WIM – WEIGH-IN-MOTION SYSTEMS – TENTATIVE CODE

WIM-23.1 I 2.26 Weigh-in-Motion Systems Used for Vehicle Direct Enforcement

Source:
New York City DOT, C2SMART, Kistler, and Maryland DOT

Purpose:
Provide a legal document that can be used by local and State agencies to certify Weigh-In-Motion (WIM) systems used for automated weight enforcement.

Item under Consideration:
Add Handbook 44 Weigh-In-Motions Systems Used for Vehicle Direct Enforcement Code as follows:

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Section 2.26 Weigh-In-Motion Systems Used for Vehicle Direct Enforcement

A. APPLICATION

A.1. General . – This code applies to systems installed in a fixed location used to weigh vehicles, while in motion, for the purpose of direct enforcement of legal weight limits.

A.2. Exception. – This code does not apply to weighing systems intended for the collection of statistical traffic data and weighing systems used for vehicle enforcement screening.

A.3. Additional Code Requirements. – In addition to the requirements of this code, weigh-in-motion systems shall meet the requirements of Section 1.10. General Code.

S. SPECIFICATIONS

WHERE DID CLASS "E" COME FROM? WHAT IS CLASS E? WHERE ARE THE OTHER CLASSES OF SYSTEMS?

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. Maximum Value of Division. – The value of the system division "d" for a Class E weigh-in-motion (WIM) system (WIM) system shall not be greater than 200 kg or 500 lb.

Why would we permit "d" greater than one hundred pounds or much less five hundred pounds? Class IIILis limited to a minimum of 2000 "d" and maximum of 10,000 "d".

S.1.3.1. Number of System Divisions. **– The number of system divisions for Class E shall be a minimum of 50 and a maximum of 1,000.**

A 200,000 pound capacity system with 4,000 divisions with equals 50 pounds as the value of "d".

S.1.3.2. Minimum Capacity. **– The minimum capacity in system divisions for Class E shall be 10.**

A systems with 200,000 capacity with value of "d" at 100 pounds would be legal with 2,000 divisions.

S.1.4. Value of Other Units of Measure.

S.1.4.1. Speed. **– Vehicle speeds shall be measured in miles per hour or kilometers per hour.**

***S.1.4.2. Axle-Spacing (Length).* – The center-to-center distance between any two successive axles shall be measured in:**

(a) **meters and decimal submultiples of a meter;**

(b) **feet and inches; or**

(c) **feet and decimal submultiples of a foot.**

***S.1.4.3. 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.1.5. 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.1.6. Identification of a Fault. – Fault conditions affecting accuracy as specified in Table T.2.3. Maintenance Tolerances for Accuracy shall be presented to the operator in a clear and unambiguous means. No weight values shall be indicated or recorded when a fault condition is detected. The following fault conditions shall be identified:

(a) **Vehicle speed is below the minimum or above the maximum system specified speed.**

(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.**

(d) **Imbalanced weight between the left and right wheels has exceeded the specified values.**

(e) **Vehicle has changed lanes between or in the proximity of the first and the last sensors.**

(f) **Any axle or wheel, or part of each is not on the load-receiving element of the sensors.**

(g) **Vehicle direction of travel is not valid for the installation.**

S.1.7. Recorded Representations.

***S.1.7.1. 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) **station ID;**

(c) **lane identification (required if more than one lane at the site has the ability to weigh a vehicle in motion);**

(d) **vehicle speed;**

(e) **number of axles;**

(f) **weight of each axle;**

(g) **identification and weight of axle groups;**

(h) **axle spacing;**

(i) **gross vehicle weight;**

(j) **total vehicle length;**

(k) **all fault conditions that occurred during the weighing of the vehicle, as identified in paragraph S.1.6. Identification of a Fault;**

(l) **violations, as identified in paragraph S.2.1. Violation Parameters, which occurred during the weighing of the vehicle; and**

(m) **time and date.**

Note: Consult the specific jurisdictional legislation for additional values that may be required to issue enforcement violations. All gross vehicle, axle, and axle group weights must be printed and/or stored with the corrected values that include any necessary reductions due to the system tolerance and adopted violation thresholds. Violation thresholds may be dependent on additional items, not specified in this code.

S.1.8. Value of the Indicated and Recorded System Division. – The value of the system's division "(d)," 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 limit; and**

(d) **bridge formula maximum.**

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

Note: Jurisdiction-defined weight limits for S.2.1 Violation Parameters (a) through (d) can be used to determine the violation.

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 E.

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 weigh-in-motion systems grouped within those accuracy classes can achieve the higher level of accuracy specified for those devices.

S.5. Design of Balance

S.5.2. Zero-Tracking Device. – A zero-tracking device shall have a range of 4% of the system capacity

and operate only when:

On 200,000 pound capacity scale with 100 pound divisions, 4% would equal 8000 pounds.

(a) the system is in a no-load condition;

(b) is in stable equilibrium; and

(c) the corrections are not more than 0.5 d per second; and

S.5.3. Totalizing Device. – A WIM system may be provided with a totalizing device for determining gross vehicle weight which operates:

(a) automatically, in which case the instrument shall be provided with a vehicle recognition device defined in S.5.4. Vehicle Recognition/Presence Device; or

(b) semi-automatically (e.g., it operates automatically following a manual command).

