Designation: D7954/D7954M – 22a

Standard Practice for Moisture Surveying of Roofing and Waterproofing Systems Using Nondestructive Electrical Impedance Scanners[1]

This standard is issued under the fixed designation D7954/D7954M; 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 practice applies to techniques that use nondestructive electrical impedance (EI) scanners to locate moisture and evaluate the comparative moisture content within insulated low-slope roofing and waterproofing systems.

1.2 This practice is applicable to roofing and waterproofing systems wherein insulation is placed above the deck and positioned underneath and in contact with electrically nonconductive single-ply or built-up roofing and waterproofing membranes and systems such as coal tar, asphalt, modified bitumen, thermoplastics, spray polyurethane foam, and similar electrically nonconductive membrane materials. This practice is also applicable to roofing and waterproofing systems without insulation placed above moisture absorbing decks such as wood, concrete, or gypsum, that are in contact with single-ply or built-up roofing and waterproofing membranes as described above.

1.3 This practice is applicable to roofing and waterproofing systems incorporating electrically nonconductive rigid board insulation made from materials such as organic fibers, perlite, cork, fiberglass, wood-fiber, polyisocyanurate, polystyrene, phenolic foam, composite boards, gypsum substrate boards, and other electrically nonconductive roofing and waterproofing systems such as spray-applied polyurethane foam.

1.4 This practice is not appropriate for all combinations of materials used in roofing and waterproofing systems.

1.4.1 Metal and other electrically conductive surface coverings and near-surface embedded metallic components are not suitable for surveying with impedance scanners because of the electrical conductivity of these materials.

1.4.2 This practice is not appropriate for use with black EPDM, any membranes containing black EPDM, or black EPDM coatings because black EPDM gives false positive readings.

1.4.3 Aluminum foil on top-faced insulation, roofing, or waterproofing membranes gives a false positive reading and is not suitable for surveying with impedance scanners; however, liquid-applied aluminum pigmented emulsified asphalt-based coatings shall not normally affect impedance scanner readings.

1.4.3.1 This practice is not appropriate for use with aluminium foil faced modified bitumen membranes, as the electrical conductivity of the aluminium foil surface can give false positive readings.

1.4.4 While their overburden remains in place, this practice is not appropriate for use with inverted roof membrane assemblies (IRMAs) or protected roof assemblies (PRMAs), which contain above the deck waterproof membrane and overburden that may include insulation, drainage components, pavers, aggregate, ballast, vegetation, or combinations thereof, because the impedance scanner will not differentiate between above and below the membrane moisture.

1.4.5 See A1.4 for some cautionary notes on roofing anomalies and limitations that affect the impedance test practice.

1.5 Moisture scanners using impedance-based technology are classified as EI scanners.

NOTE 1—The term capacitance is sometimes used when describing impedance scanners. Capacitance scanners are purely capacitive as they do not have a resistive component. Impedance scanners combine both capacitance and resistance for testing; thus, they are well suited to the measurement of different types of materials and constructions found in roofing and waterproofing systems as the combination of both components allows for a more versatile testing, calibration, and measurement arrangement.

1.6 This practice also addresses necessary verification of impedance data involving invasive test procedures using core samples.

1.7 This practice addresses two generally accepted scanning techniques for conducting moisture surveys using electrical impedance scanners:

1.7.1 *Technique A*—Continuous systematic scanning and recording (see 8.2), and

1.7.2 *Technique B*—Grid format scanning and recording (see 8.3).

1.8 This practice addresses some meteorological conditions and limitations for performing impedance inspections.

[1] This practice is under the jurisdiction of ASTM Committee D08 on Roofing and Waterproofing and is the direct responsibility of Subcommittee D08.20 on Roofing Membrane Systems.

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1.9 This practice addresses the effect of the roofing or waterproofing construction, material differences, and exterior surface conditions on the moisture inspections.

1.10 This practice addresses operating procedures, operator qualifications, operating methods, scanning, surveying, and recording techniques.

1.11 *Units*—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 nonconformance with the standard.

1.12 *This 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 standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. Caution should be taken when accessing, walking, or using scanning equipment on the roofing or waterproofing surfaces, or elevated locations, when using ladders, and when raising and lowering equipment to elevated locations.*

1.13 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C1616 Test Method for Determining the Moisture Content of Organic and Inorganic Insulation Materials by Weight

D1079 Terminology Relating to Roofing and Waterproofing

D7438 Practice for Field Calibration and Application of Hand-Held Moisture Meters

E2586 Practice for Calculating and Using Basic Statistics

F2659 Guide for Preliminary Evaluation of Comparative Moisture Condition of Concrete, Gypsum Cement and Other Floor Slabs and Screeds Using a Non-Destructive Electronic Moisture Meter

NOTE 2—See A1.3 for other referenced documents.

