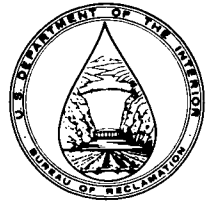




UNITED STATES DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION



USBR 1050-89

## PROCEDURE FOR CALIBRATING PRESSURE TRANSDUCERS

### 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 1050. 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 transducers.

1.2 This calibration procedure is used to determine the accuracy of pressure transducers over the full pressure range as set forth in the manufacturer's specifications.

#### 2. Auxiliary Tests

2.1 The pressure gauge used in this procedure must be calibrated in accordance with USBR 1040 prior to performing this calibration procedure.

#### 3. Applicable Documents

3.1 *USBR Procedures:*  
USBR 1040 Calibrating Pressure Gauges  
USBR 3900 Standard Definitions of Terms and Symbols Relating to Soil Mechanics

#### 4. Summary of Method

4.1 A pressure transducer and a standard pressure gauge are connected to a pressure source. Pressure is applied in predetermined increments over the full range of the pressure transducer. The pressure transducer voltage output is compared at each increment to a pressure gauge reading. The percent error of the pressure transducer when compared to the pressure gauge reading is calculated for each pressure increment over the full range calibrated. From these percent error values, a determination is made to accept or reject the pressure transducer for laboratory use.

#### 5. Significance and Use

5.1 A calibrated pressure transducer must be used in the laboratory to ensure reliable test results.

5.2 This calibration procedure is to be performed upon receipt of the pressure transducer and annually thereafter.

#### 6. Terminology

6.1 Definitions are in accordance with USBR 3900.

6.2 Terms not included in USBR 3900 specific to this designation are:

6.2.1 *Hermetically Sealed*.—A process by which a device is sealed and guaranteed to be airtight.

6.2.2 *Pressure Transducer*.—An electronic transducer that translates changes in pressure into changes in voltage. This change in voltage produces, in the readout system, a repeatable signal or indication that can be calibrated in terms of pressure applied to the transducer.

6.2.3 *Readout System*.—An electronic apparatus which accepts the output signal from a signal conditioner and converts it into a display and a record of the output signal.

6.2.4 *Signal Conditioner*.—An electronic apparatus necessary to make the output signal from a transducer compatible with the readout system. It also provides the excitation for a passive transducer element, such as a pressure transducer.

6.2.5 *Traceability Certificate*.—A certificate of inspection certifying that a measurement device meets the Federal specification for its particular grade or model and whose accuracy is traceable to the National Institute of Standards and Technology (National Bureau of Standards) or an International Standard.

#### 7. Apparatus

7.1 *Pressure Transducer* (fig. 1).—A transducer which converts a pressure input into an electrical output.

7.1.1 Components of the pressure transducer must have the following characteristics:

7.1.1.1 Electrical parts of the transducer must be hermetically sealed to prevent damage to internal components in the event of exposure to moisture.

7.1.1.2 The transducer must be threaded with appropriate threaded fittings to attach the transducer to standard pipe fittings.

7.1.1.3 Cable connections must be securely fastened to the body of the transducer.

7.2 *Pressure Gauge*.—A bourdon tube air pressure gauge whose range equals or exceeds that of the pressure transducer being calibrated is to be used. The gauge must have a current calibration accompanied with a certificate of traceability.

7.3 *Pressure Source*.—An air pressure source capable of delivering and maintaining pressure up to the maximum rated pressure of the transducer is required.

7.4 *Readout System*.—A voltmeter or a computer must be used to provide a visual display of the signal being sent from the signal conditioner.

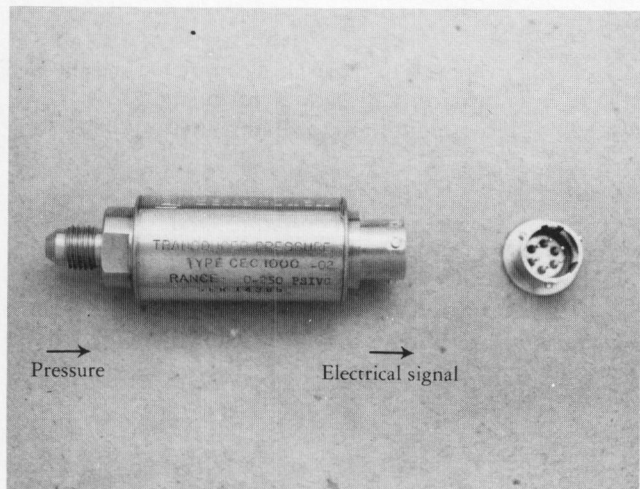


Figure 1. - Pressure transducer.

7.5 *Signal Conditioner.*—A signal conditioner must be used to make the transducer output compatible with the readout system.

8. Precautions

8.1 *Safety Precautions:*

- 8.1.1 This designation may involve hazardous materials, operations, and equipment.
- 8.1.2 Verify that all electrical wiring is properly connected.
- 8.1.3 Examine the pressure transducer body for burrs and sharp edges.
- 8.1.4 This designation involves the use of high air pressure. Appropriate precautions must be taken.

