

TECHNICAL MANUAL
CALIBRATION PROCEDURE
FOR
PRESSURE GAUGE



This publication replaces T.O. 33K6-4-427-1 dated 30 January 2012.

Distribution Statement C - Distribution authorized to U. S. Government agencies and their contractors for official use or for administrative or operational purposes only, 30 September 1988. Requests for this document shall be referred to AFMETCAL, 813 Irving-Wick Dr W, Heath, OH 43056-1199.

Destruction Notice - For unclassified, limited documents, destroy by any method that will prevent disclosure of the contents or reconstruction of the document.

PRESSURE GAUGE

1 CALIBRATION DESCRIPTION:

Table 1.

| Test Instrument (TI) Characteristics | Performance Specifications | Test Method |
|---|---|---------------------------------|
| Pressure | Range: * 0 to 12,000 psig, Pneumatic; 0 to 30,000 psig, Hydraulic Accuracy: * Group A, $\pm 0.5\%$ FS; Group B, $\pm 1\%$ FS; Group C, $\pm 2\%$ FS; Group D, $\pm 3\%$ FS; Group E, $\pm 4\%$ FS; Group F, ± 1 div; Group G, $\pm 3\%$ FS in middle half of span, $\pm 4\%$ FS remainder; Group H, $\pm 2\%$ FS in middle half of span, $\pm 3\%$ FS remainder; Group J, $\pm 0.25\%$ FS; Group K, $\pm 2.5\%$ FS; Group L, $\pm 2\%$ FS in middle third of span, $\pm 3\%$ FS remainder; Group M, $\pm 0.1\%$ FS; Group N, $\pm 1.5\%$ FS; Group P, $\pm 1\%$ FS in middle third of span, $\pm 3\%$ FS remainder; Group Q, $\pm 1\%$ FS in middle third of span, $\pm 2\%$ FS remainder; Group R, ± 2 div; Group S, $\pm 1\%$ FS in middle half of span, $\pm 2\%$ FS remainder; Group T, $\pm 0.5\%$ FS in middle third of span, $\pm 1\%$ FS remainder; Group U, stated manufacturer specification; Group V, $\pm 1.6\%$ FS | Compared with known Pressure |

* See applicable T.O. 33K-1-100-2 or Calibration Measurement Summary (CMS) using the AFCAV Viewer, and also step 3.2.

2 EQUIPMENT REQUIREMENTS:

| | Noun | Minimum Use Specifications | Calibration Equipment | Sub-Item |
|-----|-----------------------------|---|------------------------------|-----------------|
| 2.1 | PRIMARY PRESSURE STANDARD | Range: 0.2 to 1,000 psi Accuracy: * 2.0 to 1,000 psi, $\pm 0.006\%$ of ind or 0.002 psi, whichever is greater; 1.7 to 100 psi, $\pm 0.005\%$ of ind or 0.0002 psi, whichever is greater; 0.2 to 25 psi, $\pm 0.005\%$ of ind or 0.0001 psi, whichever is greater | Ruska 2465-601-69200 | |
| 2.2 | DEADWEIGHT TESTER | Range: 0 to 12,140 psig Accuracy: * $\pm 0.02\%$ ind | Ruska 120X | Ruska 125XC |
| 2.3 | PRESSURE INTENSIFIER | Range: N/A Accuracy: N/A | Ruska 2440 | |
| 2.4 | HYDRAULIC PRESSURE STANDARD | Range: 0 to 30,000 psi Accuracy: * $\pm 0.025\%$ FS of each Range (L1, L2, L3, H1, H2, H3) | DHI HGC-30000-AF | |
| 2.5 | PNEUMATIC PRESSURE STANDARD | Range: 0.2 to 1000 psig Accuracy: * $\pm 0.01\%$ FS Range | DHI PPC2AF | |
| 2.6 | PRIMARY PRESSURE STANDARD | Range: 1 to 1,000 psia/g Accuracy: * $\pm(0.004\%$ of ind + 0.000083 psi), 1 to 50 psia; $\pm(0.004\%$ of ind + 0.000028 psi), 1 to 50 psig; $\pm(0.004\%$ of ind + 0.000154 psi), 3.6 to 254 psia; $\pm(0.004\%$ of ind + 0.000133 psi), 3.6 to 254 psig; $\pm(0.005\%$ of ind + 0.000537 psi), 14.5 to 1,000 psia; $\pm(0.005\%$ of ind + 0.000531 psi), 14.5 to 1,000 psig | DHI PG7601-SYS-AF | |

