

EPO No. 16

Appendix A

Description of Test Methods

The Automatic Bulk Weighing Systems (ABWS) code of NIST Handbook 44 requires an increasing-load test to be performed up to the used capacity of the weighing system. It also requires the test be performed using test weights equal to at least 10 percent of the capacity of the system:

- on any automatic bulk-weighing systems installed after January 1, 1984 that's used to weigh grain, and
- all automatic bulk weighing systems installed after January 1, 1986, regardless of the type of product weighed.

Considering that only 10 percent of the capacity of a system in test weight is required and that most systems are typically used to weigh much heavier loads than the amount equivalent to 10 percent of system capacity, the typical increasing-load test performed on an ABWS usually necessitates the use of substitution and/or strain loads to achieve the required maximum test load amount specified. This is not to infer that substitution and/or strain loads are required to enable a proper test of an ABWS, but rather, they are usually necessary in order to achieve the required maximum test load, especially when performing the test using the least amount of test weight required.

As a general rule, it is recommended that the performance test of an ABWS be performed using as much test weight as can safely be applied onto or suspended beneath the load-receiving element of the scale in a manner that does not produce binding or off-center loading or necessitates an abnormal amount of labor. There are a number of significant benefits to using more test weight than the minimum amount required to include:

- faster completion of a test,
- a reduced amount of uncertainty in the test results,
- a reduction in labor associated with testing because fewer substitution test loads and strain loads will be needed, etc.

Recognizing that in some instances it may not be possible to safely apply more test weight than the required minimum amount specified; any one of the following three methods may be used to perform an increasing-load test on an ABWS:

- 1) ***Increasing-Load Test Using Only Test Weight***
- 2) ***Increasing-Load Test Using A Combination of Test Weight, Substitution Test Loads, and if needed, One or More Strain Loads***
- 3) ***Increasing-Load Test Using A Combination of Test Weight and One or More Strain Loads***

Proper selection of the best method to use for testing is dependent upon the amount of test weight available, the ease with which available test weight can be safely and properly applied to the load-receiving element of the scale, and whether substitution testing is appropriate. For substitution testing to be appropriate, the system operator must be able to control the loading of product onto the load-receiving element of the scale to the extent that substitution test loads may be created using bulk material entirely or a combination of bulk material and trim weights.¹

Thus, the determination of whether or not substitution testing is appropriate is dependent upon how closely an operator is able to duplicate the indication of the test load using bulk material as a substitute. This determination shall be made on a case by case basis by the official conducting the test.

A brief description of each test method is included below and intended to serve as a guide for selecting the most appropriate method for testing automatic bulk weighing systems. Some procedures referenced in the descriptions are more fully explained in other appendices included with this EPO. Those appendices should be consulted when performing those procedures to ensure proper application.

Method 1: Increasing-load Test Using Only Test Weight: *This test method should be used whenever test weight in an amount equal to the maximum test load desired for a complete test (i.e., typically to scale capacity or used capacity) is available and can be safely applied onto or suspended beneath the load-receiving element of the scale in a manner that does not produce binding or off-center loading nor necessitate an abnormal amount of labor.*

Test at multiple points from zero-load to at least used capacity, including at least one point in each 1/3rd capacity range of the system. If preset values have been programmed into the system to control the amount of product comprised of an individual draft load for one or more commodities typically weighed, include a test at the lowest preset value or at least one point below and as close as practical to the lowest preset value and a test at the highest preset value or at least one point above and as close as practical to the highest preset value. If only one preset value has been programmed, test at that preset value or at least one point above and as close as practical to that value.

¹ When creating any new substitution test load from bulk material that has been loaded onto the load-receiving element of a scale, small amounts of weight, known as “trim weights,” sometimes need to be applied to increase the weight of the substitution test load being created so that its displayed indication either:

- matches that of the previous test load for which it is intended to substitute, if using exact substitutions, or
- brought to within 5 divisions less than the indicated weight of the previous test load for which it is intended to substitute, if not using exact substitutions.

The use of exact substitutions and substitutions that are not exact during testing are fully explained in Appendix B of this EPO and its supplements.

Method 2: Increasing-load Test Using a Combination of Test Weight, Substitution Test Loads, and One or More Strain Loads (If Needed): *This test method should be used in all instances in which the total value of the test weights to be applied during testing is less than the maximum test load desired for a complete test (i.e., typically to scale capacity or used capacity) and it has been determined that substitution testing can be performed. When using this test method, error weights must be used to:*

- *establish a starting reference at no load and at each of the starting references from which test weights are applied to substituted material (and strain loads, if used during testing),*
- *determine the precise amount of error at all applied test loads, and*
- *determine the amount of any no-load change once all test loads have been removed from the load-receiving element of the scale.*

All test weights and test loads applied during testing shall be distributed equally onto or suspended from the load-receiving element in a manner that does not produce binding or off-center loading.

