White Paper for NCWM
Regional Meetings
September 21, 2017

The Weigh-in-Motion (WIM) Vehicle Scale Task Group is asking for input from the regional associations on some key development points.

Point 1: Acceptance tolerance requirements
Point 2: Guidance on 3 draft proposals for a Dynamic Field Test Procedure

Acceptance Tolerance.
The Task Group is seeking input along the following lines.

Static Test: Acceptance = ½ Maintenance Dynamic Test: Acceptance = ½ Maintenance

Or

Static Test: Acceptance = ½ Maintenance Dynamic Test: Acceptance = Maintenance

Note: For some potential WIM designs it may not be possible to conduct a static test due to the dimensions of the load receiving element.

Field Test Procedure.
The Task Group is recommending two test notes for inclusion in NIST Handbook 44 Section 2.20. Scales. The test notes, N.7.1. Static Testing and N.7.2. Dynamic testing are included for review.

For the draft test procedures, two of the draft test procedures are for dynamic testing of a WIM scale. The third is a procedure for creating one or more reference vehicles using a reference scale, if it is deemed necessary to have reference vehicles weighed on a reference scale. All draft test procedures are included below.

N.7. Weigh-in-Motion Vehicle Scale.

N.7.1. Static Testing. – A Weigh-in-Motion Vehicle Scale shall be tested statically, whenever possible, using field standard weights / test loads in accordance with Table 4, uniformly distributed on the scale platform. Additionally, for scale platforms with a length of less than 4 feet a test load not greater than one half of section capacity shall be positioned between the centerline and left and right side respectively. Scale platforms with a length of 4 feet or greater shall be tested in accordance with N.1.3.3.1.

Class IIIL acceptance and maintenance tolerance as shown in Table 6. shall apply.

N.7.2. Dynamic Testing. – The Dynamic test for a Weigh-in-Motion-Vehicle Scale shall simulate the normal intended use as closely as possible i.e. test as used. The minimum test shall consist of a vehicle(s), loaded with known field standards, dynamically weighed three consecutive times. The known field standards should then be unloaded and three additional dynamic weighments of the empty vehicle(s) should be recorded. Additionally, for scale platform widths greater than 11 feet, at least one of the loaded vehicle runs and empty vehicle runs shall be made near the left edge and right edge of the scale platform respectively. Class IIIL maintenance tolerance as shown in Table 6. shall apply to the known field test standards load minus the calculated value (loaded weight – unloaded weight = calculated value) the Table 6 tolerance values shall be based on the value of the known test load.

(Added 20XX)

Below are five questions that were developed by the Task Group and for which the Task Group is seeking input. The various draft field test procedures were developed prior to the development of N.7.1. and N.7.2. and may need to be updated slightly for consistency with the recommended test notes. The intent of the white paper is to remain neutral on the information provided so the Regional Associations can provide input without the influence of Task Group discussion; however, Task Group members may provide opinions during Regional association open hearings.

Questions for which the Task Group is seeking input:

1. For dynamic testing only of WIM Scales will acceptance = maintenance tolerance be acceptable?

2. Noting that there may be different types/configurations of vehicles weighed on the WIM's, how many vehicles are needed to accurately conduct a dynamic test of the WIM scale?

3. For a WIM Dynamic Test Procedure.

    a. Is an approved reference scale required to establish the reference weight of test vehicle(s) that would be used as a test standard in the dynamic testing?

    b. Can the Scale Under Test (SUT) be used to establish the reference weight of a test vehicle provided the SUT is first tested statically in accordance with the recommended N.7.1.?

4. Do you believe that proposed paragraph N.7.2. provides sufficient guidance for the field official to conduct a dynamic test of a WIM scale?

a. If so, which draft test procedure option 1 or 2 listed below do you prefer?

5. If the load receiving element of a WIM scale is too small to conduct an appropriate static test, is the use of a reference scale the only option?

Draft Test Procedures

General requirements

A test vehicle(s) should be representative of the vehicles typically weighed on the Scale Under Test (SUT).

Speed during test runs must be within the speed limits marked on the SUT.

Test runs should be made in the direction(s) used during normal use.

The SUT shall be tested to a minimum net load as set forth in Table 4 of Handbook 44 Section 2.20. Scales.

At least three test runs shall be made in each direction normally used to demonstrate repeatability.

Corrections for fuel usage for the test vehicle shall be made if required. The procedure below minimizes the effect of fuel usage.

The speed of the test vehicle shall be stabilized within prescribed limits prior to entrance onto the weighing element and maintained while crossing the weighing element.

