

**QUALIFICATION ENVIRONMENTS**  
**FOR**  
**PROPELLANT TANK WITH PMD**  
**ATK P/N 80421-1**



ORBCOMM Propellant Tank 80421-1



**Table 1: P/N 80421-1 Propellant TANK SPECIFICATIONS**

<b>Parameters</b>	<b>Requirements</b>
Operating Pressure	400 psig
Proof Pressure	526 psig, Actual Proof: 531 psig
Burst Pressure	625 psig, Actual Burst: 1791 psig
External Pressure	16 Torr for twenty (20) minutes.
Internal Vacuum	
Material of Construction	Cylindrical Pressure vessel constructed out of lightweight 6AL-4V titanium with two stainless-to-titanium inertia welded transition tubes.
Membrane Thickness	0.028 inch
Tank Mount(s)	Mounting is accomplished through four .250-28 UNF-3B threads on the ported as the fixed interface. The blind end is a slip interface using a MS1502-B bearing.
Expulsion Efficiency	96.77 %
Design Fill Fraction	
Tank Capacity	531.62 in <sup>3</sup>
Internal Dimensions	4.91" Ø x 28.21"
Tank Weight	Maximum tank weight is 4.25 lbs, Actual tank weight is lbs
Propellant Capacity	lbs
Shell Leakage	<1x10 <sup>-6</sup> std cc/sec He max, Actual: 1.0 x10 <sup>-9</sup> scc/sec He @ 405 psig
Failure Mode	Burst
Natural Frequency	
Temperature Environment	
On Orbit Life	

**80421-1 was subjected to the following qualification tests:**

<b>Test Sequence</b>	<b>Test Description</b>
1	Preliminary Examination of Product
2	Pre-Proof Volume Determination
3	Proof Pressure
4	Post-Proof Volume Determination
5	Internal Vacuum Compatibility
6	Proof Pressure Cycle Life
7	MEOP Pressure Cycle Life
8	Differential Pressure & Expulsion Efficiency
9	Volume Determination
10	Vibration - Random (Wet & Dry)
11	Bubble Point Test *
12	External Leakage *
13	Radiographic Inspection
14	Penetrant Inspection
15	Mass Measurement and Visual Inspection
16	Burst Test
17	Data Review

Note: The following tests are only included in this report

- 1) Proof Pressure Test
- 2) Internal Vacuum Test
- 3) Proof Pressure Cycle Life
- 4) MEOP Pressure Cycle Life
- 5) Vibration Random (Wet & Dry)
- 6) Burst Test**

# Proof Pressure Test

Pressurized to 631 psig and held for five minutes. One cycle.

PRESSURE SYSTEMS, INC

Procedure No. 50-000551  
Page 31

## DATA SHEET "C" PROOF PRESSURE TEST (Paragraph 4.3)

Date: 1-25-00  
PSI Part No: 80421-11  
Customer Serial No.: N/A PSI Serial No.: 0001R  
Test Equipment: PRES. GAUGE PSI Part Name: Propellant Tank  
ST-1054 CAL 12-3-99 DUE 6-3-00

Test Media: Distilled/Deionized Water

	<u>Actual</u>	<u>Requirement</u>
Pressurization Rate	<u>20</u> psig	<u>20 psi/sec. maximum</u>
Test Pressure	<u>531</u> psig	<u>526, +10, -0 psig</u>
Time at 526, +10, -0 psig	<u>5</u> min	<u>5, +0.5, -0 minutes</u>
Cycles	<u>1</u>	<u>One (1)</u>
Visual Examination for Damage	<u>NONE</u>	<u>None Allowed</u>

Tested By: [Signature] Date: 1-25-00 Specimen Passed YES  
Specimen Failed NO

**Internal Vacuum Test**

Tank will be subjected to an internal vacuum through the pressurant port of 0.0001 Torr while exposed to external atmospheric conditions. Vacuum is held for 30 seconds minimum.


