Designation: D6782 – 13

Standard Test Methods for Standardization and Calibration of In-Line Dry Lumber Moisture Meters[1]

This standard is issued under the fixed designation D6782; 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 These test methods apply to instruments designed to detect, or measure, moisture in wood which has been dried below the fiber saturation point. The purpose of these tests is to provide a unified standard against which such systems can demonstrate their suitability for their intended use (see Appendix X1).

1.1.1 Sensitivity to thin layers of surface moisture such as caused by dew or brief rain exposure is not addressed by these methods. Applications, such as screening material for surface adhesion, may require additional assessment methodology and criteria (see Appendix X5).

1.2 The standard is configured to support tests by moisture meter manufacturers as well as end-users of such systems, therefore the text follows two tracks (see Appendix X2).

1.3 Test methods specified for manufacturers are generally designed for laboratory settings and are intended to provide a standard against which a manufacturer certifies calibration and general system conformance.

1.4 Test methods for end-users are generally designed for field settings and are intended as a standardized set of procedures for determining the suitability of a specific machine for a particular use.

1.5 Applications such as lumber marking or sorting systems utilizing the output of the in-line meter are not part of this standard.

1.6 Applications requiring sensitivity to and identification of localized wet areas are limited to general recommendations. The presence of wet-spots is the subject of Appendix X8.

1.7 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.8 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1990 Practice for Establishing Allowable Properties for Visually-Graded Dimension Lumber from In-Grade Tests of Full-Size Specimens

D2395 Test Methods for Density and Specific Gravity (Relative Density) of Wood and Wood-Based Materials

D2915 Practice for Sampling and Data-Analysis for Structural Wood and Wood-Based Products

D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials

D4444 Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters

D4933 Guide for Moisture Conditioning of Wood and Wood-Based Materials

D5536 Practice for Sampling Forest Trees for Determination of Clear Wood Properties

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *accept/reject meters, n*—meters that permit identification or sorting, or both, of pieces into moisture content classes. The simplest design has one set point or target level to separate wetter from drier pieces. Often the meters described in 3.1.5 may be operated as accept/reject meters.

3.1.2 *field, n*—an environment usually not meeting the criteria of 3.1.4. This is often a meter installation at the wood processing facility where the meter and the lumber are subject to the process environment of mill production.

3.1.3 *flow, n*—a term that describes the movement and orientation of the piece with respect to the sensing area.

3.1.3.1 *longitudinal-flow*—in this flow arrangement, pieces pass lengthwise through the sensing area. All or some portion of the length may be sensed.

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[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.

3.1.3.2 *transverse-flow*—in this flow arrangement, the pieces pass crosswise through the sensing area. Transverse meters frequently have more than one sensing area, consequently, the meter may sense more than one area of the piece even if the entire piece is not sensed.

3.1.4 *laboratory, n*—an environment under which conditions of temperature and moisture content can be controlled within stated tolerances and which permit use of carefully selected and controlled specimens.

3.1.5 *meters, n*—in-line (or in process) moisture sensors designed to respond in one pass to the moisture content of a piece passing the sensing area.

3.1.5.1 *Discussion*—Meters are typically a system consisting of one or more fixed sensing areas (termed heads) and a processing/readout console that may be remote from the region where sensing takes place. Meters may be either non-contact or contact types, and are considered nondestructive if the anticipated performance of the product is not adversely affected by the meter. The magnitude of the sensing area (sampling area) is often regarded in processing as representative of the entire piece, although the intended product requirements may require alternate sampling or analysis schemes. The term sensing region is sometimes used in lieu of sensing area to encompass the three-dimensional sensing pattern of a meter. Meters may have more than one sensing area; consequently, the meter may independently sense more than one area of the piece. Meters may be designed to indicate moisture content percentage, to operate as accept/reject instruments, or to be used for both applications.

3.1.6 *moisture content level, n*—the moisture content at which products are defined as dry, or at which accept/reject decisions are made. This level is dependent upon the specific grading rule, quality control requirements or product specification.

3.1.7 *moisture indicators, n*—meters which display or record the estimated moisture content, or both. The moisture content is estimated from a predetermined relationship between the meter output and moisture content determined by a standard method.

