WIM System Field Calibration and Validation Summary Report

Louisiana SPS-1
SHRP ID – 220100

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1 Executive Summary

A WIM validation was performed on July 27 and 28, 2010 at the Louisiana SPS-1 site located on route US-171 at milepost 8.4, 7.4 miles north of Interstate 10.

This site was installed on December 13, 2007 by International Road Dynamics (IRD). The in-road sensors are installed in the northbound lane. The site is equipped with quartz WIM sensors and IRD iSINC WIM controller. The LTPP lane is identified as lane 1 in the WIM controller. From a comparison between the report of the most recent validation of this equipment on March 05, 2008 and this validation visit, it appears that no changes have occurred during this time to the basic operating condition of the equipment.

The equipment is in working order. Electronic and electrical checks of all WIM components determined that all equipment was operating within tolerances. Further equipment discussion is provided in Section 3.

During the on-site pavement evaluation, no distresses that would affect the performance of the WIM scales were noted. Observations of trucks passing over the site did not detect any motions by the trucks that would affect WIM system accuracies. Further pavement condition discussion is provided in Section 4.

Based on the criteria contained in the LTPP Field Operations Guide for SPS WIM Sites, Version 1.0 (05/09), this site is providing research quality loading data. The summary results of the validation are provided in Table 1-1 below.

Table 1-1 – Post-Validation Results – 28-Jul-10

Parameter	95% Confidence Limit of Error	Site Values	Pass/Fail
Steering Axles	±20 percent	1.2 ± 4.9%	Pass
Single Axles	±20 percent	0.4 ± 5.6%	Pass
Tandem Axles	±15 percent	-0.4 ± 4.4%	Pass
GVW	±10 percent	0.0 ± 3.6%	Pass
Vehicle Length	±3 percent (2.3 ft)	-0.1 ± 0.8 ft	Pass
Axle Spacing Length	± 0.5 ft [150mm]	0.1 ± 0.4 ft	Pass

Truck speeds were manually collected for each test run by a radar gun and compared with the speed reported by the WIM equipment. For this site, the error in speed measurement was 0.3 ± 2.1 mph, which is greater than the ±1.0 mph tolerance established by the LTPP Field Operations Guide for SPS WIM Sites. However, since the site is measuring axle spacing length within specified tolerances, and the speed and axle spacing measurements are based on the distance between the axle detector sensors, it can be concluded that the distance factor is set correctly and that the speeds being reported by the WIM equipment are within acceptable ranges.

This site is not providing research quality vehicle classification data for heavy trucks (Class 6 – 13). The heavy truck misclassification rate of 5.0% is greater than the 2.0% acceptability criterion for LTPP SPS WIM sites. The overall misclassification rate of 19.8% from the 100 truck sample (Class 4 – 13) was due to the ten cross-classifications of Class 3, 4, 5, and 8 vehicles.

There were two test trucks used for the post-validation. They were configured and loaded as follows:

- The *Primary* truck was a Class 9 vehicle with air suspension on the tractor and trailer tandems, and standard (4 feet) tandem spacings. It was loaded with concrete blocks loaded on the trailer.

- The *Secondary* truck was a Class 9 vehicle with air suspension on the tractor tandem, air on the trailer tandem, standard tandem spacing on the tractor and split tandem on the trailer. The Secondary truck was loaded with steel pipe loaded on the trailer.

Prior to the validation, the test trucks were weighed and measured, cold tire pressures were taken, and photographs of the trucks, loads and suspensions were collected (see Section 7). Axle length (AL) was measured from the center hub of the first axle to the center hub of the last axle. Overall length (OL) was measured from the edge of the front bumper to the edge of the rear bumper. The test trucks were re-weighed at the conclusion of the validation. The average post-validation test truck weights and measurements are provided in Table 1-2.

Table 1-2 – Post-Validation Test Truck Measurements

Test Truck	Weights (kips)						Spacings (feet)					
	GVW	Ax1	Ax2	Ax3	Ax4	Ax5	1-2	2-3	3-4	4-5	AL	OL
1	75.7	11.0	15.4	15.4	17.0	17.0	20.2	4.3	31.7	4.2	60.4	73.5
2	67.3	10.9	15.3	15.3	12.9	12.9	20.2	4.3	31.7	10.2	66.4	79.0

The posted speed limit at the site is 65 mph. During the testing, the speed of the test trucks ranged from to 54 to 68 mph, a range of 14 mph.

During test truck runs, pavement temperature was collected using a hand-held infrared temperature device. The post-validation pavement surface temperatures varied from 77.3 to 115.3 degrees Fahrenheit, a range of 38.0 degrees Fahrenheit. The mostly cloudy weather conditions provided for a greater than 30 degree range in temperatures.

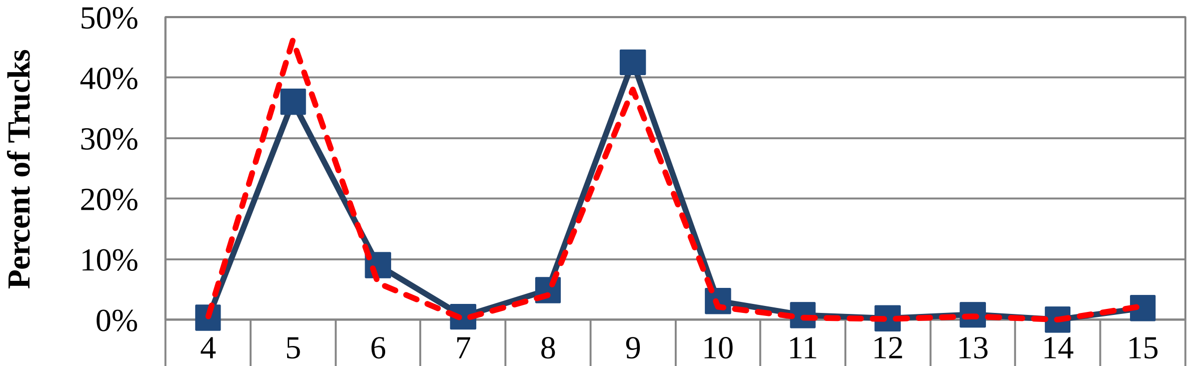
A review of the LTPP Standard Release Database 24 shows that there are 17 consecutive months of level "E" WIM data for this site. This site requires 4 additional years of data to meet the minimum of five years of research quality data.

2 Pre-Visit Data Analysis

To assess the quality of the current data, a pre-visit analysis was conducted by comparing a two-week data sample from June 14, 2010 (Data) to the most recent Comparison Data Set (CDS) from February 18, 2008. The results of the pre-visit analysis are noted and used to facilitate further analysis during the validation. The results of these analyses are provided in Section 5.

2.1 Classification Data Analysis

The traffic data was analyzed to determine the expected truck distributions. This analysis provides a basis for the classification distribution study that was conducted on site. Figure 2-1 provides a comparison of the truck type distributions for the two datasets.



	4	5	6	7	8	9	10	11	12	13	14	15
Data	0.3%	36.0%	9.0%	0.5%	4.9%	42.6%	3.1%	0.8%	0.2%	0.8%	0.0%	1.9%
CDS	0.5%	46.2%	6.0%	0.1%	4.0%	38.0%	2.1%	0.3%	0.1%	0.5%	0.0%	2.2%

Figure 2-1 – Comparison of Truck Distribution

Table 2-1 provides statistics for the truck distributions at the site for the two periods represented by the two datasets. The table shows that according to the most recent data, the most frequent truck types crossing the WIM scale are Class 9 (42.6%) or Class 5 (36.0%). It also indicates that 1.9 percent of the vehicles at this site are unclassified. During the classification study, observations of Class 15 vehicles are made to determine if unclassified vehicles are valid, as in the case of oversized vehicles with irregular trailer axle spacings. Table 2-1 also provides data for vehicle classes 14 and 15. Class 14 vehicles are vehicles that are reported by the WIM equipment as having irregular measurements and cannot be classified properly, such as negative speeds from vehicles passing in the opposite direction of a two-lane road. Class 15 vehicles are unclassified vehicles.

Table 2-1 – Truck Distribution from W-Card

Vehicle Classification	CDS		Data		Change
	Date				
	3/10/2008		6/14/2010		
4	33	0.5%	14	0.3%	-0.2%
5	2813	46.2%	1729	36.0%	-10.1%
6	365	6.0%	432	9.0%	3.0%
7	4	0.1%	24	0.5%	0.4%
8	245	4.0%	233	4.9%	0.8%
9	2315	38.0%	2042	42.6%	4.6%
10	130	2.1%	148	3.1%	1.0%
11	17	0.3%	36	0.8%	0.5%
12	5	0.1%	10	0.2%	0.1%
13	30	0.5%	39	0.8%	0.3%
14	0	0.0%	0	0.0%	0.0%
15	136	2.2%	91	1.9%	-0.3%

The table shows that the number of Class 5 vehicles has decreased by 10.1 percent from February 2008 to June 2010. This decrease may be attributed to small sample size used to develop vehicle class distributions, decreased use of the roadway for local deliveries, cross-classifications of type 3 and 5 vehicles, as well as natural variations in truck volumes. During the same time period, there was an increase of 4.6 percent in the number of Class 9 trucks. Small increases in the number of heavier trucks may be attributed to seasonal variations in truck distributions.

During the classification study, observations of Class 15 vehicles were made to determine if unclassified vehicles are valid, as in the case of oversized vehicles with irregular trailer axle spacings.

2.2 Speed Data Analysis

The traffic data received from the Phase II Contractor was analyzed to determine the expected truck speed distributions. This will provide a basis for the speed of the test trucks during validation testing. The SDC distribution of truck speeds is presented in Figure 2-2.

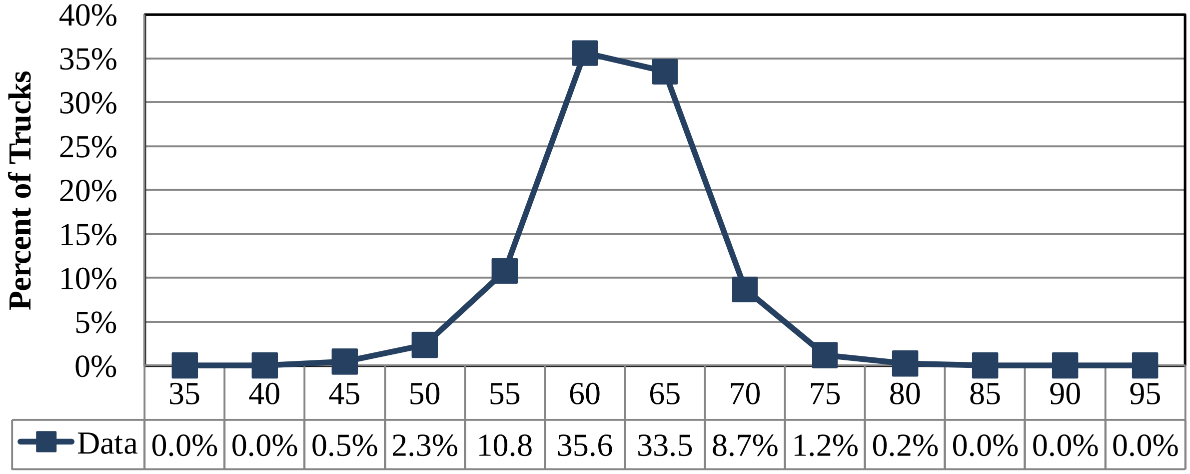


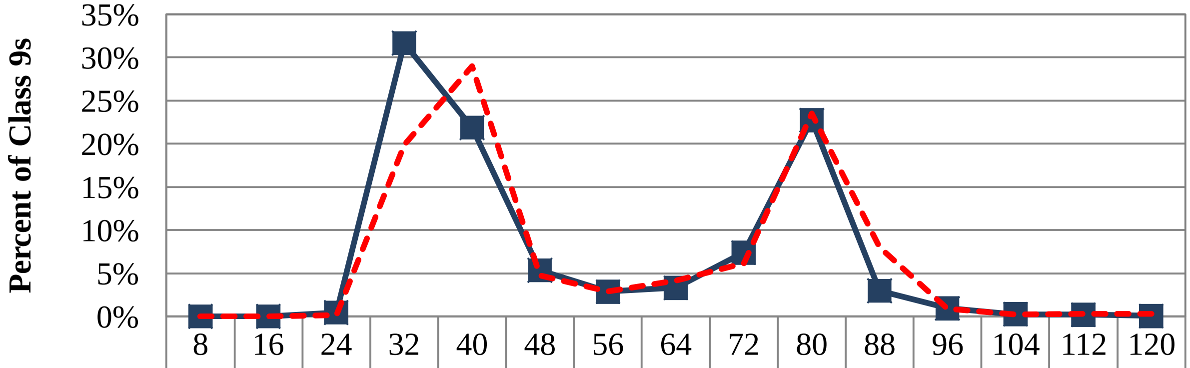
Figure 2-2 – Truck Speed Distribution – 23-Jul-10

As shown in Figure 2-2, the majority of the trucks at this site are traveling between 55 and 65 mph. The posted speed limit at this site is 65 and the 85th percentile speed for trucks at this site is 66 mph. The coverage of truck speeds for the validation will be 55 and 65 mph. Although the 85th percentile speeds for trucks is above the posted speed limit, due to low number of Class 9 samples for this site, the post-visit applied calibration will not be used to develop compensation factors for speed points above the speed limit.

2.3 GVW Data Analysis

The CDS data received from the Regional Support Contractor was analyzed to determine the expected Class 9 GVW distributions. Figure 2-3 shows a comparison between GVW plots generated using a two-week W-card sample from June 2010 and February 2008.

As shown in the figure, there is a shift to the left for the unloaded and loaded peaks between the February 2008 Comparison Data Set (CDS) and the June 2010 sample W-card dataset (Data). This may indicate a change in the pavement condition or sensor deterioration. The results indicate possible drifting in WIM weight measurement accuracy.



	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
Data	0.0%	0.0%	0.4%	31.7	21.9	5.3%	2.9%	3.3%	7.4%	22.7	3.0%	0.9%	0.2%	0.2%	0.0%
CDS	0.0%	0.0%	0.1%	19.9	29.0	4.7%	2.9%	4.1%	6.2%	23.5	8.0%	0.9%	0.2%	0.3%	0.3%

Figure 2-3 – Comparison of Class 9 GVW Distribution

Table 2-2 is provided to demonstrate the statistical comparison between the comparison and the current dataset.

Table 2-2 – Class 9 GVW Distribution from W-Card

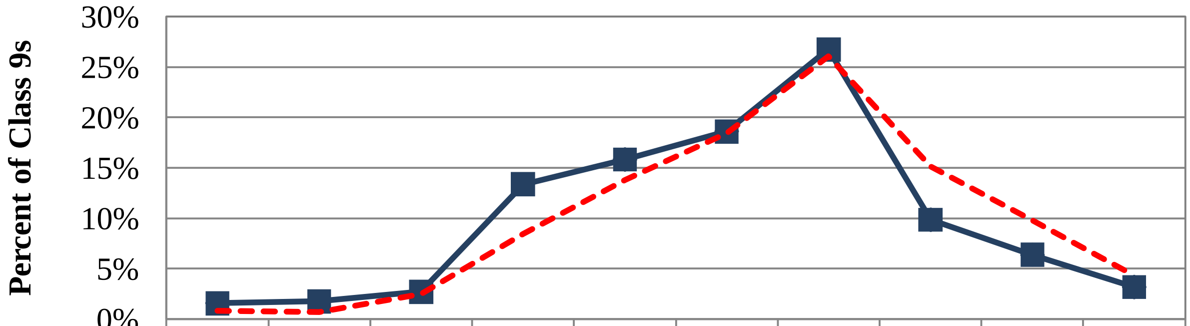
GVW weight bins (kips)	CDS		Data		Change
	Date				
	3/10/2008		6/14/2010		
8	0	0.0%	0	0.0%	0.0%
16	0	0.0%	0	0.0%	0.0%
24	3	0.1%	9	0.4%	0.3%
32	456	19.9%	642	31.7%	11.8%
40	665	29.0%	444	21.9%	-7.1%
48	109	4.7%	108	5.3%	0.6%
56	66	2.9%	58	2.9%	0.0%
64	95	4.1%	67	3.3%	-0.8%
72	142	6.2%	150	7.4%	1.2%
80	539	23.5%	461	22.7%	-0.8%
88	183	8.0%	60	3.0%	-5.0%
96	20	0.9%	19	0.9%	0.1%
104	5	0.2%	5	0.2%	0.0%
112	6	0.3%	4	0.2%	-0.1%
120	6	0.3%	1	0.0%	-0.2%
Average =	52.8		48.8		-4.1

As shown in the table, the number of unloaded class 9 trucks in the 32 to 40 kips range decreased by 7.1 percent and the number of loaded class 9 trucks in the 72 to 80 kips range decreased by 0.8 percent. The number of overweight trucks decreased during this time period by 5.2 percent and the overall GVW average for this site decreased from 52.8 kips to 48.8 kips.

2.4 Class 9 Front Axle Weight Data Analysis

The CDS data received from the regional support contractor was analyzed to determine the expected average front axle weight. This will provide a basis for the evaluation of the quality of the data by comparing the observed average front axle weight with the expected average front axle weight for Class 9 trucks of 10.3 kips.

Figure 2-4 shows a comparison between Class 9 front axle weight plots generated by using one week W-card samples in June 2010 and February 2008. The class 9 front axle weight plot is provided to indicate possible drifting in WIM weight measurement accuracies.



