QUALIFICATION ENVIRONMENTS

FOR

HS601 BIPROPELLANT TANK

ATK P/N 80350-1

Note: Not completed or finished.

Table 1: P/N 80350-1 HS601 BIPROPELLANT TANK Assembly Specifications

Parameters	Requirements
Operating Pressure	psig
Proof Pressure	325 psig, Actual Proof: 325 psig
Burst Pressure	410 psid, Actual Burst: - psig, Rupture @ 555 psig
External Pressure	Not Tested
Internal Vacuum	Not Tested
Material of Construction	Pressure vessel constructed of 6AL-4V titanium.
Membrane Thickness	″
Tank Mount(s)	
Expulsion Efficiency	99.8%
Design Fill Fraction	-
Tank Capacity	22580 in^3
Internal Dimensions	42″ Ø
Tank Weight	Maximum tank weight is 28.9 lbs, Actual tank weight is 26.98 lbs
Propellant Capacity	-
Shell Leakage	$<1x10^{-6}$ std cc/sec He max, Actual: $9.2x10^{-9}$ scc/sec He @ 270 psig
Failure Mode	N/A
Natural Frequency	-
Temperature Environment	-
On Orbit Life	-

80350-1 was subjected to the following qualification tests:

Test Sequence	Test Description	Pa
1.	Inspection	
2.	Tank Capacity	
3.	Proof Pressure Test	
4.	Tank Capacity	
5.	PMD Functional Test	
6.	External Leakage	
7.	Penetrant Inspection	
8.	Radiographic Inspection	
9.	Radiographic Inspection of PMD	
10.	Weight	
11.	Inspection and Powder Blast	
12.	Pressure Cycle	
13.	External Leakage	
14.	Acoustic Test	
15.	Sinusoidal Vibration	
16.	PMD Functional Test	
17.	Radiographic Inspection (Shell)	
18.	Radiographic Inspection of PMD	
19.	Random Vibration	
20.	External Leakage	
21.	PMD Functional Tests	
22.	Radiographic Inspection (Shell)	
23.	Radiographic Inspection of PMD	
24.	Collapse Pressure	
25.	External Leakage	
26.	Penetrant Inspection	
27.	Burst Pressure Test	

Note: The following tests are only listed in this report.

1) Pressure Log
2) Proof Pressure Test

Pressure Log

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TRW PRESSURE SYSTEMS, INC.

TRW PSI Procedure No. 50-000374
Page 33 Revision "N/C"

DATA SHEET "K"
PRESSURE CYCLE LOG

Customer: Hughes Aircraft Company Date: MAY 16, 1990

Customer Part No. 4946407 TRW PSI Part No. 80350-1

Test Para. No. 3.6.1 TRW PSI Serial No. 0003

Test Equipment: SEE ATTACHED DATA SHEETS

Date	Pressure Event	Test Media	Pressure	Duration	Cycles	Inspector
5-16-90	PROOF	H/O	325 psig	5 min	1	
6-6-90	EXT. LEAK	He	270 psig	30 min	1	PSI 103

Tested By Matteo Fiscina Date 6-6-90

Witnessed By N/A PSI 012 Date

QAC Witnessed By Date

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TRW PRESSURE SYSTEMS, INC.

TRW PSI Procedure No. 50-000375
Page 58 Revision "N/C"

DATA SHEET "W"
PRESSURE CYCLE LOG

Customer: Hughes Aircraft Company Date: 8-7-90

Customer Part No. 4946407 TRW PSI Part No. 80350-1

Test Para. No. 3.6.1 TRW PSI Serial No. 0003

Test Equipment: SEE RESPECTIVE DATA SHEETS

Date	Pressure Event	Test Media	Pressure	Duration	Cycles	Inspector
8/2/90	EXTERNAL LEAK (4.2.0)	He	270 PSIG	30.5 MIN	1	
8/6/90	PRESSURE CYCLING	H_2O	325/260 PSIG	5 SEC MAX EA CYCLE	2/75	
8-7-90	EXT. LEAK (4.7)	He	270 PSIG	20 MIN	TWO	
8-8-90	EXT. LEAK (4.7)	He	271 PSIG	30 MIN	ONE	
9-13-90	EXT. LEAK (4.7.5)	He	270 PSIG	30 MIN	ONE	
7/26/90	VIBRATION	FREON TEE/GN2	139 PSIG	41 HRS	3	

Tested By _____ Date 9/13/90

Witnessed By _____ Date 9/13/90

HAC Witnessed By off-site Date 9/13/90
not required

Proof Pressure Test

Tank is pressurized to 325 psig.

