QUALIFICATION ENVIRONMENTS

FOR

DIAPHRAGM PROPELLANT TANK

ATK P/N 80263-1

Specimen Configuration

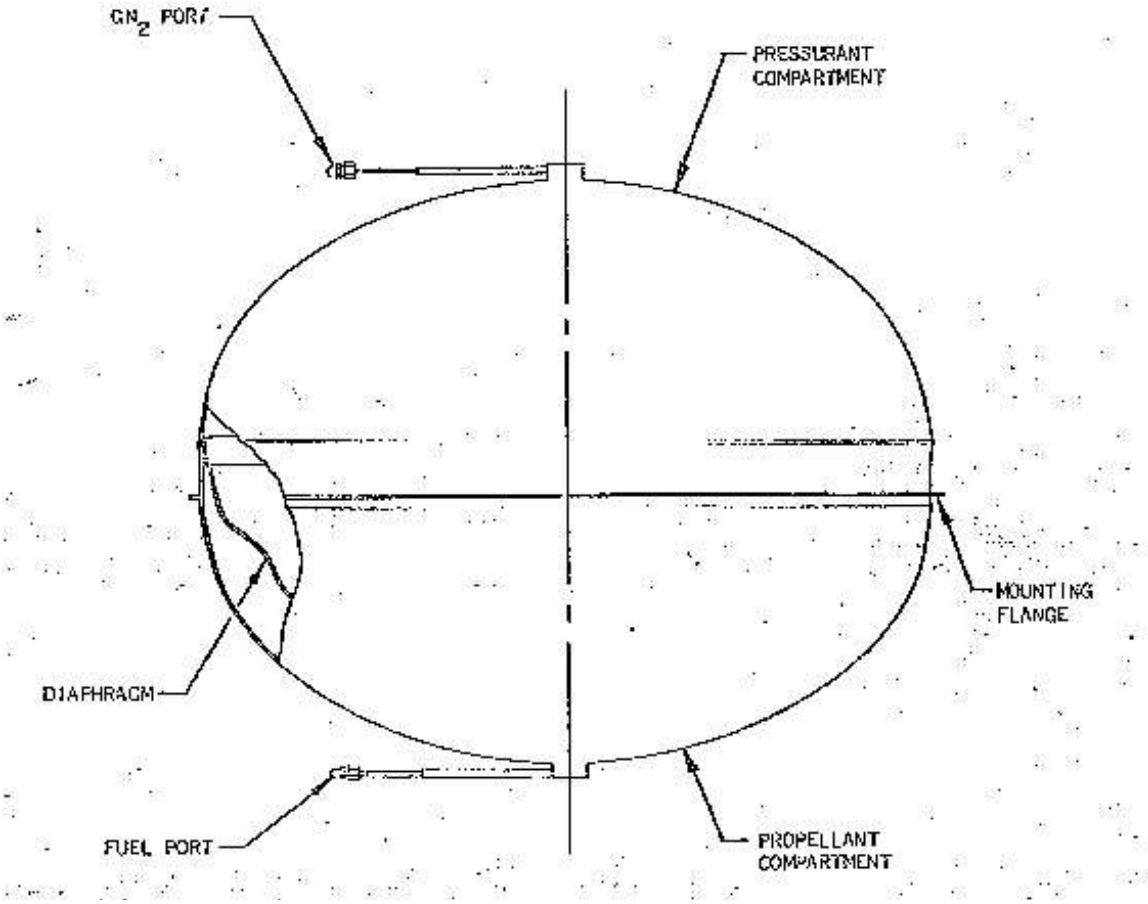


Table 1: P/N 80263-1 Diaphragm Propellant Tank

Specifications

Parameters	Requirements
Operating Pressure	338 psig @ 100°F, 100 psig @ 40°F
Proof Pressure	574 psig, Actual Proof: 580 psig
Burst Pressure	676 psig, Actual Burst: Not performed
External Pressure	Not tested
Internal Vacuum	1.9mm Hg
Material of Construction	This tank assembly is primarily fabricated from two (2) closed die forgings and one 91) roll ring forging. The material utilized in these forgings is a 6AL-4V titanium alloy. Fluid connections for the acceptance testing are made on the .250 diameter portion of the bi-metal tube assemblies.
Membrane Thickness	0.095″ - .220″
Tank Mount(s)	Mounting is accomplished on a continuous flange parallel with and adjacent to the mid-plane.
Expulsion Efficiency	-
Design Fill Fraction	-
Tank Capacity	28311.7 in^3
Internal Dimensions	40.85″ Ø x 40.35″
Tank Weight	Maximum tank weight is 76.0 lbs, Actual tank weight is 71.26 lbs
Propellant Capacity	984 lbs of hydrazine
Shell Leakage	$<1x10^{-6}$ std cc/sec He max, Actual: none
Failure Mode	Burst
Natural Frequency	-
Temperature Environment	-
On Orbit Life	10 years Space Environment 7 years minimum storage life 11 yers useful life