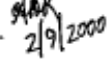
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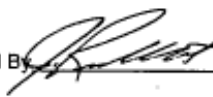

Procedure No. 50-000551  
Page 32

**DATA SHEET "D"  
INTERNAL VACUUM TEST  
(Paragraph 4.5)**

Date: 2-9-00  
 PSI Part No: 80421-11  
 Customer Serial No.: N/A PSI Serial No.: 00019  
 Test Equipment: GAGE, CONVECTION PSI Part Name: Propellant Tank  
10# ST-1151 CAL DATE 8-13-99 DJE 2-13-00

**Test Media:**

	<u>Actual</u>	<u>Requirement</u>
Internal Vacuum	<u>16 M TORR</u>	<del>0.0001 TORR</del> <u>RECORD</u> 
Time at Vacuum	<u>20 MIN. -see</u>	<u>30 seconds minimum</u> 
Cycles	<u>1</u>	<u>One (1)</u>
Visual Examination for Damage	<u>NONE</u>	<u>None Allowed</u>

Tested By:  Date: 2-9-00  Specimen Passed Y+S  
 Specimen Failed NO

# Proof Pressure Cycle Life Test

Tank is pressurized to 526, +10/-0 psig and held for 30, +5/-0 seconds.  
 Pressurization rate shall not exceed 20 psi/second. Number of cycles is 15.

PRESSURE SYSTEMS, INC

F Procedure No. 50-000551  
 Page 33

## DATA SHEET "E" PROOF PRESSURE CYCLE LIFE TEST (Paragraph 4.6)

Date: 1.25.00  
 PSI Part No.: 80421-11  
 Customer Serial No.: N/A PSI Serial No.: 0001Q  
 Test Equipment: PRES GAUGE ST-105A PSI Part Name: Propellant Tank  
CAL 12.3.99 DUE 6.3.00

Test Media: Distilled/Deionized Water

### Requirements

Test Pressure 526 +10. -0 psig  
 Pressurization Rate 20 psi / sec. max  
 Hold Period at Pressure 30 + 5. -0 seconds  
 Number of Cycles Fifteen (15)

CYCLE NO.	TEST PRESSURE	PRESSURIZATION RATE	HOLD PERIOD	CYCLE NO.	TEST PRESSURE	PRESSURIZATION RATE	HOLD PERIOD
1	531	20	30	9	529	20	30
2	531	20	30	10	528	20	30
3	530	20	30	11	535	20	30
4	530	20	30	12	534	20	30
5	528	20	30	13	534	20	30
6	531	20	30	14	532	20	30
7	529	20	30	15	534	20	30
8	532	20	30				

Tested By [Signature] Date 1.25.00 Specimen Passed YES  
 Specimen Failed NO

# MEOP Pressure Cycle Life Test

Tank is pressurized to 400, +10/-0 psig and held for 30, +5/-0 seconds.  
 Pressurization rate shall not exceed 20 psi/second. Number of cycles is 50.

PRESSURE SYSTEMS, INC

Procedure No. 50-000551  
 Page 34

## DATA SHEET "F" MEOP PRESSURE CYCLE LIFE TEST (Paragraph 4.7)

Date: 1.25.00

PSI Part No: 80421-11

Customer Serial No.: N/A

PSI Serial No.: 0001Q

Test Equipment: PRES. GAUGE ST. 1054  
CAL 12.3.99 DUE 6.3.00

PSI Part Name: Propellant Tank

Test Media: Distilled/Deionized Water

### Requirements

Test Pressure 400, +10, -0 psig  
 Pressurization Rate 20 psi / sec. max  
 Hold Period at Pressure 30 + 5, -0 seconds  
 Number of Cycles Fifty (50)

CYCLE NO.	TEST PRESSURE	PRESSURIZATION RATE	HOLD PERIOD	CYCLE NO.	TEST PRESSURE	PRESSURIZATION RATE	HOLD PERIOD
1	407	20	30	10	403	20	30
2	402	20	30	11	407	20	30
3	402	20	30	12	408	20	30
4	403	20	30	13	406	20	30
5	402	20	30	14	407	20	30
6	402	20	30	15	408	20	30
7	404	20	30	16	407	20	30
8	405	20	30	17	407	20	30
9	402	20	30	18	407	20	30

