ACF INDUSTRIES

INCORPORATED

ALBUQUERQUE DIVISION

APPLIED RESEARCH AND DEVELOPMENT

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.

PHOEBUS 1B PRESSURE VESSEL (7079 #9) STRUCTURAL PROOF TEST PROCEDURE

ACF-411-294

May 23, 1966

DISTRIBUTION:

W. W. Stagg, AEC-SAAO (2)
W. J. Jackel
W. T. Geyer
J. M. Fowler
D. G. Roberts
R. W. Randolph
J. A. Kisner
H. L. Brammer
H. E. Hendricks
J. W. Neudecker, N-7, LASL
J. E. Fisher
C. R. Garr
R. E. Wandrey
H. T. Ried (2)
R. E. Pozega
R. T. Johnson
J. G. Hanks
J. Stucki, NRDS
A. Bond, J-9, LASL-NRDS
Alameda Accountability Center (2) ←

Prepared By:

H. T. Ried

H. T. Ried
Test Engineer

Approved by:

R. E. Wandrey

R. E. Wandrey, Supervisor
Test Operations

J. E. Fisher

J. E. Fisher, Manager
Mechanical Development
and Test Engineering

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED 26

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.

BLANK

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
1	INTRODUCTION	5
2	OBJECTIVES	5
3	APPLICABLE DOCUMENTS	5
4	TEST PROCEDURE	6
	4.1 Low-Pressure Proof Test	6
	4.2 Structural Proof Test	7
	4.3 Cryogenic Proof Test	8
	4.4 Clamp Ring Thermal Shock and Proof Test	9

Table

1	LOW PRESSURE PROOF TEST LOADING SCHEDULE	18
2	INSTRUMENTATION LIST	26
3	STRUCTURAL PROOF TEST LOADING SCHEDULE	46

Figure

1	PRESSURE VESSEL ASSEMBLY	10
2	PARTS LIST	11
3	FLOW SEPARATOR — CENTER HOLE SEAL	12
4	STRESSCOAT LOCATIONS, FLOW SEPARATOR	13
5	STRESSCOAT LOCATIONS, DOME	14
6	STRESSCOAT LOCATIONS, PRESSURE VESSEL -NOZZLE END	15
7	INSTALLATION OF FLOW SEPARATOR AND FIXTURE TO DOME ASSEMBLY	16
8	HYDROSTATIC PRESSURIZATION SYSTEM	17
9	STRAIN GAGE LOCATIONS OF FLOW SEPARATOR RIB (Cross Section) . .	19
10	STRAIN GAGE LOCATIONS ON PRESSURE VESSEL DOME END (Cross Section)	20

<u>Figure</u>	<u>Title</u>	<u>Page</u>
11	STRAIN GAGE LOCATIONS ON FLOW SEPARATOR (Top View)	21
12	STRAIN GAGE LOCATIONS ON MAIN CLOSURE (Cross Section)	22
13	STRAIN GAGE LOCATIONS ON NOZZLE END	23
14	STRAIN GAGE LOCATIONS ON PRESSURE VESSEL DOME-END (Top View)	24
15	STRAIN GAGE LOCATIONS ON MAIN CLOSURE/CLAMP RING ASSEMBLY (Cross Section)	25
16	DEFLECTION GAGE LOCATIONS TO MEASURE RADIAL DISPLACEMENT AND ROTATION PRESSURE VESSEL DOME END	42
17	DISPLACEMENT GAGE LOCATIONS FOR MEASUREMENT OF GAP SEPARATION MAIN CLOSURE	43
18	DISPLACEMENT GAGE LOCATIONS FOR MEASUREMENT OF CLOSURE ROTATION, MAIN CLOSURE	44
19	ELECTRICAL SCHEMATIC FOR ROTATION MEASUREMENTS	45
20	STRAIN GAGE INSTRUMENTATION ON NOZZLE BOLTS	47
21	THERMOCOUPLE LOCATIONS, CLAMP RING AREA	48
22	CRYOGENIC STRAIN GAGE HOOKUP TO GILMORE	48
23	CRYOGENIC TEST SETUP	49

1. INTRODUCTION

- 1.1 This document establishes the procedures for testing the Phoebus 1B Pressure Vessel Assembly (7079 No. 9 Pressure Vessel Nozzle End and the mating Dome End) with a simulated Nozzle (ACF Dwg. 508205), as requested by Engineering Systems Analysis, Dept. 431, per Test Specification ACF SA-780.
- 1.2 The testing will be conducted in four phases: (1) a low-pressure proof test, (2) structural proof test, (3) A Pressure Vessel Assembly proof test at LN₂ temperatures, and (4) a thermal shock and proof test of the clamp band (this test will be performed at NRDS). The general test assembly and parts listing is shown in Figures 1 and 2.
- 1.3 The flow separator will be installed in the Pressure Vessel during room temperature proof tests and a differential pressure maintained across it to simulate operating conditions. The maximum hydrostatic pressure will be 1500 psig.
- 1.4 During the tests, surface strain gages on the Nozzle, Vessel, and Flow Separator will be monitored in addition to Stresscoat brittle lacquer, radial deflection, axial deflection and rotation of both the Nozzle and Vessel as a function of pressure vessel loading.

