WIM System Field Calibration and Validation Summary Report

New Mexico SPS-5
SHRP ID – 350500

Validation Date: January 13, 2011
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1 Executive Summary

A WIM validation was performed on January 12 and 13, 2011 at the New Mexico SPS-5 site located on route I-10 at milepost 50.2, .26 miles east of the SR 146 interchange.

This site was installed on April 30, 2008. The in-road sensors are installed in the eastbound lane. The site is equipped with quartz WIM sensors and an 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 August 19, 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 appears to be in working order. However, electronic and electrical checks of the WIM components determined that the right section of the trailing sensor was operating below manufacturer's tolerances and was providing low front axle weights when trucks traversed that section of the sensor. Further equipment discussion is provided in Section 3.

During the on-site pavement evaluation, no pavement deficiencies 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 – Pre-Validation Results – 13-Jan-11

Parameter	**95% Confidence Limit of Error**	**Site Values**	**Pass/Fail**
Steering Axles	±20 percent	-3.2 ± 8.8%	Pass
Tandem Axles	±15 percent	-0.9 ± 7.0%	Pass
GVW	±10 percent	-1.3 ± 5.9%	Pass
Vehicle Length	±3 percent (1.9 ft)	0.1 ± 0.8 ft	Pass
Axle Length	± 0.5 ft [150mm]	-0.2 ± 0.3 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 ± 1.2 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 1.0% from the 100 truck sample (Class 4 – 13) was due to one Class 5 vehicle being identified by the WIM system as a Class 8 vehicle.

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 a crane counterweightsr.

- The *Secondary* truck was a Class 9 vehicle with steel spring suspension on the tractor tandem, steel spring on the trailer tandem, standard tandem spacing on the tractor and standard tandem on the trailer. The Secondary truck was loaded with train car trucks.

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 pre-validation test truck weights and measurements are provided in Table 1-2.

Table 1-2 – Pre-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	75.6	9.8	16.5	16.5	16.4	16.4	15.9	4.3	36.0	5.0	61.2	71.0
2	65.6	11.4	14.6	14.6	12.6	12.6	17.9	4.3	27.3	4.1	53.6	58.0

The posted speed limit at the site is 75 mph. During the testing, the speed of the test trucks ranged from to 51 to 75 mph, a variance of 24 mph.

During test truck runs, pavement temperature was collected using a hand-held infrared temperature device. The post-validation pavement surface temperatures varied from 37.5 to 70.0 degrees Fahrenheit, a range of 32.5 degrees Fahrenheit. The sunny weather conditions provided for achieving the desired 30 degree range in temperatures.

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 December 13, 2010 (Data) to the most recent Comparison Data Set (CDS) from August 04, 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

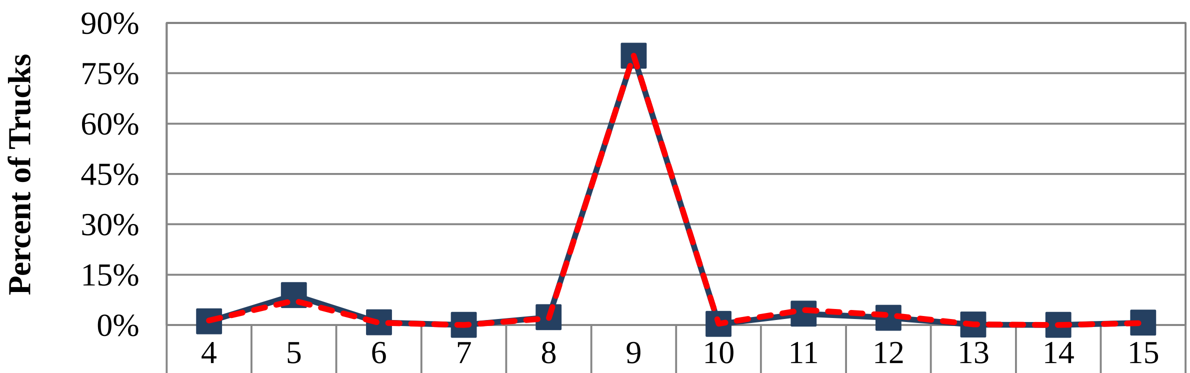
A review of the LTPP Standard Release Database 24 shows that there are 22 consecutive months of level "E" WIM data for this site. This site requires 3 additional years of data to meet the minimum of five years of research quality data. Table 2-1 provides a breakdown of the available data for years 2008 and 2009.

Table 2-1 – LTPP Data Availability

Year	Total Number of Days in Year	Number of Months
2008	275	10
2009	355	12

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.



	4	5	6	7	8	9	10	11	12	13	14	15
Data	1.1%	8.9%	0.8%	0.0%	2.3%	80.3%	0.3%	3.4%	2.2%	0.1%	0.0%	0.7%
CDS	1.3%	7.2%	0.6%	0.0%	2.0%	80.3%	0.4%	4.5%	2.9%	0.1%	0.0%	0.5%

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 (80.3%) and Class 5 (8.9%). It also indicates that 0.7 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 therefore 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.

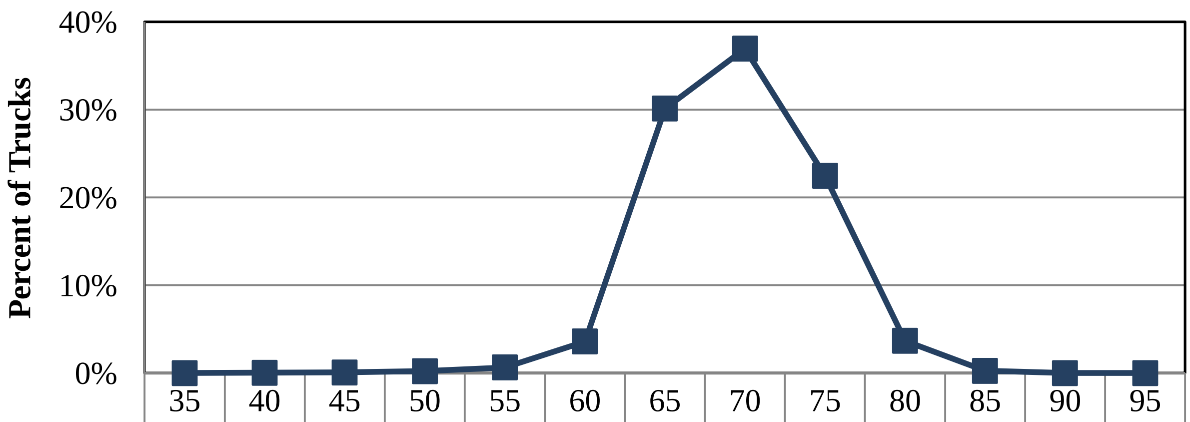
Table 2-2 – Truck Distribution from W-Card

Vehicle Classification	CDS		Data		Change
	Date				
	8/4/2008		12/13/2010		
4	719	1.3%	631	1.1%	-0.2%
5	3978	7.2%	5295	8.9%	1.7%
6	352	0.6%	463	0.8%	0.1%
7	5	0.0%	6	0.0%	0.0%
8	1112	2.0%	1383	2.3%	0.3%
9	44347	80.3%	47795	80.3%	-0.1%
10	229	0.4%	191	0.3%	-0.1%
11	2461	4.5%	2012	3.4%	-1.1%
12	1623	2.9%	1292	2.2%	-0.8%
13	79	0.1%	61	0.1%	0.0%
14	0	0.0%	0	0.0%	0.0%
15	291	0.5%	400	0.7%	0.1%

From the table it can be seen that the number of Class 9 vehicles has decreased by 0.1 percent from August 2008 and December 2010. Small decreases in the number of heavier trucks may be attributed to seasonal variations in truck distributions. During the same time period, the number of Class 5 trucks increased by 1.7 percent. These differences may be attributed to small sample size used to develop vehicle class distributions, changes in the 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 information provides a basis for the speed of the test trucks during validation testing. The CDS distribution of speeds is shown in Figure 2-2.



