

# ATK P/N 80446

## Qualification History

### ATK Space – Commerce

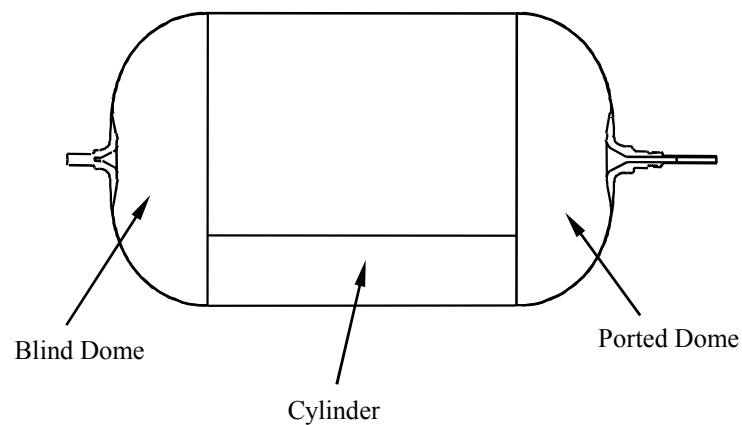


# 80446 Generic Description



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	<b>80446-1</b>
Dimension	41 cm $\varnothing$ x 66 cm long
MEOP	310 bar (4500 psi)
Volume @ MEOP	67.3 liter (4105 in <sup>3</sup> )
Actual burst	546 bar (7919 psig)
Weight of qual tank	10.1 kg (22.32 lb)



# Overview of P/N 80446 Development History



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- **P/N 80374 was the Development Program**
  - **P/N 80400 has two Delta Qualification Programs**
  - **P/N 80446 has two Delta Qualification Programs**
  - **Vibration Testing: 4 times, sine & random**
  - **Shock Testing: twice**
  - **Burst Test: five times, all above minimum requirement**
  - **Leak Before Burst: no testing performed, all failure modes were LBB**
  - **Mass of qual tanks: very consistent**
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- **AIAA paper AIAA 96-2751 documented 80400 qual testing**

# Cycle Life Analysis Results



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- Analysis results show the following:

	<b>80446</b>	<b>80436</b>
8 proof & 50 MEOP	27.9% total life	5.9% total life
16 proof & 50 MEOP	33.7% total life	7.3% total life
Note: MIL-STD-1522A requires < 80% total fatigue life		

# 80446 Tank Qualification History



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STATUS	80374 DVT	80400-1	80400-1	80446-1	80446-101
	Serial No. 0003	Serial No. 0011Q	Serial No. 0015Q	Serial No. 0001Q	Serial No. 0020Q
<b>Date Qualified</b>	7/25/1995	10/7/1997	10/5/1999	11/13/2001	9/1/2006
<b>Proof cycles</b>	4	8	8	8	8
<b>MEOP cycles</b>	57	51	52	50	50
<b>Vibration</b>	Sine & Random	Sine & Random	Sine & Random	NO	Random
<b>Shock</b>	NO	NO	YES	NO	YES
<b>Actual Burst Pressure</b>	543 bar (7880 psi)	512 bar (7427 psi)	544 bar (7896 psi)	546 bar (7919 psi)	538 bar (7798 psi)
<b>LBB</b>	Established by DVT tank failure mode	Established by DVT tank failure mode	Established by DVT tank failure mode	NO	NO
<b>Note:</b>		Delta qual, eb weld to TIG, end fitting to dome	Delta qual, requested by customer to do shock	Delta Qual for pressure cycles and burst only	Lower Shock Level Than -1
<b>MASS</b>		10.21 kg (22.47 lb)	10.3 kg (22.69 lb)	10.17 kg (22.39 lb)	10.05 kg (22.11 lb)
<b>Ref. QTP</b>	QTP 50-000464	QTP 50-000513	QTP 50-000513	QTP 50-000588	QTP 50-000667
<b>Ref. Qual Report</b>	QTR 56-000162	QTR 56-000173	QTR 56-000181	QTR 56-000189	QTR 56-000231

