UNIVERSITY OF WISCONSIN
SPACE SCIENCE AND ENGINEERING CENTER
MADISON, WISCONSIN

TWERLE

PRESSURE SENSOR

MANUFACTURING MANUAL

APRIL 1973
University of Wisconsin
Space Science and Engineering Center

T W E R L E

Pressure Sensor

Manufacturing Manual

April 1973
TVERLE PRESSURE SENSOR

GENERAL

The pressure sensor utilizes an aneroid capsule with capacitive coupling. The aneroid capacitor serves as the tuning capacitor of a Clapp oscillator. The rest of the circuitry includes a source follower buffer and a complementary output stage.

To minimize the effects of oscillator drift, the aneroid capacitor is compared to a reference capacitor. A high quality relay (gold contacts) switches between the two capacitors. The difference between the reference frequency and the aneroid frequency is a measure of pressure. The oscillator effect will be completely nullified if the two capacitors (or two frequencies) are equal. The reference capacitor is a system of three capacitors, one of them variable. The variable capacitor is adjusted for zero frequency difference at the expected flight pressure of 150mb.

The aneroid capsule was selected for its short term and long term stability, aging behavior, and small temperature coefficient. A VAISALA 150 mb mounted capsule was chosen. The capsule includes pre-mounted capacitor plates. The temperature coefficient of the capsule capacitors is approximately -10 ppm/°C, hence zero temperature coefficient capacitors (NPO) are used in the reference capacitor system. Typical values for the sensor are: reference frequency of 1 MHz, sensitivity of 500 Hz/mb and temperature dependence less than ±0.05 mb/°C. A YSI Thermistor is attached to the aneroid mount. It is connected to a separate temperature measuring circuit to yield the pressure sensor temperature within 1° C.
To allow maximum pre-flight aging at the expected pressure level, the aneroid capsule is mounted inside an evacuated bubble which has a relief valve. From the assembly stage, throughout the temperature cycling, calibration, storage, prelaunch calibration, and balloon ascent, the aneroid is never again exposed to surface pressure. (However, accidental exposure, for short periods, is not harmful.) The relief valve opens at a pressure differential of 60mb. Hence, it will only open during the balloon ascent just prior to arrival at the ceiling altitude.

The evacuated bubble allows a last minute calibration of an aged capsule, at the launching site, at a pressure of 150mb, without pressure shocks before and after the calibration.

In addition to the temperature compensation and temperature monitoring, the entire pressure sensor is enclosed in a passive temperature enclosure which was chosen after tests of various types of enclosures in actual balloon flights. The enclosure is essentially an 8" plastic foam sphere covered with aluminum foil. The upper hemisphere is covered with aluminized mylar (mylar outside) and the lower hemisphere is painted with white lead paint. Such an enclosure yielded the lowest, flatest and most stable daytime temperature curve.

Special care is devoted to the calibration. The calibration is performed after one week of temperature cycling and eight days of simulated flight conditions: pressure 150mb, temperature -55°C night, -25°C day, (expected flight temperatures: -70°C to -55°C night, -40°C to -20°C day). Frequency difference versus pressure, between 170mb and 130mb, is plotted at three temperatures: -40°C, -30°C, and -20°C (daytime range). Only after the calibration is performed at the flight temperature range are
Three more plots made at +20°C, +25°C, and +30°C. These will enable a correction to be made after the prelaunch calibration which will be performed at room temperature. It was found that after exposure to room temperature, the sensor has to pass two night-day cycles before it arrives back at the previous reading obtained at typical daytime flight temperatures.

The combination of a reference capacitor, temperature compensation and temperature monitoring, a good temperature enclosure, continuous aging and last minute calibration, the latter both being performed at the flight pressure, is expected to yield the specified accuracy of 0.5mb/6 month. A considerably better short term accuracy is expected.
Pumpdown procedure:

1. Close all valves.

2. Turn on the T.I. Gauge and allow it to fully warm up. It is recommended that the T.I. Gauge remain on all the time. Turn the pressure control valve to normal.