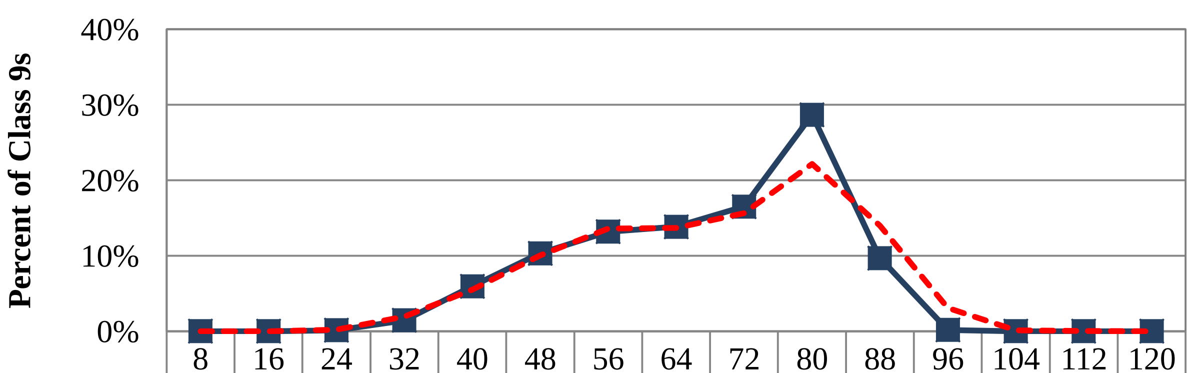
	35	40	45	50	55	60	65	70	75	80	85	90	95
Data	0.0%	0.0%	0.1%	0.2%	0.6%	3.6%	30.1	36.9	22.5	3.7%	0.3%	0.0%	0.0%

Figure 2-2 – Truck Speed Distribution – 31-Dec-10

As shown in Figure 2-2, the majority of the trucks at this site are traveling between 65 and 75 mph. The posted speed limit at this site is 75 and the 85th percentile speed for trucks at this site is 72 mph. The range of truck speeds for the validation will be 55 and 75 mph.

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 December 2010 and the Comparison Data Set from August 2008.



	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
Data	0.0%	0.0%	0.1%	1.5%	6.0%	10.3	13.2	13.8	16.5	28.7	9.7%	0.2%	0.0%	0.0%	0.0%
CDS	0.0%	0.0%	0.2%	2.0%	5.5%	10.0	13.6	13.7	15.6	22.2	14.0	3.1%	0.1%	0.0%	0.0%

Figure 2-3 – Comparison of Class 9 GVW Distribution

As shown in Figure 2-3, there is an increase in the loaded peaks and a decrease in the subsequent heavy weight ranges between the August 2008 Comparison Data Set (CDS) and the December 2010 two-week sample W-card dataset (Data). The results indicate possible drifting in WIM weight measurement accuracy.

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

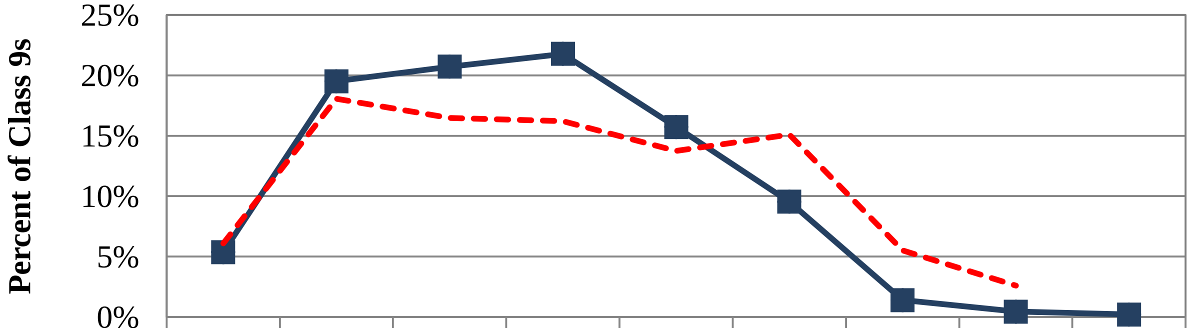
GVW weight bins (kips)	CDS		Data		Change
	Date				
	8/4/2008		12/13/2010		
8	0	0.0%	0	0.0%	0.0%
16	0	0.0%	0	0.0%	0.0%
24	91	0.2%	61	0.1%	-0.1%
32	866	2.0%	696	1.5%	-0.5%
40	2440	5.5%	2840	6.0%	0.4%
48	4432	10.0%	4926	10.3%	0.3%
56	6013	13.6%	6286	13.2%	-0.4%
64	6044	13.7%	6597	13.8%	0.2%
72	6907	15.6%	7875	16.5%	0.9%
80	9805	22.2%	13671	28.7%	6.5%
88	6183	14.0%	4615	9.7%	-4.3%
96	1364	3.1%	80	0.2%	-2.9%
104	50	0.1%	7	0.0%	-0.1%
112	21	0.0%	4	0.0%	0.0%
120	8	0.0%	2	0.0%	0.0%
Average =	64.5		63.6		-0.9

As shown in the table, the number of unloaded class 9 trucks in the 32 to 40 kips range increased by 0.4 percent while the number of loaded class 9 trucks in the 72 to 80 kips range increased by 6.5 percent. The number of overweight trucks decreased during this time period by 7.3 percent and the overall GVW average for this site decreased from 64.5 kips to 63.6 kips.

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 from the Comparison Data Set.

Figure 2-4 shows a comparison between Class 9 front axle weight plots generated by using the two week W-card sample from December 2010 and the Comparison Data Set from August 2008.



	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0
Data	5.4%	19.5%	20.7%	21.8%	15.7%	9.5%	1.4%	0.4%	0.2%
CDS	6.1%	18.1%	16.5%	16.2%	13.7%	15.1%	5.5%	2.6%	

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 11.5 kips, and the percentage of trucks with front axles at this weight have increased between the August 2008 Comparison Data Set (CDS) and the December 2010 dataset (Data).

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

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

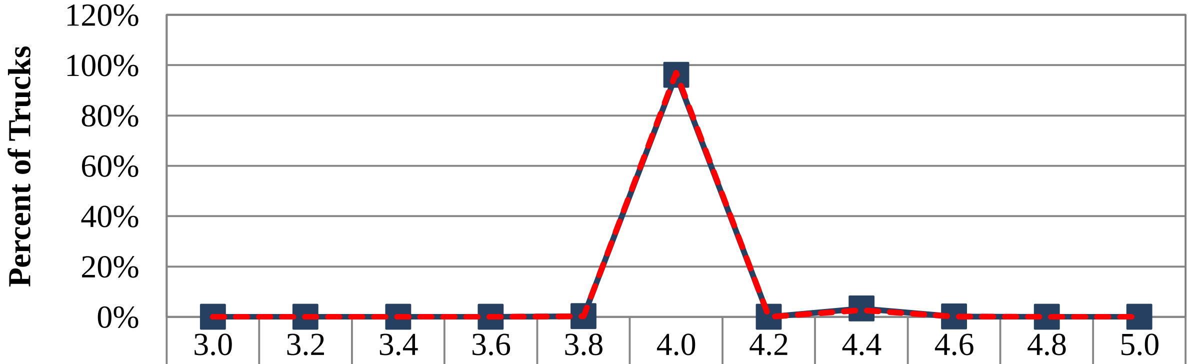
F/A weight bins (kips)	CDS		Data		Change
	Date				
	8/4/2008		12/13/2010		
10.0	2330	5.3%	2518	5.3%	0.0%
10.5	2679	6.1%	2555	5.4%	-0.7%
11.0	7941	18.1%	9283	19.5%	1.5%
11.5	7243	16.5%	9857	20.7%	4.3%
12.0	7128	16.2%	10360	21.8%	5.6%
12.5	6039	13.7%	7478	15.7%	2.0%
13.0	6644	15.1%	4540	9.5%	-5.6%
13.5	2423	5.5%	664	1.4%	-4.1%
14.0	1138	2.6%	210	0.4%	-2.1%
14.5	407	0.9%	97	0.2%	-0.7%
Average =	11.7		11.5		-0.2

The table shows that the average front axle weight for Class 9 trucks has decreased by 0.2 kips, or -1.8 percent. According to the current data, the majority of the Class 9 front axle weights are between 11.0 and 11.5 kips and the average front axle weight for Class 9 trucks is 11.5 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 from the comparison data set.

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%	0.3%	96.2%	0.0%	3.3%	0.1%	0.0%	0.0%
CDS	0.0%	0.0%	0.0%	0.0%	0.2%	97.0%	0.0%	2.7%	0.1%	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 August 2008 Comparison Data Set and the December 2010 Data are nearly identical.

Table 2-5 shows the Class 9 axle spacings between the second and third axles.

