
Chapter 2. Basic Test Procedure – Gravimetric Testing

2.1. Gravimetric Test Procedure for Checking the Net Contents of Packaged Goods

The gravimetric test method uses weight measurement to determine the net quantity of contents of packaged goods. This handbook includes general test methods to determine the net quantity of contents of packages labeled in terms of weight and special test methods for packages labeled in terms of fluid measure or count. Gravimetric testing is the preferred method of testing most products because it reduces destructive testing and improves measurement accuracy.

2.2. Measurement Standards and Test Equipment

a. What type of scale is required to perform the gravimetric test method ?

Use a scale (for this handbook the term “scale” includes balances) that has at least 100 scale divisions. It must have a load-receiving element of sufficient size and capacity to hold the packages during weighing. It also requires a scale division no larger than $\frac{1}{6}$ of the Maximum Allowable Variation (MAV) for the package size being weighed. The MAV/6 requirement ensures that the scale has adequate resolution to determine the net contents of the packages. Subsequent references to product test results requiring the agreement to within one scale division based on scale divisions that are equal to or only slightly smaller than the MAV/6. (See Appendix A, Table 2-5. “Maximum Allowable Variations (MAVs) for Packages Labeled by Weight.”)

Example: *The MAV for packages labeled with a net weight 113 g (0.25 lb) is 7.2 g (0.016 lb). Divide (\div) the MAV by 6 to obtain the maximum scale division that can be used to determine the gross, tare and net weights for a package size.*

$$7.2 \text{ g (0.016)} \div 6 = 1.2 \text{ g (0.002 lb)}$$

In this example, a 1 g (0.002 lb) scale division would be the maximum scale division appropriate for weighing these packages.

(Amended 2010)

b. How often should I verify the accuracy of a scale?

Verify the accuracy of a scale before each initial daily use, each use at a new location, or when there is any indication of abnormal equipment performance (e.g., erratic indications). Recheck the scale accuracy if it is found that the lot does not pass, so there can be confidence that the test equipment is not at fault.

c. Which accuracy requirements apply?

Scales used to check packages must meet the acceptance tolerances specified for their accuracy class in the current edition of NIST Handbook 44 (HB 44) “Specifications, Tolerances, and Other Technical

Requirements for Weighing and Measuring Devices.” The tolerances for Class II and Class III scales are presented in HB 44, Chapter 2.20. “Scales- T.N. Tolerances Applicable to Devices Marked I, II, III, III L, and IIII.”

Note: If the package checking scale is not marked with a “class” designation, use Table 2-1. “Class of Scale” to determine the applicable tolerance.

d. What considerations affect measurement accuracy?

Always use good weighing and measuring practices. For example, be sure to use weighing and measuring equipment according to the manufacturer’s instructions and make sure the environment is suitable. Place scales and other measuring equipment (e.g., flasks and volumetric measures) on a rigid support and maintain them in a level condition if being level is a requirement to ensure accuracy.

e. In testing, which tolerances apply to the scale?

Do not use a scale if it has an error that exceeds the specified tolerance in any of the performance tests described in the following section.

Steps:

1. Determine the total number of divisions (i.e., the minimum increment or graduation indicated by the scale) of the scale by dividing the scale’s capacity by the minimum division.

Example: *A scale with a capacity of 5000 g and a minimum division of 0.1 g has 50 000 divisions.*

$$5000 \div 0.1 \text{ g} = 50\,000 \text{ division}$$

2. From Table 2-1. “Class of Scale”, determine the class of the scale using the minimum scale division and the maximum number of scale divisions.

Example: *On a scale with a minimum division of 0.1 g and 50 000 total scale divisions the appropriate class is “II.”*

Note: If a scale is used where the number of scale divisions is between 5001 and 10 000 and the division size is 0.1 g or greater and is not marked with an accuracy Class II marking, Class III scale tolerances apply.

3. Determine the tolerance from Table 2-2. “Acceptance Tolerances for Class of Scale Based on Test Load in Divisions” in divisions appropriate for the test load and class of scale.

Steps:

Example: Determine the number of divisions for any test load by dividing the value of the mass standard being applied by the minimum division indicated by the scale. For example, if the scale has a minimum division of 0.1 g and a 1500 g mass standard is applied, the test load is equal to 15 000 divisions (1500/0.1). On a Class II scale with a test load between 5001 and 20 000 divisions, Table 2-2. “Acceptance Tolerances for Class of Scale Based on Test Load in Divisions” indicates the tolerance is plus or minus 1 division.

Table 2-1. Class of Scale			
Value of Scale Division¹	Minimum and Maximum Number of Divisions		Class of Scale
	Minimum	Maximum	
1 mg to 0.05 g	100	100 000	II
0.1 g or more	5 000	100 000	II
0.1 g to 2 g 0.000 2 lb to 0.005 lb 0.005 oz to 0.125 oz	100	10 000	III
5 g or more 0.01 lb or more 0.25 oz or more	500	10 000	III

¹On some scales, manufacturers designated and marked the scale with a verification division (e) for testing purposes (e = 1 g and d = 0.1 g). For scales marked Class II, the verification division is larger than the minimum displayed division. The minimum displayed division must be differentiated from the verification scale division by an auxiliary reading means such as a vernier, rider, or at least a significant digit that is differentiated by size, shape, or color. Where the verification division is less than or equal to the minimum division, use the verification division instead of the minimum division. Where scales are made for use with mass standards (e.g., an equal arm balance without graduations on the indicator), the smallest mass standard used for the measurement is the minimum division.

Table 2-2. Acceptance Tolerances for Class of Scale Based on Test Load in Divisions		
Test Load in Divisions		Tolerance
Class II Scale	Class III Scale	
0 to 5000	0 to 500	Plus or Minus 0.5 Division
5001 to 20 000	501 to 2 000	Plus or Minus 1 Division
20 001 or more	2001 to 4000	Plus or Minus 1.5 Divisions
Not Applicable	4001 or more	Plus or Minus 2.5 Divisions

f. Which performance tests should be conducted to ensure the accuracy of a scale?

Use the following procedures to verify the scale. These procedures, which are based on those required in NIST Handbook 44, have been modified to reduce the amount of time required for testing scales in field situations.

(1) Increasing-Load Test

Use certified mass standards to conduct an “increasing-load test” with all test loads centered on the load-receiving element. Start the test with the device on zero and progress with increasing test loads to a “maximum test load” of at least 10 % more than the gross weight of the packages to be tested. Use at least three different test loads of approximately equal value to test the device up to the “maximum test load.” Verify the accuracy of the device at each test load. Include the package tare weight as one of the test points.