- 80400 & 80446 were designed to the below requirements

## Qualification Sine Vibration

Qualification Sine Vibration Environment			
Axes	Frequency (Hz)	Input Level (G)	Sweep Rate
X, Y, and Z	5 - 17	0.5 in. DA	2 oct/min
	17 - 65	15	
	65 - 100	7	
1) Limit sine response to 20 g			

## Qualification Random Vibration

Qualification Spectrum				
Axes	Frequency (Hz)	PSD Input Level	Overall Level (Grms)	Duration (sec.)
X, Y, and Z	20 – 100	+3 dB/oct	17	120
	100 – 1000	0.2 g <sup>2</sup> /Hz		
	1000 - 2000	-3 dB/oct		
1) Response shall be limited to: 1.50 g <sup>2</sup> /Hz				

# Shock Test Results



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- 80446 was shock tested to the below environments

<b>Axes</b>	<b>Frequency (Hz)</b>	<b>Shock response spectrum input (g)</b>
Longitudinal and one lateral axis	100	125 ± 6 dB
	1500	7000 ± 6 dB
	3000	7000 ± 6 dB
	6000	7000 + 9 dB / -6 dB
	10000	7000 + 9 dB / -6 dB
Shock response spectrum based on Q=10		

# 80374-1 (S/N 0003Q) Vibration Test Results



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- **Sine Vibration Test Requirements – test results met requirements**

**TABLE I**

<b>FREQUENCY</b>	<b>LEVEL</b>
5-Hz to 17-Hz	0.5" DA
17-Hz to 65-Hz	15 g's
65-Hz to 100-Hz	7 g's

- **Random Vibration Test Requirements – test results met requirements**

**TABLE II - QUALIFICATION LEVEL RANDOM**

<b>FREQUENCY</b>	<b>LEVEL</b>
20-Hz to 100-Hz	+3dB/oct
100-Hz to 1000-Hz	0.2 g <sup>2</sup> /Hz
1000-Hz to 2000-Hz	-3dB/oct
Overall	17 g <sub>rms</sub>



# 80400-1 (S/N 0011Q) Vibration Test Results



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## Vibration, Sine

TABLE II

FREQUENCY	LEVEL	AXES
5-Hz to 24-Hz	0.5" DA	X, Y and Z
24-Hz to 65-Hz	15 g's	
65-Hz to 100-Hz	7 g's	

## Vibration, Random – X-axis

TABLE IV - X-AXIS - RANDOM VIBRATION NOTCHED LEVELS

FIRST NOTCH LEVEL		
FREQUENCY	LEVEL	TOLERANCE
20-Hz to 100-Hz	+3 dB/Oct.	± 3 dB
100-Hz to 275-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
275-Hz to 475-Hz	0.02 g <sup>2</sup> /Hz	± 3 dB
500-Hz to 850-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
915-Hz to —	0.002 g <sup>2</sup> /Hz	± 3 dB
1000-Hz to —	0.2 g <sup>2</sup> /Hz	± 3 dB
1000-Hz to 2,000-Hz	-3 dB/Oct.	± 3 dB
Overall g <sub>rms</sub> 15.95		DURATION: 2 minutes
SECOND NOTCH LEVEL: Levels not stored - DURATION: 3 minutes OVERALL G <sub>RMS</sub> 14.74		
THIRD NOTCH LEVEL		
FREQUENCY	LEVEL	TOLERANCE
20-Hz to 100-Hz	+3 dB/Oct.	± 3 dB
100-Hz to 235-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
250-Hz to 375-Hz	0.1 g <sup>2</sup> /Hz	± 3 dB
400-Hz to 850-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
875-Hz to 1000-Hz	0.1 g <sup>2</sup> /Hz	± 3 dB
600-Hz to 2,000-Hz	-3 dB/Oct.	± 3 dB
Overall g <sub>rms</sub> 15.19		DURATION: 2 minutes

