

**PROTOFLIGHT ENVIRONMENTS**  
**FOR**  
**MODIFIED TEMPO PROPELLANT PRESSURE VESSEL**  
**ATK P/N 80441-1**



MODIFIED TEMPO PROPELLANT PRESSURE VESSEL

ATK P/N 80441-1

**Table 1: P/N 80441-1 Modified Tempo Propellant Pressure Vessel Specifications**

| <b>Parameters</b>        | <b>Requirements</b>   |
|--------------------------|---|
| Operating Pressure       | psig  |
| Proof Pressure           | 320 psig, Actual Proof: psig  |
| Burst Pressure           | psig, Actual Burst: psig  |
| External Pressure        |   |
| Internal Vacuum          |   |
| Material of Construction | Hemispherical pressure vessel with cylindrical section of all welded construction.                            |
| Membrane Thickness       | 0.034 inch  |
| Tank Mount(s)            | Mounted by 32 circumferential tabs with nut tabs located on one of the hemispheres near the girth weld joint. |
| Expulsion Efficiency     |   |
| Design Fill Fraction     |   |
| Tank Capacity            | 77,431.8 in <sup>3</sup>  |
| Internal Dimensions      | 49.250" Ø x 57.800" long hemispherical  |
| Tank Weight              | Nominal tank weight is 91 lbs, Actual tank weight is 88.2 lbs   |
| Propellant Capacity      | N/A   |
| Shell Leakage            | <1x10 <sup>-6</sup> std cc/sec He max, Actual: 2 x10 <sup>-8</sup> scc/sec He @ 240 psig                      |
| Failure Mode             | Burst   |
| Natural Frequency        |   |
| Temperature Environment  |   |
| On Orbit Life            |   |

**80441-1 was subjected to the following protoflight tests:**

1. Preliminary Inspection of Product
2. Mass Measurement
3. Pre-Proof Volumetric Capacity
4. Ambient Proof Pressure Test
5. Post-Proof Volumetric Capacity
6. External Leakage Test
7. Tank Assembly Bubble Point Tests
8. Dry Sine, Wet Sine, and Wet Random Vibration Tests
9. Pressure Drop Test
10. External Leakage Test
11. Tank Assembly Bubble Point Tests
12. Radiographic Inspection
13. Dye Penetrant Inspection
14. Final Tank Cleaning and Packaging and Visual Inspection
15. Final Data Review

Note: The following tests are only included

- 1) Pressure Log
- 2) Ambient Proof Pressure Test
- 3) Sine Vibration Test
- 4) Random Vibration Test
- 5) Pressure Drop Test



### **Ambient Proof Pressure Test**

Tank was pressurized to 320 psig for one (1) minute and then vented to atmospheric pressure.

## Sine Vibration

### Protoflight Sine Vibration Levels (Dry)

| <u>Axis</u> | <u>Frequency (HZ)</u> | <u>Acceleration (G)<br/>(0-PEAK)</u> |
|-------------|-----------------------|--------------------------------------|
|             | 5-10.8                | .25 inch SA                          |
| Y & Z       | 10.8-20               | 3.0                                  |
|             | 20-100                | 1.5                                  |
|             | 100-400               | 1.0                                  |

### Protoflight Sine Vibration Levels (Wet)

| <u>Axis</u> | <u>Frequency (HZ)</u> | <u>Acceleration (G)<br/>(0-PEAK)</u> |
|-------------|-----------------------|--------------------------------------|
| Lateral     | 5-13                  | .25 inch SA                          |
| (Y)         | 13-17                 | 4.3                                  |
|             | 17-45                 | 3.0                                  |
|             | 45-100                | 2.0                                  |
|             |                       |                                      |
| Axial       | 5-22.3                | .20 inch SA                          |
| (Z)         | 22.3-24               | 11.2                                 |
|             | 24-26                 | Ramp Down                            |
|             | 26-50                 | 2.6                                  |
|             | 50-52                 | Ramp Down                            |
|             | 52-100                | 1.3                                  |

