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# Section 5.57. Near-Infrared Grain Analyzers

## A. Application

**A.1. General.** – This code applies to near-infrared (NIR) grain analyzers; that is, devices used to indicate the constituent values (other than moisture content) of grain using near-infrared reflectance or transmittance technology. These instruments may analyze either whole grain or ground grain samples. The code consists of general requirements applicable to all NIR analyzers and specific requirements applicable only to certain types of NIR analyzers, grain types, or grain constituents. In addition to meeting the requirements of this code, a whole grain NIR analyzer that displays a measured moisture value must also comply with the requirements of the Grain Moisture Meters Code.

(Added 2001)

**A.2. Exceptions.** – This code does not apply to devices used for in-motion measurement of grain constituent values.

**A.3. Calibrations.** – The National Type Evaluation Program (NTEP) Certificate of Conformance (CC) shall indicate the native moisture basis of each calibration. The "native" moisture basis is the default moisture basis of the sealable constituent calibration (or constituent calibration pair when a non-displayed moisture calibration is also involved). If an NIR analyzer uses a self-generated moisture measurement internally but does NOT display or record a moisture value, the moisture calibration shall be considered to be a part of the constituent calibration. For such calibrations, the CC shall state: "Includes non-displayed moisture calibration." Changes to any part of such calibrations shall require changes to the CC.

(Added 2001)

**A.4. Additional Code Requirements**. – In addition to the requirements of this code, Near-Infrared Grain Analyzers 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) Analyzers shall be equipped with a digital indicating element.*

*(b) The minimum height for the digits used to display constituent values shall be 10 mm.*

*(c) Analyzers shall be equipped with a communication interface that permits interfacing with a recording element and transmitting the date, grain type or class, constituent values, the moisture basis for each constituent value (except moisture), and calibration version identification. If the analyzer converts constituent results to a manually entered moisture basis, the "native" concentration and the "native" moisture basis must appear on the printed ticket in addition to the converted results and the manually entered moisture basis.*

(Amended 2001 and 2003)

*(d) A digital indicating element shall not display, and a recording element shall not record, any constituent value before the end of the measurement cycle.*

*(e) Constituent content shall be recorded and displayed as percent of total mass at the specified moisture basis. The moisture basis shall also be recorded and displayed for each constituent content result (except moisture). If a whole grain analyzer that is calibrated to display results on an "as is" moisture basis does NOT display or record a moisture value, it must clearly indicate that results are*

*expressed on an "as is" moisture basis. Ground grain analyzers must ALWAYS display and record a moisture measurement for "as is" content results (except moisture).*

(Amended 2001 and 2003)

*(f) An analyzer shall not display or record any constituent value that is beyond the operating range of the device unless the constituent value representation includes a clear error indication (and recorded error message with the recorded representation).*

*(g) If an NIR analyzer is used to determine a moisture value, either to determine the moisture of an "as is" constituent content measurement or to convert from one moisture basis to another, the moisture measurement must be concurrent with the measurement of other constituents.*

*(h) If the analyzer incorporates a built-in printer, or if a printer is available as an accessory to the analyzer, the information appearing on the printout shall be arranged in a consistent and unambiguous manner.*

(Added 2003)

*[Nonretroactive as of January 1, 2003]*

(Added 2001)

***S.1.2. Selecting and Recording Grain Class and Constituent.*** *– Provision shall be made for selecting and recording the type or class or multi-class group of grain and the constituent(s) to be measured. The means to select the grain type or class or multi-class group and the constituent(s) shall be readily visible and the type or class or multi-class group of grain and the constituent(s) selected shall be clearly and definitely identified in letters (such as HRWW, HRSW, WHEAT, etc., or PROT, etc.). A symbol to identify the display of the type or class or multi-class group of grain and constituent(s) selected is permitted provided that it is clearly defined adjacent to the display. Minimum acceptable abbreviations are listed in Table S.1.2. Grain Types and Multi-Class Groups Considered for Type Evaluation and Calibration and Their Minimum Acceptable Abbreviations.*
*[Nonretroactive as of January 1, 2003]*

*If more than one calibration is included for a given grain type, the calibrations must be clearly distinguished from one another.*
*[Nonretroactive as of January 1, 2004]*

(Amended 2003 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* |
|---|---|---|
| *Barley* | *Two-Rowed Barley* | *TRB* |
| | *Six-Rowed Barley* | *SRB* |
| | *All-Class Barley** | *BARLEY* |
| *Corn* | --- | *CORN* |
| *Soybeans* | --- | *SOYB* |
| *Wheat* | *All-Class Wheat** | *WHEAT* |
| | *Durum Wheat* | *DURW* |
| | *Hard Red Spring Wheat* | *HRSW* |
| | *Hard Red Winter Wheat* | *HRWW* |
| | *Hard White Wheat* | *HDWW* |
| | *Soft Red Winter Wheat* | *SRWW* |
| | *Soft White Wheat* | *SWW* |
| | *Wheat Excluding Durum** | *WHTEXDUR* |