(2) Decreasing-Load Test

For all types of scales, other than one with a beam indicator or equal-arm balance, conduct a “decreasing-load test” with all test loads centered on the load-receiving element. Use the same test loads used in the “increasing-load test” of this section, and start at the “maximum test load.” Remove the test loads in the reverse order of the increasing-load test until all test loads are removed. Verify the accuracy of the scale at each test load.

(3) Shift Test

When conducting a Shift Test on Bench Scales or Balances, use a test load equal to one-third of the “maximum test load” used for the “increasing-load test.” For bench scales (see Figure 1-1. “Bench Scales or Balances”) apply the test load as nearly as possible at the center of each quadrant of the load receiving element as shown in Figure 2-1. “Bench Scale or Balances.”

For Equal Arm Balances, use a test load equal to one-half capacity centered successively at four points positioned equidistance between the center and the front, left, back, and right edges of each pan as shown (see Figure 2-2. “Equal-Arm Balance).” For example, where the load-receiving element is a rectangular or circular shape, place the test load in the center of the area represented by the shaded.

Figure 2-1. Bench Scales or Balances

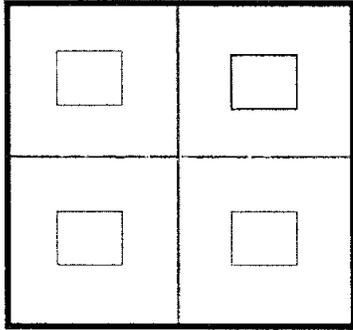
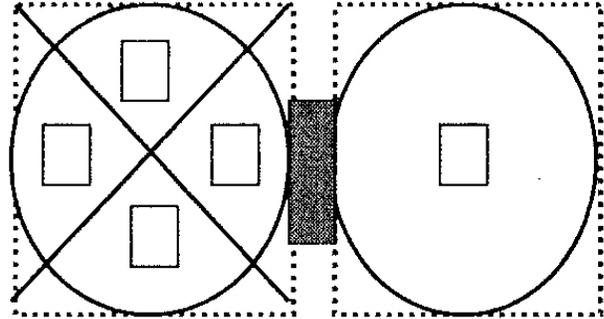


Figure 2-2. Equal-Arm Balance



(Amended 2010)

(4) Return to Zero

Conduct the return to zero test whenever all the test weights from the scale are removed; check to ensure that it returns to a zero indication.

g. Which standards apply to other test equipment?

Specifications, tolerances, and other technical requirements for the other measurement standards and test equipment cited in this handbook are specified in the following NIST publications. These publications may be obtained from the Weights and Measures Division (<http://www.nist.gov/pml/wmd/>).

- Mass Standards – Use NIST Handbook 105-1, “Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures – Field Standard Weights (NIST Class F)” (1990)
- Volumetric Flasks and Cylinders – Use NIST Handbook 105-2, “Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures – Field Standard Measuring Flasks” (1996)
- Stopwatches – Use NIST Handbook 105-5, “Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures – Field Standard Stopwatches” (1997)
- Thermometers – Use NIST Handbook 105-6, “Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures – Specifications and Tolerances for Thermometers” (1997)

2.3. Basic Test Procedure

The following steps apply when gravimetrically testing any type of packaged product except Borax and glazed or frozen foods. If the tested products contain Borax, refer to Section 2.4, “Borax.” If encased-in-ice or ice glazed food is tested, refer to Section 2.6. “Determining the Net Weight of Encased-in-Ice and Ice Glazed Products.”

Steps:

1. Identify and define the inspection lot.
2. Select the sampling plan.
3. Select the random sample.
4. Measure the net contents of the packages in the sample.
5. Evaluate compliance with the Maximum Allowable Variation (MAV) requirement.
6. Evaluate compliance with the average requirement.

2.3.1. Define the Inspection Lot

The official defines which packages are to be tested and the size of the inspection lot. The lot may be smaller or larger than the production lot defined by the packer. Only take action on the packages contained in the lot that has been defined.

Note: Normally, there will never be access to the entire “production lot” from a manufacturer. The “inspection lot” is selected from packages that are available for inspection/test at any location in the distribution chain.

Example: *An inspection lot should consist of all of the cans of a single brand of peach halves, labeled with a net quantity of 453 g (1 lb). When packages are tested in retail stores, it is not necessary to sort by lot code. If lot codes are mixed during retail testing, be sure to record the lot codes for all of the packages included in the sample so that the inspector and other interested parties can follow up on the information. For special reasons, such as a large number of packages or the prior history of problems with the product or store, the inspector may choose to define a lot as only one type of packaged product (e.g., ground beef). Another reason to narrowly define the lot is if the results of an audit test indicate the possibility of a shortage in one particular lot code within a particular product.*

a. **What is the difference between standard and random weight packages?**

Standard packages are those with identical net content declarations such as containers of soda in 2 L bottles and 2.26 kg (5 lb) packages of flour. “Random packages” are those with differing or no fixed pattern of weight, such as packages of meat, poultry, fish, or cheese.

2.3.2. Select Sampling Plans

This handbook contains two sampling plans used to inspect packages: “Category A” and “Category B.” Use the “Category B” Sampling Plans to test meat and poultry products at point-of-pack locations that are subject to U.S. Department of Agriculture Food Safety and Inspection Service (FSIS) requirements. When testing all other packages, use the “Category A” Sampling Plan.

a. **Where are sampling plans located for “Category A” inspections?**

Use Appendix A, Table 2-1. “Sampling Plans for Category A,” to conduct “Category A” inspections.

b. **Where are sampling plans located for “Category B” inspections?**

Use Appendix A, Table 2-2. “Sampling Plans for Category B,” to conduct “Category B” inspections.

2.3.3. Basic Recordkeeping

a. **How are the specific steps of the Basic Test Procedure documented?**

Use an official inspection report to record the information. Attach additional worksheets, test notes, and other information as needed. This handbook provides random and standard packaged products model inspection report forms in Appendix C, “Model Inspection Report Forms.” (Refer to Appendix C for instructions on how to complete the forms’ box numbers.) Modify the model reports and the box numbers to meet your agency’s needs. Other formats that contain more or less information may be acceptable.