See footnote at end of Equipment Requirements.

| Noun | Minimum Use Specifications | Calibration Equipment | Sub-Item |
|--|---|------------------------------|----------|
| 2.7 PRESSURE CONTROLLER/ CALIBRATOR | <p>Range: -15 kPa to 15 kPa (gage)</p> <p>Accuracy: *</p> <p>Measurement (Auto Range span ≥ 9 kPa), $\pm 0.008\%$ of ind, from 30 to 100% Auto Range span; when below 30% of Auto Range span constant $\pm 0.008\%$ of 30% of the Auto Range span;</p> <p>Measurement (Auto Range span < 9 kPa), $\pm 0.008\%$ of ind between 100% of Auto Range span and 2.7 kPa, below 2.7 kPa accuracy is $\pm 0.008\%$ of 2.7 kPa (± 0.000216 kPa);</p> <p>Delivery Pressure (Auto Range span ≥ 9 kPa), $\pm 0.009\%$ of ind from 30% to 100% Auto Range span; when below 30% of Auto Range span constant $\pm 0.009\%$ of 30% of the Auto Range span;</p> <p>Delivery Pressure (Auto Range span < 9 kPa), $\pm 0.009\%$ of ind between 100% of Auto Range span and 2.7 kPa, below 2.7 kPa accuracy is $\pm 0.009\%$ of 2.7 kPa (± 0.00024 kPa)</p> | DHI PPC3-200K BG15KP | |
| 2.8 REFERENCE PRESSURE MONITOR | <p>Range: 0 to 10,000 psi</p> <p>Accuracy: *</p> <p>$\pm 0.02\%$ of ind or ± 0.15 psi, whichever is greater, 0 to 3,000 psi;</p> <p>$\pm 0.02\%$ of ind or ± 0.5 psi, whichever is greater, 0 to 10,000 psi</p> | DHI RPM4 A70MS/A20MS-AF | |
| 2.9 REFERENCE PRESSURE MONITOR | <p>Range: 0 to 10,000 psi</p> <p>Accuracy: *</p> <p>$\pm 0.1\%$ of ind or 0.1 psi, whichever is greater, 0 to 1,000 psi;</p> <p>$\pm 0.1\%$ of ind or 1.0 psi, whichever is greater, 0 to 10,000 psi</p> | DHI RPM4-E-DWT A70ME/A7ME | |

See footnote at end of Equipment Requirements.

| Noun | Minimum Use Specifications | Calibration Equipment | Sub-Item |
|------------------------------------|--|--|----------|
| 2.10 REGULATED PRESSURE SOURCE | Range: 0 to 2000 psig Accuracy: N/A | Clean, dry nitrogen | |
| 2.11 TUBING, TEES CONNECTORS, ETC. | Range: N/A Accuracy: N/A | Capable of safely handling high pressure | |
| 2.12 ARMORED POLYCARBONATE SHIELD | Range: N/A Accuracy: N/A | Local Purchase | |

* See step 3.4.

3 PRELIMINARY OPERATIONS:

3.1 Review and become familiar with the entire procedure before beginning Calibration Process.



If removal of the glass face from the TI is required, care should be taken to avoid possible glass slivers that may be present. Wear of personal protective equipment is required. If not strictly observed, could result in injury to, or death of, personnel or long term health hazards.



Each technician assembling high or low pressure lines for test purposes must be familiar with all applicable directives and safety precautions contained in T.O. 00-25-223. It is recommended that a protective shield be used during the pressurization of all Test Instruments (TIs) up to and including 500 psi and mandatory over 500 psi. If not strictly observed, could result in injury to, or death of, personnel or long term health hazards.