**DATA SHEET "H"**  
**WET SINE VIBRATION TESTS - TANK MOUNTING**  
**(SHEET 1 OF 4)**

Date: 10-14-02

PSI Part No. 80441-1/80442-1

PSI Serial No. 0001PF

Paragraph No. 4.6.1.2

Propellant  
 PSI Part Name: Tank Assembly

Test Equipment: TORQUE WRENCH ST1296 DATE ISSUED 6-5-02 DJG 12-5-02

|  |                                       | Half<br>Torque<br>Actual | Full<br>Torque<br>Actual |
|--|---------------------------------------|--------------------------|--------------------------|
| 1. Sine - Y Axis (Initial Installation)    |                                       |                          |                          |
| A) Fasteners Installed                     | <u>32</u>                             | <u>32</u>                | <u>32</u>                |
| B) All Fasteners Torqued                   | <u>80 - 85 in-lbs (Above Running)</u> | <u>40</u> In-Lb          | <u>85</u> In-Lb          |
| 2. Sine - Z Axis (Initial Installation)    |                                       |                          |                          |
| A) Fasteners Installed                     | <u>32</u>                             | <u>32</u>                | <u>32</u>                |
| B) All Fasteners Torqued                   | <u>80 - 85 in-lbs (Above Running)</u> | <u>40</u> In-Lb          | <u>85</u> In-Lb          |
| 3. Sine - Y Axis (Prior to full level run) |                                       |                          |                          |
| A) Fasteners Installed                     | <u>32</u>                             | <u>32</u>                | <u>32</u>                |
| B) All Fasteners Torqued                   | <u>80 - 85 in-lbs (Above Running)</u> | <u>40</u> In-Lb          | <u>85</u> In-Lb          |
| 4. Sine - Z Axis (Prior to full level run) |                                       |                          |                          |
| A) Fasteners Installed                     | <u>32</u>                             | <u>32</u>                | <u>32</u>                |
| B) All Fasteners Torqued                   | <u>80 - 85 in-lbs (Above Running)</u> | <u>40</u> In-Lb          | <u>85</u> In-Lb          |

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] (SI 12) Date 10-17-02 Specimen Passed Y/S



**DATA SHEET "H"  
WET SINE VIBRATION  
(SHEET 2 OF 4)**

Date: 10-15-02

PSI Part No. 80441-1/80442-1

PSI Serial No. 0001PF

Paragraph No. 4.6.1.5

Propellant  
PSI Part Name: Tank Assembly

Test Equipment: SEE NTS EQUIPMENT LIST

| Accelerometer  | Response                                    | Control               |
|----------------|---|-----------------------|
| Locations - Y: | <u>R2Y, R3Z - BOTTOM,</u>                   | <u>C1, C2</u>         |
|                | <u>R5Y - TAB - Y, R10Y, R11Z - TOP</u>      |                       |
|                | <u>R12Y - Lower Hami / cyl</u>              |                       |
|                | <u>Z: R3Z - BOTTOM, R6Z - TAB (-X AXIS)</u> | <u>C1, C2, C3, C4</u> |
|                | <u>R11Z - TOP, R12Z - TAB (+Y AXIS),</u>    |                       |
|                | <u>R13Z - TAB (+X AXIS)</u>                 |                       |

|  | Actual     | Requirement       |
|--|------------|-------------------|
| Sketches made or photographs taken of accelerometer locations. | <u>Yes</u> | <u>Compliance</u> |
| All supply container(s) of water sampled and acceptable.       | <u>Yes</u> | <u>Compliance</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] (S) (72) Date 10-17-02 Specimen Passed Yes

