

NCWM Interim Meeting  
Virtual  
January 13-15, 2021



## Item SCL-20.12: Single Draft Weigh-in-Motion Vehicles Scales

**METTLER TOLEDO**



## Objective

There is a growing need in the market to provide commercial vehicle weighing transactions faster than can currently be done by static weighing while also maintaining the existing weighing accuracy levels.

Weighing vehicles in motion has many benefits to consumers, operators and society in general compared with traditional static vehicle scales including productivity improvement, cost savings, improved safety, and reduced carbon emissions.

## Progress to Date

- METTLER TOLEDO has been working on Item SCL-20.12 since August 2019 to add Single Draft Weigh-in-Motion Vehicle Scales to the HB44 code.
- METTLER TOLEDO conducted witness testing on March 10, 2020 to demonstrate the weigh-in-motion technology to members of the NCWM, NIST, and NTEP.
- METTLER TOLEDO has been developing the HB44 code for this item by working with members of the NCWM, NIST, NTEP and SMA.

**This presentation will cover witness testing results and highlights of the proposed HB44 code changes.**

# What is a Single Draft Weigh-in-Motion Vehicle Scale? METTLER TOLEDO | 3

**A Single Draft Weigh-in-Motion Vehicle Scale is a WIM scale that requires all axles of the vehicle to be on the scale simultaneously during the weighment.**

The first Single Draft Weigh-in-Motion Vehicle Scale at METTLER TOLEDO:



Capacity: 100'000 lb

Increment (d): 20 lb

CLC: 100'000 lb

Accuracy Class: III L

Speed Range: 1-5 mph

Maximum Speed Change: 2 mph

Max Wheelbase: 60'

Vehicle Direction Capability:

Uni-directional

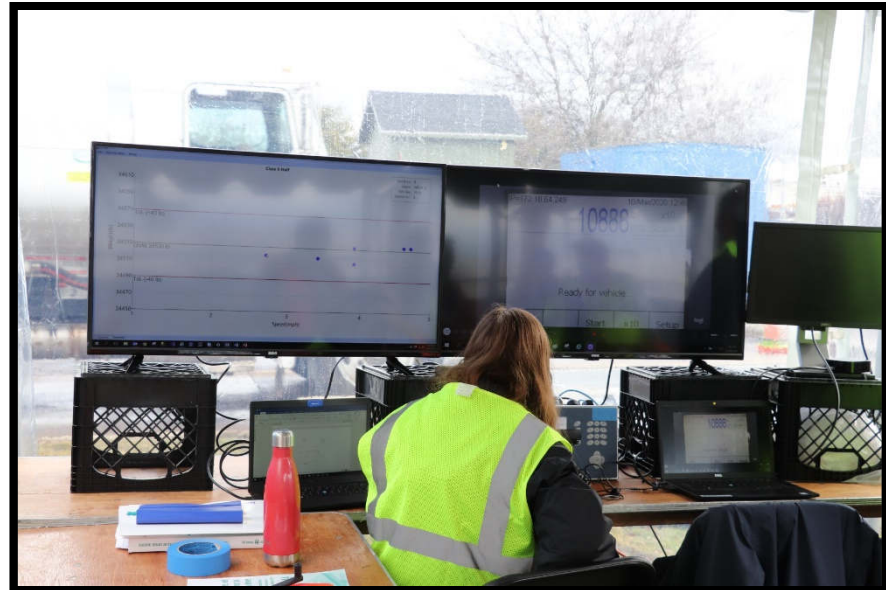
Dimensions: 70' x 11'

Approach: 11' in plane, 70' straight



# SD-WIM Witness Testing Photos – March 10, 2020

METTLER TOLEDO | 4





## Witness Testing Participants

- John Barton
  - NIST OWM, NCWM S&T
- Tom Buck
  - Ohio Dept. of Ag., W&M
- Douglas Dummer
  - Wisconsin Dept. of Ag.
- Darrell Flocken
  - NTEP Administrator
- Nathan Gardner
  - Oregon W&M, NTEP Evaluator
- Jeff Gibson
  - Ohio Dept. of Ag., W&M
- Lenny Goebel
  - Illinois Dept. of Ag., W&M
- Mike Kelley
  - Ohio Dept. of Ag., W&M

