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Standard Guide for Calibration Facility Setup for Nuclear Surface Gauges[1]

This standard is issued under the fixed designation D7013/D7013M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This guide outlines procedures for setup of a nuclear gauge calibration facility in either a shielded bay or an unshielded area—Guide A and Guide B, respectively.

1.2 This guide does not attempt to describe the calibration techniques or methods. It is assumed that this guide will be used by persons familiar with the operations of the gauge and in performing proper calibration, service and maintenance.

1.3 This guide does not attempt to address maintenance or service procedures related to the gauge.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *This ~~guide~~standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this ~~guide~~standard to establish appropriate safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document has been approved through ASTM consensus process.*

1.7 *All observed and calculated values shall conform to the guidelines for significant digits and rounding established in practice D6026.*

1.7.1 *The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in the design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

[1] This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.08 on Special and Construction Control Tests.

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***A Summary of Changes section appears at the end of this standard**

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D6026 Practice for Using Significant Digits and Data Records in Geotechnical Data

D6938 Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

3. Terminology

3.1 For definitions of common technical terms in this standard, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cinder block*—a hollow building block made with concrete and coal cinders.

3.2.2 ~~*high density*~~ *solid concrete blocks*—solid concrete blocks designed for areas requiring radiation shielding.

3.2.3 *safe position*—position of the density source during the standardization process of the gauge.

3.2.4 *shielded calibration bay*—an enclosed area surrounded by walls in order to reduce background radiation to an acceptable level.

3.2.5 *shielded storage bay*—an enclosed area with sufficient shielding material to maintain and control radiation background in the facility and to reduce influences from stored gauges.

3.2.6 *unshielded area*—an open area within a calibration facility where the closest wall is a minimum of 1 m [3 ft] from the spot in which the gauge is being calibrated.

4. Summary of Method

4.1 Nuclear moisture density gauges require proper calibration. Since these gauges contain radioactive isotopes, influences from the surroundings and other gauges ~~should~~shall be controlled during the calibration process. This guide provides procedures to facilities involved in calibration of one or more gauges in a shielded bay or and an unshielded area. The goal of this guide is to provide a calibration and storage facility for proper gauge calibration.

5. Significance and Use

5.1 To establish a proper calibration area for nuclear surface gauges.

5.2 To reduce the chance of improper calibration.

NOTE 1—The quality of the results produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of practice D3740 are generally considered capable of competent and objective testing/inspection/etc. Users of this standard are cautioned that compliance with practice D3740 does not in itself assure a means of evaluating some of those factors.

6. Apparatus

6.1 Calibration reference block(s) as per the requirements of Test Method D6938 with density certification from a qualified calibration facility.

6.2 ~~High density~~ Solid concrete blocks 9 cm ~~high × 20 cm wide × 41~~ high × 20 cm wide × 41 cm long [3.5 ~~in. × 8 in. × 16~~ in. × 8

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

in. × 16 in.] or cinder blocks 20 cm ~~high × 20 cm wide × 41~~ high × 20 cm wide × 41 cm long [8 ~~in. × 8 in. × 16~~ in. × 8 in. × 16 in.] filled with sand or other fine aggregate materials for construction of bay walls.

6.3 Lead sheet 1 to 6 mm [0.032 to 0.25 in.] thick for lining the bay walls. The exposed surfaces containing lead ~~should~~shall be painted or covered.

6.4 Miscellaneous hardware for securing lead sheets to the calibration bay walls.

7. Shielded Storage Bay Setup

7.1 Set up a shielded storage bay if more than five gauges are routinely stored at a distance of 10 m [33 ft] or less from the area where gauge calibration is to take place. If five or less gauges are routinely stored in the storage area, concrete walls are not necessary. However, gauges ~~should~~shall be stored in their shipping cases or likewise secured while other gauges are being calibrated. Refer to Appendix X1 for examples of shielded storage bay configurations.

7.1.1 The storage bay ~~should~~shall not be set up directly under or over the area where gauges are to be calibrated.

7.1.2 Stagger the blocks during wall construction to reduce gaps between blocks and to improve wall integrity.

7.1.3 If more than five gauges are routinely stored in the storage bay, build a wall made from ~~high density~~ solid concrete or cinder blocks filled with sand or fine aggregate material.