80263-1 was subjected to the following qualification tests:

TEST SEQUENCE NO.	TEST DESCRIPTION
1	PRELIMINARY EXAMINATION OF PRODUCT
2	PRE-PROOF VOLUMETRIC CAPACITY TEST
3	PROOF PRESSURE TEST
4	POST PROOF VOLUMETRIC CAPACITY TEST
5	INTERNAL (DIAPHRAGM) LEAKAGE TEST
6	EXTERNAL LEAKAGE TEST
7	PENETRANT INSPECTION
8	RADIOGRAPHIC INSPECTION
9	WEIGHT TEST
10	FINAL EXAMINATION OF PRODUCT
11	CLEANLINESS TEST
12	ACCELERATION TEST
13	INTERNAL (DIAPHRAGM) LEAKAGE TEST
14	NEGATIVE PRESSURE TEST
15	EXTERNAL LEAKAGE TEST
16	DIAPHRAGM INTEGRITY TEST
17	INTERNAL (DIAPHRAGM) LEAKAGE TEST
18	PRESSURE CYCLE TEST
19	BLOW DOWN PRESSURE TEST
20	EXPULSION CYCLE TEST
21	INTERNAL (DIAPHRAGM) LEAKAGE TEST
22	PROOF PRESSURE TEST
23	FINAL EXAMINATION OF PRODUCT
24	WEIGHT TEST
25	CLEANLINESS TEST

The following tests are listed in this document:

1) Proof Pressure Test
2) Acceleration Test
3) Negative Pressure Test
4) Pressure Cycle Test
5) Blow Down Pressure test

6) Expulsion Cycle Test

No Burst Test was performed.

Proof Pressure Test

Tank is pressurized to 580 psig and held for test duration of 10.0 seconds. Tank is depressurized in forty (40) seconds.

PSI 2017 camfield avenue los angeles, cal. 90040
PRESSURE SYSTEMS, INC.