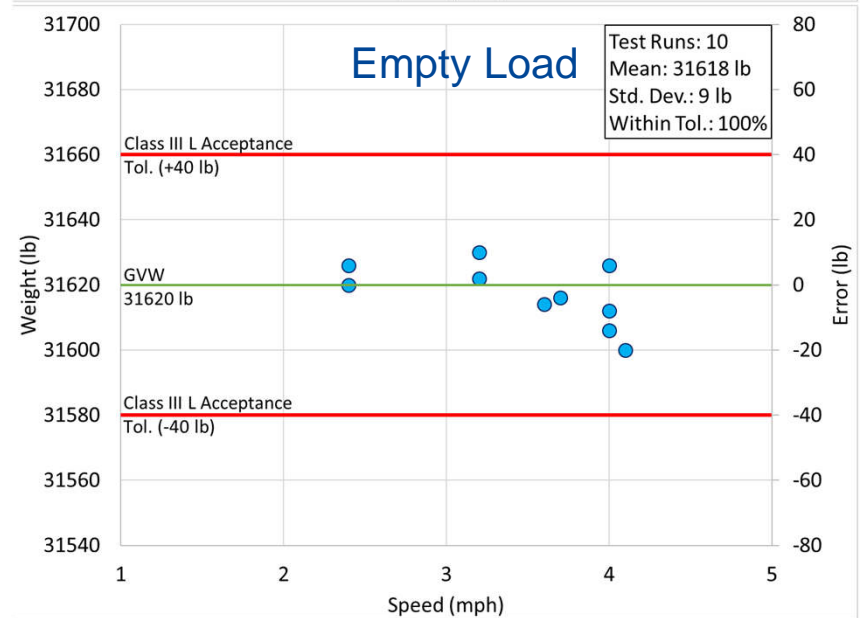
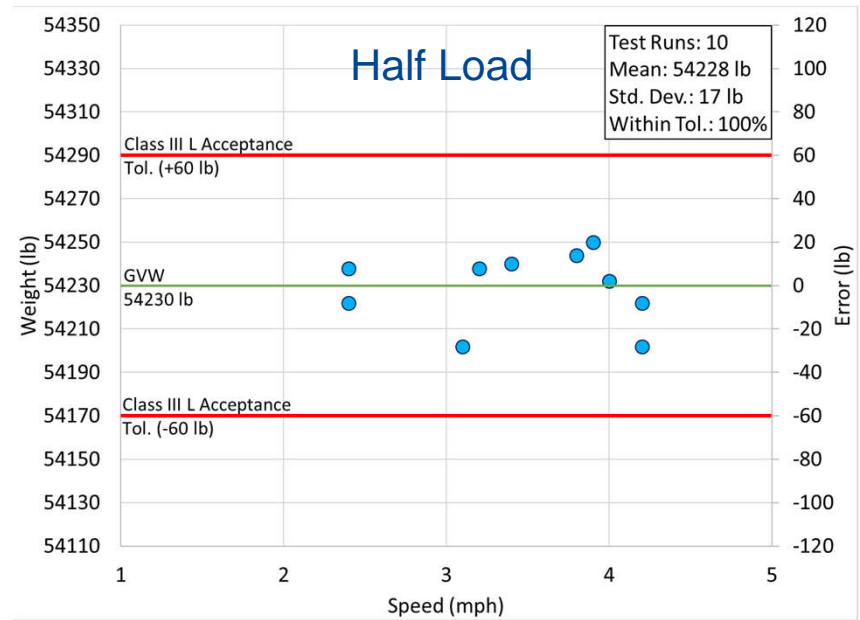