7.1.4 The wall thickness for the storage bay ~~should~~shall be a minimum of 410 mm [16 in]. The wall ~~should~~shall completely surround the area where the gauges are planned to be stored. If gauges are stored on shelves that are elevated from the floor, the height of the wall ~~should~~shall be a minimum of 0.5 m [20 in] above the height of the shelves on which gauges are stored.

~~Note 2—Additional requirements might be necessary in order to meet state and federal licensing regulations. These requirements might include, lockable doors to limit access and appropriate caution signs. Users should check their materials license requirements and check with their regulatory agency when building storage bays for nuclear gauges.~~

8. Guide A: Shielded Calibration Bay Setup

8.1 Set up a shielded calibration bay if two or more gauges are going to be calibrated simultaneously, and the space between gauges being calibrated is less than 10 m [33 ft]. If the gauge in storage bay is less than 10 m [33 ft] from the area where the calibration is going to take place, or if the area where gauges are routinely serviced is less than 10 meters [33 ft] from the calibration area. Refer to Appendix X1 for examples of shielded calibration bay configurations. Use Guide B if 8.1 does not apply to the calibration facility.

~~Note 3—Use Guide B if 8.1 does not apply to your calibration facility.~~

8.1.1 Determine the number of bays required for calibration of nuclear gauges. This can be based on the number of gauges calibrated per year and can vary from one to several bays.

8.1.2 The bay inside dimensions should be established based on the bay walls being a minimum of 610 mm [24 in.] from the center of calibration blocks and lined with 1 mm [0.032 in.] of lead. Smaller inside dimensions can be used if lead sheets thicker than 6 mm [0.25 in.] are used on the walls. However, under no circumstances ~~should~~shall the walls be less than 610 mm [24 in.] from center of the calibration block.

Note 2—Lead sheets may not be required, if it is determined that the wall influence (counts inside and outside the bay (See 8.2.1)) is within an acceptable limit.

8.1.3 ~~The~~A calibration bay wall thickness ~~should be a minimum~~ of 410 mm [16 in.] ~~thick. The walls should be constructed using high-density~~thick has been proven to be successful. Walls constructed of solid concrete blocks or cinder blocks filled with sand or fine aggregate ~~material.~~ material have been used effectively for minimizing outside influences. Stagger the blocks during wall construction to reduce gaps between blocks and to improve wall integrity.

8.1.4 The wall height should be at a minimum from 1.0 to 1.3 m [40 to 50 in.].

8.1.5 Design and construct the bay such that the opening of the bay is not in direct line with the opening of the storage bay or the area where the gauges are serviced.

8.1.6 Center the calibration reference block(s) in the bay.

8.2 *Wall Influence Verification*—The response to the surrounding walls can vary significantly for different gauge geometries. For accurate calibration, influence from the walls ~~should~~shall be eliminated.

8.2.1 Place a gauge on a calibration reference block.

8.2.2 Take two four minute measurements, in Backscatter and 300 mm [12 in.] position, and take a four minute measurement at each source rod increment of 50 mm [2 in.], between depth 50 mm [2 in.] and depth 250 mm [10 in.]. For each of these measurements, record the density count for evaluation. If the calibration reference block is a high moisture reference block, then and only then, for each measurement, record the moisture counts for evaluation.

8.2.3 Repeat step 8.2.2 for each calibration reference block in the bay.

8.2.4 Move the calibration reference block(s) out of the bay, a minimum of 1 m [3 ft] from any walls and 10 meter [33 ft] from other gauges.

8.2.5 Repeat steps 8.2.1 through 8.2.4 with the same gauge.

8.2.6 For each source rod position, the difference between the counts in steps 8.2.2 and 8.2.5 ~~should be less than ±1.0 %.~~ of less than ±1.0 % is a good indication of minimal to no wall influence. Determine the difference by equation Eq 1 and record to 0.1 %

$$\%Difference = \left(\frac{Larger\ Count - Smaller\ Count}{Larger\ Count}\right) \times 100 \quad (1)$$

8.2.7 If the difference in the counts are higher than the ± 1.0 % limit, increase the inside wall dimensions or the lead liner thickness and repeat the steps in 8.2.1 – 8.2.6.

