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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).

−0.3 gal	0	+0.3 gal
T_3	T_2 T_1	

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.

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Testing the Maximum Span Load on a Vehicle Scale

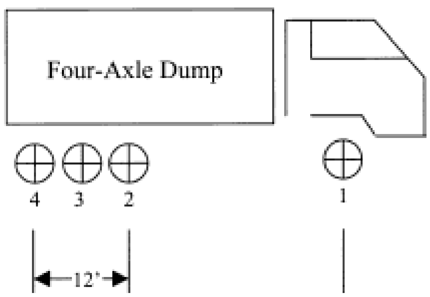
By Rick Harshman

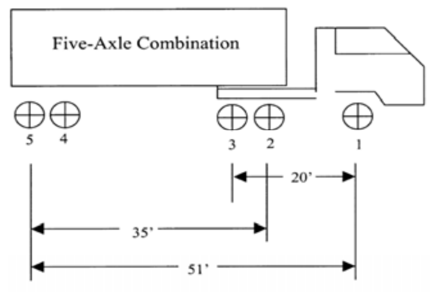
WMD has received a number of inquiries from field inspection personnel regarding the application of Scales Code, UR.3.2.1 and the accompanying Table UR.3.2.1., entitled “Span Maximum Load.” This requirement and the accompanying table were originally introduced into NIST Handbook 44 to aid users in selecting a suitable vehicle scale and to establish a uniform method of rating the axle-load capacity of a scale so that manufacturers were provided a consistent basis for competition. It is equally important to recognize the field application of the requirement, i.e., it limits the amount of load a user is permitted to apply within a specified span of vehicle scale platform.

The varying ways that loads can be applied to a vehicle scale create different stresses within the weighbridge. For example, the force per unit area is generally greater for the wheels of a dual tandem axle truck than for block test weights. This is because all of the force of the load created by a dual tandem axle is applied to the scale platform within the narrow prints of the tires that support the dual tandem axle. While block test weights of equal mass may be applied over the same platform area as the tires supporting a tandem axle, the force per unit area of the platform is less because the load is spread over the entire area. As a general rule, the greater the area of platform consumed by a load, the greater the maximum loading allowed. Table UR.3.2.1. provides a list of multipliers which take into consideration the different stresses of various axle configurations. When applying this table, you will notice that as the length between the extremes of any two or more axles of a truck is increased, a higher factor is used to determine the maximum allowable load applied by those axles.

To determine if users are exceeding the maximum allowable loading of a platform span, it is necessary to measure the distances between the centers of the sets of axles of various trucks. When selecting trucks for the testing of span loads, attempt to select only the heaviest of loaded trucks. Also try to select trucks having a variety of different axle configurations. The factors listed in Table UR.3.2.1. to be applied are based upon the total number of axles contained within a given span and the distance in feet between the extremes of the first and last axle in that span. The maximum allowable loading of any platform span is the product of the marked concentrated load capacity (CLC) times the appropriate factor determined by the axle spacing. Once maximum span loading has been calculated for a specific set of truck axles, the actual weight of those axles is determined by weighing them together, as a group, on the scale. The total weight of those axles must not exceed the calculated maximum span loading.

The illustration shown below provides some examples of axle spacing measurements taken between the extreme centers of two or more consecutive axles on two popular types of truck. The illustration also shows the outer axles that are to be measured when testing maximum span loading for these two vehicles. The axle configurations of other types of trucks can be similarly measured and used in testing. It is important to note, however, that axle spacing may vary greatly between trucks of the same type, and therefore measurements must always be taken for each truck selected for testing. Once the axle measurements have been obtained, verifying compliance is a simple matter of weighing the axles in each measured group and making certain that none of the groups exceed the calculated maximum load based upon the number of axles contained in each span. As can be seen from the illustration, all of the axle sets that have been measured can also be easily weighed together as a group on a vehicle scale.





For additional information concerning the maximum span loading of vehicle scales, contact Rick Harshman by e-mail at richard.harshman@nist.gov or by phone at 301-975-8107.