TEST PROCEDURE No. 50-000205
PAGE 22

N/C

DATA SHEET C
PROOF PRESSURE TEST

DATE 8-22-78

PSI PART NUMBER 80263-1

SERIAL NUMBER 002

PSI SERIAL NUMBER 0002

TEST PROCEDURE PARA. No. 4.3

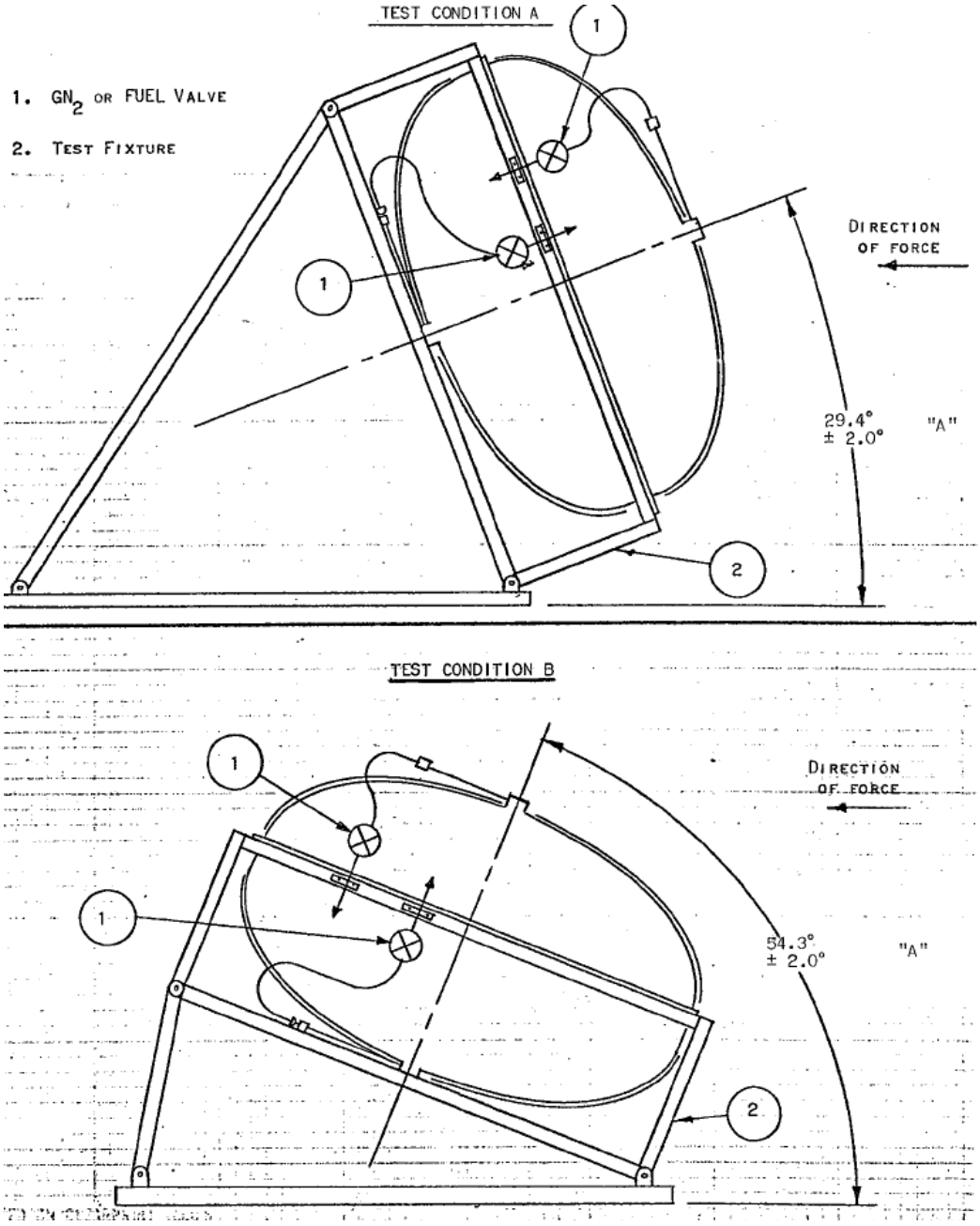
TEST EQUIPMENT HEISE (ST 0315) 0-1000 PSIG
CALIBRATION DUE 2-21-79

	TEST VALUE		REQUIREMENTS
PRESSURIZATION TIME FROM 300 PSIG TO 574 +10, -0 PSIG	35	SECONDS	60 SECONDS, MAX
SPECIMEN PRESSURE, MAXIMUM	580	PSIG	574, +10, -0 PSIG
PRESSURE HOLD TIME	10.0	SECONDS	10^{+5}_{-0} SECONDS
DEPRESSURIZATION TIME	40	SECONDS	60 SECONDS, MAX

TESTED BY [signature] DATE 8-22-78 SPECIMEN PASSED YES

Acceleration Test

Condition	Propellant Load (lbs)	Pressure (psig)	Acceleration (G)	Duration (minutes)
A	984, +20/-0	338, +20/-0	7.2, +1.0/-0	2, +0.2/-0
B	516, +20/-0	338, +20/-0	6.2, +1.0/-0	2, +0.2/-0



PRESSURE SYSTEMS, INC.

N/C A

DATA SHEET A

ACCELERATION TEST
(PAGE 1 OF 3)

DATE 8-31-78

PSI PART NUMBER 80263-1

PSI SERIAL NUMBER 0002

TEST PROCEDURE PARA. No. 4.2

TEST EQUIPMENT PH METER CHEMTRIX TYPE 40 S/N 5513
0-600 PSIG CAL DUE 11-8-78

TEST CONDITION A TEST 1

(PROPELLANT SIDE DOWN 984 LBS OF WATER)

TEST MEDIA: DISTILLED OR DEIONIZED WATER		REQUIREMENTS
WATER pH	7.4	6.0 TO 7.5
WATER RESISTIVITY	11.5 MEGS	1.0 MEGOHM/CM^2 MIN

TEST VALUE		REQUIREMENTS
LOADED WATER WEIGHT	990.0 LBS	984 $^{+20}_{-0}$ LBS
SPECIMEN PRESSURE	342.0 PSIG	338 $^{+20}_{-0}$ PSIG
ARM LENGTH	27.0 FT	N/A
ARM SPEED	28.07029.1 RPM	N/A
ACCELERATION (CALCULATED)	7.2 TO 7.8 G	7.2 $^{+1.0}_{-0}$ G
DURATION	2.1 MIN	2.0 $^{+.2}_{-.0}$ MIN
ACCELERATION(G)	$\frac{(\text{RPM} \times \frac{2\pi}{60})^2 \times \text{ARM LENGTH(FT)}}{32.2}$	
TANK POSITION	29.0°	29.4 ± 2.0°

TEST OPERATOR [signature] DATE 9-1-78 TRW Q.A. [signature] DATE 9-1-78

PSI 2017 camfair square 340

PRESSURE SYSTEMS, INC.

