WIM System Field Calibration and Validation Summary Report

Indiana SPS-6
SHRP ID – 180600

Validation Date: November 04, 2010
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1 Executive Summary

A WIM validation was performed on November 3 and 4, 2010 at the Indiana SPS-6 site located on route US-31 at milepost 216.9, 8.5 miles south of US 30.

This site was installed on July 01, 2008. The in-road sensors are installed in the northbound lane. The site is equipped with quarts piezo 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 September 04, 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 the equipment was operating within tolerances. During visual inspection, it was noted that the epoxy covering the quartz sensor homeruns in the shoulder is breaking away and needs to be patched. Further equipment discussion is provided in Section 3.

During the pre-visit profile data analysis, the highest IRI values within the full WIM section and the WIM approach section were noted. During the on-site pavement evaluation, an investigation of the pavement at these locations was conducted, which concluded that the distresses in at these locations did not appear to affect the accuracy of the WIM scale. Observations of trucks traversing the WIM scale area did not reveal any adverse truck movements. 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. Due to the accuracies that resulted from the pre-validation, a calibration of the system and consequent post-validation was not required. The summary results of the pre-validation are provided in Table 1.1 below.

Table 1-1 – Pre-Validation Results – 04-Nov-10

Parameter	95% Confidence Limit of Error	Site Values	Pass/Fail
Steering Axles	±20 percent	0.6 ± 5.3%	Pass
Tandem Axles	±15 percent	0.0 ± 5.1%	Pass
GVW	±10 percent	0.0 ± 3.2%	Pass
Vehicle Length	±3 percent (2.1 ft)	0.1 ± 1.1 ft	Pass
Axle Length	± 0.5 ft [150mm]	-0.2 ± 0.2 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 -0.1 ± 1.4 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 with a mean error of -0.2 feet, 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.

This site is providing research quality vehicle classification data for heavy trucks (Class 6 – 13). The heavy truck misclassification rate of 0.0% is within the 2.0% acceptability criterion for LTPP SPS WIM sites. The overall misclassification rate of 2.9% from the 100 truck sample (Class 4 – 13) was due to the 3 cross-classifications of Class 3, 5, and 8 vehicles.

There were two test trucks used for the pre-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 forklift over the drive tandem and steel beams over the rest of 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 standard tandem on the trailer. The Secondary truck was loaded with crane counter weights loaded on 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 obtained (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	77.9	11.0	13.7	13.7	19.8	19.8	18.8	4.3	30.5	4.1	57.7	70.0
2	66.6	10.5	13.7	13.7	14.4	14.4	18.1	4.3	35.9	4.1	62.4	68.8

The posted speed limit at the site is 60 mph. During the testing, the speed of the test trucks ranged from to 48 to 60 mph, a range of 12 mph.

During test truck runs, pavement temperature was collected using a hand-held infrared temperature device. The post-validation pavement surface temperatures varied from 34.3 to 48.4 degrees Fahrenheit, a range of 14.1 degrees Fahrenheit. The cloudy and rainy weather conditions prevented the desired 30 degree range in temperatures.

A review of the LTPP Standard Release Database 24 shows that there are 13 consecutive months of level “E” WIM data for this site. This site requires at least 4 additional years of data to meet the minimum of five years of research quality data.

2 WIM System Data Availability and 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 October 11, 2010 (Data) to the most recent Comparison Data Set (CDS) from October 08, 2008. The assessments performed prior to the site visits are used to develop reasonable expectations for the validation. The results of further investigations performed as a result of the analyses are provided in Section 5 of this report.

2.1 LTPP WIM Data Availability

A review of the LTPP Standard Release Database 24 shows that there are 13 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. The data does not meet the 210-day minimum requirement for a calendar year, however, the continuous data for the last 6 months of 2008 and the first 7 months of 2009 provide more than 210 days data, and therefore provide for a 12 month period for which 210 days of WIM data has been collected. Table 2-1 provides a breakdown of the available data for years 2008 and 2009.

Table 2-1 – LTPP Data Availability

Year	Total Number of Days in Year	Number of Months
2008	161	6
2009	198	7

2.2 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.

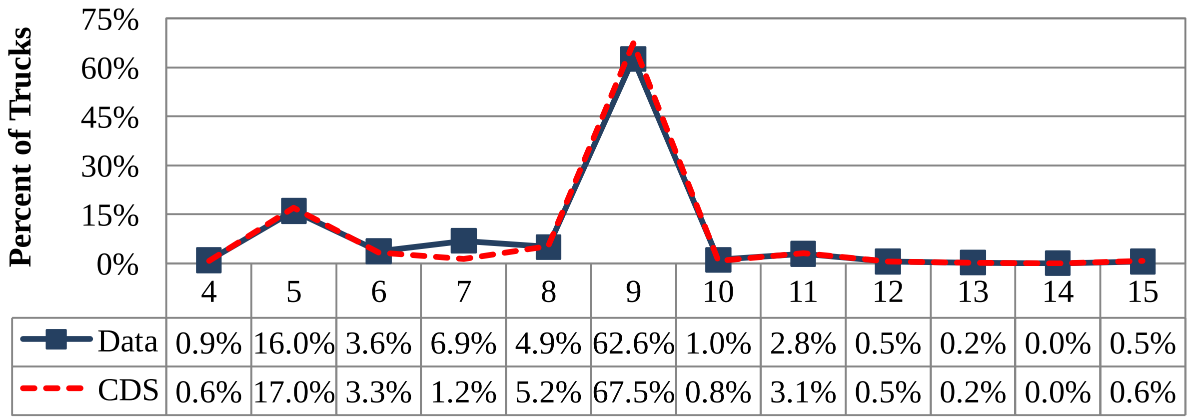


Figure 2-1 – Comparison of Truck Distribution

Table 2-2 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 (62.6%) and Class 5 (16.0%). It also indicates that 0.5 percent of the vehicles at this site are unclassified. Table 2-2 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 2-2 – Truck Distribution from W-Card

Vehicle Classification	CDS		Data		Change
	Date				
	10/8/2008		10/11/2010		
4	147	0.6%	159	0.9%	0.3%
5	4061	17.0%	2897	16.0%	-0.9%
6	778	3.3%	650	3.6%	0.3%
7	290	1.2%	1239	6.9%	5.6%
8	1249	5.2%	892	4.9%	-0.3%
9	16119	67.5%	11304	62.6%	-4.8%
10	189	0.8%	184	1.0%	0.2%
11	752	3.1%	512	2.8%	-0.3%
12	117	0.5%	89	0.5%	0.0%
13	46	0.2%	35	0.2%	0.0%
14	0	0.0%	0	0.0%	0.0%
15	149	0.6%	94	0.5%	-0.1%

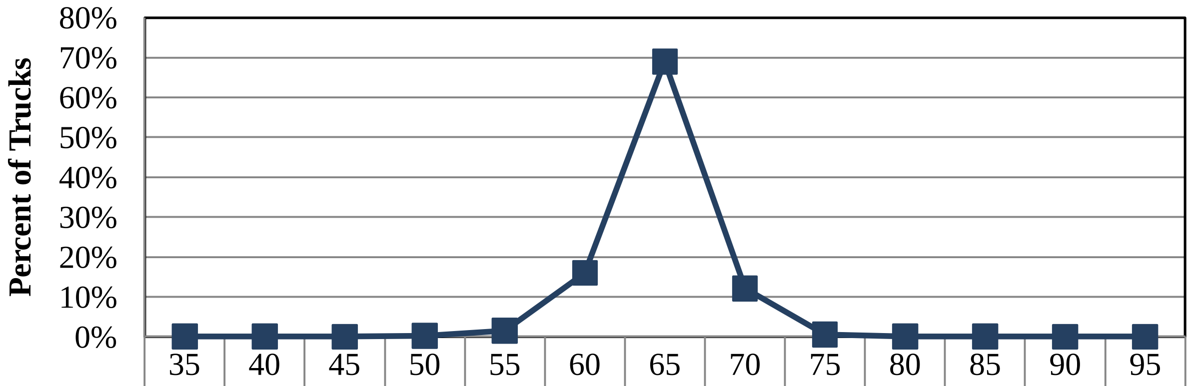
From the table it can be seen that the number of Class 9 vehicles has decreased by 4.8 percent from October 2008 and October 2010. These differences may be attributed to small sample size used to develop vehicle class distributions or seasonal variations in truck distributions. During the same time period, the number of Class 5 trucks decreased by 0.9 percent. Small decreases in the number of heavier trucks may be attributed to decreased use of the roadway for local deliveries, cross-classifications of type 3 and 5 vehicles, as well as natural variations in truck volumes.

2.3 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 CDS distribution of speeds is shown in Figure 2-2.

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 60 and the 85th percentile speed for trucks at this site is

65 mph. The coverage of truck speeds for the validation will be between 50 and 60 mph. Since the 85th percentile speeds for trucks is above the posted speed limit, the post-visit applied calibration will be used to develop compensation factors for speed points from 60 to 65 mph.