Note: Inspection reports should be legible and complete. Good recordkeeping practices typically include record retention for a specified period of time.

Steps:

1. Record the product identity, packaging description, lot code, location of test, and other pertinent data.
2. Record the labeled net quantity of contents in Box 1. Record both metric and inch-pound declarations if they are provided on the package label.

Example: *If the labeled weight is 453 g (1 lb), record this in Box 1.*

3. When the declaration of net quantity on the package includes both the International System of Units (SI) (metric) and inch-pound units, the larger of the two declarations must be verified. The rounding rules in NIST Handbook 130, “Uniform Packaging and Labeling Regulations” permit packers to round declarations up or down based on their knowledge of their package filling targets and the accuracy of packaging equipment.

Determine the larger of the values by converting the SI declaration to inch-pound units, or vice versa, using conversion factors that are accurate to at least six places. Compare the values, and use the larger value in computing the nominal gross weight (see later steps). Indicate on the report which of the declarations is being verified when packages labeled with two units of measure are encountered.

Example: *If the net weight declared on a package is 1 lb, the metric equivalent (accurate to six significant digits) is 453.592 g. Do not round*

Steps:

down or truncate values in the calculations until the nominal gross weight is determined and recorded. If the package is also labeled 454 g, then the metric declaration is larger than the inch-pound declaration and should be used to verify the net contents of the package. The Basic Test Procedure does not prohibit the use of units of weight instead of dimensionless units when recording package errors, nor does it prohibit the use of net content computer programs to determine product compliance.

4. Record the unit of measure in Box 2. The unit of measure is the minimum division of the unit of measurement used to conduct the test. If a scale is used that reads to thousandths of a pound, the unit of measure is 0.001 lb even if the scale division is 0.002 lb or 0.005 lb.

Examples: *If the scale has a scale division of 0.5 g, the unit of measure is 0.1 g. If a weighed package that has an error of “-0.5 g,” record the error as “-5” using “dimensionless units.”*

$$-0.5 \text{ g} \div 0.1 = 5 \text{ dimensionless units}$$

If the scale indicates in increments of 0.002 lb, the unit of measure is 0.001 lb. If a weighed package has an error of “+0.016,” record the error as “+16” using “dimensionless units.”

$$0.016 \div 0.001 = 16 \text{ dimensionless units}$$

When using dimensionless units, multiply package errors by the unit of measure to obtain the package error in weight.

5. Enter the appropriate MAV value in Box 3 for the type of package (weight, volume, etc.), the labeled net contents, and the unit of measure.

b. Where are Maximum Allowable Variations found?

Find the MAV values for packages labeled by weight, volume, count, and measure in the tables listed below in Appendix A, Tables.

Maximum Allowable Variations

- packages labeled by weight See Table 2-5.
- packages labeled by volume, liquid or dry See Table 2-6.
- packages labeled by count See Table 2-7.
- packages labeled by length, (width), or area See Table 2-8.
- packages bearing a USDA seal of inspection – Meat and Poultry See Table 2-9.

- textiles, polyethylene sheeting and film, mulch and soil labeled by volume, packaged firewood, and packages labeled by count with 50 items or fewer, and specific agriculture seeds labeled by count. See Table 2-10.

(Amended 2010)

c. How is the value of an MAV found?

Refer to the appropriate table of MAVs and locate the declared quantity that is on the package label in the column marked “Labeled Quantity.” Read across the table to find the value in the column titled “Maximum Allowable Variation.” Record this number in Box 3. Determine the MAV in dimensionless units and record in Box 4 on the Standard Package Report Form (a dimensionless unit is obtained by dividing the MAV recorded in Box 3 by the unit of measure recorded in Box 2). Refer to Appendix F. “Glossary,” for the definition of dimensionless units.

d. How many unreasonable minus errors (UMEs) are permitted in a sample?

To find out how many minus package errors are permitted to exceed the MAV, (errors known as unreasonable minus errors or UMEs), see Column 4 in either Table 2-1. “Sampling Plans for Category A” or Table 2-2. “Sampling Plans for Category B.” (refer to Appendix A) Record this number in Box 8.

(Amended 2010)

2.3.4. Random Sample Selection

a. How are sample packages selected?

Randomly select a sample from the inspection lot. Random number tables (see Appendix B. “Random Number Tables”) or a calculator that is able to generate random numbers may be used to identify the sample. If the packages for the sample are not randomly selected, the test results may not be statistically valid.

Note: If the inspector and the party that is ultimately responsible for the packing and declaration of net weight for the product agree to an alternative method of sample selection, document how the sample packages were selected as part of the inspection record.

b. How is the size of the “Lot” determined?

Count the number of packages comprising the inspection lot or estimate the size to within 5 % and record the inspection lot size in Box 5.

c. How is the sample size determined?

Refer to Appendix A. Table 2-1. “Sampling Plans for Category A” or Table 2-2. “Sampling Plans for Category B” to determine the sample size. In Column 1, find the size of the inspection lot (the number

recorded in Box 5 of the report form). Read across from Column 1 to find the appropriate sample size in Column 2 and record this number in Box 6 of the report form.

2.3.5. Measure Net Contents/Tare Procedures

a. What types of tare may be used to determine the net weight of package goods?

This handbook defines three types of tare for the inspection of packaged goods. The tare weight may vary considerably from package to package as compared with the variability of the package net contents, even for packages in the same production lot. Although this is not common for most packaging, the basic test procedure in this handbook considers the variation for all tare materials.

(1) Used Dry Tare

Used dry tare is used tare material that has been air dried, or dried in some manner to simulate the unused tare weight. It includes all packaging materials that can be separated from the packaged product, either readily (e.g., by shaking) or by washing, scraping, ambient air drying, or other techniques involving more than “normal” household recovery procedures, but not including laboratory procedures like oven drying. Labels, wire closures, staples, prizes, decorations, and such are considered tare. Used Dry Tare is available regardless of where the packages are tested. The net content verification procedures described in this handbook reference Used Dry Tare.

Note: When testing frozen foods with Used Dry Tare, the frost found inside frozen food packages is included as part of the net contents, except in instances in which glazed or frozen foods are tested according to Section 2.6. “Determining the Net Weight of Encased-in-Ice and Ice Glazed Products.”

(2) Unused Dry Tare

Unused dry tare is all unused packaging materials (including glue, labels, ties, etc.) that contain or enclose a product. It includes prizes, gifts, coupons, or decorations that are not part of the product. If testing packages in retail store locations where they are packaged, and sold in small quantities to the ultimate consumers, the basic test procedure may be modified by using samples of the packaging material available in the store.