Tested By [Signature] Date 1.25.00

Specimen Passed YES

Specimen Failed No



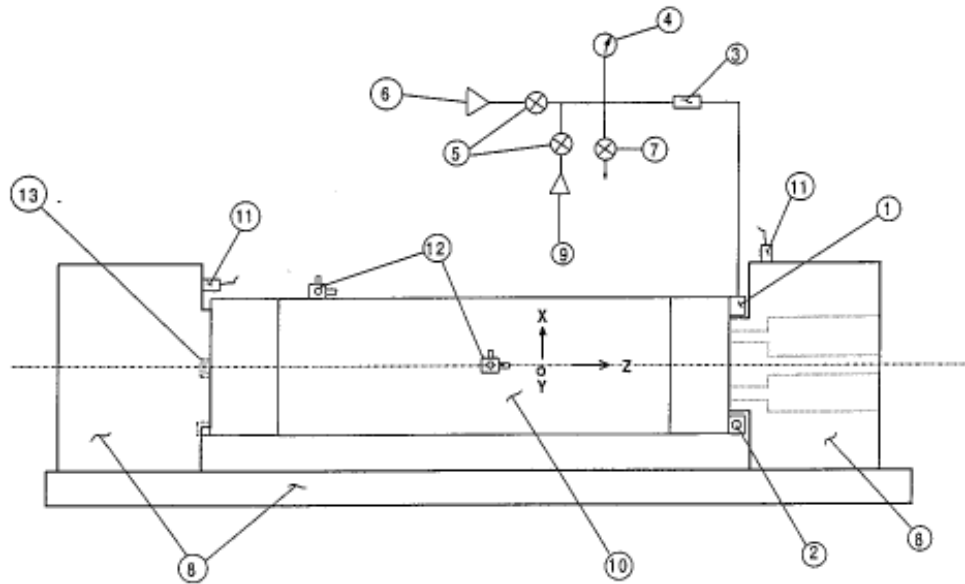
DATA SHEET "F-1"  
MEOP PRESSURE CYCLE LIFE TEST  
(Paragraph 4.7)

CYCLE NO.	TEST PRESSURE	PRESSURIZATION RATE	HOLD PERIOD	CYCLE NO.	TEST PRESSURE	PRESSURIZATION RATE	HOLD PERIOD
19	402	20	30	42	401	20	30
20	403	20	30	43	410	20	30
21	410	20	30	44	401	20	30
22	401	20	30	45	409	20	30
23	410	20	30	46	400	20	30
24	403	20	30	47	402	20	30
25	410	20	30	48	405	20	30
26	402	20	30	49	401	20	30
27	405	20	30	50	410	20	30
28	410	20	30				
29	408	20	30				
30	407	20	30				
31	407	20	30				
32	410	20	30				
33	406	20	30				
34	405	20	30				
35	407	20	30				
36	402	20	30				
37	406	20	30				
38	405	20	30				
39	407	20	30				
40	405	20	30				
41	403	20	30				

