



UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION



USBR 1040-89

PROCEDURE FOR CALIBRATING PRESSURE GAUGES

INTRODUCTION

This procedure is under the jurisdiction of the Geotechnical Services Branch, code D-3760, Research and Laboratory Services Division, Denver Office, Denver, Colorado. The procedure is issued under the fixed designation USBR 1040. The number immediately following the designation indicates the year of acceptance or the year of last revision.

1. Scope

1.1 This designation outlines the procedure for calibrating pressure gauges used for standard laboratory testing. It is recommended that any adjustments to a pressure gauge be made only by experienced personnel or the manufacturer.

1.2 This calibration procedure is limited to pressure gauges as classified in Federal Specification GG-G-76E.

2. Applicable Documents

2.1 American National Standard, ANSI B40.1-1980, Gauges-Pressure Indicating Dial Type — Elastic Element

2.2 Federal Specification GG-G-76E, Gauges, Pressure, and Vacuum, Dial Indicating, 1981

3. Summary of Method

3.1 A master gauge is calibrated using a primary pressure standard (see subpar. 9.2, figs. 1 and 3a). The pressure gauge to be calibrated is connected to the master gauge as shown on figure 3b. Pressure is applied to the pressure gauge at predetermined pressure increments over its full operating range. The value indicated by the pressure gauge is compared to the corresponding value indicated by the master gauge at each pressure increment. The percent error between the two values is calculated and the gauge is adjusted as necessary.

4. Significance and Use

4.1 Pressure gauges used in the laboratory must be calibrated to ensure reliable test results.

4.2 This calibration procedure is to be performed upon receipt of a pressure gauge and annually thereafter.

5. Apparatus

5.1 *Pressure Gauge.*—A pressure gauge meeting requirements of Federal Specification GG-G-76E and the American National Standard ANSI B40.1-1980.

5.2 *Primary Pressure Standard* (fig. 1).—A high accuracy, deadweight tester designed for precision measurement of applied gas pressure. The device consists of a weighted piston which becomes suspended in static equilibrium when a prescribed gas pressure is introduced. Calibrated masses are used for a range of pressures.

5.3 *Tubing.*—High-pressure tubing of appropriate size and length to connect pressure gauges and the primary pressure standard to the pressure source.

5.4 *Pressure Regulator.*—A pressure regulator-capable of maintaining the desired pressure to the gauges and primary pressure standard.

5.5 *Valves.*—Appropriate size valves, two required; bleed and pressure cutoff.

6. Precautions

6.1 *Safety Precautions.*—Safety glasses are to be worn when applying pressure to the gauges.

7. Calibration and Standardization

7.1 Verify that the primary pressure standard has been currently calibrated in accordance with manufacturer specifications. If the calibration is not current, it is to be performed before using the primary pressure standard for this calibration procedure.

8. Conditioning

8.1 Not applicable; special conditioning requirements are not needed for this procedure.

9. Procedure

9.1 All data are to be recorded on the "Pressure Gauge Calibration" form as shown on figure 2.

9.2 *Master Gauge Calibration:*

9.2.1 Connect the master gauge to the primary pressure standard and pressure source as shown on figure 3a.

9.2.2 Apply pressure to the master gauge in increments (a minimum of five) over the full range of the master gauge.

9.2.3 Record the value of pressure indicated by the primary pressure standard and the corresponding value of pressure indicated by the master gauge for each pressure increment.

9.2.4 Compute the percent error for each pressure increment and compare the values obtained with permissible error values in table 1.