3.1.7.1 *Discussion*—Typical sensing principles are given in Appendix X3.

3.1.8 *Standardization and Calibration:*

3.1.8.1 *standardization*—the determination of the response of the meter to a reference material (see Appendix X4).

3.1.8.2 *calibration*—the determination of the relationship between the response of a standardized meter and the moisture content of a reference material, determined by a standard method (see Appendix X4).

3.1.9 *test modes, n*—these terms describe the status of the piece during measurement.

3.1.9.1 *static*—the piece is stationary in the sensing area when the moisture measurement is made.

3.1.9.2 *dynamic*—the piece moves through the sensing area during measurement.

3.1.10 *wet-spots, n*—localized area of moisture content higher than adjacent wood, most commonly caused by infected wood, localized obstructions to uniform drying or non-uniform drying characteristics of the wood (see Appendix X8).

4. Significance and Use

4.1 In-line meters provide a rapid means of detecting moisture content of lumber or wood products in processing (that is, on a continuous production line). Two major uses are monitoring the performance of the drying process (air drying, kiln drying), and providing sorting or identification of material at predetermined levels of moisture content. These measurements are inferential in the sense that physical measurements are made and compared against calibration curves to obtain an indirect measure of moisture content. These measurements may be influenced by one or more physical properties such as actual moisture content (average and gradient; see Appendix X5), density, surface moisture, chemical composition, size, and temperature of wood. In addition, the measurements may also be influenced by environmental conditions and the design specifications of the meter. The best performance is obtained by an awareness of the effect of each parameter on the meter output and correction of readings as specified by these test methods.

4.2 The two major anticipated users of these test methods are instrument manufacturers whose primary concern is laboratory standardization and calibration, and instrument owners who may have a primary focus on field standardization and calibration. These test methods present the laboratory and the field as separate tracks (see Appendix X2).

4.2.1 *Laboratory Standardization and Calibration*—This portion of these test methods is intended for guidance of equipment manufacturers. Specific test recommendations are tailored to the capabilities of a laboratory environment.

4.2.2 *Field Standardization and Calibration*—The predominant use of in-line meters is in production in which lumber characteristics and environmental conditions reflect actual mill processes. Field standardization and calibration is essential to address or encompass much of the variability in production.

4.2.3 Applications using the output of the in-line moisture meter may modify the meter output signals or have inherent response characteristics that are not representative of the meter.

5. Laboratory Standardization and Calibration

This procedure is intended for testing of a specific model or version of meters.

5.1 *Laboratory Standardization*—Standardization shall be performed on the meter to test the integrity of the meter and sensing region. The meter shall be standardized using suitable reference materials to provide at least one reference point other than zero on the meter readout. In transverse feed systems, standardization shall be performed separately for each sensing region.

5.1.1 *Reference Specimens*—These references are often recommended or provided, or both, by the manufacturer of the meter. In absence of recommended reference specimens, materials shall be obtained that will provide consistent results during testing and retesting.

NOTE 1—Although the references are preferably non-hygroscopic, they maybe hygroscopic if due care is used to assure consistency during testing. For example, uniformly equalized clear wood specimens could be used if stored to maintain constant moisture content.

5.1.2 *Test Procedure*—In the following procedure, at least one reference specimen shall be used. Before each test, the meter shall be initialized by adjusting to the manufacturer's recommended initial reading with no material in the sensing region. The static and dynamic tests are to be conducted at room temperature (20-30°C/68-86°F). Any deviation from this temperature shall be documented in the report.

5.1.2.1 *Positioning*—The reference materials shall be positioned in the sensing region as recommended by the manufacturer and consistent with the constraints of the intended or recommended installation (see Appendix X6).

NOTE 2—Although the procedure specifies a single position, it may be useful to vary the position systematically to assess positional sensitivity. The variation in position may provide information on requirements for installation accuracy and effects from board misalignment, such as skewing or warping.

5.1.2.2 *Static Standardization Test*—After initializing, conduct a static standardization by placing the reference material in the sensing zone with the feed system disabled.