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TRW PRESSURE SYSTEMS, INC.

TRW PSI Procedure No. 50-000374
Page 23 Revision "N/C"

DATA SHEET "B"
PROOF PRESSURE & INTERNAL VOLUME
(SHEET 1 OF 2)

Customer: Hughes Aircraft Company Date: MAY 16, 1990

Customer Part No. 4946407 TRW PSI Part No. 80350-1

Test Para. No. 4.2.1, 4.2.2 TRW PSI Serial No. 0003

Test Equipment: E-0578 Cal. 4-18-90 Due 10-18-90: ST-0625 Cal 5-10-90 Due 11-10-90: ST-622515 Cal 5-10-90 Due 11-10-90: L-014 Cal 5-16-90 Due 11-16-90 ST-0700 Cal 12-9-89 Due 12-9-90

Test Media: Deionized Water

Paragraph 4.2	Test Value	Requirement
Water Specific Resistance	17 meg ohms/cm	500,000 ohms/cm min
Water pH	6.5	5.5 to 8.0
Filled per Paragraph 4.2.1	Yes	Compliance

		Temp. (degree F)	Weight (lb)
A)	Empty Specimen & Fixture (W_e)		477.9
B)	Filled Specimen & Fixture, (W_f) (No fill tube installed)	72°	1291.8
C)	TANK CAPACITY = (W_f - W_e) X Specific Volume 22580 (cu-in) (V_c)		
	Specific Volume is taken from Table 1. at measured temperature. V_c > 22450 cu-in YES complies		
D)	Filled Specimen and Fixture (Fill tube installed)		1293.1 (W_t)

Tested By Matteo Frisicia Date 5-16-90 Specimen Passed YES

Witnessed By Marjorie W Proctor Date 5-16-90 Specimen Failed NO

QAC Witnessed By Robert R Mackey Date 5-16-90

TRW PRESSURE SYSTEMS, INC.

TRW PSI Procedure No. 50-000374
Page 24 Revision "N/C"

DATA SHEET "B"
PROOF PRESSURE & INTERNAL VOLUME
(SHEET 2 OF 2)

Customer: Hughes Aircraft Company Date: MAY 15, 1990

Customer Part No. 4946407 TRW PSI Part No. 80350-1

Test Para. No. 4.2.2 TRW PSI Serial No. 0003

Test Equipment: E-0528 Cal 4-18-90 Dug 10-18-90 : ST-0625 Cal 5-10-90 Dug 11-10-90 : ST-G2515 Cal 5-10-90 Dug 11-10-90 : L-014 Cal 5-16 Dug 11-16- ST-0700 Cal 12-9-89 Dug 12-9-90

Filled Specimen Temperature Degree F 72°

	Specimen Test Pressure	Actual Pressure Psig	Wp Weight lbs	V Delta Volume In^3	V_t Total Volume In^3
A)	65 psig	65	1295.8	91.6	22671.6 $V_{20\%}$
B)	130 psig	130	1297.9	149.8	22729.8 $V_{40\%}$
C)	195 psig	195	1300.0	208.1	22788.1 $V_{60\%}$
D)	260 psig	260	1302.0	263.6	22843.6 $V_{80\%}$
E)	325 psig	325	1304.1	321.8	22901.8 $V_{100\%}$
F)	65 psig (second cycle)	65	1295.9	94.4	22674.4 V_{ss}

G) $V_{ps} = .006 \times V_{100\%}$ 137.4

H) $V_{ss} - V_{20\%} < V_{ps}$ Yes complies.