S.5.4. Vehicle Recognition/Presence Device. – WIM system which are able to operate without the intervention of an operator shall be provided with a vehicle recognition device. The device shall detect the presence of a vehicle in the weigh zone and shall detect when the whole vehicle has been weighed. WIM system shall not indicate or print the vehicle mass unless all wheel loads of the vehicle have been weighed.

S.6. Accidental Breakdown and Maladjustment. – WIM system shall be so constructed that an accidental breakdown or maladjustment of control elements likely to disturb its correct functioning cannot take place without its effect being evident.

S.7. Marking Requirements. – In addition to the marking requirements in G-S.1. 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 instrumented lanes (not required if only one lane is instrumented);

(e) minimum and maximum vehicle speed;

(f) maximum number of axles per vehicle;

(g) maximum change in vehicle speed during weighment;

(h) **minimum and maximum load; and**

(i) **any restrictions specified in the NTEP Certificate of Conformance.**

S.7.1. Location of Marking Information. – The marking information required in Section 1.10. General Code, G-S.1. Identification and S.7. 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.1.6 Test Procedures shall be performed with vehicles of these three types, at a minimum.

Exactly how many runs minimum would the examination require?

(a) **a two-axle, six-tire, single-unit truck or Federal Highway Administration (FHWA) Class 5; that is, a vehicle with two axles with the rear axle having dual wheels;**

(b) **a three-axle, single-unit truck or FHWA Class 6; and**

(c) **a five-axle, single-trailer truck or FHWA Class 9 (3S2 Type).**

(d) **The gross vehicle weights shall be as stated in N.1.2.2. *Dynamic Test Loads.***

I count a minimum of 30 test runs per type of vehicle = 90 runs minimum. Where does the inspector get the vehicles for the test runs? What is considered a non-shifting load? Where does the inspector get loads? Liquid loads not included in the category.

Note 1: Consideration should be made for testing the system using vehicles which are typical to the roadway in which the system is installed if different than the types listed in (a) through (c) above.

Note 2: If the WIM system will be used to enforce the weight limit for vehicles with liquid loads, a vehicle with a liquid load shall be included in the selection of test vehicles.

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

***N.1.1.2. Determining Reference Weights for Axles, 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 axles, axle groups, and gross vehicle weight on a reference scale before being used to conduct the dynamic tests.**

Note: The axles within an axle group are not considered single axles.

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 as specified below. Except when testing for liquid loads, the "load" shall be non-shifting and shall be positioned to present as close as possible, an equal side-to-side load.**

(a) a half load condition (60-80% of the legal load limit of the test vehicle) for a minimum of 10 runs per test vehicle type;

(b) a full load condition (> 85% of the legal load limit for the test vehicle) for a minimum of 20 runs per test vehicle type; and

(c) When it is anticipated that a system will be used to enforce weight limits for vehicles that may be unloaded, e.g., an unloaded Class 9 vehicle crossing a bridge with a 20 TN maximum capacity, tests shall include unloaded vehicles as part of the test load.

How does the inspector determine what range of the legal load he has applies? Where does the inspector get the equipment to load the test vehicle? Is there any data provided the accuracy of this testing?

N.1.3. Reference Scale. – Each reference vehicle shall be weighed statically on a multiple platform vehicle scale or a single-platform vehicle scale.

It appears in this test procedure, split-weighing is permitted on a single platform scale

The scale shall be tested prior to using it to establish reference test loads per direction from the jurisdiction and in no case more than 4 weeks prior. To qualify for use as a suitable reference scale, it must meet NIST Handbook 44, Class III L maintenance tolerances

Who would an inspector even think of testing a reference scale any days prior to the day of testing

N.1.3.1. Multi-Platform Vehicle Scale. **– It is comprised of three individual weighing/load-receiving elements, each an independent scale. The three individual weighing/load receiving elements shall be of such dimension and spacing to facilitate: the single-draft weighing of all reference test vehicles;**

(a) the simultaneous weighing of each single axle and axle group of the reference test vehicles on different individual elements of the scale; and

(b) gross vehicle weight determined by summing the values of the different reference axle and reference axle groups of a test vehicle.

N.1.3.2. Single-Platform Vehicle Scale. – Each individual axle or axle group of the reference test vehicles shall be measured on the single platform vehicle scale. Only one single axle or axle group for measurement shall be on the single platform, while other single axles or axle groups shall be off the platform. The gross vehicle weight shall be determined by summing all the single axles and axle groups.

This is split-weighing

N.1.3.3. Location of a Reference Scale. **– The location of the reference scale must be considered since vehicle weights will change due to fuel consumption.**

This nearly impossible in a lot cases?

N.1.4. Test Speeds. – All dynamic tests shall be conducted at two designated speeds.

(a) at a high speed – posted speed limit (Vmax); and

(b) at a low speed – site-specific minimum speed, not below manufacturer's requirement (Vmin).

N.1.5. Reference Axle Spacings. – To establish reference axle spacing, b*efore measuring the axle spacing, the test vehicle shall be positioned straight, and the driving axle shall also be straight. A steel tape measure shall be used for measurement. Both left and right axle spacing shall be measured, and the average of two measurements shall be recorded by the nearest cm (inches). Each axle spacing shall be made by a single measurement.*

N.1.6. Test Procedures.

