

## Appendix B

### NIST Handbook 44 – Scales

#### Item 320-3:

Revision 2 Draft Tentative Code Applicable to Weigh-In-Motion Systems Used for  
Vehicle Enforcement Screening

### Weigh-In-Motion Systems used for Vehicle Enforcement Screening – Draft Code

#### A. Application

- A.1. General.** – This code applies to systems used to weigh vehicles, while in motion, for the purpose of screening and sorting the vehicles based on the vehicle weight to determine if a static weighment is necessary.
- A.2.** The code does not apply to weighing systems intended for the collection of statistical traffic data.
- A.3.** The code is intended for field enforcement use only.
- A.4. Additional Code Requirements.** – In addition to the requirements of this code, Weigh-In-Motion Screening Systems shall meet the requirements of Section 1.10. General Code.

#### S. Specifications

##### S.1. Design of Indicating and Recording Elements and of Recorded Representations.

**S.1.1. Ready Indication.** – The system shall provide a means of verifying that the system is operational and ready for use.

**S.1.2. Value of System Division Units.** – The value of a system division “d” expressed in a unit of weight shall be equal to:

- (a) 1, 2, or 5; or
- (b) a decimal multiple or submultiple of 1, 2, or 5.

Examples: divisions may be 10, 20, 50, 100; or 0.01, 0.02, 0.05; or 0.1, 0.2, 0.5, etc.

**S.1.2.1. Units of Measure.** – The system shall indicate weight values using only a single unit of measure.

##### S.1.3. Value of Other Units of Measure.

**S.1.3.1. Speed.** – Vehicle speeds shall be measured in miles per hour or kilometers per hour.

**S.1.3.2. Axle-Spacing (Length).** – The center-to-center distance between any two successive axles shall be measured in feet and/or inches, or meters.

**S.1.3.3. Vehicle Length.** – If the system is capable of measuring the overall length of the vehicle, the length of the vehicle shall be measured in feet and/or inches, or meters.

**S.1.4. Capacity Indication.** – An indicating or recording element shall not display nor record any values greater than 105 % of the specified capacity of the load receiving element.

**S.1.5. Identification of a Fault.** – Fault conditions shall be presented to the operator in a clear and unambiguous means. The following fault conditions shall be identified:

- (a) Vehicle speed is below the minimum or above the maximum speed as specified.
- (b) The maximum number of vehicle axles as specified has been exceeded.
- (c) A change in vehicle speed greater than that specified has been detected.

**S.1.6. Recorded Representations.**

**S.1.6.1. Values to be Recorded.** – At a minimum, the following values shall be printed and/or stored electronically for each vehicle weighment:

- (a) transaction identification number;
- (b) lane identification (required if more than one lane at the site has the ability to weigh a vehicle in-motion);
- (c) vehicle speed;
- (d) number of axles;
- (e) weight of each axle;
- (f) identification and weight of axles groups;
- (g) axle spacing;
- (h) total vehicle weight;
- (i) all fault conditions that occurred during the weighing of the vehicle;
- (j) violations, as identified in paragraph S.2.1., that occurred during the weighing of the vehicle; and
- (k) time and date.

**S.1.7. Value of the Indicated and Recorded System Division.** – The value of the system's division size as recorded shall be the same as the division value indicated.

**S.2. System Design Requirements.**

**S.2.1. Violation Parameters.** – The instrument shall be capable of accepting user entered violation parameters for the following items:

- (a) single axle weight limit

- (b) axle group weight limit
- (c) gross vehicle weight
- (d) bridge formula load

The instrument shall display and or record violation conditions when these parameters have been exceeded.

**S.3. Design of Weighing Elements.**

**S.3.1. Multiple Load-Receiving Elements.** – An instrument with a single indicating or recording element, or a combination indicating-recording element, that is coupled to two or more load-receiving elements with independent weighing systems, shall be provided with means to prohibit the activation of any load-receiving element (or elements) not in use, and shall be provided with automatic means to indicate clearly and definitely which load-receiving element (or elements) is in use.

**S.4. Design of Weighing Devices, Accuracy Class.**

**S.4.1. Designation of Accuracy.** – WIM Systems meeting the requirements of this code shall be designated as accuracy Class A.

**Note:** This does not preclude higher accuracy classes from being proposed and added to this Code in the future when it can be demonstrated that WIM systems grouped within those accuracy classes can achieve the higher level of accuracy specified for those devices.

