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Section 5.56.(a) Grain Moisture Meters

Section 5.56. was reorganized into two sections beginning with the 1997 Edition of NIST Handbook 44. This Section, 5.56.(a), applies to all NTEP grain moisture meters. It also applies to any grain moisture meter manufactured or placed into service on or after January 1, 1998.

(Code reorganized and renumbered 1996)

A. Application

A.1. General Code. – This code applies to grain moisture meters, that is, devices used to indicate directly the moisture content of cereal grain and oil seeds. The code consists of general requirements applicable to all moisture meters and specific requirements applicable only to certain types of moisture meters. Requirements cited for “test weight per bushel” indications or recorded representations are applicable only to devices incorporating an automatic test weight per bushel measuring feature.

(Amended 2003)

A.2. Exceptions. – This code does not apply to devices used for in-motion measurement of grain moisture content or seed moisture content.

A.3. Type Evaluation. – The National Type Evaluation Program (NTEP) will accept for type evaluation only those devices that comply with this code. State enforcement will be based upon the effective dates identified with each requirement when specific dates are shown.

(Added 1993)

A.4. Additional Code Requirements. – In addition to the requirements of this code, 5.56.(a) Grain Moisture Meters shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Design of Indicating, Recording, and Measuring Elements.

S.1.1. Digital Indications and Recording Elements.

- (a) Meters shall be equipped with a digital indicating element.
- (b) The minimum height for the digits used to display moisture content shall be 10 mm.
- (c) Meters shall be equipped with a communication interface that permits interfacing with a recording element and transmitting the date, grain type, grain moisture results, test weight per volume results, and calibration version identification.
- (d) A digital indicating element shall not display, and a recording element shall not record, any moisture content values or test weight per volume values before the end of the measurement cycle.
- (e) Moisture content results shall be displayed and recorded as percent moisture content, wet basis. Test weight per bushel results shall be displayed and recorded as pounds per bushel. Subdivisions of these units shall be in terms of decimal subdivisions (not fractions).
- (f) A meter shall not display or record any moisture content or test weight per volume values when the moisture content of the grain sample is beyond the operating range of the device, unless the moisture and test weight representations include a clear error indication (and recorded error message with the recorded representation).

- (g) On multi-constituent meters (e.g., meters which also measure grain protein), provision shall be made for displaying and recording the constituent label (such as moisture, protein, etc.) to make it clear which constituent is associated with each of the displayed and recorded values.

(Added 1995)

(Amended 1993, 1994, 1995, 1996, and 2003)

S.1.2. Selecting or Recording Grain or Seed Type and Class. – Provision shall be made for selecting and recording the type and class or multi-class group (as appropriate) of grain or seed to be measured. The means to select the type and class or multi-class group of grain or seed shall be readily visible and the type and class or multi-class group of grain or seed selected shall be clearly and definitely identified. Abbreviations for grain types and multi-class groups indicated on the meter must meet the minimum acceptable abbreviations listed in Table S.1.2. Grain Types and Multi-Class Groups Considered for Type Evaluation and Calibration and Their Minimum Acceptable Abbreviations.

(Amended 1993, 1995, and 2007)

Table S.1.2. Grain Types and Multi-Class Groups Considered for Type Evaluation and Calibration and Their Minimum Acceptable Abbreviations		
Grain Type	Grain Class	Minimum Acceptable Abbreviation
<i>Barley</i>	<i>All-Class Barley*</i>	<i>BARLEY</i>
	<i>Six-Rowed Barley</i>	<i>SRB</i>
	<i>Two-Rowed Barley</i>	<i>TRB</i>
<i>Corn</i>	---	<i>CORN</i>
<i>Grain Sorghum</i>	---	<i>SORG or MILO</i>
<i>Oats</i>	---	<i>OATS</i>
<i>Rice</i>	<i>All-Class Rough Rice*</i>	<i>RGHRICE</i>
	<i>Long Grain Rough Rice</i>	<i>LFRR</i>
	<i>Medium Grain Rough Rice</i>	<i>MGRR</i>
<i>Small Oil Seeds (under consideration)</i>	---	---
<i>Soybeans</i>	---	<i>SOYB</i>
<i>Sunflower seed (Oil)</i>	---	<i>SUNF</i>
<i>Wheat</i>	<i>All-Class Wheat*</i>	<i>WHEAT</i>
	<i>Durum Wheat</i>	<i>DURW</i>
	<i>Hard Red Spring Wheat</i>	<i>HRSW</i>
	<i>Hard Red Winter Wheat</i>	<i>HRWW</i>
	<i>Hard White Wheat</i>	<i>HDWW</i>
	<i>Soft Red Winter Wheat</i>	<i>SRWW</i>
	<i>Soft White Wheat</i>	<i>SWW</i>
	<i>Wheat Excluding Durum*</i>	<i>WHTXDUR</i>
Note: Grain Types marked with an asterisk (*) are “Multi-Class Calibrations.”		