2. OBJECTIVES

Three principal objectives of the test are as follows:

- (a) To prove the structural integrity of the design, particularly the weld areas at cryogenic temperatures.
- (b) To verify the methods used to analyze the Pressure Vessel Assembly.
- (c) To determine the operation limitation of the assembly.

3. APPLICABLE DOCUMENTS

The following documents are applicable to this assembly and test:

- (a) ACF SA-502, "Kiwi P Pressure Vessel 6061 #5 and Rocketdyne RN-6 Nozzle Structural Proof Test Specification."
- (b) ACF 411-191, "Kiwi B Pressure Vessel 6061 #5 and Rocketdyne RN-6 Nozzle Structural Proof Test Report."
- (c) ACF Drawing No. 512280 (Pressure Vessel Dome End).
- (d) ACF Drawing No. 512281 (Pressure Vessel Nozzle End).
- (e) ACF Drawing No. 514743 (Pressure Vessel Clamp Ring).
- (f) ACF Drawing No. 514739 (Pressure Vessel Clamp Ring Segments).
- (g) ACF Drawing No. 508205 (Simulated Nozzle).
- (h) ACF Drawing No. 505259 (Wave Ring Seal).
- (i) ACF Drawing No. 515868 (Omega Seal).
- (j) ACF Drawing No. 511721 ("O" Ring).
- (k) ACF Drawing No. 514981 (Flow Separator Assembly).
- (l) ACF Drawing No. 515494 (Flow Separator Test Device).

- (m) ACF Drawing No. 515499 (Adapter Plug).
- (n) ACF Drawing No. 515324 (Test Ring Clamp Ring Assembly).
- (o) ACF SA-780 (Phoebus 1B Pressure Vessel, 7079, No. 9, Structural Test Specification).

4. TEST PROCEDURE

4.1 Low-pressure Proof Test

- 4.1.1 Plug all holes in the Pressure Vessel with the seals and plugs specified in Figure 2.
- 4.1.2 Plug the small holes in the Flow Separator with rubber stoppers and seal the large center hole as shown in Figure 3.
- 4.1.3 Apply Stresscoat brittle lacquer to both sides of the Flow Separator, as shown in Figure 4, and the inside surfaces of the Dome and Nozzle Ends of the Pressure Vessel as shown in Figures 5 and 6. Spray three (3) calibration bars for each sensitivity of Stresscoat.
- 4.1.4 Install the Flow Separator and the Flow Separator Test Fixture in the Dome as shown in Figure 7. (The Dome must be centered in the assembly stand.) Place one calibration bar of each of the following sensitivities in the Flow Separator Dome cavity: 600, 1200, and 3000 $\mu\text{in/in}$.
- 4.1.5 Pressurize the Flow Separator to $21 \pm$ psig and check the assembly visually for leaks. Seal all observed leaks.
- 4.1.6 Install the Nozzle End of the Pressure Vessel on the Dome and measure the load required to pull the Clamp Ring into position. Install the Clamp Ring Segments starting at 0° .
- 4.1.7 Install the Nozzle using the "O" Ring, Dwg. No. 511721. Apply Led-plate, #250 to the nozzle bolt threads and Dow-Corning No. 11 to the washers. Torque the nozzle bolts in 60 ft-lb increments, in diametrically opposed pairs, to 180 ft-lbs.
- 4.1.8 Apply Stresscoat to the outside of the Pressure Vessel Dome and Nozzle ends as shown in Figures 5 and 6.
- 4.1.9 Fill the Flow Separator Dome Cavity, the Clamp Ring, and the Nozzle End with 70 to 75°F temperature-controlled water, taking care that all air is bled from the vessel.
- 4.1.10 Connect the pressurization system to the vessel as shown in Figure 8.
- 4.1.11 Apply pressure in stepped increments and release after each application as shown in Table 1. After releasing the pressure, allow a waiting period of three times the loading time to permit the creep in the Stresscoating to recover.

- 4.1.12 After stabilizing the pressure at each stepped increment, raise the pressure in the Flow Separator-Dome cavity (P_2) to the value specified in Table 1 to obtain the differential pressure between it and the Nozzle End of the Pressure Vessel (P_1). The maximum allowable differential pressure is 22 psig.
- 4.1.13 Record the data from the instrumentation at each increment of pressure. Photograph the over-all Stresscoat pattern. Determine the threshold crack sensitivity of the Stresscoat at appropriate times during the test.
- 4.1.14 Drain the vessel completely. Disassemble it taking care to preserve Stresscoat crack pattern. Record nozzle bolt break-away torque values.
- 4.1.15 Dye and photograph all Stresscoat crack patterns using bright line lighting techniques. Determine the threshold crack sensitivity of the calibration bars which were inside the Flow Separator Dome cavity.