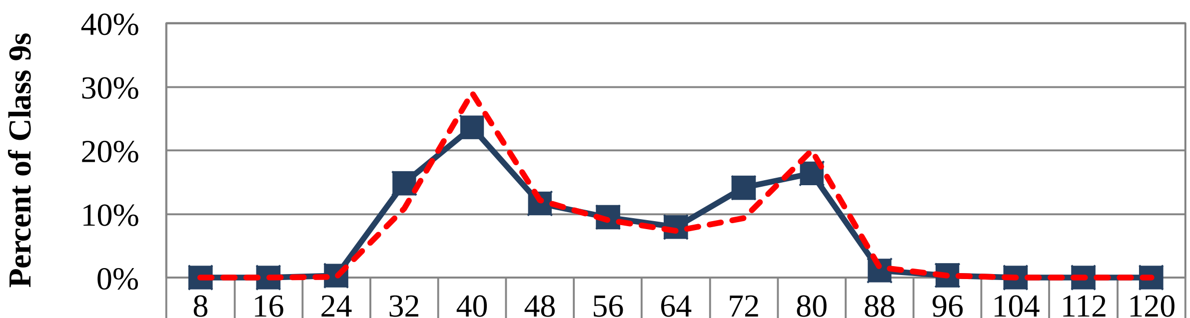
	35	40	45	50	55	60	65	70	75	80	85	90	95
Data	0.1%	0.1%	0.0%	0.2%	1.5%	16.0	69.0	12.1	0.5%	0.1%	0.1%	0.0%	0.0%

Figure 2-2 – Truck Speed Distribution – 25-Oct-10

2.4 GVW Data Analysis

The traffic 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 October 2010 and the Comparison Data Set from October 2008.

As shown in Figure 2-3, the unloaded and loaded peaks for the October 2008 Comparison Data Set (CDS) and the October 2010 two-week sample W-card dataset (Data) are similar and do not indicate a shift in weight estimations by the WIM equipment.



	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
Data	0.0%	0.0%	0.3%	14.9	23.6	11.7	9.5%	8.0%	14.2	16.4	1.1%	0.4%	0.0%	0.0%	0.0%
CDS	0.0%	0.0%	0.2%	10.9	29.1	12.2	9.0%	7.4%	9.4%	20.0	1.6%	0.3%	0.0%	0.0%	0.0%

Figure 2-3 – Comparison of Class 9 GVW Distribution

Table 2-3 is provided to show the statistical comparison between the Comparison Data Set and the current dataset.

Table 2-3 – Class 9 GVW Distribution from W-Card

GVW weight bins (kips)	CDS		Data		Change
	Date				
	10/8/2008		10/11/2010		
8	0	0.0%	0	0.0%	0.0%
16	0	0.0%	0	0.0%	0.0%
24	25	0.2%	36	0.3%	0.2%
32	1747	10.9%	1674	14.9%	4.0%
40	4666	29.1%	2660	23.6%	-5.4%
48	1961	12.2%	1318	11.7%	-0.5%
56	1451	9.0%	1072	9.5%	0.5%
64	1183	7.4%	897	8.0%	0.6%
72	1503	9.4%	1595	14.2%	4.8%
80	3211	20.0%	1849	16.4%	-3.6%
88	262	1.6%	126	1.1%	-0.5%
96	50	0.3%	40	0.4%	0.0%
104	1	0.0%	0	0.0%	0.0%
112	0	0.0%	0	0.0%	0.0%
120	0	0.0%	0	0.0%	0.0%
Average =	51.1		50.9		-0.2

As shown in the table, the number of unloaded class 9 trucks in the 32 to 40 kips range decreased by 5.4 percent while the number of loaded class 9 trucks in the 72 to 80 kips range decreased by 3.6 percent. The number of overweight trucks between these two data sets decreased by 0.5 percent and the overall GVW average for this site decreased from 51.1 kips in CDS to 50.9 kips in the current dataset.

2.5 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 average for Class 9 trucks of 10.3 kips. Figure 2-4 shows a comparison between Class 9 front axle weight plots generated by using the two week W-card sample from October 2010 and the Comparison Data Set from October 2008.

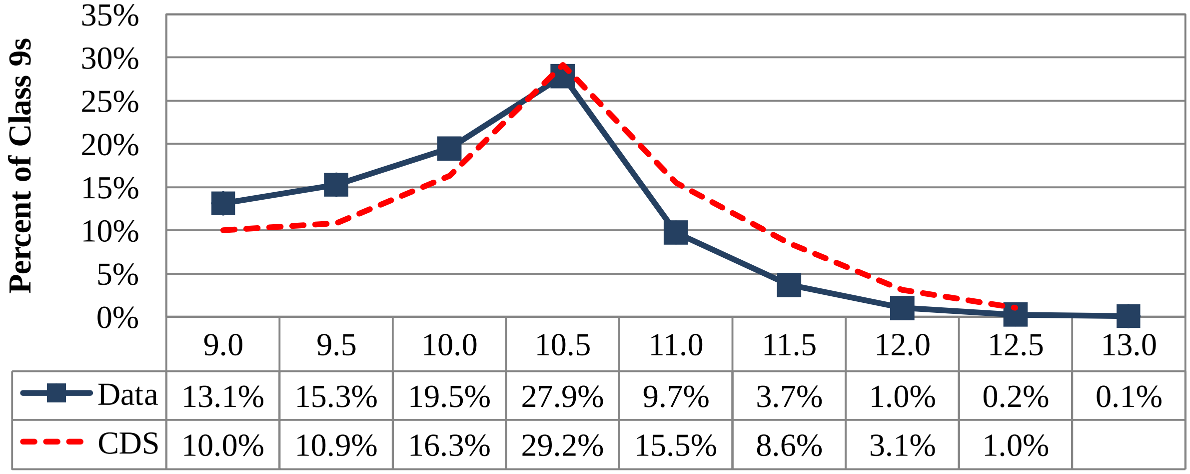


Figure 2-4 – Distribution of Class 9 Front Axle Weights

It can be seen in the figure that the greatest percentage of trucks have front axle weights averaging 10.5, the percentage of trucks at this weight are similar between the October 2008 Comparison Data Set (CDS) and the October 2010 dataset (Data).

Table 2-4 provides the Class 9 front axle weight distribution data for the October 2008 Comparison Data Set (CDS) and the October 2010 dataset (Data).

Table 2-4 – Class 9 Front Axle Weight Distribution from W-Card

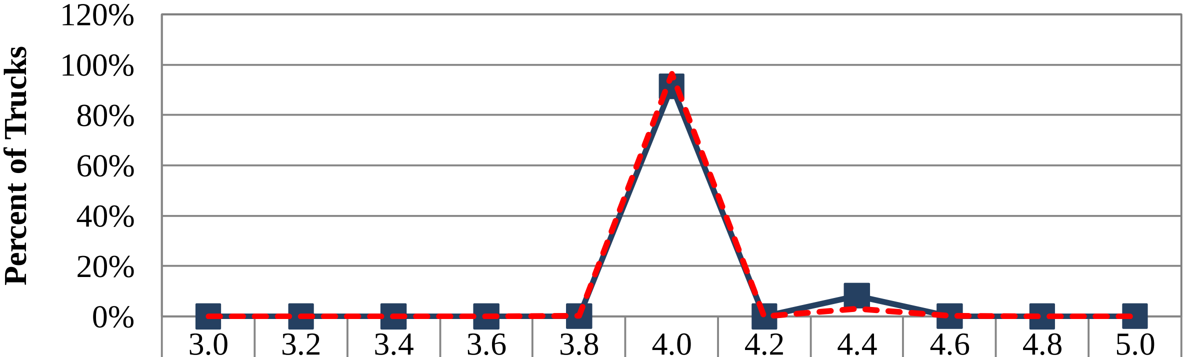
F/A weight bins (kips)	CDS		Data		Change
	Date				
	10/8/2008		10/11/2010		
9.0	848	5.3%	1074	9.5%	4.3%
9.5	1608	10.0%	1476	13.1%	3.1%
10.0	1741	10.9%	1717	15.3%	4.4%
10.5	2619	16.3%	2190	19.5%	3.1%
11.0	4677	29.2%	3133	27.9%	-1.3%
11.5	2489	15.5%	1095	9.7%	-5.8%
12.0	1372	8.6%	414	3.7%	-4.9%
12.5	497	3.1%	113	1.0%	-2.1%
13.0	161	1.0%	28	0.2%	-0.8%
13.5	25	0.2%	8	0.1%	-0.1%
Average =	10.5		10.2		-0.3

The table shows that the average front axle weight for Class 9 trucks in the current dataset has decreased by 0.3 kips, or -3.2 percent compared to the CDS. According to the current data, the majority of the Class 9 front axle weights are between 10.5 and 11.0 kips and the average front axle weight for Class 9 trucks is 10.2 kips.

2.6 Class 9 Tractor Tandem Spacing Data Analysis

The CDS data received from the Regional Support Contractor was analyzed to determine the expected average tractor tandem spacing. This 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 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%	0.1%	91.4%	0.0%	8.2%	0.1%	0.0%	0.1%
CDS	0.0%	0.0%	0.0%	0.0%	0.2%	96.4%	0.0%	3.1%	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 October 2008 Comparison Data Set and the October 2010 Data are nearly identical.

Table 2-5 shows the Class 9 axle spacings between the second and third axles for the power unit. From the table it can be seen 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 2-5 – Class 9 Axle 3 to 4 Spacing from W-Card

Tandem 1 spacing bins (feet)	CDS		Data		Change
	Date				
	10/8/2008		10/11/2010		
3.0	0	0.0%	0	0.0%	0.0%
3.2	1	0.0%	0	0.0%	0.0%
3.4	2	0.0%	2	0.0%	0.0%
3.6	0	0.0%	0	0.0%	0.0%
3.8	38	0.2%	13	0.1%	-0.1%
4.0	15489	96.4%	10304	91.4%	-5.0%
4.2	0	0.0%	0	0.0%	0.0%
4.4	495	3.1%	928	8.2%	5.2%
4.6	35	0.2%	13	0.1%	-0.1%
4.8	0	0.0%	0	0.0%	0.0%
5.0	0	0.0%	8	0.1%	0.1%
Average =	4.0		4.0		0.0

From the table it can be seen 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.