3. Turn on the vacuum pump and allow to warm up for about 15 minutes.

4. Open valve #2.

5. Open valve #4 while observing the Wallace and Tiernan gauge and pumpdown to the desired pressure. Close valve #4.

6. Set the T.I. gauge readout dial to the desired pressure. Refer to the gauge calibration table for the proper counter dial setting.

7. Open valve #1.

8. If the null meter deflects far to the right, the pressure must be reduced back to the meter null position using pumpdown needle valve #7. If the null meter deflection is far to the left, the pressure must be increased by using the air inlet needle valve #6 until the meter is nulled.

9. The pressure control valve will maintain the chamber pressure at the T.I. gage setting by opening for short bursts upon an increase in chamber pressure. The amount of flow required thru the solenoid valve can be controlled by the pressure control needle valve #10. The exact setting will depend on the individual system's leak rate. Needle valves #6 and #7 can be used separately to compensate for pressure changes due to test chamber temperature changes. For example, should the chamber temperature be increased by resetting the chamber temperature control, the pressure will increase at a rate greater than what the pressure control valve can handle. Therefore during the temperature transition time it will be necessary to open pumpdown needle valve #7 slightly in order to maintain
the pressure within allowable control limits. After the chamber pressure has stabilized to the new temperature, the needle valve can be closed. Conversely, if the chamber temperature is lowered, it will be necessary to compensate for the decrease in pressure by bleeding air into the system with the air inlet needle valve #6.

Shutdown procedure:

10. Turn the T.I. Gauge to standby and close valve #1.
11. Open valve #4 and 5.
12. After a few seconds the roughing pump may be turned off.
13. Close all valves.
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<td>830-1</td>
<td>Pressure Package</td>
<td>Sub Assembly</td>
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TWERLE PRESSURE PACKAGE

ASSEMBLY PROCEDURE

and

LEAK TEST

1. Epoxy bead thermistor to Vaisala capsule mounting plate as per Dwg. TPS820-1 detail B using Hysol 907 epoxy.

2. Solder one thermistor lead to capsule mounting plate next to thermistor. Use SN60 solder.

3. Clean red paint off center screw on aneroid capsule assembly and solder a 3" length of #24 gage tinned solid wire to screw end. Refer to Dwg. #TPS 820-1.

4. Solder three aneroid mounting struts as per Dwg. #TPS 822 to capsule mounting plate edge as per Dwg. #TPS 820-1 equally spaced 120° approximately 60° from ceramic web legs. Use SN60 solder.

5. Solder 4" length of #24 gage tinned solid copper wire to the second thermistor lead approximately 1" from bead. Cut off excess thermistor lead at splice.

6. Clean and roughen with steel wool or sandpaper the two indent wells on the two Lexan bubble halves. Refer to Dwg. TPS 821.

7. Clean and roughen with steel wool or sandpaper the mating flange area to be joined on the bubble halves.

8. Clean with iso-prop. alcohol or suitable non-residue cleaner, and carefully inspect the aneroid capsule assembly. The space between the capacitor plates must be dust free and clean.

9. Insert aneroid capsule assembly in top Lexan bubble half, Dwg TPS 821 sheet 1 of 2. Make certain that the aneroid and thermistor leads have a small amount of strain relief and do not contact mounting struts or other areas on the aneroid capsule.

10. Set the top bubble half with capsule assembly inserted on a flat surface and fill indents at wire exits with Hysol 907 epoxy. Refer to Dwg. TPS 820-1.
11. Install Circle Seal valve (Item 4) and pump out tube (Item 3) on bottom half of the Lexan bubble. Refer to Dwg. TPS 820-1. Fill indents with Hysol 907 epoxy and let cure.

12. Prior to joining of the two bubble halves, inspect the inside areas, aneroid capsule assembly and relief valve for cleanliness.

13. Wet the two bubble flange surfaces to be joined with ethylene-dichloride. Join the two halves together. Clamp the flanges together in a suitable jig for one hour. Refer to Dwg. TPS 820-1.

14. Wet the outside of the pressure line tube (Item 3) with ethylene dichloride. Slip the 4" Tygon tube (Item 2) over the wetted pressure line tube and allow to stand for one hour. Refer to Dwg. TPS 820-1.