DATA SHEET A
ACCELERATION TEST
(PAGE 2 OF 3)

N/C	A					

DATE 9-1-78

PSI PART NUMBER 80263-1

PSI SERIAL NUMBER 0002

TEST PROCEDURE PARA. No. 4.2

TEST EQUIPMENT PH METER CHEMTRIX TYPE 40 S/N 5513
GAUGE 0-600 PSIG CALIBRATION DUE 11-8-78

TEST CONDITION A TEST 2
(PROPELLANT SIDE UP 516 LBS OF WATER)

TEST MEDIA: DISTILLED OR DEIONIZED WATER

		REQUIREMENTS
WATER pH	7.0	6.0 TO 7.5
WATER RESISTIVITY	15.5	1.0 MEGOHM/CM^2 MIN

TEST VALUE			REQUIREMENTS
LOADED WATER WEIGHT	520.0	LBS	516 $^{+20}_{-0}$ LBS
SPECIMEN PRESSURE	347.0	PSIG	338 $^{+20}_{-0}$ PSIG
ARM LENGTH	27.0	FT	N/A
ARM SPEED	28.0 TO 28.6	RPM	N/A
ACCELERATION (CALCULATED)	7.2 TO 7.5	G	7.2 $^{+1.0}_{-0}$ G
DURATION	2.1	MIN	2.0 $^{+.2}_{-.0}$ MIN
ACCELERATION (G) $\frac{(\text{RPM} \times \frac{2\pi}{60})^2 \times \text{ARM LENGTH (FT)}}{32.2}$			
TANK POSITION	29.0°		29.4 ± 2.0°

TEST OPERATOR W. Williams DATE 9-1-78 TRW Q.A. S Hanson DATE 9-1-78

PSI 2017 Candlestick Avenue Los Angeles, CA 90040

PRESSURE SYSTEMS, INC.

ST PROCEDURE No. 50-000209
GE 34

DATA SHEET A
ACCELERATION TEST
(PAGE 3 OF 3)
CONTINUED

N/C A

DATE 9-1-78

PSI PART NUMBER 80263-1

PSI SERIAL NUMBER 0002

TEST PROCEDURE PARA. No. 4.2

TEST EQUIPMENT PH METER CHEMTRIX TYPE 40 S/N 5513
GAUGE 0-600 PSIG CALIBRATION DUE 11-8-78

TEST CONDITION B
(PROPELLANT SIDE UP 516 LBS OF WATER)

TEST MEDIA: DISTILLED OR DEIONIZED WATER

		REQUIREMENTS
WATER pH	7.0	6.0 TO 7.5
WATER RESISTIVITY	15.5	1.0 MEGOHM/CM^2 MIN

TEST VALUE		REQUIREMENTS
LOADED WATER WEIGHT	520.0 LBS	516 $^{+20}_{-0}$ LBS
SPECIMEN PRESSURE	347.0 PSIG	338 $^{+20}_{-0}$ PSIG
ARM LENGTH	27.0 FT	N/A
ARM SPEED	26.0 TO 26.6 RPM	N/A
ACCELERATION (CALCULATED)	6.2 TO 6.5 G	6.2 $^{+1.0}_{-0}$ G
DURATION	2.1 MIN	2.0 $^{+.2}_{-.0}$ MIN
ACCELERATION (G) $\frac{(RPM \times \frac{2\pi}{60})^2 \times ARM\ LENGTH\ (FT)}{32.2}$	TANK POSITION 53.0°	54.3 ± 2.0°

TEST OPERATOR [signature] DATE 9-1-78 TRW Q.A. [signature] DATE 9-1-78

Negative Pressure Test

The tank's pressurant and propellant ports are simultaneously evacuated to a pressure of 2 mm of Hg or less for a 5, +1/-0 minute period.

PSI 2017 camfield avenue los angeles, calif. 90049
PRESSURE SYSTEMS, INC.