9.2.5 Adjust the master gauge if necessary (see subpar. 1.1) and repeat subparagraphs 9.2.2 through 9.2.4

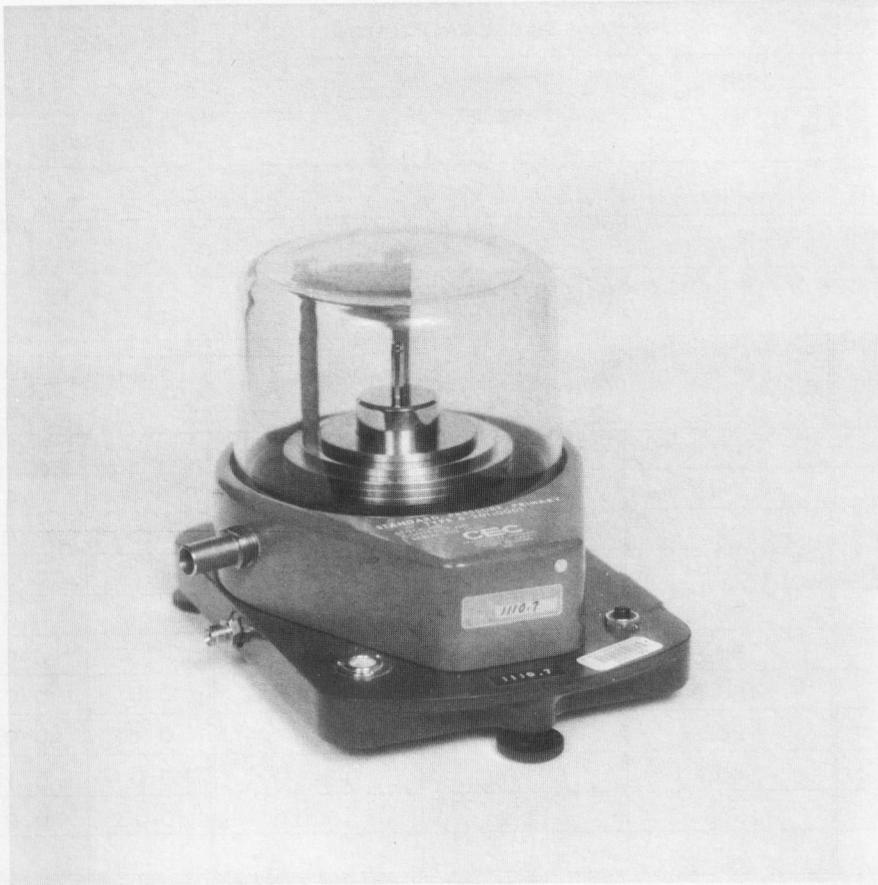


Figure 1. - Primary pressure standard.

until the calculated percent error is within the permissible range specified in table 1.

9.2.6 After three trials, if the percent error values calculated for the master gauge are not within those shown in table 1, a new master gauge should be obtained and calibrated in accordance with subparagraph 9.2.

9.3 Gauge Calibration:

9.3.1 Connect the gauge to be calibrated to the master gauge and pressure source as shown on figure 3b.

9.3.2 Apply pressure to the gauge to be calibrated in increments (a minimum of five) over the full range of the gauge.

9.3.3 Record the value of pressure indicated by the master gauge and the corresponding value of pressure indicated by the gauge being calibrated for each pressure increment.

9.3.4 Compute the percent error for each pressure increment and compare the values obtained with permissible error values in table 1.

9.3.5 Adjust the gauge if necessary (see subpar. 1.1) and repeat subparagraphs 9.3.2 through 9.3.4 until the calculated percent error values are within the permissible ranges specified in table 1.

9.3.6 After three trials, if the percent error values calculated for the gauge are not within those shown in table 1, the gauge should be rejected for laboratory use.

Table 1. - Pressure gauge accuracy grades.¹

Accuracy grade ²	Permissible error, percent of span		
	Lower one-fourth of scale	Middle one-half of scale	Upper one-fourth of scale
4A	0.1	0.1	0.1
3A	0.25	0.25	0.25
2A	0.5	0.5	0.5
A	2.0	1.0	2.0
B	3.0	2.0	3.0
C	4.0	3.0	4.0
D	5.0	5.0	5.0

¹ Table taken from ANSI B40.1-1980.

² Accuracy grade is specified by the manufacturer. An accuracy grade of 3A generally is suitable for most geotechnical laboratory testing applications.

