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# AEROSPACE STANDARD

AS 8009

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Revised

## PRESSURE ALTIMETER SYSTEMS





1. PURPOSE

This Aerospace Standard (AS) specifies minimum performance requirements for pressure altimeter systems.

2. DESIGN

This AS covers altimeter systems which measure and display altitude as a function of atmospheric pressure. The pressure transducer may be contained within the instrument display case or located remotely.

The instrument system specified herein does not include aircraft pressure lines. Unless otherwise specified, whenever the term "instrument" is used, it is to be understood to be the complete system of pressure transducer component, any auxiliary equipment and display component. Range is as marked on the nameplate of the instrument.

3. GENERAL STANDARDS

3.1 Compatibility: If components are individually acceptable but require matching for proper operation, they shall be identified in a manner that will insure performance to the requirements of this AS.

3.2 Accessibility of Controls: Controls which are not normally adjustable in flight shall not be readily accessible to flight personnel when the instrument is installed in accordance with the manufacturer's instructions.

3.3 Interchangeability: Instruments which are identified with the same manufactured part or model number shall be completely interchangeable.

3.4 Barometric System:

3.4.1 Barometric Setting System: The barometric setting system shall permit the altimeter to be set to any ambient barometric pressure throughout a minimum range of 28.1 to 31.0 in. of mercury (951.5 to 1050.0 millibars). A safety feature shall be provided which will prevent either incorrect indication or damage to the mechanism should attempts be made to operate the baro-setting adjustment beyond the design range specified for the instrument. The baro-setting number shall increase with a clockwise motion of the knob.

3.5 Multiple Mode Indications: Where an instrument has more than one mode of operation, means shall be provided to indicate other than the normal mode of operation.

NOTE: When an instrument has more than one mode of operation, the "normal mode" shall be as specified by the instrument manufacturer. If equipped with an automatic static source error correction mechanism, a positive means shall be provided to indicate when it is not in use.

3.6 Instrument Cover Glass Reflectance: The total reflectance of the instrument cover glass including the integral lighting wedge, if applicable, shall not exceed 10% of the incident light. This reflectance applies over the visible light spectrum from 450 milli-microns to 600 milli-microns, and over an incident solid angle of 60° perpendicular to the viewing plane.

3.7 Static Source Error Correction: When an instrument employs a correction mechanism that is unique to a particular aircraft, the aircraft type and model number for which the altimeter has been manufactured and performs its intended function shall be clearly and permanently marked on the instrument.

3.8 Graduations: Dial markings shall be provided at intervals not exceeding 20 ft of altitude with major increment markings at 100 ft intervals. Metric scale intervals shall not exceed 20 m with major markings at 100 m intervals. Digital displays not supplemented by an analog display shall provide 10 ft (2 m) increments, and shall have a non-ambiguous means of displaying altitudes below zero feet.

3.9 Display Markings: Altitude shall be indicated in feet, or metres as required by means of one or more pointers, dials, tapes, drums, digital readouts, or any combination thereof. Relative motion of the index with respect to the scale (either the index or the scale may be the moving element) shall be clockwise, up, or to the right for increasing altitude. In the case of the counter, drum, or tapes, the higher number shall be above the lower.

3.10 Fire Resistance: Except for small parts (such as knobs, fasteners, seals, grommets, and small electrical parts) that would not contribute significantly to the propagation of a fire, all materials used must be self-extinguishing when tested in accordance with the requirements of Federal Aviation Regulation 25.1359 (d) and Appendix F thereto, with the exception that materials tested may be configured in accordance with paragraph (b) of Appendix F or may be configured as used.

4. MINIMUM PERFORMANCE UNDER STANDARD CONDITIONS

4.1 Case Pressure: The instrument case shall withstand a positive external differential pressure of 26 in. Hg (660 mm).

4.2 Leakage: The static pressure system shall not exceed the allowable leak in one min. as specified in Table I. The total pressure system (where applicable) shall exhibit no more than a 1 knot change during one min. when subjected to full scale pressure.

4.3 Scale Error: The instrument shall meet the tolerance specified in Table II, which includes the the following conditions: Decreasing and increasing pressure for the test pressure ranges specified in Table II, or these pressures plus the static defect correction pressures (if specified) for the applicable aircraft as supplied by the airframe manufacturer.

4.3.1 Static Source Correction: Where a static source correction means is incorporated, the scale error tolerance shall be that shown in Table II, increased by an amount of 15% of the static source error in feet at each test point.