Prior to beginning and during the Calibration Process on Oxygen TMDE, ensure that the TI and the Standard are handled IAW T.O. 15X-1-102 or 37C11-1-1, whichever is applicable. Only Standards that meet the requirements of these T.O.s shall be used to calibrate Oxygen Clean TMDE. If not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

WARNING

Prior to beginning and during the Calibration Process on Divers Life Support TMDE, ensure the TI is received and handled IAW MIP 5921/032-XX. (XX- corresponds to the date the MIP was released). If not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

WARNING

Never connect a pressure supply greater than 20% over the maximum control pressure to item (2.7) Pressure Controller/Calibrator. Ensure to connect the pressure supply to the SUPPLY port; connecting to another port is likely to damage TI. If not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

WARNING

Never connect a pressure supply to or plug item (2.7) Pressure Controller/Calibrator (PPC3) EXHAUST port. If not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

WARNING

When using P/N PPC2AF Pneumatic Pressure Standard, the Maximum Pressure supply is 1100 psia. If not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

WARNING

For P/N PPC2AF Pneumatic Pressure Standard with Self Purging Liquid Trap (SPLT): Install the SPLT IAW Manufacturers Instructions. Liquid contaminants will be forcibly ejected from SPLT purge tube. Ensure SPLT tube is pointed in a safe direction. If not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

CAUTION

The P/N PPC2AF is a Pneumatic Pressure Controller. Do not use it as an indicator. Do not apply pressure to both the TI and the PPC2AF Pneumatic Pressure Controller at the same time. If not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

CAUTION

NEVER touch the lapped surfaces of the piston or cylinders with bare hands. Body oils and acids can permanently etch the surfaces. If not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

CAUTION

For item (2.9) Reference Pressure Monitor (RPM4-E-DWT A70ME/A7ME), with the Lo Q-RPT connected, never exceed pressure of 1,000 psi (7 MPa) or the Lo Q-RPT could be permanently damaged. If the red CAUTION indicator flashes and/or an audible alarm sounds, immediately reduce pressure to avoid damaging Q-RPT. If not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

CAUTION

For item (2.9) Reference Pressure Monitor (RPM4-E-DWT A70ME/A7ME), use the correct pressure connectors. The TEST port fitting is a DH500 F. This is not a 1/4 inch NPT F. Never use a fitting other than the corresponding male fitting in these connectors. Damage to the connectors and dangerous failure under pressure could result from using incorrect fittings. If not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

CAUTION

For item (2.9) Reference Pressure Monitor (RPM4-E-DWT A70ME/A7ME), do not change ranges or apply pressure until familiar with operation. The TEST port can connect internally to both the 1,000 psi (7 MPa) and 10,000 psi (70 MPa) Q-RPTs. The Lo Q-RPT SHUT OFF valve on the front isolates the low pressure Q-RPT when the high pressure Q-RPT is in use. Failure to protect the low pressure Q-RPT from overpressure may destroy the low pressure Q-RPT. The Lo Q-RPT SHUT OFF valve must always be in the closed position (knob fully CW) when operating at pressure greater than 1,000 psi (7 MPa). If not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

CAUTION

For item (2.9) Reference Pressure Monitor (RPM4-E-DWT A70ME/A7ME), do not attempt to generate greater than 100 psi (700 kPa) using the reservoir priming pump. If not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

CAUTION

For item (2.9) Reference Pressure Monitor (RPM4-E-DWT A70ME/A7ME), the VARIABLE VOLUME can generate very high pressure very quickly. When using the VARIABLE VOLUME, use caution not to generate pressure more quickly than desired and not to exceed the pressure rating of the Reference Pressure Monitor Q-RPTs or any component of the test system to which it is connected. If not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

3.2 The following procedure is a general type. Ranges and accuracies of specific TIs are listed in T.O. 33K-1-100-2 or applicable CMS. If the TI is not listed in T.O. 33K-1-100-2 or applicable CMS, the TMDE Laboratory must make every effort to obtain manufacturer specifications. The manufacturer specifications must be forwarded to AFMETCAL for inclusion in T.O. 33K-1-100-2.