2.7 Data Analysis Summary

Historical data analysis involved the comparison of the most recent Comparison Data Set (October 2008) based on the last calibration with the most recent two-week WIM data sample from the site (October 2010). Comparison of vehicle class distribution data indicates a 4.8 percent decrease in the number of Class 9 vehicles. Analysis of Class 9 weight data indicates that front axle weights have decreased by 0.3 percent and average Class 9 GVW has decreased by 0.4 percent for the October 2010 data. The data indicates an average truck tandem spacing of 4.0 feet, which is below the expected average of 4.25 feet.

3 WIM Equipment Discussion

From a comparison between the report of the most recent validation of this equipment on September 04, 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 July 01, 2008 by International Road Dynamics. It is instrumented with bending plate 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. The epoxy covering the quartz sensor homeruns in the shoulder is breaking apart and needs to be patched, as shown in Photo 3-1 and Photo 3-2.

Photo 3-1 - Broken Epoxy Leading Quartz Sensor Homerun

Photo 3-2 - Broken Epoxy Trailing Quartz Sensor Homerun

No other deficiencies 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 values for the WIM sensors and inductive loops were within tolerances. Electronic tests of the power and communication devices 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

The epoxy covering the quartz sensor homeruns in the shoulder is breaking away and needs to be patched. No other 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, the pavement areas within the 1000-foot WIM section, and the 400-foot approach section where higher IRI were noted during pre-visit profile data analysis were investigated. None of the distresses noted appear to affect the accuracy of the WIM sensors. The pavement condition in the upstream and downstream directions is shown in Photo 4-1 and Photo 4-2.

Photo 4-1 – Pavement in Upstream Direction

Photo 4-2 – Pavement in Downstream Direction

4.2 Profile and Vehicle Interaction

Profile data was collected on April 29, 2010 by the North Central Regional Support Contractor using a high-speed profiler, where the operator measures the pavement profile over the entire one-thousand foot long WIM Section, 900 feet prior to WIM scales and 100 feet after the WIM scales. 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 value within the 1000 foot WIM section is 238 in/mi and is located approximately 740 feet prior to the WIM scale. The highest IRI value within the 400 foot approach section was 96 in/mi and is located approximately 160 feet prior to the WIM scale. These areas of pavement were more closely investigated during the validation visit. The higher IRI value at a location 740 feet prior to the scales is due to a moderate bump in the pavement. The visible and audible truck dynamics at the site appear to diminish prior to trucks passing over the WIM scales. The higher IRI value at a location 160 feet prior to the scale was due to a repaired crack that does not appear to cause adverse truck movement.

Additionally, observations of trucks passing over the locations of the noted pavement distresses and the WIM site did not reveal any adverse truck movements that would affect WIM system accuracies. 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 3 left, 3 right and 5 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)	0.549	0.556	0.556			0.554
		SRI (m/km)	*0.350*	*0.330*	*0.340*			*0.340*
		Peak LRI (m/km)	0.684	0.663	0.691			0.679
		Peak SRI (m/km)	0.554	*0.452*	*0.445*			*0.484*
	RWP	LRI (m/km)	0.648	0.670	0.660			0.659
		SRI (m/km)	0.504	0.552	0.609			0.555
		Peak LRI (m/km)	0.648	0.670	0.660			0.659
		Peak SRI (m/km)	0.931	0.950	1.025			0.969
Center	LWP	LRI (m/km)	0.536	0.618	0.529	0.658	0.539	0.585
		SRI (m/km)	0.505	0.781	0.545	*0.429*	0.514	0.565
		Peak LRI (m/km)	0.643	0.618	0.600	0.659	0.540	0.630
		Peak SRI (m/km)	*0.647*	1.150	0.785	0.959	0.870	0.885
	RWP	LRI (m/km)	0.644	0.698	0.663	0.703	0.687	0.677
		SRI (m/km)	0.996	1.186	1.134	1.316	1.142	1.158
		Peak LRI (m/km)	0.644	0.699	0.663	0.704	0.687	0.678
		Peak SRI (m/km)	1.065	1.296	1.174	1.427	1.260	1.241
Right	LWP	LRI (m/km)	0.614	0.629	0.633			0.625
		SRI (m/km)	0.777	0.778	0.786			0.780
		Peak LRI (m/km)	0.632	0.629	0.633			0.631
		Peak SRI (m/km)	0.847	0.813	0.883			0.848
	RWP	LRI (m/km)	0.844	0.776	0.808			0.809
		SRI (m/km)	1.280	1.958	1.888			1.709
		Peak LRI (m/km)	0.847	0.777	0.808			0.811
		Peak SRI (m/km)	**2.464**	**2.333**	**2.209**			**2.335**

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 under the lower threshold. The highest values, on average, are the Peak SRI values in the right wheel path of the right shift passes..

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 test 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 test runs provides a general overview of system performance prior to any calibration adjustments for the given environmental, vehicle speed and other conditions.

The 42 pre-validation test truck runs were conducted on November 3 beginning at 9:54 AM and continuing through 2:50 PM and on November 4, from 8:32 AM to 9:02 AM.

The two test trucks consisted of:

- A Class 9 truck, loaded with a forklift over the drive tandem and steel beams over the rest of 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 crane counter weights 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 a standard tandem spacing on the trailer.

The test trucks were weighed prior to the pre-validation and were re-weighed at the conclusion of the pre-validation. The average 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	77.9	11.0	13.7	13.7	19.8	19.8	18.8	4.3	30.5	4.1	57.7	70.0
2	66.6	10.5	13.7	13.7	14.4	14.4	18.1	4.3	35.9	4.1	62.4	68.8

Test truck speeds varied by 12 mph, from 48 to 60 mph. The measured pre-validation pavement temperatures varied 14.1 degrees Fahrenheit, from 34.3 to 48.4. The cloudy and rainy weather conditions prevented for reaching the desired 30 degree temperature range. Table 5-2 provides a summary of the pre-validation results.

Table 5-2 – Pre-Validation Overall Results – 04-Nov-10

Parameter	95% Confidence Limit of Error	Site Values	Pass/Fail
Steering Axles	±20 percent	0.6 ± 5.3%	Pass
Tandem Axles	±15 percent	0.0 ± 5.1%	Pass
GVW	±10 percent	0.0 ± 3.2%	Pass
Vehicle Length	±3 percent (2.1 ft)	0.1 ± 1.1 ft	Pass
Axle Length	± 0.5 ft [150mm]	-0.2 ± 0.2 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 over all speeds was -0.1 ± 1.4 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 with a mean error of -0.2, 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 relationship exists between speed and WIM equipment weight and distance measurement accuracy. The posted speed limit at this site is 60 mph. The test runs were divided into three speed groups - low, medium and high speeds, as shown in Table 5-3 below.

Table 5-3 – Pre-Validation Results by Speed – 04-Nov-10

Parameter	95% Confidence Limit of Error	Low 48.0 to 52.0 mph	Medium 52.1 to 56.1 mph	High 56.2 to 60.0 mph
Steering Axles	±20 percent	0.8 ± 5.0%	1.4 ± 6.0%	-0.5 ± 5.6%
Tandem Axles	±15 percent	-0.8 ± 5.1%	0.9 ± 5.0%	0.0 ± 4.9%
GVW	±10 percent	-0.8 ± 3.1%	0.9 ± 3.1%	-0.1 ± 3.1%
Vehicle Length	±3 percent (2.1 ft)	0.2 ± 1.2 ft	0.0 ± 1.5 ft	0.3 ± 0.9 ft
Vehicle Speed	± 1.0 mph	-0.1 ± 2.0 mph	-0.2 ± 1.3 mph	-0.1 ± 1.1 mph
Axle Length	± 0.5 ft [150mm]	-0.1 ± 0.2 ft	-0.2 ± 0.3 ft	-0.1 ± 0.2 ft

From the table, it can be seen that the WIM equipment estimates all weights with reasonable accuracy 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 sections.

5.1.1.1 GVW Errors by Speed

As shown in Figure 5-1, 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.

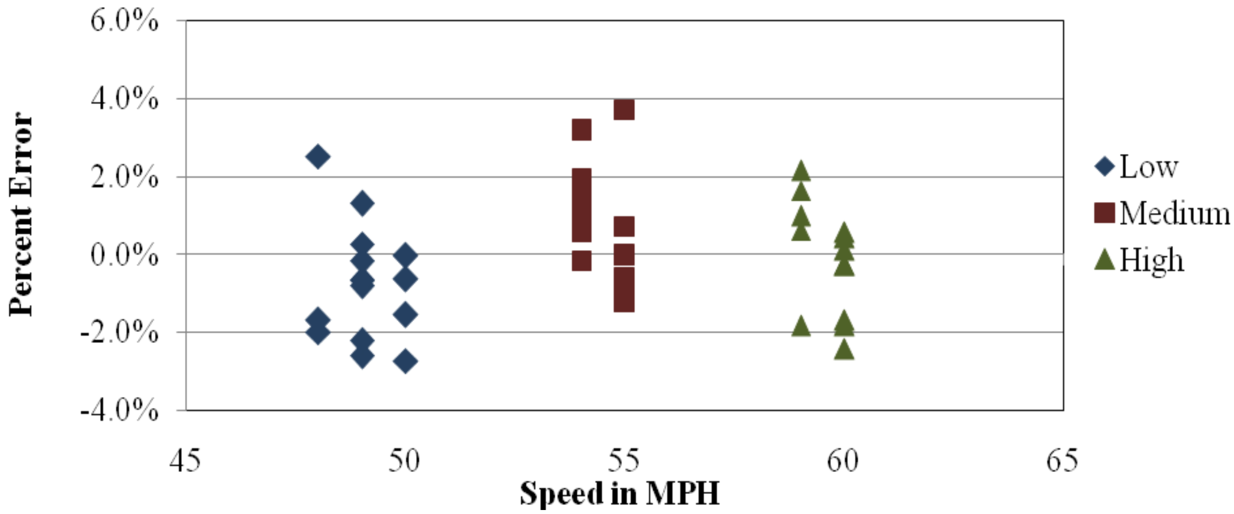


Figure 5-1 – Pre-Validation GVW Error by Speed – 04-Nov-10

5.1.1.2 Steering Axle Weight Errors by Speed

As shown in Figure 5-2, the equipment estimates steering axle weights with similar accuracy at all speeds. The range in error appears to be slightly less at the lower speeds when compared with the medium and high speeds.