10. Calculations

10.1 Calculations required are as shown on figure 2.

11. Report

11.1 The report is to consist of a completed and checked "Pressure Gauge Calibration" form (fig. 2).

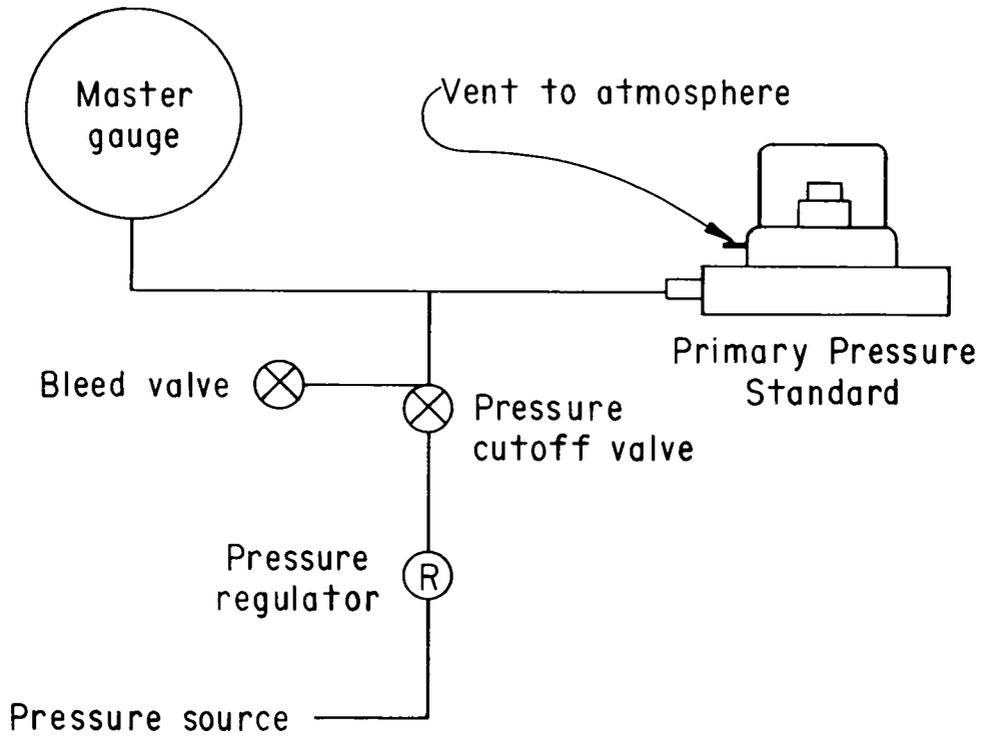
11.2 All calculations are to show a checkmark.

