QUALIFICATION ENVIRONMENTS

FOR

AMP PROGRAM

PROPELLANT TANK

ALLIANT TECHSYSTEMS, P/N 80520

ATK P/N 80520

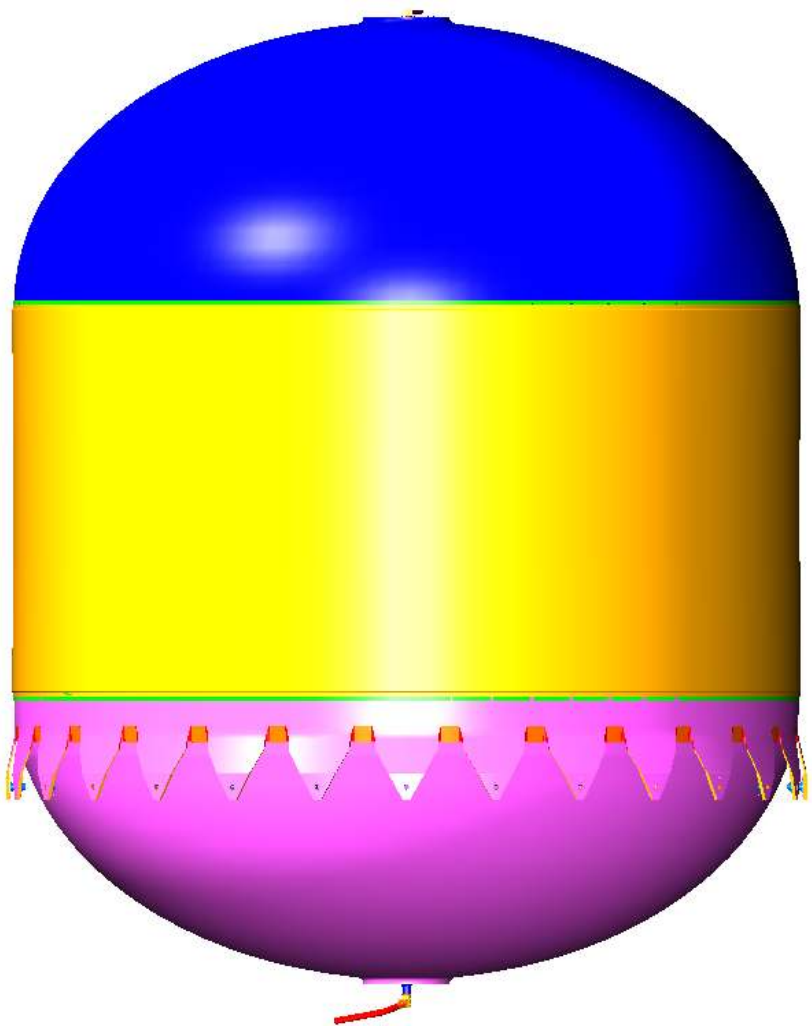


Table 1: P/N 80520 Propellant Tank Specifications

Parameters	Requirements
Operating Pressure	psig
Proof Pressure	338 psig
Burst Pressure	525 psig
External Pressure	1 atm
Internal Vacuum	-
Material of Construction	The 80520 Propellant Tank is an assembly consisting of titanium elliptical domes and cylinder, with an incorporated propellant management device. The aft dome contains an outlet/drain dome as well as the pressurization port.
Membrane Thickness	0.044″
Tank Mount(s)	Mounting is provided by a tank mounting ring located above the aft dome.
Expulsion Efficiency	>99.5%
Design Fill Fraction	50-70%
Tank Capacity	76,525 in^3
Internal Dimensions	45.950″ Ø x 59.1450″
Tank Weight	Maximum tank weight is 136 lbs, Actual tank weight is lbs
Propellant Capacity	1960 lbm
Shell Leakage	$<1x10^{-6}$ std cc/sec He max @ 256 psig, Actual:
Failure Mode	Burst
Natural Frequency	-
Temperature Environment	-
On Orbit Life	-

803520-1 was subjected to the following qualification tests:

Acceptance Test Sequence	Test Title
1	Preliminary Examination of Product
2	Pre-Proof Volumetric Capacity Test
3	Proof Pressure Test
3A	Tank Dimensions
4	Post-Proof Volumetric Capacity Test
5	In-Tank PMD Bubble Point*
6	External Leak Test*
7	Visual Inspection
8	Radiograph Inspection of Welds*
9	Penetrant Inspection*
10	Final Examination of Product and Weight

Qualification Test Sequence	Test Title
1	Cyclic Pressurization
2	Flow Rate And Pressure Drop
3	Flow Rate And Pressure Drop
4	PMD Integrity Radiographic Inspection
5	Bubble Point
6	External Leakage
7	Dry Sine Sweep- Tank Empty And Pressurized
8	Dry Random Vibration – Tank Empty and Pressurized
9	Natural Frequency – Tank Loaded and Pressurized
10	Sine Burst (Launch Accelerations – Tank Loaded and Pressurized)
11	Wet Random Vibration – Tank Loaded and Pressurized
12	Acoustic – Tank empty and pressurized
13	PMD Integrity Radiographic Inspection
14	Bubble Point
15	External Leakage
16	Visual Inspection
17	Penetrant Inspection
18	Radiographic Inspection
19	Final Dimensional Inspection
20	Burst Pressure

The following tests are listed in the document:

1) Pressure Log
2) Proof Pressure Test
3) Cyclic Pressurization Test
4) Flow Rate and Pressure Drop Test
5) Dry Sine Sweep – Tank Empty and Pressurized
6) Dry Random Vibration – Tank empty and Pressurized
7) Natural Frequency – Tank Loaded and Pressurized
8) Sine Burst Test (Launch Accelerations – Tank Loaded and Pressurized)
9) Wet Random Vibration (Tank Loaded and pressurized)
10) Acoustic Test (Tank empty and pressurized)
11) Burst Pressure Test

Pressure Log

Proof Pressure Test

Tank is pressurized to 338 psig and held for five minutes.

Cyclic Pressurization Test

MDP is assumed to be 365 psig (350 psig plus 4% temperature derating compensation). Four cycles are total are performed.

Pressurization sequence will be as followed:

Repeat the sequence four (4) times.

i. Two (2) cycles between ambient and 1.25 MDP, or 455 +5, -0 psi, at 80±40°F.

ii. Two (2) cycles between ambient and 1.0 MDP, or 365 +5, -0 psi, at 80±40°F.

iii. Three (3) cycles to 1.25 MDP, or 455 +5, -0 psi, at 80±40°F.

iv. Ten (10) cycles to 1.0 MDP, or 365 +5, -0 psi, at 80±40°F.

v. Two (2) cycles to 1.1 MDP, or 400 +5, -0 psi, at 80±40°F.

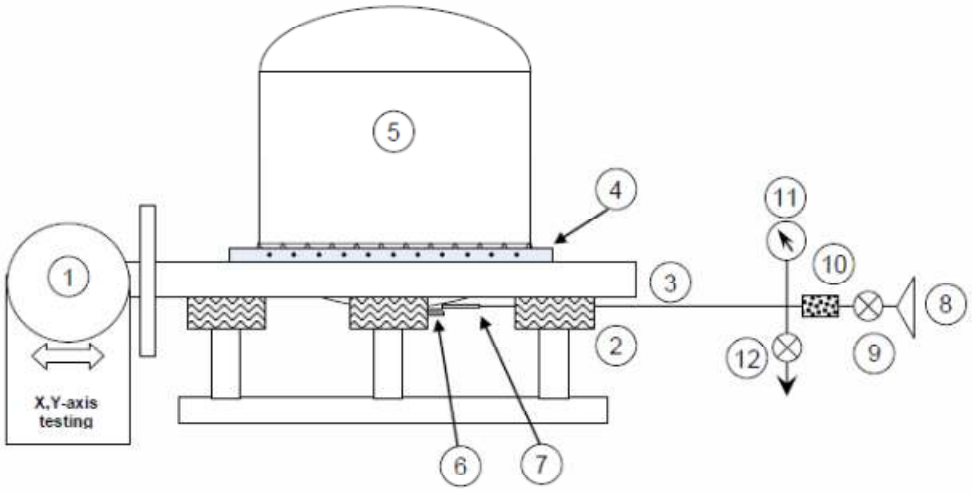
vi. Two (2) cycles to 1.0 MDP, or 365 +5, -0 psi, at 80 ±40°F.