# Single Draft Weigh-in-Motion Vehicle Scale Testing METTLER TOLEDO | 6

## Test Matrix: 3 Truck Types with 3 Load Conditions at Speeds up to 5mph

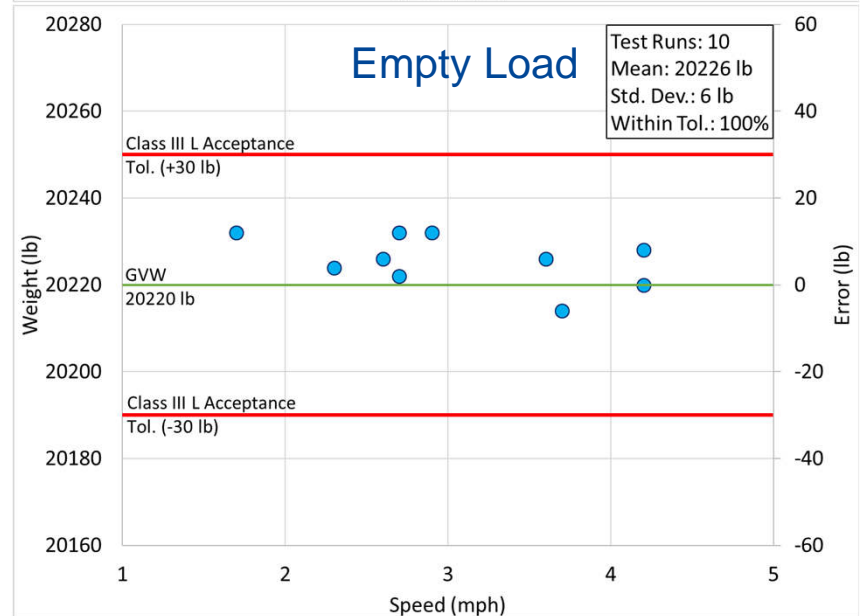
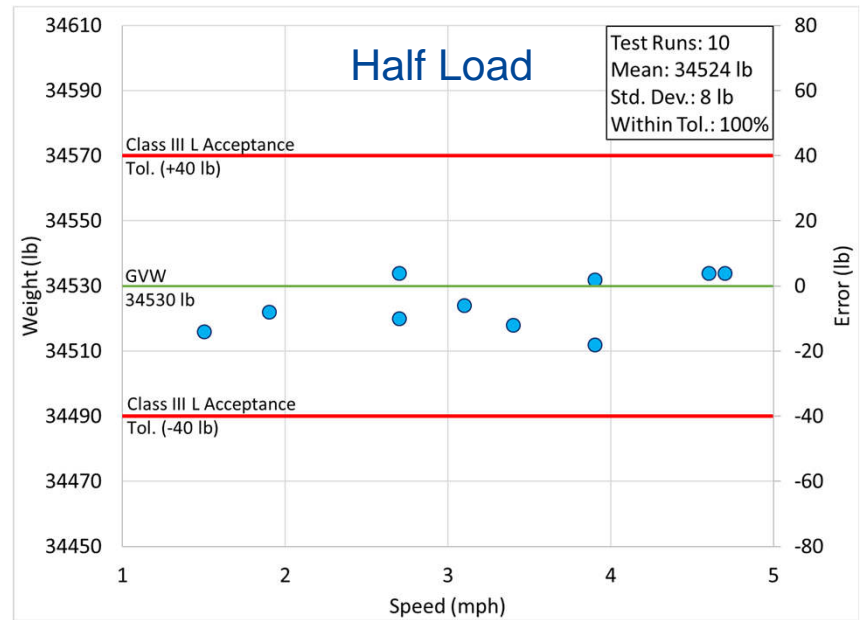
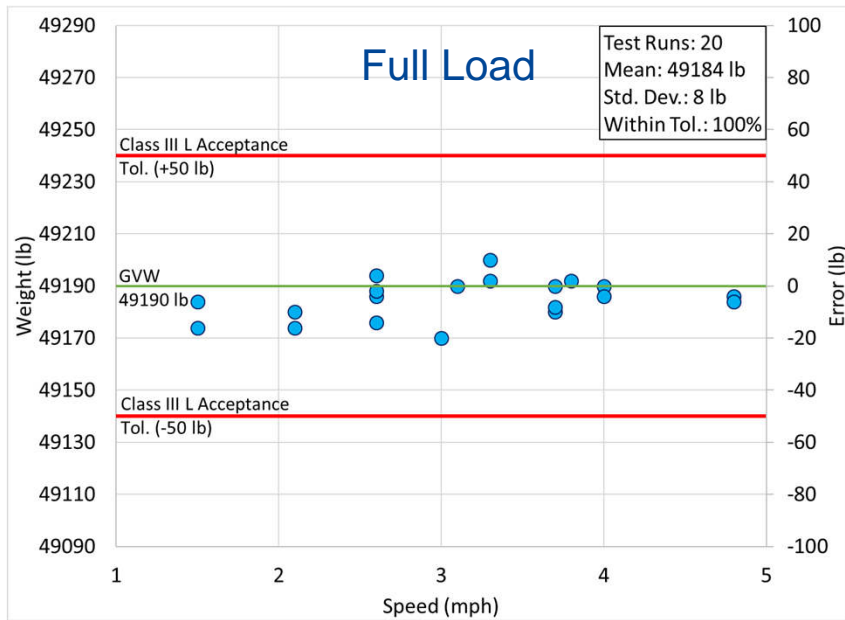
Truck Type	Gross Vehicle Weight (GVW)
Class 9 Semi-Truck 	Full Load: 76,900 lb
	Half Load: 54,230 lb
	Empty: 31,620 lb
Class 6 Tanker 	Full Load: 49,190 lb
	Half Load: 34,530 lb
	Empty: 20,220 lb
Class 5 Truck 	Full Load: 27,750 lb
	Half Load: 22,750 lb
	Empty: 17,750 lb