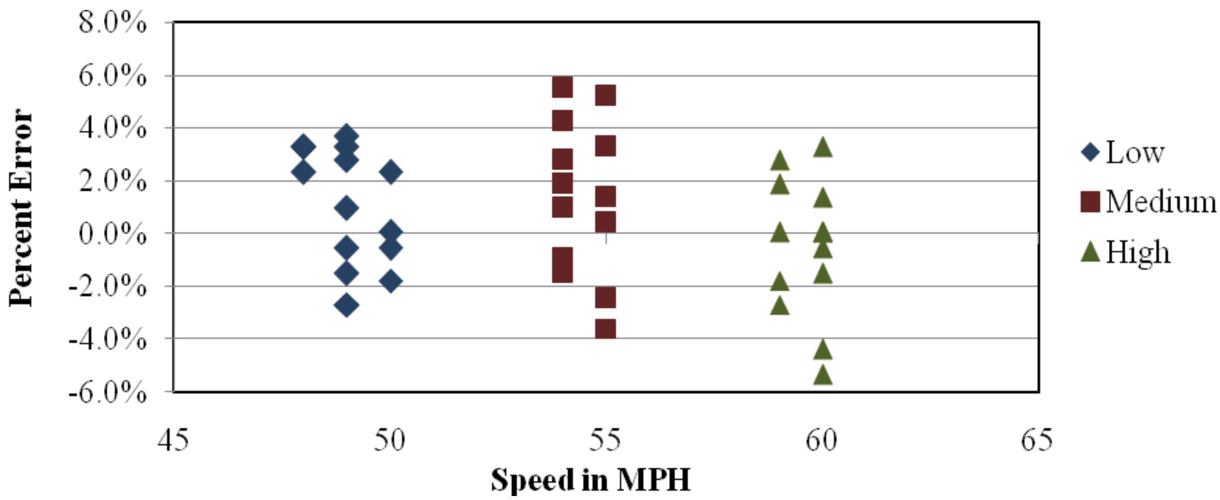


Figure 5-2 – Pre-Validation Steering Axle Weight Errors by Speed – 04-Nov-10

5.1.1.3 Tandem Axle Weight Errors by Speed

As shown in Figure 5-3, the equipment estimates tandem axle weights with similar accuracy at all speeds. The range in error is slightly less at the higher speeds.

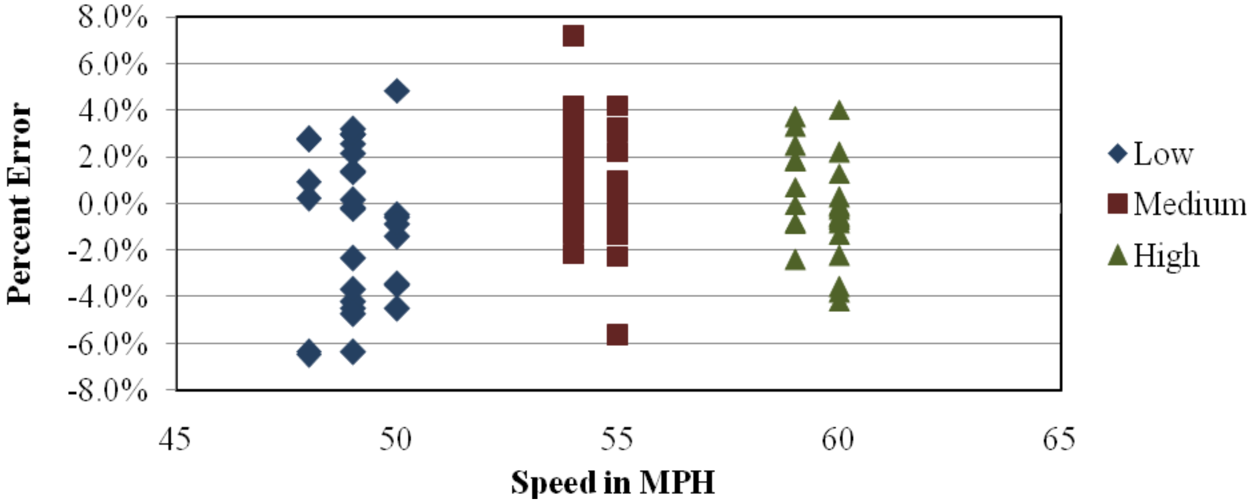


Figure 5-3 – Pre-Validation Tandem Axle Weight Errors by Speed – 04-Nov-10

5.1.1.4 GVW Errors by Speed and Truck Type

When the GVW error for each truck is analyzed as a function of speed, 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. Distribution of errors is shown graphically in Figure 5-4.

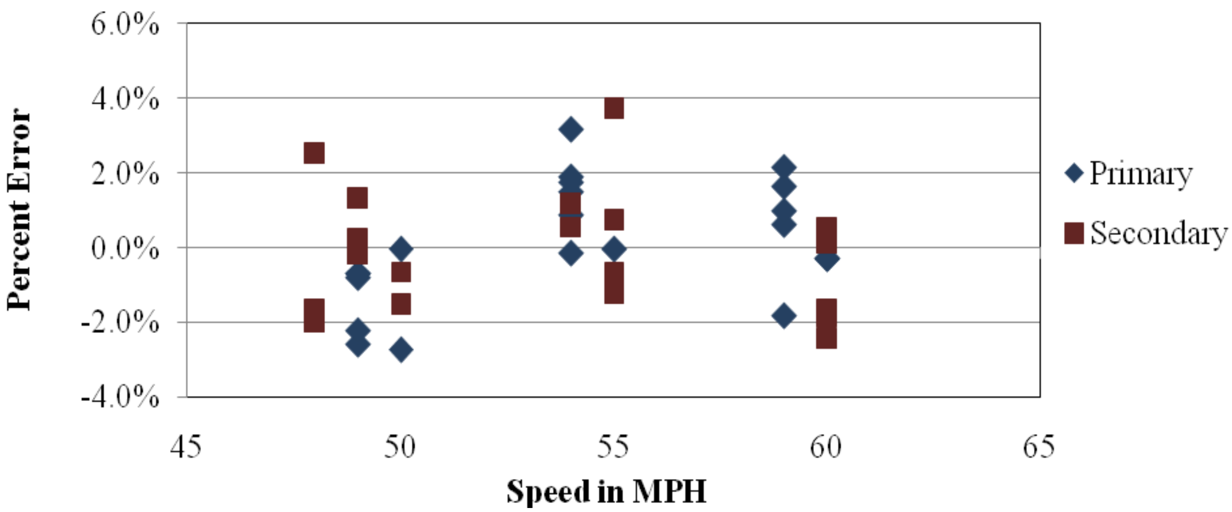


Figure 5-4 – Pre-Validation GVW Errors by Truck and Speed – 04-Nov-10

5.1.1.5 Axle Length Errors by Speed

For this site, the error in axle length measurement was consistent at all speeds. The range in axle length measurement error ranged from -0.4 feet to 0.0 feet. Distribution of errors is shown graphically in Figure 5-5.

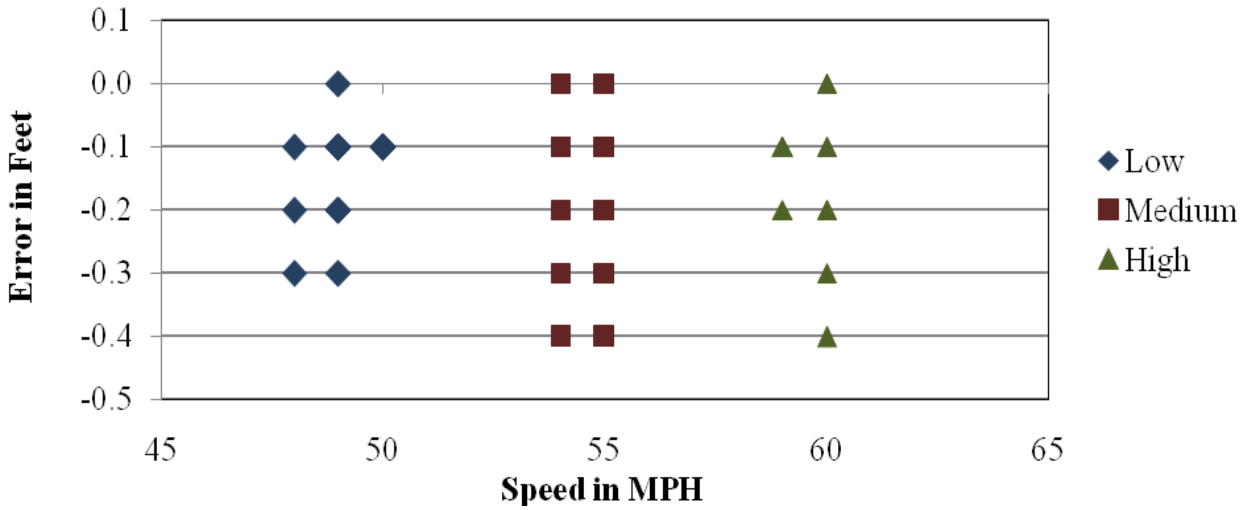


Figure 5-5 – Pre-Validation Axle Length Errors by Speed – 04-Nov-10

5.1.1.6 Overall Length Errors by Speed

For this system, the WIM equipment measured overall vehicle length consistently over the entire range of speeds, with an error range of -0.8 to 1.0 feet. Distribution of errors is shown graphically in Figure 5-6.