4.2 Structural Proof Test

- 4.2.1 Install strain gages on the pressure vessel, flow separator, and nozzle as shown in Figures 9 through 15, and the Instrumentation List, Table 2. Install C12-121-R2C, two-gage rosettes in place of the cryogenic gages for this hydrostatic test.
- 4.2.2 Install additional strain gages if required as evidenced by the Stresscoat patterns from the test of Paragraph 4.1, and connect the strain gages to the Gilmore Recorder.
- 4.2.3 Reapply Stresscoat on the Pressure Vessel Nozzle end, as shown in Figure 6.
- 4.2.4 Install deflection gages as shown in Figures 16, 17 and 18, and connect to the Gilmore Recorder as shown in Figure 19.
- 4.2.5 Assemble the Pressure Vessel Assembly, as described in Paragraphs 4.1.4 through 4.1.11, using an Omega Seal, Dwg. No. 515868, instead of the "O" Ring. Record the outputs of the strain gages numbered 1-17 and 78-87 during the installation of the Flow Separator and the Flow Separator Test Fixture into the dome cavity. Record the outputs of the strain gages numbered 66-77, 88-103 and 188-195 during the assembly of the Nozzle End of the Pressure Vessel and the Dome-End. Record the outputs of the strain gages numbered 104-119 and 204-211 during the assembly of the Nozzle into the Pressure Vessel. Installation of the Flow Separator and Flow Separator Test Fixture will depend upon the results of the low pressure test of Paragraph 4.1. Install four strain gaged nozzle bolts (Figure 20) 90° apart on the bolt circle. Lubricate the nozzle bolts as specified in Paragraph 4.1.7 and torque in 60 ft-lb increments to obtain a 30,000# bolt preload. Record the angular locations of the bolt strain gages using a line from the center of the Pressure Vessel through the center of the bolt hole as a reference.
- 4.2.6 Make dimensional checks and scribe marks to insure that the Nozzle is completely seated on the Pressure Vessel.

- 4.2.7 Apply pressure in stepped increments as shown in Table 3. The differential pressure is obtained as specified by Paragraph 4.1.12. After exercising the instrumentation (initial 30% pressure steps), preset the instrumentation to include assembly loads. Record the data at each pressure increment. Visually evaluate the Stresscoat at 1050 psig after pressurizing the vessel to maximum pressure.
- 4.2.8 Pressurize the Clamp Ring to 1800 psig for two minutes on each of the last two loading cycles with the Pressure Vessel at 1500 psi.
- 4.2.9 Drain and disassemble the Pressure Vessel Assembly. Record the Nozzle Bolt breakaway torque values and the final strain indications.
- 4.2.10 Photograph all significant Stresscoat patterns inside the Pressure Vessel.
- 4.2.11 Visually inspect the Pressure Vessel Assembly for evidence of deformation.

4.3 Cryogenic Proof Test

- 4.3.1 Install thermocouples on the pressure vessel at all cryogenic strain gage locations (Gages No. 196-211), and on Clamp Ring Area as shown in Figure 21.
- 4.3.2 Assemble the vessel using a new Omega and Wave Ring Seals. Install "K" seals under the Nozzle bolt heads and torque the Nozzle bolts to obtain a 30,000 lb. bolt preload as specified in Paragraph 4.2.5. The Flow Separator will not be installed during this test. Plug all instrumentation holes with cryogenic seals.
- 4.3.3 Transport the Pressure Vessel Assembly to the ACF explosives test site at Sandia Base.
- 4.3.4 Connect cryogenic strain gages numbered 196 to 211 to the recording equipment as shown in Figure 22. The cryogenic gages may not be used depending on the results of the High Pressure Proof Test.
- 4.3.5 Connect the LN₂ fill and pressurization system to the Pressure Vessel Assembly as shown in Figure 23.
- 4.3.6 Fill the Pressure Vessel and Clamp Ring with LN₂ until thoroughly chilled. Monitor thermocouples to determine temperature stabilization.

CAUTION

Open all relief valves mounted on the pressure vessel during filling procedure to prevent gas pressure buildup.

- 4.3.7 After temperature stabilization, pressurize vessel to 400 psig with chilled nitrogen gas. Visually inspect the assembly for leakage and seal any significant leaks.

- 4.3.8 Bleed and drain LN₂ from the assembly into the Dewar. Allow assembly to warm to room temperature.
- 4.3.9 Move Pressure Vessel Assembly into test pit and perform final instrumentation check.
- 4.3.10 Fill void between Pressure Vessel and test pit with insulation. See Figure 23 for test setup at ACF explosive site, Sandia Base.
- 4.3.11 Fill Pressure Vessel and Clamp Ring with LN₂ until thoroughly chilled and boiling of LN₂ has ceased. Monitor thermocouples to determine temperature stabilization.
- 4.3.12 After temperature stabilization, pressurize Pressure Vessel and Clamp Ring to 1200 psig in 200 psig increments, maintaining the test temperature within 20°F. Record the test data at each pressure increment. Bleed GN₂ as necessary to maintain as much LN₂ as possible.
- 4.3.13 Depressurize Pressure Vessel Assembly and allow it to warm to room temperature. Record test data.
- 4.3.14 Dissassemble Pressure Vessel Assembly and visually inspect for evidence of deformation. Dye check weld and highly stressed areas.

4.4 Clamp Ring Thermal Shock and Proof Test

- 4.4.1 This test will be performed by "J" Division of LASL at NRDS. The test unit preparation will be performed by Department 411.
- 4.4.2 Assemble the Clamp Ring to the Test Ring Fixture (Dwg. 515324). Uniformly pull the Clamp Ring on the Fixture using the same load measured in the test of Paragraph 4.1.6.
- 4.4.3 Install the thermocouples on the Clamp Ring as shown in Figure 21. Deliver the Clamp Ring Test Assembly to ACF at NRDS, Attention: J. Stucki.