Note: V = (Wp - Wt) X Specific Volume. (Specific Volume is taken from Table 1. at the measured temperature.) W_t taken from Data Sheet "B", Sheet 1.

$V_t = V + V_c$, V_c taken from Data Sheet "B", Sheet 1.

Tested By Matteo Frisina Date 5-16-90 Specimen Passed YES

Witnessed By Wayne W Powell Date 5-16-90 Specimen Failed NO

HAC Witnessed By [illegible] Date 5-16-90

Pressure Cycles

Tank is pressurized to 325, +10/-0 psid, while the pressurization rate is controlled from 0 psid to 270 psid in 5 to 7 seconds. Number of cycles is 2.

Tank is pressurized to 260, +10/-0 psid, while the pressurization rate is controlled from 0 psid to 260 psid in 5 to 7 seconds. Number of cycles is 75.

Acoustic Test

Acoustic Test Requirements

Octave (Hz)	Envelope (dB)	Tolerance (dB)	Overall (dB)	Duration (minutes)
31.5	129.1	+/- 3		
63	134.7	+/- 3		
125	140.0	+/- 3		
250	144.1	+/- 3	148.3	3
500	142.9	+/- 3	+/- 1.5	
1000	138.0	+/- 3		
2000	132.0	+/- 3		
4000	126.8	+/- 3		
8000	124.0	+/- 3		

Tank is empty and unpressurized.

Acoustic noise test is conducted for a total time of 3 minutes.

Sine Vibration (Dry)

Sinusoidal Vibration Spectrum

Axis	Frequency	Acceleration (g - peak)	Displacement (DA)
X, Y, Z	5 - 10	----	13 mm (.5 in.)
	10 - 100	2.5	

The sine input shall not be notched.

Tank is unpressurized.

The sinusoidal logarithmic sweep is applied at the rate of 2 octaves/minute in each axis (X, Y, Z).

TRW PRESSURE SYSTEMS, INC.

TRW PSI Procedure No. 50-000374
Page 26 Revision "A"

DATA SHEET "D"
RESONANCE SEARCH & SINUSOIDAL VIBRATION

Customer: Hughes Aircraft Company Date: 5-30-90

Customer Part No. 4946407 TRW PSI Part No. 80350-1

Test Para. No. 4.5 TRW PSI Serial No. 0003

Test Equipment: SEE ATTACHED EQUIPMENT LIST

	Actual	Requirement
Specimen Test Pressure	Ø psig	Empty, vented
Bolt Torque	90' ~~in~~/lbs FT (PSI C/B), 20 FT-lbs TANK BOLTS	
Visually Examine Support Structure and Specimen for Damage After Vibration Tests Complete.	✓	No Visual Damage

Axis	Frequency From	To	D. A. Inches	G Peak	Sweep Rate Minutes/Octave	Duration Total Minutes	Date
Z	SEE TEST SEQ # 7						5-30-90

Date	Time	LOG ENTRIES

Tested By George W. Cayer (NTS 15 QC) Date 5-30-90 Specimen Passed ✓

Witnessed By John F. Kirby Jr. Date 5-30-90 Specimen Failed

HAC Witnessed By [signature] Date 13 Jun 90

TRW PRESSURE SYSTEMS, INC.

DATA SHEET "D"
RESONANCE SEARCH & SINUSOIDAL VIBRATION

Customer: Hughes Aircraft Company Date: 5-30-90

Customer Part No. 4946407 TRW PSI Part No. 80350-1

Test Para. No. 4.5 TRW PSI Serial No. 0003

Test Equipment: SEE ATTACHED EQUIPMENT LIST

	Actual	Requirement
Specimen Test Pressure	Ø psig	Empty, vented
Bolt Torque	90 in-lbs, 20 Ft-lbs TANK BOLTS	
Visually Examine Support Structure and Specimen for Damage After Vibration Tests Complete.	✓	No Visual Damage

Axis	Frequency From	To	D. A. Inches	G Peak	Sweep Rate Minutes/Octave	Duration Total Minutes	Date
Y	SEE TEST SEQ # 8						5-30-90

Date	Time	LOG ENTRIES

Tested By George W. Cayer Date 5-30-90 Specimen Passed ✓

Witnessed By John J. Kroneg Date 5-30-90 Specimen Failed

HAC Witnessed By Tom J. Heath Date 13 JUN 90

TRW PRESSURE SYSTEMS, INC.