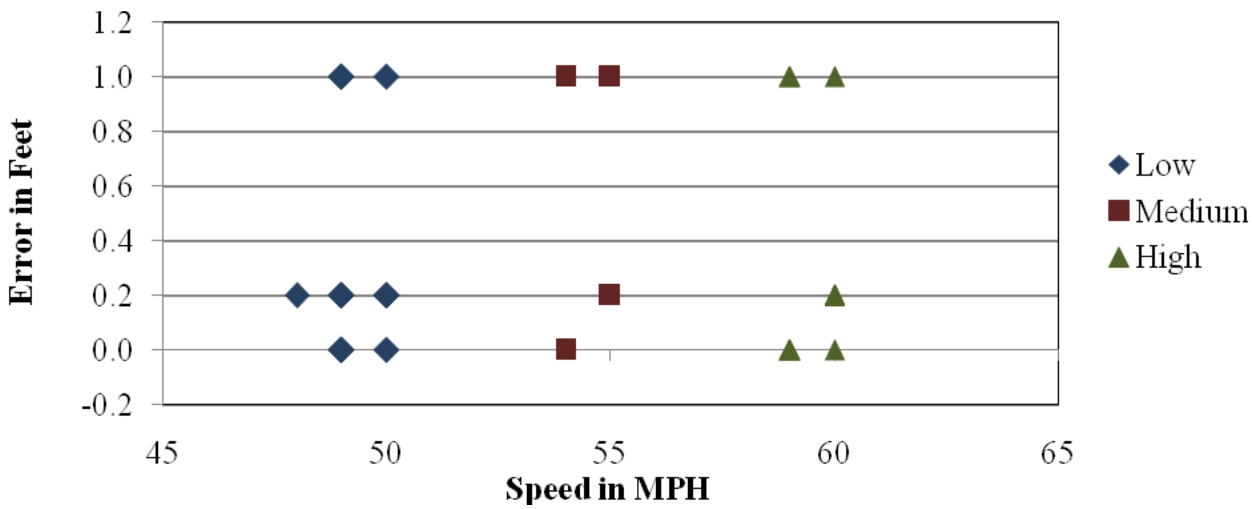


Figure 5-6 – Pre-Validation Overall Length Error by Speed – 04-Nov-10

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 14.1 degrees, from 34.3 to 48.4 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 – 04-Nov-10

Parameter	**95% Confidence Limit of Error**	**Low**	**High**
		34.3 to 41.4 degF	**41.5 to 48.5 degF**
Steering Axles	±20 percent	1.4 ± 4.5%	-0.7 ± 6.0%
Tandem Axles	±15 percent	0.4 ± 5.2%	-0.6 ± 5.3%
GVW	±10 percent	0.4 ± 2.9%	-0.7 ± 3.5%
Vehicle Length	±3 percent (2.1 ft)	0.0 ± 1.2 ft	0.4 ± 1.1 ft
Vehicle Speed	± 1.0 mph	-0.1 ± 1.3 mph	-0.2 ± 1.6 mph
Axle Length	± 0.5 ft [150mm]	-0.2 ± 0.2 ft	-0.1 ± 0.2 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

From Figure 5-7, it can be seen that the equipment appears to estimate GVW with acceptable accuracy across the range of temperatures observed in the field. There appears to be a slight correlation between temperature and weight estimates where an increase in temperature causes a minor decrease in average GVW weight estimates.

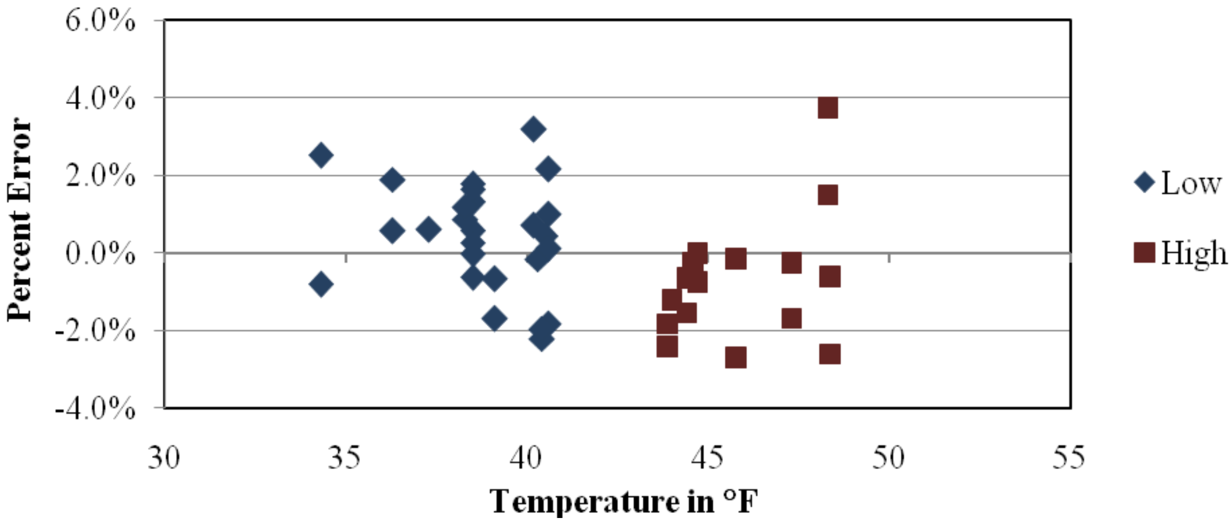


Figure 5-7 – Pre-Validation GVW Errors by Temperature – 04-Nov-10

5.1.2.2 Steering Axle Weight Errors by Temperature

Figure 5-8 demonstrates that for loaded steering axles, the WIM equipment appears to demonstrate a similar trend as with GVW estimates, where as the temperature rises, the estimation of steering axle weight decreases. The range in error is similar for different temperature groups. Distribution of errors is shown graphically in the following figure.

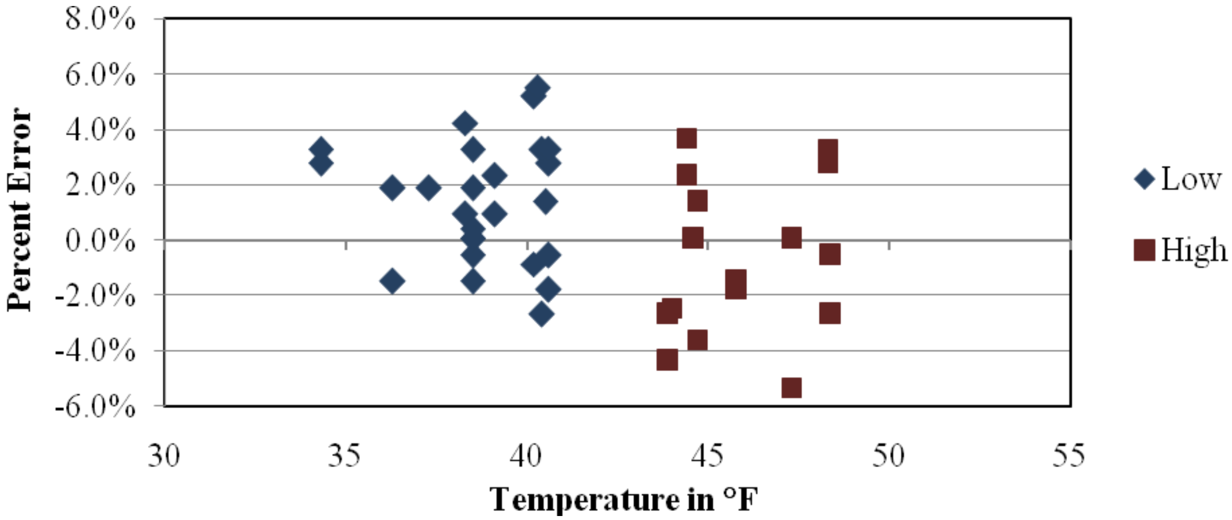


Figure 5-8 – Pre-Validation Steering Axle Weight Errors by Temperature – 04-Nov-10

5.1.2.3 Tandem Axle Weight Errors by Temperature

As shown in Figure 5-9, the equipment appears to measure loaded tandem axle weights with reasonable accuracy at all temperatures. The relationship that exists between other equipment weight estimates and temperature is not as remarkable for loaded tandem axle measurement. The range in tandem axle errors is consistent for the two temperature groups.