Figure 1. PRESSURE VESSEL ASSEMBLY

Figure 2. PARTS LIST

<u>Item</u>	<u>Part Description</u>	<u>Dwg. No.</u>
1	Simulated Nozzle	515161
2	5/8" Bolt	SPS EWB 26-10-28
3	Harrison "K" Seal	
4	Seal or "O" Ring	515868 or 511721
5	Pressure Vessel Nozzle End	512281
6	Seal	505259
7	Clamp Ring	514743
8	Clamp Ring Segments	514739
9	Pressure Vessel Dome End	512280
10	Harrison Seal	12100-DL-32
11	Adaptor Block	515499
12	Flow Separator	514981
13	Harrison Seal	20202-GL-8
	Plug	MS 24391-S8
14	Harrison Seal	121905-DL-10 (6-556200)
	Plug	516289
15	Harrison Seal	121905-DL-10 (6-556200)
	Plug	516289
16	Harrison Seal	12190-DL-10 (6-556200)
	Plug	516289
17	Harrison Seal	12190-DL-10 (6-556200)
	Plug	516289
18	Harrison Seal	12100-DL-4 (6-550003)
	Plug	MS24391-D4
19	Harrison Seal	12190-DL-10 (6-556200)
	Plug	516289
20	Harrison Seal	12100-DL-4 (6-550003)
	Plug	MS24391-D4
21	Harrison Seal	12100-DL-4 (6-550003)
	Plug	MS24391-D4
22	Harrison Seal	12190-DL-10 (6-556200)
	Plug	516289
23	Harrison Seal	12100-DL-4 (6-550003)
	Plug	MS24391-D4
24	Harrison Seal	12190-DL-10 (6-556200)
	Plug	516289

Figure 3.. FLOW SEPARATOR - CENTER HOLE SEAL

Figure 4. STRESSCOAT LOCATIONS, FLOW SEPARATOR

NOTES:

1. Apply Stresscoat to Top and Bottom of Dome as Shown
2. Apply Stresscoat to Within 3" of the Main Closure Interface

Figure 5. STRESSCOAT LOCATIONS, DOME

NOTES:

1. Apply 2500 $\mu\text{in/in}$ sensitivity for low pressure proof test and 5000 $\mu\text{in/in}$ sensitivity for structural proof test.
2. Apply 600, 800, and 1000 $\mu\text{in/in}$ sensitivity 8 inches wide to cover the hole areas, 180° apart, Stresscoat is not required on the inner surface during the structural proof test.

Figure 6. STRESSCOAT LOCATIONS, PRESSURE VESSEL-NOZZLE END

Figure 7. INSTALLATION OF FLOW SEPARATOR AND FIXTURE TO DOME ASSEMBLY

Figure 8. HYDROSTATIC PRESSURIZATION SYSTEM

Table 1

LOW PRESSURE PROOF TEST LOADING SCHEDULE

<u>Load %</u>	<u>Pressure Vessel Chamber, P₁ psig</u>	<u>Flow Separator- Dome Chamber, P₂ psig</u>
0	0	0
100	800	800
100	800	805
100	800	810
100	800	815
100	800	820
70	560	574
0	0	0

- NOTES: 1. Install gages on any one long Rib.
2. Gage Location Tolerances ± 0.030

Figure 9. STRAIN GAGE LOCATIONS ON FLOW SEPARATOR RIB (CROSS SECTION)

- NOTES: 1. Install Thermocouples at each Cryogenic Gage location for Cryogenic Test
2. Gages 24, 25, 28, 29, 32, 33, 36, 37, 40, 41, 44, 45 are located in center of radius

Figure 10. STRAIN GAGE LOCATIONS ON PRESSURE VESSEL DOME-END (Cross Section)

Figure 11. STRAIN GAGE LOCATIONS ON FLOW SEPARATOR (Top View)

Figure 12. STRAIN GAGE LOCATIONS ON MAIN CLOSURE (Cross Section)

- NOTES: 1. Install Thermocouples at each Cryogenic Strain Gage Location for the Cryogenic Test
2. LEGEND: (A) 5/8"-18 Hole Reference (0°)
 (B) And 10050-4 Hole Reference (17°)
 (C) And 10050-4 Hole Reference (17°)

Figure 13. STRAIN GAGE LOCATIONS ON NOZZLE END

Figure 14. STRAIN GAGE LOCATIONS ON PRESSURE VESSEL DOME-END (Top View)

NOTE:

1. Gages on Clamp Ring are Located 90° from Coolant Connections

Figure 15. STRAIN GAGE LOCATIONS ON MAIN CLOSURE/CLAMP RING ASSEMBLY (Cross Section)

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
1	Circumferential Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 9
2	Radial Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
3	Circumferential Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
4	Radial Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
5	Circumferential Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
6	Radial Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
7	Circumferential Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
8	Radial Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
9	Circumferential Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
10	Radial Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
11	Circumferential Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
12	Radial Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
13	Circumferential Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
14	Radial Strain	Flow Separator Rib	0 to 5000	10	Budd C12-121	" "	Gilmore Model 114	Figure 9
15	Circumferential Strain	Flow Separator Rib	0 to 5000	10	Budd 12-12-S13	" "	Gilmore Model 114	Figure 9
16	45°	Flow Separator Rib	0 to 5000	10	Budd 12-12-S13	" "	Gilmore Model 114	Figure 9
17	Radial Strain	Flow Separator Rib	0 to 5000	10	Budd 12-12-S13	" "	Gilmore Model 114	Figure 9