Flow Rate & Pressure Drop Test

Vibration Test Set-Up

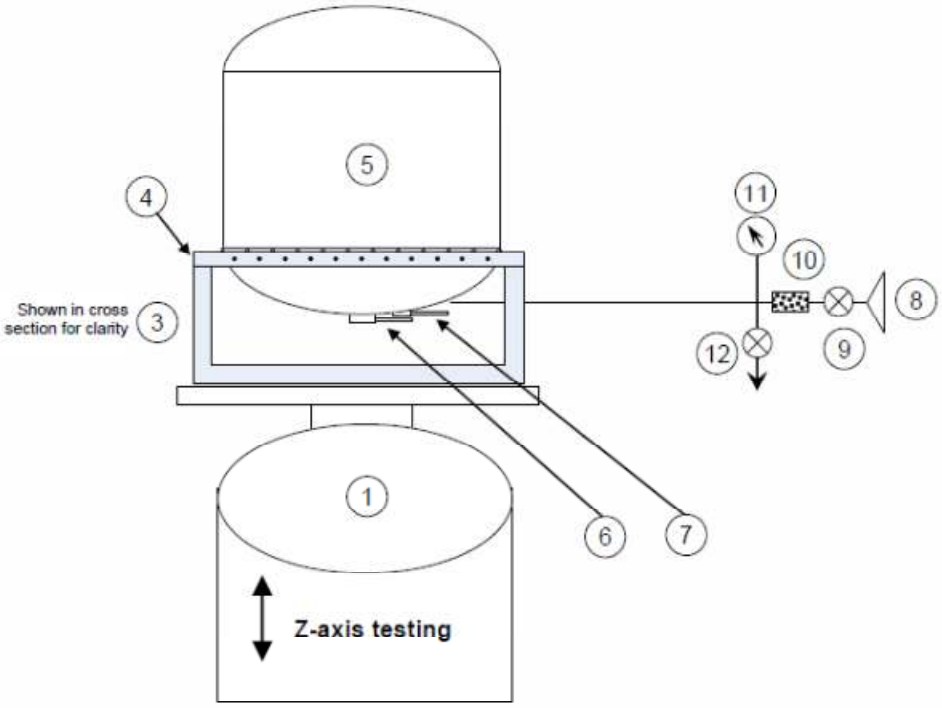
Figure No. 8 – Vibration Test

Lateral Axis
Sheet 1 of



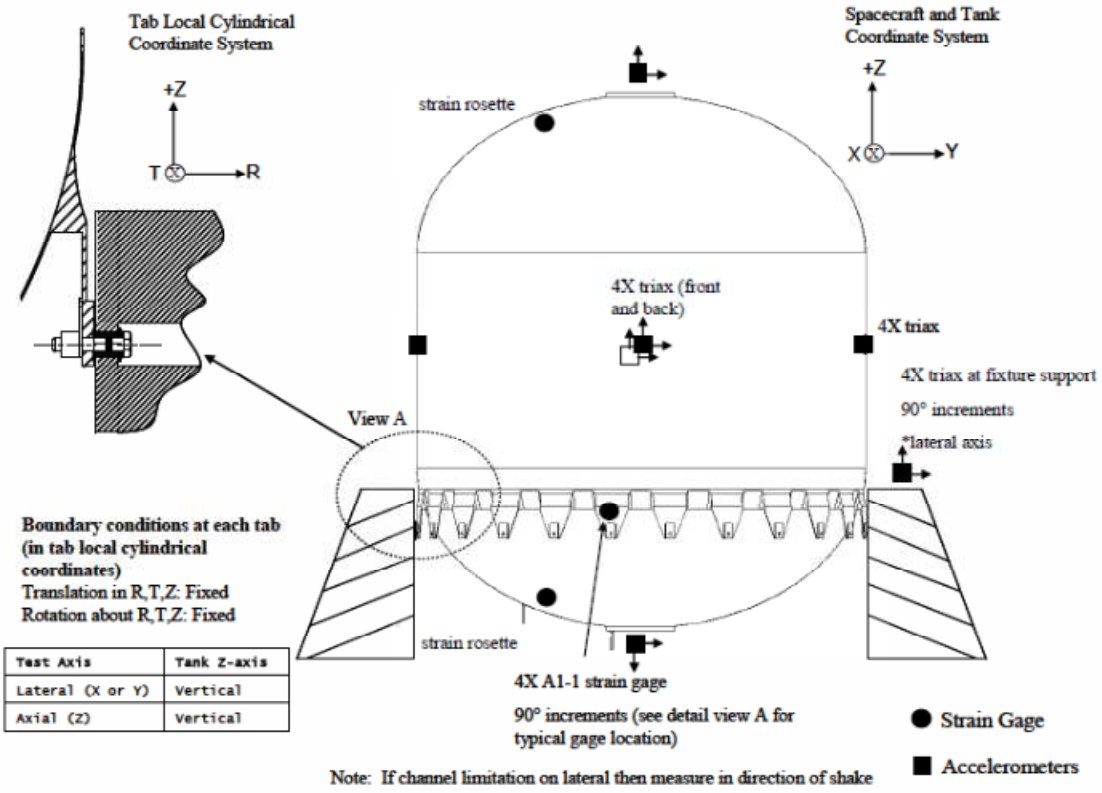
1	VIBRATION SHAKER	7	PRESSURANT PORT
2	TEAM (LINEAR HYDRAULIC) BEARINGS	8	REGULATED NITROGEN SUPPLY
3	SLIP TABLE	9	INLET VALVE
4	VIBE FIXTURE RING	10	FILTER
5	PROPELLANT TANK	11	PRESSURE GAUGE
6	PROPELLANT PORT, CAPPED	12	VENT VALVE

Figure No. 8 – Vibration Test
Axial Axis
Sheet 2 of



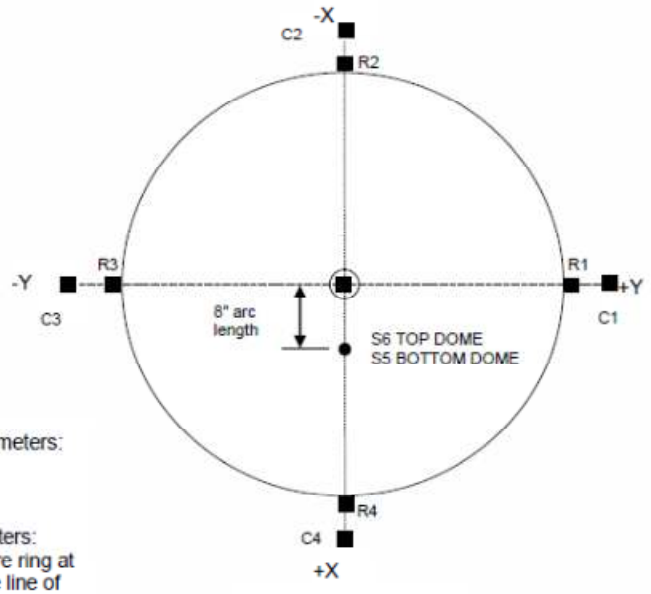
1	VIBRATION SHAKER	7	PRESSURANT PORT
2		8	REGULATED NITROGEN SUPPLY
3	VIBE FIXTURE TUB	9	INLET VALVE
4	VIBE FIXTURE RING	10	FILTER
5	PROPELLANT TANK	11	PRESSURE GAUGE
6	PROPELLANT PORT, CAPPED	12	VENT VALVE

Figure No. 8 – Vibration Test
Instrumentation Setup
Sheet 3 of



Test Axis	Tank Z-axis
Lateral (X or Y)	Vertical
Axial (Z)	Vertical

Figure No. 8 – Vibration Test
Instrumentation Setup
Sheet 4 of



Top Looking Down

Response accelerometers: triaxial as shown

R1-R6

Control accelerometers: uniaxial on the fixture ring at +X, -X, +Y, -Y in the line of action