4.4 Balance Error: Balance errors due to orientation of the instrument from the normal operating positions shall not exceed those specified in Table III.

4.5 Barometric Setting Scale: The barometric setting scale shall not introduce an error in the altimeter system greater than ±25 ft (±8 m) throughout the barometric scale range of 28 to 31 in. of mercury (955 to 1049 millibars) when tested at the points in Table IV. Beyond the limits of the barometric scale, the error shall not exceed ±25 ft (±8 m) +5 ft (1.5 m) for each barometric setting range increase equivalent to 2000 ft (610 m) in excess of the range specified in Table IV.

4.6 Friction: Friction errors shall not exceed those specified for stop and jump friction in Table V and static friction in Table VI.

4.7 Hysteresis: Errors resulting from hysteresis shall not exceed those shown in Table IX.

4.8 Minimum Operating Rate: The instrument shall be capable of a minimum operating rate of 15,000 ft/min. (4,600 m/min.), with no more lag than 200 feet (60 metres).

4.9 Threshold: The instrument shall be capable of indicating a change in display when subjected to a sinusoidal static pressure change within the tolerance values shown in Table VIII.

4.10 Monitoring Functions: Means shall be incorporated in the instrument to indicate when it is not receiving an adequate level of power (voltage and/or current). An indicator or display of the repeating or remote indicating type of component shall be provided with means to monitor and indicate the presence of the following failures:

(a) Primary power loss to the indicator or display
(b) Loss of synchro excitation
(c) Servo amplifier failure or power loss
(d) Mechanical obstruction within the indicator
(e) Electrical failure in the servo motor drive phases
(f) Loss of a "valid" signal provided by a remote sensor or computer

The failure indicating means shall display the failure or malfunction in a positive and conspicuous manner.

4.11 Vibrator: If an integral vibrator is required for instrument operation within the stated tolerances, power to the vibrator shall be monitored and a failure of the power shall be indicated in a positive and conspicuous manner.

5. MINIMUM PERFORMANCE STANDARDS UNDER ENVIRONMENTAL CONDITIONS

Unless otherwise specified, the measurement procedures applicable to a determination of the performance under environmental conditions are set forth in RTCA Document No. DO-160 entitled, "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments," dated February 28, 1975. Performance tests which must be made after subjection to test environments may be conducted after exposure to several environmental conditions. The order of tests must be in accordance with paragraph 3.2, Page 4 of DO-160.

5.1 Environmental Conditions: The instrument shall perform as in paragraph 4 throughout the environmental conditions set forth, and the conditions selected by the equipment manufacturer shall be declared as operating conditions.

5.2 High or Low Temperature: A change in the ambient room (test) temperature (25° C) shall not cause the scale error to exceed the sum of the ambient room temperature tolerance (Table II) and 1% of the tolerance for each degree C change. The high, low or extreme temperatures to be applied shall be determined by the manufacturer and shall be consistent with the environmental conditions specified in the applicable category of RTCA DO-160.

5.3 Drift and After Effect: The instrument when subjected to 80% of the operating pressure range for 6 hr shall meet the tolerances specified in Table VII for drift and after effect.

5.4 Fogging (Hermetically Sealed): The instrument cover glass shall exhibit no fogging due to vapors or other materials when the instrument is subjected to extreme changes in temperature.

5.5 Thermal Shock (Hermetically Sealed): The instruments shall be subjected to four cycles of exposure to water at 85° C ± 5° C and 4 ± 3° C without evidence of moisture penetration or damage to enclosure.

5.6 Electrical Insulation: The insulation resistance measured at 200 V DC for five sec. between all electrical circuits and the metallic case shall not be less than 5 megohms. Insulation resistance measurements shall not be made to circuits where the potential will appear across elements such as windings, resistors, capacitors, etc., since this measurement is intended only to determine adequacy of insulation.