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
18	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 10 at 90°
19	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 90°
20	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 270°
21	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 270°
22	Circumferential Strain	Inside P. V. ON Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 90°
23	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 90°
24	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031EC120	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 90°
25	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031DE120	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 90°
26	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 10 at 270°
27	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 270°
28	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031EC120	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 270°
29	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031DE120	" "	Gilmore Model 114	Figure 10 at 270°
30	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 10 at 90°
31	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 90°
32	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031EC120	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 90°
33	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031DE120	" "	Gilmore Model 114	Figure 10 at 90°
34	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C-12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 10 at 270°

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
35	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 10 at 270°
36	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031EC120	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 270°
37	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031DE120	" "	Gilmore Model 114	Figure 10 at 270°
38	Circumferential Strain	Inside P. V. ON Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 10 at 90°
39	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 90°
40	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031EC120	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 90°
41	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031DE120	" "	Gilmore Model 114	Figure 10 at 90°
42	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 10 at 270°
43	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 270°
44	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031EC 120	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 270°
45	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031DE120	" "	Gilmore Model 114	Figure 10 at 270°
46	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 10 at 90°
47	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 90°
48	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 90°
49	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 90°
50	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 10 at 270°
51	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 270°

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
52	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 270°
53	Radial Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 270°
54	Circumferential Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 10 at 90°
55	Radial Strain	Inside P.V. ON Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 90°
56	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 90°
57	Radial Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	GILMORE Model 114	Figure 10 at 90°
58	Circumferential Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7 11, 12, EC801	Gilmore Model 114	Figure 10 at 270°
59	Radial Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 270°
60	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 270°
61	Radial Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 270°
62	Circumferential Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF IS 7, 11, 12, EC801	Gilmore Model 114	Figure 10 at 90°
63	Radial Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 90°
64	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 90°
65	Radial Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 90°
66	Circumferential Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 10 at 270°
67	Radial Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 270°
68	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 270°

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
69	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 270°
70	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 10 at 90°
71	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 90°
72	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 90°
73	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 90°
74	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 10 at 270°
75	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 270°
76	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 10 at 270°
77	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 10 at 270°
78	Radial Strain	Flow Separator Rib	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 11 Long Rib
79	Radial Strain	Flow Separator Rib	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 11 Long Rib
80	Radial Strain	Flow Separator Rib	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 11 Short Rib
81	Radial Strain	Flow Separator Rib	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 11 Short Rib
82	Circumferential Strain	Flow (Top) Separator	0 to 5000	10	Fabr 12-12-513	" "	Gilmore Model 114	Figure 11 (Top)
83	45°	Flow (Top) Separator	0 to 5000	10	Fabr 12-12-513	" "	Gilmore Model 114	Figure 11 (Top)
84	Radial Strain	Flow (Top) Separator	0 to 5000	10	Fabr 12-12-513	" "	Gilmore Model 114	Figure 11 (Top)
85	Circumferential Strain	Flow (Bottom) Separator	0 to 5000	10	Fabr 12-12-513	" "	Gilmore Model 114	Figure 11 (Bottom)

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
86	45°	Flow (Bottom) Separator	0 to 5000	10	Fabr 12-12-513	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 11 (Bottom)
87	Radial Strain	Flow (Bottom) Separator	0 to 5000	10	Fabr 12-12-513	" "	Gilmore Model 114	Figure 11 (Bottom)
88	Circumferential Strain	Outside P. V. on Nozzle End	0 to 5000	10	Micro-Measurements EA-13-031EC120	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 12 at 90°
89	Radial Strain	Outside P. V. on Nozzle End	0 to 5000	10	Micro-Measurements EA-13-031DE120	" "	Gilmore Model 114	Figure 12 at 90°
90	Circumferential Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 12 at 90°
91	Radial Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 12 at 90°
92	Circumferential Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 12 at 45°
93	Radial Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 12 at 45°
94	Circumferential Strain	Outside P. V. on Nozzle End	0 to 5000	10	Micro-Measurements EA-13-031EC120	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 12 at 45°
95	Radial Strain	Outside P. V. on Nozzle End	0 to 5000	10	Micro-Measurements EA-13-031DE120	" "	Gilmore Model 114	Figure 12 at 45°
96	Circumferential Strain	Outside P. V. on Nozzle End	0 to 5000	10	Micro-Measurements EA-13-031EC120	" "	Gilmore Model 114	Figure 12 at 90°
97	Radial Strain	Outside P. V. on Nozzle End	0 to 5000	10	Micro-Measurements EA-13-031DE120	" "	Gilmore Model 114	Figure 12 at 90°
98	Circumferential Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 12 at 90°
99	Radial Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 12 at 90°
100	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031EC120	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 12 at 45°
101	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Micro-Measurements EA-13-031DE120	" "	Gilmore Model 114	Figure 12 at 45°
102	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 12 at 45°

