~Atomic Energy Act 1954~~

WANL-TME-867

1.0 SUMMARY

- 1.1 During operation of the nuclear reactor engine, the nozzle interface seal is subjected to axial compressive loads and lateral gaseous pressures. Excessive gas leakage past the nozzle seal could result in a compromise of reactor performance. Therefore, a series of tests to aid in the evaluation of the operational integrity of the nozzle seal were performed.
- 1.2 Test data is presented describing the leakage rate across the interface seal and inner reflector/nozzle flange seal (excluding the effects of the inner reflector pressure relief channels) for nitrogen and hydrogen gas environments. Test data is also presented describing the deformation and strain characteristics of the seal subjected to axially applied compressive loads.
- 1.3 Results from these tests indicate that the design of the interface seal is satisfactory for withstanding axial loads resulting from mechanical compression of the seal. The leakage rate excluding the effects of the inner reflector pressure relief channels was small in comparison to the permeability of the inner reflector (approximately 20 percent).

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~Atomic Energy Act 1954~~

2.0 INTRODUCTION

- 2.1 The interface seal between the reactor nozzle and the graphite inner reflector is composed of two flexible U-shaped rings welded to a central flange ring. The purpose of this reactor component is to restrict coolant flow from bypassing the core and going directly from the nozzle tube bundle to the core exhaust plenum (Reference 1). Excessive seal leakage could result in a compromise of thrust performance and structural damage to reactor components. A series of tests to aid in the evaluation of the operational integrity of the nozzle seal were therefore performed.
- 2.2 The leakage rate across the interface seal and inner reflector/nozzle flange seal was determined for hydrogen and nitrogen gas environments in conjunction with the inner reflector graphite cylinder permeability tests (Reference 2). (The seal leakage is defined as the difference between the total gas flows obtained during inner reflector permeability tests with and without the nozzle seal leakage paths exposed to the gaseous environment.) A similar test was conducted by the WANL Fluid Flow Laboratory (Reference 3).
- 2.3 The difference between these tests is that the test reported herein evaluated the leakage at the nozzle interface using an NRX-A type inner reflector cylinder having no pressure relief channels at the reflector aft end. This is essentially two seals in series because of the absence of relief holes and the additional impedance offered by the inner reflector and nozzle flange. The referenced test included the twenty-four pressure relief channels presently used in the current

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy

WANL-TME-867

inner reflector design. This setup eliminated the additional impedance of the inner reflector and nozzle flange interface.

- 2.4 A mechanical load test was performed on the nozzle interface seal to determine its load-deflection characteristics. The seal was subjected to an axially applied compressive load similar to that which occurs in the NRX-A reactors. The purpose of this test was to accumulate data for aiding in the evaluation of the interface seal combined loading tests (Reference 3) and to verify the analytical methods currently employed for analyzing nozzle seal designs (Reference 4).

CONFIDENTIAL
RESTRICTED DATA
At

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 The following conclusions can be drawn from tests performed on the nozzle interface seal:

3.1.1 The design of the nozzle interface seal is satisfactory for withstanding axial loads resulting from mechanical compression of the seal. No permanent deformation of the seal resulted from testing.

3.1.2 The leakage rate across the nozzle interface seal, based on these tests which do not include the effects of the inner reflector pressure relief channels, is small (approximately 20 percent) compared to the permeability of the inner reflector cylinder.

3.2 The following recommendation is presented:

3.2.1 A test be performed to determine gas leakage and deformation characteristics of the nozzle interface seal when subjected to a non-uniform axial load. This condition would become apparent if the reactor nozzle cocked during operation.

4.0 DATA ANALYSIS

4.1 Nozzle Interface Seal Leakage Tests

4.1.1 The nozzle interface seal was subjected to environments of nitrogen and hydrogen gases to aid in the determination of the seal leakage rate. These tests were performed in conjunction with the permeability evaluation of the inner reflector graphite cylinder (Reference 2). Seal leakage data was obtained for uniform gas pressures to 100 psig. The data obtained represents the gas leakage past the interface seal and the reflector/nozzle flange seal and does not include the effects of the inner reflector pressure relief channels (Reference 3).