The indicated net weigh value for each gross, tare, net determination shall be within applicable tolerance for that test load.

Comparisons for repeatability shall be based on the gross load determination in the same direction across the weighing element.

Prior to in-motion testing the weighing element shall be tested statically in accordance with NIST Handbook 112, EPO 13E and calibrated if necessary.

Note from the Task Group: As documented below, the primary difference between Draft Test Procedure Option 1 & 2 is seen in the manner and sequence in which the loaded and unloaded vehicle weights are obtained. Option 1 specifies that all loaded vehicle weights are obtained consecutively, followed by all unloaded vehicle weights being obtained consecutively. Option 2 specifies that the weighing process is performed in sets or pairs of loaded, then unloaded vehicle weights (i.e., the determination of each loaded vehicle weight is followed immediately by the determination of an unloaded vehicle weight).

Draft Test Procedure; Option 1

Loaded Weight – Unloaded Weight = Calculated Weight
Dynamic Test Procedure

Vehicles representative of each type of vehicle normally weighed shall be loaded with known test standards to obtain a loaded weight and calculated weight that will comply with the recommended minimum test weight and test load requirements of Handbook 44 Section 2.20. Scales Table 4.

Weigh each truck representative of vehicles normally weighed loaded with known test standards three times in each direction (total of six weights) to determine loaded weights.

Unload the known test standards and weigh each empty vehicle three times in each direction (total of six weights) to determine the unloaded weight.

Compare each loaded weight indication to a respective unloaded weight indication to determine the calculated difference between each loaded weight minus unloaded weight. This calculated weight is then compared to the value of the known test standards used to determine the amount of error.

Draft Test Procedure; Option 2

WIM Dynamic
Test Procedure

TEST: Bidirectional scale (in and out).

1. Starting at a distance as prescribed by the manufacture drive the empty vehicle across the weighing element and record the total unloaded weight of the empty truck
2. Turn around at a distance appropriate to begin a test in the opposite direction and shut down the engine.
3. Load known test standards onto the empty truck in an amount equal or greater than the load required by Table 4. appropriately distributed on truck bed.
4. Drive the loaded truck across the weighing element and record the gross weight of the loaded truck.
5. Turn truck around at an appropriate distance and shut down engine.
6. Determine the net indicated net weight of the test load and record any error. (Indicated net load minus actual weight of known standards.)
7. Drive loaded truck across weighing element and record gross weight of loaded truck.
8. Turn truck around at an appropriate distance and shut down engine.

9. Remove known test standards from truck.
10. Drive empty truck across the weighing element and record the total empty truck weight.
11. Turn truck around at an appropriate distance and shut down engine.
12. Determine the net indicated net weight of the test load and record any error. (Indicated net load minus actual weight of known standards.)
13. Record previous empty truck weight and reload known test standards.
14. Drive loaded truck across weighing element and record the gross weight of the loaded truck.
15. Turn truck around at an appropriate distance and shut down engine.
16. Determine the net indicated net weight of the test load and record any error. (Indicated net load minus actual weight of known standards.)
17. Repeat steps 1 through 16 until at least three complete gross net tare weighments have been made in each direction.
18. Compare net weight values in each direction to determine repeatability for each direction.

TEST: Single direction scale.

1. Starting at a distance as prescribed by the manufacture drive the empty vehicle across the weighing element and record the total tare weight of the empty truck
2. Either, circle truck around or backup to the original starting point and shut down engine.
3. Load known test standards onto the empty truck in an amount equal or greater than the load required by Table 4. appropriately distributed on truck bed.
4. Drive the loaded truck across the weighing element and record the gross weight of the loaded truck.
5. Either, circle truck around or backup to the original starting point and shut down engine.
6. Determine the calculated weight of the test load and record any error. (Indicated net load minus actual weight of known standards.)
7. Drive loaded truck across weighing element and record gross weight of loaded truck.
8. Either, circle truck around or backup to the original starting point and shut down engine.
9. Remove known test standards from truck.
10. Drive empty truck across the weighing element and record the total empty truck weight.
11. Either, circle truck around or backup to the original starting point and shut down engine.
12. Determine the calculated weight of the test load and record any error. (Indicated net load minus actual weight of known standards.)
13. Record previous empty truck weight and reload known test standards.
14. Drive loaded truck across weighing element and record the loaded weight of the loaded truck.
15. Either, circle truck around or backup to the original starting point and shut down engine.
16. Determine the calculated weight of the test load and record any error. (calculated load minus actual weight of known standards.)
17. Compare calculated weight values for each complete loaded weight, unloaded weight, calculated weight cycle to determine repeatability.

