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# Standard Guide for Moisture Conditioning of Wood and Wood-Based Materials[1]

This standard is issued under the fixed designation D4933; 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 covers standard procedures for conditioning and equilibrating wood and wood-based materials to constant moisture content. The procedures apply to solid wood, wood-based fiber and particulate materials and panels, and wood products containing adhesives. They are intended for use in research and development activities, testing laboratories, quality control, and for all other classes of producers and users. This guide includes background material on the importance of moisture content control, important definitions and technical data, possible types of apparatus, procedures, and the importance of conditioning time. Users should recognize that the necessary degree of precision and bias varies with the intentions of the users. Some research and testing, for example, might require very close control of moisture content, whereas control in an industrial storage facility might not require such close control. This guide offers procedures that include these different requirements.

1.2 The values stated in SI units are to be regarded as standard. The values of temperature in degrees Fahrenheit given in Table X1.2 are mathematical conversions that are provided for information only and are not considered standard.

1.3 The following safety hazards caveat pertains only to the procedure section, Section 6, of this guide. *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.*

1.4 *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]

D9 Terminology Relating to Wood and Wood-Based Products

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

E104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions

2.2 *ISO Standard:*

ISO 554 Atmospheres for Conditioning and/or Testing—Specifications[3]

## 3. Terminology

3.1 *Definitions:*

3.1.1 The following terms are defined in accordance with Terminology D9.

3.1.2 *equilibrium moisture content, n*—moisture content at which wood neither gains nor loses moisture to the surrounding air.

3.1.2.1 *Discussion*—Equilibrium moisture content (EMC) generally connotes a moisture content at which a nominal species of solid wood will equilibrate.“ Nominal” is used in the sense of a “hypothetical average” rather than an actual species. At constant EMC environmental conditions, however, various wood-base materials can reach different levels of EMC. It is more appropriate, therefore, to refer to conditioning at specified relative humidity (RH) and temperature conditions than to a particular EMC. Recommendations for conditioning are given in ISO 554. Nominal values for equilibrium moisture content (EMC) are given in Appendix X1. Caution must be used in calculating or using these values since they represent a

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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] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

compromise between variation with species, and adsorption and desorption. Also, wood containing high levels of extractives or chemicals may equilibrate at different moisture contents. The data in Tables X1.1 and X1.2 were generated from the regression equation in X1.1, which is explained in more detail in Ref (**1**).[4]

3.1.3 *moisture content, n*—amount of water contained in the wood, usually expressed as a percentage of the mass of the oven-dry wood.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *hysteresis, n*—dependence of the equilibrium moisture content (EMC) that wood attains at any given relative humidity and temperature upon the direction from which the EMC is approached.

3.2.1.1 *Discussion*—During desorption, the EMC will be higher (sometimes by several percent moisture content) than during adsorption. The analog of the magnetic hysteresis curve has been used to describe this phenomenon. Furthermore, the EMC during a portion of the initial desorption from the never-dried condition may be higher than those in any subsequent desorption cycle. For relative humidities between 10 and 85 % and within a broad range of temperatures, the hysteresis ratio (absorption EMC/desorption EMC) is approximately 0.85.

3.2.2 *time constant, n*—time required for a physical quantity to (a) rise from 0 to $1 - 1/e$ (that is, 63.2 %) of its final steady value when it varies with time, $t$, as $1 - e^{-kt}$, or (b) fall to $1/e$ (that is, 36.8 %) of its initial value when it varies with time, $t$, as $e^{-kt}$ ((**Ref 2**)).

3.2.2.1 *Discussion*—When applying the concept of time constant to moisture conditioning, the "initial value" is the initial MC of the specimen and the" final value" is the EMC that would be attained with extended exposure. One time constant is the time period from the start of exposure to the point of MC that is 63.2 % of the change between initial and final values. This applies in adsorption or desorption. The use of the time constant in conditioning is explained in 6.4.1.1.

## 4. Significance and Use

4.1 Many physical and mechanical properties of wood and wood-based materials change in response to the environmental equilibrium moisture content, and any comparison of these properties must take moisture content into account. A consistent base for comparison among different test samples and different laboratories is necessary. Shrinkage and dimensional change in particular are dependent on moisture content, and tests involving their measurement must be conducted with good equilibrium moisture content control. Conditioning can also be important in industrial settings where there are optimum moisture content levels for many products and processes, and conformance to these levels can reduce losses in quality and yield.

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.

## 5. Apparatus

5.1 *Hygrometers, Psychrometers*—The accuracy of hygrometers and psychrometers should be within the range of required RH control, which depends on the desired level of EMC control.

5.2 *Thermometers*—Thermometers to measure air temperature should be capable of measuring temperature within one-half of the temperature control requirement (see Section 8). Thermometers used in psychrometers for determining relative humidity (see 5.1) must have an accuracy which is consistent with the required sensitivity. This sensitivity can be determined from analyzing the tables which convert measured temperatures to relative humidities.

5.3 *Weighing Device*—A balance is required to weigh specimens with an accuracy that will allow measurement of the EMC within the desired limits (see Test Methods D4442).

5.4 *Conditioning Chamber*—The chamber in which specimens are conditioned should be monitored for constant temperature and humidity conditions. If aqueous solutions (saturated salts, glycerin, or sulfuric acid) are to be used, follow the procedure described in Practice E104. Commonly used saturated salt solutions are given in Table X2.1.

NOTE 1—If such solutions are used, precautions must be taken to assure that the specimens do not overly depress (or raise) the RH conditions. This can be tested by adding an equivalent dummy volume of specimens and observing how RH is affected. An RH sensor or simple mechanical hygrometer can show relative effects on RH.

## 6. Procedure

6.1 *Specimens*—Weigh an appropriate number of specimens periodically to determine when equilibrium is reached. No strict number of specimens can be established because the intent of the test will determine how critical sampling should be. A guideline would be to include enough specimens for a statistical analysis. The specimens should be uniformly distributed throughout the conditioning chamber. Consideration should also be given to selecting specimens that are representative of the material of interest.

NOTE 2—Typical conditioning time required for 20-mm thick and 100-mm wide end-coated solid wood specimens, initially at equilibrium at 50 % RH and 20°C, and exposed to 90 % RH at 20°C, is 60 days. As a rule of thumb, required conditioning time is proportional to the square of ratio of thickness. A similar specimen of 40 mm thickness, therefore, would equilibrate in about 240 days; a 10-mm one in about 15 days.

6.2 *Specimen Moisture Content*—A decision must be made concerning whether adsorption or desorption (or both) values are to be obtained. This may require preconditioning before the desired exposure. By using the relationship in the discussion under *hysteresis*, an appropriate precondition MC can be selected (below or above the EMC condition for adsorption or desorption MC, respectively).

6.3 *Specimen Preparation:*

6.3.1 If small specimens are used to represent larger or full-size specimens, coat the appropriate edges or ends of the specimens, or both, to obtain moisture content distributions that are typical of larger specimens. Coating is necessary also