(3) Wet Tare

Wet Tare is used tare material where no effort is made to dry the tare material. Free-flowing liquids are considered part of the tare weight.

Wet tare procedures must not be used to verify the labeled net weight of packages of meat and poultry packed at an official United States Department of Agriculture (USDA) facility and bearing a USDA seal of inspection. The USDA Food Safety and Inspection Service (FSIS) adopted specific sections of the 2005 4th Edition of NIST HB 133 by reference in 2008 but not the “wet tare” method for determining net weight compliance. FSIS considers the free-flowing liquids in packages of meat and poultry products, including single-ingredient, raw poultry products, to be integral components of these products (see Federal Register, September 9, 2008 [Volume 73, Number 175] [Final Rule – pages 52189-52193]).

If the jurisdiction uses wet tare to determine net weight, follow the procedures described below that reference Used Dry Tare, except make no effort to dry the tare material. If Wet Tare is used to verify the

net weight of the packages, the inspector must allow for moisture loss.
(Amended 2010)

b. How is a tare weight determined?

Except in the instance of applying unused dry tare, select the packages for the initial tare sample from the sample packages. Mark the first two (three or five) packages in the order the random numbers were selected; these packages provide the initial tare sample. Determine the gross weight of each package and record it in Block a, “Gross Wt,” under the headings “Pkg. 1,” “Pkg. 2,” “Pkg. 3,” etc. on the report form. Except for aerosol or other pressurized packages, open the sample packages, empty, clean, and dry them as appropriate for the packaging material.

c. How is the number of packages in the initial tare sample determined?

To determine the initial tare sample size, see Column 5 under initial tare sample size in Appendix A, Table 2-1. “Sampling Plans for Category A” or Column 3 under initial tare sample size in Appendix A, Table 2-2. “Sampling Plans for Category B.” Record the initial tare sample size in Box 7 on the report form.

Note: The initial tare sample size is considered the total tare sample size for the inspection lot when the sample size is less than 12.

d. How is the total number of packages to be opened for tare determined and the tare weight of the packaging material determined?

Steps:

1. Except for unused dry tare at the point-of-pack, first determine the tare weight for each package in the initial tare sample and record the value in Row b, “Tare Wt.” under the appropriate package number column.
2. For sample sizes of 12 or more, subtract the individual tare weights from the respective package gross weights (Block a, minus Block b, on the report form) to obtain the net weight for each package and record each value in Block c, “Net Wt.,” on the report form.

Determine and record the “range of package errors” (called R_c) for the initial tare sample in Box 9 on the report form. (The range is the difference between the package errors.)
(Amended 2002)

3. Determine and record the “range of tare weights” (called R_t) in Box 10.
4. Compute the ratio R_c/R_t by dividing the value in Box 9 by the value in Box 10. Record the resulting value in Box 11. (R_c and R_t must both be in the same unit of measure or both in dimensionless units.)
5. Determine and record in Box 12 the total number of packages to be opened for the tare determination from either Appendix A, Table 2-3. “Category A” or Table 2-4. “Category B.”

Steps:

- In the first column (titled Ratio of R_c/R_t), locate the range in which the computed R_c/R_t falls. Then, read across to the column headed with the appropriate sample size.
 - If the total number of packages to open equals the number already opened, go to step 6.
 - If the total number of packages to open is greater than the number of packages already opened, compute the number of additional packages to open for the tare determination open and weigh as per step 1 and step 2 and go to step 6. Enter the total number of tare samples in Box 12.
6. Determine the average tare weight using the tare weight values for all the packages opened and record the average tare weight in Box 13.

e. Does the inspection of aerosol containers require special procedures?

Yes, aerosol containers are handled differently for two reasons. First, regulations in NIST HB 130 under the Uniform Packaging and Labeling Regulation (UPLR) require that packages designed “to deliver” the product under pressure, “must state the net quantity of the contents that will be expelled when the instructions for use as shown on the container are followed.” This means that any product retained in aerosol containers after full dispersion is included in the tare weight. Second, aerosol containers must not be opened because they are pressurized; for safety reasons they should not be punctured or opened. When emptying aerosol containers to determine a tare weight, exhaust them in a well-ventilated area (e.g., under an exhaust hood or outdoors) at least 15 m (50 ft) from any source of open flame or spark.

To ensure that the container properly dispenses the product, read and follow any dispensing instructions on the package. If shaking during use is specified in the instructions, periodically shake (at least two or three times during expulsion of the product). If directions are not given, shake the container five times with a brisk wrist twisting motion. If the container has a ball agitator, continue the shaking procedure for one minute after the ball has shaken loose.

f. How is the tare of vacuum-packed coffee determined?

The gross weight of a can of vacuum-packed coffee will be more after the seal is broken and air enters the can. In the procedure to determine the tare weight of the packaging material, correct the gross weight determined for unopened cans as follows. Use the initial tare sample packages, weigh, and record the gross weight of the product-filled cans before and after breaking the vacuum seal. Compute the average gross weight difference (open weight minus sealed weight) and record this in Box 13a of the report form. The nominal gross weight equals the average tare weight minus the average difference in gross weights plus the labeled weight (Box 14): $\text{Box 13} - \text{Box 13a} + \text{Box 1}$.

g. When and where is unused dry tare used, and how is it used to determine an average tare weight?

You may determine the average tare weight using samples of unused dry tare when testing meat, poultry, or any other products that are not subject to regulation of the Food and Drug Administration (FDA). You may utilize unused dry tare samples when conducting inspections at locations where the point-of-pack and sale are identical (e.g., store-packed products in a supermarket meat case). To determine unused dry tare at the point-of-sale, randomly select two (2) samples of unused dry tare, and weigh each separately. If there is no measurable variation in weight between the samples, proceed with the test using the weight of one of the samples. If the weight of the two (2) initial samples varies, randomly select three (3) additional tare samples and determine the average weight of all five (5) samples. Use this value as the average tare weight.

(Amended 2002)

2.3.6. Determine Nominal Gross Weight and Package Errors for Tare Sample

a. How do I compute a nominal gross weight?

A nominal gross weight is used to calculate package errors. To compute the nominal gross weight, add the average tare weight (recorded in Box 13) to the labeled weight (recorded in Box 1).