[Note: Grain Types marked with an asterisk (*) are "Multi-Class Calibrations"]
*[Nonretroactive as of January 1, 2003]*

(Table Amended 2001 and 2007)

***S.1.3. Operating Range.*** *– An analyzer shall automatically and clearly indicate when the operating range of the device has been exceeded. The statement of the operating range shall be specified in the operator's manual and shall operate as follows:*

*(a) The ambient temperature range over which the analyzer 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 constituent value may be displayed when the temperature range is exceeded. An appropriate error message shall be displayed when the temperature of the analyzer is outside its specified operating range.*

*(b) The constituent range at the moisture basis specified in Table N.1.1. Constant Moisture Basis for Type Evaluation and Field Inspections shall be specified for each grain or seed for which the analyzer is to be used. A constituent value may be displayed when the constituent range is exceeded if accompanied by a clear indication that the constituent range has been exceeded.*

(Amended 2001)

*(c) For whole grain analyzers only, the temperature range shall be specified for each grain or seed for which an analyzer is to be used. The minimum temperature range for each grain shall be 10 °C to 30 °C. No constituent 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 temperature range for the grain. The requirements of this subsection (c) are not applicable to ground grain analyzers.*

*(d) For whole grain analyzers, the maximum allowable difference in temperature between the instrument environment (ambient temperature) and the sample for which an accurate constituent determination can be made shall be specified. The minimum temperature range shall cover at least 10 °C. No constituent value may be displayed when the maximum allowable temperature difference is exceeded. An appropriate error message shall be displayed when the difference between the ambient temperature*

*and the sample temperature exceeds the specified difference. The requirements of this subsection (d) are not applicable to ground grain analyzers.*
*[Nonretroactive and effective as of January 1, 2003]*

***S.1.4. Operating Temperature.***

*(a) An analyzer shall not display or record any usable values until the internal operating temperature necessary to meet tolerance requirements has been attained, or the analyzer shall bear a conspicuous statement adjacent to the indication stating that the analyzer shall be turned on for a time period specified by the manufacturer prior to use.*

*(b) If an instrument does not meet tolerance requirements because there is an upper internal operating temperature limit that could be exceeded when operating within the ambient temperature range specified by the manufacturer, then a means of sensing and indicating an over-temperature condition must be provided.*
*[Nonretroactive as of January 1, 2003]*

***S.1.5. Value of Smallest Unit.*** *– The display shall permit constituent value determination to both 0.01 % and 0.1 % resolution. The 0.1 % resolution is for commercial transactions; the 0.01 % resolution is for calibration purposes only, not for commercial purposes.*
*[Nonretroactive as of January 1, 2003]*

**S.2. Design of NIR Analyzers.**

***S.2.1. Minimum Sample Size.*** *– Analyzers shall be designed to measure constituent values of representative size grain samples. The minimum allowable sample size used in analysis shall be 20 g.*
*[Nonretroactive as of January 1, 2003]*

**S.2.2. Electric Power Supply.**

***S.2.2.1. Power Supply, Voltage and Frequency.*** *– An analyzer that operates using alternating current must perform within tolerance requirements over the line voltage range 100 V to 130 V and over the frequency range of 59.5 Hz to 60.5 Hz.*
*[Nonretroactive as of January 1, 2003]*

***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.*
*[Nonretroactive as of January 1, 2003]*

***S.2.3. Level Indicating Means.*** *– Analyzers shall be equipped with a level indicator and leveling adjustments if its performance is changed by an amount greater than the tolerance requirement when the instrument is moved from a level position into 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 instrument parts requiring a tool.*
*[Nonretroactive as of January 1, 2003]*

***S.2.4. Environmental Conditions.*** *– Instrument optics and electronics must be protected from exposure to dust by either sealing these areas or by protecting them with a dust filtration system suitable for the removal of air-borne grain dust.*
*[Nonretroactive as of January 1, 2003]*

**S.2.5. Calibration Transfer and Verification.**

***S.2.5.1. Calibration Transfer.*** *– The instrument hardware/software design and calibration procedures shall permit calibration development and the mathematical transfer of calibrations between instruments of like models.*

***Note:*** *Only the manufacturer or the manufacturer's designated service agency may make calibration transfer or slope adjustments on near-infrared grain analyzers and, except for instrument failure and repair, only during a prescribed period of time during the year. This does not preclude the possibility of the operator installing the manufacturer-specified calibration constants or standardization parameters under the instructions of the manufacturer or the manufacturer's designated service agency. Nor does it preclude operator bias adjustments when made under the conditions specified in UR.2.8. Slope and Bias Adjustments.*
*[Nonretroactive and effective as of January 1, 2003]*

