National Conference on Weights and Measures July 10, 2023
1135 M Street, Suite 110
Lincoln, Nebraska 68508
Attn: Chair, Specification and Tolerances (S&T) Committee
RE: WIM-23.1

RE: NIST Handbook 44 Amendments, Weigh-In-Motion Systems Code

Mr. Glass:

After the interim meeting, we have completed a calibration of a WIM system as recommended by NIST as well as the S&T committee to not only demonstrate the accuracy and capability of the system for the benefit of the National Conference on Weight and Measures they continue the review of item WIM-23.1, Handbook amendment but also provide a demonstration of the procedure to ensure practicality and usefulness in meeting the intent of certification of the system. The test was conducted in Madison Wisconsin on 4/19 through 4/21.

Attached please see the following items for reference with regards to the demonstration:

1. Test procedure
2. Attendee sign in sheet
3. Summary of Demonstration data
4. Excel spreadsheet with data of the runs
5. Presentation with general site data as well as summary of tests results

As part of discussion that followed the demonstration certain changes in the procedure were identified as appropriate to meet the intent of the procedure. There included:

a) Drivers have difficulty identifying left, center and right within the lane, it was agreed that instead of having runs split this way, they would all be “within” the lane which will result in a variety of locations within the lane, simulating operational conditions.
b) Empty truck runs can lead to errors, particularly for class 9 due to the ability of the back axles to bounce. As enforcement would be focused on overweight vehicles, it is more appropriate to test at nearly maximum loading and at another lower loading condition, in lieu of empty and full.
c) In order to issue violations per bridge formula, axle spacing needs to be measured by the system and calibration procedure needs to incorporate appropriate guidance in this regard.

We look forward to finalizing the procedure in the near future and discussions towards that goal at the annual meeting.

Sincerely,

WIM-23.1 Submitters

Cc: S&T Committee members

Demo Results (Summary) and Discussion

Full Load	Valid	Pass	Ratio
Single (20%)	131	131	100%
Tandem (15%)	102	102	100%
GVW (10%)	99	99	100%
	332	**332**	**100%**

Empty Load	Valid	Pass	Ratio
Single (20%)	74	74	100%
Tandem (15%)	54	50	**93%**
GVW (10%)	55	54	**98%**
	183	**178**	**97%**

Total	Valid	Pass	Ratio
Single (20%)	205	205	100%
Tandem (15%)	156	152	**97%**
GVW (10%)	154	153	**99%**
	515	**510**	**99%**

- Off-scale records (when the vehicle was not on the load receiving element of the sensor) were excluded. In actual calibration testing, additional runs should be made.
- Full load case achieved target accuracy at 100% compliance. All OW trucks will be at or above full load case.
- Empty load case did not achieve target accuracy for tandem (93% compliance) and GVW (98% compliance). This is because of the high vehicle dynamic when the vehicle was not loaded.
- Axle spacing was more accurate at high speeds (60-65 mph) than low speed (25-35 mph). The error was within 1.4% (6 in. diff for Class 9) at high speed and 1.7% (12 in. diff for Class 9).
- Position test (left and right) was very subjective and dependent on the truck driver. "Left" or "Right" yielded off-scale warning.

Subject: Calibration Procedure for SWEF Demo with NCMW S&T Committee
Date: Tuesday 04/18/2023 & Wednesday 04/19/2023

Contacts on Testing Dates:

- Tanvi Pandya (NYCDOT) @ (347) 931-2437
- Hani Nassif (C2SMART) @ (732) 207-8225
- Alex Schumacher (Kistler) @ (231) 463-5266
- Chaekuk Na (C2SMART) @ (732) 258-5997
- Roy Czinku (IRD) @ (306) 270-9492

Daily Schedule, Sunday 4/16/2023

- 5 pm or after: Meeting at the Hyatt Hotel to discuss all logistics of the Demo tests

Daily Schedule, Monday 4/17/2023

- 9 am ~ 3 pm (exact time to be determined): Meeting at EB Weigh Station – Madison SWEF to go over all logistics of the Demo tests on site.
- 6 pm or after: Meeting with S&T Committee or other attendees if available