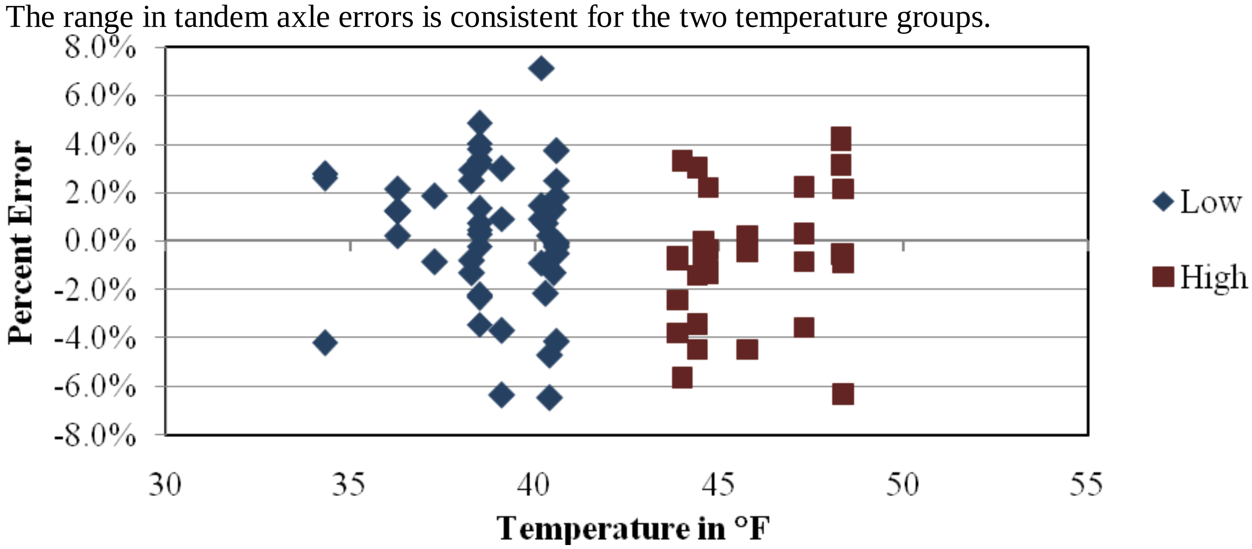


Figure 5-9 – Pre-Validation Tandem Axle Weight Errors by Temperature – 04-Nov-10

5.1.2.4 GVW Errors by Temperature and Truck Type

When analyzed for each test truck, GVW measurement errors for both trucks follow similar patterns: GVW for both trucks decreases slightly as temperature increases. For both trucks, the range of errors is reasonably consistent over the range of temperatures. Distribution of errors is shown graphically in Figure 5-10.

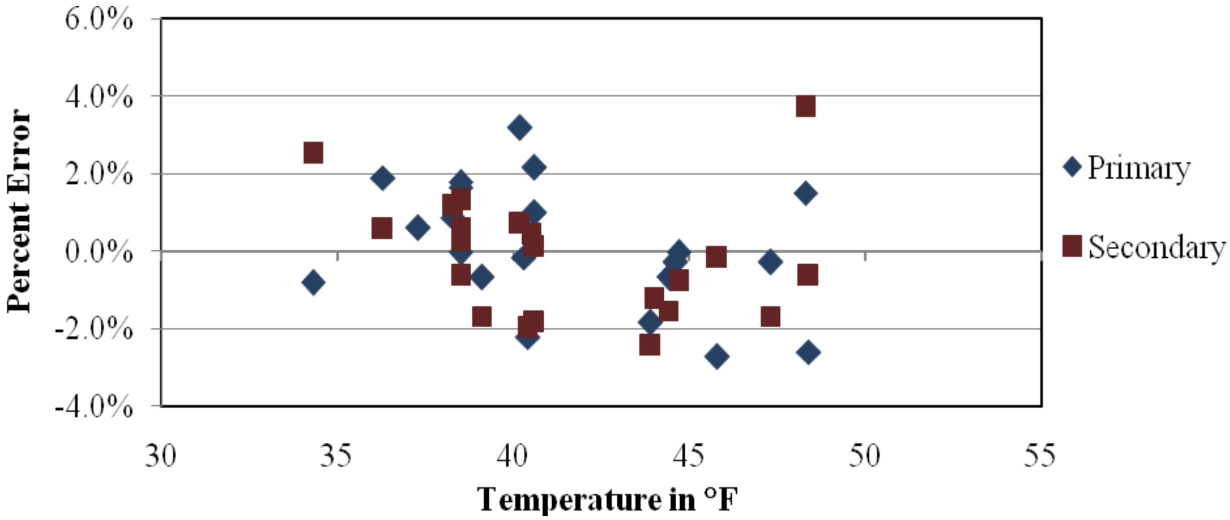


Figure 5-10 – Pre-Validation GVW Error by Truck and Temperature – 04-Nov-10

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 102 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 5-5 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 – 04-Nov-10

Class	4	5	6	7	8	9	10	11	12	13
Observed Count	0	18	2	6	5	69	0	0	0	0
WIM Count	0	18	2	6	7	69	0	0	0	0
Observed Percentage	0	18	2	6	5	68	0	0	0	0
WIM Percentage	0	18	2	6	7	68	0	0	0	0
Misclassified Count	0	1	0	0	0	0	0	0	0	0
Misclassified Percentage	N/A	6	0	0	0	0	N/A	N/A	N/A	N/A
Unclassified Count	0	0	0	0	0	0	0	0	0	0
Unclassified Percentage	N/A	0	0	0	0	0	N/A	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 the percentage of the misclassified vehicles in the manual sample. The misclassifications by pair are provided in Table 5-6.

Table 5-6 – Pre-Validation Misclassifications by Pair – 04-Nov-10

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

Based on the vehicles observed during the pre-validation study, the misclassification percentage is 0.0% for heavy trucks (6 – 13), which is within the 2.0% acceptability criteria for LTPP SPS WIM sites. The overall misclassification rate for all vehicles (3 – 15) is 2.9%.

As shown in the table, a total of 3 vehicles, including zero heavy trucks (6 – 13) were misclassified by the equipment. All of the misclassifications were due to Class 3, 5, and 8 cross-classifications.

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 – 04-Nov-10

Observed/ WIM	Number of Pairs	Observed/ WIM	Number of Pairs	Observed/ WIM	Number of Pairs
3/15	0	7/15	0	11/15	0
4/15	0	8/15	0	12/15	0
5/15	0	9/15	0	13/15	0
6/15	0	10/15	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 -0.1 mph; the range of errors was 1.3 mph.

The WIM equipment required no calibration iterations between the pre- and post-validations. For GVW, the pre-validation test truck runs produced an overall error of 0.0% and errors of -0.8%, 0.9%, and -0.1% at the 50, 55 and 60 mph speed points respectively. Consequently, no changes were made to the compensation factors.

5.1.4 Multivariable Analysis

This section provides additional analysis using a multivariable statistical technique of multiple linear regression. The same 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.

5.1.4.1 Data

All errors from the weight measurement data collected by the equipment 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 48 to 60 mph.

- Pavement temperature. Pavement temperature ranged from 34.3 to 48.4 degrees Fahrenheit.

5.1.4.2 Results

For analysis of GVW weights, the value of regression coefficients and their statistical properties are summarized in Table 5-8. The value of regression coefficients defines the slope of the relationship between the % error in GVW (y in Equation 1) and the predictor variables (x_i in Equation 1). The values of the t-distribution (for the regression coefficients) given in Table 5-8 table are for the null hypothesis that assumes that the coefficients are equal to zero. The effects of temperature were found statistically significant. The probabilities that the effect of temperature on the observed GVW errors occurred by chance alone are less than 5.0 percent.

Table 5-8 – Table of Regression Coefficients for Measurement Error of GVW

Parameter	Regression coefficients	Standard error	Value of t-distribution	Probability value
Intercept	2.1932	3.7489	0.5850	0.5622
Speed	0.0555	0.0574	0.9665	0.3403
Temp	-0.1286	0.0614	-2.0963	0.0431
Truck	0.1547	0.4858	0.3185	0.7519

The relationship between temperature and measurement errors is shown in Figure 5-11. The figure includes trend line for the predicted percent error. Besides the visual assessment of the relationship, Figure 5-11 provides quantification and statistical assessment of the relationship.

The quantification is provided by the value of the regression coefficient, in this case -0.1286 (in Table 5-8). This means, for example, that for a 20 degree increase in temperature, the % error is decreased by about 2.6 % (-0.1286 x 20). The statistical assessment of the relationship is provided by the probability value of the regression coefficient.

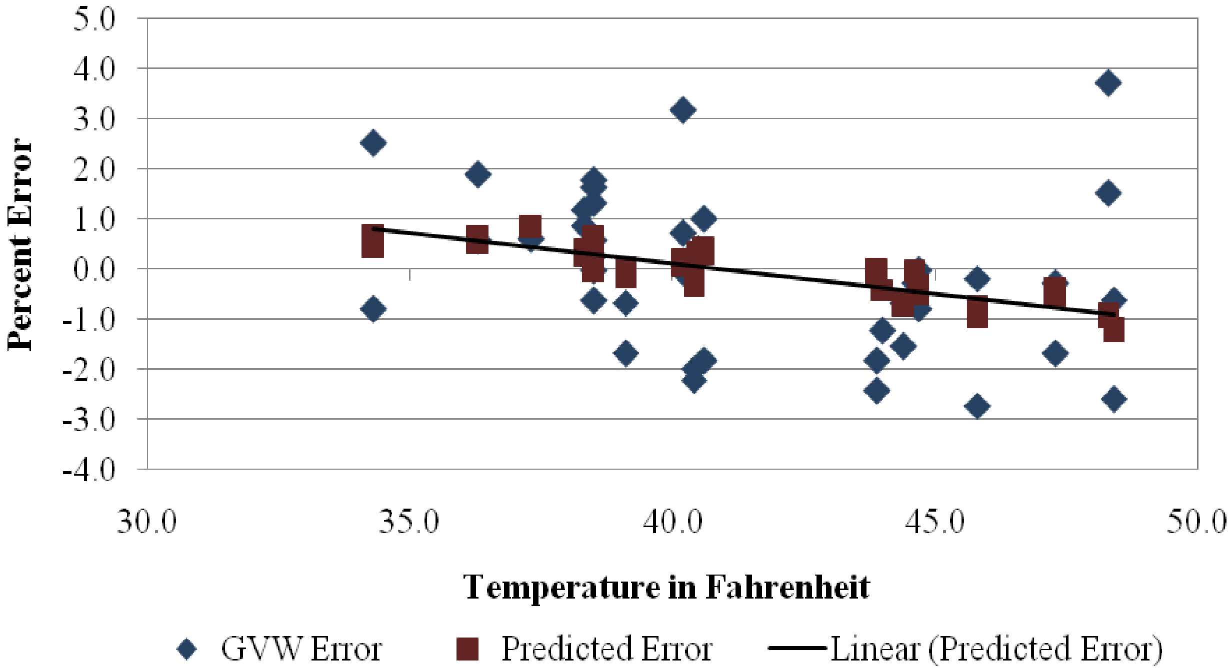


Figure 5-11 – Influence of Temperature on the Measurement Error of GVW

The effect of speed on GWV was not statistically significant. The probability that the regression coefficient for speed (0.05546 in Table 5-8) is not different from zero was 0.3403. In other words, there is about 34 percent chance that the value of the regression coefficient is due to the chance alone. The site did not exhibit sensitivity to truck type.