# SD-WIM Weighments: Class 9 Semi-Tractor-Trailer METTLER TOLEDO | 7



# SD-WIM Weighments: Class 6 Tanker Truck

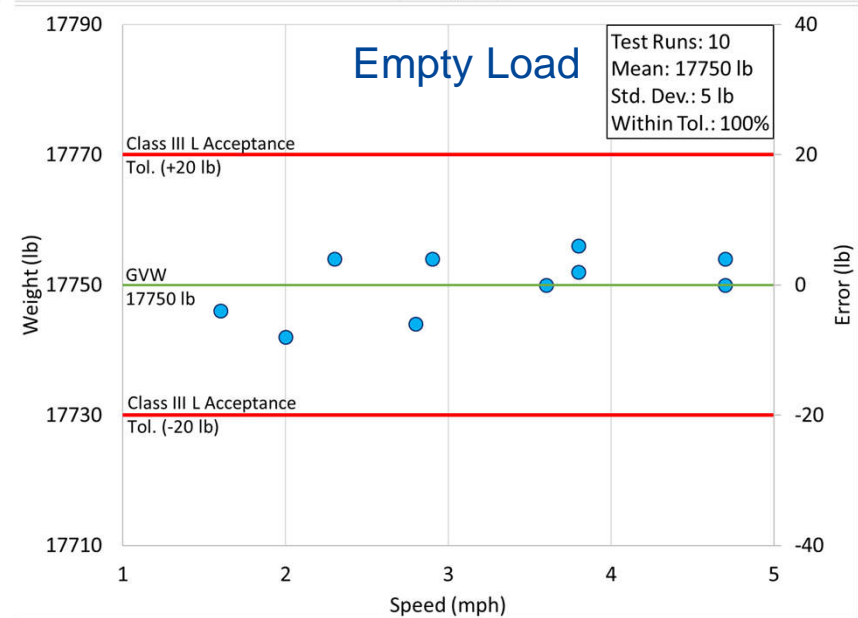
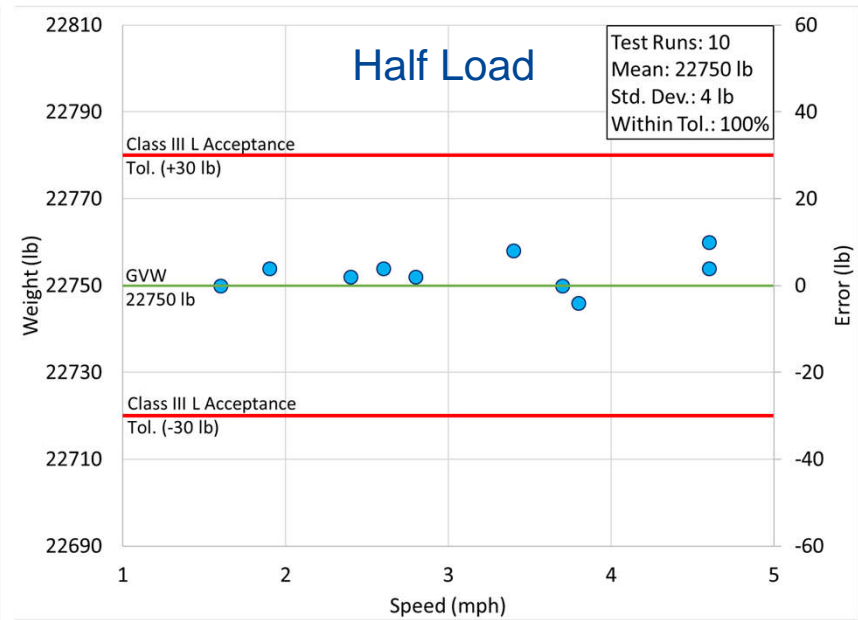
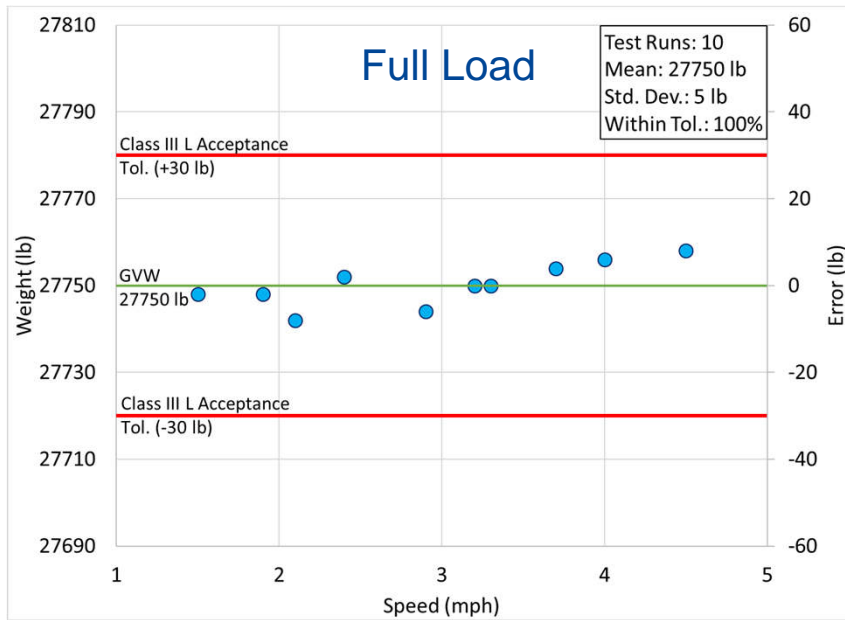
METTLER TOLEDO | 8