3. Terminology

3.1 For definitions of terms used in this practice, refer to Terminology D1079.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *comparative moisture, content, n*—qualitative characterization of moisture content in relative terms (that is, low, medium, and high levels of moisture).

3.2.2 *core sample, n*—small specimen of insulation and membrane having a minimum of 2 in. [50 mm] diameter obtained by cutting through these components down to the deck and removing them from the roofing section under test.

3.2.2.1 *Discussion*—Core samples are used to verify the membrane and insulation composition and ascertain information on their condition.

3.2.3 *detect or detection, v or n*—for the purpose of impedance scanning, the condition at which there is a consistent indication that an elevated level of impedance reading is present within the roofing or waterproofing system.

3.2.4 *false-positive, adj*—reading that indicates that elevated moisture is present when it is not.

3.2.4.1 *Discussion*—For example, a false positive in roofing for impedance scanning may be returned when some other electrically conductive material is present in the roofing system.

3.2.5 *gravimetric analysis, n*—determination of moisture content by weight of a material by comparing wet weight to oven dry weight expressed as a percentage.

3.2.6 *moisture content, MC, n*—mass of moisture per unit mass of dry material.

3.2.6.1 *Discussion*—The moisture content is usually expressed as a percentage by weight and determined gravimetrically.

3.2.7 *roof assembly, n*—assembly of interacting roof components including the roof deck, air or vapor retarder, insulation and membrane, or primary roof covering designed to weatherproof a structure.

3.2.8 *roof section, n*—portion of a roof that is separated from adjacent portions by walls or expansion joints with no changes in the components throughout the section.

4. Summary of Practice

4.1 This practice covers a procedure in which a specifically developed nondestructive electronic impedance (EI) based moisture scanner is used in conjunction with interpretive data and invasive verification practices to detect and evaluate the moisture conditions within low-sloped roofing and waterproofing systems by nondestructively measuring the electrical alternating current (ac) impedance.

4.2 This practice is intended to be used in conjunction with the impedance scanner manufacturer's operation instructions and guides.

5. Significance and Use

5.1 Excess moisture trapped in roofing or waterproofing systems can adversely affect performance and lead to premature failure of roofing or waterproofing systems and its components. It also reduces thermal resistance, resulting in reduced energy efficiency and inflated energy costs. Impedance scans can be effective in identifying concealed and entrapped moisture within roofing or waterproofing systems.

5.2 This practice is intended to be used at various stages of the roofing and waterproofing system's life such as: during or at completion of installation of roofing or waterproofing system to determine if there was moisture intrusion into the roofing or

[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.

waterproofing system or underlying materials; at regular intervals as part of a preventative maintenance program; and to aid in condition assessment, or before replacement or repair work, or combinations thereof, to assist in determining the extent of work and replacement materials.

5.3 This practice alone does not determine the cause of moisture infiltration into roofing or waterproofing systems; however, it can be used to help tracing excess moisture to the point of ingress.

6. Apparatus

6.1 *EI Scanner*—This apparatus shall be specifically developed to detect and evaluate nondestructively comparative moisture conditions within roofing and waterproofing systems.

6.1.1 *Principles of Operation*—The EI of a material varies in proportion with the material's moisture content. The EI of materials such as those listed in 1.2 and 1.3 in the roofing or waterproofing system directly under the footprint of the scanner is measured by creating an alternating electric field that penetrates the materials under test. The small alternating current (ac) flowing through this field is inversely proportional with the impedance of these moisture-absorbing materials. The instrument determines the current's amplitude and converts this value to a comparative moisture value.

6.1.1.1 The depth of the signal penetration varies depending on the sensitivity and signal strength settings of the scanner as well as the composition of materials, thickness, and moisture content of the roofing or waterproofing system under test.

6.1.2 *Apparatus Requirements:*

6.1.2.1 The moisture scanner shall be capable of sending signals nondestructively into the materials below the surfacing and the scanner.

6.1.2.2 The moisture scanner shall have integrated adjustable calibration ability for the differing composition, thickness, density of materials, and moisture conditions that can be encountered in roofing or waterproofing assemblies.

