

2015 NIST EPO No. 16

Examination Procedure Outline for Automatic Bulk Weighing Systems

It is recommended that this outline be followed for automatic bulk weighing systems (ABWS's); that is, weighing systems adapted to the automatic weighing of a commodity in successive drafts of predetermined amounts automatically recording the no-load and loaded weight values and accumulating the net weight of each draft. Requirements that apply only to scales marked with an accuracy class are indicated with an asterisk. Nonretroactive requirements are followed by the applicable date in parentheses.

This outline is comprised of four separate parts plus three supplements. The title and a description of the information contained in each of those parts and supplements are as follows:

1. EPO No.16 Examination Procedure Outline for Automatic Bulk Weighing Systems – This document contains the outline of NIST Handbook 44 references for examining automatic bulk weighing systems.
2. EPO No. 16 Appendix A Description of Test Methods – This document describes three different test methods that may be used to conduct a performance test on an ABWS and provides guidance on which method to apply.
3. EPO No. 16 Appendix B High-Level Steps to Performing the Increasing-Load Test Using the Substitution or Alternative Substitution Test Method - This EPO recognizes two acceptable types of substitution test loads used in testing, those that are exact and those that are not. Appendix B describes the high level steps to performing the increasing load test on an ABWS using either type of substitution test loads.
 - a. EPO No. 16 Appendix B (Supplement 1) Applying the High-Level Steps of the Substitution and Alternative Substitution Test Method - This document is a supplement to Appendix B and provides detailed instructions on applying each of the high-level steps that are identified in that appendix.
 - b. EPO No. 16 Appendix B (Supplement 2) Determining Scale Error When Applying the Substitution Test Method – This document is also a supplement to Appendix B and further clarifies how scale error is determined from results obtained using exact substitution test loads. This supplement also provides an indication of how results of a test using exact substitution test loads may be recorded.
 - c. EPO No. 16 Appendix B (Supplement 3) Determining Scale Error When Applying the Alternative Substitution Test Method – This document is also a supplement to Appendix C and further clarifies how scale error is determined from results obtained during testing using substitution test loads that are not exact. This supplement also provides an indication of how results of a test using substitution test loads that are not exact may be recorded.
4. EPO No. 16 Appendix C Definitions – This document provides definitions of terms that have special meaning when used in any of the various parts of the EPO.

The Grain Inspection Packers and Stockyards Administration (GIPSA) is provided the authority to regulate ABWS's used in the official weighing of grain under Section 7B (a) of the United States Grain Standards Act (Act). When performing certification testing on equipment used in the official weighing of grain as provided under the Act, the most current version of the GIPSA Weighing Handbook should be consulted. The GIPSA Weighing Handbook can be obtained by contacting GIPSA using the following contact information:

GIPSA Administrator

Stop 3601, Room 2055-South Building
1400 Independence Avenue, SW
Washington, DC 20250-3601
(202) 720-0219
<http://www.gipsa.usda.gov>

Note that some of the test procedures outlined in the NIST EPO for ABWS's may differ significantly from those in the GIPSA Weighing Handbook. For this reason, when considering using any of the test procedures included in this EPO to perform an official examination of an ABWS as part of the GIPSA scale testing program, you might wish to consult GIPSA beforehand to confirm their acceptance of those procedures prior to using them.

SAFETY NOTES

When excerpting this Examination Procedure Outline for duplication, the EPO Safety Annex (Safety Considerations and Glossary of Safety Key Phrases) should be duplicated and included with this outline.

Safety policies and regulations vary among jurisdictions. It is essential that inspectors or servicepersons be aware of all safety regulations and policies in place at the inspection site and to practice their employer’s safety policies. The safety reminders included in this EPO contain general guidelines useful in alerting inspectors and servicepersons to the importance of taking adequate precautions to avoid personal injury. These guidelines can only be effective in improving safety when coupled with training in hazard recognition and control.

Prior to beginning any inspection, the inspector should read and be familiar with the EPO Safety Annex - “Safety Considerations and Glossary of Safety Key Phrases.” The terms and key phrases in each safety reminder of this outline are found in the glossary of the EPO Safety Annex. The inspector is reminded of the importance of evaluating potential safety hazards prior to an inspection and taking adequate precautions to avoid personal injury or damage to the device. As a minimum, the following safety precautions should be noted and followed during the inspection.