Table 2-5 – Class 9 Axle 3 to 4 Spacing from W-Card

Tandem 1 spacing bins (feet)	CDS		Data		Change
	Date				
	8/4/2008		12/13/2010		
3.0	0	0.0%	0	0.0%	0.0%
3.2	0	0.0%	3	0.0%	0.0%
3.4	17	0.0%	6	0.0%	0.0%
3.6	0	0.0%	0	0.0%	0.0%
3.8	101	0.2%	122	0.3%	0.0%
4.0	42892	97.0%	45869	96.2%	-0.7%
4.2	0	0.0%	0	0.0%	0.0%
4.4	1186	2.7%	1593	3.3%	0.7%
4.6	34	0.1%	64	0.1%	0.1%
4.8	0	0.0%	0	0.0%	0.0%
5.0	3	0.0%	3	0.0%	0.0%
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 identical to the expected average provided by the comparison data set. 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 (August 2008) based on the last calibration with the most recent two-week WIM data sample from the site (December 2010). Comparison of vehicle class distribution data indicates a 0.1 percent decrease in the number of Class 9 vehicles. Analysis of Class 9 weight data indicates that front axle weights have decreased by 0.2 percent and average Class 9 GVW has decreased by 1.4 percent for the December 2010 data. The data indicates an average truck tandem spacing of 4.0 feet, identical to the expected average of 4.0 feet provided by the comparison data set.

3 WIM Equipment Discussion

From a comparison between the report of the most recent validation of this equipment on August 19, 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 April 30, 2008 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 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 and no sensor deficiencies were noted. The number 7 Quartz sensor (right side of the trailing sensor) read below tolerances for both capacitive and resistive values. These measurements are provided on the Sheet 22 which accompanies this report in the Supplemental information packet. All values for the 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

Generally, the WIM system appeared to collect, analyze and report vehicle measurements normally. Intermittently, however, the trailing sensor would provide lower weights than expected for the steering axle. It is believed that the right wheel of the test truck's steering axle had traversed the number 7 sensor on these occasions. No troubleshooting actions were taken.

3.5 Recommended Equipment Maintenance

It is recommended that further investigation into the low readings for the number 7 sensor be performed. It is expected that this sensor will be disabled from the configuration.

4 Pavement Discussion

4.1 Pavement Condition Survey

During a visual distress survey of the pavement conducted from the shoulder, no areas of pavement distress that may affect the accuracy of the WIM sensors were noted.

4.2 Profile and Vehicle Interaction

Profile data was collected on April 23, 2010 by the Southern 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 140 in/mi and is located approximately 490 feet prior to the WIM scale. The highest IRI value within the 400 foot approach section was 129 in/mi and is located approximately 325 feet prior to the WIM scale. These areas of pavement were closely investigated during the validation visit, and 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 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)	0.901	0.915	1.047			0.954
		SRI (m/km)	0.584	*0.484*	0.822			0.630
		Peak LRI (m/km)	**0.901**	**0.924**	**1.047**			**0.957**
		Peak SRI (m/km)	0.669	0.564	0.991			0.741
	RWP	LRI (m/km)	0.706	0.710	0.600			0.672
		SRI (m/km)	0.810	0.718	0.680			0.736
		Peak LRI (m/km)	0.714	0.710	0.600			0.675
		Peak SRI (m/km)	0.844	0.797	*0.701*			0.781
Center	LWP	LRI (m/km)	0.668	0.698	0.650	0.689	0.734	0.676
		SRI (m/km)	1.005	0.686	0.715	0.898	0.856	0.826
		Peak LRI (m/km)	0.679	0.704	0.650	0.693	0.737	0.682
		Peak SRI (m/km)	1.053	*0.733*	0.768	0.914	0.876	0.867
	RWP	LRI (m/km)	0.542	0.553	0.596	0.576	0.600	0.567
		SRI (m/km)	0.585	0.712	0.640	0.518	0.545	0.614
		Peak LRI (m/km)	0.609	0.553	0.596	0.616	0.601	0.594
		Peak SRI (m/km)	*0.611*	*0.713*	*0.676*	*0.611*	*0.696*	*0.653*
Right	LWP	LRI (m/km)	0.533	0.564	0.614			0.570
		SRI (m/km)	0.577	0.576	*0.473*			0.542
		Peak LRI (m/km)	0.533	0.564	0.616			0.571
		Peak SRI (m/km)	*0.579*	*0.597*	*0.542*			*0.573*
	RWP	LRI (m/km)	0.693	0.615	0.528			0.612
		SRI (m/km)	*0.472*	0.593	*0.421*			*0.495*
		Peak LRI (m/km)	0.693	0.615	0.556			0.621
		Peak SRI (m/km)	0.849	0.784	*0.479*			*0.704*

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, which are italicized in the table. The highest values, on average, are the Peak LRI values in the left wheel path of the left shift passes, which are bolded in the table.

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 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, if required, 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 40 pre-validation test truck runs were conducted on January 12, 2011, beginning at approximately 8:24 AM and continuing until 6:00 PM.

The two test trucks consisted of:

- A Class 9 truck, loaded with crane counterweights, 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 train car trucks, and equipped with steel spring suspension on the tractor, steel spring suspension on the trailer, with standard tandem spacing on the tractor and 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	75.6	9.8	16.5	16.5	16.4	16.4	15.9	4.3	36.0	5.0	61.2	71.0
2	65.6	11.4	14.6	14.6	12.6	12.6	17.9	4.3	27.3	4.1	53.6	58.0

Test truck speeds varied by 24 mph, from 51 to 75 mph. The measured pre-validation pavement temperatures varied 32.5 degrees Fahrenheit, from 37.5 to 70.0. The sunny weather conditions provided for achieving the desired 30 degree temperature range. Table 5-2 provides a summary of the pre-validation results.

Table 5-2 – Pre-Validation Overall Results – 13-Jan-11

Parameter	95% Confidence Limit of Error	Site Values	Pass/Fail
Steering Axles	±20 percent	-3.2 ± 8.8%	Pass
Tandem Axles	±15 percent	-0.9 ± 7.0%	Pass
GVW	±10 percent	-1.3 ± 5.9%	Pass
Vehicle Length	±3 percent (1.9 ft)	0.1 ± 0.8 ft	Pass
Axle Length	± 0.5 ft [150mm]	-0.2 ± 0.3 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 -0.3 ± 1.2 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 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 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 75 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 – 13-Jan-11

Parameter	95% Confidence Limit of Error	Low	Medium	High
		51.0 to 59.0 mph	59.1 to 67.1 mph	67.2 to 75.0 mph
Steering Axles	±20 percent	-4.0 ± 8.0%	-3.0 ± 11.8%	-2.6 ± 9.4%
Tandem Axles	±15 percent	-1.0 ± 7.9%	-0.7 ± 6.0%	-1.1 ± 8.1%
GVW	±10 percent	-1.5 ± 5.9%	-1.1 ± 6.0%	-1.3 ± 7.4%
Vehicle Length	±3 percent (1.9 ft)	0.1 ± 0.8 ft	0.2 ± 0.9 ft	0.0 ± 0.8 ft
Vehicle Speed	± 1.0 mph	0.1 ± 1.3 mph	-0.2 ± 0.9 mph	-0.6 ± 1.1 mph
Axle Length	± 0.5 ft [150mm]	-0.2 ± 0.3 ft	-0.2 ± 0.2 ft	-0.2 ± 0.4 ft

From the table, it can be seen that the WIM equipment underestimates steering axle weights at all speeds. The cause is probably the sensor deficiency. The equipment estimates all other 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 range in error at high speeds is lower when compared to low and medium speeds. However, there are two outlier points in the high speed range with an error of approximately -8 percent. This is probably due to the light front axle weights for the primary truck at these speeds as a result of the wheel traversing the suspect sensor. Distribution of errors is shown graphically in the following figure.

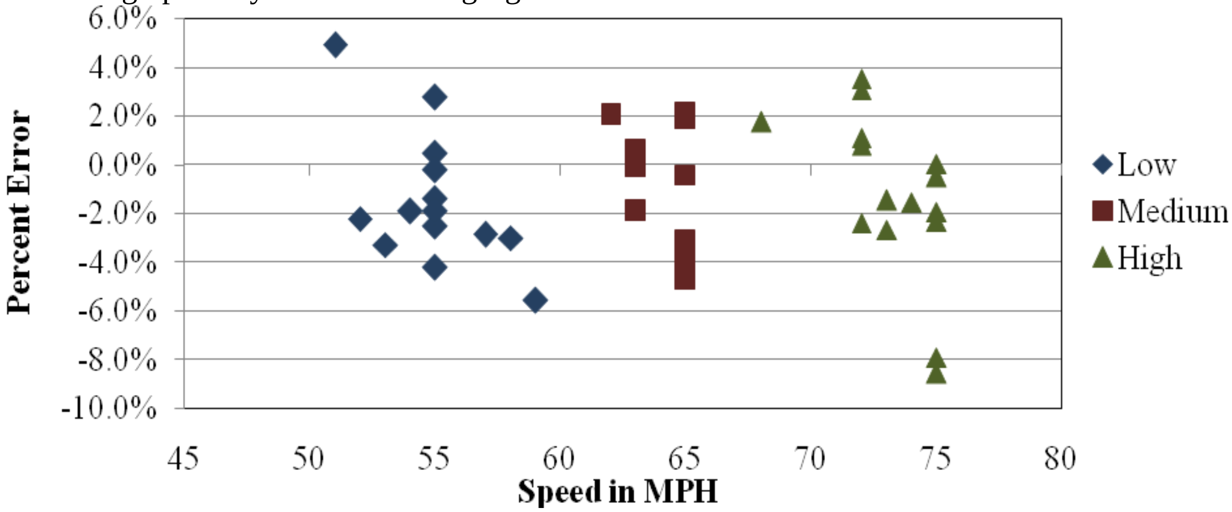


Figure 5-1 – Pre-Validation GVW Error by Speed – 13-Jan-11

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 medium and high speeds. The range in error appears to be lesser for low speeds when compared to medium and high speed ranges. Distribution of errors is shown graphically in the following figure.

