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Why Ratio Test?

By Rick Harshman

NIST Handbook 44 requires that a ratio test be conducted on any scale equipped with counterpoise weights and on all nonautomatic-indicating equal arm scales. WMD frequently receives inquiries regarding the purpose of the ratio test, how it is to be performed, and how the tolerances are to be applied.

The ratio test determines the amount of error in a scale caused by a change in the manufacturer's designed multiple for the lever system. That is, the test determines the amount of error in a scale created entirely by the lever system and excludes any error created by other components of the scale, such as the errors created by nonuniform spacing of graduations on a beam or inaccurate counterpoise weights. The "multiple" of a scale provides an indication of the amount of weight that is reduced by the design of the scale's lever system and is generally stated as a ratio. For example, many of today's portable platform scales have a design multiple of 100:1, which implies that a 100-lb load applied to the platform can be counterbalanced by a 1-lb weight applied to the tip hanger of the beam. All equal arm scales have a designed multiple of 1:1, meaning that applied loads are not reduced, but rather, must be counterbalanced by loads of equal value.

The distance between each of the pivots of a lever in the lever system of a scale determines the actual multiple of the scale. During the regular use of a scale, its multiple can change as the pivots lose their sharpness or are damaged by improper loading. When the multiple of a lever is changed, an error in the scale is created. An incorrect multiple can usually be corrected by altering the distances between the various pivots using equipment specifically designed for this purpose. In cases of extreme wear, it may be necessary to replace the worn pivots.

The ratio test should be performed in conjunction with both the increasing load and shift test of a scale. The ratio test is conducted during the increasing load test by substituting field standards for each of the weights (e.g., counterpoise weights) that are commercially used with a scale. When performing the shift test, all quadrants of a platform should be tested using ratio test methods, that is, the test load applied to each quadrant of the platform and the load that counterbalances it should both be comprised of only field standards. **Note:** Slotted field standards may be purchased to test scales equipped with counterpoise weights.

To better understand the ratio test procedures, consider the test of a 1000-lb portable platform scale that has a designed multiple of 100:1, equipped with two 1-lb, one 2-lb, and one 5-lb counterpoise weights, and a 100-lb capacity weighbeam. Assume there is a maximum of 500 lb of field standards available for testing the scale. During the increasing load test, ratio tests should be performed at test loads of 100 lb, 200 lb, 300 lb, 400 lb, and 500 lb. The shift test, which can be conducted during the increasing load test, is also performed as a ratio test and, under normal circumstances, is performed at quarter capacity (250 lb) or half capacity (500 lb). In all cases, the

ratio test is accomplished by applying known field standards, in the amount necessary to counterbalance the weight of the test loads (which are also known field standards), from the tip hanger of the beam. **Note** that to perform the shift test as a ratio test on the above scale, it would be necessary to suspend 2.5 lb of field standards from the tip hanger of the beam to counterbalance the 250 lb shift test load. In addition to the ratio tests described above, NIST Handbook 112, EPO 7/8 requires the testing of a beam at half- and full-capacity, as well as the testing of each counterpoise weight equipped with the scale.

Tolerances for ratio tests are less than those applicable to other accuracy tests because many of the components of a scale are not used during this test and, therefore, their potential of contributing to the overall error in the test is eliminated. For example, the counterpoise weights with which a scale is equipped may have errors in them which contribute to errors in the scale's performance. By substituting known field standards for these counterpoise weights, this potential source of error is eliminated during the ratio test. The tolerances for ratio tests are 0.75 of the applicable tolerance on all scales marked with an accuracy class and most unmarked scales.

Conducting the ratio test is important not only because results provide a good indication of whether or not the lever system of a scale is properly reducing the force of all loads, but because it also provides insight in determining the possible causes of inaccuracies in a scale. By comparing the results of the ratio test to other tests completed at the same test load, a number of conclusions can often be drawn relative to a scale's performance. For example, comparing the errors in a scale that was tested using counterpoise weights versus slotted field standards will make evident any incorrect counterpoise weights. Errors in the beam can also be detected by making similar comparisons.

For more information on the ratio test, contact Rick Harshman at 301-975-8107 or at rick.harshman@nist.gov.