Electrical Hazards

Personal Protection Equipment

First Aid Kit

e.g., Safety Shoes

Lifting

Support – for Scale and Test weights

Location

Transportation of Equipment

also:

Wet and Slick Conditions

Chemicals, Petroleum Products and

Hazardous Materials

Obstructions

Inspection:

SAFETY REMINDER!!!

- Check the inspection site carefully for safety hazards and take appropriate precautions.
- Learn the nature of hazardous products used at or near the inspection site.
- Use personal protection equipment appropriate for the inspection site.
- Be sure that a first aid kit is available and that the kit is appropriate for the type of inspection activity

**H-44 General Code and
ABWS Code References**

1. Accessibility for inspection, testing, and sealing..... G-UR.2.3.
2. Zero or no-load reference indication S.1.1., S.1.1.1., G-S.5.2.2.(d)
(1/1/86)

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Zero-load adjustment.....	S.2.1. ¹
Manual zero-setting mechanism.....	S.2.1.1.
Semiautomatic zero-setting mechanism.....	S.2.1.2.
3. General Considerations	
Selection of equipment.....	G-UR.1.1., G-UR.1.2.
Number of scale divisions (n) - systems used to weigh grain	UR.1.1 (1/1/84)
Number of scale divisions (n) - systems used to weigh commodities other than grain	UR.1.2. (1/1/87)
Installation.....	G-UR.2.1.
Obstructions between indicating/recording element and weighing element ...	G-UR.2.2.
Protection from environmental factors.....	UR.2.1.
Foundation, supports, and clearance	UR.2.2.
Weighing sequence	S.1.4.
Recording sequence.....	S.1.5.
Provisions for sealing	G-S.8. (1/1/90), G-UR.4.5., S.1.6.
Verification (testing) standards	N.2.
4. Marking	
a) General Code marking requirements – applicable to all equipment except as noted in G-S.1.	
Identification	G-S.1.
Name, initials, or trademark of manufacturer or distributor	Retroactive
Model identifier	Retroactive
Model identifier prefix.....	(1/1/03)
Acceptable abbreviations for “model” and “number”	(1/1/03)
Nonrepetitive serial number.....	(1/1/68)
Serial number prefix	(1/1/86)
Acceptable abbreviations for “serial” and “number”	(1/1/01)
Current software version or revision identifier (for not-built-for-purpose, software based devices)	(1/1/04)
Version or revision identifier preface and acceptable abbreviations for the “version”, “revision”, and “number”	(1/1/07)
NTEP CC number or CC addendum number and prefix (for devices that have an NTEP CC)	(1/1/03)
Location of marking information for not built-for-purpose, software-based devices	G-S.1.1. (1/1/04)
Remanufacturer information, as appropriate	G-S.1.2.
Name, initials, or trademark of the last remanufacturer or distributor	(1/1/02)
Model designation if different from original model designation.....	(1/1/02)
Lettering.....	G-S.7.
Operational controls, indications, and features	G-S.6.(1/1/77)
Visibility of identification.....	G-UR.2.1.1.
Interchange or reversal of parts.....	G-S.4.

Inspection (cont.):

b) ABWS Code marking requirements - (in addition to General Code marking requirements)	
Capacity and value of the scale division.....	S.5.1.
Temperature limits (unless the temperature range is -10 °C to 40 °C (14 °F to 104 °F)	S.5.3 (1/1/86)
Accuracy class ²	S.5.4. (1/1/86)

¹ An automatic zero-setting mechanism is a prohibited feature on an automatic bulk weighing system.

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weighing elementsS.5.2.

In addition to the marking requirements outlined in 4 a) and 4 b) of this EPO, the main elements (i.e., the indicating element, weighing element, and load cells) of an ABWS, when not contained in a single enclosure for the entire scale, shall be marked in accordance with Scales Code Table S.6.3.a and explained in the accompanying notes S.6.3.b. except when such marking conflicts with that required by the ABWS Code. In all cases of conflict, the marking requirements contained in the ABWS Code, which are outlined in their entirety in 4 b) of this EPO, supersede those in the Scales Code. The Scales Code marking requirements applicable to the separable main elements of a scale are outlined in c) through e) below.