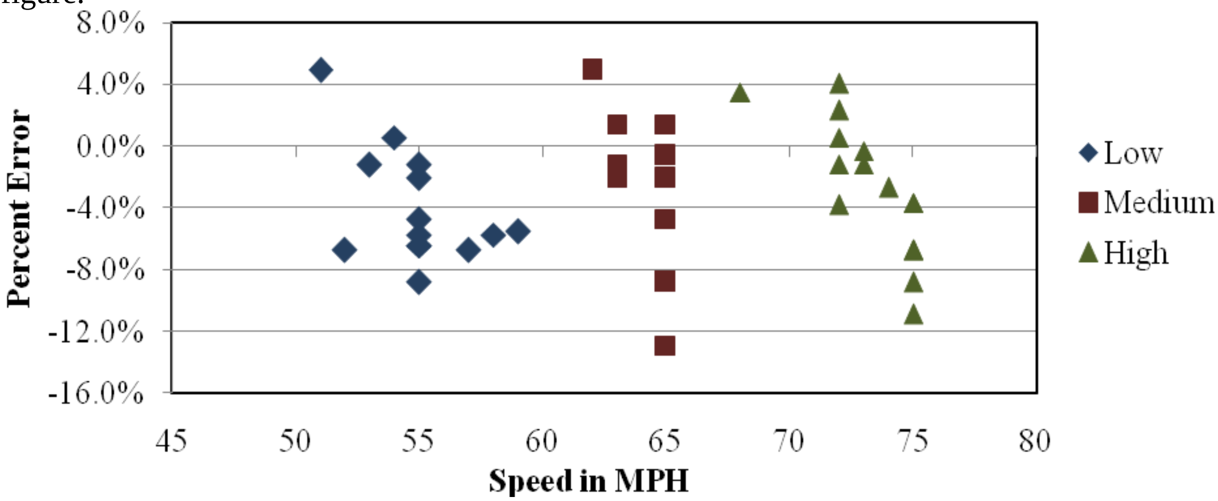


Figure 5-2 – Pre-Validation Steering Axle Weight Errors by Speed – 13-Jan-11

5.1.1.3 Tandem Axle Weight Errors by Speed

As shown in Figure 5-3, the equipment estimates tandem axle weights with different accuracy levels at various speed ranges. The range in error is lowest and medium speeds and highest at high speeds. Distribution of errors is shown graphically in the following figure.

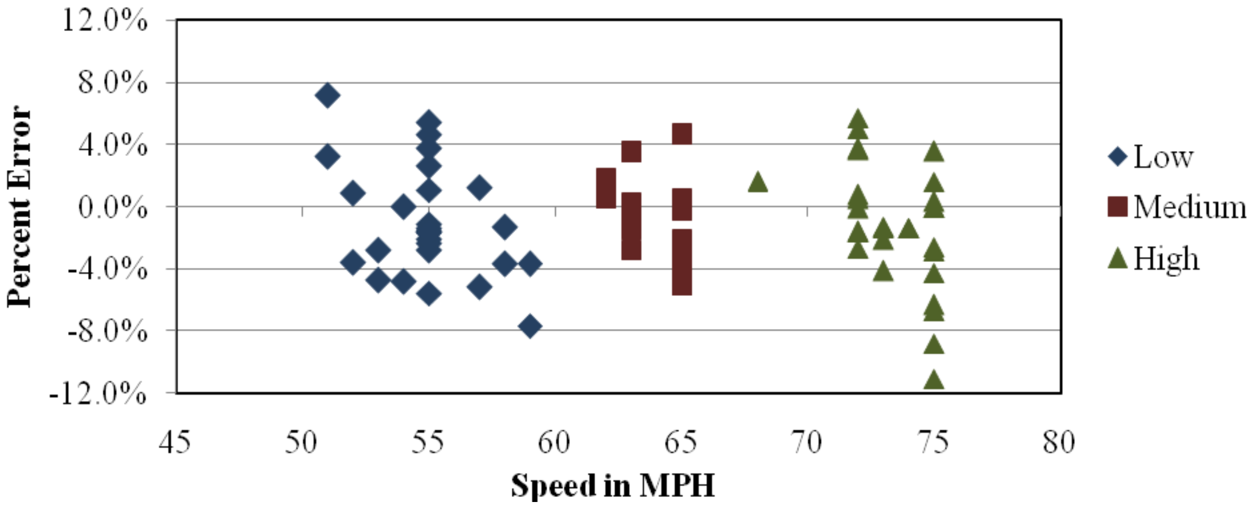


Figure 5-3 – Pre-Validation Tandem Axle Weight Errors by Speed – 13-Jan-11

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 generally underestimates GVW for the heavily loaded (Primary) truck and estimates GVW for the partially loaded (Secondary) truck with reasonable accuracy. Distribution of errors is shown graphically in Figure 5-4.

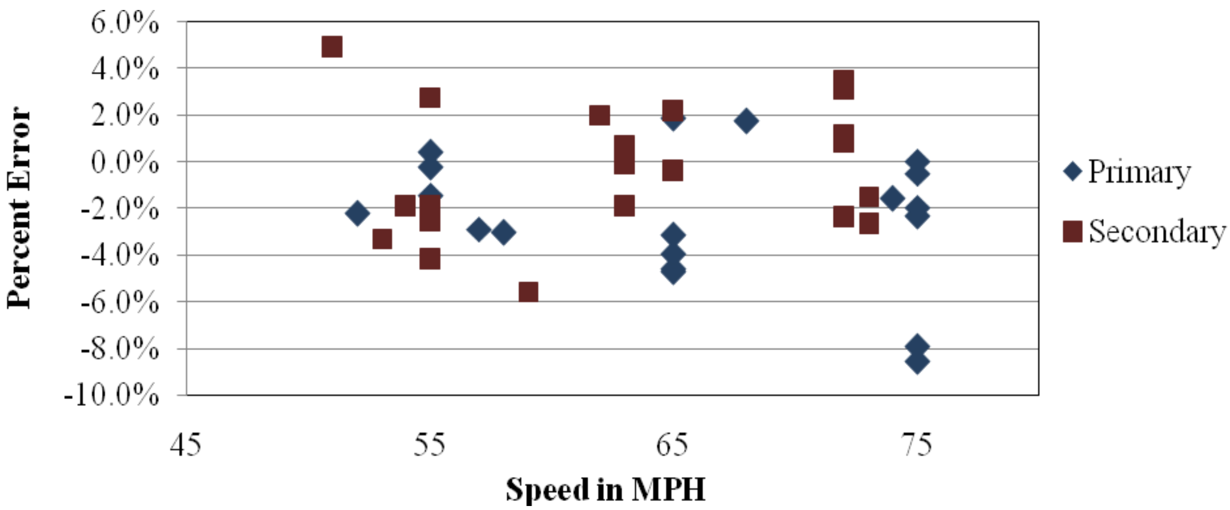


Figure 5-4 – Pre-Validation GVW Errors by Truck and Speed – 13-Jan-11

5.1.1.5 Axle Length Errors by Speed

For this site, the equipment estimated axle length with reasonable accuracy at all speeds. The range in axle length measurement error ranged from -0.5 feet to 0.1 feet. Distribution of errors is shown graphically in Figure 5-5.

