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Applying One-half "d" Tolerances

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This discussion applies to digital scales that round to the nearest division (d), which function as normal "round off" scales. The maintenance tolerances in Table 6 NIST Handbook 44 (H44) Scales Code 2.20. are specified in whole scale divisions. H44 also specifies that the acceptance tolerance values are one-half the maintenance tolerance values. Tolerances ending in one-half d should not be rounded.

The WMD receives numerous questions about how to apply the tolerance or interpret the error in the scale indication when a scale tolerance ends in one-half d, because you cannot directly read to one-half division on a digital scale. As a practical matter, a scale can be tested using direct reading or by using error weights. Either method is acceptable. Weights and measures officials typically use direct reading because it is more efficient and the focus of their work is to determine whether the scale meets or exceeds the tolerance limits. The use of error weight testing allows you to determine scale error to a finer weight value than you can derive from the displayed indication.

To illustrate how to apply acceptance tolerances consider a Class III 30-lb x 0.01-lb digital-indicating scale that rounds to the nearest scale division. The acceptance tolerance for test loads between 0 to 500 divisions based on Table 6 is 0.5 d, which corresponds to 0.005 lb in our example of a digital scale. The acceptance tolerance values calculated for a digital-indicating scale cannot be read in the same manner as a mechanical scale. On a mechanical scale you are able to see which weight value is closer to the index of the indicator.

To determine whether or not the digital scale complies with acceptance tolerance, place a 1-lb test weight on the scale; with 100 divisions on the scale the device must meet an acceptance tolerance of plus or minus 0.5 d. To be within acceptance tolerance, the scale must measure the 1-lb load to be a weight value of 0.995 lb to 1.005 lb; however, the scale does not have the ability to display weight values less than 0.01 lb.

If a digital "round off" scale interprets the 1-lb load as a weight value of 0.995 lb to 1.005 lb, inclusive, then the rounding of the weight value to the nearest scale division means that the scale will indicate 1.00 lb. Hence, the scale is within acceptance tolerance. Following is an illustration of how to apply the acceptance tolerance to a scale with a 0.01-lb division size and a 1-lb test load:

-If the indicated weight is 1.00 lb, the scale meets the +/- 0.5 d tolerance;

-If the indicated weight is stable at 0.99 lb or at 1.01 lb, the scale exceeds the 0.5 d tolerance;

-If the indicated weight is flickering between 0.99 lb and 1.00 lb or between 1.00 lb and 1.01 lb, the scale is in what is considered a "zone of uncertainty." This is called the zone of uncertainty because the scale is at a point halfway between scale divisions where the scale may alternately display one weight value and sometimes display another weight value. The scale should be considered within the 0.5 d tolerance.

NOTE: Later generations of electronic scales have stability features in their programming where the zone of uncertainty may be much less than 0.3 d, or virtually undetectable; for example, at a 0.1 d zone of uncertainty you may not be able to see flickering of the indication between two adjacent weight values. Error weights may be used at any time when testing a digital-indicating scale where the environmental conditions permit.