H-44 Scales Code References (Required Markings for Separable Main Elements)

- c) Scales Code marking requirements – applicable to indicating element not permanently attached to weighing and load-receiving element or covered by a separate CC Table S.6.3.a.
 - Accuracy Class (1/1/86)
 - Nominal Capacity Retroactive
 - Value of Scale Division (1/1/83)
 - Value of the verification scale division (e) if different than the value of the scale division (d)..... (1/1/86)
 - Special application..... (1/1/86)
 - Maximum number of scale divisions (n_{max}) (1/1/88)
- d) Scales Code marking requirements – applicable to weighing and load-receiving element not permanently attached to an indicating element or covered by a separate CC Table S.6.3.a.
 - Accuracy class (1/1/88)
 - Nominal capacity Retroactive
 - Temperature limits (if range on the NTEP CC is narrower than and within -10 °C to 40 °C (14 °F to 104 °F) (1/1/86)
 - Special application..... (1/1/86)
 - Maximum number of scale divisions (n_{max})..... (1/1/88)
 - Minimum verification scale division for which device complies with the requirements (e_{min} or d)..... (1/1/88)
- e) Scales Code marking requirements – applicable to load cell with Certificate of Conformance..... Table S.6.3.a.

Note: Requires information on a data plate attached to the load cell or in an accompanying document. If a document is provided, the serial number shall appear on the load cell and in the document (1/1/88)

 - Manufacturer’s name or trademark, model designation, and identifying symbols for the model and serial numbers as required by paragraph G-S.1. shall also be marked on both the load cell and in any accompanying documents..... (1/1/91)
 - Accuracy class (1/1/88)

Inspection (cont.):

- Temperature limits (if range on the NTEP CC is narrower than and within -10 °C to 40 °C (14 °F to 104 °F) (1/1/86)
- “S” or “M” for single or multiple cell applications (1/1/88)
- Direction of loading, if not obvious..... (1/1/88)
- Minimum dead load, maximum capacity, safe load limit, and load cell

² Systems manufactured as of January 1, 1986 that are used to weigh grain shall be marked Class III. Systems used to weigh materials other than grain manufactured as of January 1, 1986 are permitted to be marked either Class III or Class III L.

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verification interval, v_{\min} (1/1/88)

H-44 General Code and ABWS Code References

5. Indicating and Recording Elements
 - Appropriateness of design G-S.5., (except G-S.5.2.1.)
 - Value of the scale division (d) S.1.2. (1/1/86)
 - Digital rounding G-S.5.2.2.(c)
6. Weighing Elements
 - Antifriction S.4.1.
 - Adjustable components S.4.2.
 - Multiple load-receiving elements S.4.3.
 - Venting S.4.4.
7. Interlocks and Gate Control
 - Interlocks S.3.2.
 - Overfill Sensor S.3.3. (a)
 - Systems equipped with a lower garner or surge bin S.3.3. (b) (1/1/98)
 - Gate position S.3.1.
8. Maintenance, Use, and Environmental Factors
 - Facilitation of fraud G-S.2.
 - Operation G-UR.3.1.
 - Position of equipment G-UR.3.3.
 - Maintenance of equipment G-UR.4.1.
 - Abnormal performance G-UR.4.2.
 - Use of adjustments G-UR.4.3.
 - Loading requirements
 - Minimum draft (systems used to weigh grain) UR.3.1.
 - Minimum draft (systems used to weigh commodities other than grain) UR.3.2. (1/1/87)
 - System modification UR.4.
9. Assistance in testing G-UR.4.4.

Pretest Determinations

Each application of an ABWS is unique with its own special capacity requirements, location specifications, types of material handled, environmental conditions, etc. Consequently, each ABWS is usually custom-designed to some extent by the manufacturer to conform to a purchaser’s particular application, thus, resulting in each installation being somewhat different from the next. The variations in design present some obstacles to overcome by those responsible for testing these devices. Most ABWS’s require the use of special equipment and the need for special assistance in order to conduct a performance test. An on-site visit prior to scheduling an official test of an ABWS is recommended in order to determine the best means of conducting the test, verifying the availability of any special equipment that might be needed for testing, and make known to the owner or operator any special assistance that will likely be needed on the scheduled date of test.

- 1. Select the appropriate test method to apply when conducting the increasing-load test after reviewing the various test method descriptions outlined in Appendix A of this EPON.1.2.

Automatic bulk weighing systems shall be tested to at least used capacity, (i.e. the maximum single-draft load weighed during commercial operation) by performing an increasing-load test using a combination of test weights and bulk material.³ For initial verifications, it is recommended that ABWS’s be tested to scale capacity providing it is practical and safe to do so.

If substitution or strain-load tests are to be performed, verify there is a sufficient amount of bulk material available on site to enable testing to the desired test-load amount.

- 2. Minimum test weightsN.1.1.