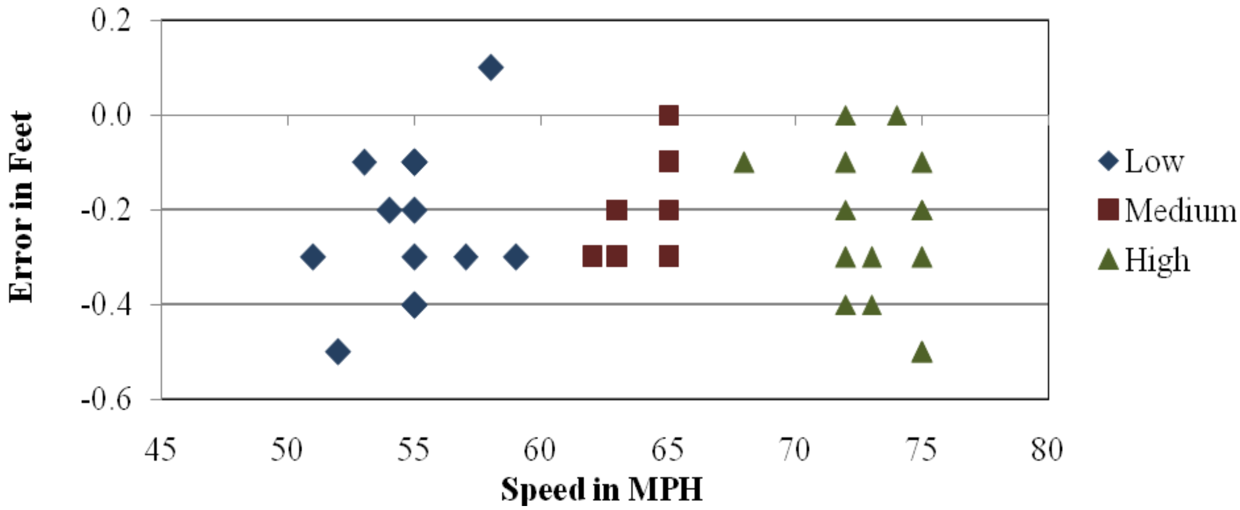


Figure 5-5 – Pre-Validation Axle Length Errors by Speed – 13-Jan-11

5.1.1.6 Overall Length Errors by Speed

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

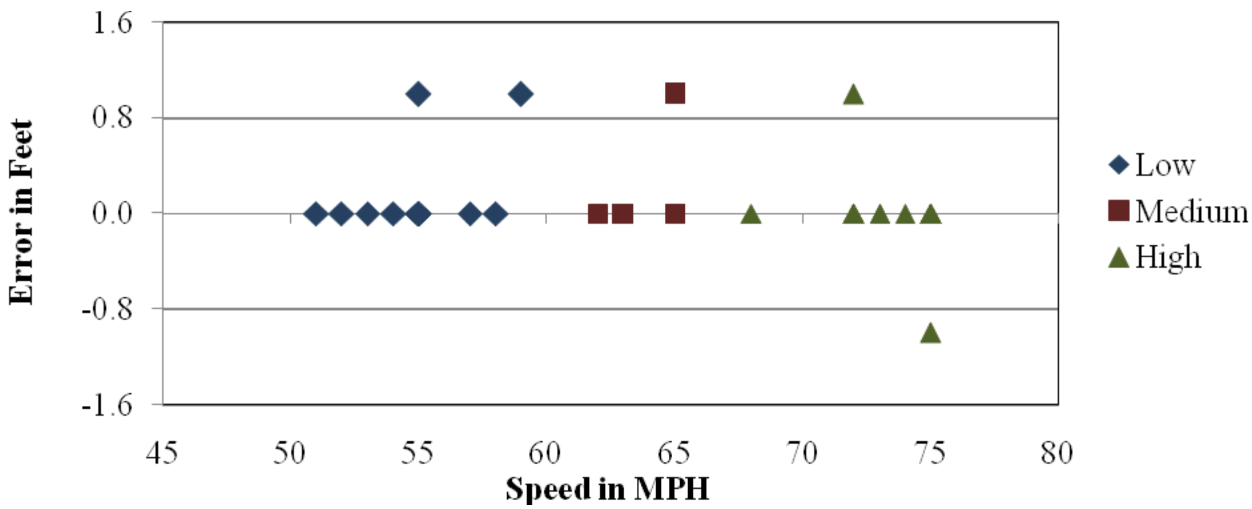


Figure 5-6 – Pre-Validation Overall Length Error by Speed – 13-Jan-11

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 32.5 degrees, from 37.5 to 70.0 degrees Fahrenheit. The pre-validation test runs are being reported under three temperature groups as shown in Table 5-4.

Table 5-4 – Pre-Validation Results by Temperature – 13-Jan-11

Parameter	**95% Confidence Limit of Error**	**Low**	**Medium**	**High**
		37.5 to 51 degF	**51.1 to 61.0 degF**	**61.1 to 70.0 degF**
Steering Axles	±20 percent	-2.3 ± 12.3%	-3.3 ± 6.5%	-4.2 ± 8.0%
Tandem Axles	±15 percent	-0.5 ± 8.5%	-1.2 ± 5.7%	-1.2 ± 8.0%
GVW	±10 percent	-0.7 ± 7.5%	-1.5 ± 4.6%	-1.8 ± 6.5%
Vehicle Length	±3 percent (1.9 ft)	0.1 ± 1.1 ft	0.2 ± 0.9 ft	0.0 ± 0.0 ft
Vehicle Speed	± 1.0 mph	-0.3 ± 1.0 mph	-0.1 ± 1.5 mph	-0.3 ± 1.4 mph
Axle Length	± 0.5 ft [150mm]	-0.3 ± 0.3 ft	-0.2 ± 0.4 ft	-0.3 ± 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 range of GVW errors is lowest at the medium temperature range when compared with the low and high temperature ranges. The positive bias in GVW is slightly greater at low temperatures when compared with the medium and high temperatures.

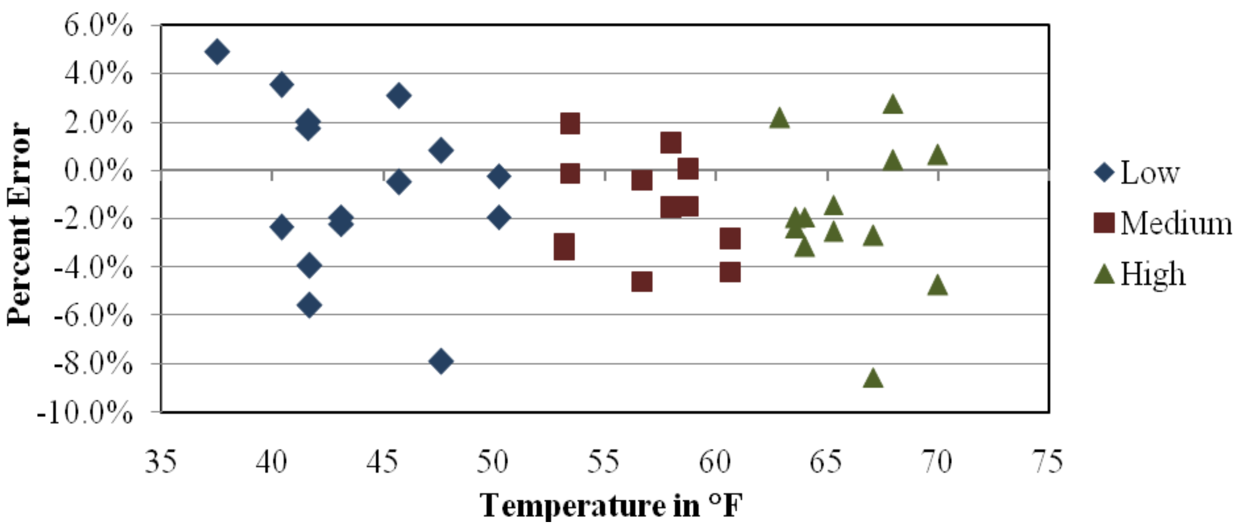


Figure 5-7 – Pre-Validation GVW Errors by Temperature – 13-Jan-11

5.1.2.2 Steering Axle Weight Errors by Temperature

Figure 5-8 demonstrates that for steering axles, the WIM equipment underestimates weights at all temperatures. Low temperatures exhibit a wider range of errors when compared with medium and high temperatures. Distribution of errors is shown graphically in the following figure.