18. Compare net weight values for each complete gross, tare, net cycle to determine repeatability.

Reference Scale & Reference Vehicle(s) for Testing a Weigh in Motion Vehicle Scale

As a general guideline the Reference Scale should be a full length vehicle scale of sufficient length and capacity to weigh the Reference Vehicle(s) in a single draft. The Reference Scale should be located as close as possible to the Weigh in Motion (WIM) scale to be evaluated. The Reference vehicle(s) should be representative of those normally weighed on the WIM scale being evaluated. The Reference Scale is to be tested as close as possible to immediately prior to the evaluation of the WIM scale being evaluated and within a maximum of 24 hours prior to the WIM scale evaluation.

Prior to testing the indicator of the Reference scale may be set to a higher resolution (10 lb) for the purpose of weighing the Reference Vehicle(S). The Reference Scale shall be tested to at least the weight of the heaviest Reference vehicle to be used in conducting the WIM scale evaluation using either sufficient known test weights or a combination of known test weights and substitution test procedures. All reference Scale readings shall be made using error weights to 0.1 d and the lower edge of the zone of uncertainty as reference point or with expanded resolution if available. If reasonably stable reading using error weights cannot be achieved due to environmental factors such as wind, testing should be suspended until reasonably stable reading can be achieved. It is recommended that the reference scale the Reference Scale shall be adjusted to near zero error as possible, but in any case when weighing the Reverence Vehicle and error found in the range of the weight of the vehicle(s) shall be taken into account and the weight of the vehicle(s) assigned accordingly.

The Reference Vehicle(s) should be weighed at least three times, taking care to locate the vehicle in the same position on the Reference Scale each time, to determine repeatability of the scale. All weight readings shall be made using error weights to 0.1 d and the lower edge of the zone of uncertainty as a reference point or expanded resolution if available. A maximum variation in the multiple weighments shall be not greater than 1/3rd of the tolerance applicable to the WIM scale being evaluated, at the weight of Reference Vehicle. If a variation in the repeatability of the Reference Vehicle is observed, the weight value assigned should be the average to the weights determined.

When testing the WIM scale fuel consumption by the Reference Vehicle must be taken into account. Whenever possible the engine of the Reference Vehicle should be shut down to conserve fuel. Other correction should be made using the known mileage rating (provided by the vehicle operator) and the weight of fuel per gallon used, using 6.073 lb / gallon for gasoline and 7.15 lb / gallon for #2 diesel fuel.

Using error weights and the lower edge of the zone of uncertainty:

1. Apply error weights to the load receiving element (LRE) equal to the division of the Reference Scale.
2. Zero the Scale leaving the error weights on the LRE.
3. At zero load apply error weights to the LRE in increments of 0.1 d until the indictor begins to flash between zero and +1 d and record the amount required. Remove the error weights and return to zero.
4. Remove error weights from weights original balance in to the LRE in increments of 0.1 d until the indicator begins to flash between zero and – 1 d and record the amount required. Replace the error weights to reestablish a zero indication. In most cases the amount added or removed to reach the zone of uncertainty will be the same or very close to equal. If not repeat both procedures being sure that the tests are starting from a center of zero condition.

   The amount of error weights required to bring the indicator to the zone of uncertainty in either an increasing or decreasing load fashion will be used to determine any actual error in the scale during all increasing load or section testing.

   As an example: With a 10 lb d; from zero 6 lb of error weight bring the scale to the zone of uncertainty in the applicable direction. When 12,000 lb of known test load is applied to the LRE the initial indication is 11,990 lb. The amount of error weight required to display the zone of uncertainty between 11,990 and 12,000 is 8 lb. Therefor the error in the scale at that test load is 12 lb. [6 lb] – [8 lb] + [(11,990 – 12,000)] = - 12 lb.
5. Record the error determined for this test load.
6. Continue the increasing load test using known test weights and substation test methods to at least the weight of the largest Reference Vehicle to be weighed.

   When establishing a substitution load value the substitution load will be "trimmed" using small weights to reproduce the zone of uncertainty value of the previous known test load. At that point the weight of the substitution load will actually equal the same amount of know test standards.

7. Once all testing of the LRE is completed the Reference Vehicle(s) shall be weighed as described above using the same zone of uncertainty procedure and taking into account the actual error in the scale at the range of the weight of the vehicle. When the actual weight of the Reference Vehicle has been determined it may be convenient to "trim" the weight of the Reference Vehicle to the next whole value of d for the WIM scale to be evaluated.