15. Mount the four Lexan angle brackets to the bubble flange as per Dwg. TPS 820-1 using ethylene dichloride as solvent glue. Clamp and allow to dry for one hour.

16. Install bubble assembly on completed printed circuit board as per Dwg. TPS 830-1.

17. Solder a #24 gage solid wire from the P.C. board com. pad to any one of the three aneroid mounting struts extending outside of the bubble. Solder the thermistor lead to the thermistor P.C. pad. Solder the lead extending from the aneroid to the aneroid pad.

18. Electrical checkout:
Wire up power and ground. Observe output on an oscilloscope and frequency counter. Measure input current on both the +12 and -12 volt supply. -12 volt current should be between 1 and 2 ma. +12 volt current should be between 2 and 3 ma. Output signal on oscilloscope should be a square wave from ground (OV) to +12 volts (11 volt min.).

19. Attach pressure line to vacuum system and gauge. Hold relief valve closed and begin pumpdown. Evacuate bubble to 150 mb + .1 mb. Maintain this pressure throughout the following adjustment.

20. Energize the relay by connecting between +12 volts and the relay pad. Measure and record the output frequency.
21. Adjust capacitor C10 with the relay de-energized so that the output frequency is within 1 KHz of the output frequency with the relay energized. Both frequencies should be between 0.8 to 1.2 MHz.

22. Repeat steps 20 and 21 and readjust C10 if necessary. Note that the full adjustment range of C10 is a 180° rotation from the point where the black dot on the rotating portion matches the arrow point on the capacitors side. Record the two frequencies. (Relay de-energized = f ref, relay energized = f aneroid) and the difference frequency Δf = f ref - f aneroid.

23. Change the pressure to 160 ± .1 mb and record the new Δf @ 160 mb. Establish from this data the sensitivity = \(\frac{\Delta f}{160 - \Delta f 150} \) [Hz/mb]. The sensitivity should be between 350 and 700 Hz/mb.

24. Install the pinch-off clamp on the Tygon tubing while the system is connected to the vacuum system at 150 mb ± .1 mb pressure. Refer to Dwg. #TPS 830-1.

25. Disconnect from power and store for one week. After one week, connect to power and read Δf. Convert the change in mb using the sensitivity calculated in Step 23. Leak rate should not exceed 15 mb/week. If leak rate is greater than 15 mb/week, bubble assembly must be leak checked and repaired. If bubble assembly is replaced, Steps 18 thru 25 must be repeated.

26. Install flight train wiring harness to P.C. board. Refer to Dwg. #TPS 830-1.

27. Install P.C. board and bubble assembly into top half of pressure package. (Styrofoam ball, mylar covered).

28. Install the bottom half of pressure package (styrofoam ball, white paint coating) to the top half of the pressure package leaving both bottom plugs out. Tape the separation point with 2" wide aluminized mylar tape. The package is now ready for relief valve and bubble correction factor measurement and calibration. After the calibration is complete the clamped pressure line will be stuffed inside the package being careful not to interfere with the relief valve. The two styrofoam plugs can now be installed.
Measurement of
Relief Valve Release Differential
and
Bubble Correction Factor

Differential Pressure Test and Relief Valve Test:
The object of the following tests is to evaluate the pressure system behavior to changes in atmospheric pressure as the bubble pressure remains constant at 150 mb, and to determine the atmospheric pressure required to open the relief valve while the bubble pressure is maintained @ 150 mb. Refer to the pressure test system functional block diagram.

1. Install complete pressure package assembly with plugs removed in vacuum test chamber including electrical connections. Attach clamped off Tygon pressure line to the chamber pressure line feed-thru. Be sure that the package is aligned in the fixture such that the pushrod feed-thru can be used to close the relief valve. Leave the bell jar open.

2. For this test the pressure test system should be started in the following manner:
   Turn T.I. gage to standby and allow gage to fully warm up. This gage should normally be left in standby with power on and valved off at 150 mb. Pressure control box switched to normal.