Test at multiple points from zero-load to at least used capacity, including not less than one point in each 1/3rd capacity range of the system using test loads consisting of test weight and a combination of test weight and substituted bulk material. If preset values have been programmed into the system to control the amount of product comprised of an individual draft load for one or more commodities typically weighed, include a test at the lowest preset value or at least one point below and as close as practical to the lowest preset value and a test at the highest preset value or at least one point above and as close as practical to the highest preset value. If only one preset value has been programmed, test at that preset value or at least one point above and as close as practical to that preset value.

Note: This EPO recognizes two types of acceptable substitution test loads; those that are exact (which are used with the test method referred to in this EPO as the “Substitution Test Method”) and those that are not (which are used with the test method referred to in this EPO as the “Alternative Substitution Test Method”). Both types are described more fully in Appendix B of this EPO and its supplements.

In consideration of both types, in order to qualify as a substitution test load, the weight of the load created for substitution must either:

- precisely match the weight of the test load for which it is intended to substitute (for exact substitution test loads), or
- weigh slightly less (i.e., weigh not more than 5 divisions less) than the indicated value of the test load for which it is intended to substitute after any trim weights have been applied (for substitution test loads that are not exact).

The procedures used to create each type of substitution test load during testing are

somewhat different as are the test procedures to be applied when using them to conduct an increasing-load test. One significant difference in the two types of substitution test methods is the means by which scale error is determined (or measured). For example:

- When using exact substitution test loads (substitution test method), scale error is determined for a series of test loads applied in an increasing manner from the same starting reference. No more than three substitution test loads may be developed from a particular starting reference in order to minimize the effect of scale creep (or drift), which can result when applied loads are left remaining on a scale for long periods of time; in this case, the time required to develop the substitution test loads and perform the tests. Consequently, depending upon the amount of test weight available for testing, it is sometimes necessary to use one or more strain loads to be able to verify performance of a scale in its upper weighing range, e.g., in its range of use, nominal scale capacity, etc.
- When using substitution test loads that are not exact (alternative test method), each substitution test load becomes the starting reference for the next applied test weight load. Thus, scale error is determined (or measured) from a new starting reference each time the test weight is applied (i.e., for each segment of the test). Creep (or drift) is usually not an issue because the time typically required to develop the substitution load and apply the test weight is of short duration. Consequently, the alternative test procedure can be applied in as many steps as needed to achieve a test to scale capacity (e.g., as many as nine substitution test loads may be used to test an ABWS if using test weight equal to only ten percent of scale capacity, etc.), and strain loads are not needed.

Due to the differences in these procedures, it is recommended that either method be selected and used throughout the entire test of an ABWS.

For step by step instructions on performing an increasing-load test using substitution test loads refer to:

- Appendix B High-Level Steps to Performing the Increasing-Load Test Using the Substitution or Alternative Substitution Test Method; and
- Appendix B (Supplement 1) Applying the High-Level Steps of the Substitution and Alternative Substitution Test Method

To view recorded results (with descriptive notations included) of a hypothetical increasing-load test performed using exact substitution test loads, refer to Appendix B (Supplement 2) of this EPO.

To view recorded results (with descriptive notations included) of a hypothetical increasing-load test performed using substitution test loads that are not exact, refer to Appendix B (Supplement 3) of this EPO.

Method 3: Increasing-load Test Using a Combination of Test Weight and One or More Strain-loads: *This method should be used when the amount of test weight to be applied during testing is less than the maximum test load desired for a complete test (i.e., typically to scale capacity or used capacity) and it has been determined that substitution testing can not be performed with reasonable ease. It is recommended that when using this method, test weight of at least 25% of scale capacity be used to assure that errors disclosed during testing reflect inaccuracy in the performance of the scale. Ideally, a scale should be tested from a no-load reference to at least 25% of scale capacity using test weights entirely and that same amount of test weight should then be applied to one or more strain loads such that the scale's performance is tested over its entire range of use. To minimize the amount of uncertainty in test results, error weights must be used to establish all starting reference points from which to apply the test weights during testing and to determine the precise amount of error in the scale at all test loads.² All test weights and test loads shall be distributed equally onto or suspended from the load-receiving element in a manner that does not produce binding or off-center loading.*

Test at multiple points from a zero-load reference to at least used capacity, including not less than one point in each 1/3rd capacity range of the system using test weight and strain-load test methods. If preset values have been programmed into the system to control the amount of product comprised of an individual draft load for one or more commodities typically weighed, include testing at a point that is within 5% of the value of system capacity below the lowest programmed preset value and at a point that is within 5% of the value of system capacity above the highest programmed preset value. If only one preset value has been programmed, test at a point that is within 5% of the value of system capacity above that preset value. For strain-load tests, tolerances apply only to the known test load portion of the applied load.

² Although titled "High-Level Steps to Performing the Increasing-Load Test Using the Substitution or Alternative Substitution Test Method," high-level steps 1 through 3 of Appendix B and the detailed instructions corresponding to these steps provided in Appendix B (Supplement 1) explain how to properly use error weights to establish a proper starting reference and determine scale error when testing a scale with digital indication. Thus, in addition to these instructions applying to the substitution and alternative substitution test methods, they also apply to the strain-load method (i.e., Method 3) of testing an ABWS.