	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5
Data	1.6%	1.8%	2.7%	13.4%	15.8%	18.6%	26.7%	9.9%	6.4%	3.2%
CDS	0.8%	0.7%	2.5%	8.5%	13.8%	18.4%	26.1%	15.1%	9.8%	4.3%

Figure 2-4 – Distribution of Class 9 Front Axle Weights

As can be seen in the figure, there is no significant difference between the February 2008 Comparison Data Set (CDS) and the June 2010 dataset (Data).

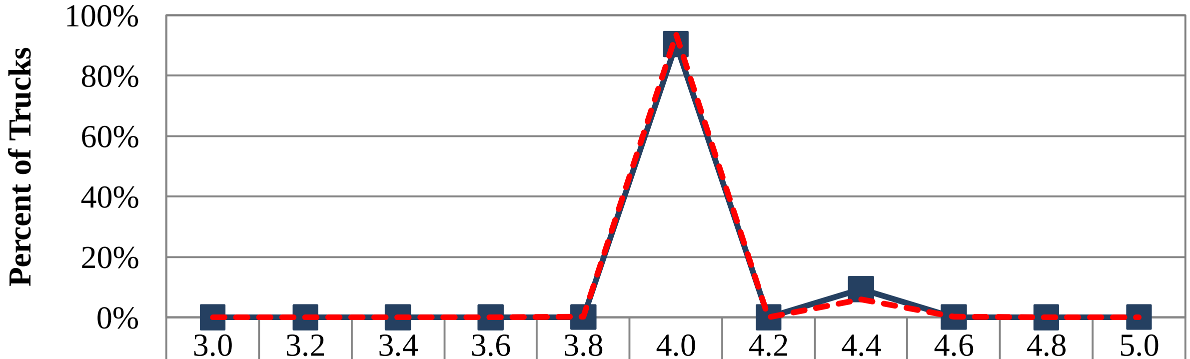
Table 2-3 indicates that the average front axle weight for Class 9 trucks has decreased by 0.3 kips, or 2.5 percent. According to the current data, the majority of the Class 9 front axle weights are between 10.5 and 11.5 kips and the average front axle weight for Class 9 trucks is 10.4 kips.

Table 2-3 – Class 9 Front Axle Weight Distribution from W-Card

F/A weight bins (kips)	CDS		Data		Change
	Date				
	3/10/2008		6/14/2010		
8.0	18	0.8%	31	1.6%	0.8%
8.5	16	0.7%	35	1.8%	1.0%
9.0	56	2.5%	54	2.7%	0.2%
9.5	190	8.5%	266	13.4%	4.9%
10.0	309	13.8%	315	15.8%	2.1%
10.5	413	18.4%	370	18.6%	0.2%
11.0	585	26.1%	532	26.7%	0.7%
11.5	339	15.1%	196	9.9%	-5.3%
12.0	220	9.8%	127	6.4%	-3.4%
12.5	97	4.3%	63	3.2%	-1.2%
Average =	10.6		10.4		0.3

2.5 Class 9 Tractor Tandem Spacing Data Analysis

The expected average tractor tandem spacing will provide a basis for the evaluation of the accuracy of the equipment distance and speed measurements by comparing the observed average tractor tandem spacing from the equipment with the expected average tractor tandem spacing of 4.25 feet. The class 9 tractor tandem spacing plots in Figure 2-5 are provided to indicate possible shifts in WIM system distance and speed measurement accuracies.



	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0
Data	0.0%	0.0%	0.0%	0.0%	0.0%	90.5%	0.0%	9.3%	0.0%	0.0%	0.1%
CDS	0.0%	0.0%	0.0%	0.0%	0.1%	93.6%	0.0%	6.0%	0.2%	0.0%	0.0%

Figure 2-5 – Comparison of Class 9 Tractor Tandem Spacing

As seen in the figure, the Class 9 tractor tandem spacing for the February 2008 Comparison Data Set and the June 2010 dataset are nearly identical.

Table 2-4 indicates that the spacing of the tractor tandems for Class 9 trucks at this site is between 3.8 and 4.6 feet. The average tractor tandem spacing is 4.0 feet, which is below the expected average of 4.25 feet. Further analyses are performed during the validation and post-validation analysis.

Table 2-4 – Class 9 Axle 3 to 4 Spacing from W-Card

Tandem 1 spacing bins (feet)	CDS		Data		Change
	Date				
	3/10/2008		6/14/2010		
3.0	0	0.0%	0	0.0%	0.0%
3.2	0	0.0%	0	0.0%	0.0%
3.4	1	0.0%	0	0.0%	0.0%
3.6	0	0.0%	0	0.0%	0.0%
3.8	3	0.1%	1	0.0%	-0.1%
4.0	2152	93.6%	1835	90.5%	-3.2%
4.2	0	0.0%	0	0.0%	0.0%
4.4	138	6.0%	189	9.3%	3.3%
4.6	4	0.2%	1	0.0%	-0.1%
4.8	0	0.0%	0	0.0%	0.0%
5.0	0	0.0%	2	0.1%	0.1%
Average =	4.0		4.0		0.0

2.6 Data Analysis Summary

Historical data analysis involved the comparison of the most recent Comparison Data Set (February 2008) based on the last calibration with the most recent two-week WIM data sample from the site (June 2010). Comparison of vehicle class distribution indicate a 10 percent decrease in the number of Class 5 vehicles and about five percent increase in Class 9 vehicles.. Analysis of Class 9 GVW and Class 9 front axle weights indicated a decrease in weights for the June 2010 data . The Class 9 Tractor Tandem Spacing did not indicate any significant deviation in the WIM equipment performance.

3 WIM Equipment Discussion

From a comparison between the report of the most recent Validation of this equipment on March 05, 2008 and this validation visit, it appears that no changes have occurred during this time to the basic operating condition of the equipment.

3.1 Description

This site was installed on December 13, 2007 by International Road Dynamics. It is instrumented with quartz weighing sensors and IRD iSINC WIM Controller. As the installation contractor, IRD also performs routine equipment maintenance and data quality checks of the WIM data.

3.2 Physical Inspection

Prior to the pre-validation test truck runs, a physical inspection of all WIM equipment and support services equipment was conducted. No discrepancies were noted. Photographs of all system components were taken and are presented in Section 7.

3.3 Electronic and Electrical Testing

Electronic and electrical checks of all system components were conducted prior to the pre-validation test truck runs. Dynamic and static electronic checks of the in-road sensors were performed. All insulation and capacitive values for the quartz piezo sensors were within tolerances. Electronic tests of the electric and telephone services indicated that they were operating normally.

3.4 Equipment Troubleshooting and Diagnostics

The WIM system appeared to collect, analyze and report vehicle measurements normally. No troubleshooting actions were taken.

3.5 Recommended Equipment Maintenance

No equipment maintenance actions are recommended.

4 Pavement Discussion

4.1 Pavement Condition Survey

During a visual distress survey of the pavement conducted from the shoulder, no significant pavement distress was noted and no adverse truck movements prior to, or as they traversed the WIM scale area, were noted. Pavement condition upstream and downstream of the WIM scale area is shown in Photo 4-1 and Photo 4-2.

Photo 4-1 - Upstream from Louisiana SPS-1 WIM Site

Photo 4-2 - Downstream from the Louisiana SPS-1 WIM Site

4.2 Profile and Vehicle Interaction

Profile data collected on March 07, 2010 by the Southern Regional Support Contractor using a high-speed profiler, where the operator travels over the entire one-thousand foot WIM Section, 900 feet prior to WIM scales and 100 feet after the WIM scales, was obtained. Each pass collects International Roughness Index (IRI) values in both the left and right wheel paths. For this site, 11 profile passes were made, 5 in the center of the travel lane and 6 that were shifted to the left and to the right of the center of the travel lane.

From a pre-visit review of the IRI values for the center, right, and left profile runs, the highest IRI values within the 1000 foot WIM section were 260 in/mi and are located approximately 60 feet prior to the WIM scale. The highest IRI values within the 400 foot approach section were 260 in/mi and are located approximately 60 feet prior to the WIM scale. During the validation visit truck dynamics in this area were closely observed. There were no distresses observed that would influence truck dynamics in the WIM scale area.

Additionally, a visual observation of the trucks as they approach, traverse and leave the sensor area did not indicate any visible motion of the trucks that would affect the performance of the WIM scales. Trucks appear to track down the center of the lane.

4.3 LTPP Pavement Profile Data Analysis

The IRI data files are processed using the WIM Smoothness Index software. The indices produced by the software provide an indication of whether or not the pavement roughness may affect the operation of the WIM equipment. The recommended thresholds for WIM Site pavement smoothness are provided in Table 4-1.

Table 4-1 – Recommended WIM Smoothness Index Thresholds

Index	Lower Threshold (m/km)	Upper Threshold (m/km)
Long Range Index (LRI)	0.50	2.1
Short Range Index (SRI)	0.50	2.1
Peak LRI	0.50	2.1
Peak SRI	0.75	2.9

When all values are less than the lower threshold shown in Table 4-1, it is unlikely that pavement conditions will significantly influence sensor output. Values between the threshold values may or may not influence the accuracy of the sensor output and values above the upper threshold would lead to sensor output that would preclude achieving the research quality loading data.

The profile analysis was based on four different indices: Long Range Index (LRI), which represents the pavement roughness starting 25.8 m prior to the scale and ending 3.2 m after the scale in the direction of travel; Short Range Index (SRI), which represents the pavement roughness beginning 2.74 m prior to the WIM scale and ending 0.46 m after the scale; Peak LRI – the highest value of LRI within 30 m prior to the scale; and Peak SRI – the highest value of SRI between 2.45 m prior to the scale and 1.5 m after the scale. The results from the analysis for each of the indices for the right wheel path (RWP) and left wheel path (LWP) values for the three left, three right, and five center profiler runs are presented in Table 4-2.

Table 4-2 – WIM Index Values

Profiler Passes			Pass 1	Pass 2	Pass 3	Pass 4	Pass5	Avg
Left	LWP	LRI (m/km)	1.547	1.688	1.560			1.598
		SRI (m/km)	1.552	**2.260**	1.550			1.787
		Peak LRI (m/km)	1.553	1.688	1.571			1.604
		Peak SRI (m/km)	1.594	2.318	1.647			1.853
	RWP	LRI (m/km)	1.939	1.695	1.998			1.877
		SRI (m/km)	**2.205**	**2.325**	**2.183**			**2.238**
		Peak LRI (m/km)	1.939	1.696	1.998			1.878
		Peak SRI (m/km)	2.233	2.337	2.189			2.253
Center	LWP	LRI (m/km)	1.977	1.886	1.808	1.919	1.751	1.868
		SRI (m/km)	**3.178**	**2.629**	**2.354**	**3.051**	**2.160**	**2.674**
		Peak LRI (m/km)	1.977	1.886	1.808	1.919	1.751	1.868
		Peak SRI (m/km)	**3.201**	2.629	2.419	**3.072**	2.224	2.709
	RWP	LRI (m/km)	1.672	1.650	1.749	1.699	1.612	1.676
		SRI (m/km)	1.579	1.048	1.122	1.176	1.079	1.201
		Peak LRI (m/km)	1.672	1.650	1.749	1.699	1.612	1.676
		Peak SRI (m/km)	1.647	1.178	1.347	1.210	1.194	1.315
Right	LWP	LRI (m/km)	1.762	1.732	1.859			1.784
		SRI (m/km)	**2.188**	2.075	**2.600**			**2.288**
		Peak LRI (m/km)	1.763	1.732	1.859			1.785
		Peak SRI (m/km)	**2.191**	**2.117**	**2.601**			**2.303**
	RWP	LRI (m/km)	1.888	1.953	1.900			1.914
		SRI (m/km)	1.967	**2.333**	2.029			**2.110**
		Peak LRI (m/km)	1.888	1.965	1.902			1.918
		Peak SRI (m/km)	2.021	2.437	2.079			2.179

From Table 4-2 it can be seen that most of the indices computed from the profiles are between the upper and lower threshold values, with the remaining values above the higher threshold, indicated in bold. The highest values, on average, are located in the left wheel path when vehicles are traveling in the center of the lane. SRI values for these profile runs indicate that the pavement condition may influence the accuracy of the WIM sensors.

4.4 Recommended Pavement Remediation

No pavement remediation is recommended.

5 Statistical Reliability of the WIM Equipment

The following section provides summaries of data collected during the pre-validation, the calibration, and the post-validation test truck runs, as well as information resulting from the classification and speed studies. All analyses of test truck data and information on necessary equipment adjustments are provided.

5.1 Pre-Validation

The first set of tests provides a general overview of system performance prior to any calibration adjustments for the given environmental, vehicle speed, and other conditions.

The 49 pre-validation test truck runs were conducted on July 26, 2010, beginning at approximately 8:29 AM and continuing until 12:45 PM.

The two test trucks consisted of:

- A Class 9 truck, loaded with concrete blocks loaded on the trailer, and equipped with air suspension on truck and trailer tandems and with standard tandem spacings on both the tractor and trailer.
- A Class 9 truck, loaded with steel pipe loaded on the trailer, and equipped with air suspension on the tractor, air suspension on the trailer, with standard tandem spacing on the tractor and split tandem spacing on the trailer.

The test trucks were weighed before and after the pre-validation. The average pre-validation test truck weights and measurements are provided in Table 5-1.

Table 5-1 - Pre-Validation Test Truck Weights and Measurements

Test Truck	Weights (kips)						Spacings (feet)					
	GVW	Ax1	Ax2	Ax3	Ax4	Ax5	1-2	2-3	3-4	4-5	AL	OL
1	75.9	11.1	15.4	15.4	17.0	17.0	20.2	4.3	31.7	4.2	60.4	73.5
2	67.5	11.0	15.4	15.4	12.9	12.9	20.2	4.3	31.7	10.2	66.4	79.0

Test truck speeds varied by 15 mph, from 52 to 67 mph. The measured pre-validation pavement temperatures varied 31.3 degrees Fahrenheit, from 88.0 to 119.3. The cloudy in the morning to sunny in the afternoon weather conditions provided for reaching the desired 30 degree temperature range. Table 5-12 is a summary of pre-validation results.

Table 5-2 – Pre-Validation Overall Results – 27-Jul-10

Parameter	95% Confidence Limit of Error	Site Values	Pass/Fail
Steering Axles	±20 percent	-3.9 ± 4.4%	Pass
Single Axles	±20 percent	-5.5 ± 4.7%	Pass
Tandem Axles	±15 percent	-6.1 ± 4.0%	Pass
GVW	±10 percent	-5.7 ± 2.6%	Pass
Vehicle Length	±3 percent (2.3 ft)	-0.8 ± 0.8 ft	Pass
Axle Spacing Length	± 0.5 ft [150mm]	-0.5 ± 0.4 ft	FAIL

Truck speed was manually collected for each test run using a radar gun and compared with the speed reported by the WIM equipment. For this site, the average error in speed measurement over all speeds was 0.5 ± 3.4 mph, which is greater than the ±1.0 mph tolerance established by the LTPP Field Guide. However, since the site is measuring axle spacing length within specified tolerances, and the and the speed and axle spacing measurements are based on the distance between the axle detector sensors, it can be concluded that the distance factor is set correctly and that the speeds being reported by the WIM equipment are within acceptable ranges.

5.1.1 Statistical Speed Analysis

Statistical analysis was conducted on the test truck run data to investigate whether a relation exists between speed and WIM equipment weight and distance measurement accuracy. The posted speed limit at this site is 65 mph. The test runs were divided into three speed groups - low, medium and high speeds, as shown Table 5-3 below.

Table 5-3 – Pre-Validation Results by Speed – 27-Jul-10

Parameter	95% Confidence Limit of Error	Low	Medium	High
		52.0 to 57.0 mph	57.1 to 62.1 mph	62.2 to 67.0 mph
Steering Axles	±20 percent	-3.6 ± 5.2%	-4.6 ± 4.6%	-3.5 ± 3.7%
Single Axles	±20 percent	-5.2 ± 4.2%	-5.6 ± 4.5%	-5.7 ± 6.5%
Tandem Axles	±15 percent	-5.8 ± 3.9%	-5.3 ± 3.4%	-5.7 ± 4.4%
GVW	±10 percent	-5.4 ± 2.4%	-5.7 ± 3.0%	-6.3 ± 2.8%
Vehicle Length	±3 percent (2.3 ft)	-0.8 ± 0.7 ft	-0.8 ± 0.9 ft	-1.0 ± 0.8 ft
Vehicle Speed	± 1.0 mph	0.5 ± 5.1 mph	0.6 ± 2.7 mph	0.3 ± 1.7 mph
Axle Spacing Length	± 0.5 ft [150mm]	-0.5 ± 0.4 ft	-0.5 ± 0.4 ft	-0.6 ± 0.5 ft

From the table, it can be seen that the WIM equipment underestimated all weight measurements at all speeds. The bias and range of GVW error was consistent over all speeds.

To aid in the speed analysis, several graphs were developed to illustrate the possible effects of speed on GVW, single axle, and axle group weights, and axle and overall length distance measurements, as discussed in the following sections.

5.1.1.1 GVW Errors by Speed

Figure 5-1 indicates that the negative bias and distribution of GVW errors is similar for all three speed ranges.