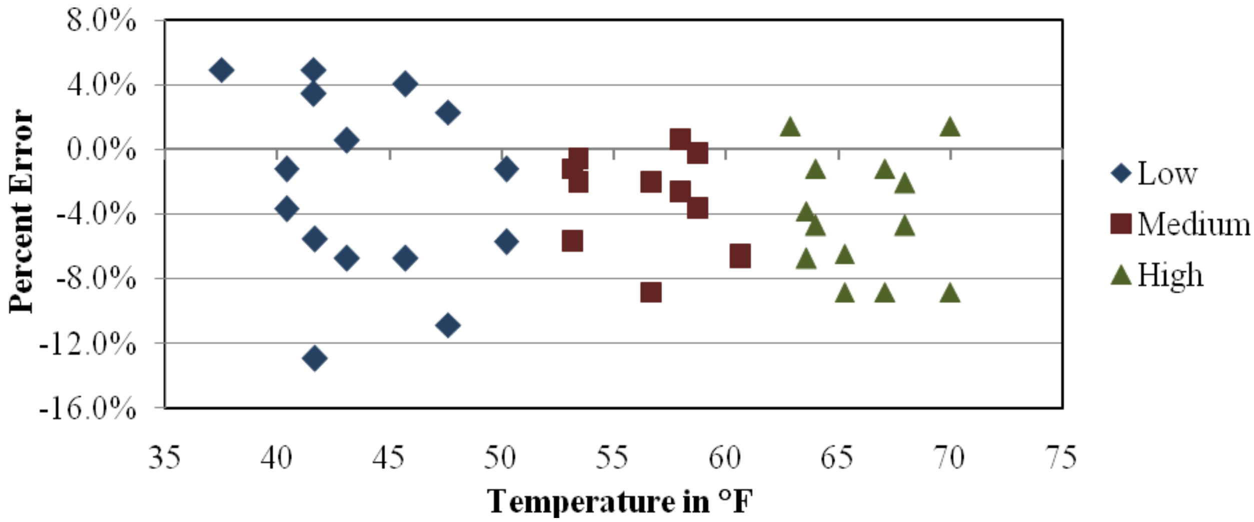


Figure 5-8 – Pre-Validation Steering Axle Weight Errors by Temperature – 13-Jan-11

5.1.2.3 Tandem Axle Weight Errors by Temperature

As shown in Figure 5-9, the range of errors is the lowest at medium temperatures when compared with low and high temperatures. Distribution of errors is shown graphically in the following figure.

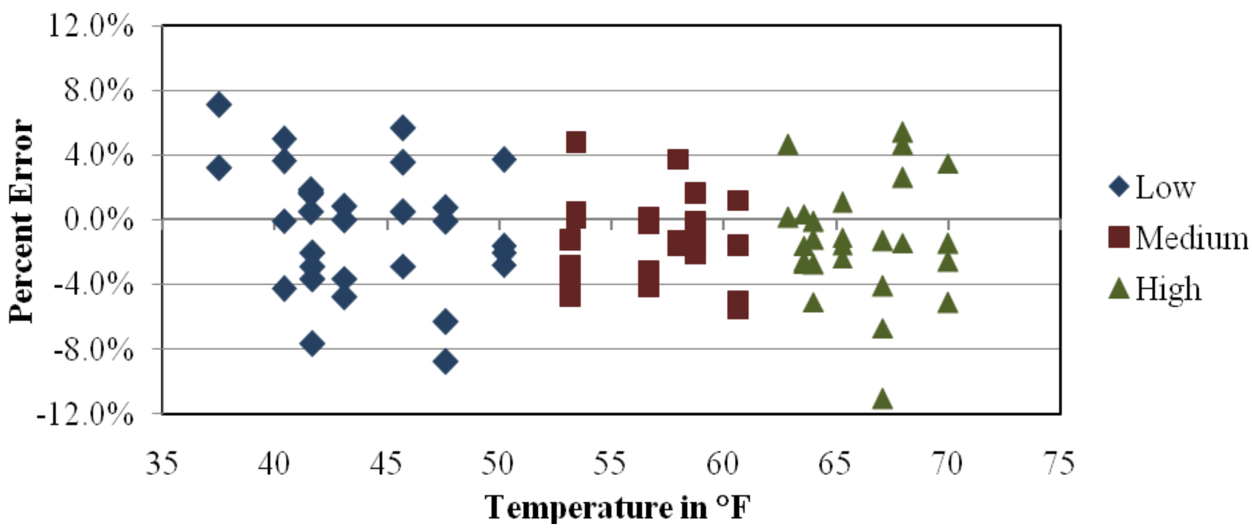


Figure 5-9 – Pre-Validation Tandem Axle Weight Errors by Temperature – 13-Jan-11

5.1.2.4 GVW Errors by Temperature and Truck Type

When analyzed for each test truck, the WIM equipment slightly underestimates GVW for the heavily loaded (Primary) truck at all temperatures, and estimates GVW for the partially loaded (Secondary) truck without apparent bias at all temperatures. Distribution of errors is shown graphically in Figure 5-10.

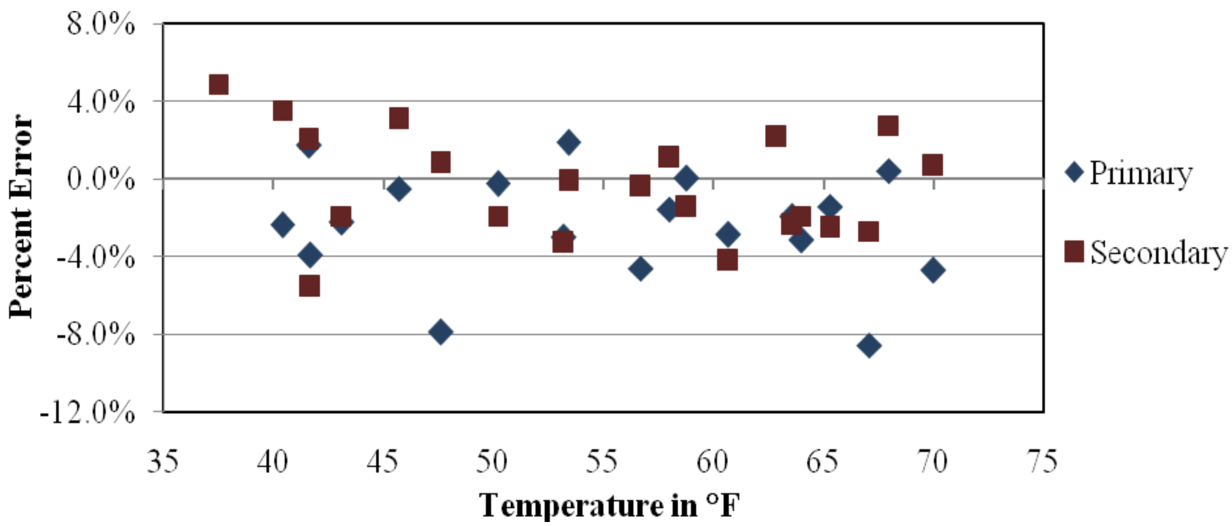


Figure 5-10 – Pre-Validation GVW Error by Truck and Temperature – 13-Jan-11

5.1.3 Multivariable Analysis

This section provides additional analysis of post-validation results using a multivariable statistical technique of multiple linear regression. 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.

5.1.3.1 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 on trailers. The separate evaluation was carried out because the tandem axles on trailers may have different dynamic response to loads than tandem axles on tractors.

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 51 to 75 mph.
- Pavement temperature. Pavement temperature ranged from 37.5 to 70.0 degrees Fahrenheit.
- Interaction between the factors such as the interaction between speed and pavement temperature.

5.1.3.2 Results

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

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

Parameter	Regression coefficients	Standard error	Value of t-distribution	Probability value
Intercept	4.2243	4.3311	0.9753	0.3359
Speed	-0.0090	0.0564	-0.1596	0.8741
Temp	-0.0625	0.0452	-1.3849	0.1746
Truck	-2.5355	0.9001	-2.8168	0.0078

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 0.0625 (in Table 5-5). This means, for example, that for a 30 degree increase in temperature, the % error is increased by about 1.9 % (0.0625 x 30). The statistical assessment of the relationship is provided by the probability value of the regression coefficient.

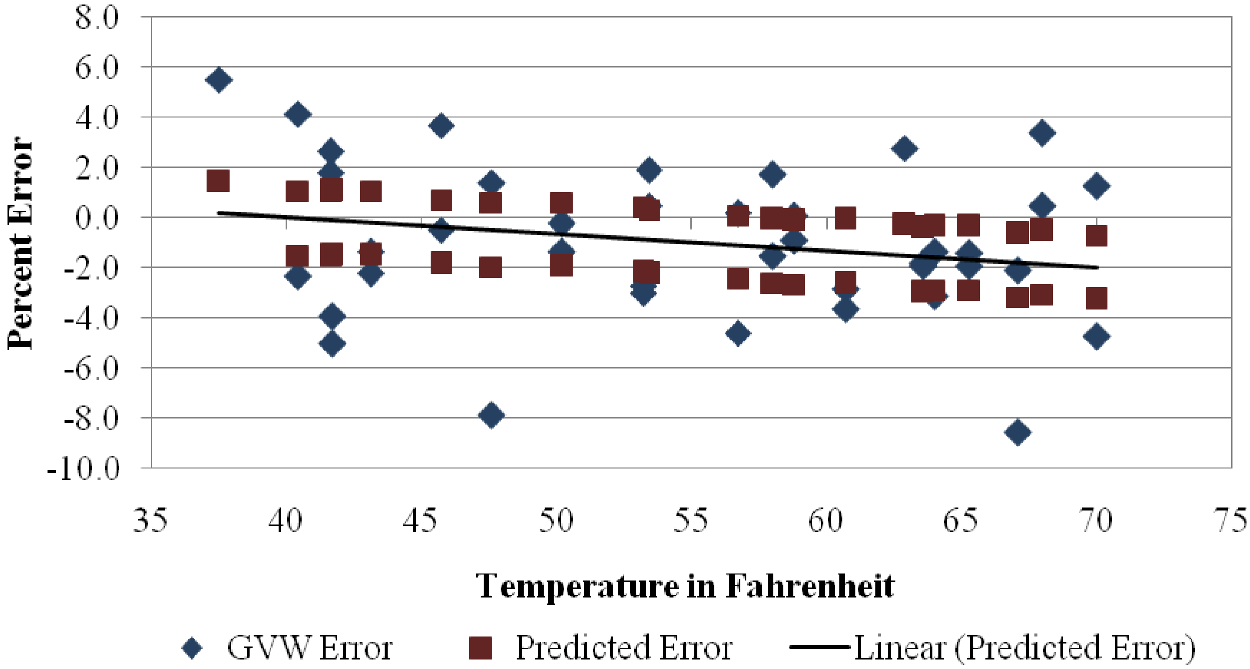


Figure 5-11 – Influence of Temperature on the Measurement Error of GVW.