5.7 Other Conditions: The instrument shall be tested in the following additional environmental disciplines as per the procedures in RTCA DO-160.

a) Vibration
b) Humidity
c) Shock
d) Power Input Variation
e) Conducted Voltage Spike
f) Audio - Frequency Susceptibility
g) Radio - Frequency Susceptibility
h) Radio - Frequency Emission
i) Magnetic Effect

TABLE I

LEAKAGE

STATIC PRESSURE

| ALTITUDE RANGE | | TEST ALTITUDE | | LEAK TOLERANCE | |
|---|---|---|---|---|---|
| FEET | METRES | FEET | METRES | FEET/MIN | METRES/MIN |
| 20,000 | 6,100 | 10,000 | 3,000 | 50 | 15 |
| 35,000 | 10,500 | 17,000 | 5,200 | 50 | 15 |
| 50,000 | 15,000 | 23,000 | 7,000 | 50 | 15 |

TABLE II

SCALE ERROR
TOLERANCE ENVELOPE FOR BOTH INCREASING AND DECREASING ALTITUDE
(AMBIENT ROOM TEMPERATURE)

| TEST PRESSURE ALTITUDE | | TOLERANCE | |
|---|---|---|---|
| FEET | METRES | FEET | METRES |
| -1,000 | -300 | ±30 | ±9 |
| 0 | 0 | ±30 | ±9 |
| 1,000 | 300 | ±30 | ±9 |
| 2,000 | 600 | ±30 | ±9 |
| 3,000 | 900 | ±30 | ±9 |
| 4,000 | 1,200 | ±30 | ±9 |
| 5,000 | 1,500 | ±30 | ±9 |
| 10,000 | 3,000 | ±50 | ±15 |
| 20,000 | 6,000 | ±75 | ±20 |
| 30,000 | 9,000 | ±120 | ±35 |
| 40,000 | 12,000 | ±150 | ±45 |
| 50,000 | 15,000 | ±180 | ±55 |

TABLE III

BALANCE

| TEST PRESSURE ALTITUDE | | TOLERANCE | |
|---|---|---|---|
| FEET | METRES | FEET | METRES |
| 2,500 | 750 | ±20 | ±6 |
| 25,500 | 7,500 | ±30 | ±9 |

TABLE IV

BAROMETRIC SETTING MECHANISM

| BAROMETRIC PRESSURE SCALE | | CORRECT DIFFERENCE | | BARO-SETTING TOLERANCE | |
|---|---|---|---|---|---|
| IN. HG | MB | FEET | METRES | FEET | METRES |
| 22.00 | 745 | -8266 | -2520 | ±40 | ±12 |
| 23.27 | 788 | -6794 | -2071 | ±35 | ±11 |
| 23.92 | 810 | -6065 | -1830 | ±35 | ±11 |
| 24.98 | 846 | -4907 | -1496 | ±30 | ±9.0 |
| 25.98 | 880 | -3850 | -1173 | ±30 | ±9.0 |
| 26.99 | 914 | -2825 | -861 | ±25 | ±7.5 |
| 27.55 | 933 | -2265 | -691 | ±25 | ±7.5 |
| 28.20 | 955 | -1630 | -497 | ±25 | ±7.5 |
| 28.58 | 968 | -1264 | -385 | ±25 | ±7.5 |
| 28.94 | 980 | -920 | -280 | ±25 | ±7.5 |
| 29.91 | 1013 | -10 | -3 | ±25 | ±7.5 |
| 30.15 | 1021 | 211 | 64 | ±25 | ±7.5 |
| 30.77 | 1042 | 776 | 237 | ±25 | ±7.5 |
| 30.98 | 1049 | 965 | 294 | ±25 | ±7.5 |

TABLE V

STOP AND JUMP FRICTION ERROR

| TEST PRESS. ALTITUDE | | ASCENT & DESCENT | | TOLERANCE COLUMN A | | COLUMN B | | COLUMN C | |
|---|---|---|---|---|---|---|---|---|---|
| FEET | METRES | FT/MIN | METRES/MIN | FT | METRES | FT | METRES | FT | METRES |
| 1,000 | 300 | 500 | 150 | 25 | 8 | 200 | 60 | 70 | 20 |
| 3,000 | 900 | 500 | 150 | 25 | 8 | 200 | 60 | 70 | 20 |
| 5,000 | 1,500 | 500 | 150 | 25 | 8 | 200 | 60 | 70 | 20 |
| 10,000 | 3,000 | 500 | 150 | 25 | 8 | 350 | 105 | 70 | 20 |
| 20,000 | 6,000 | 3,000 | 900 | 25 | 8 | 350 | 105 | 100 | 30 |
| 30,000 | 9,000 | 3,000 | 900 | 25 | 8 | 450 | 140 | 140 | 40 |
| 40,000 | 12,000 | 3,000 | 900 | 50 | 15 | 600 | 180 | 180 | 55 |
| 50,000 | 15,000 | 3,000 | 900 | 50 | 15 | 750 | 230 | 250 | 75 |