3.3 When the accuracy of a specific TI cannot be determined due to lack of an identifying part number refer to T.O. 33K-1-100-1.

3.4 The minimum use specifications for (2.1) Primary Pressure Standard, (2.2) Dead Weight Tester, (2.4) Hydraulic Pressure Standard, (2.5) Pneumatic Pressure Standard, (2.6) Primary Pressure Standard, (2.7) Pressure Controller/ Calibrator, (2.8) Reference Pressure Monitor and (2.9) Reference Pressure Monitor are broad in order to cover the requirements for any item listed in this Calibration Procedure. Select substitute equipment based on the accuracy of the item being calibrated (maintain a 4:1 TAR) not the minimum use specifications listed in Section 2. Refer to T.O. 00-20-14 for guidance concerning substitution of equipment.

3.5 Adapt the TI to the standard being used for calibration. Removal of the attached hose is permitted, but must be re-installed after calibration is completed.

3.6 Check TI hose for nicks, tears and excessive wear.

3.7 During calibration, the TI must be mounted in the vertical position or the position in which the TI is used.

3.8 To minimize friction error, lightly tap the TI with a finger before reading.

3.9 To convert kPa from psi use:

$$\begin{array}{rclcl} \text{psi} & \times & 6.895 & = & \text{kPa} \\ \text{bar} & \times & 14.504 & = & \text{psi} \end{array}$$

3.10 Mechanically zero all TIs that do not have a Zero Post (metal post at zero mark). For TIs with a Zero Zone, mechanical zero is not required as long as the indicator rests within the zone.

3.11 The Direct Drive TIs have no internal adjustments; if TI fails calibration, return to manufacturer for repair.

3.12 Definitions:

The span of a TI is the algebraic difference between the limits of the unretarded portion of the scale.

Example: The span of a 0 to 100 psi TI is 100 psi.

The span of a suppressed scale TI is the difference between the maximum and minimum scale pressures.

Example: The span of a 200 to 500 psi TI is 300 psi.

3.13 Connect test equipment to an appropriate power source. Set POWER switches to ON and allow warm-up as required by the manufacturer.

3.14 Immediately prior to calibration of the TI, ensure the TI is exercised three (3) times to FS or, if the TI is mounted and will be calibrated in a Test Stand, exercise the gage 3 times to the limit allowable by the Test Stand not to exceed the gage FS.

NOTE

For Heise Models CC, CM and CMM, during the exercise routine apply FS value for several minutes before returning to zero. IAW Installation and Maintenance Manual for these gauges, FS value shall be applied for several minutes and re-zeroed, if necessary, before calibration.

3.15 Perform only those portions of the Calibration Process that pertain to the TI being calibrated.

NOTE

Para 4.1 is for test point indications read off the TI, para 4.1A is for test point indications read off the pressure standard.

3.16 Gauges with a Maximum Indicating Pointer (MIP) shall be calibrated using the MIP. If user directs PMEL not to calibrate gauge using the MIP, this will be considered a limited calibration. Annotate and attach a Limited Certification Label stating: Maximum Indicating Pointer not calibrated.

NOTE

If applicable, for Liquid Filled Gauges with a FS range of 300 PSI and below: If the gauge does not return to zero or is having problems with the calibration, vent the case by opening the vent/fill port to atmosphere. IAW Manufacturer, atmospheric changes, temperature fluctuations and process applications may cause the liquid filling to expand and/or contract which may increase or decrease the internal case pressure. This may affect the accuracy and the pointer may not return to zero properly. After calibration is complete, ensure the vent/fill port is closed.

3.17 After the calibration is complete, check TI commercial data, using AFCAV, to check if the TI has temperature coefficient specifications.

NOTE

TIs may or may not have temperature coefficients that can affect the accuracy of the gauge.