The nominal gross weight is represented by the formula:

$$\textit{Nominal gross weight} = \textit{average tare} + \textit{labeled weight}$$

b. How do I compute the package error?

To obtain the package error, subtract the nominal gross weight from each package's gross weight. The package error is represented by the formula:

$$\textit{Package error} = \textit{gross weight} - \textit{nominal gross weight}$$

(Added 2010)

c. How are individual package errors determined for the tare sample packages?

Determine the errors of the packages opened for tare by subtracting the nominal gross weight recorded in Box 14 from the individual package gross weights recorded for each package (Pkg. 1, Pkg. 2, etc.) in Block a, "Gross Wt." The nominal gross weight must be used, rather than the actual net weight, for each package to determine the package error. This ensures that the same average tare weight is used to determine the error for every package in the sample, not just the unopened packages.

- **Standard Packages.** – Record the package error in the appropriate plus or minus column on the report form for each package opened for tare.
- **Random Packages.** – Determine the package error for the tare sample using a nominal gross weight for each package so that all of the package errors are determined with the same tare

weight value. Record the package error on the Random Package Report Form in the appropriate plus or minus column under Package Errors.

Note: Converting the package error to dimensionless units allows the inspector to record the package errors as whole numbers disregarding decimal points and zeroes in front and unit of measure after the number.

Example: *If weighing in 0.001 lb increments, the unit of measure is 0.001 lb. If the package error for the first package opened for tare is +0.008 lb, instead of recording 0.008 lb in the plus column, record the error as “8” in the plus column. If the second package error is +0.060 lb, record the package error as “60” in the plus column, and so on. (This section does not prohibit the use of software or units of weight instead of dimensionless units.)*

d. How are individual package errors determined for the other packages in the sample?

Compare the gross weight of each of the unopened sample packages with the nominal gross weight (Box 14). Record the package errors in the “Package Errors” section of the report form using either units of weight (lb or g) or dimensionless units.

e. How is the total package error computed?

Add all the package errors for the packages in the sample. Be sure to subtract the minus package errors from the plus package errors and to record the total net error in Box 15, indicating the positive or negative value of the error.

(Amended 2010)

2.3.7. Evaluating Results

a. How is it determined if a sample passes or fails?

The following steps lead the inspector through the process to determine if a sample passes or fails. If the product is subject to moisture allowance, follow the procedures under Section 2.3.8. “Moisture Allowances” to correct the MAV.

b. How is it determined if packages exceed the Maximum Allowable Variation?

Compare each minus package error with the MAV recorded in Box 3 or Box 4 (if using dimensionless units). Circle the package errors that exceed the MAV. These are “unreasonable errors.” Record the number of unreasonable minus errors found in the sample in Box 16.

- c. **How is it determined if the negative package errors in the sample exceed the number of MAVs allowed for the sample?**

Compare the number in Box 16 with the number of unreasonable errors allowed (recorded in Box 8). If the number found exceeds the allowed number, the lot fails. Record in Box 17 whether the number of unreasonable errors found is less or more than allowed.

- d. **How is the average error of the sample determined and does the inspected lot pass or fail the average requirement?**

Determine the average error by dividing the total error recorded in Box 15 by the sample size recorded in Box 6. Record the average error in Box 18 if using dimensionless units or in Box 19 if using units of weight. Compute the average error in terms of weight (if working in dimensionless units up to this time) by multiplying the average error in dimensionless units by the unit of measure and record the value in Box 19.

Note: If the total error recorded in Box 15 is a plus value, and Box 17 is “No,” (the number of unreasonable errors is equal to or less than the number allowed, recorded in Box 8), the lot passes.

Steps:

1. If the average error is positive, the inspection lot passes the average requirement.
2. If the average error is negative, the inspection lot fails under a “Category B” test. Record in Box 20.
3. If the average error is a negative value when testing under the Sampling Plans for “Category A,” compute the Sample Error Limit (SEL) as follows:

- Compute the Sample Standard Deviation and record it in Box 21.

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (X_i - \bar{X})^2}$$

- Obtain the Sample Correction Factor from Column 3 of Appendix A. Table 2-1. “Sampling Plans for Category A” test. Record this value in Box 22.
- Compute the Sample Error Limit using the formula:

$$\begin{aligned} & \text{Sample Error Limit (Box 23)} \\ & = \text{Sample Standard Deviation (Box 21)} \times \text{Sample Correction Factor (Box 22)} \end{aligned}$$

4. Compliance Evaluation of the Average Error:
 - If the value of the Average Error (Box 18) is smaller than the Sample Error Limit (Box 23), the inspection lot passes.

Steps:

- If the value of the Average Error (disregarding the sign) (Box 18) is larger than the Sample Error Limit (Box 23), the inspection lot fails. However, if the product is subject to moisture loss, the lot does not necessarily fail. Follow the procedures under “Moisture Allowances” in this chapter.

2.3.8. Moisture Allowances

When no predetermined allowance is found in NIST HB 133, the potential for moisture loss must be considered. Inspectors should follow their jurisdiction’s guidance for making their determination on an acceptable moisture allowance.

(Added 2010)

a. How is reasonable moisture loss allowed?

If the product tested is subject to moisture loss, provide for the moisture allowance by following the steps listed below.

Determine the value of the moisture allowance if the product is listed below.

b. What are the moisture allowances for flour, dry pet food, and other products? (See Table 2-3. “Moisture Allowances”)

Table 2-3. Moisture Allowances		
Verifying the labeled net weight of packages of:	Moisture Allowance is:	Notes
Flour	3 %	
Dry pet food	3 %	Dry pet food means all extruded dog and cat foods and baked treats packaged in Kraft paper bags and/or cardboard boxes with a moisture content of 13 % or less at time of pack.
Borax	See Section 2.4.	
Wet Tare Only¹		
Fresh poultry	3 %	Fresh poultry is defined as poultry above a temperature of – 3 °C (26 °F) that yields or gives when pushed with the thumb.
Franks or hot dogs	2.5 %	

Table 2-3. Moisture Allowances		
Bacon, fresh sausage, and luncheon meats	0 %	For packages of bacon, fresh sausage, and luncheon meats, there is no moisture allowance if there is no free-flowing liquid or absorbent material in contact with the product and the package is cleaned of clinging material. Luncheon meats are any cooked sausage product, loaves, jellied products, cured products, and any sliced sandwich-style meat. This does not include whole hams, briskets, roasts, turkeys, or chickens requiring further preparation to be made into ready-to-eat sliced product. When there is no free-flowing liquid inside the package and there are no absorbent materials in contact with the product, Wet Tare and Used Dried Tare are equivalent.
<p>¹Wet tare procedures must not be used to verify the labeled net weight of packages of meat and poultry packed at an official United States Department of Agriculture (USDA) facility and bearing a USDA seal of inspection. The Food Safety and Inspection Service (FSIS) adopted specific sections of the 2005 4th Edition of NIST HB 133 by reference in 2008 but not the “wet tare” method for determining net weight compliance. FSIS considers the free-flowing liquids in packages of meat and poultry products, including single-ingredient, raw poultry products, to be integral components of these products (see Federal Register, September 9, 2008 [Volume 73, Number 175] [Final Rule – pages 52189-52193]).</p>		

(Amended 2010)

c. What moisture allowance is used with Used Dry Tare when testing packages that bear a USDA Seal of Inspection?