USBR 1040

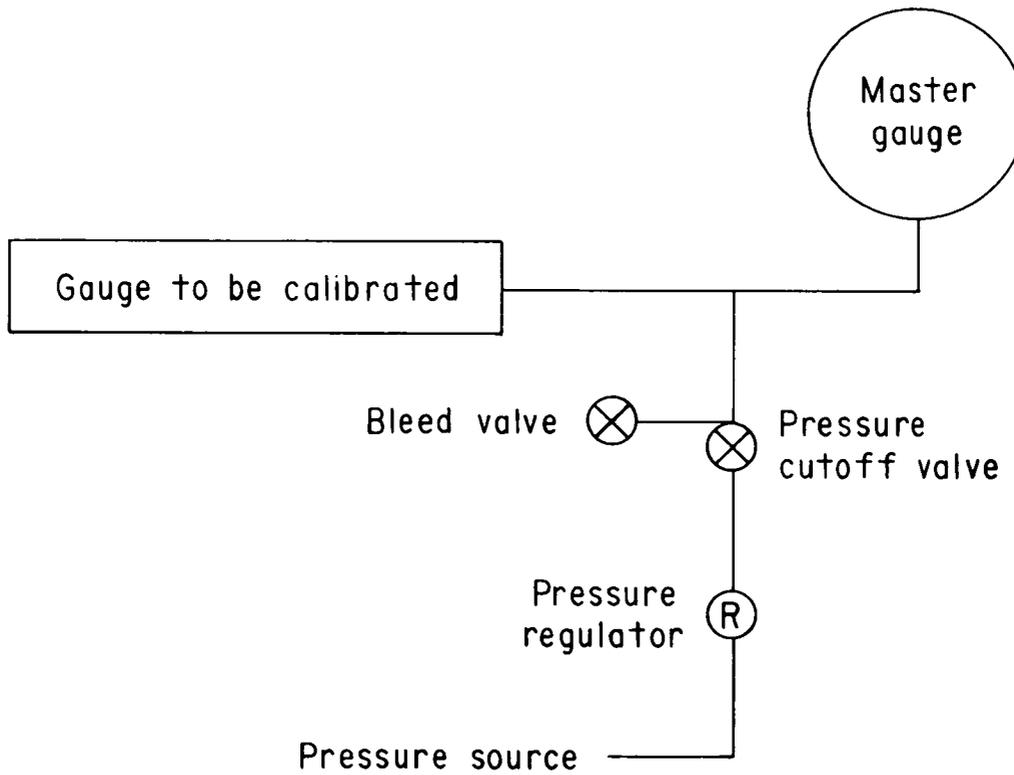
7-2328 (10-85) Bureau of Reclamation	PRESSURE GAUGE CALIBRATION	Designation: USBR 1040 - 89
MANUFACTURER <p style="text-align:center;">EXAMPLE</p>		
GAUGE RANGE 0-1400 kPa	ACCURACY GRADE 3A	SERIAL NO. 7
MASTER GAUGE RANGE 0-1500kPa	ACCURACY GRADE 3A	SERIAL NO. 45787
CALIBRATED BY	DATE	CHECKED BY. DATE
FULL SCALE MASTER GAUGE INDICATION (FCM) <u>1500 kPa</u> Master gauge calibration		
Pressure applied lbf/in ² <input type="checkbox"/> kPa <input checked="" type="checkbox"/>	Master gauge reading (MGR) lbf/in ² <input type="checkbox"/> kPa <input checked="" type="checkbox"/> Trial	$\% \text{ error} = \frac{(1) - (MGR)}{(FCM)} \times 100$
(1)	(A) (B) (C)	(A) (B) (C)
0	0 0 0	0.0 0.0 0.0
200	200 200 200	0.0 0.0 0.0
400	401 400 402	-0.07 0.0 -0.13
600	598 600 599	0.13 0.0 0.07
800	801 801 801	-0.07 -0.07 -0.07
1000	1000 1000 1000	0.0 0.0 0.0
1200	1202 1201 1200	-0.13 -0.07 0.0
1400	1400 1398 1399	0.0 0.13 0.07
1500	1502 1500 1500	-0.13 0.0 0.0
FULL SCALE MASTER GAUGE INDICATION (FCG) <u>1400 kPa</u> Gauge calibration		
Master gauge reading lbf/in ² <input type="checkbox"/> kPa <input checked="" type="checkbox"/>	Gauge reading (GR) lbf/in ² <input type="checkbox"/> kPa <input checked="" type="checkbox"/> Trial	$\% \text{ error} = \frac{(1) - (GR)}{(FCG)} \times 100$
(1)	(A) (B) (C)	(A) (B) (C)
0	0	0.0
200	202	-0.14
400	402	-0.14
600	602	-0.14
800	802	-0.14
1000	1000	0.0
1200	1200	0.0
1400	1400	0.0
Remarks <u>Trial A indicates gauge meets permissible error percentages given</u> <u>in Table I for 3A accuracy grade.</u>		
Accept <input checked="" type="checkbox"/>		
Reject <input type="checkbox"/>		

GPO 849-232

Figure 2. - Pressure gauge calibration — example.



(a) Schematic of master gauge calibration



(b) Schematic of gauge calibration

Figure 3. - Schematics of calibration assemblies.