(Note added 1995) (Amended 1995)

***S.2.5.2. Calibration Version. –*** *An instrument 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 constituent determinations, and that the appropriate instrument settings have been made for the calibration being used.*
*[Nonretroactive as of January 1, 2003]*

(Amended 2001)

***S.2.5.3. Calibration Corruption.*** *– If calibration constants are digitally stored in an electronically alterable form, the analyzer 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.*
*[Nonretroactive as of January 1, 2003]*.

***S.2.6. Provision for Sealing.*** *– 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 1000 records are required. (**Note:** Does not require 1000 changes to be stored for each parameter.)*
*[Nonretroactive as of January 1, 2003]*

(Amended 1997)

***S.3. Accessory Equipment.*** *– When the operating instructions for an NIR analyzer require accessory equipment separate from and external to the analyzer, such equipment shall be appropriate and complete for the measurement.*
*[Nonretroactive as of January 1, 2003]*

***S.3.1. Grinders.*** *– The make and model of grinder used for ground grain NIR analyzers must be specified by the manufacturer and required as auxiliary equipment in the determination of constituent values for applicable grain types.*
*[Nonretroactive as of January 1, 2003]*

***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 constituent value. Operating instructions shall include the following information:*

*(a) name and address or trademark of the manufacturer;*

*(b) the type or design of the device for which the operating instructions are intended to be used;*

*(c) date of issue;*

*(d) the kind or classes of grain or seed for which the device is designed to measure constituent values; and*

*(e) the limitations of use, including but not limited to constituent range, grain or seed temperature, kind or class of grain or seed, instrument temperature, voltage and frequency ranges, electromagnetic interferences, and necessary accessory equipment.*

*[Nonretroactive as of January 1, 2003]*

## N. Notes

### N.1. Testing Procedures.

**N.1.1. Field Inspection.** – Whole grain samples shall be used as the official field inspection standards. Five samples per grain type or class shall be used to check instrument performance. Each sample will be analyzed once. One of the samples will be analyzed an additional four times to test instrument repeatability. For ground grain instruments, the ground sample will be repacked four times. A new grind is not required. Test results must be converted to the standard moisture bases shown in Table N.1.1. Constant Moisture Basis for Type Evaluation and Field Inspection before applying the tolerances of Table T.2. Acceptance and Maintenance Tolerances for NIR Grain Analyzers. Test results on whole grain analyzers that produce results on an "as is" basis without displaying or recording a moisture value shall be converted to the standard moisture bases shown in Table N.1.1. Constant Moisture Basis for Type Evaluation and Field Inspection using sample moisture values determined with the facility's moisture meter (which must be certified for commercial use).

(Amended 2001)

***Table N.1.1.***
***Constant Moisture Basis for Type Evaluation and Field Inspection***

| *Grain Type or Class* | *Constituents(s)* | *Moisture Basis* |
|---|---|---|
| *Durum Wheat, Hard Red Spring Wheat, Hard Red Winter Wheat, Hard White Wheat, Soft Red Winter Wheat, Soft White Wheat* | *Protein* | *12 %* |
| *Soybeans* | *Protein*<br>*Oil* | *13 %* |
| *Two-rowed Barley*<br>*Six-rowed Barley* | *Protein* | *0 % (dry basis)* |
| *Corn* | *Protein*<br>*Oil*<br>*Starch* | *0 % (dry basis)* |

*[Nonretroactive as of January 1, 2003]*

(Table Added 2001)

Constituent values shall be assigned to test samples by the Grain Inspection, Packers and Stockyards Administration (GIPSA). Tolerances shall be applied to individual sample measurements, the average of individual measurements on each of the five test samples, and the maximum difference (range) in results for five analyses on one of the test samples.

(Amended 2001)

**N.1.2. Standard Reference Samples.** – Reference samples used for field inspection purposes shall be clean and selected to reasonably represent the constituent range. These samples shall be selected such that the difference between constituent values obtained using the GIPSA standard reference method and an official GIPSA NIR grain analyzer does not exceed one-half of the acceptance tolerance shown in Table T.2. Acceptance and Maintenance Tolerances for NIR Grain Analyzers for individual test samples or 0.375 times the acceptance tolerance shown for the average of five samples.

(Amended 2001and 2003)

## T. Tolerances

**T.1. To Underregistration and to Overregistration.** – The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration and shall be based on constituent values expressed at the moisture bases shown in Table N.1.1. Constant Moisture Basis for Type Evaluation and Field Inspection.