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.

5.1.4.3 Summary Results

Table 5-9 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 5-9 indicates that the relationship was not statistically significant (the probability that the relationship can occur by chance alone was greater than 20 percent).

Table 5-9 – Summary of Regression Analysis

	Factor					
	Speed		Temperature		Truck type	
Weight, % error	Regression coefficient	Probability value	Regression coefficient	Probability value	Regression coefficient	Probability value
GVW	-	-	-0.1286	0.0431	-	-
Steering axle	-0.1310	0.1683	-0.2069	0.0450	-	-
Tandem axle tractor	-0.1417	0.0401	-0.0981	0.1765	2.3029	0.0002
Tandem axle trailer	0.2788	0.0076	-	-	-	-

5.1.4.4 Conclusions

1. Truck type had statistically significant effect on only measurement errors of weights of tandem axles on tractors.

2. Although speed had statistically significant effect on measurement errors of steering axle and tandem axle weights, it was insignificant for GVW measurement errors. This due to the fact that the effect of speed was negative for steering axles and tandem axles on tractors, but positive for tandem axles on trailers (the signs of the corresponding regression coefficients were both positive and negative).

3. Temperature had statistically significant effect on measurement errors of GVW and steering axle weights.

4. Although the effects of speed, temperature, and truck type had statistically significant impacts on some of the measurement errors, these impacts are small and do not have practical significance.

5.2 Calibration

The pre-validation study demonstrated that the site is currently providing high-quality research-type traffic loading data. In addition, the average weight measurement errors are close to zero. For example, the average measurement error was +0.1 percent for the primary truck and -0.2 percent and for the secondary truck. Consequently, considering the uncertainty that can be introduced by even marginal changes to the calibration factors, no calibration changes are recommended and none were made. Since no changes were made to any of the speed or distance compensation factors, a post-validation classification and speed study was not carried out.

5.3 Post Visit Applied Calibration

The 85th percentile speed for trucks, based on the CDS data, is 65 mph, 5 mph above the posted speed limit of 60 mph. Consequently, the use of applied calibration was utilized to determine if recommendations for changes to the 60 and 65 mph speed point compensation factors will be made.

Figure 5-12 is provided to illustrate the predicted GVW error with respect to the post-validation errors by speed. This provides a reasonable expectation for the applied errors.

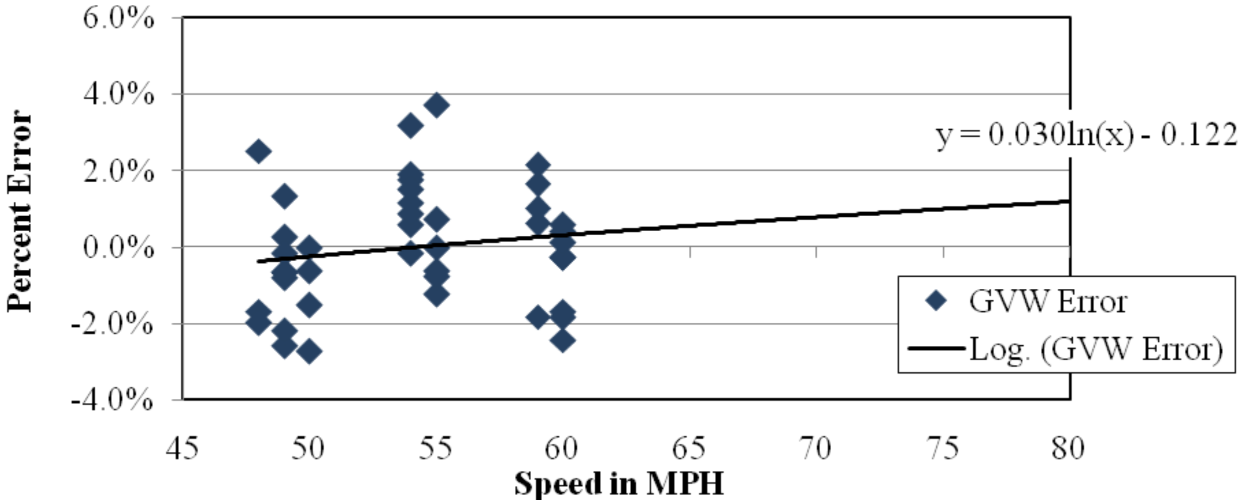


Figure 5-12 – GVW Error Trend

Pre-validation and pre- and post-visit front axle and GVW averages for Class 9 trucks were compared with the most recent data comparison set and the errors were plotted in Figure 5-13.

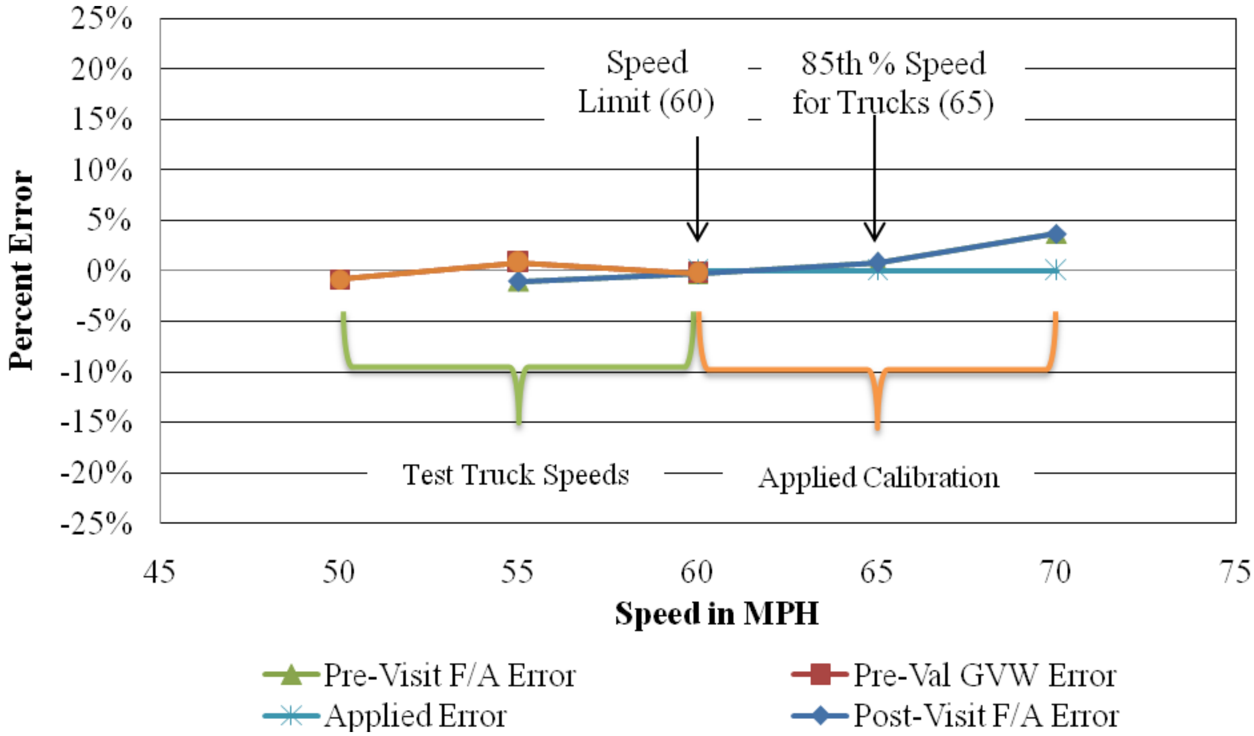


Figure 5-13 – Applied Calibration

Based on these errors and the GVW error trend developed from the post-validation test truck runs and shown in Figure 5-13, applied errors were calculated and are given in Table 5-10.

Table 5-10 – Recommended Factor Changes from Applied Error

Speed Point	Speed	Old Factors		Applied Error	New Factors	
		Left	Right		Left	Right
60	37	3127	3127	0.0%	3127	3127
65	40	3046	3046	0.0%	3046	3046
70	44	3050	3050	0.0%	3050	3050

Considering the parameters left in place at the conclusion of the post-validation on November 04, 2010, along with the post-visit applied calibration recommendations shown above, the final factor recommendations are provided in Table 5-11. As shown in the table, applied calibration was not recommended for the 60 to 70 mph speed points. The final factors left in place at the conclusion of the validation are provided in the table.