4.1.2 The nozzle seal leakage rate is defined as the difference between the total gas flows measured during inner reflector permeability tests with and without the seal leakage paths exposed to the gaseous environments. (Silastic cement was used to prevent gaseous flow past the nozzle seal for the applicable tests.) A tabulation of the nozzle seal leakage rates at different external pressure levels (0 to 100 psi) is given in Table I. Figures 1 and 2 show comparisons of test data obtained for seal leakage under nitrogen and hydrogen gas environments. (The accuracy of the test readings is approximately 3 percent.) The data indicate that at 100 psig uniform external pressure, the seal leakage rate was 0.071 lb/min for hydrogen gas. These values

are approximately 20 percent of the total gas flow diffusing through the inner reflector graphite cylinder.

4.1.3 The test data presented indicated that the gas leakage past the interface seal and reflector/flange seal is small when compared to the gas permeability of the inner reflector.

4.2 Nozzle Interface Seal Mechanical Load Tests

4.2.1 A mechanical load test was performed on the nozzle interface seal to determine its load-deflection characteristics. This test was designed to accumulate data for aiding in the evaluation of interface seal combined loading tests (Reference 3) and to verify the analytical methods employed for analyzing nozzle seal designs (Reference 4).

4.2.2 The nozzle interface seal was subjected to an axial compressive load similar to that which occurs in the NRX-A reactor. Strain and deflection measurements were taken at various circumferential positions - the results of which are given in Tables 2 and 3. The test data is shown graphically in Figures 3, 4, 5 and 6. All data presented represents average values obtained from four tests.

4.2.3 Figure 3 shows a comparison of seal deflection under uniform axial loading for different circumferential positions. These data indicate that the seal deflection is not uniform but varies with respect to circumferential position. The differences in the load-deflection curves result from the circumferential

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~Atomic Energy 1954~~

WANL-TME-867

variations in seal geometry. Table 4 shows measurements taken of nozzle seal depth and thickness. During axial loading, the nozzle seal will deflect until Position F is reached (Figure 7). The axial compressive load required to produce further deflection will then significantly increase since this load will be distributed over more of the seal surface area. Dimensional measurements of the seal indicated circumferential variations in depth at Position F from 0.303 to 0.337 in.; parts of the seal will therefore require larger axial loads to deflect than others do. A load-deflection curve would then indicate non-uniform seal deflection as is shown in Figure 3. An average load-deflection curve (obtained from Figure 3) for the seal is shown in Figure 4.

4.2.4 Figures 5 and 6 show measurements taken of seal radial strains for different axial loads. These measurements indicate that the seal is not strained uniformly but varies with respect to circumferential position. The strains obtained for the nozzle flange side of the seal also differ from those taken on the reflector side. These strain differences are again attributable to the dimensional variations in the seal depth and thickness. The maximum strain recorded was 2210 μ in./in. at Station TA-270° (Figure 7). This value represents a stress in the seal of 66,300 psi. This stress level is below the maximum (approximately 100,000 psi) the material can withstand and therefore indicates that the design of the seal is satisfactory for

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~Atomic Energy 1954~~

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~Atomic Energy Act 1954~~

WANL-TME-867

withstanding the axial compressive loads.

- 4.2.5 Circumferential strain measurements were also taken during testing (Figure 7). These measurements indicated strains of approximately $40 \mu\text{in./in.}$ at 500 lb and $150 \mu\text{in./in.}$ at 1770 lb load, which were considerably lower than those reported above. Radial and circumferential strain measurements do correlate well with theoretical predictions (Reference 4). No permanent deformation of the seal resulted from testing.

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
Ato

5.0 TEST DESCRIPTION

- 5.1 Tests to determine the gas leakage rate and structural deformation characteristics of the nozzle interface seal have been performed.
- 5.2 The leakage rate across the nozzle interface seal was evaluated in conjunction with the inner reflector permeability tests (Appendix A). Pressure differentials of 0 to 100 psi were applied to the seal using nitrogen and hydrogen gas environments. The leakage rate was determined by measuring the total gas permeability of the inner reflector with and without the seal leakage paths exposed to the gaseous environment. The difference between these gas permeabilities then represented the seal and reflector/flange leakage rate.
- 5.3 Structural deformation characteristics of the nozzle interface seal were determined for simulated NRX-A type axial loads (Appendix B). The interface seal was placed between two flat plates. Axial compressive loads were induced to the seal by applying equally spaced calibrated weights to the plates (Figure 10). Strain and deformation characteristics were monitored for each increment of axial loading.