C1-C4

Strain Gages:

uni-axial on two tabs- axial

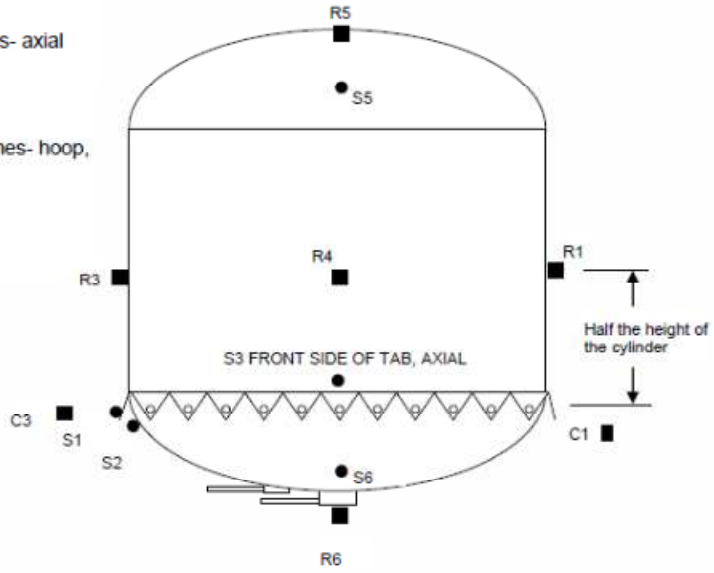
S1- S2 on –Y tab

S3-S4 on +X tab

rosettes on the domes- hoop, axial, 45°

S5 top dome

S6 bottom dome



Dry Sine Sweep

Run sine sweep scan: Expose the tank to a low-level sine sweep at a rate of 2 oct/min:

A) In the lateral direction, the frequency shall be swept from 2 – 50 Hz at 0.5g amplitude.

B) Amplitude shall ramp down to 0.2g over 50 – 60 Hz, and then remains constant at 0.2g up to 120 Hz.

C) In the axial direction, the frequency shall be swept from 2 – 50 Hz, while simultaneously ramping the amplitude from 0.1 to 0.5g

D) The frequency sweep shall continue up to 120 Hz, at constant 0.5g amplitude.

E) Repeat step 0for each orthogonal axis.

Dry Random Vibration

Expose the tank to a vibration profile according to Table 1:

Table 1 – Dry Random Vibration Profile

Frequency, Hz	Levels	Units
20	0.02	g^2/Hz
20 to 50	+9	dB/octave
50 to 1000	0.30	g^2/Hz
1000 to 2000	-6	dB/octave
2000	0.075	g^2/Hz
Overall	20.9	g_{rms}
Time per Axis	3	Minutes