TABLE IV (cont.) - X-AXIS - RANDOM VIBRATION NOTCHED LEVELS

FULL NOTCH LEVEL		
FREQUENCY	LEVEL	TOLERANCE
20-Hz to 100-Hz	+3 dB/Oct.	± 3 dB
100-Hz to 1000-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
1000-Hz to 2,000-Hz	-3 dB/Oct.	± 3 dB
Overall g <sub>rms</sub> 18.13		DURATION: 9 seconds
FOURTH NOTCH LEVEL		
FREQUENCY	LEVEL	TOLERANCE
20-Hz to 100-Hz	+3 dB/Oct.	± 3 dB
100-Hz to 200-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
225-Hz to 375-Hz	0.045 g <sup>2</sup> /Hz	± 3 dB
400-Hz to 800-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
825-Hz to 1000-Hz	0.1 g <sup>2</sup> /Hz	± 3 dB
1000-Hz to 2,000-Hz	-3 dB/Oct.	± 3 dB
Overall g <sub>rms</sub> 14.57		DURATION: 3 minutes
FINAL LEVEL		
FREQUENCY	LEVEL	TOLERANCE
20-Hz to 100-Hz	+3 dB/Oct.	± 3 dB
100-Hz to 200-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
225-Hz to 375-Hz	0.045 g <sup>2</sup> /Hz	± 3 dB
400-Hz to 800-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
825-Hz to 1000-Hz	0.05 g <sup>2</sup> /Hz	± 3 dB
1000-Hz to 2,000-Hz	-3 dB/Oct.	± 3 dB
Overall g <sub>rms</sub> 12.96		DURATION: 2 minutes

# 80400-1 (S/N 0011Q) Vibration Test Results



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**TABLE V - Y-AXIS - RANDOM VIBRATION NOTCHED LEVELS**

FIRST NOTCH LEVEL		
FREQUENCY	LEVEL	TOLERANCE
20-Hz to 100-Hz	+3 dB/Oct.	± 3 dB
100-Hz to 250-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
270-Hz to 450-Hz	0.15 g <sup>2</sup> /Hz	± 3 dB
500-Hz to 720-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
750-Hz to 950-Hz	0.025 g <sup>2</sup> /Hz	± 3 dB
1000-Hz to —	0.2 g <sup>2</sup> /Hz	± 3 dB
1000-Hz to 2,000-Hz	-3 dB/Oct.	± 3 dB
Overall g <sub>rms</sub> 15.57		DURATION: 3 minutes
SECOND (FINAL) NOTCH LEVEL		
FREQUENCY	LEVEL	TOLERANCE
20-Hz to 100-Hz	+3 dB/Oct.	± 3 dB
100-Hz to 300-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
325-Hz to 450-Hz	0.03 g <sup>2</sup> /Hz	± 3 dB
500-Hz to 850-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
900-Hz to 1000-Hz	0.1 g <sup>2</sup> /Hz	± 3 dB
1000-Hz to 2,000-Hz	-3 dB/Oct.	± 3 dB
Overall g <sub>rms</sub> 14.73		DURATION: 2 minutes

**TABLE VI - Z-AXIS - RANDOM VIBRATION NOTCHED LEVELS**

FULL NOTCH LEVEL		
FREQUENCY	LEVEL	TOLERANCE
20-Hz to 100-Hz	+3 dB/Oct.	± 3 dB
100-Hz to 300-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
325-Hz to 450-Hz	0.03 g <sup>2</sup> /Hz	± 3 dB
500-Hz to 850-Hz	0.2 g <sup>2</sup> /Hz	± 3 dB
900-Hz to 1000-Hz	0.1 g <sup>2</sup> /Hz	± 3 dB
1000-Hz to 2,000-Hz	-3 dB/Oct.	± 3 dB
Overall g <sub>rms</sub> 14.73		DURATION: 2 minutes - Run from -12dB to -3dB