**DATA SHEET "H"**  
**WET SINE VIBRATION ("Y"-AXIS) - LATERAL**  
**(SHEET 3 OF 4)**

Date: 10-15-02

PSI Part No. 80441-1 80442-1

PSI Serial No. 0001 PF

Paragraph No. 4.6.2.2

Propellant  
PSI Part Name: Tank Assembly

Test Equipment: LAZLE, ASHCROFT ST 0220 CAL DATE 8-5-02 DJK 2-5-03

| Y-AXIS    |                           |                     |                 |
|-----------|---------------------------|---------------------|-----------------|
| Frequency | Input Amplitude           | Sweep Rate          | Date            |
| From To   | (g)                       | 4 Oct/Min (Maximum) |                 |
| <u>Y</u>  | <u>SEE NTS DATA SHEET</u> |                     | <u>10-15-02</u> |

| Date            | Time        | Log Entries           |
|-----------------|-------------|-----------------------|
| <u>10-15-02</u> | <u>1424</u> | <u>1/2 LEVEL SINE</u> |
| <u>10-15-02</u> | <u>1441</u> | <u>FULL SINE</u>      |

Test Media: Water and Nitrogen Gas

|                                       | Actual           | Requirement   |
|---------------------------------------|------------------|---|
| Specimen Load                         | <u>2695</u> lb.  | <u>2645 + 5, -0 lb. (80441-1)</u><br>or <u>3038, +5, -0 lb. (80442-1)</u> |
| Specimen Pressure                     | <u>250</u> psig  | <u>250 + 0, -10 psig</u>  |
| Specimen Temperature                  | <u>70</u> deg. F | <u>Record</u>   |
| 1/2 Level Lateral Axis Test Performed | <u>Yes</u>       | <u>Record</u>   |
| Specimen Damage After Test            | <u>NONE</u>      | <u>None Allowed</u>   |

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Tested By: [Signature] Date 10-15-02 Specimen Passed Yes

**DATA SHEET "H"  
WET SINE VIBRATION ("Z"-AXIS) - AXIAL  
(SHEET 4 OF 4)**

Date: 10-17-02

PSI Part No. 80441-1/80442-1

PSI Serial No. 0001PF

Paragraph No. 4.6.2.2

Propellant  
PSI Part Name: Tank Assembly

Test Equipment: GAGE, ASHCROFT ST-0270 CAL DATE 8-5-02 DUJ 2-5-03

Z-AXIS

| <u>Frequency</u><br>From To | <u>Input</u><br><u>Amplitude</u><br>(g) | <u>Sweep Rate</u><br>4 Oct/Min<br>(Maximum) | <u>Date</u>     |
|-----------------------------|---|---|-----------------|
| <u>Z</u>                    | <u>SEE NTS DATA SHEET</u>               |   | <u>10-17-02</u> |

| <u>Date</u>     | <u>Time</u> | <u>Log Entries</u>     |
|-----------------|-------------|------------------------|
| <u>10-17-02</u> | <u>1130</u> | <u>1/2 LEVEL SINE</u>  |
| <u>10-17-02</u> | <u>1140</u> | <u>FULL LEVEL SINE</u> |

Test Media: Water and Nitrogen Gas

|                                     | <u>Actual</u>    | <u>Requirement</u>  |
|-------------------------------------|------------------|---|
| Specimen Load                       | <u>2645 lb.</u>  | 2645 + 5, -0 lb. (80441-1)<br>or 3038, +5, -0 lb. (80442-1) |
| Specimen Pressure                   | <u>250</u> psig  | <u>250 + 0, -10</u> psig                                    |
| Specimen Temperature                | <u>69</u> deg. F | <u>Record</u>   |
| 1/2 Level Axial Axis Test Performed | <u>Yes</u>       | <u>Record</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] (PSI) Date 10-17-02 Specimen Passed Yes

**Acceleration Load Limits**

| <b><u>Axis</u></b> | <b><u>Frequency (Hz)</u></b> | <b><u>Limit Acceleration (G)</u></b><br><b><u>(0-PEAK)</u></b> |
|--------------------|------------------------------|--|
| Lateral            | 5.0-17                       | 4.3  |
| (Y)                | 17-100                       | 3.0  |
|                    |                              |  |
| Axial              | 5.0-26                       | 11.2   |
| (Z)                | 26-52                        | 4.5  |
|                    | 52-100                       | 2.6  |

For the wet case, the tank is loaded with 2645, +5/-0 lbs of water and pressurized to 250, +0/-10 psig.