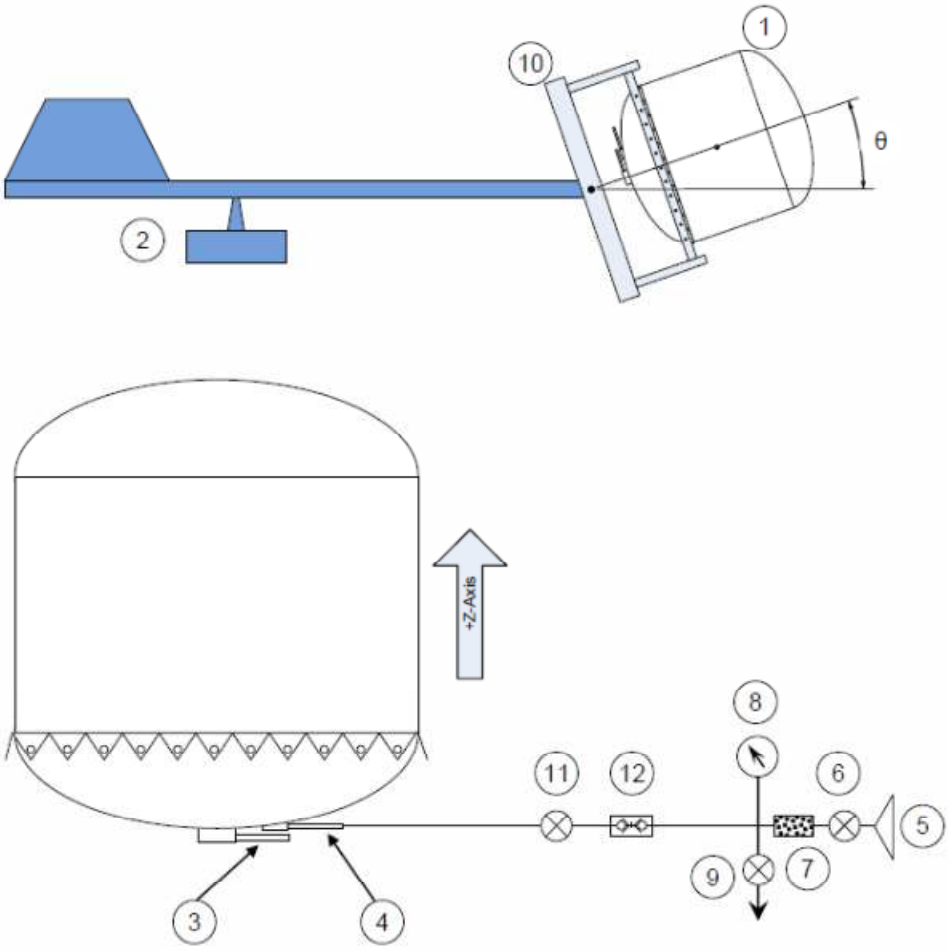
Natural Frequency – Tank loaded and Pressurized

The minimum natural frequency of the tank, in any direction, when filled and pressurized shall be 40 Hz.

Fill tank with water through the propellant port until the tank is fully loaded with 2832 +10/-0 lbm of water (1960 lbm x 1.445). Disconnect the water supply and cap the propellant port. With the tank filled, pressurize the tank to 365 +10/-0 psig. Expose the tank to a low-level sine sweep at a sweep rate of 2 oct/min for the three orthogonal axes. Verify no natural frequencies occur below 40 Hz.

Acceleration Test Set-Up

Figure No. 7 – Acceleration Test



1	PROPELLANT TANK ASS'Y	7	FILTER
2	CENTRIFUGE	8	PRESSURE GAUGE
3	PROPELLANT PORT, CAPPED	9	VENT VALVE
4	PRESSURANT PORT	10	FIXTURE
5	REGULATED He SUPPLY	11	TANK PRESSURANT VALVE
6	INLET VALVE	12	DISCONNECT FITTING

Sine Burst Test

Tank will be filled to maximum capacity (approximately 1960 lbm of propellant and pressurized to 350 psia @ 120°F) and will withstand the acceleration load tets described in table 2 below.

Table 2 – Qualification Acceleration Load Values

	Flight Axial Acceleration (g)	Flight Lateral Acceleration (g)	Resultant Load (g)	Angle WRT Horizontal (deg)	Radius (cm)	ω (RPM)
Maximum Axial Ascent	11.25	3.75	11.86	18.43	304.80	58.99
Maximum Lateral Ascent	5.00	7.50	9.01	56.31	304.80	51.43

Notes:

1. Resultant includes 1g initial condition
2. Angle is measured from the tank starting with the Z-axis in a horizontal position.