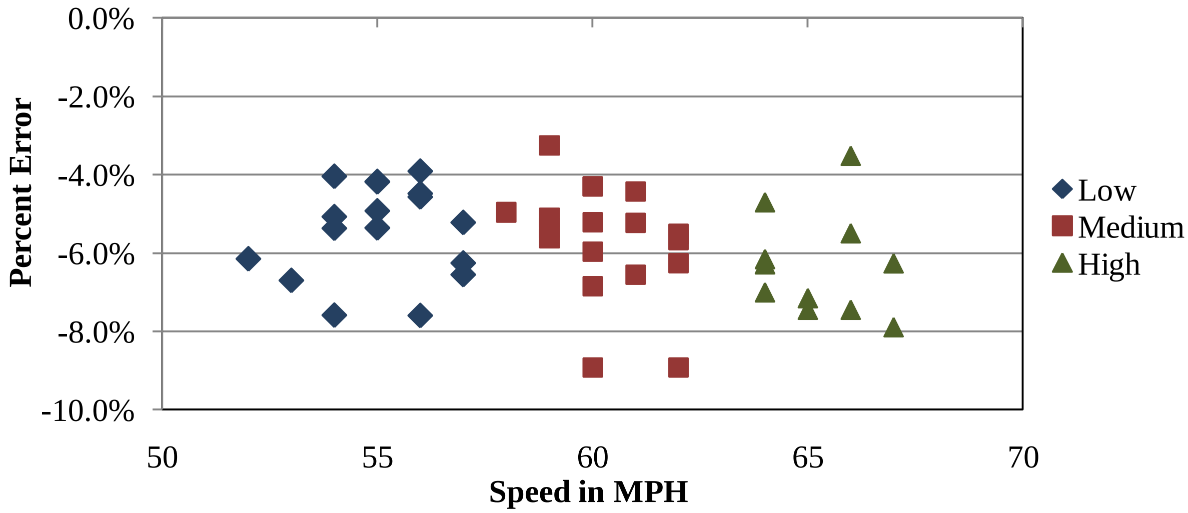


Figure 5-1 – Pre-Validation GVW Error by Speed – 27-Jul-10

5.1.1.2 Steering Axle Weight Errors by Speed

Steering axle weights were generally underestimated by the WIM equipment. From Figure 5-2, it can be seen that the negative bias in steering axle weight appears to be consistent throughout the entire speed range. Low speeds exhibit the widest range of errors.

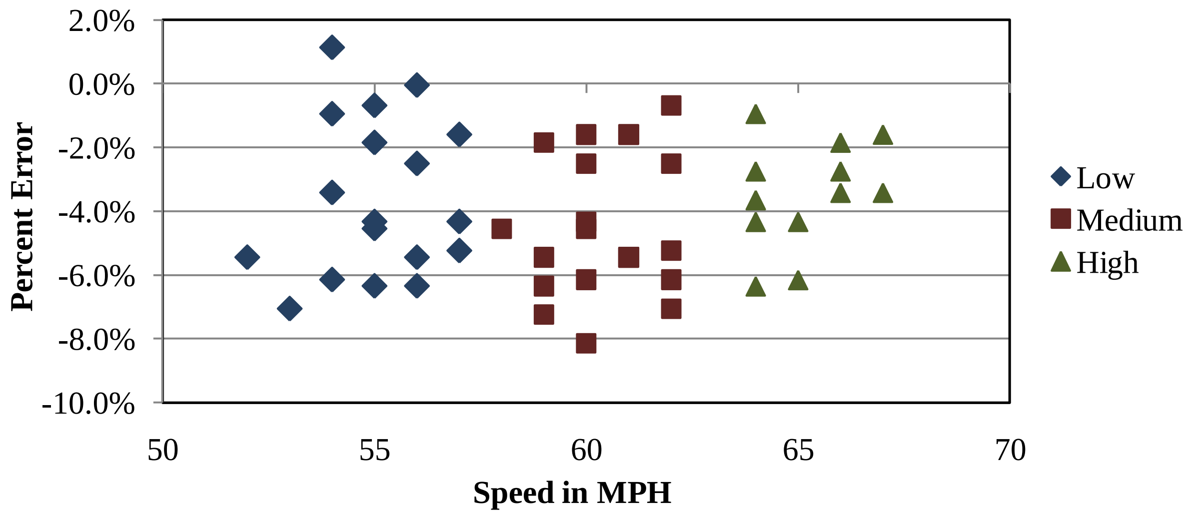


Figure 5-2 – Pre-Validation Steering Axle Error by Speed – 27-Jul-10

5.1.1.3 Single Axle Weight Errors by Speed

Single axles include the steering axles and any axles pairs on the either the truck or trailer that are separated by more than 10 feet. As shown in Figure 5-3, the equipment estimates single axle weights with increasingly negative bias as speed increases. Distribution in error appears to be consistent throughout the entire speed range.

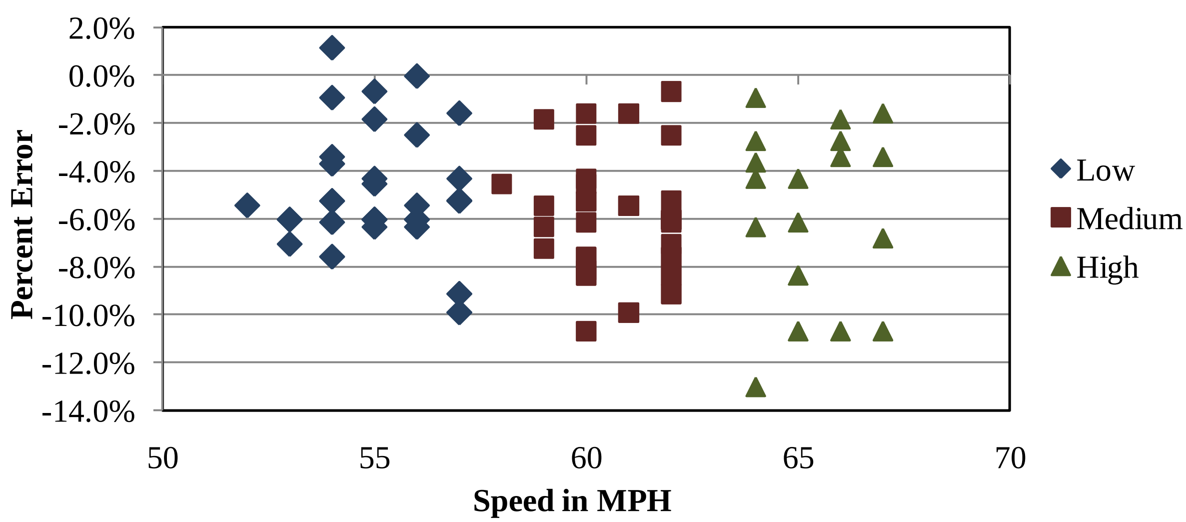


Figure 5-3 – Pre-Validation Single Axle Error by Speed – 27-Jul-10

5.1.1.4 Tandem Axle Weight Errors by Speed

As shown in Figure 5-4, the negative bias in tandem axle weight appears to be consistent throughout the entire speed range. High speeds exhibit the widest range of errors.

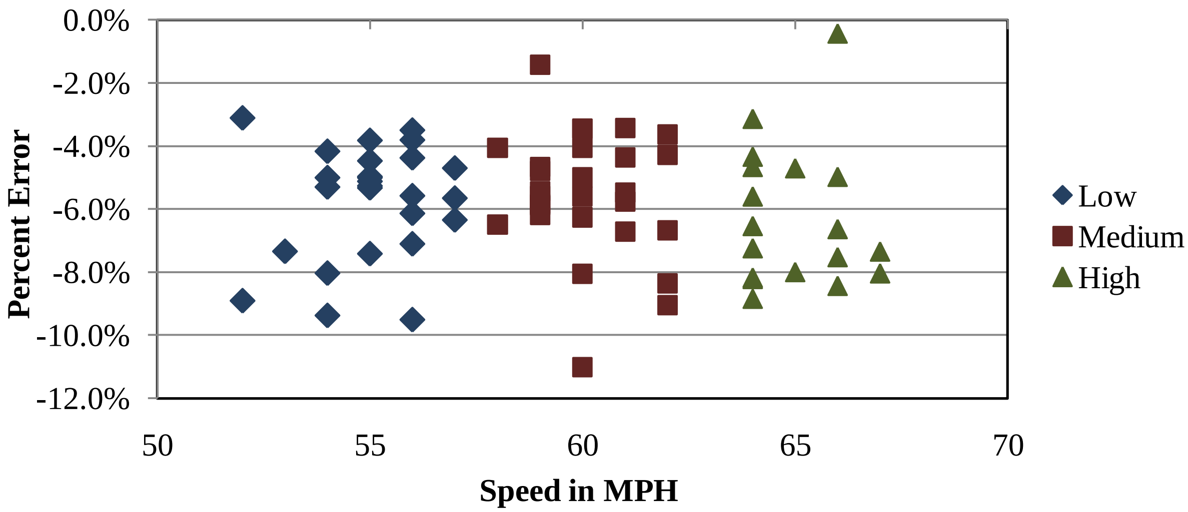


Figure 5-4 – Pre-Validation Tandem Axle Error by Speed – 27-Jul-10

5.1.1.5 GVW Errors by Speed and Truck Type

It can be seen in Figure 5-5 that when the GVW errors for each truck are analyzed independently, it can be seen that the secondary truck has higher negative bias in GVW estimates.

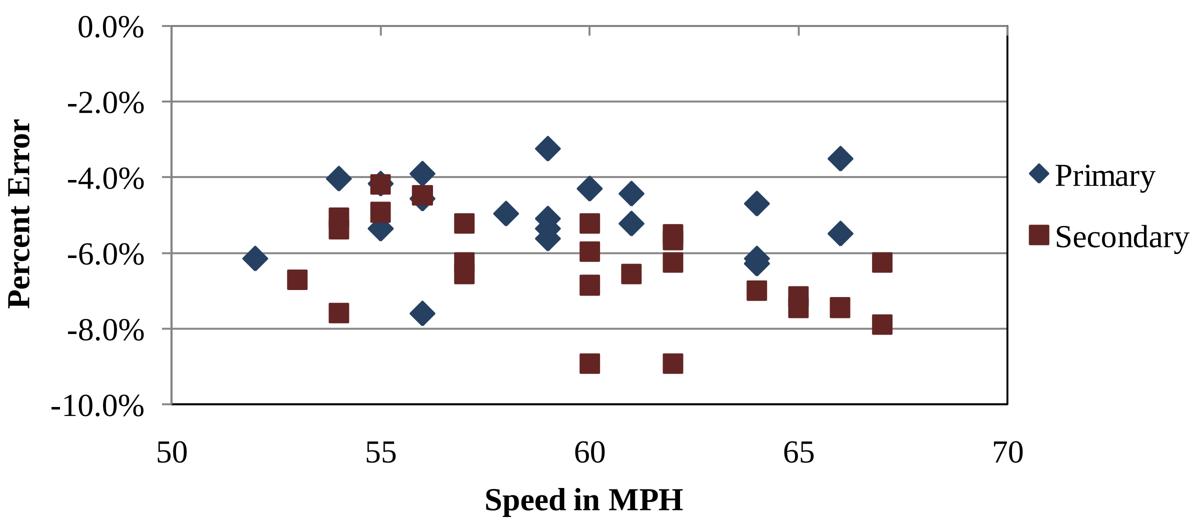


Figure 5-5 – Pre-Validation GVW Error by Truck and Speed – 27-Jul-10

5.1.1.6 Axle Length Errors by Speed

For this site, the error in this measurement was consistent at all speeds, as shown in Figure 5-6. The range in axle length measurement error was -1.1 feet to -0.1 feet. The WIM equipment underestimated axle lengths in all cases. Distribution of errors is shown graphically in the figure.

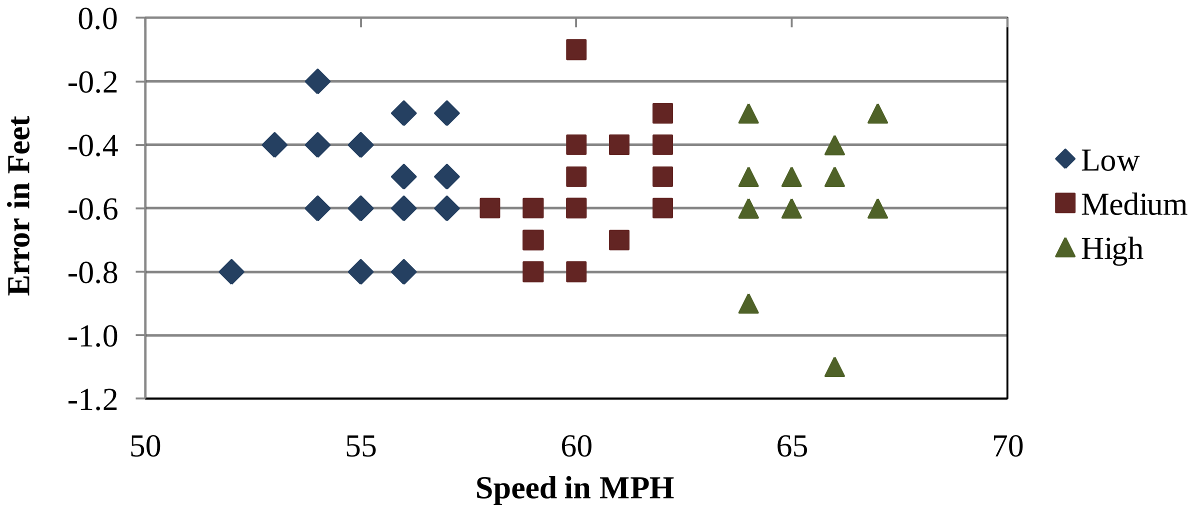


Figure 5-6 – Pre-Validation Axle Length Error by Speed – 27-Jul-10

5.1.1.7 Overall Length Errors by Speed

For this system, the WIM equipment underestimated overall vehicle length by -1.5 to 0.0 feet. Distribution of errors is shown graphically in Figure 5-7.

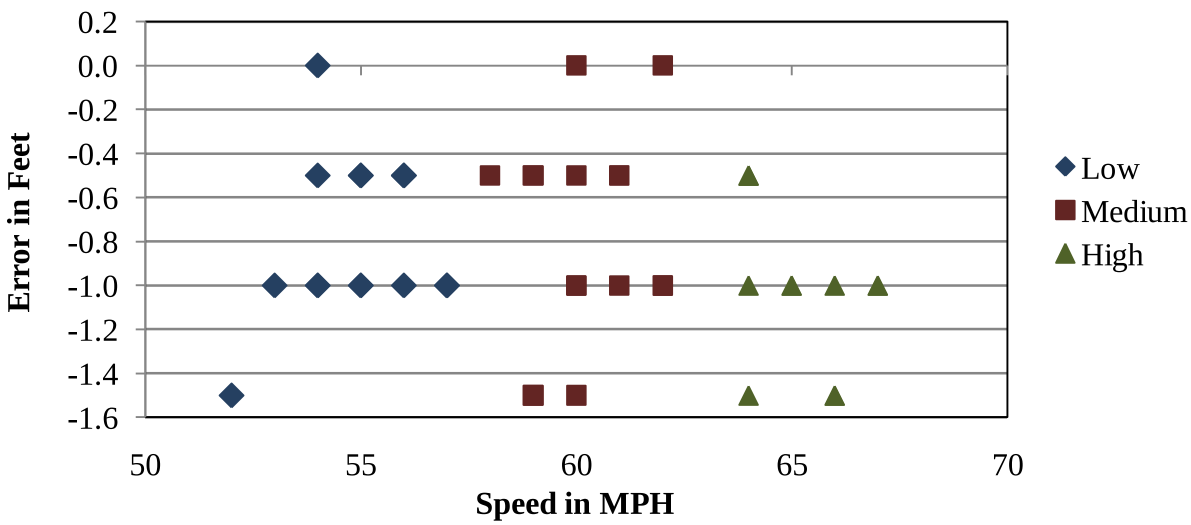


Figure 5-7 – Pre-Validation Overall Length Error by Speed – 27-Jul-10

5.1.2 Statistical Temperature Analysis

Statistical analysis was performed for the test truck run data to investigate whether there is a relation between pavement temperature and WIM equipment weight and distance measurement accuracy. The range of pavement temperatures varied 31.3 degrees, from 88.0 to 119.3 degrees Fahrenheit. The pre-validation test runs are being reported under two temperature groups as shown in Table 5-4.

Table 5-4 – Pre-Validation Results by Temperature – 27-Jul-10

Parameter	95% Confidence Limit of Error	Low	High
		88.0 to 103.7 degF	103.8 to 119.4 degF
Steering Axles	±20 percent	-4.2 ± 4.3%	-3.5 ± 5.1%
Single Axles	±20 percent	-6.1 ± 4.6%	-4.3 ± 4.3%
Tandem Axles	±15 percent	-6.2 ± 3.7%	-4.8 ± 3.7%
GVW	±10 percent	-6.3 ± 2.4%	-4.7 ± 1.7%
Vehicle Length	±3 percent (2.3 ft)	-0.9 ± 0.7 ft	-0.8 ± 1 ft
Vehicle Speed	± 1.0 mph	0.4 ± 3.8 mph	0.7 ± 2.7 mph
Axle Spacing Length	± 0.5 ft [150mm]	-0.5 ± 0.4 ft	-0.6 ± 0.5 ft

To aid in the analysis, several graphs were developed to illustrate the possible effects of temperature on GVW, single axle, and axle group weights.

5.1.2.1 GVW Errors by Temperature

Figure 5-8 shows that the equipment underestimates GVW at all temperatures. The spread in GVW measurement errors is less at high temperatures.