[Nonretroactive as of January 1, 1998]

(Table Added 1993) (Amended 1995, 1998, and 2007)

S.1.3. Operating Range. – A meter shall automatically and clearly indicate when the operating range of the meter has been exceeded. The operating range shall specify the following:

- (a) **Temperature Range of the Meter.** – The temperature range over which the meter may be used and still comply with the applicable requirements shall be specified. The minimum temperature range shall be 10 °C to 30 °C. No moisture value may be displayed when the temperature range is exceeded. An appropriate message shall be displayed when the temperature of the meter is outside its specified operating range.
- (b) **Temperature Range of each Grain or Seed.** – The temperature range for each grain or seed for which the meter is to be used shall be specified. The minimum temperature range for each grain shall be 0 °C to 40 °C. No moisture value may be displayed when the temperature range is exceeded. An appropriate error message shall be displayed when the temperature of the grain sample exceeds the specified temperature range for the grain.
- (c) **Moisture Range of the Grain or Seed.** – The moisture range for each grain or seed for which the meter is to be used shall be specified. Moisture and test weight per bushel values may be displayed when the moisture range is exceeded if accompanied by a clear indication that the moisture range has been exceeded.
(Amended 2003)
- (d) **Maximum Allowable Meter/Grain Temperature Difference.** – The maximum allowable difference in temperature between the meter and the sample for which an accurate moisture determination can be made shall be specified. The minimum temperature difference shall be 10 °C. No moisture value may be displayed when the maximum allowable temperature difference is exceeded. An appropriate error message shall be displayed when the difference in temperature between the meter and the sample exceeds the specified difference.

(Added 1993) (Amended 1995)

S.1.4. Value of Smallest Unit. – The display shall permit moisture value determination to both 0.01 % and 0.1 % resolution. The 0.1 % resolution is for commercial transactions; the 0.01 % resolution is for type evaluation and calibration purposes only, not for commercial purposes. Test weight per bushel values shall be determined to the nearest 0.1 pound per bushel.

(Amended 2003)

S.1.5. Operating Temperature.

- (a) Warm-up period: When a meter is turned on it shall not display or record any usable values until the operating temperature necessary for accurate determination has been attained, or the meter shall bear a conspicuous statement adjacent to the indication stating that the meter shall be turned on for a time period specified by the manufacturer prior to use.
- (b) A meter shall meet the requirements of T.2. Tolerances when operated in the temperature range of 10 °C to 30 °C (50 °F to 86 °F) or within the range specified by the meter manufacturer.
- (c) If the manufacturer specifies a temperature range, the range shall be at least 20 °C (36 °F).

(Added 1993) (Amended 1995 and 1996)

S.2. Design of Grain Moisture Meters.

S.2.1. Minimum Sample Size. – Meters shall be designed to measure the moisture content of representative-size grain samples. The minimum allowable sample size used in analysis shall be 100 g or 400 kernels or seeds, whichever is smaller.

(Added 1993) (Amended 1995)

S.2.2. Electric Power Supply.**S.2.2.1. Power Supply, Voltage and Frequency.**

- (a) A meter that operates using alternating current must perform within the tolerances defined in Section T.2. Tolerances over the line voltage range 100 V to 130 V, or 200 V to 250 V rms as designed, and over the frequency range of 59.5 Hz to 60.5 Hz.
- (b) Battery-operated instruments shall not indicate or record values outside the applicable tolerance limits when battery power output is excessive or deficient.

S.2.2.2. Power Interruption. – A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits.