6.1.2.3 The moisture scanner shall have a display giving comparative readings of moisture conditions of materials found in roofing and waterproofing systems.

6.2 *Scanner Types*—Two types of impedance scanners are commercially available:

6.2.1 Handheld scanner designed to be used for point readings on a grid system, and

6.2.2 Mobile-wheeled scanner, which can be rolled across the roofing or waterproofing to obtain continuous readings as the scanner moves over the surface.

NOTE 3—See A1.1 and A1.2 for examples of typical handheld and mobile-wheeled types of impedance scanners.

7. Operator Qualifications and Referenced Materials

7.1 The operator shall:

7.1.1 Be familiar with the use of the impedance scanner;

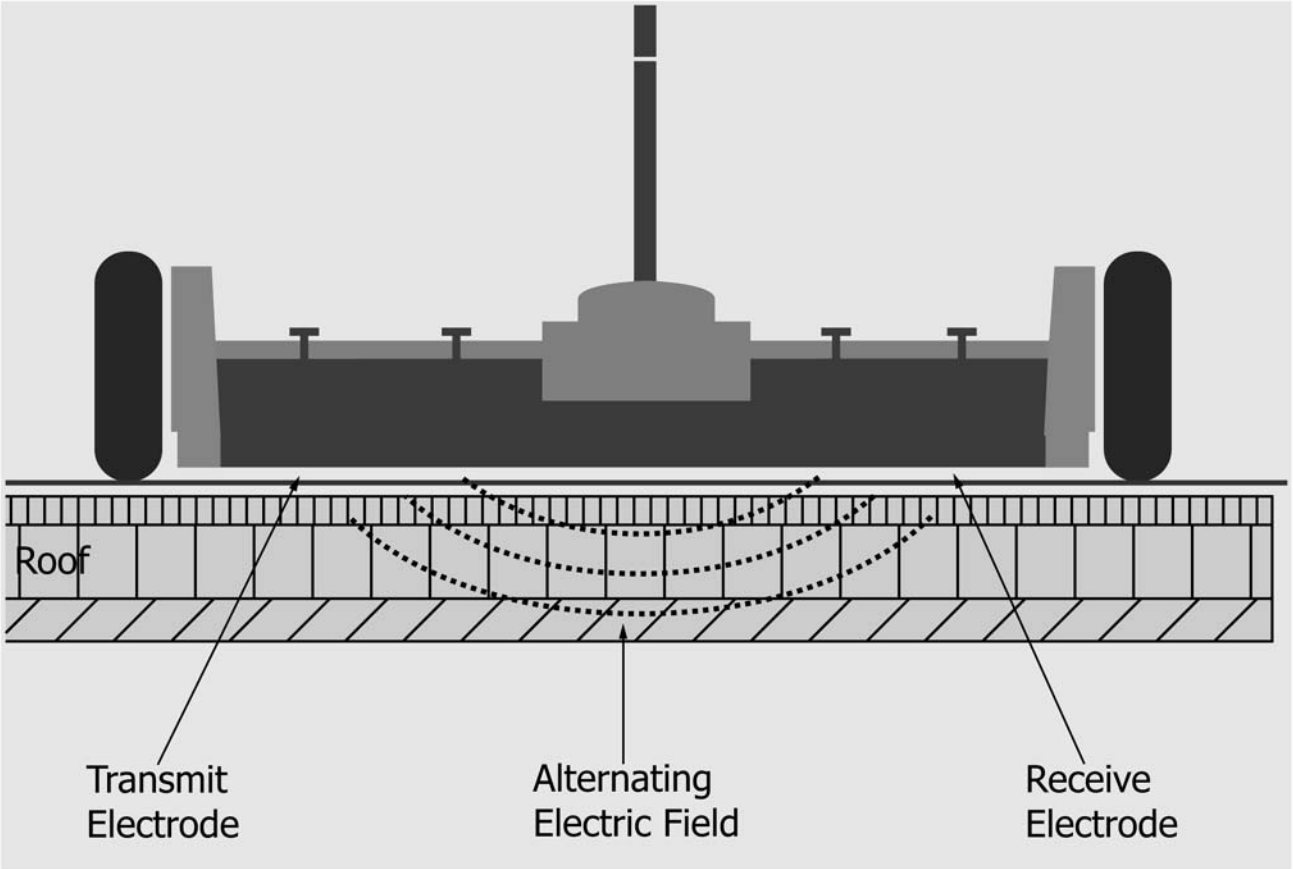

FIG. 1 Typical Nondestructive Moisture Scanner