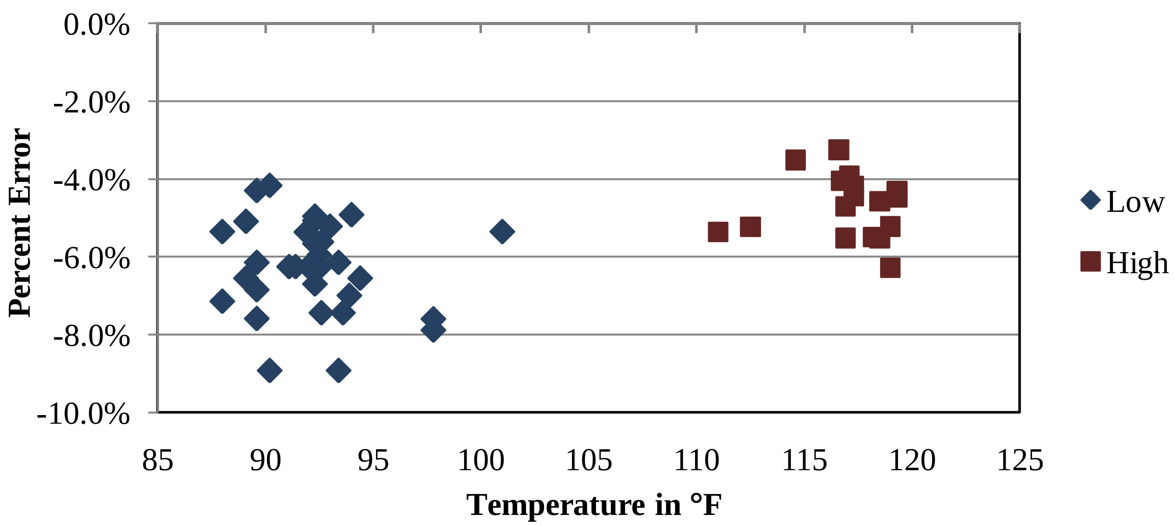


Figure 5-8 – Pre-Validation GVW Error by Temperature – 27-Jul-10

5.1.2.2 Steering Axle Weight Errors by Temperature

Figure 5-9 demonstrates the bias in steering axle weight measurements is slightly less for high temperatures. Distribution of errors is shown graphically in the following figure.

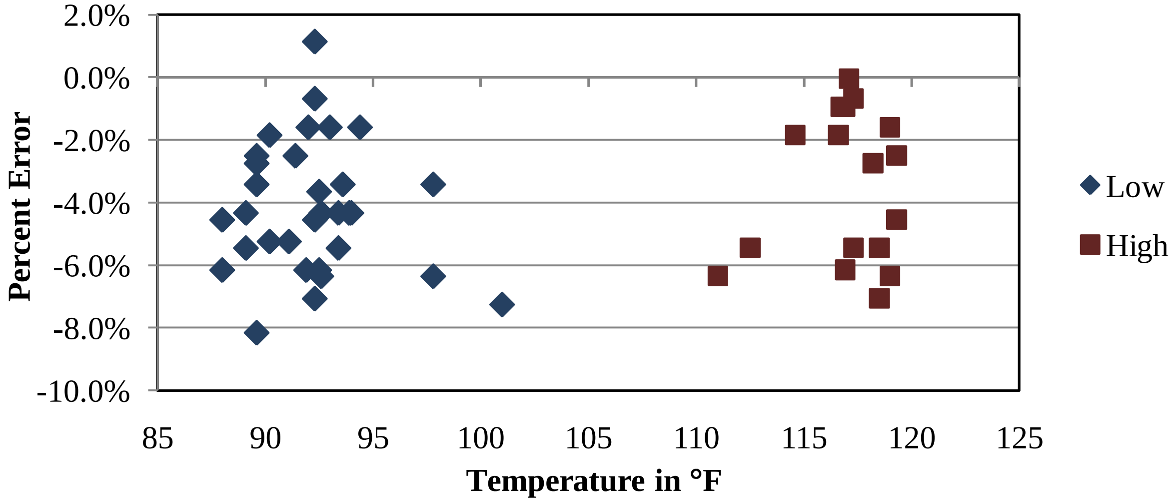


Figure 5-9 – Pre-Validation Steering Axle Weight Error by Temperature – 27-Jul-10

5.1.2.3 Single Axle Weight Errors by Temperature

Figure 5-10 demonstrates that for loaded single axles, the WIM equipment appears to demonstrate the same trend as with steering axle estimates. Distribution of errors is shown graphically in the following figure.

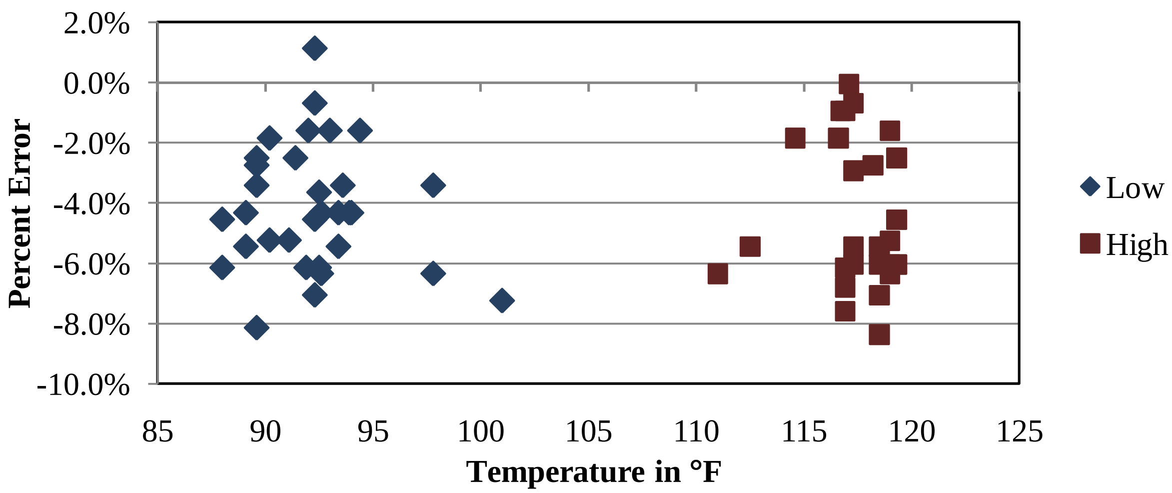


Figure 5-10 – Pre-Validation Single Axle Weight Error by Temperature – 27-Jul-10

5.1.2.4 Tandem Axle Weight Errors by Temperature

As shown in Figure 5-11, there appears to be a relationship between loaded tandem axle measurement error and temperature. The range in tandem axle errors is consistent for the two temperature groups. Distribution of errors is shown graphically in the following figure.

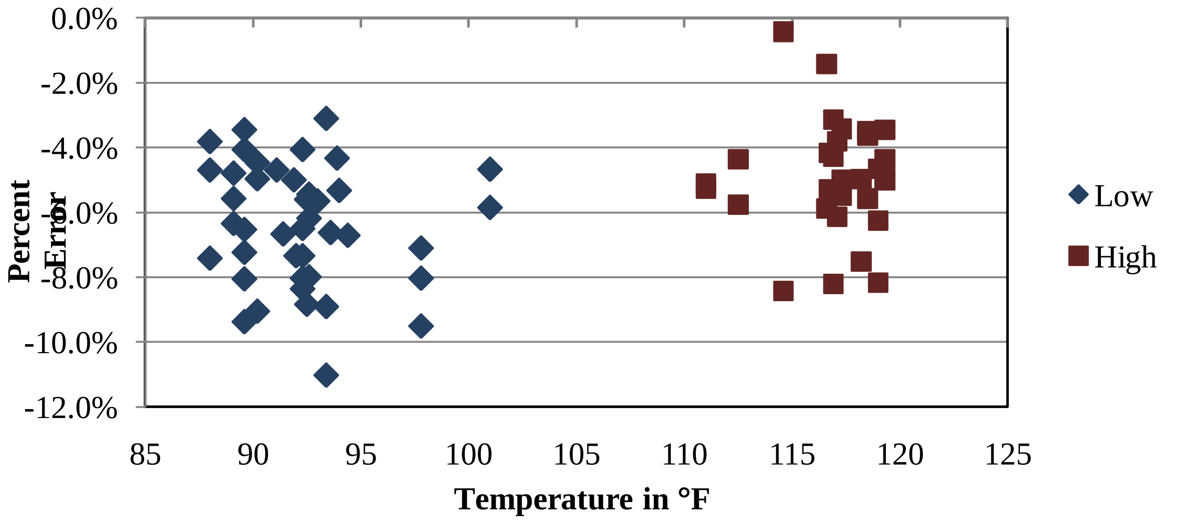


Figure 5-11 – Pre-Validation Tandem Weight Axle Error by Temperature – 27-Jul-10

5.1.2.5 GVW Errors by Temperature and Truck Type

As shown in Figure 5-12, when analyzed for each test truck, both trucks demonstrate the tendency for the equipment to underestimate GVW less at all temperatures.

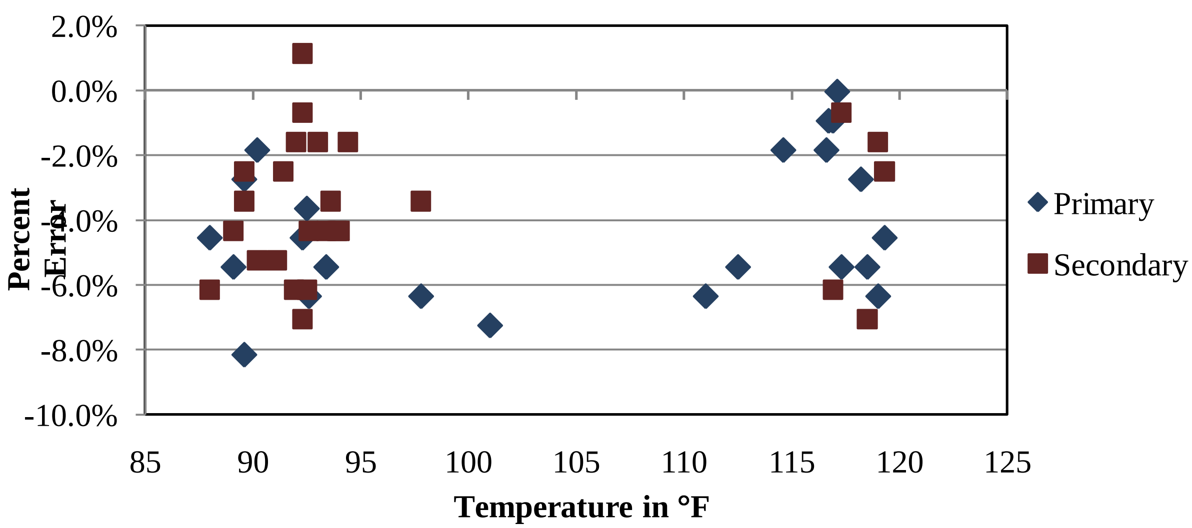


Figure 5-12 – Pre-Validation GVW Error by Truck and Temperature – 27-Jul-10

5.1.3 Classification and Speed Evaluation

The pre-validation classification and speed study involved the comparison of vehicle classification and speed data collected manually with the information for the same vehicles reported by the WIM equipment.

For the pre-validation classification study at this site, a manual sample of 77 vehicles including 77 trucks (Class 4 through 13) was collected. Video was collected during the study to provide a means for further analysis of misclassifications and vehicles whose classifications could not be determined with a high degree of certainty in the field. Table 5-5 illustrates the breakdown of vehicles observed and identified by the WIM equipment for the manual classification study.

Table 5-5 – Pre-Validation Classification Study Results – 27-Jul-10

Class	4	5	6	7	8	9	10	11	12	13
Observed Count	0	27	6	0	1	40	2	0	0	1
WIM Count	0	17	6	0	3	39	2	0	0	1
Observed Percentage	0	35	8	0	1	52	3	0	0	1
WIM Percentage	0	22	8	0	4	51	3	0	0	1
Misclassified Count	0	10	0	0	0	1	1	0	0	1
Misclassified Percent.	N/A	37	0	N/A	0	3	50	N/A	N/A	100

Misclassified vehicles are defined as those vehicles that are manually classified by observation as one class of vehicle but identified by the WIM equipment as another class of vehicle. The misclassified percentage represents the percentage of the misclassified vehicles in the manual sample.

Based on the vehicles observed during the pre-validation study, the misclassification percentage is 3.9% for heavy trucks (6 – 13), which is greater than the 2.0% acceptability criteria for LTPP SPS WIM sites. The overall misclassification rate for all vehicles (3 – 15) is 16.9%. The misclassifications by pair are provided in Table 5-6.

Table 5-6 – Pre-Validation Misclassifications by Pair – 27-Jul-10

Observed/ WIM	Number of Pairs	Observed/ WIM	Number of Pairs
3/5	0	8/9	0
3/8	0	9/5	0
4/5	0	9/8	1
4/6	0	9/10	0
5/3	9	10/9	0
5/4	0	10/13	1
5/8	1	11/12	0
6/4	0	12/11	0
7/6	0	13/10	1
8/3	0	13/11	0
8/5	0		

As shown in the table, a total of 13 vehicles, including 3 heavy trucks (6 – 13) were misclassified by the equipment. For all vehicles, the majority (9) of the misclassifications were Class 5s identified by the WIM equipment as Class 3s. For trucks, one Class 9 that was observed was identified by the WIM equipment as Class 8, one Class 10 was identified as a Class 13, and one Class 13 was identified as Class 10. A review of the equipment algorithm identified that all single trailer trucks with more than 6 axles are being identified as Class 13s. The cause was not identified in the field. Further investigation of the classification algorithm should be performed to correct this discrepancy.

Unclassified vehicles are defined as those vehicles that cannot be identified by the WIM equipment algorithm. These are typically trucks with unusual trailer tandem configurations and are identified as Class 15 by the WIM equipment. The unclassified vehicles by pair are provided in Table 5-7.

Table 5-7 – Pre-Validation Unclassified Trucks by Pair – 27-Jul-10

Observed/ WIM	Number of Pairs	Observed/ WIM	Number of Pairs
3/15	0	9/15	0
4/15	0	10/15	0
5/15	0	11/15	0
6/15	0	12/15	0
7/15	0	13/15	0
8/15	0		

Based on the manually collected sample of the 77 trucks, 0.0% of the vehicles at this site were reported as unclassified during the study. This is within the established criteria of 2.0% for LTTP

SPS WIM sites. For speed, the mean error for WIM equipment speed measurement was 0.9 mph; the range of errors was 1.6 mph.

5.2 Calibration

The WIM equipment required one calibration iteration between the pre- and post-validations. Information regarding the basis for changing equipment compensation factors, supporting data for the changes, and the resulting WIM accuracies from the calibrations are provided in this section.

The operating system weight compensation parameters that were in place prior to the pre-validation are shown in Table 5-8.

Table 5-8 – Initial System Parameters – 28-Jul-10

Speed Point	MPH	Left
80	50	3295
88	55	3364
96	60	3329
105	65	3338
112	70	3338
		Right
80	50	3279
88	55	3348
96	60	3314
105	65	3323
112	70	3323
Axle Distance (cm)	305	
Dynamic Comp (%)	102	

5.2.1 Calibration Iteration 1

5.2.1.1 Equipment Adjustments

For GVW, the pre-validation test truck runs produced an overall error of -1.7% and errors of -0.8%, -2.1%, and -2.4% at the 50, 55 and 60 mph speed points respectively. The errors for 55 mph and 65 mph speeds were extrapolated to derive new compensation factors for the 50 and 70 mph speed points. To compensate for these errors, the changes in Table 5-9 were made to the compensation factors.

Table 5-9 – Calibration 1 Equipment Factor Changes – 28-Jul-10

Speed Points	GVW Error	Old Factors		New Factors	
		Right	Left	Right	Left
80	-5.42%	3279	3295	3467	3484
88	-5.42%	3348	3364	3540	3557
96	-5.68%	3314	3329	3514	3530
105	-6.30%	3323	3338	3546	3562
112	-6.30%	3323	3338	3546	3562
Axle Distance (cm)	0.9%	305		308	
Dynamic Comp (%)	-4.0%	102		100	

5.2.1.2 Calibration 1 Results

The results of the first calibration verification runs are provided in Table 5-10 and Figure 5-13. As can be seen in the table, the bias in weight measurement significantly decreased from the pre-validation.

Table 5-10 – Calibration 1 Results – 28-Jul-10

Parameter	95% Confidence Limit of Error	Site Values	Pass/Fail
Steering Axles	+20 percent	0.3 ± 3.9%	Pass
Single Axles	+20 percent	-1.0 ± 5.0%	Pass
Tandem Axles	+15 percent	-2.4 ± 4.9%	Pass
GVW	+10 percent	-1.7 ± 3.0%	Pass
Vehicle Length	±3 percent (2.3 ft)	-0.2 ± 0.7 ft	Pass
Axle Spacing Length	+ 0.5 ft [150mm]	0.0 ± 0.4 ft	Pass

From Figure 5-13, it can be seen that the underestimation of the GVW weights at all speeds was decreased as a result of the calibration.

