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How to Apply Repeatability Tolerances

By Juana Williams

In the February 2004 newsletter, the differences between accuracy tolerances and repeatability tolerances were addressed. NIST Handbook 44 Section 3 Measuring Devices Codes include requirements for repeatability testing results to be within a specified allowable range. The requirements also require each individual test draft to be within the allowable accuracy tolerance. Repeat-ability testing determines whether or not a device is capable of repeating its indications and recorded representations within a certain limit under the same conditions.

Except for Sections 3.33 Hydrocarbon Gas Vapor-Measuring Devices and 3.36 Water Meters, repeatability tolerance requirements in the measuring devices codes specify that when multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 % of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance.

The measuring devices codes also require that repeatability tests include a minimum of three consecutive test drafts of approximately the same size under conditions where variables do not affect the results.

An example of how to apply repeatability tolerances is based on an Accuracy Class 0.3 liquid-measuring device. In this example, the meter indication is a 100 gallon delivery for each of three test runs taken at approximately the same flow rate and a maintenance tolerance of 0.3 % with the following results after correcting the data for the effects of temperature:

Test (T)	Meter Indication (gal)	Error (gal)	Maint. Tol. (%)	Maint. Tol. (gal)
1	100.0 gal	+ 0.2	± 0.3	± 0.3
2	100.0 gal	+ 0.1	± 0.3	± 0.3
3	100.0 gal	– 0.2	± 0.3	± 0.3

Applying the Repeatability Tolerance:

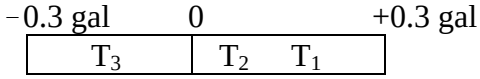
The repeatability tolerance specifies that the range of the test results shall not exceed 40 % of the absolute value of the maintenance tolerance. The maintenance tolerance is ± 0.3 %. The absolute value of a number is equal to that number without the + or –

signs; the absolute value of the maintenance tolerance in this case is 0.3 %. Thus, 40 % of the absolute value of maintenance tolerance is 40 % of 0.3 % or 012 %. In this example of a test draft of 100 gallons, the repeatability tolerance is calculated as follows:

- 0.40 x 0.003 = 0.0012 (or 0.12 %) of the indicated 100 gallons delivered and
- the allowable range is 0.12 gallons or 27.7 cubic inches.

The range between Test Run 1 and Test Run 2 results is 0.1 gallons or 23.1 cubic inches
The range between Test Run 2 and Test Run 3 results is 0.3 gallons or 69.3 cubic inches
The range between Test Run 1 and Test Run 3 results in 0.4 gallons or 92.4 cubic inches

Calculation of the Applicable Tolerance:
The applicable tolerance for the individual results is the entire range of plus or minus 0.3 %, which is equivalent to plus or minus 0.3 gallon (plus or minus 69.3 cubic inches).



The applicable tolerance allows indica-tions from −0.3 gallon to +0.3 gallon for a total range of 0.6 gallon. All individual test results are within the allowable error limits.

Although the individual test results are within applicable tolerances, the range of the multiple test results exceeds the allowable limits for repeatability toler-ance and the device fails the repeatability test.