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~Atomic Energy Act of 1954~~

WANL-TME-867

6.0 REFERENCES

1. "NRX-A Block I Mechanical Design" prepared by Mechanical Design, approved by A. Selz and W. G. Roman; Westinghouse Astronuclear Laboratory.
2. "Structural Evaluation of the Inner Reflector" prepared by W. G. Parker; WANL-TME-768, Westinghouse Astronuclear Laboratory
3. "Flow Rate and Pressure Drop Characteristics of Inconel X-750 Nozzle Interface Seal Test" prepared by R. J. Steffen; WANL-TME-865, Westinghouse Astronuclear Laboratory
4. "Stress Analysis: NRX-A Nozzle Interface Seal" prepared by E. A. Henne; WANL-TME-881, Westinghouse Astronuclear Laboratory

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~Atomic Energy Act of 1954~~

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~Atomic Energy 354~~

WANL-TME-867

7.0 APPENDIX A

NOZZLE INTERFACE SEAL LEAKAGE TESTS PROCEDURE FOR DETERMINING THE LEAKAGE RATE ACROSS THE NOZZLE INTERFACE SEAL

7.1 PURPOSE:

7.1.1 The purpose of this test was to determine the leakage rate across the nozzle interface seal for nitrogen and hydrogen gas environments. The seal leakage rate is defined as the difference between the total gas flows obtained during inner reflector permeability tests with and without the nozzle seal leakage paths exposed to the gaseous environment.

7.2 OBJECTIVE:

7.2.1 To determine the nozzle interface seal leakage rate for nitrogen and hydrogen gas environments.

7.3 TEST SPECIMEN:

7.3.1 The test component for this program was a production quality nozzle interface seal (Inconel X750 steel). This seal was employed for previously performed permeability and buckling tests of the inner reflector graphite cylinder.

7.4 TEST EQUIPMENT:

7.4.1 The inner reflector graphite cylinder and the nozzle interface seal were inserted into a steel pressure vessel. Pressure differentials across the barrel and the seal were applied with nitrogen and hydrogen gas flowing between the steel vessel and the graphite barrel. Figure 8 shows the test pressure vessel and associated equipment employed for applying and measuring the

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~Atomic Energy 354~~

gas pressure.

7.5 TEST SEQUENCE:

- 7.5.1 The reflector and the interface seal were inserted into the steel pressure vessel and the tie-down bolts were preloaded to 800 μ in. strain. The tubing was connected to the test pressure vessel, flowmeter, manifold, etc. as shown in Figure 8. The pressure on each nitrogen and hydrogen gas supply was checked to insure full tanks (2000 psi or better).
- 7.5.2 Silastic cement was placed between the interface seal and adjoining surfaces such that the seal leakage paths were unexposed to the gaseous environments.
- 7.5.3 Nitrogen gas pressure was applied to the reflector and the seal up to 20 psi for purge and checkout of the system. Leak-tec was applied to the interior of the system to insure gas-tight conditions.
- 7.5.4 Nitrogen gas pressure was applied to the barrel and held at 10, 30, 50, 60, 70, 80, 90 and 100 psi. Flowmeter readings, flowmeter inlet pressure, and flowmeter inlet temperature were recorded manually. At the completion of data acquisition at 100 psi, the pressure was reduced to 60 psig and 30 psig and all readings were repeated.
- 7.5.5 The nitrogen gas was turned off after completing all readings at 30 psig. Item 7.5.3 of this procedure was repeated.
- 7.5.6 Nitrogen gas was turned off and hydrogen gas turned on. Item

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~Atomic Energy, 1954~~

WANI-TME-867

7.5.4 was repeated.

7.5.7 Hydrogen gas was turned off and nitrogen gas turned on (20 psig) for purging the system.

7.5.8 The silastic cement was removed from the interface seal surfaces and items 7.5.3, 7.5.4, 7.5.5, 7.5.6 and 7.5.7 were repeated.

7.6 TEST PARAMETERS:

7.6.1 Ambient Temperature

7.6.2 Differential Pressure - 0 to 100 psi

7.6.3 Nitrogen and Hydrogen Gas Environment.

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~Atomic Energy, 1954~~

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~

WANL-TME-867

8.0 APPENDIX B

NOZZLE INTERFACE SEAL MECHANICAL LOAD TESTS PROCEDURE FOR DETERMINING THE DEFLECTION CHARACTERISTICS OF THE INTERFACE SEAL

8.1 PURPOSE:

8.1.1 The purpose of this test was to determine the deflection of the nozzle interface seal when subjected to a mechanically applied longitudinal load.

8.2 TEST OBJECTIVES:

- 8.2.1 To determine empirically a relationship between longitudinal loading and deflection of the seal.
- 8.2.2 To determine any permanent deformation that results during loading.
- 8.2.3 To determine seal strain with respect to longitudinal loading.