There is no moisture allowance when inspecting meat and poultry from a USDA inspected plant when Used Dry Tare and “Category A” sampling plans are used.

d. What moisture allowance is used with wet tare?

When there is free-flowing liquid and liquid absorbed by packaging materials in contact with the product, all free-flowing liquid and the absorbed liquid is part of the wet tare.

(Added 2010)

Note: Wet tare procedures must not be used to verify the labeled net weight of packages of meat and poultry packed at an official United States Department of Agriculture (USDA) and bearing a USDA seal of inspection. The Food Safety and Inspection Service (FSIS) adopted specific sections of the 2005 4th Edition of NIST HB 133 by in 2008 reference but not the “wet tare” method for determining net weight compliance. FSIS considers the free-flowing liquid in packages of meat and poultry products, including single-ingredient, raw poultry products, to be integral components of these products (see Federal Register, September 9, 2008 [Volume 73, Number 175] [Final Rule – pages 52189-52193]).

See Table 2-3. “Moisture Allowances – Wet Tare Only.”

2.3.9. Calculations

a. How is moisture allowance computed and applied?

To compute moisture allowance, multiply the labeled quantity by the decimal percent value of the allowance.

Example:

Labeled net quantity of flour is 907 g (2 lb)

Moisture Allowance is 3 % (0.03)

Moisture Allowance = 907 g (2 lb) x 0.03 = 27 g (0.06 lb)

Record this value in Box 13a.

b. How is a Moisture Allowance made prior to determining package errors?

If the Moisture Allowance is known in advance (e.g., flour and dry pet food), it can be applied by adjusting the Nominal Gross Weight (NGW) used to determine the sample package errors. The Moisture Allowance (MA) in Box 13a is subtracted from the NGW to obtain an Adjusted Nominal Gross Weight (ANGW) which is entered in Box 14. The NGW is the sum of the Labeled Net Quantity of Contents (LNQC e.g., 907 g) and the Average Tare Weight (ATW) from Box 13.

Example: *Use an Average Tare Weight of 14 g (0.03 lb)*

The calculation is:

*Labeled Net Quantity of Contents 907 g (2 lb) + Average Tare Weight 14 g (0.03 lb) = 921 g
(2.03 lb) – Moisture Allowance 27 g (0.06 lb) = Adjusted Nominal Gross Weight of 894 g (1.97 lb)*

This result is entered in Box 14.

Package errors are determined by subtracting the Adjusted Nominal Gross Weight from the Gross Weights of the Sample Packages (GWSP).

Example: *The calculation is:*

Gross Weight of the Sample Packages – Adjusted Nominal Gross Weight = Package Error

Note: When the Nominal Gross Weight is adjusted by subtracting the Moisture Allowance value(s) the Maximum Allowable Variation(s) is not changed. This is because the errors that will be found in the sample packages have been adjusted by subtracting the Moisture Allowance (e.g., 3 %) from the Nominal Gross Weight. That increases the individual package errors by the amount of the moisture allowance (e.g., 3 %). If the value(s) of the MAV(s) were also adjusted it would result in doubling the allowance. MAV is always based on the labeled net quantity.

(Added 2010)

c. **How is a Moisture Allowance made after determining package errors?**

You can make adjustments when the value of the Moisture Allowance is determined following the test (e.g., after the sample fails or if a packer provides reasonable moisture allowance based on data obtained using a scientific method) using the following approach:

If the sample fails the Average Requirement but has no unreasonable package errors, only step 1 is used. If the sample passes the Average Requirement but fails because the sample included one or more Unreasonable Minus Errors (UMEs), only step 2 is used.

If the sample fails the Average and/or the Individual Package Requirements, both of the following steps are applied.

Steps:

1. Use the following approach to apply a Moisture Allowance to the sample after the test is completed:

- the Moisture Allowance (MA) is computed;

Example:

3 % x 907 g (2 lb) = 27 g (0.06 lb) and added to the Sample Error Limit (SEL)

- added to the Sample Error Limit (SEL);

Example:

if the SEL is 0.023 add 0.06 to obtain an Adjusted SEL of 0.083)

- the Adjusted Sample Error Limit (ASEL) is then compared to the Average Error of the Sample and:
- If the average error (disregarding sign) in Box 18 is smaller than the Adjusted Sample Error Limit, the sample passes.

HOWEVER,

- If the average error (disregarding sign) in Box 18 is larger than the Adjusted Sample Error Limit, the sample fails.

2. To apply Moisture Allowance is to be applied to the Maximum Allowable Variation(s), the following method is recommended:

- compute Moisture Allowance (MA);

Example: *3 % x 907 g (2 lb) = 27 g (0.06 lb)*

- add to Maximum Allowable Variation(s) (MAV) for labeled net quantity of the package to get Adjusted Maximum Allowable Variations (AMAVs);

Steps:

Example:

*MAV for 907 g (2 lb) is 31.7 g (0.07 lb) + 27 g (0.06 lb) =
Adjusted Maximum Allowable Variation(s) (AMAV) of 58.7 g*

- compare each minus package error to the AMAV;
- mark package errors that exceed the AMAV and record the number of unreasonable minus errors found in the sample; and
- if this number exceeds the number of unreasonable errors allowed, the sample fails.

(Added 2010)

d. What should you do when a sample is in the moisture allowance (gray) area?

When the average error of a lot of fresh poultry, franks or hot dogs is minus, but does not exceed the established “moisture allowance” or “gray area,” contact the packer or plant management personnel to determine what information is available on the lot in question. Questions to the plant management representative may include:

- Is a quality control program in place?
- What information is available concerning the lot in question?
- If net weight checks were completed, what were the results of those checks?
- What adjustments, if any, were made to the target weight?