COLUMN A - VIBRATOR "ON" - ALL TYPES
COLUMN B - VIBRATOR "OFF" - COUNTER-POINTER TYPE
COLUMN C - VIBRATOR "OFF" - ALL OTHER TYPES, OR NON-VIBRATOR TYPES

TABLE VI

STATIC FRICTION

| TEST PRESSURE ALTITUDE | | TOLERANCE | | | |
|---|---|---|---|---|---|
| | | COLUMN A | | COLUMN B | |
| FEET | METRES | FEET | METRES | FEET | METRES |
| 1,500 | 457 | 70 | 21 | 25 | 8 |
| 2,500 | 762 | 70 | 21 | 25 | 8 |
| 5,500 | 1,676 | 70 | 21 | 25 | 8 |
| 15,500 | 4,724 | 90 | 27 | 25 | 8 |
| 25,500 | 7,772 | 120 | 37 | 25 | 8 |
| 35,500 | 10,820 | 120 | 37 | 50 | 15 |
| 45,500 | 13,868 | 150 | 46 | 50 | 15 |

COLUMN A - FRICTION IN THE INSTRUMENT NOT CONTAINING AN INTEGRAL VIBRATOR OR WITH THE INTEGRAL VIBRATOR OFF.

COLUMN B - RESIDUAL FRICTION NOT REMOVED BY AN INTEGRAL VIBRATOR.

TABLE VII

DRIFT AND AFTER EFFECT

| ALTITUDE RANGE | | TOLERANCE | | | |
|---|---|---|---|---|---|
| | | DRIFT | | AFTER EFFECT | |
| FEET | METRES | FEET | METRES | FEET | METRES |
| -1,000 TO 80% OF FULL SCALE | -300 TO 80% OF FULL SCALE | 40 | 12 | 30 | 9 |

TABLE VIII

THRESHOLD

| TEST PRESSURE ALTITUDE | | TOLERANCE | |
|---|---|---|---|
| FEET | METRES | FEET | METRES |
| 0 | 0 | 10 | 3 |
| 10,000 | 3,000 | 15 | 4.5 |
| 20,000 | 6,000 | 20 | 6 |
| 30,000 | 9,000 | 25 | 7.5 |
| 40,000 | 12,000 | 30 | 9 |
| 50,000 | 15,000 | 40 | 12 |

TABLE IX

HYSTERESIS

| TEST POINT | | TOLERANCE | |
|---|---|---|---|
| FEET | METRES | FEET | METRES |
| 25,000 | 7,600 | 50 | 15 |
| 20,000 | 6,000 | 50 | 15 |
| 0 | 0 | 30 | 9 |

6. TEST PROCEDURES

6.1 Case Pressure: The instrument shall be placed in a pressure chamber with the pressure port(s) connected to outside ambient pressure during this test. The chamber pressure shall be increased to 26 in. (660 mm) of mercury differential (gage) and maintained at approximately 25° C for a period of one hour. At the conclusion of the test period, the instrument shall be examined and any evidence of deformation, damage or unsatisfactory operation shall be cause for rejection.

6.2 Case Leak:

6.2.1 Static Pressure: The static pressure conncection and the pitot or total pressure connection (if applicable) shall be "Y" connected to the master test equipment and to a source of vacuum. The total volume of equipment and plumbing including the instrument under test shall be 100 ±10 cu in. (1650 ±165 $cm^3$). An absolute pressure shall be applied to the pressure connections in accordance with Table I. After the instrument indication has stabilized, the source shall then be sealed off for a period of one minute during which time the readings of the master test equipment shall not exceed the tolerance specified in Table I.

NOTE: Electrical power should be applied as required and thermal equilibrium shall be maintained while performing this test.

6.2.2 Total Pressure (If Applicable): The pitot pressure port shall be connected to the master test equipment and to a source of pressure, and the static port vented to atmospheric pressure. The total volume including the instrument under test shall be 100 ±10 cu in. (1650 ± 165 $cm^3$). A pressure equivalent to the maximum airspeed for which the equipment was designed shall be applied to the total pressure connection. After the instrument indication has stabilized, the pressure source shall then be sealed off for a period of one minute during which the master test equipment pressure indication shall change no more than 1 knot.