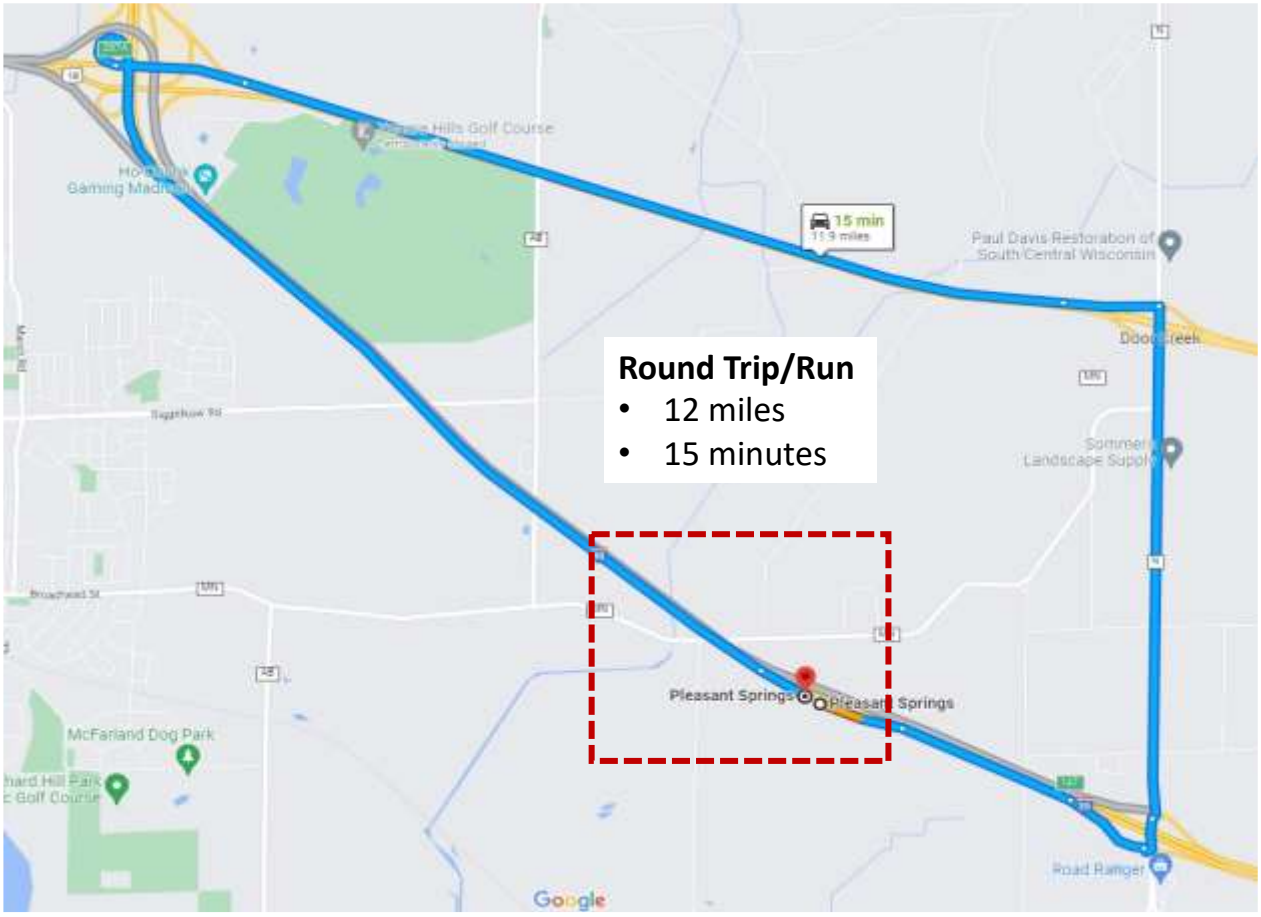
Daily Schedule, Tuesday 4/18/2023

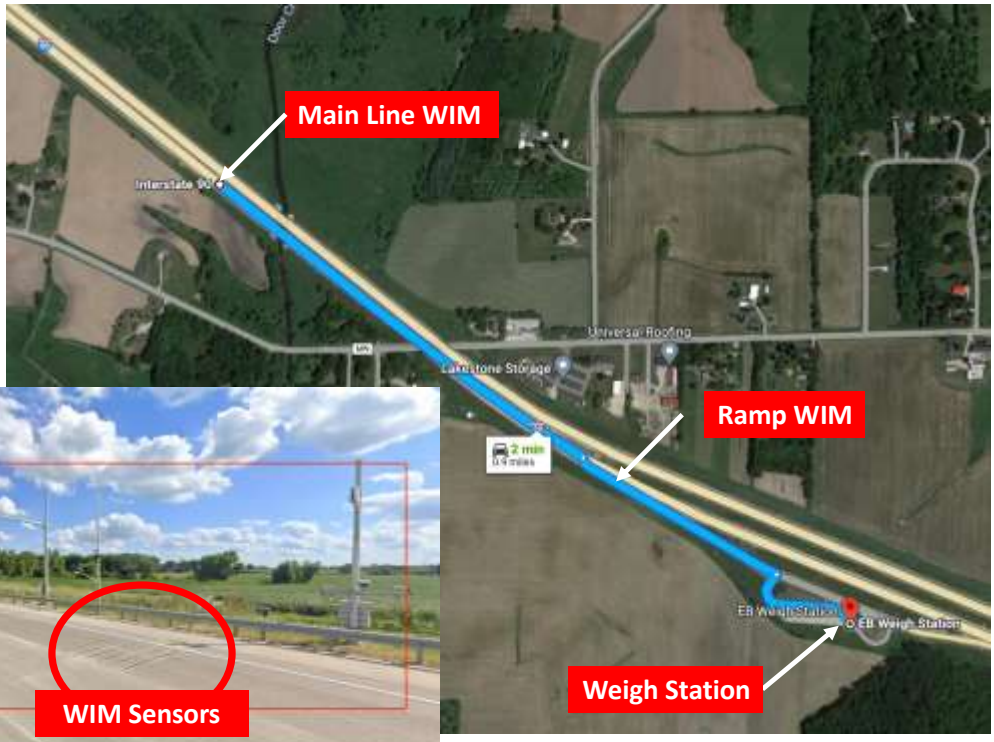
- 7:15 am: Meet with S&T Committee (tentatively at Hyatt Hotel) and drive to the site
- 7:45 am: Arriving at EB Weigh Station – Madison SWEF.
- 8 am Close the station and Block the ramp entrance with flashing light vehicles for safety.
- 8 am ~8:20 am: Visit the ramp WIM electronics and sensors.
- 8:20 am ~ 8:40 am: Meeting with truck drivers. Alex and Chaekuk to measure the truck length and axle spacings, and discuss with the truck drivers the logistics
- 8:40 am ~ 9:00 am: Measuring truck weights at static scale and release to make first pass.
- 9 am ~ 9:15 am: (S&T Committee) Roy, Tanvi, and Hani to introduce the EB Weigh Station configuration and incoming data format. Review the logistics of the Demo tests.
- 9:15 am ~ 4:30 pm: Testing as scheduled below.
    - A real-time update will be provided for each run.
    - Packed lunch to be provided.
    - Statically weigh the trucks at lunch and the end of the day.
- 4:30 pm ~ 5 pm: Debriefing of the test runs.

Daily Schedule, Wednesday 4/19/2023

- 7:30 am: Meeting with S&T Committee (tentatively at Hyatt Hotel) and drive to the site.
- 8 am: Arriving at EB Weigh Station – Madison SWEF.
- 8:15 am Close the station and Block the ramp entrance with flashing light vehicles for safety.
- 8:15 am ~ 8:30 am: Meeting with truck drivers. Alex and Chaekuk to discuss with the truck drivers the logistics
- 8:30 am ~ 9 am: Measuring truck weights at static scale
- 9 am ~ 12:30 pm: Testing as scheduled below.
    - A real-time update will be provided for each run.
    - Packed lunch to be provided.
    - Statically weigh the trucks at lunch and the end of the day.
- 12:30 pm ~ 1 pm: Debriefing of the test runs.