Table 5-11 – Recommended Final Speed Factors

Speed Point	Speed	Old Factors		Applied Error	New Factors	
		Left	Right		Left	Right
50	31	3328	3207	0.0%	3328	3207
55	34	3328	3207	0.0%	3328	3207
60	37	3244	3127	0.0%	3244	3127
65	40	3161	3046	0.0%	3161	3046
70	44	3194	3050	0.0%	3194	3050

6 Previous WIM Site Validation Information

The information reported in this section provides a summary of the performance of the WIM equipment since it was installed or since the first validation was performed on the equipment. The information includes historical data on weight and classification accuracies as well as a comparison of post-validation results.

6.1 Sheet 16s

This site has validation information from one previous visit as well as the current one as summarized in the tables below. Table 6-1 data was extracted from the most recent previous 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	
3-Sep-08	100	8	0	0	0	0	0	0	N/A	0	0
4-Sep-08	N/A	6	0	0	25	0	0	0	N/A	N/A	0
4-Nov-10	N/A	6	0	0	0	0	N/A	N/A	N/A	N/A	0

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

Table 6-2 – Weight Validation History

Date	Mean Error and (SD)		
	GVW	Single Axles	Tandem
3-Sep-08	3.7 (1.6)	1.8 (2.6)	4.2 (2.5)
4-Sep-08	-1.7 (0.8)	-0.8 (3.4)	-1.7 (2.0)
4-Nov-10	0.0 (1.6)	0.6 (2.6)	0.0 (2.5)

The weight estimate error and the variability of the weight errors appears to have remained reasonably consistent since the site was first validated. The table also demonstrates the effectiveness of the validation in bringing the weight estimations 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	
		4-Sep-08	4-Nov-10
Single Axles	±20 percent	-0.8 ± 3.4	0.6 ± 2.6
Tandem Axles	±15 percent	-1.7 ± 2.0	0.0 ± 2.5
GVW	±10 percent	-1.7 ± 0.8	0.0 ± 1.6

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

Indiana, SPS-6
SHRP ID: 180600

Validation Date: November 4,, 2010
Submitted: 11/9/10


Photo 1 - Cabinet Exterior


Photo 2 - Cabinet Interior (Back)

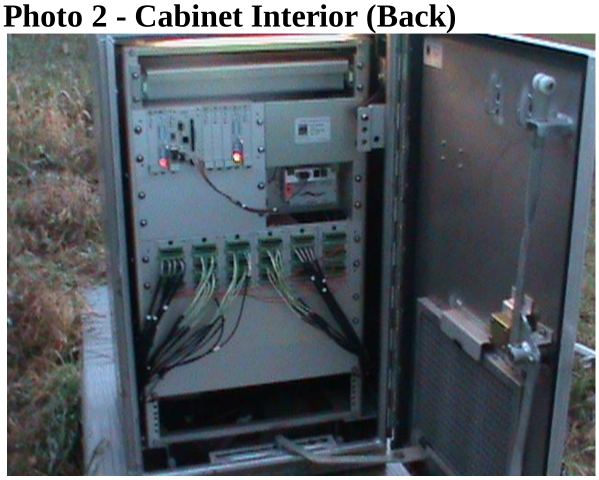


Photo 3 - Cabinet Interior (Front)


Photo 4 - Leading Loop


Photo 5 - Leading WIM Sensor


Photo 6 – Trailing WIM Sensor

Photo 7 - Trailing Loop Sensor

Photo 8 – Power Box

Photo 9 – Telephone Pedestal

Photo 10 - Downstream

Photo 11 - Upstream

Photo 12 – Broken Epoxy – Leading WIM Sensor

Photo 13 – Broken Epoxy – Trailing WIM Sensor

Photo 14 – Truck 1

Photo 15 – Truck 1 Tractor

Photo 16– Truck 1 Trailer and Load

Photo 17 – Truck 1 Suspension 1

Photo 18 - Truck 1 Suspension 2/3

Photo 19 - Truck 1 Suspension 4/5

Photo 20 – Truck 2

Photo 21 – Truck 2 Tractor

Photo 22 – Truck 2 Trailer and Load

Photo 23 – Truck 2 Suspension 1

Photo 24 - Truck 2 Suspension 2/3

Photo 25 - Truck 2 Suspension 4/5

Traffic Sheet 16 LTPP MONITORED TRAFFIC DATA SITE CALIBRATION SUMMARY	STATE CODE: 18 SPS WIM ID: 180600 DATE (mm/dd/yyyy) 11/3/2010

SITE CALIBRATION INFORMATION

1. DATE OF CALIBRATION {mm/dd/yy} 11/3/10

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 -

Dynamic and Static GVW:	0.0%	Standard Deviation:	1.6%
Dynamic and Static Single Axle:	0.6%	Standard Deviation:	2.6%
Dynamic and Static Double Axles:	0.0%	Standard Deviation:	2.5%

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

9. DEFINE SPEED RANGES IN MPH:

			Low		High	Runs
a.	Low	-	48.0	to	52.0	15
b.	Medium	-	52.1	to	56.1	14
c.	High	-	56.2	to	60.0	13
d.	0	-		to		
e.	0	-		to		

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10. CALIBRATION FACTOR (AT EXPECTED FREE FLOW SPEED) 3201 | 3057

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:

Manual

13. METHOD TO DETERMINE LENGTH OF COUNT: Number of Trucks

14. MEAN DIFFERENCE IN VOLUMES BY VEHICLES CLASSIFICATION:

FHWA Class 9:	0.0	FHWA Class	______	-	______
FHWA Class 8:	40.0	FHWA Class	______	-	______
		FHWA Class	______	-	______
		FHWA Class	______	-	______

Percent of "Unclassified" Vehicles: 0.0%

Validation Test Truck Run Set - Pre

Person Leading Calibration Effort: **Dean Wolf**

Contact Information: Phone: 717-512-6638

E-mail: dwolf@ara.com

Traffic Sheet 20	STATE CODE:	18
LTPP MONITORED TRAFFIC DATA	SPS WIM ID:	180600
SPEED AND CLASSIFICATION STUDIES	DATE (mm/dd/yyyy)	11/3/2010

WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class
60	7	9718	60	7	62	9	11125	62	9
59	9	9740	59	9	61	8	11140	60	8
61	9	9806	62	9	64	5	11147	65	5
59	9	9821	59	9	60	9	11171	61	9
65	9	9845	64	9	60	9	11175	62	9
57	5	9857	59	5	63	9	11188	63	9
67	8	9860	61	5	61	9	11193	60	9
59	5	9881	59	5	60	9	11207	59	9
60	9	9888	59	9	58	5	11218	58	5
60	9	9891	57	9	64	6	11244	63	6
65	5	9905	62	5	65	5	11275	66	5
60	9	9912	60	9	64	9	11276	65	9
60	5	9924	60	5	62	9	11289	62	9
62	9	9943	62	9	62	8	11297	62	3
64	8	9958	64	8	63	9	11306	64	9
64	5	9974	64	5	62	5	11320	62	5
64	9	9984	64	9	60	9	11339	60	9
62	7	9987	63	7	64	9	11346	64	9
59	7	10001	59	7	62	9	11354	62	9
62	8	10006	61	8	61	9	11361	62	9
61	9	10029	61	9	62	9	11363	63	9
63	9	10038	63	9	64	9	11366	65	9
63	9	10046	64	9	65	9	11369	63	9
63	5	10060	63	5	64	9	11370	64	9
61	9	10063	62	9	64	9	11373	63	9

Validation Test Truck Run Set - Pre

Sheet 1 - 0 to 50   Start: 10:57:00   Stop:

Recorded By: djw   Verified By: sk

Traffic Sheet 20	STATE CODE:	18
LTPP MONITORED TRAFFIC DATA	SPS WIM ID:	180600
SPEED AND CLASSIFICATION STUDIES	DATE (mm/dd/yyyy)	11/3/2010

WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class
63	9	11402	65	9	64	5	11605	63	5
64	9	11405	64	9	59	9	11609	61	9
64	5	11409	61	5	63	9	11616	63	9
57	5	11413	58	5	62	7	11625	63	7
60	9	11420	61	9	53	5	11663	52	5
62	9	11423	63	9	61	9	11666	62	9
63	9	11435	63	9	62	9	11667	62	9
60	9	11443	60	9	62	9	11673	61	9
64	9	11453	64	9	59	9	11678	60	9
64	5	11462	64	3	62	9	11692	62	9
64	9	11471	63	9	64	9	11700	64	9
62	9	11472	62	9	62	9	11710	62	9
62	9	11473	64	9	64	9	11716	63	9
60	9	11478	60	9	63	9	11722	64	9
60	8	11479	61	8	62	9	11727	64	9
63	7	11484	60	7	60	6	11752	61	6
60	9	11512	62	9	59	9	11754	61	9
66	5	11523	67	5	62	8	11784	63	8
62	9	11527	63	9	62	9	11787	61	9
64	9	11532	64	9	61	9	11789	63	9
60	9	11537	61	9	64	9	11820	67	9
59	9	11550	60	9	62	9	11822	63	9
63	9	11557	62	9	62	9	11837	61	9
62	7	11573	61	7	62	5	11839	60	5
63	9	11603	63	9	63	5	11846	63	5

Validation Test Truck Run Set - Pre

Sheet 2 - 51 to 100 Start: Stop: 14:02:12

Recorded By: djw Verified By: sk

Traffic Sheet 20 LTPP MONITORED TRAFFIC DATA SPEED AND CLASSIFICATION STUDIES	STATE CODE: SPS WIM ID: DATE (mm/dd/yyyy)	18 180600 11/3/2010

WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class
62	9	11862	65	9					
64	9	11866	64	9					

Validation Test Truck Run Set - Pre

Sheet 101 - 150 Start: 14:03:20 Stop: 14:03:56

Recorded By: djw Verified By: sk