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
103	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 12 at 45°
104	Circumferential Strain	Outside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 13 at 17°
105	Radial Strain	Outside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 13 at 17°
106	Circumferential Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 13 at 17°
107	Radial Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 13 at 17°
108	Circumferential Strain	Outside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 13 at 137°
109	Radial Strain	Outside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 13 at 137°
110	Circumferential Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 13 at 137°
111	Radial Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 13 at 137°
112	Circumferential Strain	Outside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 13 at 17°
113	Radial Strain	Outside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 13 at 17°
114	Circumferential Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 13 at 17°
115	Radial Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 13 at 17°
116	Circumferential Strain	Outside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 13 at 137°
117	Radial Strain	Outside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 13 at 137°
118	Circumferential Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 13 at 137°
119	Radial Strain	Inside P. V. on Nozzle End	0 to 5000	10	Budd C12-121-R2C	" "	Gilmore Model 114	Figure 13 at 137°

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
120	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 14 (Inside)
121	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14 (Inside)
122	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 14 (Outside)
123	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14 (Outside)
124	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 14 (Inside)
125	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14 (Inside)
126	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 14 (Outside)
127	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14 (Outside)
128	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 14 (Inside)
129	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14 (Inside)
130	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 14 (Outside)
131	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14 (Outside)
132	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 14 (Inside)
133	Radial Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14
134	Circumferential Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 14
135	Radial Strain	Outside P. V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14
136	Circumferential Strain	Inside P. V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 14

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
137	Radial Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 14
138	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 14
139	Radial Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14
140	Circumferential Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 14
141	Radial Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14
142	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-111	ACF I.S. 7, 11, 12, 13	Gilmore Model 114	Figure 14
143	Radial Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14
144	Circumferential Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S.7, 11,12,EC801	Gilmore Model 114	Figure 14
145	Radial Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14
146	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 14
147	Radial Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14
148	Circumferential Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 14
149	Radial Strain	Inside P.V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14
150	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-111	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 14
151	Radial Strain	Outside P.V. On Dome	0 to 5000	10	Budd C12-111	" "	Gilmore Model 114	Figure 14
152	Circumferential Strain	Inside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 14
153	45°	Inside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
154	Radial Strain	Inside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 14
155	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	ACF I. S. 7, 11,12,13	Gilmore Model 114	Figure 14
156	45°	Outside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
157	Radial Strain	Outside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
158	Circumferential Strain	Inside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 14
159	45°	Inside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
160	Radial Strain	Inside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
161	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 14
162	45°	Outside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
163	Radial Strain	Outside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
164	Circumferential Strain	Inside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 14
165	45°	Inside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
166	Radial Strain	Inside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
167	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 14
168	45°	Outside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
169	Radial Strain	Outside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
170	Circumferential Strain	Inside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	ACF I. S. 7, 11,12,EC801	Gilmore Model 114	Figure 14

Table 2 INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
171	45°	Inside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	ACFT I.S. 7, 11,12,EC801	Gilmore Model 114	Figure 14
172	Radial Strain	Inside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
173	Circumferential Strain	Outside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	ACFT I.S. 7, 11, 12, 13	Gilmore Model 114	Figure 14
174	45°	Outside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
175	Radial Strain	Outside P.V. On Dome	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 14
176	Circumferential Strain	Clamp Ring	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 15
177	45°	Clamp Ring	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 15
178	Radial Strain	Clamp Ring	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 15
179	Circumferential Strain	Clamp Ring	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 15
180	45°	Clamp Ring	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 15
181	Radial Strain	Clamp Ring	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 15
182	Circumferential Strain	Clamp Ring	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 15 at 90°
183	45°	Clamp Ring	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 15 at 90°
184	Radial Strain	Clamp Ring	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 15
185	Circumferential Strain	Clamp Ring	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 15
186	45°	Clamp Ring	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 15
187	Radial Strain	Clamp Ring	0 to 5000	10	Fabr 12-12-S13	" "	Gilmore Model 114	Figure 15

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
188	Circumferential Strain	Outside P. V. on Nozzle End	0 to 5000	10	C-12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 15
189	Radial Strain	Outside P. V. on Nozzle End	0 to 5000	10	C-12-121-R2C	" "	Gilmore Model 114	Figure 15
190	Circumferential Strain	Inside P. V. on Nozzle End	0 to 5000	10	C-12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 15
191	Radial Strain	Inside P. V. on Nozzle End	0 to 5000	10	C-12-121-R2C	" "	Gilmore Model 114	Figure 15
192	Circumferential Strain	Outside P. V. on Nozzle End	0 to 5000	10	C-12-121-R2C	ACF I. S. 7, 11, 12, 13	Gilmore Model 114	Figure 15
193	Radial Strain	Outside P. V. on Nozzle End	0 to 5000	10	C-12-121-R2C	" "	Gilmore Model 114	Figure 15
194	Circumferential Strain	Inside P. V. on Nozzle End	0 to 5000	10	C-12-121-R2C	ACF I. S. 7, 11, 12, EC801	Gilmore Model 114	Figure 15
195	Radial Strain	Inside P. V. on Nozzle End	0 to 5000	10	C-12-121-R2C	" "	B & F Recorder	Figure 15
196	Circumferential Strain	Inside P. V. On Dome End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	" "	B & F Recorder	Figure 10 at 90°
197	Radial Strain	Inside P. V. On Dome End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	" "	B & F Recorder	Figure 10 at 90°
198	Circumferential Strain	Outside P. V. On Dome End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	ACF I. S. 7, 11, 12, 13	B & F Recorder	Figure 10 at 90°
199	Radial Strain	Outside P. V. On Dome End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	" "	B & F Recorder	Figure 10 at 90°
200	Circumferential Strain	Inside P. V. On Dome End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	ACF I. S. 7, 11, 12, EC801	B & F Recorder	Figure 10 at 270°
201	Radial Strain	Inside P. V. On Dome End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	" "	B & F Recorder	Figure 10 at 270°
202	Circumferential Strain	Outside P. V. On Dome End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	ACF I. S. 7, 11, 12, 13	B & F Recorder	Figure 10 at 270°
203	Radial Strain	Outside P. V. On Dome End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	" "	B & F Recorder	Figure 10 at 270°
204	Circumferential Strain	Inside P. V. on Nozzle End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	ACF I. S. 7, 11, 12, EC801	B & F Recorder	Figure 13 at 0°