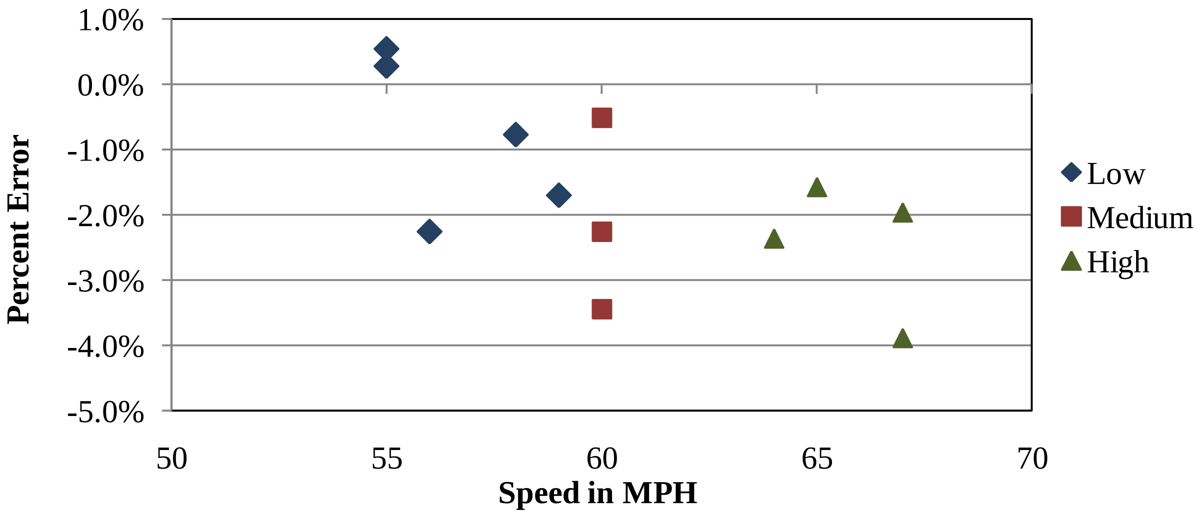


Figure 5-13 – Calibration 1 GVW Error by Speed – 28-Jul-10

The results of the first calibration show that GVW was being underestimated at the medium and high speeds. In other words, GWV errors increase with speed. Based on the results of the pre-validation, where GVW errors decreased as pavement temperatures increased (see Figure 5-8), it was anticipated that pavement temperatures would have similar effect on the post-validation results. Consequently, because the trend of increased errors with speed and the trend of decreased errors with temperature are expected to counteract, a second calibration was not considered to be necessary.

Based on the results of the first calibration, no further adjustments to system settings were deemed necessary, and 30 additional test runs were conducted to complete the minimum 40 post-validation test truck runs. The analysis of the combined calibration 1 test truck runs and the additional 30 post-validation test runs are provided in Section 5.3.

5.3 Post-Validation

The 42 post-validation test truck runs were conducted on July 28, 2010, beginning at approximately 7:45 AM and continuing until 12:50 PM.

The two test trucks consisted of:

- A Class 9 truck, loaded with concrete blocks loaded on the trailer, and equipped with air suspension on truck and trailer tandems and with standard tandem spacings on both the tractor and trailer.

- A Class 9, 5-axle truck, loaded with steel pipe loaded on the trailer, and equipped with air suspension on the tractor, air suspension on the trailer, with a standard tandem spacing on the tractor and a split tandem spacing on the trailer.

Prior to the post-validation, the test trucks were weighed. The test trucks were re-weighed at the conclusion of the post-validation. The average post-validation test truck weights and measurements are provided in Table 5-11.

Table 5-11 - Post-Validation Test Truck Measurements

Test Truck	Weights (kips)						Spacings (feet)					
	GVW	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5	1-2	2-3	3-4	4-5	AL	OL
1	75.7	11.0	15.4	15.4	17.0	17.0	20.2	4.3	31.7	4.2	60.4	73.5
2	67.3	10.9	15.3	15.3	12.9	12.9	20.2	4.3	31.7	10.2	66.4	79.0

Test truck speeds varied by 14 mph, from 54 to 68 mph. The measured post-validation pavement temperatures varied 38.0 degrees Fahrenheit, from 77.3 to 115.3. The mostly cloudy weather conditions provided for reaching the desired 30 degree temperature range. Table 5-12 is a summary of post validation results.

Table 5-12 – Post-Validation Overall Results – 28-Jul-10

Parameter	95% Confidence Limit of Error	Site Values	Pass/Fail
Steering Axles	±20 percent	1.2 ± 4.9%	Pass
Single Axles	±20 percent	0.4 ± 5.6%	Pass
Tandem Axles	±15 percent	-0.4 ± 4.4%	Pass
GVW	±10 percent	0.0 ± 3.6%	Pass
Vehicle Length	±3 percent (2.3 ft)	-0.1 ± 0.8 ft	Pass
Axle Spacing Length	± 0.5 ft [150mm]	0.1 ± 0.4 ft	Pass

Truck speed was manually collected for each test run using a radar gun and compared with the speed reported by the WIM equipment. For this site, the average error in speed measurement for all speeds was 0.3 ± 2.1 mph, which is greater than the ±1.0 mph tolerance established by the LTPP Field Guide. However, since the site is measuring axle spacing length within specified tolerances, and the speed and spacing measurements are based on the distance between the axle detector sensors, it can be concluded that the distance factor is set correctly and that the speeds being reported by the WIM equipment are within acceptable ranges.

5.3.1 Statistical Speed Analysis

Statistical analysis was conducted on the test truck run data to investigate whether a relation exists between speed and WIM equipment weight and distance measurement accuracy. The posted speed limit at this site is 65 mph. The test runs were divided into three speed groups - low, medium and high speeds, as shown in Table 5-13.

Table 5-13 – Post-Validation Results by Speed – 28-Jul-10

Parameter	95% Confidence Limit of Error	Low 54.0 to 58.7 mph	Medium 58.8 to 63.4 mph	High 63.5 to 68.0 mph
Steering Axles	+20 percent	1.8 ± 6.8%	0.0 ± 3.6%	1.6 ± 3.9%
Single Axles	+20 percent	0.7 ± 6.1%	0.6 ± 5.0%	-0.2 ± 6.1%
Tandem Axles	+15 percent	0.3 ± 5.2%	1.1 ± 4.1%	-0.1 ± 6.8%
GVW	+10 percent	0.1 ± 4.0%	0.5 ± 3.7%	-0.5 ± 3.8%
Vehicle Length	±3 percent (2.3 ft)	-0.1 ± 0.9 ft	0.0 ± 0.8 ft	-0.1 ± 0.8 ft
Vehicle Speed	± 1.0 mph	-0.1 ± 2.1 mph	0.6 ± 2.5 mph	0.5 ± 1.7 mph
Axle Spacing Length	+ 0.5 ft [150mm]	0.0 ± 0.4 ft	0.1 ± 0.4 ft	0.1 ± 0.5 ft

From the table, it can be seen that the WIM equipment estimates all weights with reasonable accuracy at all speeds and the range of errors is consistent at all speeds. There does not appear to be a relationship between weight estimates and speed at this site.

To aid in the speed analysis, several graphs were developed to illustrate the possible effects of speed on GVW, single axle and axle group weights, and axle and overall length distance measurements, as discussed in the following paragraphs.

5.3.1.1 GVW Errors by Speed

As shown in Figure 5-14, the equipment estimated GVW with reasonable accuracy at all speeds. The range in error and bias is similar throughout the entire speed range. Distribution of errors is shown graphically in the following figure.

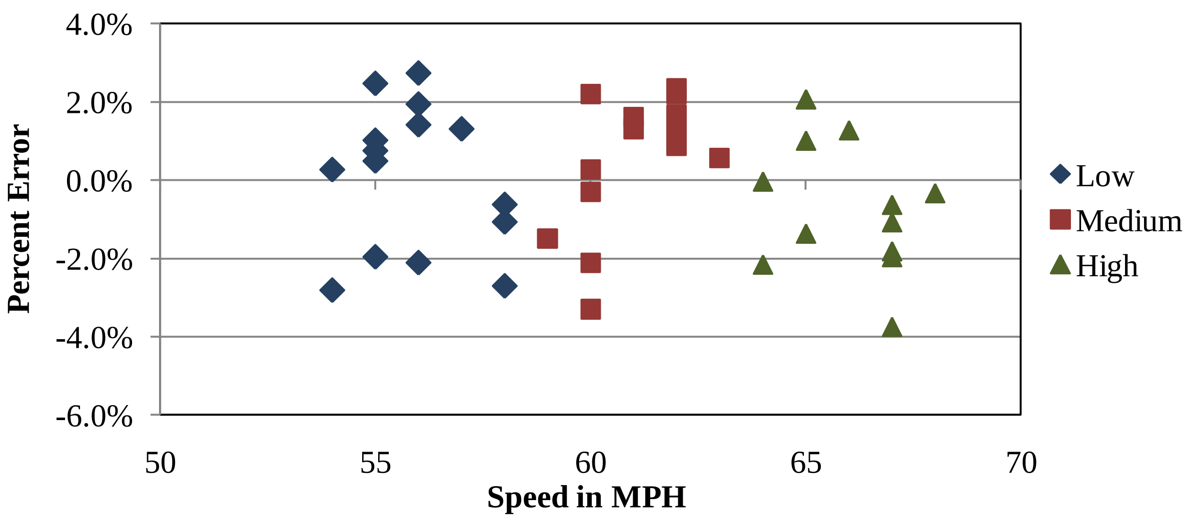


Figure 5-14 – Post-Validation GVW Error by Speed – 28-Jul-10

5.3.1.2 Steering Axle Weight Errors by Speed

As shown in Figure 5-15, the equipment estimates steering axle weights with similar accuracy at all speeds except for one error point with higher bias observed at low speed range. The range in error appears to be consistent throughout the entire speed range.

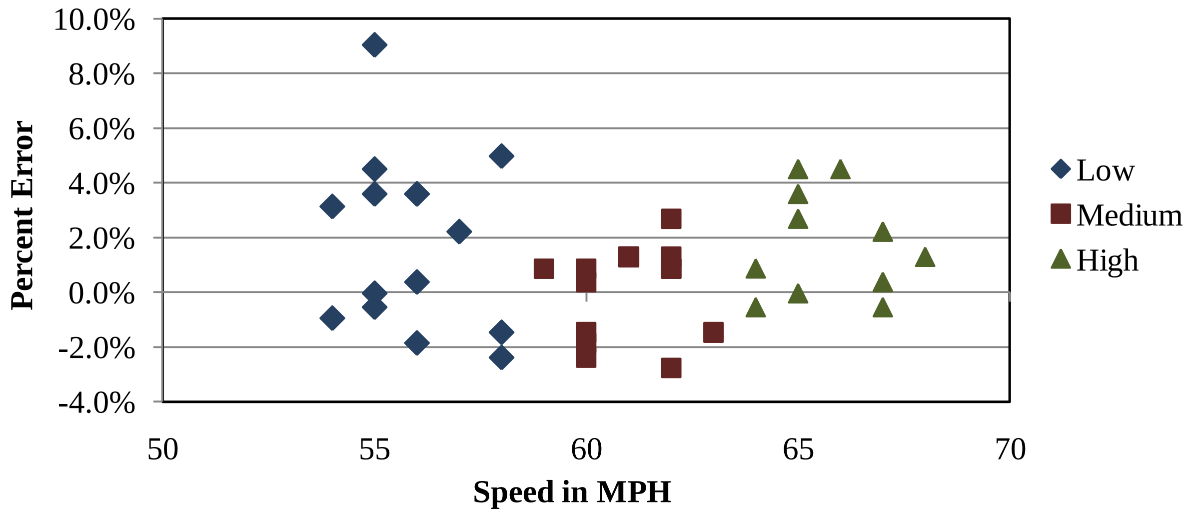


Figure 5-15 – Post-Validation Steering Axle Weight Error by Speed – 28-Jul-10

5.3.1.3 Single Axle Weight Errors by Speed

As shown in Figure 5-16, the equipment estimates single axle weights with similar accuracy at all speeds. The range in error appears to be consistent throughout the entire speed range.

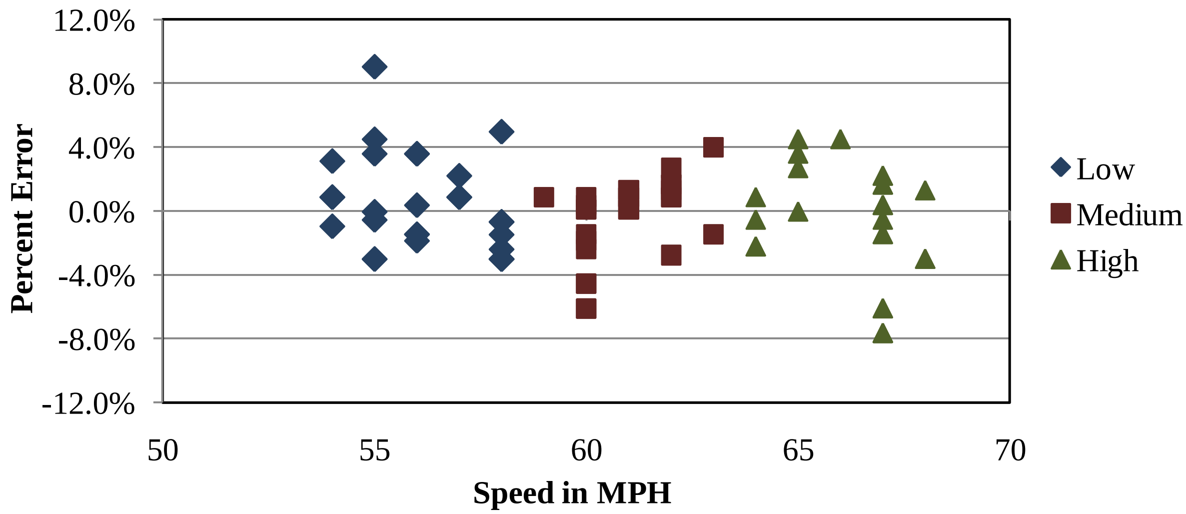


Figure 5-16 – Post-Validation Single Axle Weight Error by Speed – 28-Jul-10

5.3.1.4 Tandem Axle Weight Errors by Speed

As shown in Figure 5-17, the equipment estimates tandem axle weights with similar accuracy at all speeds. The range in error is similar throughout the entire speed range. The bias seems to be low for all speed ranges.

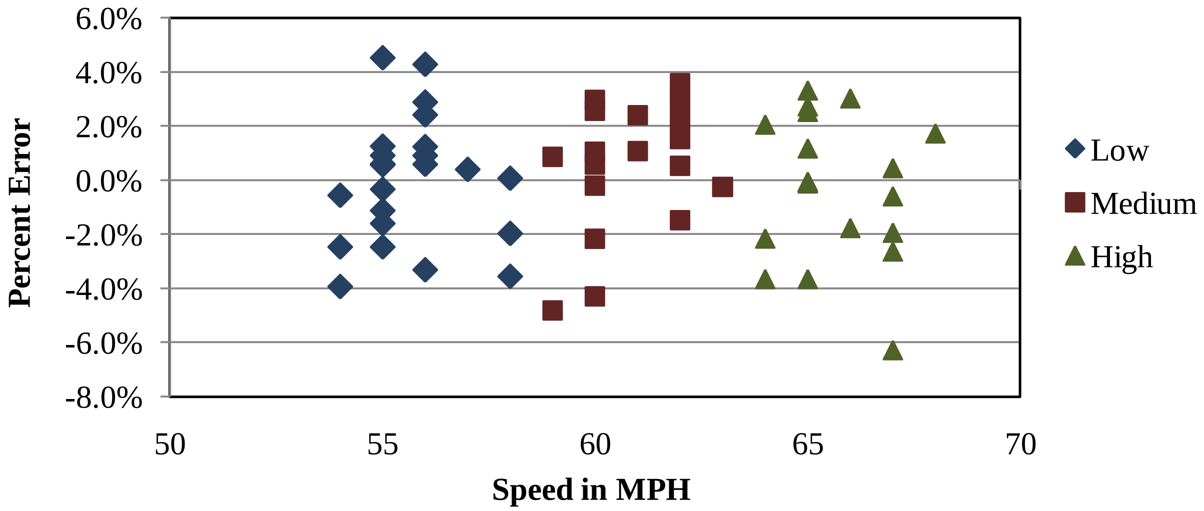


Figure 5-17 – Post-Validation Tandem Axle Weight Error by Speed – 28-Jul-10

5.3.1.5 Truck GVW Errors by Speed and Truck Type

As shown in Figure 5-18, when the GVW errors are analyzed by truck type, it can be seen that the WIM equipment precision and bias is similar for both the heavily loaded (Primary) truck and the partially loaded (Secondary) truck.