TEST PROCEDURE No. 50-000209
PAGE 36

N/C	A					

DATA SHEET C

NEGATIVE PRESSURE TEST

DATE 9-7-78

PSI PART NUMBER 80263-1

SERIAL NUMBER 002

PSI SERIAL NUMBER 0002

TEST PROCEDURE PARA. No. 4.4

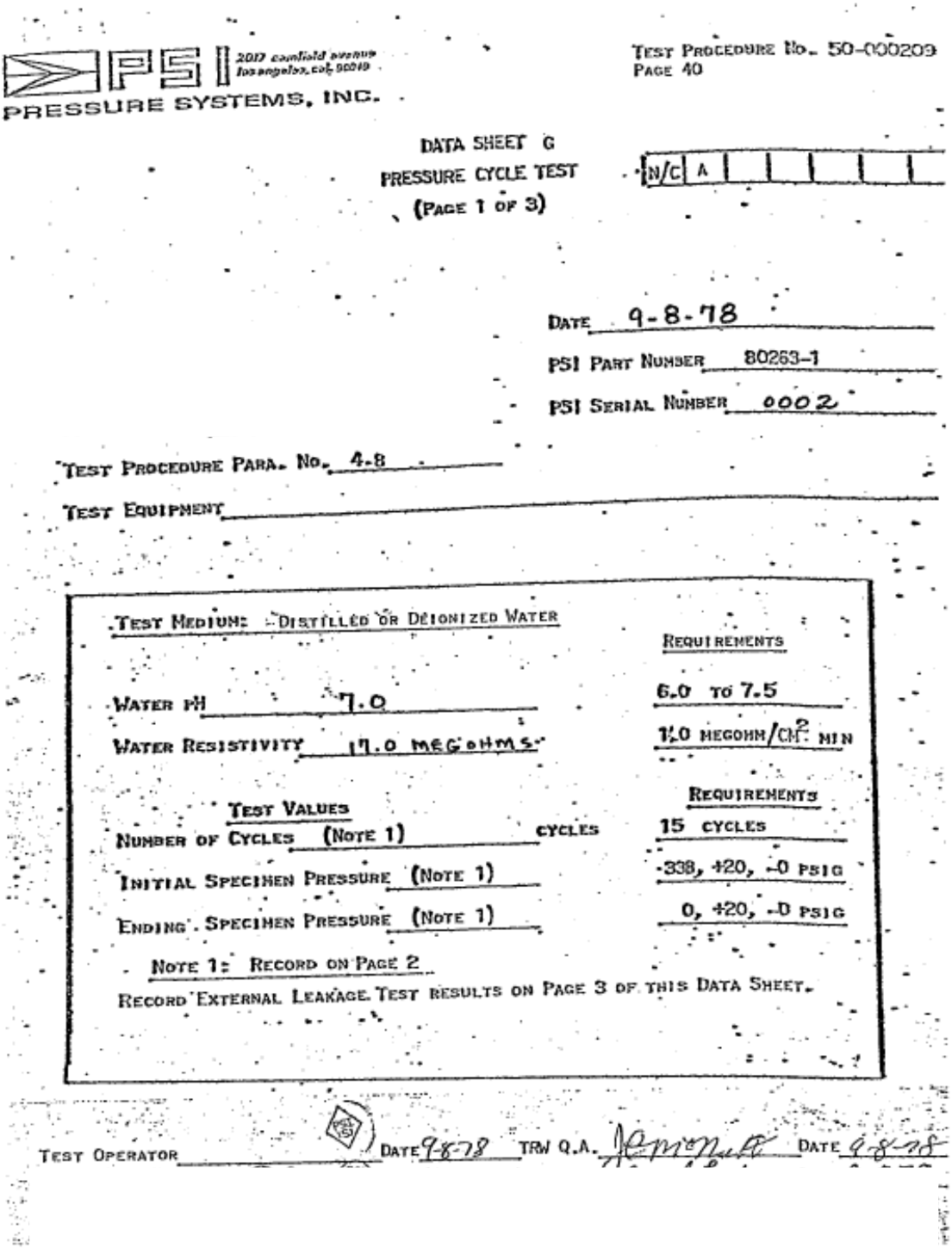
TEST EQUIPMENT WALLACE & TIERNAN PRESSURE GAUGE S/N. ST-0488
CALIB. DUE 10-6-78

TEST VALUES	REQUIREMENTS
SPECIMEN PRESSURE 1.9 mm	2 MM HG OR LESS
TEST DURATION 6 min.	5 + 1, -0 MINUTES
VISUAL DAMAGE NOTED NONE	RECORD

TEST OPERATOR Ann Quelick DATE 9-7-78 TRW Q.A. J.M. Nutt DATE 9-7-78

Pressure Cycle Test

Tank is filled with water and pressurized to 338, +20/-0 psig. Pressure is held for 30 seconds. Number of cycles is 15.