Tested By *[Signature]* Date 1-25-00 Specimen Passed YES  
Specimen Failed NO

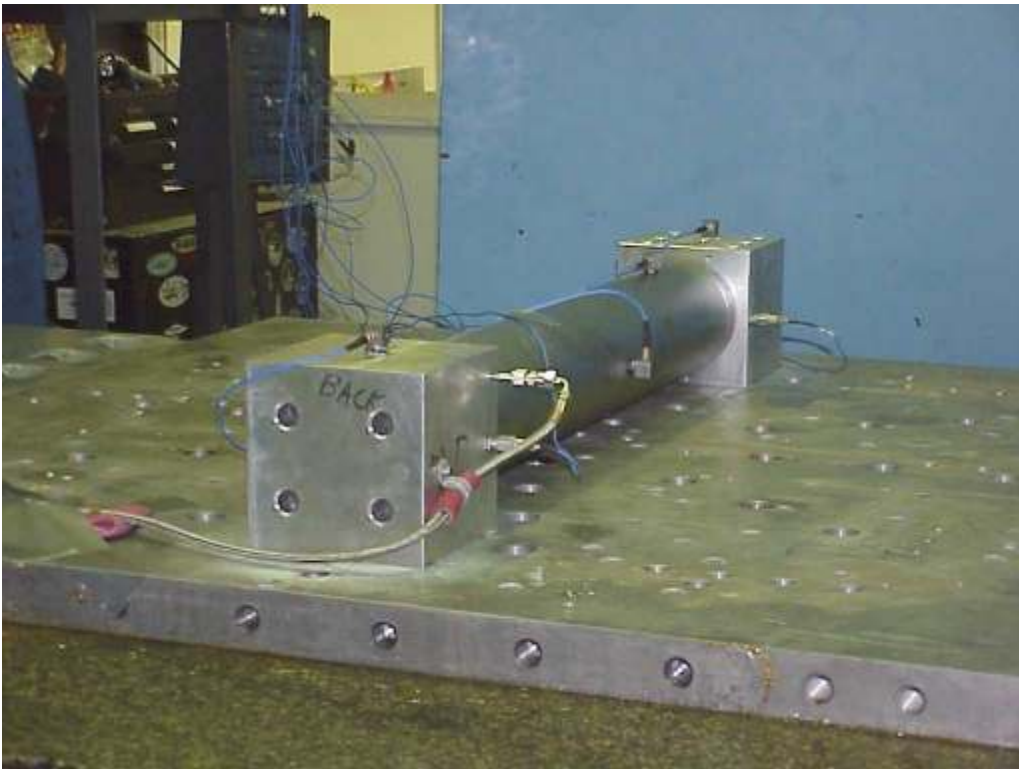
# Vibration Test Set-Up

FIGURE NO. 7  
RANDOM VIBRATION TEST  
TEST SET-UP



1. Pressurant Port
2. Propellant Port
3. Filter
4. Pressure Gauge
5. Shut-Off Valve
6. Pressurized Deionized Water Supply
7. Vent Valve (Nitrogen and Water)
8. Test Fixture No. T-6038 (Two (2) Mounting Blocks and one (1) Base Plate, All Magnesium)
9. Regulated Nitrogen Supply
10. Specimen
11. Control Accelerometer (2 Required)
12. Tri-Axial Response Accelerometer (2 Required)
13. Bearing, MS 14102-8 (1 Required)

## Vibration Test Pictures



## Random Vibration Test (Wet & Dry)

<u>Random Vibration Levels</u>	
<u>Frequency (Hz)</u>	<u>Levels (g<sup>2</sup>/Hz)</u>
15	0.096
20	1.194
60	1.194
70	0.096
1350	0.096
2000	0.016

TEST DURATION = 3 min/axis  
Grms = 14.28

Vibration tested in each of the three orthogonal axes.

For the dry condition, tank is pressurized to 400 psig.

For the wet condition, tank is loaded with 18.3 lbs of water and pressurized to 400 psig.

DATA SHEET "F"  
WET RANDOM VIBRATION ("X"-AXIS - LATERAL)  
(SHEET 2 OF 4)

Date: 2.3.00  
 PSI Part No. 80421-11  
 Customer Serial No. N/A  
 PSI Serial No. 0001Q  
 Paragraph No. 4.10.4 & 4.10.8  
 PSI Part Name: Propellant Tank  
 Test Equipment: SEE NTS EQUIP LIST

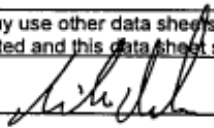
X-AXIS (Full Level Run)								
Axis	Frequency		G2/Hz	Grms	dB/Oct	Run Time	Date	Comment
	From	To						
X	SEE NTS DATA SHEETS						2.3.00	

Date	Time	Log Entries
2.3.00	9:01	PRE SINE SEARCH
2.3.00	11:37	FULL LEVEL RANDOM
2.3.00	14:28	POST SINE SEARCH

Test Media: Distilled, Deionized Water and Nitrogen Gas

	Actual	Requirement
Specimen Load	<u>18.3</u> lbs	<u>18.3 + 0.2</u> lbs
Specimen Pressure (Before Test)	<u>400</u> psig	<u>400, +10, -0</u> psig
Specimen Pressure (After Test)	<u>400</u> psig	<u>400, +10, -0</u> psig
Shaft Engagement	<u>.515</u> in.	<u>0.460</u> inches
1/4-28 Mtg. Fastener Torque	<u>65</u> in/lbs	<u>60-65</u> in/lbs
Specimen Damage After Test	<u>NONE</u>	<u>None Allowed</u>

Vendor may use other data sheets and attach them to this sheet, but the top of this data sheet shall be completed and this data sheet shall be signed and witnessed.