To minimize uncertainty in the test results, it is recommended that a greater amount of test weights than the minimum required by ABWS Code paragraph N.1.1. be used during testing providing they are available and can be applied safely to the load-receiving element in a manner that does not produce binding or off-center loading.⁴ Ideally, when the increasing-load test is to be performed using substitution or strain-load test methods, test weights in amount of at least 25% of scale capacity should be used. Thus, when applying the substitution test method, not more than 3 substitutions plus the addition of the test weights will be needed to achieve a maximum test load equal to scale capacity. For strain-load tests, use of the additional test weights (i.e., in an amount totaling at least 25% of scale capacity) provides necessary verification over a sufficient weighing range of the scale to assure that any errors revealed during testing reflect inaccuracy in the performance of the scale.

For additional information on substitution and strain-load testing, refer to Appendix A and Appendix B of this EPO.

Pretest Determinations (cont.):

³ Although not mentioned in paragraph N.1.2. of the ABWS Code, test weight alone may also be used to perform the increasing-load test (i.e., providing it can be applied safely and distributed evenly onto the weighing element) and provides the least amount of uncertainty in test results.

⁴ The performance test of an ABWS to used capacity (or scale capacity, as the case may be) commonly involves the use of one or more substitution test loads and/or strain-loads. Several factors limit the accuracy of many repeated substitution or strain-load tests. Some of these factors are creep, change in zero balance, environmental conditions that might exist during testing, etc. Using a greater amount of test weight than the minimum required reduces the number of substitution test loads and/or strain loads necessary to achieve maximum test load and also reduces the amount of uncertainty in test results.

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3. Verify the availability of any special equipment or accessories that will be needed to perform the test. If hooks, chains, cables, etc. are to be used to suspend test weights from the load-receiving element, ensure that such equipment is of sufficient strength to safely withstand the force of all loads to be applied during testing and that the position of such equipment after attachment facilitates the even distribution of test weights to be applied. G-UR.4.4.
4. Tolerance application T.1.
 - Acceptance/maintenance G-T.1., G-T.2.
 - Errors of underregistration and overregistration..... G-T.3., T.1.1.
 - Intermediate values G-T.4.
 - Increasing-load tests T.1.2.
 - o For substitution tests, tolerances apply equally to the substitution test load and test weights
 - o For strain-load tests, tolerances apply only to the test weights or substitution test loads
 - Decreasing-load tests (required on devices used to weigh out)..... T.1.3.
5. Tolerance values
 - Tests involving digital indications or representations T.1.4.
 - Minimum tolerance T.2.
 - Minimum tolerance for systems used to weigh construction materials..... T.2.1.
 - Basic acceptance tolerance T.3.1.
 - Basic maintenance tolerance
 - Systems used to weigh grain T.3.2.
 - Systems used to weigh commodities other than grain..... T.3.3.
 - Repeatability..... T.5.
6. Verify that the system operator has a clear indication of the position of the gates leading directly to and from the weigh hopper S.3.1.
7. Discrimination – digital automatic indicating scales T.6.
8. Perform a visual inspection of the weighing and load-receiving element:
 - a) Verify that the lever system or load cells, the load-receiving element, and any permanently installed test weights are adequately protected from environmental factors, such as wind, weather, and RFI. If permanently installed test weights are available, confirm they are being properly maintained, are of suitable condition for use in testing (e.g., clean, free of a significant amount of surface rust, etc.) and that the date of last certification complies with any jurisdictional policy concerning certification frequency, if one exists UR.2.1.
 - b) Confirm there is adequate clearance provided around all live parts to the extent that no contacts may result before or during operation of the system. If the load-receiving element is a hopper, pay particular attention to the clearance around the hopper and any fill, vent, or discharge mechanism(s) or any housing surrounding the hopper, if the hopper is enclosed. Also, confirm that any accessory equipment, whether permanently or temporarily installed, is positioned correctly and fastened securely such that the position of the equipment cannot shift to the extent that contacts may result before or during operation of the system. UR.2.2.