Note: If the plant management has data on the lot, such data may help to substantiate that the “lot” had met the net content requirements at the point of manufacture.

This handbook provides “moisture allowances” for some meat and poultry products, flour, and dry pet food. These allowances are based on the premise that when the average net weight of a sample is found to be less than the labeled weight, but not by an amount that exceeds the allowable limit, either the lot is declared to be within the moisture allowance or further investigation can be conducted.

Reasonable variations from net quantity of contents caused by the loss or gain of moisture from the package are permitted when caused by ordinary and customary exposure to conditions that occur under good distribution practices. If evidence is obtained and documented to prove that the lot was shipped from the packaging plant in a short-weight condition or was distributed under inappropriate or damaging distribution practices, appropriate enforcement action should be taken.

(Amended 2010)

2.4. Borax

a. How is it determined if the net weight labeled on packages of borax is accurate?

Use the following procedures to determine if packages of borax are labeled correctly. This procedure applies to packages of powdered or granular products consisting predominantly (more than 50 %) of borax. Such commodities are labeled by weight. Borax can lose more than 23 % of its weight due to moisture loss. However, it does not lose volume upon moisture loss, and this property makes possible a method of volume testing based on a density determination in the event that the net weight of the product does not meet the average or individual package requirements. This method may be used for audit testing to identify possible short-filling by weight at point-of-pack. Since the density of these commodities can vary at point-of-pack, further investigation is required to determine whether, such short-filling has occurred.

Test Equipment

- Metal density cup with a capacity of 550.6 mL or (1 dry pint)
- Metal density funnel with slide-gate and stand
- Scale or balance having a scale division not larger than 1 g or (0.002 lb)
- Rigid straightedge or ruler
- Pan suitable for holding overflow of density cup

Test Procedure

Steps:

1. Follow Section 2.3.1. “Define the Inspection Lot.” Use a “Category A” sampling plan in the inspection; select a random sample; then use the following test procedure to determine product compliance.
2. If the lot does not comply by weight with the sampling plan requirements (either the average or individual package requirements), select the lightest package and record the net weight of this package.
3. Determine the empty weight of the density cup.
4. Place the density cup in the pan and put the funnel on top of the density cup. Close the funnel slide-gate.
5. Pour sufficient commodity into the funnel so that the density cup can be filled to overflowing.
6. Quickly remove the slide-gate from the funnel, allowing the commodity to flow into the density cup.

Steps:

7. Carefully, without agitating the density cup, remove the funnel and level off the commodity with the ruler or straightedge. Hold the ruler or straightedge at a right angle to the rim of the cup, and carefully draw it back across the top of the density cup to leave an even surface.
8. Weigh (in pounds) the filled density cup to determine gross weight. Subtract the empty density cup weight from the gross weight. This will give the net weight of the commodity.

b. How is the volume determined?

Steps:

1. Multiply the package net weight (in pounds) determined in step 8 above by 550.6.
2. Divide the answer just obtained (step 1) by the weight of the commodity in the density cup, determined in step 8 above. The result is the net volume of commodity in the package in milliliters.
3. Compare the net volume of the commodity in the package with the volume declared on the package. The volume declaration must not appear on the principal display panel. Instead, it will appear on the back or side of the package and may appear as:

Volume ____ mL per NIST Handbook 133

Note: 1 mL = 1 cm³

c. What action can be taken based on the results of the density test?

If the net volume of commodity in the lightest package equals or exceeds the declared volume on the package, treat the lot as being in compliance based on volume and take no further action. If the net volume of borax in the lightest package is less than the declared volume on the package, further compliance testing will be necessary. Take further steps to determine if the lot was in compliance with net weight requirements at point-of-pack or was short-filled by weight. To determine this, perform a laboratory moisture loss analysis to ascertain the weight of the original borax product when it was fully hydrated; obtain additional data at the location of the packager; and/or investigate the problem with the packager of the commodity.

2.5. Determination of Drained Weight

Since the weight per unit volume of a drained product is of the same order of magnitude as that of the packaging liquid that is drained off, an “average nominal gross weight” cannot be used in checking packages of this type. The entire sample must be opened. The procedure is based upon a test method accepted by the U.S. Food and Drug Administration (FDA).

A tare sample is not needed because all the packages in the sample will be opened and measured.

The weight of the container plus drained-away liquid is determined. This weight is then subtracted from the gross weight to determine the package error.

Test Equipment

- Scales and weights recommended in Section 2.2. “Measurement Standards and Test Equipment” are suitable for the determination of drained weight.
- Sieves
 - For drained weight of 1.36 kg or (3 lb) or less, one 20 cm or (8 in) No. 8 mesh U.S. Standard Series sieve, receiving pan, and cover

HOWEVER

- For drained weight greater than 1.36 kg or (3 lb), one 30 cm or (12 in) sieve, with same specifications as above
- For canned tomatoes, a U.S. Standard test sieve with 11.2 mm ($\frac{7}{16}$ in) openings must be used.

- Stopwatch

(Amended 2010)

Test Procedure

Steps:

1. Follow the Section 2.3.1. “Define the Inspection Lot.” Use a “Category A” or a “Category B” sampling plan in the inspection (depending on the location of test); select a random sample; then use the following test procedure to determine lot compliance.
2. Use Appendix C. “Standard Package Report.” Fill out Boxes 1 through 8. Select the random sample. Determine and record on a worksheet the weight of the receiving pan.
3. Determine and record on a worksheet the gross weight of each individual package comprising the sample.
4. Pour the contents of the first package into the dry sieve with the receiving pan beneath it, incline sieve to an angle between 17° to 20° from horizontal to facilitate drainage, and allow the liquid from the product to drain into receiving pan for 2 minutes. (Do not shake or shift material on the sieve.) Remove sieve and product.
5. Weigh the receiving pan, liquid, wet container, and any other tare material. (Do not include sieve and product.) Record this weight as tare and receiving pan.
6. Subtract the weight of the receiving pan, determined in step 2, from the weight obtained in step 4 to obtain the package tare weight (which includes the weight of the liquid).