6.2.3 Hermetically Sealed Components (If Applicable): Hermetically sealed components shall be tested for leaks by a mass spectrometer leak detector of the helium type or equivalent. The leak rate shall not exceed 0.0434 micron cu ft per hr per cu in. in filling gas, at a pressure differential of one atmosphere.

NOTE: A micron cu ft/hr leak rate is defined as that gas leakage which would change the pressure of a one cubic foot volume by the amount of one micron (one millionth of a metre of mercury) in one hour. At a pressure differential of one atmosphere at 25° C.

6.3 Scale Error:

6.3.1 Scale Error at Room Temperature Operation (25° C): For Altimeters Without Automatic Static Pressure Error Correction Mechanism:

A period of not less than 12 hr shall be allowed to elapse before testing, during which time the instrument shall not have been subjected to other than ambient pressures and no adjustments shall have been made. The barometric pressure scale shall be set at 29.92 in. of mercury (1013. mb). The instrument shall be subjected successively to decreasing and increasing pressures specified in Table II (within the maximum pressure altitude range).

Change in pressure shall be made at a rate not in excess of 20,000 ft (6100 m) per min. until within approximately 500 ft (150 m) of the test point, then the test point shall be approached at a rate compatible with the test equipment, being careful not to overshoot the test point. Static pressure shall be stabilized at each test point for at least 20 sec., but not more than one min. before the scale error value is recorded. The scale error in feet of altitude at any test pressure within the altitude range of the instrument shall not exceed the tolerance specified in Table II. The movement of the indicating means shall be free from erratic motion when the pressure is changed uniformly.

6.3.2 Scale Error at Room Temperature Operation (25° C): For Altimeters with Automatic Static Pressure Error Correction Mechanism: A period of not less than 12 hr shall be allowed to elapse before testing, during which time the instrument shall not have been subjected to other than ambient pressures and no adjustments shall have been made. The barometric pressure scale shall be set at 29.92 in. of mercury (1013.25 mb). The instrument shall be subjected successively to decreasing and increasing pressures specified in Table II or these pressures plus the equivalent of the static pressure error (within the maximum pressure altitude range), while the static pressure error correction functions are varied over the ranges specified for the applicable aircraft. Change in pressures shall be made at a rate not in excess of 20,000 ft (6100 m) per min. until within approximately 500 ft (150 m) of the test point, then the test point shall be approached at a rate compatible with the test equipment. Static pressure shall be stabilized at each test point for at least 20 sec., but not more than 1 min. before the scale error value is recorded.

(1) For aircraft requiring a static source correction system as a function of Mach (and/or other parameters), the altimeter should be calibrated by providing inputs to the system which apply all the variables to be accounted for in the correction system at 40 or more points distributed over the useful range of each variable. Readings shall be taken at each test point in Table II.

The scale error at each test point shall not exceed that shown in Table II increased by 15% of the static source error.

6.4 Balance Error: The instrument shall be subjected to the test pressures (within the maximum pressure altitude range) specified in Table III and readings taken while the instrument is in each of the following attitudes:

(1) Normal operating position
(2) Instrument rotated clockwise around its X (longitudinal) axis, 90° from its normal position
(3) Instrument rotated clockwise around its X (longitudinal) axis, 180° from its normal position
(4) Instrument rotated counterclockwise around its X (longitudinal) axis, 90° from its normal position
(5) Instrument rotated about its Y (lateral) axis, 90° from its normal operating position so that its dial is up
(6) Instrument rotated about its Y (lateral) axis, 90° from its normal operating position so that its dial is down

A change in indication from that obtained when tested in the normal position (item 1 above) shall be considered "balance error" and shall not exceed the tolerance specified in Table III.

6.5 Barometric Setting Scale: The instrument shall be subjected to a constant pressure between -1000 and 5000 ft (-300 and 1500 m) altitude when performing this test. Starting below the lowest value on the barometric scale, it shall be set successively to each value of barometric setting number shown in Table IV, first with increasing and then with decreasing barometric settings.