PSI 2017 canfield avenue los angeles, calif. 90049
PRESSURE SYSTEMS, INC.

TEST PROCEDURE No. 50-000209
PAGE 40

DATA SHEET G
PRESSURE CYCLE TEST
(PAGE 1 OF 3)

N/C A

DATE 9-8-78
PSI PART NUMBER 80263-1
PSI SERIAL NUMBER 0002

TEST PROCEDURE PARA. No. 4.8
TEST EQUIPMENT

		REQUIREMENTS
TEST MEDIUM: DISTILLED OR DEIONIZED WATER		
WATER pH	7.0	6.0 TO 7.5
WATER RESISTIVITY	17.0 MEGOHMS	1.0 MEGOHM/CM² MIN
TEST VALUES		REQUIREMENTS
NUMBER OF CYCLES (NOTE 1)	CYCLES	15 CYCLES
INITIAL SPECIMEN PRESSURE (NOTE 1)		338, +20, -0 PSIG
ENDING SPECIMEN PRESSURE (NOTE 1)		0, +20, -0 PSIG

NOTE 1: RECORD ON PAGE 2
RECORD EXTERNAL LEAKAGE TEST RESULTS ON PAGE 3 OF THIS DATA SHEET.

TEST OPERATOR DATE 9-8-78 TRW Q.A. DATE 9-8-78

PSI Los Angeles, Calif. 90040
PRESSURE SYSTEMS, INC.

DATA SHEET G
PRESSURE CYCLE TEST
(PAGE 2 OF 3)

N/C A

CHECK OR STAMP APPROPRIATE BOX AFTER OPERATION IS PERFORMED

DATE 9-8-1978

PSI PART NUMBER 80263-1

PSI SERIAL NUMBER 0002

TEST PROCEDURE PARA. NO. 4.8

TEST EQUIPMENT Gage ST-0315 Due (2-21-79)

CYCLE NUMBER	INITIAL SPECIMEN PRESSURE	ENDING SPECIMEN PRESSURE	OPERATOR STAMP
1	340	0	PSI 151
2	340	0	PSI 151
3	340	0	PSI 151
4	340	0	PSI 151
5	340	0	PSI 151
6	340	0	PSI 151
7	340	0	PSI 151
8	340	0	PSI 151
9	340	0	PSI 151
10	340	0	PSI 151
11	340	0	PSI 151
12	340	0	PSI 151
13	340	0	PSI 151
14	340	0	PSI 151
15	340	0	PSI 151

TEST OPERATOR PSI 151 DATE TRW Q.A. [illegible] DATE 9-8-78

PSI 2017 camfield avenue los angeles, cal. 90040
PRESSURE SYSTEMS, INC.

TEST PROCEDURE No. 50-C00209
PAGE 42

N/C	A					

DATA SHEET G
POST PRESSURE CYCLE TEST
EXTERNAL LEAKAGE TEST
(PAGE 3 OF 3)

DATE SEPTEMBER 11, 1978

PSI PART NUMBER 80263-1

PSI SERIAL NUMBER 0002

TEST PROCEDURE PARA. No. 4.8

TEST EQUIPMENT ASHCROFT (ST0334) 0-600PSIG, CALIBRATION DUE 2-26-7

	TEST VALUE	REQUIREMENTS
VACUUM CHAMBER PRESSURE	.01	0.2 MICRONS OF MERCURY MAXIMUM
MASS SPECTROMETER SENSITIVITY	2.0×10^{-10}	1×10^{-8} STD CC/SEC/DIV. MINIMUM
SPECIMEN PRESSURE	345	338 $^{+420}_{-0}$ PSIG
TEST PERIOD	5.1	5 MINUTES MINIMUM
LEAK RATE	0	1×10^{-7} STD CC/SEC. MAXIMUM

TEST OPERATOR [signature] DATE 9-11-78 TRW Q.A. [signature] DATE 9-11-78

Blowdown Pressure Test

PSI 2017 camfield avenue los angeles, cal. 90040
PRESSURE SYSTEMS, INC.