DATA SHEET "D"
RESONANCE SEARCH & SINUSOIDAL VIBRATION

Customer: Hughes Aircraft Company Date: 6-1-90

Customer Part No. 4946407 TRW PSI Part No. 80350-1

Test Para. No. 4.5 TRW PSI Serial No. 0003

Test Equipment: SEE ATTACHED EQUIPMENT LIST

	Actual	Requirement
Specimen Test Pressure	0 psig	Empty, vented
Bolt Torque	90** Ft-lbs (FIXTURE)	20 Ft-lbs TANK BOLTS
Visually Examine Support Structure and Specimen for Damage After Vibration Tests Complete.	✓	No Visual Damage

Axis	Frequency From	Frequency To	D. A. Inches	G Peak	Sweep Rate Minutes/Octave	Duration Total Minutes	Date
X	SEE TEST SEQ # 14						6-1-90

Date	Time	LOG ENTRIES

Tested By George W. Cayes Date 6-1-90 Specimen Passed ✓

Witnessed By Tig-Kuan Ku Date 6-13-90 Specimen Failed No

HAC Witnessed By [signature] Date 13 June '90

Random Vibration (Wet)

Axes	Frequency	PSID (G^2/Hz)	PSID (dB/oct)	Grms
X, Y & Z	20 - 50		+ 6	
	50 - 200	.076		
	200 - 390		- 6	6.14
	390 - 800	.020		
	800 - 2000		- 6	

NOTE: The random spectrum shall be program or active notched in narrow frequency bands at the fundamental resonance so as to achieve the response levels in each axis as follows:

X axis 10 G peak
Y axis 10 G peak
Z axis 12 G peak

The tank is filled with 1135 pounds of Freon and pressurized to 135, +5/-0 psig with nitrogen.

Vibration levels are applied for a duration of 3 minutes per axis.

Collapse Pressure

The tank is subjected to ambient external pressure (14.6 psi minimum) with simultaneous internal evacuation to P = -4.0, +0.1/-0 psid.

This pressure is held for 15, +1/-0 minutes.

Burst Pressure Test

The burst test requires pressurization up to 357 psig. The normalized burst pressure requirement is 410 psid.

The actual burst pressure was 555 psig. The normalized burst pressure was 470.9 psig.

PRESSURE SYSTEMS, INC.

DATA SHEET "U"
BURST TEST

Customer: Hughes Aircraft Company Date: 10/8/90

Customer Part No. 4946407 TRW PSI Part No. 80350-1

Test Para. No. 4.27 TRW PSI Serial No. 0003

Test Equipment: GAUGE: S/N L25(5)ST-0625 CAL: 9/5/90 DUE 3/5/91

Test Media: Deionized Water

		Test Value	Requirement
A)	Water Specific Resistance	15 megohms/cm	0.5 Megohms/cm min.
B)	Water pH	6.5	5.5 to 8.0
C)	Specimen (Water) Temperature	72 deg. F	N/A
D)	Specimen Filled	YES	Compliance
E)	Pressurization Rate (less than 357 psig)	60 PSIG/min	75 psig/min.
F)	Pressurization Rate (above 357 psig)	60 PSIG/min	1000 psig/min.
G)	Rupture Pressure	555 psig	Record
H)	Burst Pressure	psig	(normalized) 410 psid minimum

Tested By: [signature] Date 10/8/90 Specimen Passed YES

Witnessed By: N/A (QA) Date 10/8/90 Specimen Failed NO

HAC Witnessed By: [signature] (SQG VCERT KO2) Date 10-8-90