***N.1.6.1. Dynamic Load Test.* – The dynamic test shall be conducted using the test vehicles defined in N.1.1. Selection of Test Vehicles and at the load condition as stated in N.1.2. Test Loads and at the speed as stated in N.1.4. Test Speeds. The number of runs shall be per Table N.1.5.**

At the conclusion of the dynamic test, there shall be a minimum of 20 weight readings for each single axle, axle group, and gross vehicle weight of each test vehicle. The tolerance for each weight reading shall be based on the percentage values specified in Table T.2.3. Maintenance Tolerances for Accuracy Class E.

Note. Any vehicle records identified as fault conditions listed in S.1.6. Identification of a Fault or jurisdiction defined fault conditions shall be excluded from the minimum weight readings in N.1.5.1. Dynamic Load Test.

See Table N.1.6 below to summarize the minimum number of test runs.

Table N.1.6 Minimum Number of Test Runs per Each Test Vehicle	
Load Condition	**Speed**
Half Load (10 runs)	**High Speed Vmax (5 runs)**
	Low Speed Vmin (5 runs)
Full Load (20 runs)	**High Speed Vmax (10 runs)**
	Low Speed Vmin (10 runs)

Is this posted speed of minimum and maximum speed?

***N.1.6.2. 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.2.4. Tolerance Value for Axle Spacing.**

T. TOLERANCES

T.1. Principles.

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

What does this mean exactly?

T.2. Tolerance Values for Accuracy.

T.2.1. Acceptance Tolerance. – Acceptance tolerance shall be 50% of tolerances in Table T.2.3. Maintenance Tolerances for Accuracy. The acceptance tolerance shall apply to a new installation or within 30 days of a new installation being placed in service or when an existing system undergoes major reconditioning or overhaul.

T.2.2 Tests Involving Digital Indications or Representations. – To the tolerances that would otherwise be applied in paragraphs T.2.3. Tolerance Value for Dynamic Load Test, there shall be added an amount equal to one-half the value of the system division to account for the uncertainty of digital rounding.

Are there systems in use not using digital indication?

T.2.3. Maintenance Tolerance Values for Dynamic Load Test. – The tolerance values applicable during dynamic load testing are as specified in Table T.2.3. for direct enforcement purposes.

Table T.2.3.
Maintenance Tolerances for Accuracy

Load Description*	Tolerance as a Percentage of Applied Test Load
Axle Load	± 20 %
Axle Group Load (including bridge formula)	± 15 %
Gross Vehicle Weight	± 10 %
* All weight readings shall be 100% in compliance.	

These tolerances are way out of bounds for the provided use and does not promote uniformity of the principles of the NCWM.

On a system with a capacity of 200,000 pounds and 100 pound division:

A axle with a 12,000 pounds of axle test load has an allowable tolerance of 2,400 pounds.

An axle group weighing 34,000 pounds of axle test load has allowable tolerance of 5,100 pounds

A vehicle weighing 80,000 pounds would have an allowable tolerance of 8,000 pouunds.

T.2.4. Tolerance Value for Axle Spacing. – The tolerance value applied to each axle spacing measurement shall be ± 0.15 m (6 inches) at 100% compliance.

T.3. Influence Factors. – The following factors are applicable to tests conducted under controlled conditions only.

T.3.1. Temperature. –The instrument shall operate within tolerance throughout the specified operational temperature range.

T.3.2. Temperature Effect on Zero-Load Balance. – The zero-load indication shall not vary by more than one division per 5°C (9°F) change in temperature.

T.3.3. Power Supply. – System shall satisfy the tolerance requirements in Table T.2.3. Maintenance Tolerance for Accuracy under voltage ranges of -15% to +10% of the marked nominal line voltage(s) at 60 Hz or the voltage range marked by the manufacturer at 60 Hz. The battery-operated systems shall satisfy the tolerance requirements in Table T.2.3. Maintenance Tolerance for Accuracy when the battery power output is not excessive or deficient.

T.4. 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.2.3. Maintenance Tolerances for Accuracy.

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 system divisions, value of the system division, or verification system 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.

Table 1. Typical Class or Type of Device for Weighing Applications	
Class	**Weighing Application**
E	**Enforcing of vehicles based on axle, axle group, and gross vehicle weight.**

Where did Class E come from? It should be defined in this code.

UR.2. Installation and Maintenance.

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 sensor 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.

UR.4 Enforcement Guidance. – Prior to the issuance of an enforcement violation, the user shall ensure compliance with specific jurisdictional legislation and/or protocols. All gross vehicle, axle, and axle group weights must be printed and/or stored with the corrected values that include any necessary reductions due to the system tolerance and adopted violation thresholds.

Add the following definitions to Appendix D:

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. [2.26]

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. [2.26]

axle load. – The sum of all tire loads of the wheels on an axle; a portion of the gross-vehicle weight. [2.26]

axle spacing. – The distance between the centers of any two axles. When specifying axle spacing, the axels used also need to be identified. [2.26]

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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. [2.26]

WIM System. – A set of load receptors 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. [2.26]

Previous Action:
2023: New Item

Original Justification:

1. INTRODUCTION

The Brooklyn-Queens Expressway (BQE) is an aging and deteriorating 6-lane highway which comprises a critical link of I-278 - the sole Interstate highway in Brooklyn, connecting it to Manhattan, Staten Island, and Queens in New York. Constructed in 1954 and comprised of varying and complex structure types, the segment of the BQE between Atlantic Ave. Interchange to the South and Sands St. to the North is nearing the end of its design life. Urgent repairs are underway, while roughly 110 spans may be in need of intervention by 2028, and another 75 spans may be in need of intervention within the next decade. Weigh in Motion (WIM) sensors, installed in October 2019, have revealed overweight vehicles, excessively exceeding FHWA legal load limits, with gross vehicle weights (GVW) that range from just over 80,000 lbs to as high as 200,000. The continued presence of overweight vehicles on the BQE contributes to the continued structural deterioration of this aging piece of infrastructure. The New York State legislature recently authorized the New York City Department of Transportation to conduct automated overweight vehicle enforcement through a WIM demonstration program; however, a universal standard has not yet been established that specifically defines a protocol for calibration and certification by the New York State local Division of Weights and Measures.