- Routing Map


Round Trip/Run
• 12 miles
• 15 minutes
15 min
Pleasant Springs
McFarland Dog Park
Google


Main Line WIM
Ramp WIM
Weigh Station


WIM Sensors

- Test Schedule
  - Position tests (L1, L2, R1, and R2) will be performed on an as-needed basis, depending on the actual positions of the calibration trucks for the center positions.

Run	Load Condition	Main Speed (mph)	Ramp Speed (mph)	Postion	Time	Run Time = 17 min	
Day 1					8-9AM	Weigh Trucks &Review Site	
1	Full	65	35	C1	9:00:00 AM		
2	Full	65	35	C2	9:17:00 AM		
3	Full	65	35	C3	9:34:00 AM		
4	Full	65	35	C4	9:51:00 AM		
5	Full	65	35	C5	10:08:00 AM	9AM-11:30PM	
6	Full	65	35	C6	10:25:00 AM		
7	Full	65	35	C7/L1	10:42:00 AM		
8	Full	65	35	C8/L2	10:59:00 AM		
9	Full	65	35	C9/R1	11:16:00 AM		
10	Full	65	35	C10/R2	11:33:00 AM		
	Lunch Break					11:40AM-1PM	Drivers on site 8AM-4:30PM
11	Full	60	25	C1	1:00:00 PM		
12	Full	60	25	C2	1:17:00 PM		
13	Full	60	25	C3	1:34:00 PM		
14	Full	60	25	C4	1:51:00 PM		
15	Full	60	25	C5	2:08:00 PM		
16	Full	60	25	C6	2:25:00 PM		
17	Full	60	25	C7/L1	2:42:00 PM	1PM-4:30PM	
18	Full	60	25	C8/L2	2:59:00 PM		
19	Full	60	25	C9/R1	3:16:00 PM		
20	Full	60	25	C10/R2	3:33:00 PM		
	Full	/	/	Extra	3:50:00 PM		
	Full	/	/	Extra	4:07:00 PM		
	Full	/	/	Extra	4:24:00 PM		
Day 2					8-9AM	Weigh Trucks	
21	Empty	65	35	C1	9:00:00 AM		
22	Empty	65	35	C2	9:17:00 AM		
23	Empty	65	35	C3	9:34:00 AM		
24	Empty	65	35	C4/R1	9:51:00 AM		
25	Empty	65	35	C5/L1	10:08:00 AM		
26	Empty	60	25	C6	10:25:00 AM		
27	Empty	60	25	C7	10:42:00 AM	9AM-12:30PM	Drivers on site 8AM-12:30PM
28	Empty	60	25	C8	10:59:00 AM		
29	Empty	60	25	C9/R2	11:16:00 AM		
30	Empty	60	25	C10/L2	11:33:00 AM		
	Empty	/	/	Extra	11:50:00 AM		
	Empty	/	/	Extra	12:07:00 PM		
	Empty	/	/	Extra	12:24:00 PM		