Steps:

7. Subtract the tare weight, found in step 6, from the corresponding package gross weight determined in step 3 to obtain the drained weight of that package. Determine the package error (drained weight – labeled drained weight).
8. Repeat steps 4 through 7 for the remaining packages in the sample, cleaning and drying the sieve and receiving pan between measurements of individual packages.
9. Transfer the individual package errors to the Standard Pack Report form.
10. To determine lot conformance, return to Section 2.3.7. “Evaluating Results.”

2.6. Determining the Net Weight of Encased-in-Ice and Ice Glazed Products

- a. **How should the net weight of frozen seafood, meat, poultry, or similar products encased-in-ice and frozen into blocks or solid masses be determined?**

Note: For determining the net weight of ice glazed seafood, meat, poultry, or similar products, follow the procedure in Section 2.6.b. “How should the net weight of ice glazed seafood, meat, poultry or similar products be determined?”

Test Equipment

- Balance and weights (used to verify accuracy)
- Partial immersion thermometer or equivalent with 1 °C (2 °F) graduations and a –35 °C to +50 °C (–30 °F to +120 °F) accurate to ± 1 °C (± 2 °F)
- Water source and hose with an approximate flow rate of 4 L to 15 L (1 gal to 4 gal) per minute for thawing blocks and other products
- Sink or other receptacle [i.e., bucket with a capacity of approximately 15 L (4 gal)] for thawing blocks and other products
- A wire mesh basket (e.g. used for testing large frozen blocks of shrimp) or a container that is large enough to hold the contents of one package (e.g., 2.27 kg or [5 lb] box of shrimp) and has openings small enough to retain all pieces of the product (e.g., an expanded metal test tube basket lined with standard 16-mesh screen)
- Number 8 mesh, 20 cm (8 in) or 30 cm (12 in) sieve
- Stopwatch

Test Procedure for Encased-in-Ice Product Only

Steps:

1. Follow Section 2.3.1. “Define the Inspection Lot.” Use a “Category A” or a “Category B” sampling plan in the inspection (depending on the location of test); select a random sample; then use the following test procedure to determine lot compliance.
2. Place the unwrapped frozen seafood, meat, poultry, or similar products in the wire mesh basket or an open container to thaw (e.g. it is not placed in a plastic bag) and immerse in a 15 L (4 gal) or larger container of fresh water at a temperature between 23 °C to 29 °C (75 °F to 85 °F). Submerge the basket so that the top of the basket extends above the water level.
3. Maintain a continuous flow of water into the bottom of the container to keep the temperature within the specified range. This is accomplished by maintaining a constant flow of warm water into the container holding the product (e.g., place a bucket in a sink to catch the overflow, and feed warm water into the bottom of the bucket through a hose).

Note: Direct immersion does not result in the product absorbing moisture because the freezing process causes the tissue to lose its ability to hold water.

4. As soon as the product thaws, determined by loss of rigidity, transfer all material to a sieve (20 cm [8 in] for packages less than 453 g [1 lb] or 30 cm [12 in] for packages weighing more than 453 g [1 lb]) and distribute it evenly over the sieve.
5. Without shifting the product, incline the sieve 30° from the horizontal position to facilitate drainage, and drain for 2 minutes.
6. At the end of the drain time, immediately transfer the product to a tared pan for weighing to determine the net weight.

(Amended 2010)

- b. **How should the net weight of ice glazed seafood, meat, poultry, or similar products be determined?**

For ice glazed seafood, meat, poultry or similar products, determine the net weight after removing the glaze using the following procedure.

Test Equipment

- Balance and weights (used to verify accuracy)
- Continuous cold water source
- Number 8 sieve and receiving pan, 20 cm (8 in) for packages 453 g (1 lb) or less. A 30 cm (12 in) for packages more than 453 g (1 lb).

- Means to determine a 17° to 20° angle
- Stopwatch

Test Procedures for Ice-Glazed Product Only

Steps:

1. Follow Section 2.3.1. “Define the Inspection Lot.” Use a “Category A” sampling plan in the inspection; select a random sample; and use the following test procedure to determine lot compliance.
2. Fill out the header information on boxes 1 through 8 on the Ice Glazed Package Report form (See Appendix C). A tare sample is not needed. Record package price, price per pound, lot size, sample size, and unit of measure in step 1 of the Ice Glazed Package Worksheet (See Appendix C).

Note: Use an official inspection report to record the inspection information. Attach additional worksheets, test notes, and other information as needed. This handbook provides an ice glazed worksheet and package report form in Appendix C. Modify the worksheet, package report and the box numbers to meet your agency’s needs. Other formats that contain more or less information may be acceptable.

3. Number each package. Weigh each package for gross package weight and enter in row 1 “Gross Package Weight” on worksheet.
4. Enter the labeled net weight in Row 2 “Labeled Net Weight” for each package on the worksheet. If dual units, determine and enter the larger of the two units.
5. Record the maximum allowable variation on row 3 “MAV” on the worksheet.
6. Weigh receiving pan and record the weight in row 4, “Receiving Pan Weight” on the worksheet.
7. Deglaze the product. Remove a package from low temperature storage; open it immediately and place the contents in the sieve or other draining device (e.g., colander) under a gentle spray of cold water. Carefully agitate the product. Handle with care to avoid breaking the product. Continue the spraying process until all ice glaze, that is seen or felt is removed. In general, the product should remain rigid; however, the ice glaze on certain products, usually smaller sized commodities, sometimes cannot be removed without partial thawing of the product. Nonetheless, remove all ice glaze, because it may be a substantial part of the package weight.
8. Transfer the product to the sieve (if the product is not already in the sieve) Without shifting the product, incline the sieve to an angle of 17 degrees to 20 degrees to facilitate drainage and drain (into waste receptacle or sink) for 2 minutes using a stopwatch.
9. At the end of the drain time immediately transfer the entire product to the receiving pan for weighing to determine the net weight.

Steps:

10. Place the product and receiving pan on the scale and weigh. Record the net weight in row 5 on the ice glazed package worksheet. The net weight of product is equal to the weight of the receiving pan and the product minus the receiving pan weight.
11. The package error is equal to the net weight of the product minus the labeled weight. Record the package error **Error! Bookmark not defined.** in row 6 on the ice glazed package worksheet.
12. Repeat steps 2 through 10 for each package in the sample, cleaning the sieve and cleaning and drying the receiving pan between package measurements.
13. Transfer data from the ice glazed package worksheet to the ice glazed package report.

Evaluation of Results

Follow the procedures in Section 2.3.7. “Evaluating Results.”
(Amended 2010)

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