Pretest Determinations (cont.):

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- c) Verify the relationship of the load cell verification interval value to the value of the scale division Scales Code References S.5.4. (1/1/94) and T.N. 8.1*

The value of v_{\min} marked on the load cell(s) is used to determine compliance with T.N.8.1. of the Scales Code. To be considered compliant, the value of v_{\min} marked on the load cell must be less than or equal to the value of the scale division (d) divided by the square root of the number of load cells used in the scale (for full electronic scales). For scales with lever systems v_{\min} must be less than or equal to the value of (d) divided by the square root of the number of load cells used in the system times the value of the scale multiple. The formulas for both full electronic scales and those with lever systems may be stated as follows:

a)
$$v_{\min} \leq \frac{d}{\sqrt{N}} \text{ for full electronic scales}$$

b)
$$v_{\min} \leq \frac{d}{\sqrt{N}x \text{ (scale multiple)}} \text{ for scales with a lever system}$$

9. Verify that the weighing system is equipped with adequate venting and if venting exhausts to the outside atmosphere ensure there are no obstructions in the vent ducts or their protective covers or screens which could restrict air flow. If venting is facilitated by air aspiration, open an inspection door, if possible, to verify movement of air (suction or exhaust) with system in operation.....S.4.4.
10. Inspect several recently completed scale tickets, including tickets completed at different dates and by different device users, if possible. Verify each of the following:
- each recorded gross weight value (except the final partial draft) on a ticket, representing the gross weight of a single draft load, exceeds the minimum permissible draft size.
 - Minimum draft size (systems used to weigh grain) UR.3.1.
 - Minimum draft size (systems used to weigh commodities other than grain)..... UR.3.2. (01/01/87)
 - all values recorded are properly identified (e.g., gross, tare, net, lb, kg, etc),
 - Values defined G-S.5.2.4., G-S.5.2.5.
 - the total weight recorded on each ticket representing the entire bulk load is equal to the result of subtracting the sum of all corresponding individual draft tare values from the sum of all the individual draft gross weights that are recorded on the same ticket for same complete bulk load.
 - Indicating and recording elements (General) G-S.5.1

Test Notes

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1. Verify correct weighing and recording sequence S.1.4.
 - If the system is used to receive (weigh in), the no-load reference value shall be determined and recorded only at the beginning of each weighing cycle.
 - If the system is used to deliver (weigh out), the no-load reference value shall be determined and recorded only at the end of each weighing cycle.
2. Observe the automatic operation of the device and verify that at the start and end of each weigh cycle in automatic mode, tare and gross weight values are displayed until such time that each is recorded. S.1.5.
3. Verify that an interlock provides for each of the following (if practical):..... S.3.2.
 - Product cannot be cycled and weighed if the recording element is disconnected or subjected to a power loss.
 - The recording element cannot print a weight if either of the gates leading directly to or from the weigh hopper is open.
 - A “low paper” sensor, when provided, is activated.
 - The system operates only in the proper sequence in all modes of operation.
 - When an overflow alarm is activated, the system indicates and records an overflow condition.
4. Verify the weigh hopper is equipped with an overflow sensor, which when activated, causes each of the following to occur: S.3.3.(a)
 - The feed gate to close
 - An alarm to activate
 - Weighing to be inhibited until the overflow condition has been corrected
5. If system is equipped with a lower garner or surge bin, verify that it too is equipped with an overflow sensor, which when activated, causes each of the following to occur: S.3.3.(b) (01/01/98)
 - The gate of the weigh hopper to remain open
 - An alarm to activate
 - Weighing to be inhibited until the overflow condition has been corrected
6. Check repeatability of, and agreement between, indications throughout test..... G-S.5.2.2.(a), G-S.5.2.2.(b), G-S.5.4.
7. Print a ticket at each test load comparing the value indicated with the value recorded. G-S.5.2.2.
8. Recheck zero-load balance or no-load reference each time test load is removed..... N.1.4.
9. Verify the effectiveness of motion detect
 - a. Semi-automatic zero setting mechanism (if so equipped)..... S.2.1.2.
 - b. Recording element S.2.2.

Note: Indications should not oscillate significantly or update slowly to the extent that erroneous values can be recorded by the printer during any weighing operation.

Test

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1. Discrimination test at zero load (to be performed when results will not be affected by environmental conditions) N.1.5. (01/01/86)
2. Increasing-load test (apply multiple test loads to achieve a maximum test load equal to at least used capacity of the system using the appropriate test method that was selected from the “Pretest” section of this EPO N.1.1., N.1.2.

Note: To reduce the amount of uncertainty in test results, error weights denominated in 0.1 d must be used whenever the increasing-load test is performed using substitution or strain-load test methods on an ABWS with digital indication. Detailed instructions on using error weights to perform the increasing load test using substitution or strain-load test methods are located in Appendix B of this EPO.

3. Discrimination test at maximum test load (to be performed when results will not be affected by environmental conditions) N.1.5. (01/01/86)
3. Over-capacity test (if practical) S.1.3.
4. Decreasing-load test (systems used to weigh-out)..... N.1.3.
5. Zero balance or no-load reference value change N.1.4.