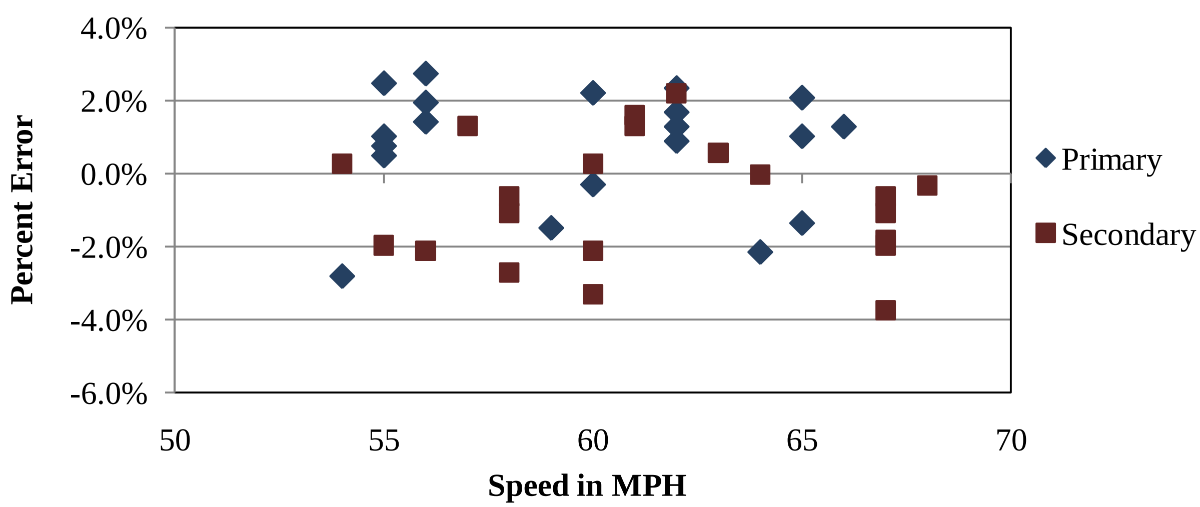


Figure 5-18 – Post-Validation GVW Error by Truck Type and Speed – 28-Jul-10

5.3.1.6 Axle Length Errors by Speed

For this site, the error in this measurement was consistent at all speeds. As shown in Figure 5-19, the range in axle length measurement error ranged from -0.4 feet to 0.6 feet. WIM equipment overestimated axle lengths in all cases. Distribution of errors is shown graphically in the figure.

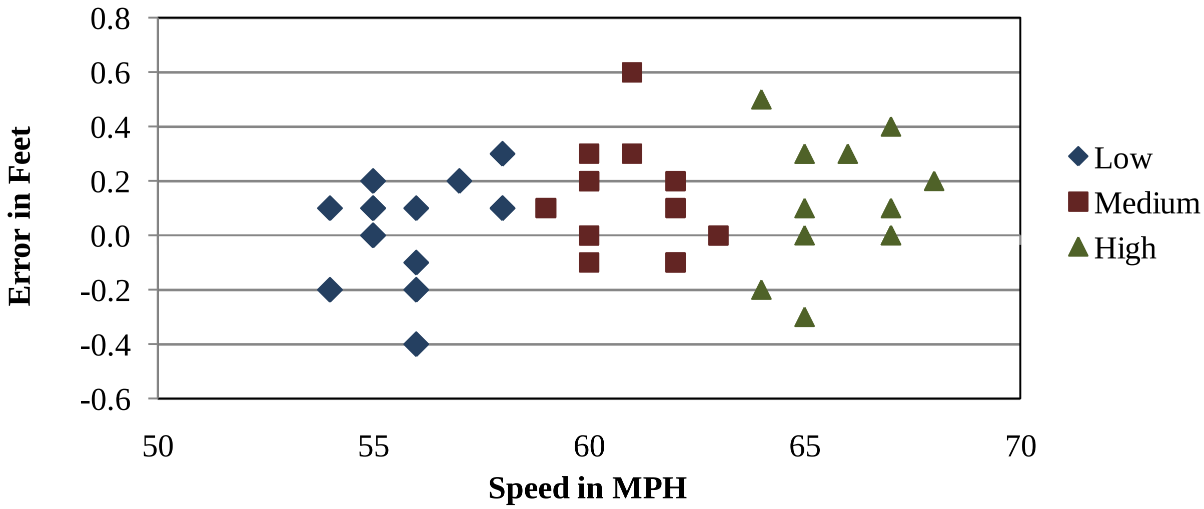


Figure 5-19 – Post-Validation Axle Length Error by Speed – 28-Jul-10

5.3.1.7 Overall Length Errors by Speed

As shown in Figure 5-20, the WIM equipment measured consistently over the entire range of speeds, with maximum errors measuring -1.0 to 0.5 feet. WIM equipment overestimated overall truck lengths in all cases. Distribution of errors is shown graphically in the figure.

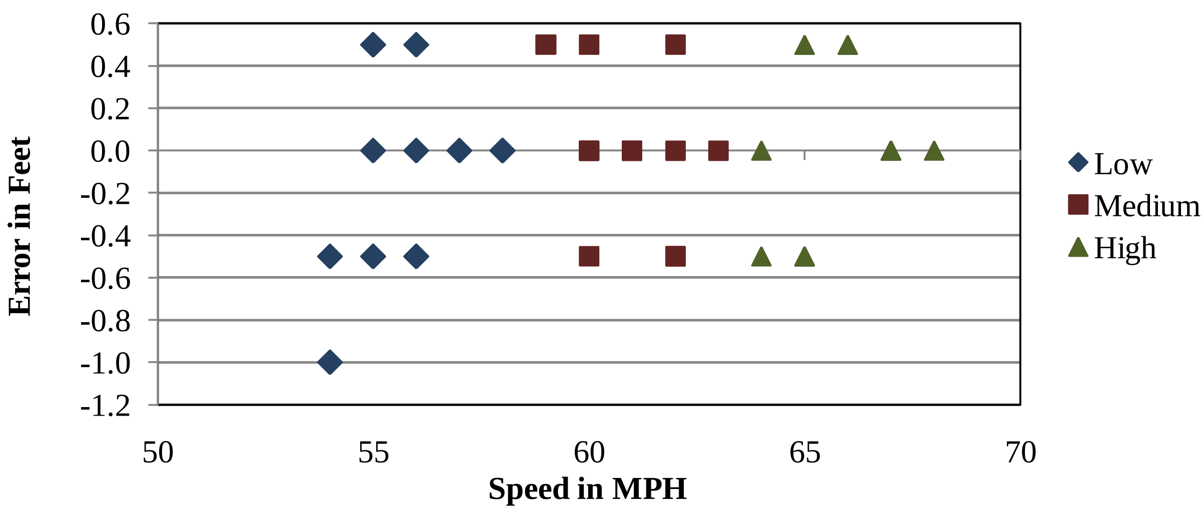


Figure 5-20 – Post-Validation Overall Length Error by Speed – 28-Jul-10

5.3.2 Statistical Temperature Analysis

Statistical analysis was performed for the test truck run data to investigate whether there is a relation between pavement temperature and WIM equipment weight and distance measurement accuracy. The range of pavement temperatures varied 38.0 degrees, from 77.3 to 115.3 degrees Fahrenheit. The post-validation test runs are being reported under three temperature groups as shown in Table 5-14.

Table 5-14 – Post-Validation Results by Temperature – 28-Jul-10

Parameter	**95% Confidence Limit of Error**	**Low**	**Medium**	**High**
		77.3 to 85 degF	**85.1 to 97.8 degF**	**97.9 to 115.3 degF**
Steering Axles	±20 percent	0.8 ± 4%	0.3 ± 4.7%	2.6 ± 5.7%
Single Axles	±20 percent	-0.9 ± 5.1%	0.0 ± 5.9%	1.8 ± 5.5%
Tandem Axles	±15 percent	-1.5 ± 5.3%	0.9 ± 4.6%	1.6 ± 3.9%
GVW	±10 percent	-1.5 ± 3%	0.1 ± 3.6%	1.2 ± 2.7%
Vehicle Length	±3 percent (2.3 ft)	-0.2 ± 0.7 ft	-0.2 ± 0.9 ft	0.1 ± 0.8 ft
Vehicle Speed	± 1.0 mph	0.3 ± 1.7 mph	0.3 ± 2.6 mph	0.4 ± 2.2 mph
Axle Spacing Length	± 0.5 ft [150mm]	0.0 ± 0.4 ft	0.1 ± 0.4 ft	0.1 ± 0.5 ft

To aid in the analysis, several graphs were developed to illustrate the possible effects of temperature on GVW, single axle, and axle group weights.

5.3.2.1 GVW Errors by Temperature

From Figure 5-21, it can be seen that the equipment estimates GVW with acceptable accuracy across the range of temperatures. There appears to be a correlation between temperature and weight estimates where temperature causes weight estimates to rise as temperature rises.

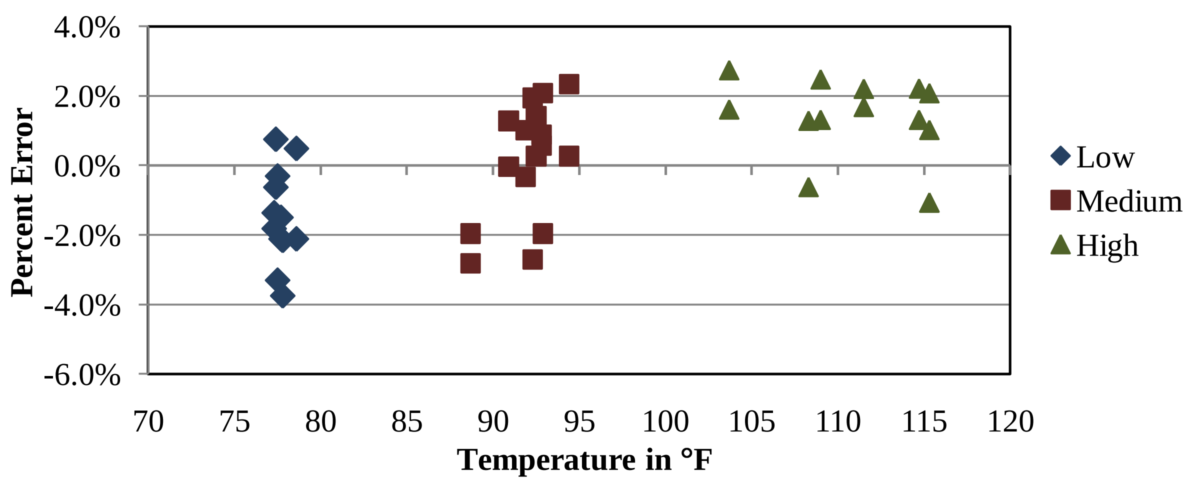


Figure 5-21 – Post-Validation GVW Error by Temperature – 28-Jul-10

5.3.2.2 Steering Axle Weight Errors by Temperature

Figure 5-22 shows that errors for steering axle weights exhibit the same trend as that observed for GVW errors; as the temperature rises, the overestimation of steering axle weight increases. The range in error is similar for different temperature groups. Distribution of errors is shown graphically in the following figure.

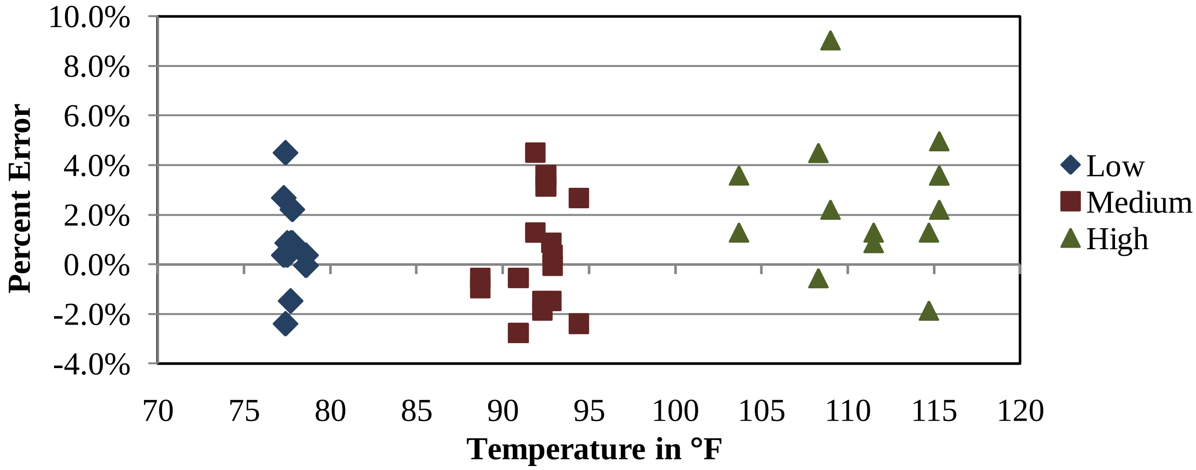


Figure 5-22 – Post-Validation Steering Axle Weight Error by Temperature – 28-Jul-10

5.3.2.3 Single Axle Weight Errors by Temperature

Figure 5-23 demonstrates that for loaded single axles, the WIM equipment appears to demonstrate the same trend as with steering axle estimates, where as the temperature rises, the overestimation of steering axle weight increases. The range in error is similar for different temperature groups. Distribution of errors is shown graphically in the following figure.

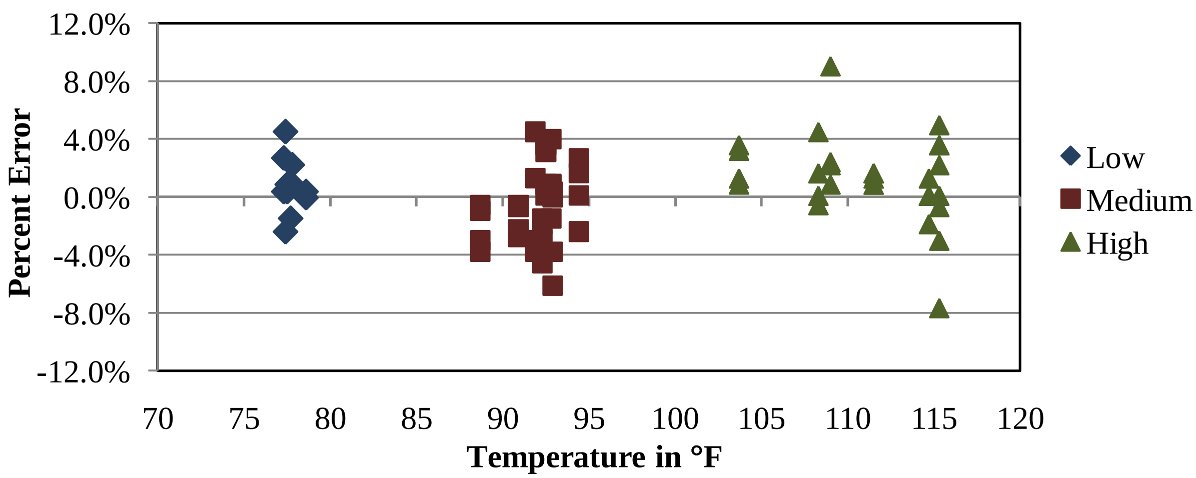


Figure 5-23 – Post-Validation Single Axle Weight Error by Temperature – 28-Jul-10

5.3.2.4 Tandem Axle Weight Errors by Temperature

As shown in Figure 5-24, the same relationship that exists between tandem axle weight estimates and temperature appears to exist between loaded tandem axle measurement and temperature, where the weight of loaded axle groups increases as temperature increases. The range in tandem axle errors is consistent for the three temperature groups.

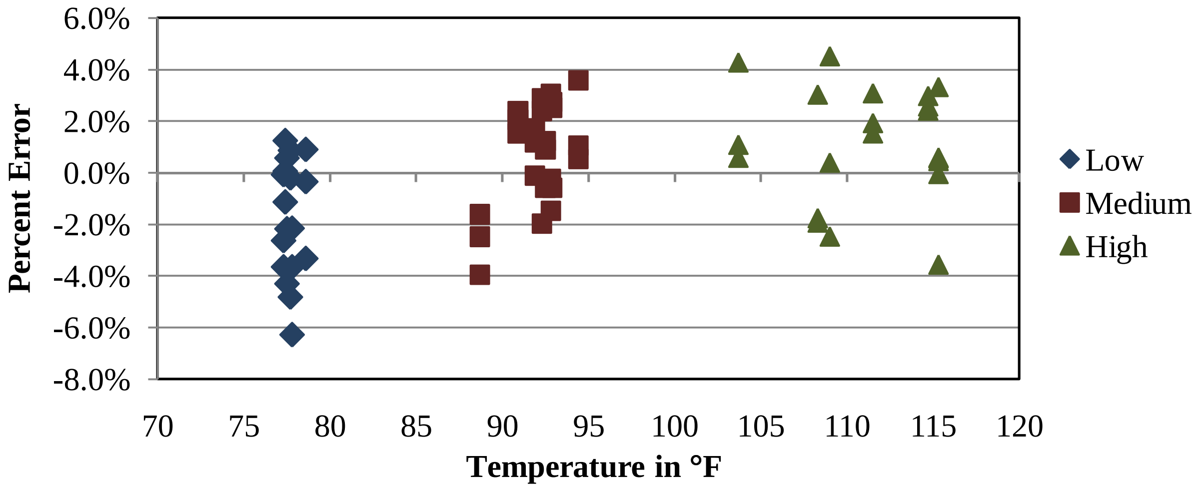


Figure 5-24 – Post-Validation Tandem Axle Weight Error by Temperature – 28-Jul-10

5.3.2.5 Truck GVW Errors by Temperature and Truck Type

As shown in Figure 5-25, when analyzed by truck type, GVW errors for both trucks follow similar patterns: GVW for both trucks increases as temperature increases. For both trucks, the range of errors and bias are reasonably consistent over the range of temperatures.