(Amended 2001)

**T.2. Tolerance Values.** – Acceptance and maintenance tolerances shall be equal. Tolerances for individual samples and the average for five samples are as shown in Table T.2. Acceptance and Maintenance Tolerances for NIR Grain Analyzers.

**Table T.2.**
**Acceptance and Maintenance Tolerances for NIR Grain Analyzers**

| Type or Class of Grain | Constituent | Individual Samples (percent) | Average for Five Samples (percent) | Range for Five Retests (percent) |
|---|---|---|---|---|
| Durum Wheat, Hard Red Spring Wheat, Hard Red Winter Wheat, Hard White Wheat, Soft Red Winter Wheat, Soft White Wheat | protein | 0.60 | 0.40 | 0.40 |
| Soybeans | protein | 0.80 | 0.60 | 0.60 |
| | oil | 0.70 | 0.50 | 0.50 |
| Two-rowed Barley Six-rowed Barley | protein | 0.70 | 0.50 | 0.50 |
| Corn | protein | 0.80 | 0.60 | 0.60 |
| | oil | 0.70 | 0.50 | 0.50 |
| | starch | 1.00 | 0.80 | 0.80 |

(Amended 2001)

## UR. User Requirements

**UR.1. Installation Requirements.** – The NIR analyzer shall be installed in an environment within the range of temperature and/or other environmental factors specified in the operating manual.

**UR.2. User Requirements.**

**UR.2.1. Operating Instructions.** – The operating instructions for the NIR analyzer 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 if any are required to obtain constituent values, and the type or class of grain to be measured with the NIR analyzer. If an NIR analyzer has the capability, the user is permitted to select the moisture basis to be used on any measurement.

(Amended 2001)

**UR.2.2. Other Devices Not Used for Commercial Measurement.** – If there are other NIR analyzers 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.2.3. Printed Tickets.**

*(a) Printed tickets shall be free from any previous indication of constituent or grain type selected. The printed ticket shall indicate constituent values and the moisture basis associated with each constituent value (except moisture). If the analyzer is calibrated to display results on an "as is" moisture basis and does NOT display or record a moisture value, the ticket must clearly indicate that results are expressed on an "as is" moisture basis.*

(Amended 2001)

*(b) The customer shall be given a printed ticket showing the date, grain type or class, constituent results, and calibration version identification. If the analyzer converts constituent results to a manually entered moisture basis, the "native" concentration and the "native" moisture basis must appear on the printed ticket in addition to the converted results and the manually entered moisture basis. If the manually entered moisture basis is intended to be the moisture value for an "as is" constituent concentration measurement, that moisture value must have been obtained on the same sample and must have been measured on a moisture meter certified for commercial use. The information presented on the ticket shall be arranged in a consistent and unambiguous manner. The ticket shall be generated by the near-infrared grain analyzer system.*

*[Nonretroactive as of January 1, 2003]*

(Amended 2001)

**UR.2.4. Grinders.** – Place grinders in a separate room from the NIR analyzer to avoid instrument contamination. If a separate room is not available, the grinder may be in the same room with the NIR analyzer provided the grinder is not placed within one meter of the air intake on the NIR.

**UR.2.5. Sampling.** – Samples 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 sample shall be taken such that it is representative of the lot. If an NIR analyzer permits user entry of the moisture value for an "as is" constituent measurement, that moisture value must have been obtained on the same sample and must have been measured on a moisture meter certified for commercial use.

(Amended 2001)

**UR.2.6. Level Condition.** – If equipped with a level indicator, an analyzer shall be maintained in a level condition.

**UR.2.7. Operating Limitation.** – Constituent determinations shall not be made when the difference in temperatures between the grain sample and the instrument environment (ambient temperature) exceeds manufacturer recommendations.

**UR.2.8. Slope and Bias Adjustments.** – Bias changes shall be made only on the basis of tests run on a current set of Standard Reference Samples (SRS) traceable to GIPSA Master Instruments.[1] A written explanation and record of all calibration changes, including those changes made by a manufacturer or the manufacturer's designated service agency, shall be maintained. The log shall indicate the date and magnitude of changes in bias and slope constants and the instrument serial number. A Calibration Adjustment Data Sheet for each log entry shall be available for inspection upon request by the field inspector. Data Sheets shall be retained by the user for a period of no less than 18 months following any calibration adjustment. The Data Sheet must show: date of test and adjustment, serial number of the instrument, calibration identification, the nature of the adjustment, the unique identification number and source of sample sets used, and, for each sample in the set, reference values, initial instrument results (except in the cases of instrument failure and repair), and instrument results after calibration adjustment or instrument repair.

(Amended 1995)

[1] Established error must be known.