8.2.8 Repeat this procedure for all model gauges that are calibrated in your facility.

8.3 *Reference Standard Count Verification*—The size and geometry of gauges will have an effect on the accuracy of the standard counts. For accurate calibration, standard counts taken on top of calibration reference block(s) ~~should~~shall closely match counts taken on the ground.

8.3.1 Place the gauge on its reference standard block on top of the calibration reference block which is to be used for gauge standardization.

8.3.2 Take a 20 minute standardization count. For example, average of 20 one minute counts, average of 5 four minute counts, etc.

8.3.3 Record the moisture and density count.

8.3.4 Remove the calibration reference block from the calibration bay.

8.3.5 Place the gauge on the reference standard block in safe position in the middle of the bay on the floor.

8.3.6 Take a total of 20 min standardization count.

8.3.7 Record the moisture and density counts.

8.3.8 Compare the counts in step 8.3.3 – 8.3.7. The difference in counts as calculated by equation 1 ~~should~~shall be less than or equal to ~~± 2.0 %~~ ±2.0 % for moisture standard and ~~± 1.0 %~~ ±1.0 % for density standard.

8.3.9 If the differences exceed the limits given in 8.3.8, expand the bay dimensions, apply correction factors for the counts taken on top of the calibration reference block(s) or take the standard counts on the ground. 8.3 ~~should~~shall be repeated for each gauge model calibrated in your facility.

8.4 *Between Bay Cross Talk Verification*—Sufficient shielding or distance ~~should~~shall be provided between adjacent calibration bays in order to eliminate influence between bays. Each bay ~~should~~shall be set up to eliminate influence from gauges being calibrated in adjacent bays.

8.4.1 Place one gauge in each bay. Place the gauges on their reference standard block in the safe position on top of the calibration block(s).

8.4.2 Take a total of 20 minute count with each gauge in each bay.

8.4.3 Record the counts for both moisture and density for both gauges.

8.4.4 Remove one of the gauges from the bay and place it in the storage bay.

8.4.5 With the second gauge still remaining in the calibration bay and without moving the gauge, take a second 20 minute standard count.

8.4.6 Record the moisture and density counts.

8.4.7 Compare the average of the 20-min counts in step 8.4.6 to counts for the same gauge in step 8.4.3.

8.4.8 The difference in the counts in step 8.4.7 ~~should~~shall be less than or equal to ± 1.0 % for density and ±2.0 % for moisture.

8.4.9 If this difference is larger than the limits in 8.4.8, increase the wall thickness between the bays or add to the thickness of the lead sheet liners attached to the wall.

8.4.10 Repeat the steps in this section for each set of adjacent bays to verify that cross talk between bays has been eliminated.

8.4.11 Repeat this section for each gauge model calibrated in the facility.

NOTE 3—Do not use the calibration bays as gauge storage bays. This may cause inaccuracy in calibration counts taken in adjacent bays.

8.5 Follow block manufacturers procedures to complete the gauge calibration.

9. Guide B: Calibration in an Unshielded Area

9.1 ~~The~~ A distance of 10 m [33 ft] between the area where the gauges are stored and are being worked on ~~should be at least 10 m [33 ft] away from~~ and the area where the calibration reference block(s) are placed for ~~calibration.~~ calibration have been found to be successful in minimizing background effect in the calibration area.

9.2 If more than 5 gauges are kept in the facility, either remove the extra gauges and place 10 m [33 ft] away while calibrating the gauges or build a shielded storage bay according to Section 7.

9.3 If more than one gauge is being calibrated simultaneously, place the calibration reference block(s) a minimum of 10 m [33 ft] away from each other.

9.4 Follow block manufacturers procedures to complete the gauge calibration.

10. General Care

10.1 Clean calibration reference block(s) periodically using block manufacturers recommendations.

10.2 Monitor the background readings in your calibration area. Backgrounds ~~taken should not vary by more than~~variations of less