Tested By: [Signature]  Date 2.3.00 Specimen Passed YES  
 Specimen Failed NO

DATA SHEET "I"  
WET RANDOM VIBRATION ("Y"-AXIS - LATERAL)  
(SHEET 3 OF 4)

Date: 2.3.00  
 PSI Part No. 80421-11  
 Customer Serial No. N/A  
 PSI Serial No. 0001Q  
 Paragraph No. 4.10.4 & 4.10.8  
 PSI Part Name: Propellant Tank  
 Test Equipment: SEE NTS EQUIP LIST


Y-AXIS (Full Level Run)									
Axis	Frequency		G2/Hz	Grms	dB/Oct	Run Time	Date	Comment	
	From	To							
Y	SEE NTS DATA SHEETS						2.3.00		

Date	Time	Log Entries
2.3.00	15:08	PRE SINE SEARCH
2.3.00	15:31	FULL LEVEL RANDOM
2.3.00	15:50	POST SINE SEARCH

Test Media: Distilled, Deionized Water and Nitrogen Gas

	Actual	Requirement
Specimen Load	<u>18.3</u> lbs	<u>18.3 ± 0.2 lbs</u>
Specimen Pressure (Before Test)	<u>400</u> psig	<u>400, +10, -0 psig</u>
Specimen Pressure (After Test)	<u>400</u> psig	<u>400, +10, -0 psig</u>
Shaft Engagement	<u>.515</u> in.	<u>0.460 inches</u>
1/4-28 Mtg. Fastener Torque	<u>65</u> in/lbs	<u>60-65 in/lbs</u>
Specimen Damage After Test	<u>NONE</u>	<u>None Allowed</u>

Vendor may use other data sheets and attach them to this sheet, but the top of this data sheet shall be completed and this data sheet shall be signed and witnessed.

Tested By: [Signature]  Date 2.3.00  
 Specimen Passed YES  
 Specimen Failed NO

DATA SHEET "I"  
WET RANDOM VIBRATION ("Z"-AXIS - AXIAL)  
(SHEET 4 OF 4)

Date: 2.3.00  
 PSI Part No. 80421-11  
 Customer Serial No. N/A PSI Serial No. 0001Q  
 Paragraph No. 4.10.4 & 4.10.8 PSI Part Name: Propellant Tank  
 Test Equipment: SEE NTS EQUIP LIST

Z-AXIS (Full Level Run)


Axis	Frequency		G2/Hz	Grms	dB/Oct	Run Time	Date	Comment
	From	To						
<u>Z</u>	<u>SEE NTS DATA SHEETS</u>						<u>2.3.00</u>	

Date	Time	Log Entries
<u>2.3.00</u>	<u>16:27</u>	<u>PRE SINE SEARCH</u>
<u>2.3.00</u>	<u>17:03</u>	<u>FULL LEVEL RANDOM</u>
<u>2.3.00</u>	<u>17:15</u>	<u>POST SINE SEARCH</u>

Test Media: Distilled, Deionized Water and Nitrogen Gas

	Actual	Requirement
Specimen Load	<u>18.3</u> lbs	<u>18.3 ± 0.2</u> lbs
Specimen Pressure (Before Test)	<u>400</u> psig	<u>400, +10, -0</u> psig
Specimen Pressure (After Test)	<u>400</u> psig	<u>400, +10, -0</u> psig
Shaft Engagement	<u>.515</u> in.	<u>0.460</u> inches
1/4-28 Mtg. Fastener Torque	<u>65</u> in/lbs	<u>60-65</u> in/lbs
Specimen Damage After Test	<u>NONE</u>	<u>None Allowed</u>

Vendor may use other data sheets and attach them to this sheet, but the top of this data sheet shall be completed and this data sheet shall be signed and witnessed.

Tested By: [Signature]  Date 2.3.00 Specimen Passed YES  
 Specimen Failed NO

**DATA SHEET "J"  
DRY RANDOM VIBRATION TESTS  
(SHEET 1 OF 4)**

Date: 2.1.00  
 PSI Part No: 80421-11  
 Customer Serial No.: N/A PSI Serial No.: 0001Q  
 Paragraph No.: 4.10.5 PSI Part Name: Propellant Tank  
 Test Equipment: SEES NTS EQUIP. LIST

Accelerometer	Response	Control
Locations - X: (Lateral)	<u>R1X CENTER OF TANK, R2X FREE END, R3X FIXED END BLOCK, R4X FREE END BLOCK</u>	<u>C1 FIXED END BLOCK C2 FREE END BLOCK</u>
Y: (Lateral)	<u>R1Y CENTER OF TANK, R2Y FREE END, R3Y FIXED END BLOCK, R4Y FREE END BLOCK</u>	<u>C1 FIXED END BLOCK C2 FREE END BLOCK</u>
Z: (Axial)	<u>R1Z CENTER OF TANK, R2Z FREE END, R3Z FIXED END BLOCK R4Z FREE END BLOCK</u>	<u>C1 FIXED END BLOCK C2 FREE END BLOCK</u>

Sketches made or photographs taken of accelerometer locations. Actual  Requirement   
Compliance

Vendor may use other data sheets and attach them to this sheet, but the top of this data sheet shall be completed and this data sheet shall be signed and witnessed.

