Mass Standards Handbook — Weight Selection Guidelines

Definitions –

Tolerance: The maximum amount by which the conventional mass of the weight is allowed to deviate from the assigned nominal value. Also defined as Maximum Permissible Error.

Correction: The difference between the actual value of the mass and the assigned nominal value. Also defined as Error. If the correction on your weight calibration certificate is a negative number, the weight is below nominal value by that amount. A positive correction means that the weight is heavier than the nominal value by that amount.

Uncertainty: A parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand. Typically reported at a 95% confidence level.

Readability: The mass value of the smallest scale or digital interval displayed by the weighing machine.

Repeatability: A measure of a weighing machine's ability to display the same result when repeated measurements are made under the same weighing conditions.

Linearity: Plus or minus deviation from the theoretically straight-lined course of two interdependent values. In balances, this expression is applied to the plus or minus deviation of the indicated measurement value from the true value of the load.

The following are guidelines for selecting the proper calibration weight for an electronic balance.

1. Refer to the balance operating manual to determine the calibration load.
2. If the calibration load cannot be determined through documentation, contact the manufacturer or put the balance in the calibration mode. Many times the calibration weight needed will flash on the display.
3. Determine the readability of the balance.
4. Determine the calibration weight accuracy by dividing the readability by 3. Refer to the Tolerance Table on page 66 for the given weight and select the tolerance that meets or exceeds the requirement.
5. In some cases, the readability will exceed the best available weight tolerance. In this case, purchase the weight with the tolerance that is 1/3 of the accuracy required for your measurement.

Example:

A calibration weight is needed for a 1000 g balance.

1. Referring to the operating manual, it is determined that a 1000 g weight is needed to calibrate the balance.
2. To verify this information, switch the balance into calibration mode. The balance displays a flashing 1000 g which verifies that 1000 g is the calibration load.
3. Checking the balance display, it is determined that the balance reads to 0.01 g or 10 mg.
4. Divide 10 mg by 3. The tolerance of the 1000 g weight needed should be 3 mg or better. Checking the ASTM Class 1 Tolerance Table, it lists a tolerance of 2.5 mg for 1000 g. In this case, you should purchase a 1000 g Class 1 weight to calibrate the balance.

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The following are guidelines for determining weights to be used for calculating balance error at the load in which the balance is used.

1. Determine at what load the balance will be used.
2. Determine what accuracy is required for the application. Be sure that the weighing equipment can satisfy the measurement accuracy requirements.
3. The tolerance for the weight should be at least 1/3 of the accuracy needed for the application.
4. Review the Tolerance Table on page 66 to determine the correct calibration weight for the application.

Example:

A range of samples from 10 g to 15 g needs to be weighed. An accuracy of 0.5 mg is required. The balance has a 100 g capacity and a readability of .00001 g. The balance needs to be verified at the minimum and maximum of the range of samples.

1. The correct weights to select are one 10 g weight and one 5 g weight. To check the balance at 15 g, use the 5 g and the 10 g weights together.
2. The accuracy of the 10 g and 5 g weights should be 1/3 times 0.5 mg or 0.16 mg. The cumulative tolerance of both weights should be applied at the 15 g load and should be considered when selecting the tolerance for both weights.
3. Reviewing the Tolerance Table at 10 g, ASTM Class 2 has a tolerance of 0.074 mg. The 5 g tolerance at ASTM Class 2 is 0.054 mg. The total tolerance at 15 g is 0.128 mg. ASTM Class 2 or better should be chosen as the tolerance for this application.

The following are guidelines for the direct readings of newly purchased or recalibrated weights.

The expected value of the weight when placed on the balance will vary according to the following equation:

Expected Value = (Nominal Value
+Correction – Linearity)
+/- Root Sum Square of
Uncertainty and
Repeatability

Example:

Expected value of a 100 g Class 1 weight, direct reading on a balance with a readability of 0.01 mg.

Correction
(Provided by Manufacturer) = 0.18 mg

Linearity of Balance at 100 g = -0.00008 g

Uncertainty of Mass Value
(k=1) = 0.000014 g

Repeatability of Balance
(k=1) = 0.00003 g

Root Sum Square of Uncertainty and
Repeatability (k=2) = 0.00007 g

Expected Value = 100 g + 0.00018 g
- 0.00008 g
+/- 0.00007 g

Expected Value = 100.00010 g
+/- 0.00007 g

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