(Added 1988)

S.2.3. Level Indicating Means. – A meter shall be equipped with a level indicator and leveling adjustments if its performance is changed by an amount greater than the applicable tolerance when the meter is moved from a level position to a position that is out of level in any upright direction by up to 5 % (approximately three degrees). The level-indicating means shall be readable without removing any meter parts requiring a tool.

(Added 1988) (Amended 1994)

S.2.4. Calibration Integrity.

S.2.4.1. Calibration Version. – A meter must be capable of displaying either calibration constants, a unique calibration name, or a unique calibration version number for use in verifying that the latest version of the calibration is being used to make moisture content and test weight per bushel determinations.

(Added 1993) (Amended 1995 and 2003)

S.2.4.2. Calibration Corruption. – If calibration constants are digitally stored in an electronically alterable form, the meter shall be designed to make automatic checks to detect corruption of calibration constants. An error message must be displayed if calibration constants have been electronically altered.

(Added 1993) (Amended 1995)

S.2.4.3. Calibration Transfer. – *The instrument hardware/software design and calibration procedures shall permit calibration development and the transfer of calibrations between instruments of like models without requiring user slope or bias adjustments.*

[Note: Only the manufacturer or the manufacturer's designated service agency may make standardization adjustments on moisture meters. This does not preclude the possibility of the operator installing manufacturer-specified calibration constants under the instructions of the manufacturer or its designated service agency.] Standardization adjustments (not to be confused with grain calibrations) are those physical adjustments or software parameters which make meters of like type respond identically to the grain(s) being measured.

[Nonretroactive as of January 1, 1999]

(Added 1994) (Amended 1998)

S.2.5. Provision for Sealing. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. For parameters adjusted using other means, the following applies:

An approved means of security shall be provided (as defined in Table S.2.5. Categories of Device and Methods of Sealing for Devices Manufactured Between January 1, 1999 and January 1, 2020 and paragraph S.2.5.1. Sealing

Requirements for Devices Manufactured on or after January 1, 2020) before any change that affects the metrological integrity of the device can be made to any mechanism.

(Amended 2019 and 2021)

<p align="center">Table S.2.5. Categories of Device and Methods of Sealing For Devices Manufactured Between January 1, 1999 and January 1, 2020</p>	
Categories of Device	Methods of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters (000 to 999) and one for configuration parameters (000 to 999). If equipped with event counters, the device must be capable of displaying, or printing through the device or through another on-site device, the contents of the counters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. A device shall clearly indicate that it is in the remote configuration mode and shall not be capable of operating in the measure mode while enabled for remote configuration.	The hardware enabling access for remote communication must be at the device and sealed using a physical seal or two event counters: one for calibration parameters (000 to 999) and one for configuration parameters (000 to 999). If equipped with event counters, the device must be capable of displaying, or printing through the device or through another on-site device, the contents of the counters.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). When accessed for the purpose of modifying sealable parameters, the device shall clearly indicate that it is in the configuration mode and shall not be capable of operating in the measuring mode.	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter (for calibration changes consisting of multiple constants, the calibration version number may be used rather than the calibration constants). A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 25 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)
Category 3a: No remote capability, but operator is able to make changes that affect the metrological integrity of the device (e.g., slope, bias, etc.) in normal operation. *When accessed for the purpose of modifying sealable parameters, the device shall clearly indicate that it is in the configuration mode and shall not be capable of operating in the measuring mode.	Same as Category 3
Category 3b: No remote capability, but access to metrological parameters is controlled through a software switch (e.g., password). *When accessed for the purpose of modifying sealable parameters, the device shall clearly indicate that it is in the configuration mode and shall not be capable of operating in the measuring mode.	Same as Category 3

[Nonretroactive as of January 1, 1999]

[*Nonretroactive as of January 1, 2014]

(Amended 1998, 2013, 2019, and 2021)

Note: Zero-setting and test point adjustments are considered to affect metrological characteristics and must be sealed.

(Added 1993) (Amended 1995 and 1997)

S.2.5.1. Sealing Requirements for Devices Manufactured on or after January 1, 2020. – An event logger is required in the device. The event logger must include an event counter (000 to 999); the parameter ID; the date and time of the change; and the new value of the parameter (for calibration changes consisting of multiple constants, the calibration version number may be used rather than the calibration constants).