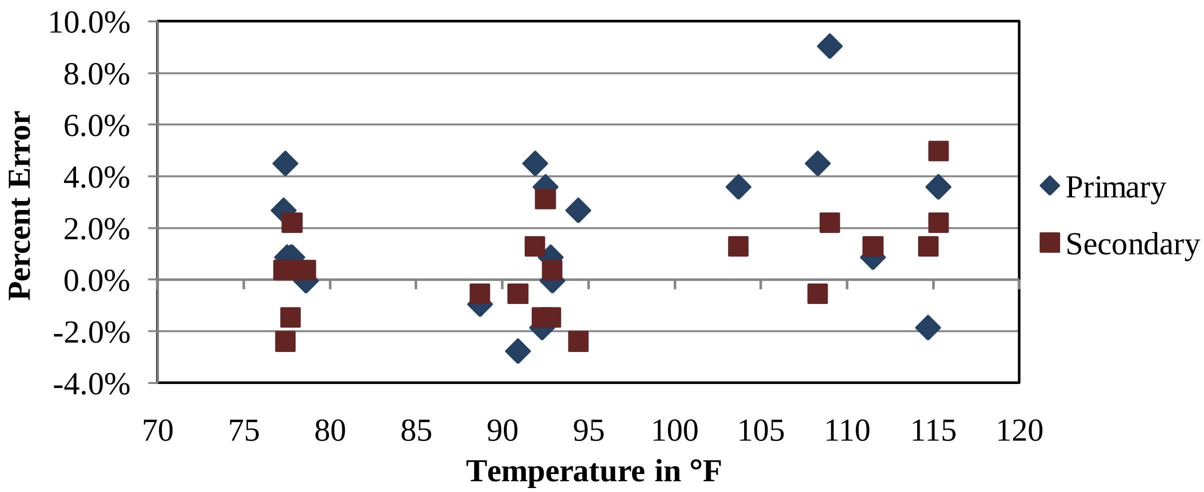


Figure 5-25 – Post-Validation GVW Error by Truck and Temperature – 28-Jul-10

5.3.3 Multivariable Analysis

This section provides additional analysis of post-validation results using a multivariable statistical technique of multiple linear regressions. The same calibration data analyzed and discussed previously are analyzed again, but this time using a more sophisticated statistical methodology. The objective of the additional analysis is to investigate if the trends identified using previous analyses are statistically significant, and to quantify these trends.

Multivariable analyses provide additional insight on how speed, temperature, and truck type affect weight measurement errors for a specific site. It is expected that multivariable analyses done systematically for many sites will reveal overall trends.

5.3.3.1 Data

All errors from the weight measurement data collected by the equipment during the validation were analyzed. The percent error is defined as percentage difference between the weight measured by the WIM system and the static weight. Compared to analysis described previously, the weight of "axle group" was evaluated separately for tandem axles on tractors and trailers.

The measurement errors were statistically attributed to the following variables or factors:

- Truck type – Primary truck and secondary truck.
- Truck test speed – Truck test speed ranged from 54 to 68 mph.
- Pavement temperature. Pavement temperature ranged from 77.3 to 115.3 degrees Fahrenheit.
- Interaction between the factors such as the interaction between speed and pavement temperature.

5.3.3.2 Results

For analysis of GVW, the value of regression coefficients and their statistical properties are summarized in Table 5-15. The value of regression coefficients defines the slope of the relationship between the % error in GVW and the predictor variables. The values of the t-distribution (for the regression coefficients) given in Table 5-15 table are for the null hypothesis that assumes that the coefficients are equal to zero. The effects of temperature and truck type were found statistically significant. The probabilities that the effect of truck type and temperature on the observed GVW errors occurred by chance alone are less than 1 percent.

Table 5-15 – Table of Regression Coefficients for Measurement Error of GVW

Parameter	Regression coefficients	Standard error	Value of t-distribution	Probability value
Intercept	-6.0414	3.1850	-1.8968	0.0659
Speed	-0.0298	0.0473	-0.6304	0.5324
Temperature	0.0752	0.0158	4.7694	0.0000
Truck type	1.5827	0.4144	3.8194	0.0005

The quantification is provided by the value of the regression coefficient, in this case 0.0752 (in Table 5-15). This means, for example, that for a 20 degree increase in temperature, the % error is increased by about 1.5 % (0.0752 x 20). The statistical assessment of the relationship is provided by the probability value of the regression coefficient.

The relationship between temperature and measurement errors is shown in Figure 5-26. The figure includes a trend line for the predicted percent error. Besides the visual assessment of the relationship, the figure provides quantification and statistical assessment of the relationship.

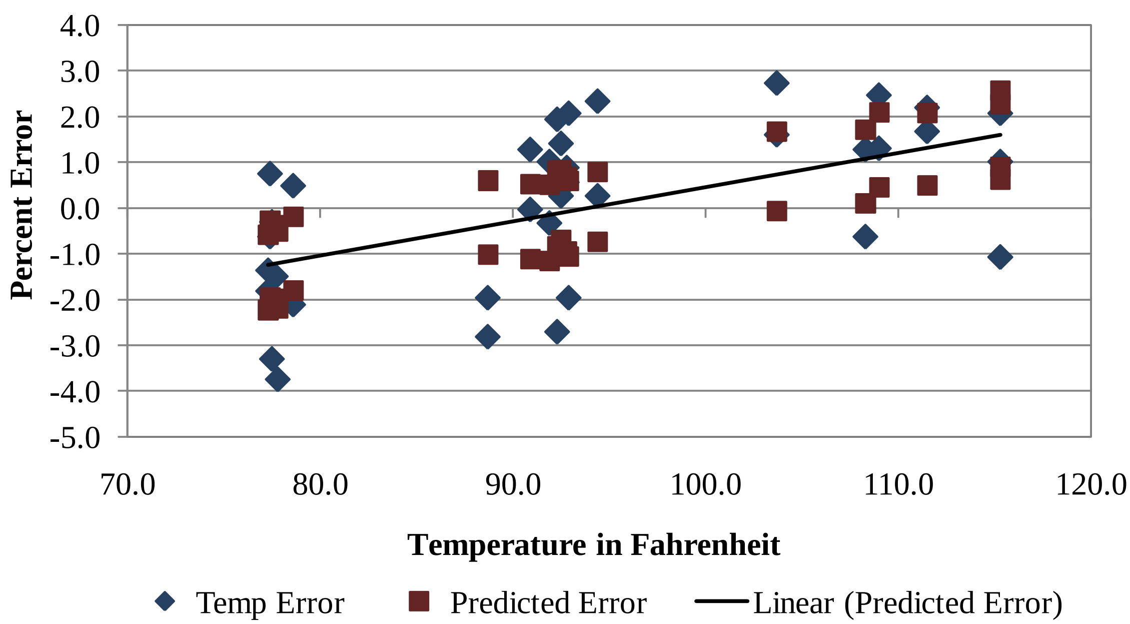


Figure 5-26 – Influence of Temperature (in Fahrenheit) on the Measurement Error of GVW

The effect speed on GVW was not statistically significant. The probability that the regression coefficient for speed (-0.0298 in Table 5-15) is not different from zero was 0.5324. In other words, there is about 53 percent chance that the value of the regression coefficient is due to the chance alone.

The interaction between speed, temperature, and truck type was investigated by adding an interactive variable (or variables) such as the product of speed and temperature. No interactive variables were statistically significant. The intercept was not statistically significant and does not have practical meaning.

5.3.3.3 Summary Results

Table 5-16 lists regression coefficients and their probability values for all combinations of factors and % errors evaluated. Not listed in the table are factor interactions because the interactions were not statistically significant. Entries in the table are provided only if the probability value was smaller than 0.20. The dash in Table 5-16 indicates that the relationship was not statistically significant (the probability that the relationship can occur by chance alone was greater than 20 percent).

Table 5-16 – Summary of Regression Analysis

	Factor					
	Speed		**Temperature**		**Truck type**	
Weight, % error	Regression coefficient	Probability value	Regression coefficient	Probability value	Regression coefficient	Probability value
GVW	-	-	0.076	5.7E-06	1.548	0.0004
Steering axle	-	-	0.058	0.0325	1.317	0.0740
Tandem axle tractor	-	-	0.066	0.0085	-	-
Tandem axle trailer	-	-	0.090	0.001	2.558	0.0006

5.3.3.4 Conclusions

1. Speed had no statistically significant effect on measurement errors.

2. Temperature affected measurement error of all axles and thus also the measurement error of the GVW. The regression coefficients ranged from 0.058 for the steering axle to 0.09 for the tandem axel on trailer. The difference between regression coefficients obtained for different axle types and GVW was not statistically significant.

3. Truck type affected the GVW, steering axle weight, and the tandem axle trailer weight errors. The regression coefficient for truck type in Table 5-16, represent the difference between the mean errors for the primary and secondary trucks. (Truck type is an indicator variable with values of 0 or 1.). For example, the mean error in GVW for the secondary truck was about 1.5 % larger than the error for the primary truck.

4. Even though temperature and truck type had statistically significant effect on measurement errors, the practical significance of these factors is small and does not affect the validity of the calibration.

5.3.4 Classification and Speed Evaluation

The post-validation classification and speed study involved the comparison of vehicle classification and speed data collected manually with the information for the same vehicles reported by the WIM equipment.

For the post-validation classification study at this site, a manual sample of 101 vehicles including 100 trucks (Class 4 through 13) was collected. Video was collected during the study to provide a means for further analysis of misclassifications and vehicles whose classifications could not be determined with a high degree of certainty in the field. Table 5-17 illustrates the breakdown of vehicles observed and identified by the WIM equipment for the manual classification study.

Table 5-17 – Post-Validation Classification Study Results – 28-Jul-10

Class	4	5	6	7	8	9	10	11	12	13
Observed Count	0	31	3	0	5	42	4	0	0	4
WIM Count	0	43	3	0	3	43	8	0	0	0
Observed Percentage	0	43	3	0	3	43	8	0	0	0
WIM Percentage	0	31	3	0	5	42	4	0	0	4
Misclassified Count	0	14	0	0	0	1	4	0	0	0
Misclassified Percent.	N/A	33	0	N/A	0	2	50	N/A	N/A	N/A

Misclassified vehicles are defined as those vehicles that are manually classified by observation as one class of vehicle but identified by the WIM equipment as another class of vehicle. The misclassified percentage represents percentage of the misclassified vehicles in the manual sample.

Based on the vehicles observed during the post-validation study, the misclassification percentage is 5.0% for heavy trucks (6 – 13), which is greater than the 2.0% acceptability criteria for LTPP SPS WIM sites. The overall misclassification rate for all vehicles (3 – 15) is 19.8%. The misclassifications by pair are provided in Table 5-18.

Table 5-18 – Post-Validation Misclassifications by Pair – 28-Jul-10

Observed/ WIM	Number of Pairs	Observed/ WIM	Number of Pairs
3/5	1	8/9	0
3/8	0	9/5	1
4/5	0	9/8	0
4/6	0	9/10	0
5/3	12	10/9	0
5/4	0	10/13	4
5/8	2	11/12	0
6/4	0	12/11	0
7/6	0	13/10	0
8/3	0	13/11	0
8/5	0		

As shown in the table, a total of 19 vehicles, including 5 heavy trucks (6 – 13) were misclassified by the equipment. For all vehicles, the majority (12) of the misclassifications were Class 5s identified by the WIM equipment as Class 3. For trucks, four of the eight Class 10 trucks were identified as Class 13, and one Class 9 was identified as Class 5 by the controller. A review of the system algorithm indicates that there is not a Class 10 classification for single trailer trucks with more than six axles. All trucks Class 8 and above were observed and identified by the WIM equipment similarly with the exception of one Class 9 that was identified as a Class 5 by the controller. The cause of the misclassification was not investigated in the field.

Unclassified vehicles are defined as those vehicles that cannot be identified by the WIM equipment algorithm. These are typically trucks with unusual trailer tandem configurations and are identified as Class 15 by the WIM equipment. The unclassified vehicles by pair are provided in Table 5-19.

Table 5-19 – Post-Validation Unclassified Trucks by Pair – 28-Jul-10

Observed/ WIM	Number of Pairs	Observed/ WIM	Number of Pairs
3/15	0	9/15	0
4/15	0	10/15	0
5/15	0	11/15	0
6/15	0	12/15	0
7/15	0	13/15	0
8/15	0		

Based on the manually collected sample of the 100 trucks, 0.0% of the vehicles at this site were reported as unclassified during the study. This is within the established criteria of 2.0% for LTTP SPS WIM sites.

For speed, the mean error for WIM equipment speed measurement was 1.9 mph; the range of errors was 2.0 mph.

5.4 Post Visit Applied Calibration

The 85th percentile speed for trucks, based on CDS Data, is 66 mph, 1 mph above the posted speed limit of 65 mph and 1 mph above the highest test truck speed. However, due to the low number of Class 9 trucks at this site available for applied calibration, it will not be utilized to develop recommendations for changes to the 65 and 70 mph speed point compensation factors.

The calibration factors that were in place at the conclusion of the post-validation conducted on July 28, 2010 are provided in Table 5-20.

Table 5-20 – Final System Parameters

Speed Point	**MPH**	**Left**
80	50	3484
88	55	3557
96	60	3530
104	65	3562
112	70	3562
		Right
80	50	3467
88	55	3540
96	60	3514
104	65	3546
112	70	3546
Axle Distance (cm)	308	
Dynamic Comp (%)	100	

6 Previous WIM Site Validation Information

As of March 05, 2008, the date of the most recent validation, this site required 5 more years of research quality data. Research quality data is defined to be at least 210 days in a year of data of known calibration meeting LTPP's precision requirements. A review of the LTPP Standard Release Database 24 shows that there are 17 consecutive months of level "E" WIM data for this site. This site requires 4 additional years of data to meet the minimum of five years of research quality data.

6.1 Sheet 16s

This site has validation information from one previous visit as well as the current one in the tables below. Table 6-1 data was extracted from the most recent validation and was updated to include the results of this validation.

Table 6-1 – Classification Validation History

Date	Misclassification Percentage by Class										Pct Unclass
	4	5	6	7	8	9	10	11	12	13	
4-Mar-08	100	29	0	N/A	40	0	N/A	N/A	N/A	N/A	0
5-Mar-08	100	12	0	N/A	0	0	N/A	N/A	N/A	0	0
27-Jul-10	N/A	37	0	N/A	0	3	50	N/A	N/A	100	0
28-Jul-10	N/A	33	0	0	0	1	50	N/A	N/A	N/A	0

Table 6-2 data was extracted from the most previous validation and was updated to include the results of this validation.

Table 6-2 – Weight Validation History

Date	Method	Mean Error and (SD)		
		GVW	Single Axles	Tandems
4-Mar-08	Test Trucks	0.4 (2.4)	0.9 (4.1)	0.2 (5.5)
5-Mar-08	Test Trucks	0.6 (4.0)	-0.2 (4.2)	-0.8 (7.4)
27-Jul-10	Test Trucks	-5.7 (2.6)	-3.9 (4.4)	-6.1 (4.0)
28-Jul-10	Test Trucks	0.0 (3.6)	0.4 (5.6)	-0.4 (4.4)

The variability of the weight errors appears to have remained reasonably consistent since the site was first validated. From this information, it appears that the system demonstrates a tendency for the equipment to move toward an underestimation of GVW over time. The table shows the tendency of the equipment to increasingly underestimate all weights. The WIM equipment has demonstrated a negative drift of approximately 2.3 percent per year, on average. The graph demonstrates the effectiveness of the validations in bringing the weight estimations back to within LTPP SPS WIM equipment tolerances.

6.2 Comparison of Past Validation Results

A comparison of the post-validation results from previous visits is provided in Table 6-3.

Table 6-3 – Comparison of Post-Validation Results

Parameter	95 %Confidence Limit of Error	Site Values	
		5-Mar-08	28-Jul-10
Single Axles	±20 percent	-0.2 ± 4.2	0.4 ± 5.6
Tandem Axles	±15 percent	-0.8 ± 7.4	-0.4 ± 4.4
GVW	±10 percent	0.6 ± 4.0	0.0 ± 3.6

From the table, it appears that the variance for all weights has remained reasonably consistent since the equipment was installed.