Demonstration Overview

- Schedule: Tuesday 4/18/23 ~ Wednesday 4/19/2023
  - 4/18/23, 8 am – 4:30 pm: Truck shall be fully loaded as noted below.
  - 4/19/23, 8 am – 12:30 pm: Truck shall be empty.
  - Same trucks on both days shall be provided.
  - Meeting at 8 am at the Weigh Station each day.
- Test Location: EB Weigh Station – Madison SWEF.
  - https://goo.gl/maps/yEPqZuLbaSS6D4j28
- Test Trucks: Three (3) calibration trucks will be hired for demonstration of weigh in motion performance testing and system features.
  - Class 9 Truck – 5-axle semi-trailer truck with GVW close to 80,000 lbs.
  - Tandem shall be 48-51" spacing and no split tandem (10').
    - Dry Run Demo Truck
      - GVW (full) = 72,580 lbs
      - GVW (empty) = 33,360 lbs
      - Total spacing = 60'-7"

  - Class 6 Truck – 3-axle dump truck with GVW close to 72,000 lbs or legal limit.
    - Any pusher axle shall not be used in any case from loading until the completion of the two-day testing.
    - Dry Run Demo Truck
      - GVW (full) = 44,900 lbs
      - GVW (empty) = 28,460 lbs
      - Total spacing = 24'-2"

  - Class 5 Truck – 2-axle dump truck with GVW close to 33,000 lbs or legal limit.
    - Dry Run Demo Truck
      - GVW (full) = 27,760 lbs
      - GVW (empty) = 17,880 lbs
      - Total spacing = 22'-8"

  - Truck shall have air ride suspension.
  - Truck load shall comply with the legal limit.
  - Loads shall be non-shiftable. Any liquid is <u>not</u> acceptable.
  - Gas tank shall be <u>full</u> before starting the runs each day.

- <u>Test Lane</u>: Three (3) trucks shall run in series in "Main Line" and "Ramp" for 30 runs at 2 speeds and 3 positions, as summarized in the table below.
  - <u>Main Line</u>: Right Lane will be tested.
    - Speed: 60 mph and 65 mph
    - Position: Center, Right and Left within the test lane
  - <u>Ramp</u>: Ramp will be tested.
    - Speed: 35 mph and 25 mph
    - Position: Center, Right, and Left within the test lane
  - The headway between calibration trucks shall be at least 100 ft. (200 ft. preferred). However, no other trucks shall be running between calibration trucks.
- <u>Test Lane Position – see "Position" in the table below:</u>
  - Three (3) lane positions will be tested. Most runs will be "Center", and several runs will be "Left" and "Right".
    - *<u>(Note) It was noticed that the truck drivers tended to drive over the lane stripping for the lane positioning test, which resulted in a system warning per the existing configuration. Therefore, the team will visually check the actual truck positions while running over the sensors and use that information to confirm the lane positioning.</u>*
  - Center (**C**): Truck shall be positioned in the "center" of the lane.
  - Left (**L**): Truck shall run left of center by 1 foot. We want to avoid driving on the left lane striping and not on the active weighing surface. Preferred to stay 1 ft away from the lane striping edge.
  - Right (R): Truck shall run left of center by 1 foot. We want to avoid driving on the left lane striping and not on the active weighing surface. Preferred to stay 1 ft away from the lane striping edge.
    - Note: the system has "offscale" detectors to warn when the vehicles are not correctly passing over the WIM sensors.
- Required Support: Communication with drivers during the entire process.
  - If possible, share your real-time location on Google Maps.
    - Click your Google ID (right top corner) and select "Location Sharing". Select the contact to share your location.
    - You MUST remove them after testing for your privacy.
    - Will discuss this on-site at 8 am.
- <u>Note to the Driver</u>: Trucks shall maintain the speed 200 ft upstream and 100 ft downstream at the designated position from the test location. No acceleration and braking, unless deemed necessary for safety. Avoid other trucks in the same and adjacent lanes, if possible.

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WIM Demostration

4/18/2023