3. With all valves closed, start the vacuum pump and allow to warm up for 15 minutes. Open valve #3.

4. Slowly open valve #4 while observing the Wallace and Tiernan gage and evacuate the lines to 150 mb. Close valve #4. Line should stay at 150 mb.

5. Remove the pressure line pinch-off clamp. If necessary, bring the line pressure back to 150 mb using needle valve #7. Close valve #7 with bubble and line at 150 mb.

6. Open valve #1 and turn the T.I. gage to manual operate position and make sure that the T.I. gage is set to read 150 mb. Allow the pressure control valve to maintain 150 mb.
7. Close the bell jar.

8. Measure and record $f_{\text{ref}}$ (output frequency with relay de-energized) and $f_{\text{aneroid}}$ (output frequency with relay energized). Record $\Delta f = (f_{\text{ref}} - f_{\text{aneroid}})$.

9. Close valve #1 and #3.

10. Turn T.I. gage to standby.

11. Open valve #2 and #4 while observing the Wallace and Tiernan gage and evacuate the bell jar to 300 mb ± 5 mb. Close valve #4 and make sure that the bell jar will hold at 300 mb.

12. Close valve #2.

13. Open valve #4 and evacuate line to 150 mb. Close valve #4 at 150 mb.

14. Turn T.I. gage to manual and open valve #1.

15. Open valve #3 and allow pressure control valve to maintain 150 mb bubble pressure.

16. Repeat step #8 and record as $\Delta f$ at 150 mb with 300 mb outside.

17. Close valve #1 and turn T.I. gage to standby.

18. Close valve #3.

19. Energize the relay and observe the output frequency. Keep the relay energized.

20. Open valve #2.

21. Slowly open pumpdown needle valve #7 while observing the Wallace and Tiernan gage and output frequency. Allow the bell jar pressure to decrease slowly and record the exact pressure on the Wallace and Tiernan gage when the output frequency suddenly jumps to a higher valve. This occurs when the relief valve opens. Relief valve opening pressure range is 190-250 mb. Record the valve opening pressure. Close valve #7.

22. Close valve #2.

23. Push and hold relief valve closed with the push rod feed-thru.

24. Open air inlet valve #9 and allow bell jar pressure to return to atmospheric. Retract the pushrod feed-thru.
25. Slowly open valve #7 and evacuate the line to 150 mb as indicated on the Wallace and Tiernan gage.

26. Open valve #3 and reset the bubble pressure to 150 mb as indicated on the Wallace and Tiernan gage with valve #7. Close valve #7.

27. Turn the T.I. gage to manual and open valve #1. Allow the pressure control valve to reset bubble pressure to 150 mb.

28. Close valve #3.

29. Close valve #1 and turn the T.I. gage to standby.

30. Remove or open the bell jar.

31. Install the pressure line pinch-off clamp.

32. Pressure package can now be removed from the test system.

33. Test system shut-down procedure. If the mechanical vacuum pump is to be turned off the following procedure should be followed in order to prevent roughing pump oil from being drawn into the test system. With all other valves closed, open valve #4 and air inlet valve #5 wide open. Shut off the vacuum pump after a gurgling sound is heard or when it is apparently pumping at atmospheric pressure.
CALIBRATION PROCEDURE

1. Evacuate the pressure sensor aneroid bubble to 150mb with the relief valve closed. (NOTE: This will be the last time that the aneroid will be exposed to surface pressure.) Read $f_{\text{ref}}$ and $f_{\text{aneroid}}$.

2. Install the pressure line pinch off clamp and remove the bubble from the vacuum system.

3. Temperature cycle the entire assembly between $-55^\circ\text{C}$ and $+55^\circ\text{C}$ for one week. Each temperature cycle consists of a 12 hour soak at $-55^\circ\text{C}$ and a 12 hour soak at $+55^\circ\text{C}$.

4. Install the package in the pressure test system chamber. Connect the electrical leads and record $f_{\text{ref}}$ and $f_{\text{aneroid}}$. Energize the relay and observe $f_{\text{aneroid}}$ as the following steps are carried out. Find the approximate inside pressure from $\Delta f$. If the inside pressure is outside the range 100 to 200mb, check for leakage.