8.2 *Technical Precautions:*

- 8.2.1 Use the same cables for calibrating the transducer and for performing a test. A different cable length will change the resistance of the circuit and will result in a change in calibration.
- 8.2.2 It is recommended that the serial number be used for control purposes. Use a marking pencil rather than a scribe to mark on the transducer body. If the transducer must be marked use extreme care.
- 8.2.3 The transducer must be stored in a suitable box or case when not in use.

9. Calibration and Standardization

9.1 Verify that the pressure gauge used is currently calibrated in accordance with USBR 1040. If the calibration is not current, perform the calibration before using the equipment for this calibration procedure.

9.2 Verify that the readout system used is currently calibrated. If the calibration is not current it is to be performed in accordance with the manufacturer's guidelines. At the Bureau's Denver Office, a computer is used to accept the output signal from the signal conditioner and convert it into a transducer measurement. A voltmeter

also may be used as the readout system for this calibration procedure.

10. Conditioning

- 10.1 During the calibration procedure the room temperature should not vary more than  $\pm 10^{\circ}\text{C}$ .
- 10.2 Allow all electronic equipment to warm up for at least 30 minutes before use to ensure stability.
- 10.3 Place the pressure transducer and calibration standards in the environment in which they are to be calibrated for at least 24 hours prior to the time of calibration.

11. Procedure

- 11.1 All data are to be recorded on the "Pressure Transducer Calibration" form as shown on figure 2.
- 11.2 Locate and record the serial number or control number of the pressure transducer.
- 11.3 Determine and record the pressure range to be calibrated.
- 11.4 Connect the electrical end of the transducer to the excitation source and readout instrument. Follow the manufacturer's recommendation for how much voltage to apply to the signal conditioner.
- 11.5 Connect the transducer to a pressure source which is connected to a calibrated pressure gauge.
- 11.6 Take a reading of the pressure transducer with no pressure on the system.
- 11.7 Record the pressure transducer output as the *Readout response* on the form.
- 11.8 Use table 1 to determine the appropriate pressure increments to be used depending on the range of the pressure transducer being calibrated.
- 11.9 Raise the pressure in the appropriate increments given in table 1 and determine the gauge reading and corresponding transducer output.
- 11.10 Record the pressure gauge reading and the corresponding pressure transducer output as the *Applied pressure* and *Readout response*, respectively on the calibration form as shown on figure 2.
- 11.11 Repeat subparagraphs 11.9 and 11.10 for the full pressure range to be calibrated.
- 11.12 Release the system pressure to zero.
- 11.13 Calculate the pressure transducer error and percent error for each pressure increment.
- 11.14 Evaluate the values of error obtained. If the percent error for the transducer does not fall within the tolerances specified by the manufacturer, subparagraphs 11.6 through 11.12 are to be repeated. If the pressure transducer still does not meet the specified requirements, it is to be rejected for laboratory use.

Table 1. - Recommended pressure increments for calibrating pressure transducers

Pressure range		Pressure increment	
lbf/in <sup>2</sup>	kPa	lbf/in <sup>2</sup>	kPa
0 - 200	0 - 1400	25	175
200 - 1000	1400 - 7000	100	700

**12. Calculations**

12.1 Determine pressure transducer error for each pressure increment.

$$\text{Error} = \text{applied pressure} - \text{readout response}$$

12.2 Determine percent error for each pressure increment.

$$\text{Percent error} = 100 \left( \frac{\text{error}}{\text{applied pressure}} \right)$$

**13. Report**

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

13.2 All calculations are to show a checkmark.

**14. Background References**

*Electrical Transducer Nomenclature and Terminology*, ANSI, ISA-S37.1, Research Triangle Park, North Carolina, December 1982.

*Specifications and Tests for Strain Gage Pressure Transducers*, ANSI, ISA-S37.3, Research Triangle Park, North Carolina, December 1982.

USBR 1050

7-2307 (6-85)  
Bureau of Reclamation

PRESSURE TRANSDUCER CALIBRATION

Designation USBR 1050 - 89

Manufacturer Example Serial No. 14385 Range 0 - 7000kPa

Calibration performed by \_\_\_\_\_ Date \_\_\_\_\_

Calibration checked by \_\_\_\_\_ Date \_\_\_\_\_

Trial Number	Applied pressure ( kPa )	Readout response ( kPa )	Error ( kPa )	Error %	
	0	0	0	0	
1	172	172	0	0	
	345	345	0	0	
	517	517	0	0	
	689	688	1	0.15	
	861	860	1	0.12	
	1034	1033	1	0.10	
	1206	1204	2	0.17	
	1378	1376	2	0.15	
	2067	2064	3	0.15	
	2756	2753	3	0.11	
	3445	3441	4	0.12	
	4134	4129	5	0.12	
	4823	4817	6	0.12	
	5512	5505	7	0.13	
	6201	6194	7	0.11	
6890	6882	8	0.12		
	0	0	0	0	
2					

REMARKS

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Figure 2. - Pressure transducer calibration - example.