# SD-WIM Weighments: Class 5 Truck




METTLER TOLEDO | 9



# Single Draft Weigh-in-Motion Test Summary

METTLER TOLEDO | 10

**In total 110 SD-WIM weighments were performed of which 100% were within Handbook 44 Class III L acceptance tolerance limits.**

Truck Type		Tests Within Class III L Acceptance Tolerance	
Class 9 Semi-Truck		Full Load: 100%	✓
		Half Load: 100%	✓
		Empty: 100%	✓
Class 6 Tanker		Full Load: 100%	✓
		Half Load: 100%	✓
		Empty: 100%	✓
Class 5 Truck		Full Load: 100%	✓
		Half Load: 100%	✓
		Empty: 100%	✓

## Key elements of the proposed HB44 code

- Single Draft WIM Vehicle Scales are a subset of all vehicle scales.
  - All existing requirements that apply to vehicle scales also apply to Single Draft WIM Vehicle Scales.
  - Only requirements specific to Single Draft WIM Vehicle Scales need to be added to the HB44 code.
  - This limits the amount of changes required in the HB44 code and prevents redundancy.
- Single Draft WIM Vehicle Scales must pass all applicable tests as a static scale before it can be qualified as a Single Draft WIM Vehicle Scale.
  - This reduces the amount of testing that must be done in motion while still ensuring good weighing performance.
- Class III L tolerances that apply to Single Draft WIM Vehicle Scales are the same tolerances that apply to any other vehicle scale.
  - There is no additional tolerance given just because the weighments are being done in motion.
  - The accuracy of Single Draft WIM Vehicle Scales must be as good as any other Class III L vehicle scale.