**S.5. Marking Requirements.** – In addition to the marking requirements in G-S.1. Identification (except G-S.1.(e)), G-S.4. Interchange or Reversal of Parts, G-S.6. Marking Operational Controls, Indications, and Features, G-S.7. Lettering, and G-UR.2.1.1. Visibility of Identification. The system shall be marked with the following information:

- (a) Accuracy Class;
- (b) Value of the System Division “d;”
- (c) Operational Temperature Limits;
- (d) Number of Lanes;
- (e) Minimum and Maximum Vehicle Speed;
- (f) Maximum Number of Axles per Vehicle;
- (g) Maximum Change in Vehicle Speed during Weighment; and
- (h) Minimum and Maximum Load.

**S.5.1. Location of Marking Information.** – The marking information required in G-S.1. Identification of the General Code and S.5. Marking Requirements shall be visible after installation. The information shall be marked on the system or recalled from an information screen.

## N. Notes

### N.1. Test Procedures.

**N.1.1. Selection of Test Vehicles.** – All dynamic testing associated with the procedures described in each of the subparagraphs of N.1.5. Test Procedures shall be performed with a minimum of two test vehicles.

- (a) The first test vehicle may be a two axle, six tire, single unit truck; a vehicle with two axles with the rear axle having dual wheels. The vehicle shall have a maximum Gross Vehicle Weight of 10 000 lb.
- (b) The second test vehicle shall be a five axle, single trailer truck with a maximum Gross Vehicle Weight of 80 000 lb.

**Note:** Consideration should be made for testing the systems using vehicles which are typical to the systems daily operation.

**N.1.1.1. Weighing of Test Vehicles.** – All test vehicles shall be weighed on a reference scale before being used to conduct the dynamic tests.

**N.1.1.2. Determining Reference Weights for Axle, Axle Groups and Gross Vehicle Weight** – The reference weights shall be the average weight value of a minimum of three static weighments of all single axle, axle groups and gross vehicle weight.

**Note:** The weight of individual axles within an axle group is not considered as a single axle. Only the weight of the axle group is used when conducting the test described in N.1.5. Test Procedures.

### N.1.2. Test Loads.

**N.1.2.1. Static Test Loads.** – All static test loads shall use certified test weights.

**N.1.2.2. Dynamic Test Loads.** – Test vehicles used for dynamic testing shall be loaded to 85 % to 95 % of their maximum Gross Vehicle Weight. The “load” shall be non-shifting and shall be positioned to present as close as possible, an equal side-to-side load.

**N.1.3. Reference Scale.** – Each reference vehicle shall be weighed statically on a three platform vehicle. The scale shall have been certified to NIST Handbook 44, Class III L maintenance tolerances within the last 30 days.

**N.1.3.1. Location of a Reference Scale.** – The location of the Reference Scale must be considered as vehicle weights will change due to fuel consumption.

**N.1.4. Test Speeds.** – All dynamic tests shall be conducted within 20 % below or at the posted speed limit.

### N.1.5. Test Procedures.

**N.1.5.1. Dynamic Load Test.** – The dynamic test shall be conducted using the test vehicles defined in N.1.1. The test shall consist of a minimum of 20 runs for each test vehicle at the speed as stated in N.1.4. Test Speeds.

At the conclusion of the dynamic test, there will be a minimum of 20 weight readings for each single axle, axle group, and gross vehicle weight. The tolerance for each weight reading shall be based on the percentage values specified in Table T.3.1. Tolerances as a Percentage of Applied Test Load.

**N.1.5.2. Axle Spacing Test.** – The axle spacing test is a review of the displayed and/or recorded axle spacing distance of the test vehicles. The tolerance value for each distance shall be based on the tolerance value specified in T.3.2.

**N.1.5.3. Vehicle Position Test.** – During the conduct of the dynamic testing the vehicle shall adjust its position along the width of the sensor from one run to the next but ensuring that the vehicle stays within the defined roadway. The test shall be conducted with 10 runs in the center, five runs on the right side, and five runs on the left side. All weighments shall be within tolerance.

## T. Tolerances

### T.1. Principles.

**T.1.1. Design.** – The tolerance for a weigh-in-motion system is a performance requirement independent of the design principle used.

### T.2. Tolerance Application.

**T.2.1. General.** – The tolerance values are positive (+) and negative (–). No more than 5 % of each single axle, axle group or gross vehicle weight reading shall be outside the applicable tolerances.

### T.3. Tolerance Values for Accuracy Class A.

**T.3.1. Tolerance Values for Dynamic Testing.** – The tolerance values applicable during dynamic load testing are as specified in Table T.3.1. Tolerances as a Percentage of Applied Test Load.