* Gages 196 through 211 are C12-121-R2C two gage rosettes during the high pressure hydrostatic tests.

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
205	Radial Strain	Inside P.V. on Nozzle End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	ACF I. S. 7, 11,12,EC801	B & F Recorder	Figure 13 at 0°
206	Circumferential Strain	Outside P.V. on Nozzle End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	ACF I. S. 7, 11, 12, 13	B & F Recorder	Figure 13 at 0°
207	Radial Strain	Outside P.V. on Nozzle End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	" "	B & F Recorder	Figure 13 at 0
208	Circumferential Strain	Inside P.V. on Nozzle End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	ACF I. S. 7, 11,12,EC801	B & F Recorder	Figure 13 at 90°
209	Radial Strain	Inside P.V. on Nozzle End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	" "	B & F Recorder	Figure 13 at 90°
210	Circumferential Strain	Outside P.V. on Nozzle End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	ACF I. S. 7, 11, 12, 13	B & F Recorder	Figure 13 at 90°
211	Radial Strain	Outside P.V. on Nozzle End	0 to 5000	10	*BLH FNB-25-12 (Cryogenic)	" "	B & F Recorder	Figure 13 at 90°
212	Axial Strain	Nozzle Bolt #1 0°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 0°
213	Axial Strain	Nozzle Bolt #1 90°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 0°
214	Axial Strain	Nozzle Bolt #1 180°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 0°
215	Axial Strain	Nozzle Bolt #1 270°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 0°
216	Axial Strain	Nozzle Bolt #2 0°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 90°
217	Axial Strain	Nozzle Bolt #2 90°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 90°
218	Axial Strain	Nozzle Bolt #2 180°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 90°
219	Axial Strain	Nozzle Bolt #2 270°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 90°
220	Axial Strain	Nozzle Bolt #3 0°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 180°
221	Axial Strain	Nozzle Bolt #3 90°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 180°

* Gages 196 through 211 are C12-121-R2C two gage rosettes during the high pressure hydrostatic tests.

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
222	Axial Strain	Nozzle Bolt #3 180°	0 to 10,000	20	Budd C6-111	ACF I. S. 7, 11, 12, 13	B & F Recorder	Figure 20 Bolt at 180°
223	Axial Strain	Nozzle Bolt #3 270°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 180°
224	Axial Strain	Nozzle Bolt #4 0°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 270°
225	Axial Strain	Nozzle Bolt #4 90°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 270°
226	Axial Strain	Nozzle Bolt #4 180°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 270°
227	Axial Strain	Nozzle Bolt #4 270°	0 to 10,000	20	Budd C6-111	" "	B & F Recorder	Figure 20 Bolt at 270°
228	Radial Displacement	Inside Main Clos. Int'face	0 to 5000	10	ACF Series "D" Displacement Gage	ACF I.S. 7, 11,12,EC801	B & F Recorder	Figure 17 at 45°
229	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "D" Displacement Gage	" "	B & F Recorder	Figure 17 at 45°
230	Radial Displacement	Inside Main Clos. Int'face	0 to 5000	10	ACF Series "D" Displacement Gage	ACF I. S. 7, 11,12,EC801	B & F Recorder	Figure 17 at 90°
231	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "D" Displacement Gage	" "	B & F Recorder	Figure 17 at 90°
232	Radial Displacement	Inside Main Clos. Int'face	0 to 5000	10	ACF Series "D" Displacement Gage	" "	B & F Recorder	Figure 17 at 225°
233	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "D" Displacement Gage	" "	B & F Recorder	Figure 17 at 225°
234	Radial Displacement	Inside Main Clos. Int'face	0 to 5000	10	ACF Series "D" Displacement Gage	" "	B & F Recorder	Figure 17 at 270°
235	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "D" Displacement Gage	ACF I. S. 7, 11, 12, 13	B & F Recorder	Figure 17 at 270°
236	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 18 at 0°
237	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 18 at 0°
238	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 18 at 180°