| (1) | | (2) | | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|---|
| ALTITUDE | | SETTING NBR. | | IND READING ⇩ | DIFF. | ERROR | IND READING ⇧ | DIFF. | ERROR |
| FEET | METRES | IN. HG. | MB | | (3)-A | (4)-(1) | | (6)-B | (7)-(1) |
| -1630 | -497 | 28.20 | 955 | | | | | | |
| -1264 | -385 | 28.58 | 968 | | | | | | |
| - 920 | -280 | 28.94 | 980 | | | | | | |
| - 10 | - 3 | 29.91 | 1013 | (A) | | | (B) | | |
| + 211 | + 64 | 30.15 | 1021 | | | | | | |
| + 776 | +237 | 30.77 | 1042 | | | | | | |
| + 965 | +294 | 30.98 | 1049 | | | | | | |

READING (A) - READING (B) = C = BACKLASH @ 29.92

(DROP MINUS SIGN IF "C" IS MINUS)

COLUMNS 5 AND 8 ERROR (FUNCTION ERROR) TOLERANCE = $\pm$ (25 - $\frac{C}{2}$) ft

= $\pm$ (8 - $\frac{C}{2}$) m

Figure 1

BAROMETRIC SETTING DATA SHEET

The instrument indication shall be recorded at each setting. (See 6.5, Fig. 1, Barometric Setting Data Sheet). The difference between each increasing reading and the reading at the 29.92 setting (A Column 3) and the difference between each decreasing reading and the reading at the 29.92 setting (B Column 6) shall be obtained. The difference in feet between the A and B readings (representing the system "backlash" at 29.92 in. of mercury, or 1013.25 millibars) shall be divided by 2 and this quotient subtracted from 25 ft (8 metres). This resultant value is the tolerance which applies to each difference (function error) obtained above (Column 5 and 8). The difference between the values recorded for the clockwise and counterclockwise rotations of the baro-set knob (backlash) shall not exceed 20 feet. If both inches of mercury and millibar barometric setting indications are provided, the test shall be conducted for each indication independently.

If the specific design of barometric setting system is such that additional barometric setting errors are possible and are undetected by the procedure above, the manufacturer shall submit a method of measuring this error, and the tolerance for the test in Table IV, and beyond, as applicable, shall be reduced by this amount so as to retain the total allowable tolerance of Table IV.

The barometric setting knob shall be tested through its full range in either direction. The torque required to turn the knob shall be between two and ten inch ounces. (14.1 N.mm and 70.6 N.mm).

6.6 Stop and Jump:

6.6.1 Counter-Pointer Display: With the integral vibrator in operation, the instrument shall be subjected to a constant rate of decreasing and increasing pressure equivalent to the rate indicated at the test points specified in Table V. The change in reading of the pointer at the test points, due to its stopping and jumping shall be recorded as friction and shall not exceed the tolerance specified in Table V, Column "A". This test shall be repeated with the integral vibrator inoperative. The friction shall not exceed the tolerances specified in Table V, Column "B".

6.6.2 Other Displays: With the integral vibrator in operation, the instrument shall be subjected to a constant rate of decreasing and increasing pressure equivalent to the rate indicated at the test point specified in Table V. The change in reading of the indication at the test points, due to its hesitation shall be recorded as friction and shall not exceed the tolerance specified in Table V, Column "A". This test shall be repeated with the integral vibrator inoperative. The friction shall not exceed the tolerances specified in Table V, Column "C".

6.7 Static Friction:

6.7.1 Instrument Without Integral Vibrator: While connected as in the Scale Error Test, the instrument shall be tested for friction at each of the test pressures specified in Table VI. Pressure shall be decreased at a rate compatible with the test equipment, but not to exceed 5,000 ft (1500 m) per min. until within approximately 500 ft (150 m) of a test point when the rate shall be gradually reduced until the test pressure is approximated. The pressure shall then be held constant while two readings are taken. The first with no external vibration applied to the instrument and the second with external vibration applied to the instrument. Sufficient external vibration shall be applied to assure removal of all friction. The difference between the two readings shall be considered "friction" and shall not exceed the tolerance specified in Table VI, Column "A".

6.7.2 Instrument With Integral Vibrator: While connected as in the Scale Error Test, the instrument shall be tested for friction at each of the test pressures specified in Table VI. Pressure shall be decreased at a rate compatible with the test equipment, but not to exceed 5,000 ft (1500 m) per min. until within approximately 500 ft (150 m) of a test point when the rate shall be gradually reduced until the test pressure is approximated. The pressure shall then be held constant while three readings are taken. The first with no internal vibration applied (integral vibrator inoperative) nor external vibration applied to the instrument. The second with only internal vibration applied (integral vibrator operating) and the third with both internal and external vibration applied to the instrument. The difference between the first and third reading shall not exceed the tolerance specified in Table VI, Column "A", and the difference between the second and third reading shall not exceed the tolerance specified in Table VI, Column "B".