A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 25 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)

(Added 2021)

S.2.6. Determination of Quantity and Temperature. – The moisture meter system shall not require the operator to judge the precise volume or weight and temperature needed to make an accurate moisture determination. External grinding, weighing, and temperature measurement operations are not permitted. In addition, if the meter is capable of measuring test weight per bushel, determination of sample volume and weight for this measurement shall be fully automatic *and means shall be provided to ensure that measurements of test weight per volume are not allowed to be displayed or printed when an insufficient sample volume is available to provide an accurate measurement.**

[*Nonretroactive as of January 1, 2004]

(Added 1994) (Amended 1995 and 2003)

S.3. Accessory Equipment. – When the operating instructions for a moisture meter require accessory equipment separate from and external to the moisture meter, such equipment shall be appropriate and complete for the measurement.

S.4. Operating Instructions and Use Limitations. – The manufacturer shall furnish operating instructions for the device and accessories that include complete information concerning the accuracy, sensitivity, and use of accessory equipment necessary in obtaining a moisture content. Operating instructions shall include the following information:

- (a) name and address or trademark of the manufacturer;
- (b) the type or design of the device with which it is intended to be used;
- (c) date of issue;
- (d) the kinds or classes of grain or seed for which the device is designed to measure moisture content and test weight per bushel; and
(Amended 2003)
- (e) the limitations of use, including but not confined to the moisture measurement range, grain or seed temperature, maximum allowable temperature difference between grain sample and meter, kind or class of grain or seed, moisture meter temperature, voltage and frequency ranges, electromagnetic interferences, and necessary accessory equipment.

(Added 1984)

N. Notes

N.1. Testing Procedures. – Field evaluation of grain moisture meters shall be performed by one of the following methods:

N.1.1. Air Oven Reference Method Transfer Standards. – Official grain samples shall be used as the official transfer standards with moisture content and test weight per bushel values assigned by the reference methods. The reference methods for moisture shall be the oven drying methods as specified by the USDA GIPSA. The test weight per bushel value assigned to a test weight transfer standard shall be the average of 10 test weight per bushel determinations using the quart kettle test weight per bushel apparatus as specified by the USDA GIPSA. Tolerances shall be applied to the average of at least three measurements on each official grain sample. Official grain samples shall be clean and naturally moist, but not tempered (i.e., water not added).

(Amended 1992, 2001, and 2003)

N.1.2. Minimum Test. – A minimum test of a grain moisture meter shall consist of tests using samples (need not exceed three) of each grain or seed type for which the device is used, and for each grain or seed type shall include the following:

- (a) tests of moisture indications, using samples having at least two different moisture content values within the operating range of the device; and
- (b) if applicable, tests of test weight per volume indications, with at least the lowest moisture samples used in (a) above.

(Added 2003)

(Amended 1986, 1989, and 2003)

N.1.3. Meter to Like-Type Meter Method Transfer Standards. – Properly standardized reference meters using National Type Evaluation Program (NTEP) approved calibrations shall be used as transfer standards. A reference meter shall be of the same model family, as defined by the NTEP Certificate of Conformance, as the meter under test. Tests shall be conducted side-by-side using, as a comparison medium, grain samples that are clean and naturally moist, but not tempered (i.e., water not added).

(Added 2001) (Amended 2023)

T. Tolerances

T.1. To Underregistration and to Overregistration. – The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

T.2. Tolerances.

T.2.1. Air Oven Reference Method. – Maintenance and acceptance tolerances shall be as shown in Table T.2.1. Acceptance and Maintenance Tolerances Air Oven Reference Method. Tolerances are expressed as a fraction of the percent moisture content of the official grain sample, together with a minimum tolerance.

(Amended 2001)

Table T.2.1. Acceptance and Maintenance Tolerances Air Oven Reference Method		
Type of Grain, Class, or Seed	Tolerance	Minimum Tolerance
Corn, oats, rice, sorghum, sunflower	0.05 of the percent moisture content	0.8 % in moisture content
All other cereal grains and oil seeds	0.04 of the percent moisture content	0.7 % in moisture content

(Amended 2001)

T.2.2. Meter to Like-Type Meter Method. – Maintenance and acceptance tolerances shall be as shown in Table T.2.2. Acceptance and Maintenance Tolerances Meter to Like-Type Meter Method. The tolerances shall apply to all types of grain and seed.