5. Turn on the vacuum pump and open valve #2 with all other valves closed.

6. Slowly begin pumpdown by opening valve #4 while observing the Wallace and Tiernan gauge and the output frequency.

7. Observe and record the gauge pressure at the time of relief valve opening as evidenced by a step change in output frequency. This pressure differential should be within $\pm50$mb of the differential recorded in step #21 of the measurement of relief valve release differential and bubble correction factor, TPS 800-5. This test will confirm the presence of a bubble leak or a change in the relief valve opening point during thermal cycle. The bubble temperature during this test should be the same as in step #21 of document TPS 800-5.

8. Adaptation phase:

With the package installed in the test chamber, pumpdown to 150mb $\pm .1$mb. Record the pressure sensor temperature by measuring the resistance of the aneroid temperature thermistor. Data will be recorded during the thermal cycle of $-55^\circ\text{C}$ to $-25^\circ\text{C}$. One thermal cycle consists of 8 hours at $-55^\circ\text{C} \pm 5^\circ\text{C}$ and 16 hours at $-25^\circ\text{C} \pm 2^\circ\text{C}$. A minimum of 8 cycles will be required. Pressure at $-55^\circ\text{C}$ is 150mb $\pm 25$mb and at $-25^\circ\text{C}$ it is 150mb $\pm .02$mb. Begin by soaking at $-55^\circ\text{C}$ for 8 hours, at the specified
pressure, and then reset to -25°C. After the first 8 hours of soak at
-25°C at 150mb ± .1mb, record the reference frequency and the aneroid
frequency every 2 hours until the end of the 16 hour soak at -25°C at
150mb ± .02mb. Do this for all 8 cycles. Plot the \( \Delta f = (f_{\text{ref}} - f_{\text{aneroid}}) \) as a function of time (days) during the test. Refer back to
the data recorded in step #23 of the TWERLE Pressure Package Assembly
Procedure and Leak Test, TPS 800-4, to establish the sensitivity in
Hz/mb for the particular unit being calibrated. The change in \( \Delta f \) during
the last 4 thermal cycles taken at -25°C should not represent a pressure
change of greater than .2mb. For example, if the sensitivity of the
unit is 500 Hz/mb, the plotted data (\( \Delta f \)) during the last 4 days of the
test should indicate a change in \( \Delta f(f_{\text{ref}} - f_{\text{aneroid}}) \) of less than
100Hz.

Calibration phase:

(NOTE: Under no circumstances can the sensor temperature be allowed to
increase above -10°C between steps #8 and 11.)

9. Soak at -40°C at 150mb ± .1mb for 8 hours. Record the thermistor
resistance. Record \( \Delta f(f_{\text{ref}} - f_{\text{aneroid}}) \) at 170mb ± .02mb, 160mb ± .02mb,
150mb ± .02mb, 140mb ± .02mb, and 130mb ± .02mb. Record the data after
10 minutes at each pressure setting.

10. Soak at -30°C at 150mb ± .1mb for 8 hours and repeat the remainder of
step #9.

11. Soak at -20°C at 150mb ± .1mb for 8 hours and repeat the remainder of
step #9.

12. Soak at +20°C at 150mb ± .1mb for 8 hours and repeat the remainder of
step #9.

13. Soak at +30°C at 150mb ± .1mb for 8 hours and repeat the remainder of
step #9.

14. Soak at +25°C at 150mb ± .1mb for 8 hours and repeat the remainder of step
#9.

15. While at +25°C and 150 ± .1mb, depress the relief valve shut with valve
#2 closed. Start bleeding the chamber pressure back to atmospheric
by opening valve #9 while maintaining pressure on the relief valve
to assure that it is closed.
16. With the chamber at ambient pressure, attach the pinched off pressure line to the test system feedthru. Open valve #3. Evacuate the lines to 150mb as indicated on the Wallace and Tiernan gauge. Open the pinch off clamp. Set the bubble pressure to 150 ± 0.02mb using the T.I. Gauge. The bubble pressure should be near 150mb already. Record the thermistor resistance and \( \Delta f (f_{\text{ref}} - f_{\text{aneroid}}) \). Install the pressure line pinch off clamp. Turn the T.I. gauge to standby and close valve #1.