The effect speed on GWV was not statistically significant. The probability that the regression coefficient for speed (-0.009 in Table 5-5) is not different from zero was 0.8741. In other words, there is about 87 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.

5.1.3.3 Summary Results

Table 5-6 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 5-6 indicates that the relationship was not statistically significant (the probability that the relationship can occur by chance alone was greater than 20 percent).

Table 5-6 – Summary of Regression Analysis

	Factor					
	Speed		Temperature		Truck type	
Weight, % error	Regression coefficient	Probability value	Regression coefficient	Probability value	Regression coefficient	Probability value
GVW	-	-	-0.0625	0.1746	-2.5355	0.0078
Steering axle	-	-	-0.1005	0.0800	-8.8964	0.0000
Tandem axle tractor	-	-	-	-	-	-
Tandem axle trailer	-	-	-	-	-3.3141	0.0070

5.1.3.4 Conclusions

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

2. Temperature had statistically significant effect on the measurement error of steering axle weights only.

3. Truck type had statistically significant effect on the measurement errors of GVW, steering axle weight, and the weight of tandem axles on trailers. The value of the regression coefficient for truck type in Table 5-6, 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 2.5 % larger than the error for the primary truck.

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

5.1.4 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 100 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 5-7 illustrates the breakdown of vehicles observed and identified by the WIM equipment for the manual classification study.

Table 5-7 – Pre-Validation Classification Study Results – 13-Jan-11

Class	4	5	6	7	8	9	10	11	12	13
Observed Count	1	4	2	0	2	89	0	0	2	0
WIM Count	1	3	2	0	3	89	0	0	2	0
Observed Percent	1	4	2	0	2	89	0	0	2	0
WIM Percent	1	3	2	0	3	89	0	0	2	0
Misclassified Count	0	1	0	0	0	0	0	0	0	0
Misclassified Percent	0	25	0	N/A	0	0	N/A	N/A	0	N/A
Unclassified Count	0	0	0	0	0	0	0	0	0	0
Unclassified Percent	0	0	0	N/A	0	0	N/A	N/A	0	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. In the table above, it can be seen that one Class 5 vehicle was misclassified as a Class 8 by the WIM equipment. This resulted in an overcount of one Class 8 vehicle and an undercount of one Class 5 vehicle. The misclassified percentage represents the percentage of the misclassified vehicles in the manual sample. The misclassifications by pair are provided in Table 5-8.

Table 5-8 – Pre-Validation Misclassifications by Pair – 13-Jan-11

Observed/ WIM	Number of Pairs	Observed/ WIM	Number of Pairs	Observed/ WIM	Number of Pairs
3/5	0	5/9	0	9/5	0
3/8	0	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 1.0%.

As shown in the table, one vehicle was misclassified by the equipment. The misclassification was a Class 5 identified by the WIM equipment as a Class 8.

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 5-9.

Table 5-9 – Pre-Validation Unclassified Trucks by Pair – 13-Jan-11

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 -0.3 mph; the range of errors was 1.6 mph.

5.2 Calibration

The WIM equipment required no calibration iterations. The final compensation factors left in place at the conclusion of the validation are provided in Table 5-10.

Table 5-10 – Final Speed Compensation Factors

Speed Point	MPH	Left	Right
88	55	3630	3107
96	60	3563	3082
104	65	3613	3092
112	70	3684	3153
120	75	3657	3130
Axle Distance (cm)	307		
Dynamic Comp (%)	100		

5.3 GVW and Steering Axle Error Trend

Figure 5-12 is provided to illustrate the predicted GVW error with respect to the pre-validation errors by speed.

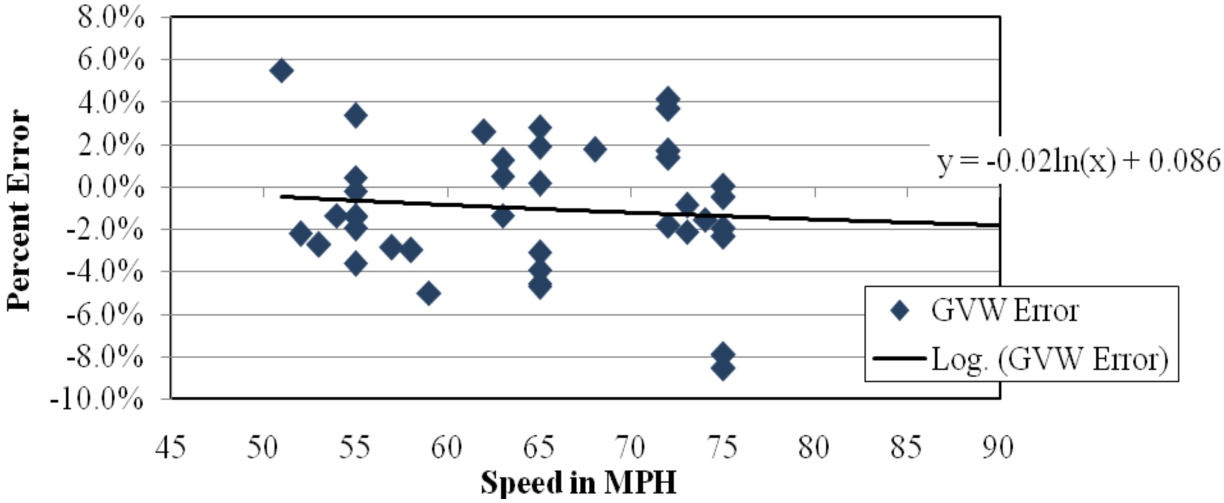


Figure 5-12 – GVW Error Trend by Speed

Figure 5-13 is provided to illustrate the predicted GVW error with respect to the pre-validation errors by speed.

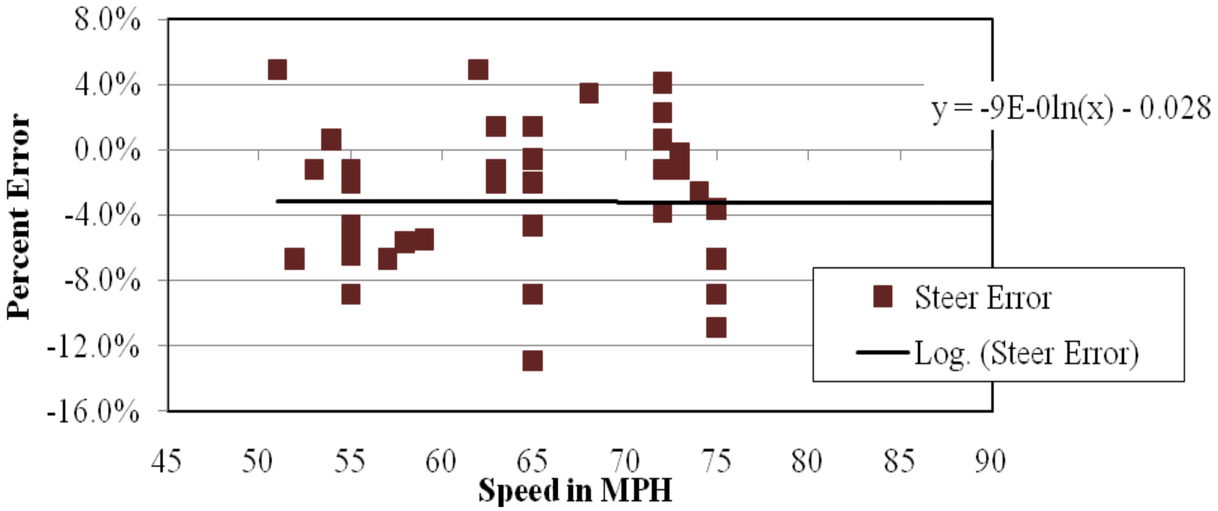


Figure 5-13 - Steering Axle Error Trend by Speed

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	
18-Aug-08	0	33	0	N/A	50	0	0	0	0	N/A	0
19-Aug-08	N/A	50	N/A	N/A	33	0	N/A	0	0	N/A	0
13-Jan-11	0	25	0	N/A	0	0	N/A	N/A	0	N/A	0