In response to this challenge, this proposal seeks an amendment of Section 2.25 of NIST Handbook 44 to allow for Weigh-In-Motion Systems Used for Automated Vehicle Weight Enforcement. The remainder of this proposal lays out the justification for the amendment, using the BQE as an example to establish the urgent need for the amendment, supported by data received from other State programs, including New Jersey, Maryland,

and Indiana. The City of New York is not alone in its struggle to maintain the safety and the structural integrity of its infrastructure. Guarding against violations of vehicle weight restrictions that are enacted to protect critical infrastructure is an issue of national concern.

The combined interstate data presented here stresses the national importance of establishing protocols for automated vehicle weight enforcement using WIM, citing:

- the deleterious effects of overweight vehicles and axles on primary structural components and pavements;
- the difficulty associated with the use of screening combined with stationary weighing stations to enforce vehicle weight regulations;
- the percentages of overweight vehicles on major interstates across the nation; and
- the proven accuracy of WIM equipment used in several states across the nation.

2. THE BROOKLYN-QUEENS EXPRESSWAY: THE NEED FOR URGENT INTERVENTION

Constructed in 1954, the BQE is a network of varying and complex structure types, including multi-girder steel bridges, concrete arch bridges, and double and triple concrete cantilever structures. The triple-cantilever section possesses unusual engineering characteristics. Its three levels of cantilevered structure (comprised of two levels of vehicular roadway and a top-level pedestrian Brooklyn Heights Promenade) are supported by a vertical wall that also serves to hold back the earth, and, in turn, the neighborhood of Brooklyn Heights behind it. Thus, there is a complex system of forces acting to hold up the cantilevered decks and soil, and moving one of its parts affects the others. With major structural components nearly 70 years old, this segment of the BQE is rapidly approaching the end of its design life. Due to its complex nature and its historic integration with the surrounding communities, repair and replacement of this segment of the BQE requires careful and strategic planning, exhausting every avenue to maintain the safety of its operations and the integrity of its structural condition.

Its aging characteristics are evidenced by a number of factors, including:

- Visible signs of deterioration, including scaling, efflorescence, transverse cracking, map cracking, and spalling, with exposed and corroded rebar at the underdeck, walls, and substructure components;
- Poor freeze-thaw results in the concrete cores;
- High chloride levels in the deck, leading to the onset and propagation of steel rebar corrosion in the structural decks and substructure components;
- Deteriorated concrete beneath the surface, as detected by Non-Destructive Test and Evaluations (NDT/E) and verified by probe samples; and
- Projected decreases in structural load ratings to below standard limits, with isolated segments projected to fall below standard limits by 2026, and large segments of this portion of the corridor projected to fall below standard limits by 2028.

Numerous traffic studies have been completed for this segment of the corridor, revealing average daily traffic (ADT) of approximately 153,000 vehicles, including a substantial average daily truck traffic (ADTT, up to 13 percent of the total ADT). In addition, the installation of WIM sensors in October 2019 has revealed that a considerable number of the vehicles traversing the BQE are classified as overweight, when compared with FHWA legal load limits. WIM data shows Gross Vehicle Weights ranging from just over 80,000 lbs to as high as 200,000 lbs, with roughly 20% of North-bound traffic classified as overweight, and roughly 8% of South-bound traffic classified as overweight.

The New York City Mayoral Executive Order 51, executed in January 2020, mandated the formation of the New York City Police Department (NYPD) BQE Truck Enforcement Task Force, whose purpose is to ensure that all existing weight restrictions on the BQE are strictly enforced. However, the lack of roadway shoulders on this stretch of the BQE means that there is insufficient space for the New York City Department of Transportation (NYCDOT) to introduce stationary weighing stations, or for NYPD enforcement officers to pull over overweight vehicles and use portable scales to screen and enforce legal weight limits.

Urgent repairs are currently underway for two spans within this complex network, while structural assessments show that roughly 110 spans may be in need of intervention by 2028, and roughly 75 spans may be in need of intervention within the next decade.

In response to this challenge, NYCDOT has initiated aggressive efforts to develop and implement a plan that maintains the operational safety of the BQE, as well as protects its structural integrity, including the pursuit of automated weight enforcement using WIM on this segment of corridor. It has combined its efforts with other local and State agencies in order to demonstrate that this is not an isolated local problem, but a national need.

3. AUTOMATED TRUCK ENFORCEMENT USING WIM: THE NATIONAL NEED

The national roadway infrastructure, including bridges and pavement, has handled substantial daily truck traffic. While trucks have been an integral part of the freight movement network in distributing goods and services to various communities, many trucks are often found to be overweight beyond the FHWA legal load limits. Illegally overweight vehicles have been shown to be one of the primary causes of the deterioration of aging pavement and bridges. Accordingly, the infrastructure suffers from significant deterioration because of the existing environmental conditions exacerbated by the frequently increasing and substantial number of overweight vehicles.