(Added 2001)

Table T.2.2. Acceptance and Maintenance Tolerances Meter to Like-Type Meter Method	
Sample Reference Moisture	Tolerance
Up to 22 %	0.5 % in moisture content

(Added 2001)

Note: Like-type as described in paragraph N.1.3. Meter to Like-Type Meter Method Transfer Standards.

(Note Added 2023)

T.3. For Test Weight Per Bushel Indications or Recorded Representations. – The maintenance and acceptance tolerances on test weight per bushel indications or recorded representations shall be as shown in Table T.3. Acceptance and Maintenance Tolerances Test Weight per Bushel. Tolerances are (+) positive or (–) negative with respect to the value assigned to the official grain sample.

(Amended 1992 and 2003)

Table T.3. Acceptance and Maintenance Tolerances Test Weight per Bushel	
Type of Grain or Seed	Tolerance (Pounds Per Bushel)
Corn, oats	0.8
All wheat classes	0.5
Soybeans, all barley classes, all rice classes, sunflower, sorghum	0.7

(Added 2003)

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Value of the Smallest Unit on Primary Indicating and Recording Elements. – The resolution of the moisture meter display shall be 0.1 % moisture and 0.1 pounds per bushel test weight during commercial use. (Amended 2003)

UR.1.2. See G-UR.1.2. Environment.

UR.2. Installation Requirements. – The grain moisture meter shall be installed in an environment within the range of temperature and/or other environmental factors specified in the operating instructions.

UR.3. Use Requirements.

UR.3.1. Operating Instructions. – The operating instructions for the use of the grain moisture meter shall be readily available to the user, service technician, and weights and measures official at the place of installation. It shall include a list of accessory equipment and the kinds of grain or seed to be measured with the moisture meter. (Amended 1988)

UR.3.2. Other Devices Not Used for Commercial Measurement. – If there are other moisture meters on the premises not used for trade or determining other charges for services, these devices shall be clearly and conspicuously marked “Not for Use in Trade or Commerce.”

UR.3.3. Maintaining Integrity of Grain Samples. – Whenever there is a time lapse (temperature change) between taking the sample and testing the sample, means to prevent condensation of moisture or loss of moisture from grain samples shall be used. For example, a cold grain sample may be kept in a closed container in order to permit the cold grain to come to the operating temperature range of the meter before the grain moisture measurements are made.

UR.3.4. Printed Tickets.

- (a) Printed tickets shall be free from any previous indication of moisture content or type of grain or seed selected.
- (b) The customer shall be given a printed ticket at the time of the transaction or as otherwise specified by the customer. The printed ticket shall include the date, grain type, grain moisture results, test weight per bushel, and calibration version identification. The ticket information shall be generated by the grain moisture meter system.

(Amended 1993, 1995, 2003, and 2013)

UR.3.5. Accessory Devices. – Accessory devices, if necessary in the determination of a moisture content value, shall be in close proximity to the moisture meter and allow immediate use.

UR.3.6. Sampling. – A grain sample shall be obtained by following appropriate sampling methods and equipment. These include, but are not limited to grain probes of appropriate length used at random locations in the bulk, the use of a pelican sampler, or other techniques and equipment giving equivalent results. The grain sample shall be taken such that it is representative of the lot.

UR.3.7. Location. – Also see G-UR.3.3. Position of Equipment.

UR.3.8. Level Condition. – If equipped with a level indicator, a meter shall be maintained in a level condition.
(Added 1988)

UR.3.9. Current Calibration Data. – Grain moisture determinations shall be made using only the most recently published calibration data.
(Added 1988)

UR.3.10. Posting of Meter Operating Range. – The operating range of the grain moisture meter shall be clearly and conspicuously posted in the place of business such that the information is readily visible from a reasonable customer position. The posted information shall include the following:

- (a) The temperature range over which the meter may be used and still comply with the applicable requirements. If the temperature range varies for different grains or seed, the range shall be specified for each.
- (b) The moisture range for each grain or seed for which the meter is to be used.
- (c) The temperature range for each grain or seed for which the meter is to be used.
- (d) The maximum allowable difference in temperature that may exist between the meter and the sample for which an accurate moisture determination can be made.

(Added 1988)