**Protoflight Random Vibration Levels**

| <b><u>Frequency (HZ)</u></b> | <b><u>Levels</u></b>   |
|------------------------------|------------------------|
| 90-100                       | +30dB/Octave           |
| 100-800                      | .054G <sup>2</sup> /HZ |
| 800-2000                     | -3dB/Octave            |
| Overall G-rms                | 8.7                    |

The 8.7 G-rms random vibration spectrum may be split into two bands, if necessary, to meet vibration shaker equipment limitations.

The tank is loaded with 2645, +5/-0 lbs of water and pressurized to 250, +0/-10 psig.

**DATA SHEET "I"**  
**WET RANDOM VIBRATION TESTS - TANK MOUNTING**  
**(SHEET 1 OF 4)**

Date: 10-14-02

PSI Part No. 80441-1/80442-1

PSI Serial No. 0001 PF

Paragraph No. 4.6.1.2

Propellant  
PSI Part Name: Tank Assembly

Test Equipment: TORQUE WRENCH SF-1296 DATE ISSUED 6-5-02 DUE 12-5-02

|  |                                       | Half<br>Torque<br><u>Actual</u> | Full<br>Torque<br><u>Actual</u> |
|--|---------------------------------------|---------------------------------|---------------------------------|
| 1. Random - Y Axis (Initial Installation)    |                                       |                                 |                                 |
| A) Fasteners Installed                       | <u>32</u>                             | <u>32</u>                       | <u>32</u>                       |
| B) All Fasteners Torqued                     | <u>80 - 85 in-lbs (Above Running)</u> | <u>40</u> In-Lb                 | <u>85</u> In-Lb                 |
| 2. Random - Z Axis (Initial Installation)    |                                       |                                 |                                 |
| A) Fasteners Installed                       | <u>32</u>                             | <u>32</u>                       | <u>32</u>                       |
| B) All Fasteners Torqued                     | <u>80 - 85 in-lbs (Above Running)</u> | <u>40</u> In-Lb                 | <u>85</u> In-Lb                 |
| 3. Random - Y Axis (Prior to full level run) |                                       |                                 |                                 |
| A) Fasteners Installed                       | <u>32</u>                             | <u>32</u>                       | <u>32</u>                       |
| B) All Fasteners Torqued                     | <u>80 - 85 in-lbs (Above Running)</u> | <u>40</u> In-Lb                 | <u>85</u> In-Lb                 |
| 4. Random - Z Axis (Prior to full level run) |                                       |                                 |                                 |
| A) Fasteners Installed                       | <u>32</u>                             | <u>32</u>                       | <u>32</u>                       |
| B) All Fasteners Torqued                     | <u>80 - 85 in-lbs (Above Running)</u> | <u>40</u> In-Lb                 | <u>85</u> In-Lb                 |

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Tested By: [Signature] Date 10-17-02 Specimen Passed 705

DATA SHEET "I"  
WET RANDOM VIBRATION  
(SHEET 2 OF 4)