Vehicles on Interstate highways must conform to the Federal Bridge Formula (FBF), designed to protect bridges from vehicle overloads beyond the legal limits. To date, the enforcement regulations have been executed at stationary weighing stations across the nation, especially at the borders between states. However, the stationary stations have limited resources for effective enforcement because: (1) the number of stationary weighing stations is not spatially well distributed across the nation; (2) the operation hours are limited; and (3) the number of enforcement officers is insufficient.

Though each state allows a certain number of permitted vehicles to exceed the FHWA weight limits on Interstate Highways, the number of permit overweight vehicles is typically a small fraction of the total. According to a previous study (Nassif et al., 2016)[1], the number of permit overweight vehicles is only 4% of the total overweight vehicles observed at NJ WIM stations. In New Jersey, it was also noticed that the overweight vehicles cited at the stationary weighing stations were only a small fraction (6.4%) of the *actual* overweight populations recorded by the WIM sensors on the main lanes, and this is, in turn, 0.142% of the total number of vehicles (Nassif et al., 2021)[2]. In New York City, enforcement officers have been able to cite only 14.7% of the *actual* number of overweight vehicles on and near Interstate Highway I-278 between February and December of 2021. Therefore, the overweight enforcement practices at the stationary weighing stations, combined with using mobile enforcement units, are ineffective in substantially reducing the percentage of overweight vehicles.

The figure below summarizes the percent of overweight vehicles, relative to the ADTT for each US State. The overall overweight percentage out of ADTT is 13.2%, based on the data in the figure below.

[1] Nassif, H., K. Ozbay, H. Wang, R. Noland, P. Lou, S. Demiroluk, D. Su, C.K. Na, J. Zhao, and M. Beltran. Impact of freight on highway infrastructure in New Jersey. Final Report FHWA-2016-004, NJDOT, 2016

[2] Nassif, H., K. Ozbay, C.K. Na, and P. Lou. Feasibility of Autonomous Enforcement using A-WIM system to Reduce Rehabilitation Cost of Infrastructure, C2SMART Tier 1 University Transportation Center, Year 3 Final Report, 2021

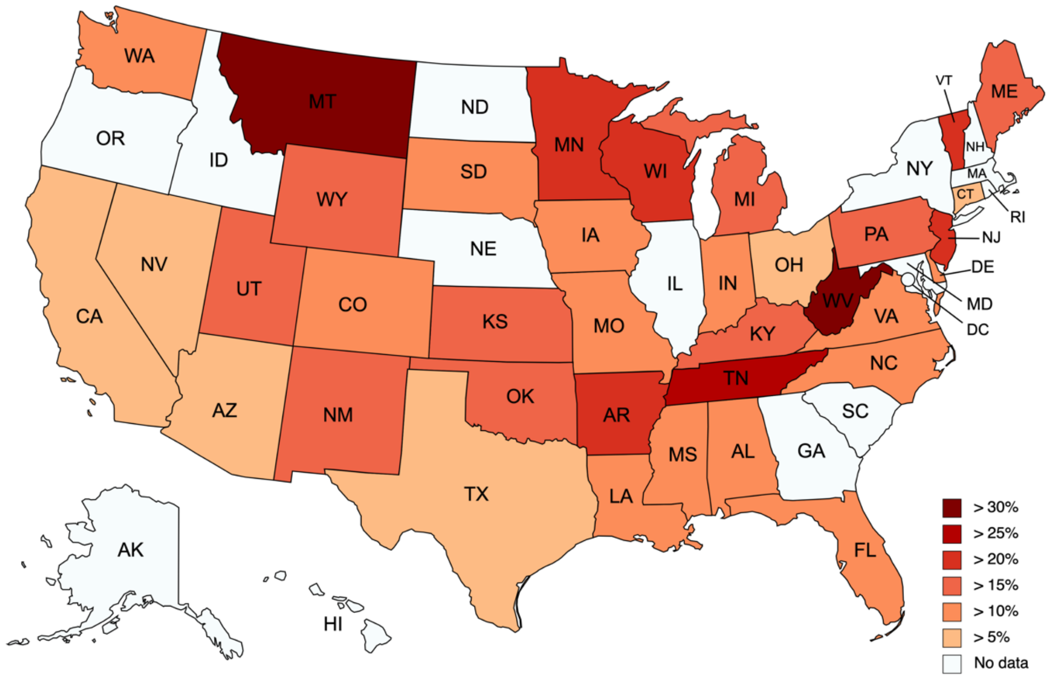

Figure 1. Overweight percentage per State

Going beyond weight enforcement, officers in most States are responsible for checking Commercial Motor Vehicles (CMV's) for safety. This includes different levels of truck inspection, including the driver credentials, hours of service, key systems on the truck, load securement, and many more. The highest level of inspection, Level 1, has 20+ safety criteria that an officer checks on a CMV. There is an opportunity with automated weight enforcement to, not only deter overweight vehicles on the nation's infrastructure, but to automate the inspection tasks of officers, freeing them up so they can do more inspections for other safety issues related to CMV's. Currently, with most sites running with a single officer, as they are focused on weighing, doing an inspection, or interviewing a driver, other unsafe vehicles behind the current one go by without scrutiny until an officer can complete their task.