DATA SHEET H — TEST PROCEDURE NO. 50-0000 — PAGE 43

BLOWDOWN PRESSURE TEST — N/C A

DATE SEPTEMBER 12, 1978

PSI PART NUMBER 80263-1

PSI SERIAL NUMBER 0002

TEST PROCEDURE PARA. NO. 4.9

TEST EQUIPMENT ASHCROFT (ST-033A) 0-30 PSIG (CALIBRATION DUE 2-26-79)
BARTON INST. (ST 0364) 0-15PSID (CALIBRATION DUE 3-12-79)
TOLEDO SCALE (S130) 0-2000 LBS (CALIBRATION DUE 2-18-79)

TEST MEDIA: DISTILLED OR DEIONIZED WATER

			REQUIREMENTS
WATER pH	7.0		6.0 TO 7.5
WATER RESISTIVITY	17. MEGOHMS		1.0 MEGOHM/CM^2 MIN
	TEST VALUE		REQUIREMENTS
DRY WEIGHT OF SPECIMEN AND FIXTURE (Wo)	179.9	LBS	RECORD
LOADED WEIGHT OF SPECIMEN AND FIXTURE (Wi)	895.1	LBS	RECORD
WEIGHT OF WATER (Wi-Wo)	715.2	LBS	710 +10, -0 LBS
INITIAL NITROGEN GAS PRESSURE	338	LBS	338 +20, -0 PSIG
WEIGHT OF SPECIMEN, FIXTURES AND 2% OF WATER (Wb)	194.2	LBS	LBS
DIFFERENTIAL PRESSURE (INITIAL)	0	PSID	1.0 MAXIMUM, PSID
DIFFERENTIAL PRESSURE (FINAL)	.3	PSID	1.0 MAXIMUM, PSID
WATER FLOW RATE (INITIAL)	13.0	GAL/HR	13 ± 1 GAL/HR
WATER FLOW RATE (FINAL)	13.0	GAL/HR	13 ± 1 GAL/HR
NITROGEN GAS PRESSURE AT 98% BLOWDOWN	72.0	PSIG	RECORD
FINAL WEIGHT OF TANK AND FIXTURE (Wf)	180.6	LBS	RECORD
EXPULSION EFFICIENCY	99.90	%	99% MINIMUM

$W_b = W_o + (0.02)(W_i - W_o)$

$$\text{EXPULSION EFFICIENCY} = \frac{W_i - W_f}{W_i - W_o}(100) = \frac{895.1 - 180.6}{895.1 - 179.9} = 99.90$$

TEST OPERATOR [signature] DATE 9-12-78 TRW Q.A. [signature] DATE 9-12-78

Expulsion Cycle Test

Tank is loaded with approximately 990 lbs of distilled water and cycled for fifty cycles @ 340 psig.

PSI PRESSURE SYSTEMS, INC. Los Angeles, Calif. 90040

PAGE 44

DATA SHEET 1

EXPULSION CYCLE TEST (PAGE 1 OF 3)

N/C A

DATE SEPTEMBER 19, 1978

PSI PART NUMBER 80263-1

PSI SERIAL NUMBER 0002

TEST PROCEDURE PARA. NO. 4.10

TEST EQUIPMENT SCALE - TOLEDO SMI 8130 Cal 8-18-78

POTENTIOMETER E-0215 (DUE 12-18-78)

CONTROLLER RECORDER S-1-0394 (DUE 11-22-78)

TEST MEDIA: DISTILLED OR DEIONIZED WATER

		REQUIREMENTS
WATER PH	7.0	6.0 TO 7.5
WATER RESISTIVITY	17.0	1.0 MEGOHM/CM^2 MIN

TEST VALUES		REQUIREMENTS
LOW TEMPERATURE EXPULSION CYCLES	(NOTE 1)	25 CYCLES
WATER LOADED	(NOTE 1)	984 $^{+20}_{-0}$ LBS
TEMPERATURE	(NOTE 1)	40 ±5°F
INITIAL PRESSURE	(NOTE 1)	338 $^{+20}_{-0}$ PSIG
HIGH TEMPERATURE EXPULSION CYCLES	(NOTE 2)	25 CYCLES
WATER LOADED	(NOTE 2)	984 $^{+20}_{-0}$ LBS
TEMPERATURE	(NOTE 2)	100 ±5°F
INITIAL PRESSURE	(NOTE 2)	338 $^{+20}_{-0}$ PSIG

NOTE 1: RECORD ON PAGE 2 OF DATA SHEET 1
NOTE 2: RECORD ON PAGE 3 OF DATA SHEET 1.