6.8 Minimum Slew Rate - (Servoed Indicators): Power shall be applied and the instrument subjected to a pressure equivalent to a value above 25,000 ft (7600 m) altitude. With power off, the pressure shall be changed to zero feet (metres) altitude. Power shall then be applied and the time required for the instrument indication to change from 20,000 ft to 12,500 (6000 m to 3800) shall be 30 sec. or less.

6.9 Threshold: The pressure altitude shall be set at each of the altitude test points in Table VIII. The static pressure shall be slowly increased and decreased around each test point (sinusoidal rates are desired) until a change in indication or output is noticed. The total change in increasing and decreasing pressure shall not exceed the values in Table VIII.

6.10 Drift and After Effect: Electrical power shall be applied as required. The reading at the zero foot test point shall be recorded. The pressure shall then be reduced, at a rate corresponding to an increase in altitude of approximately 10,000 ft (3000 m) per min. to a pressure equal to 80% of the maximum pressure altitude range and a reading taken within two min. after reaching altitude. The instrument shall be held at 80% of the full altitude range for a period of six hr, the pressure shall be maintained within ±2,000 ft (600 m). At the completion of the six hr exposure period, the pressures shall be readjusted to the previous pressure and reading taken. The pressure shall then be increased at a rate corresponding to a decrease in altitude of approximately 10,000 ft (3000 m) per min. until within approximately 500 ft (150 m) of the zero foot test point then the test pressure shall be approached and reached at a rate compatible with the test equipment. Within three minutes after passing through the 500 ft (150 m) approach point, a reading shall be taken at the zero foot test point. The allowable change in indication between the first and second reading (drift) taken at the 80% test point shall not exceed the tolerance specified in Table VII. The allowable change in indication between the first and second reading (after effect) taken at zero foot test point shall not exceed the tolerance specified in Table VII.

6.11 Low Temperature Operation: The instrument shall be subjected to the low temperature environmental conditions as specified in the applicable category of RTCA DO-160. Scale error tests as specified in 4.3 shall be conducted at the low temperature environment. The altitude scale error shall not exceed the sum of the room temperature tolerance (Table II) and 1% of this tolerance for each degree of temperature change from the room temperature (25° C).

6.12 High Temperature Operation: The instrument shall be subjected to the high temperature environmental conditions as specified in the applicable category of RTCA DO-160. Scale error tests as specified in 4.3 shall be conducted at the high temperature environment. The altitude scale error shall not exceed the sum of the room temperature tolerance (Table II) and 1% of this tolerance for each degree of temperature change from the room temperature (25° C).

6.13 Extreme Temperature Exposure: The instrument shall be exposed to low and high temperature for the environmental conditions specified in the applicable category of RTCA DO-160 for a period of 24 hr at each extreme temperature, without operating. After the instrument has attained the normal operating temperature for three hr, the instrument shall meet the applicable individual performance tests specified in 4.1 through 4.10. There shall be no evidence of damage as a result of exposure to the extreme temperatures specified.

6.14 Vibration: The instrument shall be tested in accordance with the Standard Vibration Environment of RTCA DO-160 after the completion of the tests, no damage should be evident, the barometric scale shall not have shifted more than .01 in. of mercury (.339 mb) and the instrument shall meet the individual performance tests specified in 4.1 through 4.10.

6.15 Humidity: The instrument, unless hermetically sealed, shall be mounted in its normal operating attitude (with simulated installation conditions by connecting 10 ft of coiled copper tubing to the pressure port(s) in such a manner that moisture can drain out the open end), and subjected to the Standard Humidity tests of RTCA DO-160.

Following this test, there shall be no evidence of damage or corrosion which affects performance and the instrument shall meet the requirements of 4.1 through 4.10.

6.16 Fogging: (Hermetically Sealed Instruments Only) The instrument, while operating, shall be exposed to a 70° C ambient temperature for a minimum period of one hour. After this period, and while as the specified temperature, an ice cube shall be rubbed on the cover glass for a period of one to two minutes. The glass shall be wiped dry (do not use compressed air) and the instrument inspected for evidence of water or oil fog inside the cover glass. Evidence of fogging shall be cause for rejection.