4. AUTOMATED TRUCK ENFORCEMENT USING WIM: PROVEN ACCURACY OF WIM TECHNOLOGY

ASTM E1318-09 Type III accuracy requirements have been used by many States in their fixed and virtual weigh stations to screen CMV's for over a decade. In New York, three calibration tests were performed using various trucks (Class 9, Class 7, Class 6, and Class 5), and it was found that the WIM system could provide 100% compliance for GVW within 6%, single axle weight within 15%, tandem axle weight within 10%, and even wheel weight within 20%. In Indiana, the Indiana DOT and Purdue University studied the accuracy of the virtual WIM sensors on the main lanes compared to the stationary weighing station. They found that 98% of the virtual WIM weights were within 5% of the static weights.

Attachment A includes data from New York, Indiana, and Maryland, proving the accuracy of their WIM technology. Additionally, Wisconsin, and two other States have expressed interest in sharing data from their sites which meet these accuracy requirements.

Given the consistent accuracy of WIM measurements, compared with measurements obtained from the stationary scales, the amendment of Handbook 44 to expand its provisions for screening to include automated vehicle weight enforcement using WIM is both prudent and justified.

5. CONCLUSIONS

Across the nation, the deterioration of aging infrastructure is exacerbated by the presence of overweight vehicles in excess of the Federal Bridge Formula (FBF). Though several states have implemented vehicle weight enforcement measures using a screening protocol that includes the use of mobile enforcement officers and stationary scales, these measures have been insufficient in significantly reducing the volumes of overweight vehicles on the nation's infrastructure. The use of WIM for the purposes of automated vehicle weight enforcement would both alleviate this problem and free up local and state resources to address other safety concerns. However, to date, no unified national standard specifically paves the way for the certification of WIM technology to be used for the purposes of automated vehicle weight enforcement. The amendment of Section 2.25 of NIST Handbook 44 will provide such a standard. With several states evidencing the proven accuracy of current WIM technology, the amendment of Section 2.25 to expand its screening provisions to include automated vehicle weight enforcement using WIM is both prudent and justified.

This request is not to introduce new regulations to the trucking industries but to guide the trucking industries to comply with the applicable laws to protect our infrastructure, provide safe corridors to the nation's taxpayers, and improve the resilience of our built environment. Moreover, this request would allow the United States to catch up with other countries globally that have successfully implemented and proved automated weight enforcement, including China (2004), the Czech Republic (2010), Russia (2013), Hungary (2016), France (in process) and Brazil (in process).

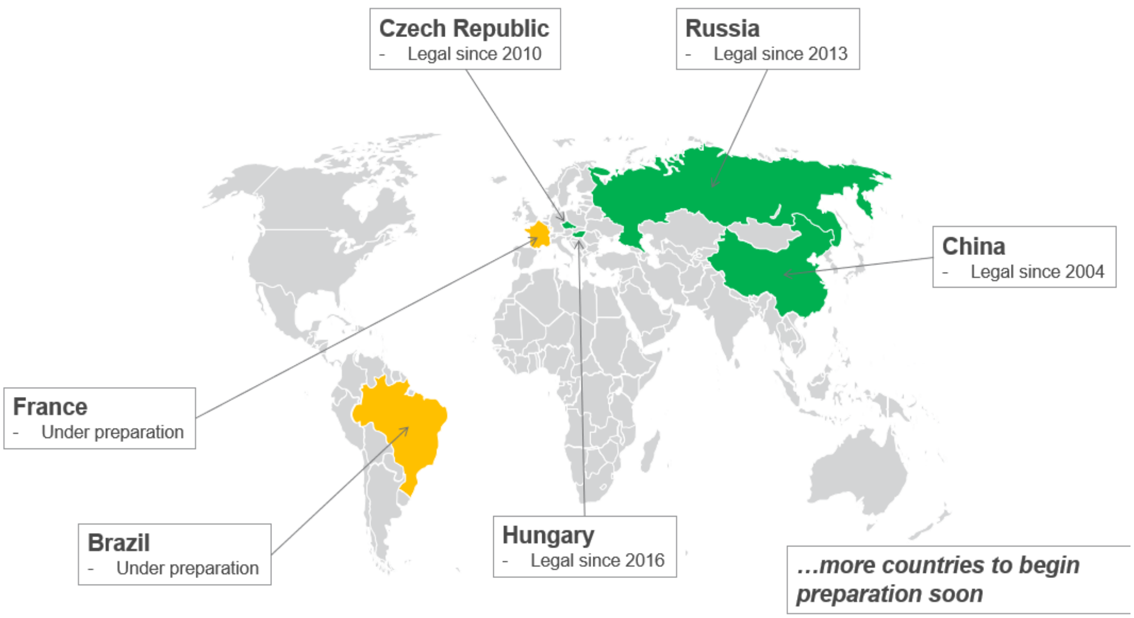

Figure 2. Automated enforcement around the world

The submitters requested that this be a Voting item in 2023.

Comments in Favor:

Regulatory:

- Interim 2023: Doug Musick (State of Kansas) commented as to the original intent was for screening and now to become enforcement. Supports developmental status as the tolerances are not fully understood.
- Interim 2023: Tim Chesser (State of Arkansas) commented that he supports removing the tentative status for screening and that a set procedure for testing is missing from the proposal. This cannot be guesswork. Recommended Developmental status.

- Annual 2023: The State of New York commented they had attended a demonstration of the WIM system in Wisconsin and was confident with the resulting test data.