TEST OPERATOR W. Mac Pencil DATE 9-22-78 PSI Q.A. E. Hanson DATE 9-22-7

DATA SHEET 1

EXPULSION CYCLE TEST | N/C | A | | | | | |

LOW TEMPERATURE EXPULSION CYCLES
(PAGE 2 OF 3)

CHECK OR STAMP APPROPRIATE BOX AFTER OPERATION IS PERFORMED

DATE 9-18-1978

PSI PART NUMBER 80263-1

PSI SERIAL NUMBER 0007

TEST PROCEDURE PARA. No. 4.10

TOLEDO 8130 CALIBRATED 8-18-78
ASHCROFT GAUGE (ST 0334) 0-600 PSIG
CALIBRATION DUE 2-26-79

	CYCLE No.	WATER LOADED 984 +20 -0 LBS.	TEMPERATURE 40 ± 5°F	PRESSURE 338 +20 -0 PSIG	OPERATOR STAMP
SEPT 18, 1978	1	996.8	39°	340	BL
	2	996.9	39°	340	BL
	3	996.3	39°	340	BL
	4	996.4	40°	340	BL
	5	996.9	40°	340	BL
	6	996.4	40°	340	BL
SEPT 19, 1978	7	996.3	39°	340	BL
	8	996.3	38°	340	BL
	9	996.3	40°	340	BL
	10	996.5	39°	340	BL
	11	996.4	38°	340	BL
	12	996.4	39°	340	BL
	13	996.1	39°	340	BL
	14	996.6	39°	340	BL
	15	996.4	40°	340	BL
	16	996.4	39°	340	BL
	17	1000.5	40°	340	BL
	18	999.9	40°	340	BL
SEPT 20, 1978	19	997.2	39°	340	BL
	20	997.3	40°	340	BL
	21	994.8	39°	340	BL
	22	997.4	40°	340	BL
	23	993.9	42°	340	BL
	24	993.8	41°	340	BL
	25	994.1	40°	340	BL

TEST OPERATOR [signature] DATE 9-22-78 TRW Q.A. [signature] DATE 9-20-78

PSI 2017 camfield avenue los angeles, calif. 90040
PRESSURE SYSTEMS, INC.

DATA SHEET 1
EXPULSION CYCLE TEST

N/C | A

HIGH TEMPERATURE EXPULSION CYCLES
(PAGE 3 OF 3)

CHECK OR STAMP APPROPRIATE BOX AFTER OPERATION IS PERFORMED

DATE 9-21-1978

PSI PART NUMBER 80263-1

PSI SERIAL NUMBER 0002

TEST PROCEDURE PARA. NO. 4.10

CYCLE NO.	WATER LOADED 984 +20 -0 LBS.	TEMPERATURE 100 ± 5°F	PRESSURE 338 +20 -0 PSIG	OPERATOR STAMP
26	998.1	102 °F	340	BC
27	993.9	101 °F	340	BC
28	994.4	102 °F	340	BC
29	991.7	102 °F	340	BC
30	992.8	102 °F	340	BC
31	995.4	103 °F	340	BC
32	996.0	103 °F	340	BC
33	994.7	102 °F	340	BC
34	995.6	101 °F	340	BC
35	994.2	102 °F	340	BC
36	993.7	102 °F	340	BC
37	991.8	99 °F	340	BC
38	993.0	99 °F	340	BC
39	991.7	99 °F	340	BC
40	997.0	99 °F	340	BC
41	995.5	100 °F	340	BC
42	994.4	100 °F	340	BC
43	994.0	100 °F	340	BC
44	990.3	98 °F	340	BC
45	1002.0	98 °F	340	BC
46	996.4	99 °F	340	BC
47	993.2	99 °F	340	BC
48	994.3	99 °F	340	BC
49	991.9	101 °F	340	BC
50	992.2	100 °F	340	BC

9-21-78

TEST OPERATOR [signature] DATE 9-22-78 TRW Q.A. [signature] DATE 9-22-78

Normalized Burst Pressure:

The normalized burst pressure is 840 psig per Qualification Test Report 56-000120.

$$\text{Normalized burst pressure} = \text{Actual burst pressure} \times \frac{\text{Minimum design wall thickness}}{\text{Actual wall thickness}} \times \frac{\text{Design ultimate tensile strength}}{\text{Actual ultimate tensile strength}}$$

$$\times \text{ (effect of temperature)} = 921 \times \frac{.072}{.075} \times \frac{161.7}{168.4} \times \frac{.97}{.98} = 840 \text{ psig.}$$