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

Table 6-2 – Weight Validation History

Date	Mean Error and 95% Confidence		
	GVW	Single Axles	Tandem
18-Aug-08	-4.3 (4.6)	-2.1 (4.6)	-4.7 (6.2)
19-Aug-08	-0.2 (5.1)	0.3 (4.5)	-0.3 (7.3)
13-Jan-11	-1.3 (5.9)	-3.2 (8.8)	-0.9 (7.0)

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 also 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 (Mean Error, 95% Confidence Interval)**	
		19-Aug-08	**13-Jan-11**
Single Axles	±20 percent	0.3 ± 4.5	-3.2 ± 8.8
Tandem Axles	±15 percent	-0.3 ± 7.3	-0.9 ± 7.0
GVW	±10 percent	-0.2 ± 5.1	-1.3 ± 5.9

From the table, it appears that the variance for single axle weights has increased over time. All other weight errors and variances have remained reasonably consistent since the equipment was installed.

A review of the LTPP Standard Release Database 24 shows that there are 22 consecutive months of level "E" WIM data for this site. This site requires 3 additional years of data to meet the minimum of five years of research quality data.

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
- Pre-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 24A/B – Site Photograph Logs
- Updated Handout Guide

WIM System Field Calibration and Validation - Photos

New Mexico, SPS-5
SHRP ID: 350500

Validation Date: January 13, 2011

Photo 1 – Cabinet Exterior

Photo 2 – Cabinet Interior (Front)

Photo 3 – Cabinet Interior (Back)

Photo 4 – Leading Loop

Photo 5 – Leading WIM Sensor

Photo 6 – Trailing WIM Sensor

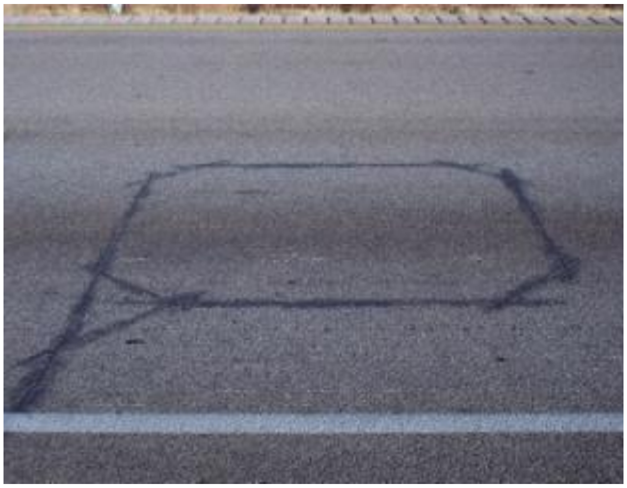


Photo 7 – Trailing Loop Sensor

Photo 8 – Solar Panel

Photo 9 – Telephone Pedestal

Photo 10 – Downstream

Photo 11 – Truck 1

Photo 12 – Truck 1 Tractor


Photo 13 – Truck 1 Suspension 1


Photo 14 – Truck 1 Suspension 2


Photo 15 – Truck 1 Suspension 3


Photo 16 – Truck 1 Suspension 4/5


Photo 17 – Truck 2


Photo 18 – Truck 2 Tractor


Photo 19 – Truck 2 Suspension 1


Photo 20 – Truck 2 Suspension 2


Photo 21 – Truck 2 Suspension 3


Photo 22 – Truck 2 Suspension 4/5


Photo 23 – Truck 2 Suspension 5

Traffic Sheet 16 LTPP MONITORED TRAFFIC DATA SITE CALIBRATION SUMMARY	STATE CODE: 35 SPS WIM ID: 350500 DATE (mm/dd/yyyy) 1/13/2011

SITE CALIBRATION INFORMATION

1. **DATE OF CALIBRATION** {mm/dd/yy} 1/13/11

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. Inductance Loops
   b. Quartz Piezo
   c.
   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: 20

	Type	Drive Suspension	Trailer Suspension
Truck 1:	9	air	air
Truck 2:	9	steel spring	steel spring
Truck 3:			

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

Mean Difference Between -

Dynamic and Static GVW:	-1.3%	Standard Deviation:	2.9%
Dynamic and Static Single Axle:	-3.2%	Standard Deviation:	4.4%
Dynamic and Static Double Axles:	-0.9%	Standard Deviation:	3.4%

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

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

			Low		High	Runs
a.	Low	-	51.0	to	59.0	14
b.	Medium	-	59.1	to	67.1	11
c.	High	-	67.2	to	75.0	15
d.		-		to		
e.		-		to		

Traffic Sheet 16 LTPP MONITORED TRAFFIC DATA SITE CALIBRATION SUMMARY	STATE CODE: SPS WIM ID: DATE (mm/dd/yyyy)	35 350500 1/13/2011

10. CALIBRATION FACTOR (AT EXPECTED FREE FLOW SPEED) 3627 | 3104

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

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

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:	50.0	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: 717-512-6638

E-mail: dwolf@ara.com

Traffic Sheet 20	STATE CODE:	35
LTPP MONITORED TRAFFIC DATA	SPS WIM ID:	350500
SPEED AND CLASSIFICATION STUDIES	DATE (mm/dd/yyyy)	1/13/2011

WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class
69	9	144	69	9	64	9	226	65	9
76	9	145	76	9	66	9	227	66	9
70	9	146	70	9	73	9	232	73	9
71	9	147	71	9	61	9	235	62	9
68	12	149	69	12	66	9	236	66	9
69	9	150	68	9	73	9	239	73	9
64	9	151	68	9	64	9	261	64	9
63	9	152	62	9	70	9	262	71	9
62	9	153	64	9	69	9	264	69	9
67	9	180	68	9	58	9	265	61	9
67	9	181	68	9	63	9	269	64	9
72	9	184	71	9	68	9	271	69	9
65	9	185	70	9	71	9	273	71	9
68	9	186	68	9	63	6	278	63	6
64	9	187	65	9	64	9	280	64	9
70	9	188	66	9	71	9	281	71	9
64	9	189	64	9	67	9	282	62	9
70	9	201	70	9	65	9	288	65	9
65	9	205	63	9	75	9	290	74	9
59	9	206	65	9	72	9	293	73	9
73	9	210	76	9	72	9	294	71	9
68	9	212	68	9	77	9	296	77	9
67	9	213	67	9	67	9	298	66	9
58	5	215	54	5	72	9	301	72	9
55	5	216	53	5	67	9	302	70	9

Sheet 1 - 0 to 50 Start: ____________ Stop: 9:26:50

Recorded By: kt Verified By: djw

Validation Test Truck Run Set - Post

Traffic Sheet 20 LTPP MONITORED TRAFFIC DATA SPEED AND CLASSIFICATION STUDIES	STATE CODE: 35 SPS WIM ID: 350500 DATE (mm/dd/yyyy) 1/13/2011

WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class
65	9	443	68	9	69	9	495	70	9
72	9	444	72	9	64	9	496	64	9
64	9	446	65	9	64	9	501	64	9
64	9	447	64	9	65	9	503	65	9
67	9	450	68	9	62	9	505	63	9
75	9	452	74	9	70	9	506	71	9
61	9	455	61	9	63	9	508	63	9
68	8	460	68	8	59	9	510	59	9
64	9	461	65	9	70	9	537	71	9
69	9	463	70	9	64	9	539	64	9
63	9	464	64	9	68	9	540	68	9
75	9	468	74	9	64	9	542	65	9
67	9	470	67	9	65	5	545	62	5
69	9	472	70	9	64	9	547	65	9
69	9	473	70	9	68	9	549	67	9
67	9	476	67	9	74	9	552	75	9
68	4	477	68	4	67	9	556	67	9
69	9	479	70	9	62	9	557	62	9
68	9	483	71	9	71	9	559	70	9
69	12	484	70	12	60	9	561	60	9
63	9	485	63	9	73	9	565	73	9
59	**8**	**487**	**60**	**5**	71	9	566	70	9
72	9	490	73	9	68	9	567	68	9
75	8	491	71	8	62	9	568	63	9
64	9	492	63	9	63	6	571	63	6

Sheet 2 - 51 to 100 Start: ______ Stop: 10:29:51

Recorded By: kt Verified By: djw

Validation Test Truck Run Set - Post