Tested By: [Signature]  Date: 2.3.00 Specimen Passed: YES  
 Specimen Failed: NO



DATA SHEET "J"  
DRY RANDOM VIBRATION ("X"-AXIS - LATERAL)  
(SHEET 2 OF 4)

Date: 2.2.00

PSI Part No. 80421-11

Customer Serial No. N/A

PSI Serial No. 0001 Q

Paragraph No. 4.10.4 & 4.10.7

PSI Part Name: Propellant Tank

Test Equipment: SEE NTS EQUIP LIST

X-AXIS

Axis	Frequency		G2/Hz	Grms	dB/Oct	Run Time	Date	Comment
	From	To						
X	SEE NTS DATA SHEETS						2.2.00	

Date	Time	Log Entries
2.2.00	16:42	PRE SINE SEARCH
2.2.00	17:56	FULL LEVEL RANDOM
2.2.00	18:18	POST SINE SEARCH

Test Media: Distilled, Deionized Water and Nitrogen Gas

	Actual	Requirement
Specimen Pressure (Before Test)	<u>400</u> psig	400, +10, -0 psig
Specimen Pressure (After Test)	<u>400</u> psig	400, +10, -0 psig
Shaft Engagement	<u>.515</u> in.	0.460 inches
1/4-28 Mtg. Fastener Torque	<u>65</u> in/lbs	60-65 in/lbs
Specimen Damage After Test	<u>NONE</u>	None Allowed

Vendor may use other data sheets and attach them to this sheet, but the top of this data sheet shall be completed and this data sheet shall be signed and witnessed.

Tested By: [Signature] Date 2.2.00

Specimen Passed YES  
Specimen Failed NO

DATA SHEET "J"  
DRY RANDOM VIBRATION ("Y"-AXIS - LATERAL)  
(SHEET 3 OF 4)

Date: 2.2.00  
 PSI Part No. 80421-11  
 Customer Serial No. N/A  
 PSI Serial No. 0001Q  
 Paragraph No. 4.10.4 & 4.10.7  
 PSI Part Name: Propellant Tank  
 Test Equipment: SEE NTS EQUIP LIST

Y-AXIS								
Axis	Frequency		G2/Hz	Grms	dB/Oct	Run Time	Date	Comment
	From	To						
Y	SEE NTS DATA SHEETS						2.2.00	

Date	Time	Log Entries
2.2.00	12:03	PRE SINE SEARCH
2.2.00	13:40	FULL LEVEL RANDOM
2.2.00	14:07	POST SINE SEARCH

Test Media: Distilled, Deionized Water and Nitrogen Gas

	Actual	Requirement
Specimen Pressure (Before Test)	<u>400</u> psig	<u>400, +10, -0</u> psig
Specimen Pressure (After Test)	<u>400</u> psig	<u>400, +10, -0</u> psig
Shaft Engagement	<u>.515</u> in.	<u>0.460</u> inches
1/4-28 Mtg. Fastener Torque	<u>65</u> in/lbs	<u>60-65</u> in/lbs
Specimen Damage After Test	<u>NONE</u>	<u>None Allowed</u>

Vendor may use other data sheets and attach them to this sheet, but the top of this data sheet shall be completed and this data sheet shall be signed and witnessed.