5.1.2.3 *Dynamic Standardization Test*—After initializing and conducting the static standardization (5.1.2), sequentially place each reference specimen (See 5.1.1 and Note 3) on a feed assembly outside the sensing zone. Energize the feed assembly to move the reference through the sensing zone at a selected constant speed. The speed selected shall be consistent with the intended installation. Record the meter reading (for example, maximum or average) as the reference standard passes through the sensing zone. Repeat the test at the selected test speeds. (The more detailed procedure of the dynamic test is described in Appendix X7).

NOTE 3—In some systems, such as longitudinal flow meters operating at high speed, it may not be possible to conduct dynamic laboratory standardization at operating speeds for practical reasons of control and safety. In these situations, the static or slow speed standardization results will necessarily be the basis for proceeding to the calibration step.

5.1.2.4 *Temperature Test*—The test shall be conducted at -20°C, 0°C, 20°C, 40°C and 60°C (-4°F, 32°F, 68°F, 104°F and 140°F) to determine the response of reference material, sensing heads, and console with temperature. At each temperature level, the system components shall be at specified thermal equilibrium, allowing sufficient time for any temperature soak effect. Record the observed temperature and meter reading at each temperature level.

(*1*) *Reference Material*—With the sensing heads and console at ambient room temperature (20-30°C/68-86°F), condition the reference material at the temperatures listed in 5.1.2.4. Quickly insert the reference material within the electrical field of one sensing head. Repeat the measurement at each temperature level and record average readings.

(*2*) *Sensing Heads*—With the console at ambient room temperature (20-30°C/68-86°F), place the sensing heads in a room to cycle to temperatures listed in 5.1.2.4. Allow the reference specimen to remain with the sensing heads. Determine the thermal drift of each sensing head by the difference of readings from those obtained in (*1*).

(*3*) *Console*—With the sensing heads and reference material at ambient room temperature (20-30°C/68-86ºF), cycle the console through the temperatures listed in 5.1.2.4. Determine the thermal drift of the console by differences in readings from those obtained in (*1*) and (*2*).

5.1.3 *Report*—The report shall include the data collected in 5.1.2 together with a detailed description of the reference materials, the method used for temperature exposure, and any variation from the specified procedure.

5.2 *Laboratory Calibration (MC Indicators)*—This method is intended for obtaining the greatest accuracy by comparison of the meter output to moisture content obtained gravimetrically using the oven-drying method (see Test Methods D4442). The accuracy of the desired results must be consistent with the indicated accuracy of the specific oven-drying procedure in Test Methods D4442. Laboratory calibration procedures are intended to provide reference data under controlled conditions of wood and ambient variables, This calibration is designed for full-scale calibration of the meter on actual wood specimens having uniform moisture content (see 5.2.2). Meters must be standardized (see 5.1) before being calibrated. In transverse feed systems, calibration shall be done separately for each sensing region. The calibration curve should neither be extrapolated below the lowest nor above the highest value tested.

5.2.1 *Calibration Objectives*—Establish the objectives of the calibration test including specimen characteristics criteria (for example, uniformity of moisture content, density, species, and so forth), operating speed, and environmental conditions.

5.2.2 *Specimen Selection and Preparation*—Specimens shall be selected to represent the characteristics identified as calibration variables in 5.2.1. Other characteristics that are to be held constant shall be identified as selection criteria. One example is the nominal thickness of the particular species for which calibration is desired. Specimen length shall exceed the dimensions of the sensing region for transverse meters and, for longitudinal meters, be a single length unless length is a variable for which calibration is desired. The selected specimens shall be free of visible irregularities such as knots, decay, reaction wood, wane, and resin concentrations. These specimens shall be carefully selected to be representative for the particular species and growth site. Specimens shall be chosen to be entirely sapwood or heartwood if possible.

5.2.2.1 If density is a variable chosen for calibration, evaluation requires data from a wide range of wood samples representing various density groups will be required. At a minimum, three density groups shall be prepared.

5.2.2.2 Where growth site is the subject of calibration, development of corrections will require specimens representing several different growth sites. Where the desired accuracy of the calibration is known and the influence of site can be estimated, Practice D2915 can be used to establish a sampling plan.

5.2.2.3 If testing of meter sensitivity to presence of wet pockets is required, it will be necessary to prepare a group of specimens with well defined wet pockets (size, position with respect to a board, MC gradients) of several typical sizes and locations (see Appendix X8). The obtained data shall be included in the report.