## Key elements of the proposed HB44 code (continued)

- The concept of using a Reference Scale to create a temporary field standard for testing already exists in the HB44 code.
  - Reference Scales are already used in the testing of:
    - Dynamic Monorail Weighing Systems
    - Coupled-in-Motion Railroad Weighing System
    - Belt-Conveyor Scale Systems
    - Automatic Weighing Systems
    - Weigh-In-Motion Systems – Tentative Code
    - Mass Flow Meters
  - These weighing and measuring devices were used as precedents for how to implement this same concept for Single Draft WIM Vehicle Scales.
- The Single Draft WIM Vehicle Scales testing procedure is relatively simple but still thorough enough to ensure good weighing performance.
  - This limits the amount of time and equipment required for in motion testing.
- Additional common questions are answered in the Item SCL-20.12 FAQ.

Section Number	Change	Explanation
HB44 Appendix D	Added/Amended	Some new terms are introduced with the addition of SD-WIM vehicle scales. Since SD-WIM vehicle scales must comply with static scale requirements, this has been added to the vehicle scale definition.

**data acquisition time (DAT).** – The total time an object is completely on a load-receiving element while it is being weighed in motion. An object is completely on a load-receiving element from the time the trailing edge of an object to be weighed first moves onto the load-receiving element up to the time the leading edge of the object first moves off the load-receiving element. This time duration is affected by the length of the load-receiving element, speed of the object to be weighed, and the length of the object to be weighed. [2.20]

**(Added 20XX)**

- .
- .
- .

**reference vehicle.** – A vehicle with an associated load, including the driver, that has been statically weighed for temporary use as a field standard, typically the time required to test one Weigh-in-Motion Vehicle Scale. [2.20]

**(Added 20XX)**

- .
- .
- .

**vehicle scale.** – A scale **(including weigh-in-motion vehicle scales)** adapted to weighing highway, farm, or other large industrial vehicles (except railroad freight cars), loaded or unloaded. [2.20]

**(Amended 20XX)**

- .
- .
- .

**weigh-in-motion (WIM) vehicle scale.** – A vehicle scale adapted to weighing vehicles as they travel across the scale without stopping. [2.20]

**(Added 20XX)**

Section Number	Change	Explanation
HB44 2.20. Scales S.1.14.1.	Added	Specific fault conditions for SD-WIM must be identified. This section follows the format of S.1.6 of the Weigh-in-Motion Systems tentative code.

## **S.1.14. Weigh-in-Motion (WIM) Vehicle Scales**

**S.1.14.1. Identification of a Fault. – Fault conditions shall be presented to the customer and the operator in a clear and unambiguous manner. No weight value shall be indicated or recorded when a fault condition is detected. The following fault conditions shall be identified if applicable:**

- (a) **Vehicle speed was below the minimum or above the maximum speed as specified by the manufacturer.**
- (b) **A change in vehicle speed greater than that specified by the manufacturer was detected.**
- (c) **Vehicle direction of travel was not valid for the installation.**
- (d) **The amount of time all vehicle axles were simultaneously on the scale was below the minimum Data Acquisition Time.**
- (e) **Vehicle's path of travel was outside the lateral side edges of the load-receiving element.**



Section Number	Change	Explanation
HB44 2.20. Scales S.1.14.2.	Added	There is additional information needed as compared to static weighing. This section follows the format of S.1.7 of the Weigh-in-Motion systems tentative code.

**S.1.14.2 Information to be Recorded. – In addition to the information that is normally recorded for vehicle scales, the following shall also be printed and/or stored electronically for each vehicle weighment if applicable:**

- (a) **Scale identification if more than one lane at the site has the ability to weigh a vehicle in motion.**
- (b) **Vehicle direction of travel if the Weigh-in-Motion Vehicle Scale is bi-directional.**

**(Added 20XX)**

Section Number	Change	Explanation
HB44 2.20. Scales S.3.4.	Added	There is a minimum length requirement needed for the WIM scale to ensure single-draft weighing.

**S.3.4. Length of Weigh-In-Motion Vehicle Scales – The load-receiving element shall be of sufficient length to allow the weighment of any vehicle intended to be weighed on the scale in a single draft (i.e. all axles of the vehicle are on the load-receiving element simultaneously during the weighment).**

**(Added 20XX)**

Section Number	Change	Explanation
HB44 2.20. Scales Table S.6.3.a.	Amended	Additional marking requirements are needed specific for SD-WIM scales.