Industry:

- Interim 2023: Tanvi Pandya (NYC DOT- Submitter) gave a brief overview of the deteriorating infrastructure issue on the Bronx Queens Expressway in NYC and this proposal seeks to remove the tentative status of the WIM proposal and establish testing standards for the automated enforcement of weight infractions.
- Interim 2023: Jess Helmlinger from Kistler gave a brief presentation. Commented also that this application is to increase efficiency vs accuracy and the tolerances proposed allow for the tolerance to be taken into account.
- Interim 2023: Russ Vires (SMA) recommended to remove the tentative status and use this code as originally intended for screening.
- Annual 2023: The submitters of the proposal gave a presentation with the July 2023 updates to their proposal that appeared on the NCWM website.

Advisory:

- Interim 2023: Jan Konijnenburg (NIST OWM) supports this item, but item is not ready for a vote yet. This application is for situations that do not allow for static scales.
- Annual 2023: NIST OWM commented that this proposal has come a long way in a short amount of time. NIST does not share the concerns of the SMA. This system is a law enforcement application, not commercial, and they can’t be compared.

Comments Against:

Regulatory:

- Interim 2023: Vince (State of Arizona) commented that the notes are confusing and needs work.
- Annual 2023: The State of California commented that the newest version of the submitters proposal that appeared on the NCWM website had not been reviewed as of this meeting, however, there could be issues with creating a wider tolerance for dynamic scales.

Industry:

- Annual 2023: The SMA commented that they oppose this item as highway enforcement scales are currently listed as Class IIII and dynamic scales should not have a greater tolerance.

Advisory:

- None

Neutral Comments:

Regulatory:

- None

Industry:

- None

Advisory:

- None

Item Development:
NCWM 2023 Interim Meeting: The committee has updated this item to the latest version received from the submitter. In the most recent version of the proposal, the submitters changed N.1.3. to require the reference scale be tested no more than 2 weeks prior to the test of the WIM scale, instead of 24 hours. The committee does not agree with this change and has decided to leave it as currently written in Handbook 44. The committee continues to work on this item, including User Requirements, to address concerns it heard during the Interim. The submitters intend to provide a demonstration of a WIM scale in use in the near future. The committee has decided to leave the item as informational and encourages the submitters to continue to work with the committee, NIST OWM, and stakeholders for further development.

NCWM 2023 Annual Meeting: The committee used the updated (7/11/23) proposal from the submitters as a basis for the current item under consideration, but with changes in the following sections: S.1.6, N.1.1.2 Note 1, N.1.2.3 (a), N.1.3., N.1.4., Table N.1.5., N.1.6.1., T.2.4., and UR.4., and removed N.1.5.4.. The committee also believes that N.1.3 needs to better clarify the use of "single platform vehicle scale". As written, it currently promotes split weighing, or could be confused with the use of axle-load scales. The committee encourages the submitters to continue to work with the committee, NIST OWM and other stakeholders to further develop this item.

Regional Associations' Comments:
CWMA 2023 Interim Meeting: Tanvi Pandya and Chaekuk Na presented on behalf of the submitters outlining the changes that have been made to address previous concerns.

Mike Harrington from Iowa supports this item and recommends it moving forward as voting.

Greg VanderPlaats from Minnesota commented that the submitters have done a lot of work and have made changes per the feedback received at the National Conference. He supports this item as voting.

The committee recommends this item moving forward as a voting item with the proposed changes by the submitter which are attached to the end of this report. [APPENDIX B]

WWMA 2023 Annual Meeting: During the WWMA 2023 annual meeting the following comments were received:

A presentation was given from the submitters of this item regarding updated language provided for consideration and posted on the WWMA website {Events – Meeting Documents – WIM.23-1} Proposed Language. The submitters spoke to:

- This device is not a scale in the traditional application and intended for use dynamically of overweight vehicle enforcement.

- The intent is to remove the "Tentative" status for Class E devices. The "Tentative" status would remain for Class A devices.

- A demonstration was conducted on a similar device in April 2023.

- This application would exclude all liquid tank trucks.

- It is difficult to be consistent with vehicle positioning. The submitter clarified that if the vehicle is not in the correct position the system will default to "Error". This "Error" is an appropriate performance function.

Mr. Cory Hainy (Representing the SMA): The association formed a position in April 2023 of opposition to this item prior to the updated language being proposed and will meet in November 2023 to reassess the item. It was reemphasized that the proposed tolerances were a point of contention with the association. The association would like to see revisions that address dynamic weighing should not be allowed a greater tolerance, acceptance and maintenance tolerances should be applied, and harmonizing existing tolerances with the scale code.

Mr. Loren Minnich (NIST OWM): OWM reached out to the submitter to clarify the intention regarding tentative and permanent status for "Class A" and "Class E" devices subject to this code. Examples were provided in open hearing of existing code such as Grain Analyzers as an example of separating this code for enforcement and screening purposes.

The WWMA S&T Committee posed the following questions:

- Can the submitter clarify the intent of all weights for 100% compliance regarding the applicable tolerances?

  The submitter response clarified the device should perform within the applicable tolerances at all test loads and that a fault qualifies towards the 100% compliance.

- Can the submitter clarify what is meant by 100% compliance regarding T.2.4?

  The submitter clarified that the axle spacing must be predetermined by the inspector and must match the device. The system will identify a bridge formula violation and the inspector has to accurately measure the axle spacing and then verify the system measurement within the tolerance specified with T.2.4

- Can the submitter provide data to support the +/- 10% to 20% tolerance range?