<b>Table T.3.1. Tolerances for Accuracy Class A</b>	
<b>Load Description</b>	<b>Tolerance as a Percentage of Applied Test Load</b>
Axle Load	20 %
Axle Group Load	15 %
Gross Vehicle Weight	10 %

**T.3.2. Axle Spacing Tolerance.** – The tolerance value applied to the axle spacing measurement shall be  $\pm 0.5$  ft (0.15 m).

### T.4. Influence Factors.

– The following factor are applicable to tests conducted under controlled conditions only.

**T.4.1. Temperature.** – Systems shall satisfy the tolerance requirements under all operating temperature unless a limited operating temperature range is specified by the manufacturer.

### T.5. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility.

– The difference between the weight indication due to the disturbance and the weight indication without the disturbance shall not exceed the tolerance value as stated in Table T.3.1. Tolerances for Accuracy Class A.

## UR. User Requirements

**UR.1. Selection Requirements.** – Equipment shall be suitable for the service in which it is used with respect to elements of its design, including but not limited to, its capacity, number of scale divisions, value of the scale division, or verification scale division and minimum capacity.

**UR.1.1. General.**

The typical class or type of device for particular weighing applications is shown in Table 1. Typical Class or Type of Device for Weighing Applications.

<b>Table 1. Typical Class or Type of Device for Weighing Applications</b>	
<b>Class</b>	<b>Weighing Application</b>
A	Screening and sorting of vehicles based on axle, axle group and gross vehicle weight.
<b>Note:</b> A WIM system with a higher accuracy class than that specified as “typical” may be used.	

**UR.2. User Location Conditions and Maintenance.** – The system shall be installed and maintained as defined in the manufacturer’s recommendation.

**UR.2.1. System Modification.** – The dimensions (e.g., length, width, thickness, etc.) of the load receiving element of a system shall not be changed beyond the manufacturer’s specifications, nor shall the capacity of a scale be increased beyond its design capacity by replacing or modifying the original primary indicating or recording element with one of a higher capacity, except when the modification has been approved by a competent engineering authority, preferably that of the engineering department of the manufacturer of the system, and by the weights and measures authority having jurisdiction over the system.

**UR.2.2. Foundation, Supports, and Clearance.** – The foundation and supports shall be such as to provide strength, rigidity, and permanence of all components.

On load-receiving elements which use moving parts for determining the load value, clearance shall be provided around all live parts to the extent that no contacts may result when the load-receiving element is empty, nor throughout the weighing range of the system.

**UR.2.3. Access to Weighing Elements.** – If necessary, adequate provision shall be made for inspection and maintenance of the weighing elements.

**UR.3. Maximum Load.** – A system shall not be used to weigh a load of more than the marked maximum load of the system.

**The following are proposed definitions to be added to NIST Handbook 44, Appendix D to support the Weigh-In-Motion Systems used for Vehicle Enforcement Screening – Draft Code.**

**weigh-in-motion (WIM).** – A process of estimating a moving vehicle’s gross weight and the portion of that weight that is carried by each wheel, axle, or axle group, or combination thereof, by measurement and analysis of dynamic vehicle tire forces.

**axle.** – The axis oriented transversely to the nominal direction of vehicle motion, and extending the full width of the vehicle, about which the wheel(s) at both ends rotate.

**axle-group load.** – The sum of all tire loads of the wheels on a group of adjacent axles; a portion of the gross-vehicle weight.

**axle load.** – The sum of all tire loads of the wheels on an axle; a portion of the gross-vehicle weight.

**axle spacing.** – The distance between the centers of any two axles. When specifying axle spacing, you also need to identify the axles used.

**single-axle load.** – The load transmitted to the road surface by the tires lying on the same longitudinal axis (that axis transverse to the movement of the vehicle and about which the wheels rotate).

**tandem-axle load.** – The load transmitted to the road surface by the tires of two single-axles lying on the same longitudinal axis (that axis transverse to the movement of the vehicle and about which the wheels rotate).

**triple-axle load.** – The load transmitted to the road surface by the tires of three single-axles lying on the same longitudinal axis (that axis transverse to the movement of the vehicle and about which the wheels rotate).

**Weigh-in-Motion Screening Scale.** – A WIM system used to identify potentially overweight vehicles.

**Wheel weight.** – The weight value of any single or set of wheels on one side of a vehicle on a single axle.

**WIM System.** – A set of sensors and supporting instruments that measure the presence of a moving vehicle and the related dynamic tire forces at specified locations with respect to time; estimate tire loads; calculate speed, axle spacing, vehicle class according to axle arrangement, and other parameters concerning the vehicle; and process, display, store, and transmit this information. This standard applies only to highway vehicles.

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