- **Qualification Shock Test – Requirements**

**TABLE I - QUALIFICATION LEVEL PYROTECHNIC SHOCK**

FREQUENCY (Hz)	SHOCK RESPONSE SPECTRUM INPUT (G)
100	125 ± 6dB
1500	7000 ± 6dB
3000	7000 ± 6dB
3000	7000 +9dB/-6dB
10000	7000 +9dB/-6dB
Shock Response Spectrum Levels are based on Q=10.0	

- **Qualification Shock Test – Test Results (met requirements)**

**TABLE 3, Sequence of Events, Pyrotechnic Shock Test**

Date	Seq.	Event
9/09/99	1	X, Y and Z-Axis, Full level Impact shock impulse
	2	X, Y and Z-Axis, Full level Impact shock impulse

## ■ Qualification Sine & Random Vibration Test – Requirements

**TABLE II**

FREQUENCY	LEVEL
5-Hz to 24-Hz	0.5" DA
24-Hz to 65-Hz	15 g's
65-Hz to 100-Hz	7 g's

**TABLE III - QUALIFICATION LEVEL RANDOM**

FREQUENCY	LEVEL
20-Hz to 100-Hz	+3dB/oct
100-Hz to 1000-Hz	0.2 g <sup>2</sup> /Hz
1000-Hz to 2000-Hz	-3dB/oct
Overall	17 g <sub>rms</sub>

## ■ Qualification Sine & Random Vibration Test – Test Results

**TABLE 4, Sequence of Events, Qualification Sine and Random Vibration Test**

Date	Seq.	Event
9/22/99	1	X-Axis, low level flat random, Pre-test Signature Survey
	2	X-Axis, Full level Sine Sweep
	3	X-Axis, low level flat random, Intermediate Signature Survey
	4	X-Axis, Full level random, 20~2000 Hz
	5	X-Axis, low level flat random, Post-test Signature Survey
9/23/99	6	Z-Axis, low level flat random, Pre-test Signature Survey
	7	Z-Axis, Full level Sine Sweep
	8	Z-Axis, low level flat random, Intermediate Signature Survey
	9	Z-Axis, Full level random, 20~2000 Hz
9/23/99	10	Z-Axis, low level flat random, Post-test Signature Survey
	11	Y-Axis, low level flat random, Pre-test Signature Survey
	12	Y-Axis, Full level Sine Sweep
	13	Y-Axis, low level flat random, Intermediate Signature Survey
	14	Y-Axis, Full level random, 20~2000 Hz
	15	Y-Axis, low level flat random, Post-test Signature Survey

## ■ Shock Environment

Axes	No of Shocks per Axis	Frequency (Hz)	Acceleration (G)
X, Y, and Z	3	100	127
		1,400	2541
		10,000	2541

## ■ Random Vibration Environment

Qualification Spectrum				
Axes	Frequency (Hz)	PSD Input Level	Overall Level (Grms)	Duration (sec.)
X, Y, Z	20-100	+3 dB/oct	18.1	180 per axis
	100-1000	0.2 g <sup>2</sup> /Hz		
	1000-2000	-3 dB/oct		

- **S7000 GEO Commercial Satellites (Lockheed Martin GEO bus)**
  - Optus, AMC 14, JCSat, VinaSat, Astra, Echostar, etc.
- **Star 2 GEO Commercial Satellites (Orbital Sciences GEO bus)**
- **AEHF**
- **SBIRS**
- **DRTS (Data Relay Test Satellite, JAXA)**
- **SELENE (Selenological and Engineering Explorer, JAXA)**
- **MESSENGER (Mercury exploration)**
- **Chandrayaan I (India's lunar program)**
- **IRNS (Indian Regional Navigational Satellites)**
- **Chandrayaan II (India lunar program)**
- **Himawari (Japan)**
- **GPS III**
- **Small Geo (derivative of 80446)**
- **EDRS (derivative of 80446)**
- **And more**

# Burst Pressure Tests



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