  The submitter response clarified the intent of the use of the device is for dynamic and not static weighment. Scales currently function at a lower range of 6% but the addition of the 100% compliance is to justify the tolerance. It was expressed that the intention of the proposed code is to enforce grossly overweight vehicles.

  The submitter clarified that the 100% compliance came from the original proposed 95% compliance. The submitter clarified 100% of the total number of runs would need to be within tolerance.

- Can the body please clarify how or if 2.20 scale code regarding WIM systems and the proposed WIM system code will impact each other?

  Mr. Loren Minnich (NIST OWM) clarified each section of the existing code has an application section to identify what devices are covered by that code. The application section for each code should be reviewed to verify that there is no overlap.

Mr. Cory Hainy (Representing the SMA): Raised concern regarding tolerances specifically whether OIML R 134-1 standards where considered.

Mr. Chaekuk Na (Rutgers University): OIML 134-1 standards were considered and further clarified there are different levels of accuracy. The tolerances selected are currently being used in other countries, the F-10 for 10% gross meet the proposed tolerances.

Mr. Cory Hainy (Representing the SMA): Reinforced the concern regarding the large tolerances and spoke to already existing tolerances. Existing scales are held to certain standards even if used for law enforcement purposes.

Ms. Tanvi Pandya (New York City DOT): Clarified this is a dynamic test and supports the tolerances as written.

Mr. Aaron Yanker (Colorado Dept. Ag Weights and Measures): Questioned the note in Table 1 regarding the comment of additional accuracy classes. The submitter responded that the language in the note of Table 1 is carry over language of the item from its original draft.

The WWMA S&T Committee recommends that the NCWM S&T Committee consider incorporation of the updated language as provided by the submitter and that this item remain Informational. This will allow stakeholders to provide comments on the updated language. We further recommend that NCWM S&T Committee consider the comments and questions which came up in the WWMA S&T open hearing session while further developing the item with special attention to the comments from NIST OWM.

The proposed updated language will be included in the WWMA S&T Committee 2023 Final Report as an Appendix to the item.

SWMA 2023 Annual Meeting: Tanvi Pandya, NYCDOT, co-submitter, gave a presentation on the item. She has had some edits since the July report. She stated these systems are used internationally, and it isn't realistic to statically weigh the 10% of all trucks that are overweight on the road. She feels the tolerance is acceptable for enforcement purposes. She stated that this device is to be used for law enforcement and screening purposes only and not commercial applications. She noted some jurisdictions have raised concerns to her about removing the tentative status. She also stated that she hasn't had a chance to resolve some issues with NIST, and that the New York Department of Agriculture is requiring a corresponding code in Handbook 44 before they will certify the weighing system.

Chaekuk Na, Rutgers University, co-submitter, stated they are trying to harmonize the language in the item with the OIML code. Mr. Na stated fuel consumption of the test vehicle is not relevant due to the large tolerances allowed in their current code.

Cory Hainy, SMA, stated they are opposed to the item and have not had a chance to review the latest revision. SMA stated that they are concerned that enforcement scales are already defined, acceptance and maintenance tolerances have not already been established, and that adding it to the WIM code will create two conflicting law enforcement codes. The specifics of their concerns are in their April positions from SMA.

Tim Chesser, Arkansas, echoed Mr. Hainy's position and asked what other states besides New York and Maryland plan to use this code? He also raised a concern that once this code is in the handbook some states would be forced to enforce it. He also stated the tolerances were too wide for enforcement. He also expressed concern about the axle spacing measurement being confusing.

Alison Wilkinson, Maryland, raised concerns about the lack of standards, the use of the word "may", and stated the reference scale code is vague in regard to testing logistics such as how far or near the reference scale should be to the system being tested. She also raised concerns about the fuel consumption of the test vehicles. She stated the state of Maryland is opposed to this item, and that she agrees with Tim Chesser's comments. She believes this code should only be used for screening.

Mauricio Mejia, Florida, agreed with the concerns raised by other commenters, questioned whether this is the proper channel for this type of code, and that it should only be used for gross vehicle weight.

Juana Williams, NIST OWM, has concerns about combining tentative and non-tentative codes. She stated NIST OWM is of the opinion that acceptance tolerance should be 50% of the maintenance tolerance. She also stated that this code should cover all vehicles, including those carrying liquids and empty vehicles.

John Stokes, South Carolina, agreed with Arkansas in opposition to the item.

Robert Huff, Delaware, stated this item will result in numerous complaints that they will not be able to handle.

The committee heard no comments in support of this item from the SWMA membership and suggests that the NCWM S&T committee work with the submitters and NIST to address the issues raised.

The committee recommends the item remain as an Informational item.

NEWMA 2023 Interim Meeting: A presentation was made by submitters with updates to the item, including having 2.25 remain tentative for screening and creating 2.26 for enforcement. The submitters are working with NIST to finalize language and the updated proposal after taking feedback from the regions. The State of NY recommends voting. The Commonwealth of PA questions if it should be in the handbook. The States of New Hampshire, New

Jersey, and the Commonwealth of Massachusetts supports as voting. Upon consensus of the body, the Committee recommends this item be Voting with the upcoming changes to the item.

Additional letters, presentation and data may have been submitted for consideration with this item. Please refer to www.ncwm.com/publication-15 to review these documents.