Wet Random Vibration

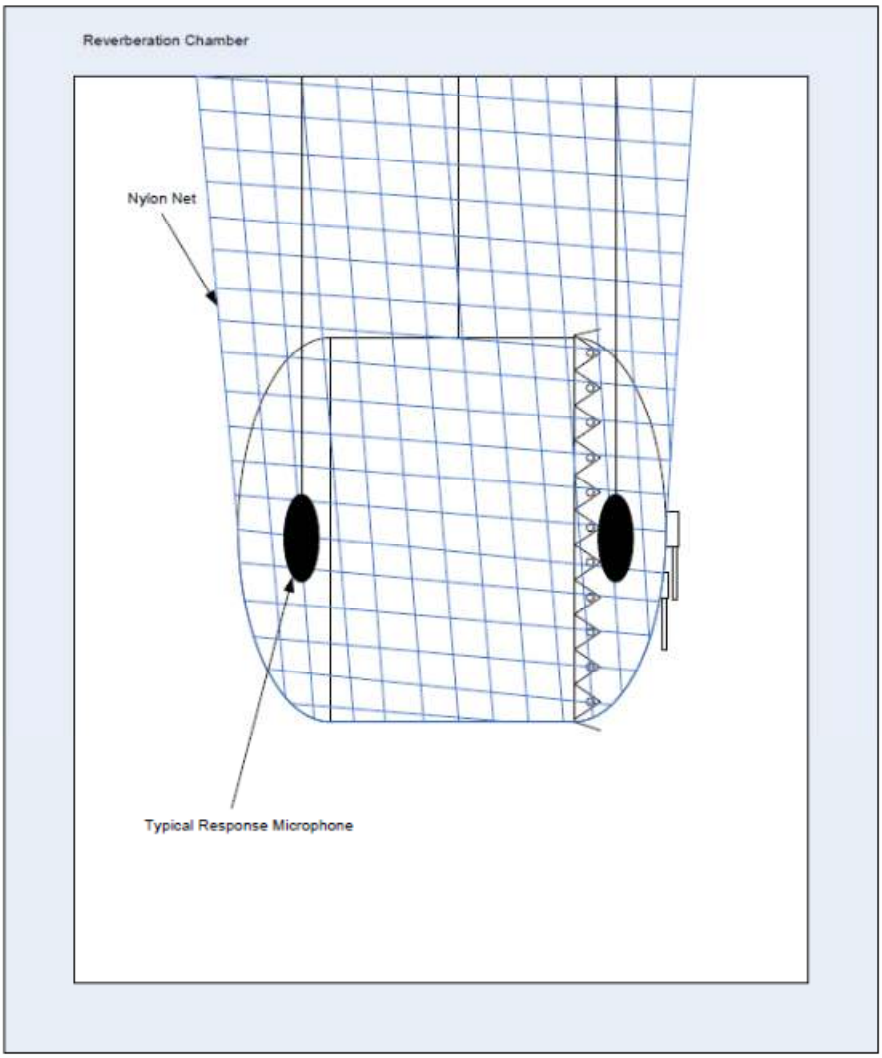
Expose all orthogonal axes of the tank to a vibration profile according to Table 3:

Table 3 – Wet Random Vibration Profile

Frequency (Hz)	Qualification PSD Level (g^2/Hz)	
	Lateral	Axial
20	0.020	0.020
50 - 140	0.081	0.081
170 - 300	0.081	0.081
500 - 1000	0.020	0.020
2000	0.004	0.004
Overall	6.96 G_{rms}	6.96 G_{rms}
Duration / Axis	3 minutes	3 minutes

Acoustic Test Set-Up

Figure No. 9 – Acoustic Test



Acoustic Test

The mounted test specimen shall be subjected to Qualification Acoustic Noise test requirement specified in Table 4 for a total of 180 , +6, -0 seconds.

Table 4 – Acoustic Test Levels

1/3 Octave Band Center Frequency (Hz)	Sound Pressure Levels, dB (ref 2 x 10^{-5} N/m^2)
32.0	134.8
40.0	134.8
50.0	135.8
63.0	136.8
80.0	137.8
100.0	138.3
125.0	138.8
160.0	138.0
200.0	136.5
150.0	136.5
315.0	136.2
400.0	135.5
500.0	134.0
630.0	131.0
800.0	129.0
1,000.0	127.5
1,250.0	126.0
1,600.0	124.5
2,000.0	123.0
2,500.0	121.0
3,150.0	119.5
4,000.0	118.0
5,000.0	116.5
6,300.0	115.0
8,000.0	113.5
10,000.0	112.0
Overall level	148.1
Test duration	3 min

Burst Pressure Test

A pressure trace shall be recorded for the burst test. Pressurize the test tank to 545 psig +5, -0 at 70°F. Pressurization rate shall be 100 – 300 psig per minute. Hold pressure for 15 to 20 seconds.

Increase pressure 100 – 300 psig per minute until tank rupture. Record the rupture pressure.

Burst Tank Pictures