**Suggestion for Analysis of Inspection Results for Vehicle Scales**

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The most effective justifications for weights and measures programs use the actual inspection results for the jurisdiction. Developing an approach to calculate the economic impact for W&M inspections of scales is more difficult than for meters. Scales are tested at many test loads, whereas each meter is typically tested at only two flow rates. Additionally, weights are placed over each section of a vehicle scale and then strain load tests are often conducted. From a practical standpoint, it is virtually impossible to test a vehicle scale using only test weights all the way to scale capacity. Vehicle scales should be tested using test weights equal to a minimum of 12.5% of scale capacity, a substitution test to at least 25% of scale capacity, and then a strain load conducted to at least the used capacity of the scale. In reality, it is common that vehicle scales are tested using about 20,000 lb of test weights over each section starting at zero load and then a strain load is conducted using the 20,000 lb of test weights.

Vehicle scales are often used to weigh the empty (tare) weight of a truck and then weigh the truck after it has been loaded. The net weight is calculated from these two weights.

The proposed approach to estimate the W&M impact of testing vehicle scales is to:

1. Use the percentages of out of tolerance for scale accuracy determined separately for scales with minus errors and scales with plus errors;
2. Use the largest plus or minus error in the scale for the test loads that were applied;
3. Calculate the average minus and average plus errors for the scales that were out of tolerance (but excluding outliers so that the averages are not unduly skewed);
4. Use the amount of sales in dollars that pass over all of the vehicle scales in one year to calculate the value of the weighing errors in dollars for the out-of-tolerance scale errors; and
5. Compare the inspection results to any other reference point (benchmark) that the jurisdiction would like to use.

One can argue whether or not it is appropriate to use the maximum error for the scale tests in the calculation for the economic impact. If someone has a better suggestion, then another value should be considered.

One objection may be that a vehicle scale consists of multiple sections, so the maximum error for a single section may not be appropriate. However, the tolerance on the range of test results among sections (TN.4.4.) provides a limit on how much results may vary from section to section. Another objection may be that trucks are weighed empty and loaded, so the maximum error associated with the section tests and the strain load tests may not be appropriate. However, one supporting rationale is that:

* Vehicle scales are tested with rather small test loads relative to the capacities of the scales;
* Scale accuracy is expected to be linear up to the capacity of the scale; hence, if a scale has an error of 40 lb at 20,000 lb, you expect that the scale should have an error of 80 lb at 40,000 lb; and
* Since trucks usually carry a net load that is often greater than the tare weight of the truck, the difference between the gross and tare weight (i.e., the net weight) will be greater than the errors determined using the test weights applied for the test loads used to test the scale.

As stated previously, if someone has a better idea, I am open to improvements to the approach.

**Steps for the Calculation**

1. Identify the largest error for accuracy for each scale tested. Retain the sign (+ or -) with the value.
2. Calculate the average for the largest **minus** errors for the scales that were out of tolerance. Exclude outliers.
3. Calculate the average for the largest **plus** errors for the scales that were out of tolerance. Exclude outliers.
4. Identify the typical amount of test weights used to test the scale, e.g., 20,000 lb. This value is used to calculate the percentage values for the averages of the largest plus and minus errors.
5. Count the number of scales that were out of tolerance for minus errors and count the number of scales that were out of tolerance for plus errors.
6. Calculate as a percentage, the number of all scales tested that were out of tolerance plus errors and then the percentage out of tolerance for minus errors.
7. Obtain a value for the amount of product sold in the jurisdiction based upon weights from the vehicle scales.
8. Plug the numbers into the spreadsheet.

**Additional Analysis and Presentation of Inspection Results**

To visually present inspection results, the following are suggested. Categorize the reasons that scales are rejected based upon the largest errors in the inspection results. Categorize the errors as multiples of the tolerance. Then present the information as pie charts as count and as a percentage of the total number of devices inspected. (See the charts below. These charts are not based on actual data.) There may be two or more tolerances to which a scale may not comply, so the total number of reasons that scales were rejected may exceed the number of scales that were tested. This information may be helpful for program management and to present inspection results to administrators who are not that familiar with the requirements of Handbook 44.



It may also be useful to look at the distribution of the largest errors for the scales as multiples of the tolerance value for the largest test load. Please see the chart below. (Actual data was not used for the chart.)

In cases where a high percentage (say greater than 90%) of devices tested are in tolerance, these charts are not an effective way to present the inspection results. In these cases, a simple table of the results may be more effective. The use of these charts can be adapted to other types of weighing and measuring devices.