Date: 10-15-02

PSI Part No. 80441-1/80442-1

PSI Serial No. 0001PF

Paragraph No. 4.6.1.5

Propellant  
PSI Part Name: Tank Assembly

Test Equipment: SEE NTS EQUIPMENT LIST

| Accelerometer  | Response                                 | Control               |
|----------------|--|-----------------------|
| Locations - Y: | <u>R2Y, R3Z - BOTTOM,</u>                | <u>C1, C2, C3, C4</u> |
|                | <u>R5Y - TAB - Y,</u>                    |                       |
|                | <u>R10Y, R11Z - TOP,</u>                 |                       |
|                | <u>R12Y - LOWER HORN/CYL</u>             |                       |
| Z:             | <u>R3Z - BOTTOM, R6Z - TAB (X-AXIS),</u> |                       |
|                | <u>R11Z - TOP, R12Z - TAB (+Y AXIS),</u> |                       |
|                | <u>R13Z - TAB (X-AXIS)</u>               |                       |

|  | Actual     | Requirement       |
|--|------------|-------------------|
| Sketches made or photographs taken of accelerometer locations. | <u>YES</u> | <u>Compliance</u> |
| All supply container(s) of water sampled and acceptable.       | <u>YES</u> | <u>Compliance</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 10-17-02 Specimen Passed YES

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

Date: 10-15-02

PSI Part No. 80441-1/80442-1

PSI Serial No. 0001PF

Paragraph No. 4.6.2.4

Propellant  
 PSI Part Name: Tank Assembly

Test Equipment: CAULG ASHCROFT ST-0270 CAL DATE 8-5-02 DUE 2-5-03

Y-AXIS

| Frequency |      | G2/Hz | Grms | dB/Oct | Run Time | Date     |
|-----------|------|-------|------|--------|----------|----------|
| From      | To   |       |      |        |          |          |
| 90        | 100  |       |      | +30dB  | 1 MIN    | 10-15-02 |
| 100       | 800  | .054  |      |        |          |          |
| 800       | 2000 |       | 8.7  | -3dB   |          |          |

| Date     | Time | Log Entries |
|----------|------|-------------|
| 10-15-02 | 1527 | RANDOM RUN  |

Test Media: Water and Nitrogen Gas

|                            | Actual           | Requirement   |
|----------------------------|------------------|---|
| Specimen Load              | <u>2645</u> lb.  | 2645 + 5, -0 lb. (80441-1)<br>or 3038, +5, -0 lb. (80442-1) |
| Specimen Pressure          | <u>250</u> psig  | 250 + 0, -10 psig   |
| Specimen Temperature       | <u>70</u> deg. F | Record  |
| 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 10-15-02 Specimen Passed Yes



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

Date: 10-17-02

CUSTOMER PART NO. 11279991107999



PSI Part No. 80441-1/80442-1

PSI Serial No. 0001PF

Paragraph No. 4.6.2.4

Propellant  
PSI Part Name: Tank Assembly

Test Equipment: LAURE, ASHCROFT ST-0270 CAL DATE 8-5-02 DW 2-5-03

Z-AXIS

| Frequency  |               | G2/Hz       | Grms       | dB/Oct       | Run Time     | Date            |
|------------|---------------|-------------|------------|--------------|--------------|-----------------|
| From       | To            |             |            |              |              |                 |
| <u>2</u>   | <u>90-100</u> |             |            | <u>+30dB</u> | <u>1 min</u> | <u>10-17-02</u> |
| <u>100</u> | <u>800</u>    | <u>.054</u> |            |              |              |                 |
| <u>800</u> | <u>2000</u>   |             | <u>8.7</u> | <u>-3dB</u>  |              |                 |

| Date            | Time        | Log Entries       |
|-----------------|-------------|-------------------|
| <u>10-17-02</u> | <u>1147</u> | <u>RANDOM RUN</u> |

Test Media: Water and Nitrogen Gas

|                            | Actual           | Requirement   |
|----------------------------|------------------|---|
| Specimen Load              | <u>2645</u> lb.  | <u>2645 + 5, -0 lb. (80441-1)</u><br>or <u>3038, +5, -0 lb. (80442-1)</u> |
| Specimen Pressure          | <u>250</u> psig  | <u>250 + 0, -10 psig</u>  |
| Specimen Temperature       | <u>69</u> deg. F | <u>Record</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: 10-17-02 Specimen Passed Y-S