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
239	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "C" Displacement Gage	ACF I. S. 7, 11, 12, 13	B & F Recorder	Figure 18 at 180°
240	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 18 at 0°
241	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 18 at 180°
242	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 18 at 0°
243	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 18 at 180°
244	Vessel Rotation	Outside Main Clos. Int'face	0 to 5000	10	Gage 236 minus 238	----	B & F Recorder	Figure 18 at 0°
245	Vessel Rotation	Outside Main Clos. Int'face	0 to 5000	10	Gage 237 minus 239	----	B & F Recorder	Figure 18 at 180°
246	Vessel Rotation	Outside Main Clos. Int'face	0 to 5000	10	Gage 240 minus 242	----	B & F Recorder	Figure 18 at 0°
247	Vessel Rotation	Outside Main Clos. Int'face	0 to 5000	10	Gage 241 minus 243	----	B & F Recorder	Figure 18 at 180°
248	Radial Displacement	Outside Main Clos. Int'face	0 to 5000	10	ACF Series "C" Displacement Gage	ACF I. S. 7, 11, 12, 13	B & F Recorder	Figure 16 at 0°
249	Radial Displacement	Outside P. V. On Dome	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 16 at 180°
250	Radial Displacement	Outside P. V. On Dome	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 16 at 0°
251	Radial Displacement	Outside P. V. On Dome	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 16 at 180°
252	Radial Displacement	Outside P. V. On Dome	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B&F Recorder	Figure 16 at 0°
253	Radial Displacement	Outside P. V. On Dome	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 16 at 180°
254	Radial Displacement	Outside P. V. On Dome	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 16 at 0°
255	Radial Displacement	Outside P. V. On Dome	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B&F Recorder	Figure 16 at 180°

Table 2. INSTRUMENTATION LIST

Gage No.	Measurement				Gage Identification	Gage Installation	Recording Instrument	Reference
	Description	Location	Range $\mu\text{in/in}$	Sensitivity $\mu\text{in/in}$				
256	Radial Displacement	Outside P. V. On Dome	0 to 5000	10	ACF Series "C" Displacement Gage	ACF I. S. 7, 11, 12, 13	B & F Recorder	Figure 16 at 0°
257	Radial Displacement	Outside P. V. On Dome	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 16 at 180°
258	Radial Displacement	Outside P. V. On Dome	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 16 at 0°
259	Radial Displacement	Outside P. V. On Dome	0 to 5000	10	ACF Series "C" Displacement Gage	" "	B & F Recorder	Figure 16 at 180°
260	Vessel Rotation	Outside P. V. On Dome	0 to 5000	10	Gage 242 minus 244	----	B & F Recorder	Figure 16
261	Vessel Rotation	Outside P. V. On Dome	0 to 5000	10	Gage 246 minus 248	----	B & F Recorder	Figure 16
262	Vessel Rotation	Outside P. V. On dome	0 to 5000	10	Gage 250 minus 252	----	B & F Recorder	Figure 16
263	Vessel Rotation	Outside P. V. On Dome	0 to 5000	10	Gage 243 minus 245	----	B & F Recorder	Figure 16
264	Vessel Rotation	Outside P. V. On Dome	0 to 5000	10	Gage 247 minus 249	----	B & F Recorder	Figure 16
265	Vessel Rotation	Outside P. V. On Dome	0 to 5000	10	Gage 251 minus 253	----	B & F Recorder	Figure 16

Figure 16. DEFLECTION GAGE LOCATIONS TO MEASURE RADIAL DISPLACEMENT AND ROTATION PRESSURE VESSEL DOME END

Figure 17. DISPLACEMENT GAGE LOCATIONS FOR MEASUREMENT OF GAP SEPARATION MAIN CLOSURE

Figure 18. DISPLACEMENT GAGE LOCATIONS FOR MEASUREMENT OF CLOSURE ROTATION, MAIN CLOSURE

- NOTES:
1. Typical setup for channels 244 through 247 and 260 through 265
 2. Channels 236 and 238 read independently
 3. Channel 240 reads channel 236 minus 238

Figure 19. ELECTRICAL SCHEMATIC FOR ROTATION MEASUREMENTS

Table 3

STRUCTURAL PROOF TEST LOADING SCHEDULE

Load %	Pressure Vessel Chamber, P_1 psig	Flow Separator- Dome Chamber, P_2 psig	Load %	Pressure Vessel Chamber, P_1 psig	Flow Separator- Dome Chamber, P_2 psig
0	0	0	80	1200	1220
30	450	450	90	1350	To Be
0	0	0	100	1500	Determined
30	450	450	70**	1050	During Test
0	0	0	0	0	
30	450	450	100***	1500	
0	0	0	0	0	
0*	0	0	100***	1500	
10	150	150	0	0	
20	300	300	* Preset strain indications to include assembly loads ** Pressure to be held for visual Stresscoat evaluation *** Pressurize the clamp ring to 1800 psig during this phase of the test.		
30	450	450			
40	600	600			
50	750	750			
60	900	900			
70	1050	1050			
80	1200	1200			
80	1200	1205			
80	1200	1210			
80	1200	1215

Figure 20. STRAIN GAGE INSTRUMENTATION ON NOZZLE BOLTS

ACF-411-294

NOTE:

1. Thermocouples located 90° from coolant connections.

Figure 21. THERMOCOUPLE LOCATIONS, CLAMP RING AREA

Figure 22. CRYOGENIC STRAIN GAGE HOOKUP TO GILMORE

Figure 23. CRYOGENIC TEST SETUP

BLANK