17. Remove power from the pressure package. The package may now be removed from the test system, the styrofoam plugs installed, and the assembly stored away.
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<th>f ref</th>
<th>f aneroid</th>
<th>(f ref-f an)</th>
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<td>Erie</td>
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<td>Capacitor, Tantalum, 10µ-25v 196D106 x 9025KAL</td>
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<td>Sprague</td>
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<td>R20</td>
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<td>Teledyne</td>
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POT CORE HALF
FERROXCUBE CORE
107F-00-03DS
(2)
*CONSTANT PRESSURE SPRING
*SOFTWARE CAN

FERROXCUBE, 1107FD
S0881N, 55 turns,
#36 FORMVAR WIRE

POT CORE HALF
*P.C. TERMINAL PLATE

SEE DETAIL FOR WIRE LOOPIING

CAN MOUNTING TAB
CAN INLET PIN

DETAIL OF DIRECTION OF WIRING LOOPIING AROUND P.C. TERMINAL PLATE

*PART OF FERROXCUBE HARDWARE KIT 1107FD
<table>
<thead>
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<td>820-1</td>
<td>Pinchit Tube Shut-Off Clamp--Part 5330K14</td>
<td>Mc Master--Carr (Chicago)</td>
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<td>820-1</td>
<td>Tygon Tube 1/4 ID x 3/8&quot; OD x 4&quot; long</td>
<td>Rohm &amp; Hass Co.</td>
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<td>820-1</td>
<td>Plexiglass Tube 1/8&quot; I x 1/4&quot; OD x 5/8&quot; long</td>
<td>Circle Seal Corp. p71-673</td>
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<td>820-1</td>
<td>Vacuum Relief Valve</td>
<td>YSI 44005</td>
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<td>Thermistor 3K @25°C</td>
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<td>820-1</td>
<td>Aneroid Capsule &amp; Mount</td>
<td>Hysol Corp.</td>
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<td>820-1</td>
<td>Shell Epon 907 Epoxy</td>
<td>Allmetal Screw Co.</td>
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<td>820-1</td>
<td>#2-56 Screw &amp; Nut</td>
<td>In-House Manufacture</td>
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<td>821</td>
<td>Bubble, Lexan</td>
<td>In-House Manufacture</td>
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<td>822</td>
<td>Strut, Aneroid Support</td>
<td>In-House Manufacture</td>
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<td>823</td>
<td>Bracket, Mounting</td>
<td>In-House Manufacture</td>
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#52 DRILL (.063)
3 PLACES
EQ SPACED
.150 RADIUS

* 71 DRILL (.026)

MATERIAL:
.060 LEXAN SHEET

NOTE.
VACUUM FORMED
ON PART 821-1

ONE REQ.

SECTION A-A

---

THE UNIVERSITY OF WISCONSIN
SPACE SCIENCE & ENGINEERING CENTER
MADISON, WISCONSIN

TITLE
HOLE DIMENSIONS FOR THE TWO BUBBLE HALVES

SCALE
FULL

DRAFTSMAN
J.G.M
4/2/73

CHECKER
J.G.M
4/2/73

ENGINEER
J.G.M
4/2/73

NEXT HIGHER ASSEMBLY
TPS 820-1

PRODUCT ASSURANCE

DATE
PROJECT APPROVAL

DATE

PROJECT NO.
6310

SIZE
A

SHEET 1 OF 2

DRAWING NO.
TPS 821
SECTION A-A

MATERIAL
.060 LEXAN SHEET

NOTE
VACUUM FORMED ON PART 821-1
ONE REQ

DRILL "R" (0.339)