8.3 TEST SPECIMEN:

8.3.1 The test component for this program was a production quality nozzle interface seal (Inconel X750 steel). This seal was employed during previously conducted permeability and buckling tests of the inner reflector graphite cylinder.

8.4 TEST EQUIPMENT:

8.4.1 Figure 9 shows an assembly drawing of the test setup. The nozzle interface seal was placed between two flat plates. (These plates were previously used for the permeability and buckling tests.) A series of calibrated weights (20 lb each) were used to induce longitudinal compressive loading to the seal (approximately 100 weights were required for the test).

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~

Strain gages were mounted on the seal as shown in Figure 7. Dial gages were used to determine the seal deflection. Baldwin SR-4 strain indicator and switching unit were used to record the strain readings.

8.5 TEST SEQUENCE:

- 8.5.1 Prior to testing, the nozzle interface seal was inspected by Quality Control Department at WANL. The seal was also re-inspected after testing was complete. The weight of the top plate resting on the seal was also determined.
- 8.5.2 The nozzle interface seal was mounted in the test rig as described in Figure 9. Plate surfaces adjacent to the seal were visually inspected and cleaned of any burrs, etc. that existed. The entire test rig was placed upon the vibration slip table.
- 8.5.3 Longitudinal loading was imposed to the seal using calibrated weights. A diagram of the position of the weights is given in Figure 10. (An initial deflection of the seal resulted from the weight of the top plate. This deflection was recorded.) The seal was loaded in the following increments: 0, 160, 400, 800, 1200, 1300, 1520, 1600, 1680, and 1760 lb. At each load increment, strain gage and dial gage readings (deflection readings were taken at 90° intervals around the circumference of the seal) were recorded. In order to produce each load increment, the number of weights used at each position described in Figure 10

was as follows:

LOAD	NUMBER OF WEIGHTS - WEIGHT POSITION FIGURE							
	A	B	C	D	E	F	G	H
0	0	0	0	0	0	0	0	0
160	1	1	1	1	1	1	1	1
400	3	2	3	2	3	2	3	2
800	5	5	5	5	5	5	5	5
1200	8	7	8	7	8	7	8	7
1360	9	8	9	8	9	8	9	8
1520	10	9	10	9	10	9	10	9
1600	10	10	10	10	10	10	10	10
1680	11	10	11	10	11	10	11	10

The load was then removed from the seal and all readings repeated for the following loads: 1520, 1200, 800, 400, 160 and 0.

8.5.4 The above seal loading procedure was repeated four times.

8.5.5 During each unloading operation, care was taken so that the seal returned to its initial position before proceeding to the next test.

9.0 TEST PARAMETERS

9.1 Ambient Temperature

9.2 Axial Loads - 0 to 1770 lb

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
Atomic Energy

WANI-TME-867

FIGURE 1
NOZZLE INTERFACE SEAL LEAKAGE RATE TEST
NITROGEN GAS ENVIRONMENT

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
Atomic Energy

FIGURE 2
NOZZLE INTERFACE SEAL LEAKAGE RATE TEST
HYDROGEN GAS ENVIRONMENT

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~

~~January 1954~~

WANL-TME-867

FIGURE 3
NOZZLE INTERFACE SEAL MECHANICAL LOAD TEST
SEAL DEFLECTION VERSUS AXIAL LOAD

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~

SEAL DEFLECTION - INCHES
FIGURE 4

NOZZLE INTERFACE SEAL MECHANICAL LOAD TEST

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~
~~August 1954~~

WANL-TME-867

FIGURE 5
NOZZLE INTERFACE SEAL MECHANICAL LOAD TEST
(RADIAL STRAIN VERSUS APPLIED LOAD)

~~CONFIDENTIAL~~
~~RESTRICTED DATA~~

FIGURE 6

NOZZLE INTERFACE SEAL MECHANICAL LOAD TEST
(RADIAL STRAIN VERSUS APPLIED LOAD)

602899A

FIGURE 7
 NOZZLE INTERFACE SEAL STRAIN GAGE LOCATIONS

597764A

FIGURE 8

TEST PRESSURE VESSEL AND ASSOCIATED EQUIPMENT
 FOR PRESSURIZATION OF INNER REFLECTOR CYLINDER

602888A

FIGURE 9
NOZZLE INTERFACE SEAL TEST - TEST ASSEMBLY

FIGURE 10
NOZZLE INTERFACE SEAL TEST
(WEIGHT POSITIONS)