7 Additional Information

The following information is provided in the attached appendix:

- Site Photographs
  - Equipment
  - Test Trucks
  - Pavement Condition
- Pre-validation Sheet 16 – Site Calibration Summary
- Post-validation Sheet 16 – Site Calibration Summary
- Pre-validation Sheet 20 – Classification and Speed Study
- Post-validation Sheet 20 – Classification and Speed Study

Additional information is available upon request through LTPP INFO at ltppinfo@dot.gov, or telephone (202) 493-3035. This information includes:

- Sheet 17 – WIM Site Inventory
- Sheet 18 – WIM Site Coordination
- Sheet 19 – Calibration Test Truck Data
- Sheet 21 – WIM System Truck Records
- Sheet 22 – Site Equipment Assessment plus Addendum
- Sheet 23 – WIM Troubleshooting Outline
- Sheet 24A/B/C – Site Photograph Logs
- Updated Handout Guide

WIM System Field Calibration and Validation - Photos

Louisiana, SPS-1
SHRP ID: 220100

Validation Date: July 28, 2010
Submitted: 10/22/2010

Photo 1 – Cabinet Exterior

Photo 2 – Cabinet Interior (Back)

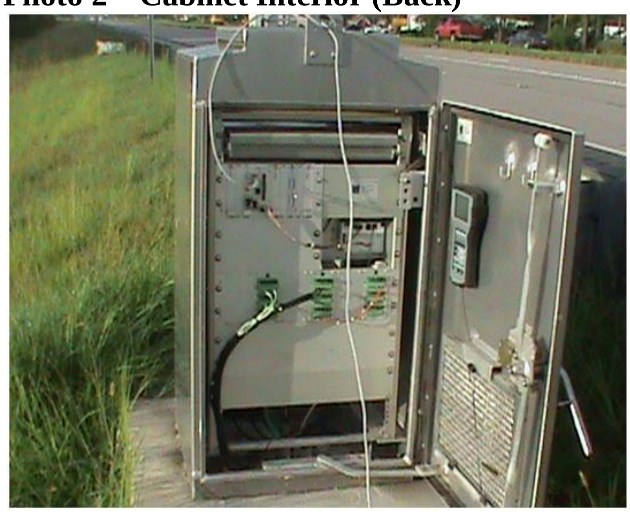


Photo 3 – Cabinet Interior (Front)

Photo 4 – Leading Loop

Photo 5 – Leading WIM Sensor

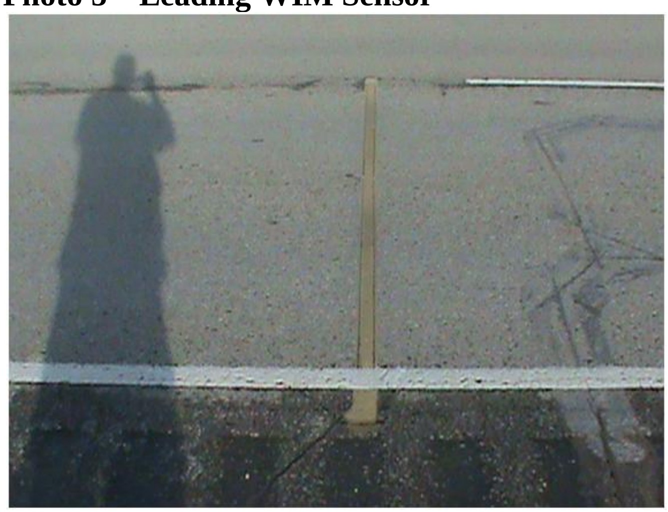


Photo 6 – 220100 – Trailing WIM Sensor

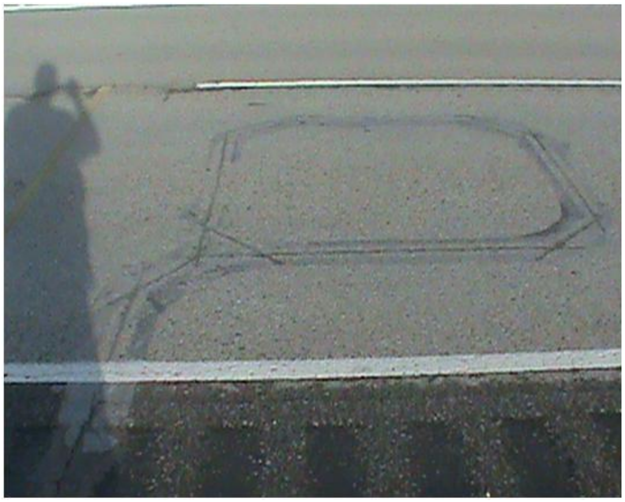


Photo 7 – Trailing Loop Sensor

Photo 8 – Power Service Box

Photo 9 – Telephone Pedestal

Photo 10 – Downstream

Photo 11 – Upstream

Photo 122 – 220100 – Truck 1

Photo 133 – 220100 – Truck 1 Tractor

Photo 16 – Truck 1 Suspension 2/3

Photo 144 – 220100 – Truck 1 Load

Photo 17 – Truck 1 Suspension 4

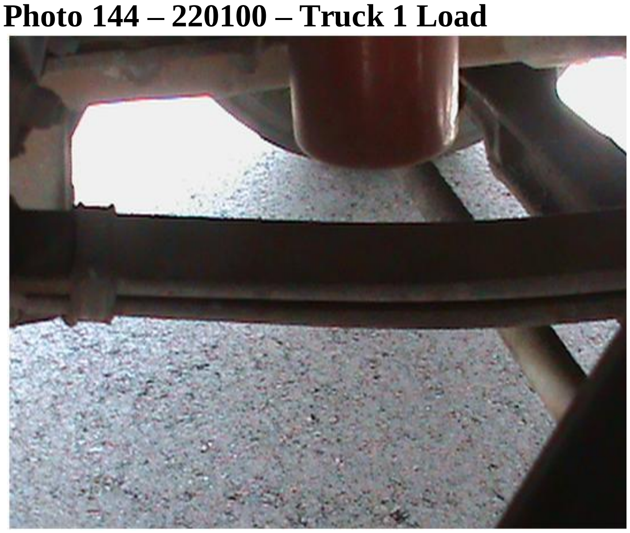


Photo 155 – 220100 – Truck 1 Suspension 1

Photo 18 – 220100 – Truck 1 Suspension 5

Photo 19 – 220100 – Truck 2

Photo 20 – 220100 – Truck 2 Tractor

Photo 21 – 220100 – Truck 2 Trailer and Load

Photo 22 – 220100 – Truck 2 Suspension 1

Photo 23 – Truck 2 Suspension 2/3

Photo 24 – Truck 2 Suspension 4

Photo 25 – Truck 2 Suspension 5

Traffic Sheet 16 LTPP MONITORED TRAFFIC DATA SITE CALIBRATION SUMMARY	STATE CODE: 22 SPS WIM ID: 220100 DATE (mm/dd/yyyy) 7/27/2010

SITE CALIBRATION INFORMATION

1. DATE OF CALIBRATION {mm/dd/yy} 7/27/10

2. TYPE OF EQUIPMENT CALIBRATED: Both

3. REASON FOR CALIBRATION: LTPP Validation

4. SENSORS INSTALLED IN LTPP LANE AT THIS SITE (Select all that apply):

a. Quartz Piezo c.
b. Inductance Loops d.

5. EQUIPMENT MANUFACTURER: IRD iSINC

WIM SYSTEM CALIBRATION SPECIFICS

6. CALIBRATION TECHNIQUE USED: Test Trucks

Number of Trucks Compared:
Number of Test Trucks Used: 2
Passes Per Truck: 25

	Type	Drive Suspension	Trailer Suspension
Truck 1:	9	air	air
Truck 2:	9	air	air
Truck 3:	0	0	0

7. SUMMARY CALIBRATION RESULTS (expressed as a %):

Mean Difference Between -

	Mean Difference		Standard Deviation
Dynamic and Static GVW:	-5.7%	Standard Deviation:	1.3%
Dynamic and Static Single Axle:	-5.5%	Standard Deviation:	2.3%
Dynamic and Static Double Axles:	-6.1%	Standard Deviation:	2.0%

8. NUMBER OF SPEEDS AT WHICH CALIBRATION WAS PERFORMED: 3

9. DEFINE SPEED RANGES IN MPH:

			Low		High	Runs
a.	Low	-	52.0	to	57.0	18
b.	Medium	-	57.1	to	62.1	19
c.	High	-	62.2	to	67.0	12
d.	0	-		to		
e.	0	-		to		

Traffic Sheet 16 LTPP MONITORED TRAFFIC DATA SITE CALIBRATION SUMMARY	STATE CODE: 22 SPS WIM ID: 220100 DATE (mm/dd/yyyy) 7/27/2010

10. CALIBRATION FACTOR (AT EXPECTED FREE FLOW SPEED) 3546 | 3530

11. IS AUTO- CALIBRATION USED AT THIS SITE? No

If yes , define auto-calibration value(s):

The Auto-cal feature is using a linear progression of numerical values, starting at 1000 for 0 degrees, with a value incremented by 4 for every degree up to 100 degrees.

CLASSIFIER TEST SPECIFICS

12. METHOD FOR COLLECTING INDEPENDENT VOLUME MEASUREMENT BY VEHICLE CLASS:

____

13. METHOD TO DETERMINE LENGTH OF COUNT: ______________________

14. MEAN DIFFERENCE IN VOLUMES BY VEHICLES CLASSIFICATION:

FHWA Class 9:	-3.0	FHWA Class	______	-	______
FHWA Class 8:	200.0	FHWA Class	______	-	______
		FHWA Class	______	-	______
		FHWA Class	______	-	______

Percent of "Unclassified" Vehicles: 0.0%

Validation Test Truck Run Set - Pre

Person Leading Calibration Effort: **Dean J. Wolf**

Contact Information: Phone: 717-975-3550

E-mail: dwolf@ara.com

Traffic Sheet 16 LTPP MONITORED TRAFFIC DATA SITE CALIBRATION SUMMARY	STATE CODE: 22 SPS WIM ID: 220100 DATE (mm/dd/yyyy) 7/28/2010

SITE CALIBRATION INFORMATION

1. **DATE OF CALIBRATION** {mm/dd/yy} 7/28/10

2. **TYPE OF EQUIPMENT CALIBRATED:** Both

3. **REASON FOR CALIBRATION:** LTPP Validation

4. **SENSORS INSTALLED IN LTPP LANE AT THIS SITE** (Select all that apply):
   a. Quartz Piezo   c. ______
   b. Inductance Loops   d. ______

5. **EQUIPMENT MANUFACTURER:** IRD iSINC

WIM SYSTEM CALIBRATION SPECIFICS

6. **CALIBRATION TECHNIQUE USED:** Test Trucks

   Number of Trucks Compared: ______
   Number of Test Trucks Used: 2
   Passes Per Truck: 21

	Type	Drive Suspension	Trailer Suspension
Truck 1:	9	air	air
Truck 2:	9	air	air
Truck 3:	0	0	0

7. **SUMMARY CALIBRATION RESULTS** (expressed as a %):

Mean Difference Between -

	Mean		Standard Deviation
Dynamic and Static GVW:	0.0%	Standard Deviation:	1.8%
Dynamic and Static Single Axle:	0.4%	Standard Deviation:	2.8%
Dynamic and Static Double Axles:	-0.4%	Standard Deviation:	2.2%

8. **NUMBER OF SPEEDS AT WHICH CALIBRATION WAS PERFORMED:** 3

9. **DEFINE SPEED RANGES IN MPH:**

		Low		High	Runs
a.	Low	54.0	to	58.7	15
b.	Medium	58.8	to	63.4	14
c.	High	63.5	to	68.0	13
d.	0		to		
e.	0		to		

Traffic Sheet 16 LTPP MONITORED TRAFFIC DATA SITE CALIBRATION SUMMARY	STATE CODE: 22 SPS WIM ID: 220100 DATE (mm/dd/yyyy) 7/28/2010

10. CALIBRATION FACTOR (AT EXPECTED FREE FLOW SPEED) 3531 | 3515

11. IS AUTO- CALIBRATION USED AT THIS SITE? No

If yes , define auto-calibration value(s):

The Auto-cal feature is using a linear progression of numerical values, starting at 1000 for 0 degrees, with a value incremented by 4 for every degree up to 100 degrees.

CLASSIFIER TEST SPECIFICS

12. METHOD FOR COLLECTING INDEPENDENT VOLUME MEASUREMENT BY VEHICLE CLASS: ____________

13. METHOD TO DETERMINE LENGTH OF COUNT: ____________

14. MEAN DIFFERENCE IN VOLUMES BY VEHICLES CLASSIFICATION:

FHWA Class 9:	-2.0	FHWA Class		-	
FHWA Class 8:	67.0	FHWA Class		-	
		FHWA Class		-	
		FHWA Class		-	

Percent of "Unclassified" Vehicles: 0.0%

Validation Test Truck Run Set - Post

Person Leading Calibration Effort: **Dean J. Wolf**

Contact Information: Phone: 717-975-3550

E-mail: dwolf@ara.com

Traffic Sheet 20 LTPP MONITORED TRAFFIC DATA SPEED AND CLASSIFICATION STUDIES	STATE CODE: 220100 SPS WIM ID: LA DATE (mm/dd/yyyy) 7/27/2010

WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class
68	9	20490	70	9	65	9	20654	64	9
62	9	20493	61	9	63	9	21731	61	9
63	9	20494	62	9	60	9	21742	61	9
62	9	20495	62	9	59	9	21752	59	9
52	9	20496	52	9	50	9	21783	48	9
57	5	20497	53	5	50	5	21793	50	5
57	9	20500	57	9	55	9	21819	54	9
54	5	20502	53	5	52	9	21820	51	9
54	9	20505	55	9	55	9	21842	55	9
51	3	20507	52	5	56	6	21843	56	6
58	10	20533	58	10	53	5	21865	52	5
58	9	20540	58	9	61	5	21909	59	5
43	6	20541	42	6	57	8	21913	54	9
55	3	20544	54	5	73	3	21919	70	5
57	8	20563	55	8	56	9	21925	56	9
64	9	20579	64	9	59	3	21953	55	5
60	6	20586	60	6	54	9	21970	53	9
59	9	20607	57	9	52	5	21988	51	5
60	9	20631	59	9	59	9	21995	61	9
60	3	20635	59	5	67	9	21996	65	9
49	3	20636	49	5	62	9	22009	59	9
61	5	20641	61	5	60	9	22020	60	9
70	5	20646	69	5	59	3	22028	59	5
60	5	20652	59	5	53	10	22035	53	13
66	9	20653	65	9	57	9	22048	57	9

Sheet 1 - 0 to 50

Recorded By: ______________________ Verified By: ______________________

Traffic Sheet 20 LTPP MONITORED TRAFFIC DATA SPEED AND CLASSIFICATION STUDIES	STATE CODE: 220100 SPS WIM ID: LA DATE (mm/dd/yyyy) 7/27/2010

WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class
55	9	22069	54	9	55	5	24234	54	5
64	9	22075	63	9	61	9	24238	61	9
55	9	22087	53	9		STOP@7:30AM 28 JUL10			
60	3	22106	59	5					
56	5	22107	57	5					
57	9	22111	58	9					
49	6	22112	50	6					
59	13	22118	59	10					
55	5	22127	52	5					
62	9	22141	59	9					
58	9	22172	55	9					
56	5	22192	56	5					
54	5	22257	45	5					
69	5	22260	65	5					
59	6	24170	58	6					
55	9	24177	55	9					
60	5	24178	59	5					
61	3	24186	61	5					
51	8	24188	52	5					
50	5	24189	50	5					
56	9	24213	55	9					
66	9	24220	66	9					
58	9	24223	56	9					
63	6	24224	62	6					
49	9	24229	48	9					

Sheet 2 - 51 to 100

Recorded By: ____________________ Verified By: ____________________

Traffic Sheet 20 LTPP MONITORED TRAFFIC DATA SPEED AND CLASSIFICATION STUDIES	STATE CODE: SPS WIM ID: DATE (mm/dd/yyyy)	220100 LA 7/28/2010

WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class
62	5	24395	62	5	54	8	24571	52	8
57	5	24396	56	5	70	9	24573	69	9
48	10	24399	47	10	60	13	24590	60	10
62	9	24410	62	9	58	5	24600	56	5
54	9	24413	50	9	60	9	24602	60	9
62	6	24421	61	6	62	9	24610	61	9
62	8	24422	61	5	57	3	24618	52	5
59	9	24429	61	9	56	3	24619	53	5
61	10	24435	59	10	55	9	24626	54	9
59	10	24446	54	10	67	3	24632	65	5
58	5	24449	58	9	57	5	24643	61	5
55	5	24451	53	5	61	9	24649	54	9
66	5	24453	64	5	67	9	24650	60	9
65	5	24454	63	5	62	9	24656	58	9
59	9	24457	57	9	64	3	24658	62	5
62	5	24459	58	5	61	6	24671	59	6
59	9	24486	56	9	55	9	24702	53	9
68	5	24496	65	5	63	9	24705	62	9
57	9	24502	54	9	61	9	24715	62	9
62	9	24525	57	9	65	9	24718	64	9
59	9	24529	58	9	49	5	24724	44	5
59	5	24539	55	5	55	5	24730	55	5
67	3	24546	62	5	60	9	24733	58	9
59	9	24560	55	9	53	5	24740	54	5
58	9	24561	53	9	62	9	24755	61	9

Sheet 1 - 0 to 50

Recorded By: kt

Verified By: djw

Traffic Sheet 20 LTPP MONITORED TRAFFIC DATA SPEED AND CLASSIFICATION STUDIES	STATE CODE: 220100 SPS WIM ID: LA DATE (mm/dd/yyyy) 7/28/2010

WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class
60	5	24952	58	5	55	5	25685	54	5
59	9	24964	58	9	62	9	25689	61	9
62	9	24965	60	9	57	3	25693	54	5
60	3	24975	58	5	57	5	25723	54	5
59	9	24978	52	9	67	9	25776	64	9
59	9	24992	54	9	62	13	25777	62	10
53	13	25004	52	10	53	10	25778	53	10
62	9	25010	60	9	63	8	25808	61	5
52	5	25016	52	5	58	9	25817	55	9
52	5	25017	50	5	70	3	25848	68	5
55	5	25019	53	5	57	3	25853	54	5
59	9	25028	58	9	65	6	25857	63	6
62	9	25034	58	9	47	9	25870	47	9
56	9	25039	54	9	55	9	25898	56	9
59	5	25040	58	5	63	9	25907	61	9
67	5	25047	61	5	59	9	25908	59	9
50	5	25048	49	5	77	5	25909	76	3
59	9	25050	59	9	69	5	25918	67	5
67	9	25057	64	9	60	5	25934	59	5
50	13	25058	50	10	63	3	25972	66	5
61	8	25080	59	8	66	3	25973	65	5
59	5	25084	57	5	66	9	25974	63	9
57	5	25097	57	5	58	8	25995	57	8
59	5	25105	62	5	59	3	25996	54	5
62	9	25109	60	9	54	5	26007	53	5

Sheet 2 - 51 to 100

Recorded By: kt

Verified By: djw

Traffic Sheet 20 LTPP MONITORED TRAFFIC DATA SPEED AND CLASSIFICATION STUDIES	STATE CODE: SPS WIM ID: DATE (mm/dd/yyyy)	220100 LA 7/28/2010

WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class
40	5	26011	38	5					

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Recorded By: kt

Verified By: djw