Example of TI Temperature Coefficients: $\pm(0.1\% \text{ FS}/1 \text{ }^\circ\text{F})$

Not a TI Temperature Coefficient: $\pm 1\% \text{ FS}$ from 40 to 100 $^\circ\text{F}$

3.17.1 If temperature coefficient specifications are listed, annotate and attach appropriate Certification Label with the temperature at which the TI was calibrated, as recorded in steps 4.1.6 or 4.1A.6, along with the temperature coefficients of the gauge.

3.17.2 If temperature coefficient specifications are not listed, it is not required to annotate the temperature on the Certification Label.

4 CALIBRATION PROCESS:

NOTE

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met, before proceeding.

4.1 PRESSURE CALIBRATION:

4.1.1 Set up appropriate pressure standard, whichever is required for the range of TI.

4.1.2 Connect TI to appropriate output of pressure standard connection.

4.1.3 As applicable for the TI being calibrated, some TIs require calibration in descending order. For these TIs, calibrate in descending order by reversing the test points in steps 4.1.4 through 4.1.4.3 or steps 4.1.5 through 4.1.5.3 to start with a pressure equal to about 95% of the range of TI.

4.1.4 For TIs with a certified manufacturers accuracy of $\pm 0.5\%$ FS or better:

4.1.4.1 Generate pressure equal to about 10% of the range of TI.

4.1.4.2 TI indication must be within the limits as determined by the accuracies listed in Table 1.

4.1.4.3 Repeat steps 4.1.4.1 and 4.1.4.2 for pressures equal to about 20, 30, 40, 50, 60, 70, 80, 90 and 95% of the range of TI. Do not exceed full scale of TI.

4.1.5 For all other TIs:

4.1.5.1 Generate pressure to the nearest point within the resolution of the pressure standard to about 20% of the range of TI.

4.1.5.2 TI indication must be within the limits as determined by the accuracies listed in Table 1.

4.1.5.3 Repeat steps 4.1.5.1 and 4.1.5.2 at about 40, 60, 80 and 95% of the range of TI. Do not exceed full scale of TI.

4.1.6 After the final calibration point, record the lab temperature.

4.1.7 Set pressure to atmosphere.

4.1.8 If calibration is complete, proceed to step 4.1A.8.

4.1A PRESSURE CALIBRATION: (Alternate Method)

4.1A.1 Set up appropriate pressure standard, whichever is required for the range of TI.

4.1A.2 Connect TI to appropriate output of pressure standard connection.

4.1A.3 As applicable for the TI being calibrated, some TIs require calibration in descending order. For these TIs, calibrate in descending order by reversing the test points in steps 4.1A.4 through 4.1A.4.3 or steps 4.1A.5 through 4.1A.5.3 to start with a pressure equal to about 95% of the range of TI.

4.1A.4 For TIs with a certified manufacturers accuracy of $\pm 0.5\%$ FS or better:

4.1A.4.1 Generate pressure equal to about 10% of the range of TI.

4.1A.4.2 The pressure standard indication must be within the limits as determined by the accuracies listed in Table 1.

4.1A.4.3 Repeat steps 4.1A.4.1 and 4.1A.4.2 at cardinal points on TI equal to about 20, 30, 40, 50, 60, 70, 80, 90 and 95% of the range of TI. Do not exceed full scale of TI.

4.1A.5 For all other TIs:

4.1A.5.1 Generate pressure at a cardinal point on TI within the resolution of the pressure standard to about 20% of the range of TI.

4.1A.5.2 The pressure standard indication must be within the limits as determined by the accuracies listed in Table 1.

4.1A.5.3 Repeat steps 4.1A.5.1 and 4.1A.5.2 at cardinal points on TI to about 40, 60, 80 and 95% of the range of TI. Do not exceed full scale of TI.

- 4.1A.6 After the final calibration point, record the lab temperature.
- 4.1A.7 Set pressure to atmosphere.
- 4.1A.8 Calibration complete. Set POWER switches to OFF, disconnect and secure all equipment.
- 4.1A.9 Annotate and attach appropriate Certification Label per step 3.16 or 3.17, as applicable.

CALIBRATION PERFORMANCE TABLE

Not Required