TABLE 1
NOZZLE INTERFACE SEAL LEAKAGE RATE
NITROGEN GAS

Pressure (psig)	Flow Rate (lb/min)		Seal Leakage Rate (lb/min)
	Seal Unexposed*	Seal Exposed	
0	0	0	0
10	.029	.036	.007
30	.088	.108	.020
50	.155	.190	.045
60	No Reading Taken	.230	----
70	No Reading Taken	.274	----
80	.283	.337	.054
90	No Reading Taken	.386	----
100	.376	.447	.071

HYDROGEN GAS

Pressure (psig)	Flow Rate (lb/min)		Seal Leakage Rate (lb/min)
	Seal Unexposed*	Seal Exposed	
0	0	0	0
10	.007	.007	0
30	.020	.023	.003
50	.0385	.0426	.0041
60	.0485	.0566	.0081
70	.0615	.0674	.006
80	.070	.0806	.0106
90	.083	.0943	.0113
100	.092	.109	.017

*Silastic cement was used to prevent gas flow past the nozzle seal.

TABLE 2
 NOZZLE INTERFACE SEAL MECHANICAL LOAD TESTS
 Axial Load Versus Seal Strain

Axial Load (lb)	Seal Strain - μ in./in.							
	Sta. TA-0°	Sta. BA-0°	Sta. TA-90°	Sta. TA-270°	Sta. BA-270°	Sta. TC-0°	Sta. BC-0°	Sta. BD-0°
0	0	0	0	0	0	0	0	0
90	0	67.5	66.3	172	184	30	136	161
250	20	320	317	687	429	100	328	414
490	203	610	567	1066	777	220	674	709
890	592	964	981	1398	1112	537	987	1047
1290	810	1165	1293	1747	1423	682	1124	1223
1450	900	1224	1420	1880	1519	713	1168	1285
1610	980	1290	1500	2085	1800	750	1200	1340
1690	1010	1335	1640	2140	1930	760	1225	1370
1770	1050	1370	1840	2210	1960	770	1250	1390

Notes: (1) The test data represents average values obtained from four tests.

(2) Refer to Figure 7 for gage locations.

TABLE 3
NOZZLE INTERFACE SEAL MECHANICAL LOAD TESTS
Axial Load Versus Axial Deflection

Axial Load (lb)	Axial Deflection (in.)				
	0°	90°	180°	270°	Average
90	.004	.002	.0090	.0090	.0060
250	.0205	.0161	.0227	.0269	.0216
490	.0335	.0281	.0399	.0414	.0357
890	.0480	.0459	.0529	.0586	.0514
1290	.0547	.0546	.0646	.0715	.0614
1450	.0559	.0565	.0672	.0747	.0636
1610	.0560	.058	.0688	.0760	.0647
1690	.0565	.059	.0696	.0770	.0655
1770	.0570	.0595	.0705	.0780	.0663

Note: (1) The test data represent average values obtained from four tests.
(2) All measurements were obtained using dial gages.

TABLE 4
NOZZLE INTERFACE SEAL

Seal Width and Thickness Variation
at Various Circumferential Positions

Circumferential Position	SEAL WIDTH		SEAL THICKNESS	
	Position E	Position F	Inner Reflector Side	Nozzle Flange Side
0°	.382	.333	.024	.0245
15°	.390	.337	.026	.0245
30°	.386	.337	.0245	.025
45°	.386	.318	.0245	.0235
60°	.382	.325	.027	.024
75°	.387	.330	.025	.0235
90°	.384	.324	.0235	.024
105°	.380	.333	.024	.024
120°	.384	.330	.0245	.024
135°	.385	.320	.026	.024
150°	.384	.318	.0235	.024
165°	.388	.325	.026	.024
180°	.387	.312	.024	.024
195°	.388	.303	.025	.024
210°	.387	.330	.023	.024
225°	.387	.336	.025	.0235
240°	.388	.312	.023	.0235
255°	.381	.311	.025	.0245
270°	.380	.314	.024	.024
285°	.383	.302	.026	.0235
300°	.386	.320	.024	.024
315°	.385	.327	.025	.024
330°	.376	.332	.025	.024
345°	.386	.335	.0245	.024

Notes: (1) Refer to Figure 8 for position locations.

(2) Design Specifications * - $.396 \pm .020$
 ** - $.300$ maximum
 *** - $.022 \pm .002$

(3) Measurements performed by WANL Quality Control
Department.