Table S.6.3.a. Marking Requirements					
To Be Marked With ↓	Weighing Equipment				
	Weighing, Load-Receiving, and Indicating Element in Same Housing or Covered on the Same CC <sup>1</sup>	Indicating Element not Permanently Attached to Weighing and Load-Receiving Element or Covered by a Separate CC	Weighing and Load-Receiving Element Not Permanently Attached to Indicating Element or Covered by a Separate CC	Load Cell with CC (11)	Other Equipment or Device (10)
<u>Minimum and Maximum Speed</u> (25)			<u>X</u>		
<u>Maximum Speed Change</u> (26)			<u>X</u>		
<u>Vehicle Direction Restriction</u> (27)			<u>X</u>		



Section Number	Change	Explanation
HB44 2.20. Scales Table S.6.3.b.	Amended	Additional notes for marking requirements are needed for SD-WIM scales.

Table S.6.3.b. Notes for Table S.6.3.a. Marking Requirements
<p><b><u>25. Weigh-in-Motion Vehicle Scales must be marked with minimum and maximum vehicle speed limitations.</u></b>  <b><u>(Added 20XX)</u></b></p> <p><b><u>26. Weigh-in-Motion Vehicle Scales must be marked with maximum vehicle speed change allowed during the weighing.</u></b>  <b><u>(Added 20XX)</u></b></p> <p><b><u>27. Weigh-in-Motion Vehicle Scales must be marked as uni-directional if the travel direction is restricted.</u></b>  <b><u>(Added 20XX)</u></b></p>

Section Number	Change	Explanation
HB44 2.20. Scales N.7.1.	Added	A single draft Reference Scale will be used to obtain the weight of the Reference Vehicles. The Reference Scale must be sufficiently accurate for this purpose.

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

**N.7.1. Reference Scale – A static scale as approved by the local jurisdiction shall be used to establish the weight of Reference Vehicles used in this procedure.**

**N.7.1.1. Dimension - The Reference Scale shall be of such dimension and spacing as to weigh Reference Vehicles in a single draft.**

**N.7.1.2. Location - The Reference Scale should be located near the Weigh-in-Motion Vehicle Scale to minimize the effect of vehicle fuel consumption. The Reference Scale and the Weigh-in-Motion Vehicle Scale may be the same scale.**

**N.7.1.3. Timing - The Reference Scale shall be tested immediately prior to using it to establish Reference Vehicle weights. A subsequent test of the Reference Scale may be performed immediately following the establishment of the Reference Vehicle weights to ensure its repeatability.**

**N.7.1.4. Qualification - The Reference Scale shall comply with the principles in the Fundamental Considerations paragraph 3.2. Tolerances for Standards.**

Section Number	Change	Explanation
HB44 2.20. Scales N.7.2.	Added	Reference Vehicles should be readily available while also covering a wide range of cases in order to be able to complete testing in a timely manner.

**N.7.2. Reference Vehicle – One or more Reference Vehicles shall be used to provide varying weight conditions for testing. Reference Vehicles should be representative of vehicles that are customarily weighed on the Weigh-in-Motion Vehicle Scale during normal operation. A motorized Field Standard Weight Cart with test weights and a driver may be used as an additional Reference Vehicle.**

**N.7.2.1. Weight Conditions - Reference Vehicle(s) shall be selected to provide at least a high and low weight condition. Different vehicle types may be used.**

**N.7.2.2. Load Position - Loads on the Reference Vehicle should be positioned equally side-to-side.**

**N.7.2.3. Static Weight - Reference Vehicle(s) shall be statically weighed on a Reference Scale as defined in N.7.1. immediately before being used to conduct the Weigh-in-Motion Vehicle Scale tests.**

**N.7.2.3.1. Rounding - Error weights may be added to the Reference Vehicle to increase its weight to a whole scale division to minimize rounding errors.**

**N.7.2.3.2. Re-weighing - Reference Vehicles may be re-weighed at the discretion of the testing authority.**

Section Number	Change	Explanation
HB44 2.20. Scales N.7.3.	Added	Test speeds must cover the range of operation as defined by the marking requirements.