Tested By: [Signature] Date 2.2.00  
 Specimen Passed YES  
 Specimen Failed NO

DATA SHEET "J"  
DRY RANDOM VIBRATION ("Z"-AXIS - AXIAL)  
(SHEET 4 OF 4)

Date: 2.1.00  
 PSI Part No. 80421-11  
 Customer Serial No. N/A  
 PSI Serial No. 0001Q  
 Paragraph No. 4.10.4 & 4.10.7  
 PSI Part Name: Propellant Tank  
 Test Equipment: SEE NTS EQUIP. LIST


Z-AXIS								
Axis	Frequency		G2/Hz	Grms	dB/Oct	Run Time	Date	Comment
	From	To						
<u>Z</u>	<u>SEE NTS DATA SHEETS</u>						<u>2.1.00</u>	

Date	Time	Log Entries
<u>2.1.00</u>	<u>11:22</u>	<u>ADJ LEVEL RANDOM</u>

Test Media: Distilled, Deionized Water and Nitrogen Gas

	Actual	Requirement
Specimen Pressure (Before Test)	<u>400</u> psig	<u>400, +10, -0</u> psig
Specimen Pressure (After Test)	<u>400</u> psig	<u>400, +10, -0</u> psig
Shaft Engagement	<u>.515</u> in.	<u>0.460</u> inches
1/4-28 Mtg. Fastener Torque	<u>65</u> in/lbs	<u>60-65</u> in/lbs
Specimen Damage After Test	<u>NONE</u>	<u>None Allowed</u>

Vendor may use other data sheets and attach them to this sheet, but the top of this data sheet shall be completed and this data sheet shall be signed and witnessed.

Tested By: [Signature]  Date 2.1.00 Specimen Passed YES  
 Specimen Failed NO

## Burst Test

Note: Test was aborted. See Data Sheet N-1 for new results.

Tank design burst pressure is 625 psig, held at 15 seconds.

The actual burst pressure was 1791 psig.

PRESSURE SYSTEMS, INC.

Procedure No. 50-000551  
Page 49

### DATA SHEET "N" BURST TEST (Paragraph 4.16)

Date: 2-10-00

PSI Part No: 80421-11

Customer Serial No.: N/A

PSI Serial No.: 00019


Test Equipment: GAGE, TRANSDUCER

PSI Part Name: Propellant Tank

ST-1045 CAL DATE 12-3-99 DUE 6-3-00

Test Media: Distilled/Deionized Water

	<u>Test Value</u>	<u>Requirement</u>
A) Specimen Water Temperature	<u>70</u> deg. F	<u>Record</u>
B) Design Burst Pressure (=P <sub>b</sub> ) (From Paragraph 4.16C)	<u>625</u> psig	<u>PB, +10.0, -0 psig</u>
C) Pressurization Rate to Burst	<u>600</u> psig/min	<u>1200 psig/minute</u>
D) Time at Pressure	<u>          </u> sec	<u>15 sec. Minimum</u>
E) Evidence of Rupture or Leak	<u>          </u>	<u>None Allowed</u>
F) Pressurization Rate Between Burst Pressure and Rupture	<u>          </u> psig/min	<u>1200 psig/minute</u>
G) Rupture Pressure	<u>          </u> psig	<u>Record</u>
H) Visual Inspection	<u>          </u>	<u>Compliance</u>

TEST ABORTED IDR#6671  FEB 11 2000

Tested By:   Date 2-10-00

Specimen Passed NO  
Specimen Failed YES

**DATA SHEET "N-1"  
BURST TEST  
(Paragraph 4.16)**

Date: 2-10-00  
 PSI Part No: 80421-11  
 Customer Serial No.: N/A PSI Serial No.: 00019  
 Test Equipment: GAGE TRANSDUCER PSI Part Name: Propellant Tank  
ST-1045 CAL DATE 12-3-99 DUE 6-3-00

Test Media: Distilled/Deionized Water

	<u>Test Value</u>	<u>Requirement</u>
A) Specimen Water Temperature	<u>73</u> deg. F	<u>Record</u>
B) Design Burst Pressure (=P <sub>b</sub> ) (From Paragraph 4.16C)	<u>625</u> psig	<u>PB, +10.0, -0 psig</u>
C) Pressurization Rate to Burst	<u>600</u> psig/min	<u>1200 psig/minute</u>
D) Time at Pressure	<u>15</u> sec	<u>15 sec. Minimum</u>
E) Evidence of Rupture or Leak	<u>NONE</u>	<u>None Allowed</u>
F) Pressurization Rate Between Burst Pressure and Rupture	<u>600</u> psig/min	<u>1200 psig/minute</u>
G) Rupture Pressure	<u>1791</u> psig	<u>Record</u>
H) Visual Inspection	<u>YES</u>	<u>Compliance</u>

Tested By: [Signature] Date 2-10-00 Specimen Passed Yes  
 Specimen Failed NO

**Burst Tank Pictures**