DRILL 15/64

THE UNIVERSITY OF WISCONSIN
SPACE SCIENCE & ENGINEERING CENTER
MADISON, WISCONSIN

TITLE
HOLE DIMENSIONS FOR THE TWO BUBBLE HALVES

SCALE FULL DRAFTSMAN J.G.M DATE 4/2/73 CHECKER J.G.M DATE 4/2/73 ENGINEER J.G.M DATE 4/2/73
NEXT HIGHER ASSEMBLY TPS 820-1 PRODUCT ASSURANCE DATE PROJECT APPROVAL DATE
PROJECT NO. 0310 SIZE A SHEET 2 OF 2 DRAWING NO. TPS 821
MATERIAL: ALUM

1 REQ
MOLD FOR BUBBLE HALF

(TO BE SUPPLIED BY NCAR)
MOLD FOR BUBBLE HALF

(To be supplied by NCAr)

DETAIL 2
FINISH TIN WIRE
WITH SN 60 SOLDER

MIN BEND RADIUS \( \frac{1}{4} \)
TYP.

MATERIAL
PHOSPHOR BRONZE WIRE
SAE STANDARD NO. 81
17 ga. (0.045 diam.)

ANEROID MOUNTING STRUT
\frac{1}{32} \text{ RADIUS MIN.}

\#39 DRILL .099
2 PLACES

\begin{align*}
\text{AT ASSEMBLY SOLVENT} \\
\text{GLUE TO PART 821} \\
\text{REMOVE EXCESS MATERIAL} \\
\text{MATERIAL} \\
.060 \text{ LEXAN SHEET} \\
4 \text{ REQ}
\end{align*}
OPERATING PRESSURE : 0-50 PSI
OPERATING TEMP. : -65° to +250°F
INTERNAL LEAKAGE : ZERO AT CLOSING PRESS.
EXTERNAL LEAKAGE : 0
MOUNT LIMITATIONS : NONE
SUITABLE FOR : AIR, N₂
CLOSING PRESSURE : 1 PSI ± 10%
VALVE MATERIAL : ALUM. 2024-T351
FINISH : CHROMIC ANODIZE
SPRING MATERIAL : CRES 302
SEALS - PART NO. : 05003-24
SEALS - MATERIAL : SILICONE
LUBRICANT : MIL-G-4343

PART ORDERED FROM:
JAMES POND & CLARK DIV.
CIRCLE SEAL CORPORATION
ANAHEIM, CALIF.
PER THEIR DRAWING NO. P71-473

THE UNIVERSITY OF WISCONSIN
SPACE SCIENCE & ENGINEERING CENTER
Madison, Wisconsin

TITLE
VACUUM RELIEF VALVE

SCALE
4IN 4IN
DATE
CHECKER
ENGINEER
DATE

PROJECT NO.
0300
SIZE
A
SHEET
1
OF
1
DRAWING NO.
TPS 824
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<td>Sphere, 8th Enclosure</td>
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<td>832</td>
<td>Net, Supporting</td>
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MATERIAL
RIGID POLYSTYRENE
FOAM HEMISPHERES
DENSITY 2 lb/ft²
REQUIRED
1 UPPER - 1 LOWER PER ENCLOSURE

ALUMINUM FOIL
.002 THICK
COVERING HEMISPHERE AND 1/4" OF EQUATORIAL PLANE

ALUMINIZED MYLAR
ADHESIVE BACKED
MYLAR SIDE OUT
.001 THICK
COVERING HEMISPHERE EXCEPT 1/4" ABOVE EQUATOR

ALUMINIZE MYLAR
ADHESIVE BACKED
MYLAR SIDE OUT
.001 THICK
COVERING 1" ABOVE 1" BELOW EQUATOR

WHITE LEAD PAINT
COVERING HEMISPHERE EXCEPT FOR 1"
BELOW EQUATOR

ALUMINUM FOIL
.002 THICK
COVERING HEMISPHERE AND 1/4" OF EQUATORIAL PLANE

CUT RADIAL GROOVE
1/8" wide x 1/8" deep
BOTH HEMISPHERES

30°

A

SECTION A - A
ALUMINUM FOIL
.002 THICK

1/8" DIAM HOLE
AIR VENT

WHITE LEAD
PAINT

CUT FROM POLYSTYRENE
HEMISPHERE (SEE SHEET 1)
PLUGS FOR THE TWO HOLES

2 REQ.