**N.7.3. Test speeds – The speed of the Reference Vehicle shall be maintained within the parameters as specified by the manufacturer during each test (see also S.1.14.1.a and S.1.14.1.b).**

**N.7.3.1 Range - Various speeds of the Reference Vehicle shall be used between the minimum and maximum operating speed specified for the Weigh-in-Motion Vehicle Scale. The minimum speed capability of the Reference Vehicle may be used as the minimum speed.**



Section Number	Change	Explanation
HB44 2.20. Scales N.7.4.	Added	The WIM scale must be tested as a static scale to ensure accurate weighments and minimize the amount of in-motion testing required.

**N.7.4. Static Tests for Weigh-in-Motion Vehicle Scale – The Weigh-in-Motion Vehicle Scale shall comply with applicable vehicle scale tests defined in N.1. when tested statically.**

Section Number	Change	Explanation
HB44 2.20. Scales N.7.5.	Added	Multiple tests of the Reference Vehicle at various speeds must be completed to ensure the SD-WIM scale is accurate. More stringent testing (i.e. fault testing) will be completed during NTEP testing.

**N.7.5 Dynamic Tests for Weigh-in-Motion Vehicle Scale – Test procedures shall simulate the normal intended use as closely as possible (i.e. test as used).**

**N.7.5.1. Vehicles - The tests shall be performed using the Reference Vehicle(s) defined in N.7.2.**

**N.7.5.2. Weighments - Each Reference Vehicle shall have a minimum of 5 weighments at the speeds as defined in N.7.3.**

**N.7.5.3. Vehicle Position - Reference Vehicle(s) must stay within the defined roadway along the load receiving element (see also S.1.14.1e).**

**N.7.5.4. Travel Directions - The tests shall be performed in both directions of travel unless travel direction is restricted by the marking.**

**N.7.5.5. Results - At the conclusion of the weigh-in-motion tests, there shall be a minimum of 10 total weight readings for the Reference Vehicle(s) for each applicable direction of travel. The tolerance for each weight reading shall be based on the gross vehicle weight and the applicable tolerance values for Class III L.**

**(Added 20XX)**

Section Number	Change	Explanation
HB44 2.20. Scales Table 7a.	Amended	A clarification is added to Class III L scales to specifically include SD-WIM vehicle scales.

Table 7a. Typical Class or Type of Device for Weighing Applications	
Class	Weighing Application or Scale Type
I	Precision laboratory weighing
II	Laboratory weighing, precious metals and gem weighing, grain test scales
III	All commercial weighing not otherwise specified, grain test scales, retail precious metals and semi-precious gem weighing, grain-hopper scales, animal scales, postal scales, vehicle on-board weighing systems with a capacity less than or equal to 30 000 lb, and scales used to determine laundry charges
III L	Vehicle scales ( <u>including weigh-in-motion vehicle scales</u> ), vehicle on-board weighing systems with a capacity greater than 30 000 lb, axle-load scales, livestock scales, railway track scales, crane scales, and hopper (other than grain hopper) scales
IIII	Wheel-load weighers and portable axle-load weighers used for highway weight enforcement
Note: A scale with a higher accuracy class than that specified as “typical” may be used.	

(Amended 1985, 1986, 1987, 1988, 1992, 1995, and 2012, and 20XX)

## Conclusion

- METTLER TOLEDO has demonstrated the technology to weigh vehicles in motion to Class III L tolerances as witnessed by state regulators, NTEP, and NIST.
- Despite cancelled and limited NCWM Regional meetings, METTLER TOLEDO has met with and worked with key individuals in all four Regions in over twelve separate online meetings to develop the proposed HB44 code for Single Draft WIM Vehicle Scales.
- METTLER TOLEDO has also met several times with NTEP and NIST representatives to obtain further feedback and input on the current HB44 code proposal.
- METTLER TOLEDO believes the current HB44 code proposal identifies the required specifications and tolerances in sufficient detail needed to add Single Draft WIM Vehicle Scales to HB44, and follows similar methodologies as other dynamic weighing codes in HB44.
- METTLER TOLEDO is committed to working with NTEP and NIST to further develop the NTEP test procedures and NIST EPOs needed to further define the more detailed processes for testing.
- METTLER TOLEDO believes this proposal is ready to be made a voting item for the July NCWM annual meeting. We ask for your support of this item.

**Thank you !**