WIM System Field Calibration and Validation Summary Report

New Mexico SPS-5
SHRP ID – 350500

Validation Date: July 31, 2012
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1 Executive Summary

A WIM validation was performed on July 31 and August 1, 2012 at the New Mexico SPS-5 site located on route I-10, milepost 50.2, 0.26 miles east of SR 146 interchange.

This site was installed on April 30, 2008. The in-road sensors are installed in the eastbound, righthand driving 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 January 13, 2011 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 the WIM components determined that the the equipment is operating within the manufacturer's tolerances. None of the in-road sensors show signs of damage or excessive wear and appear to be fully secured in the pavement. Further equipment discussion is provided in Section 3.

During the on-site pavement evaluation, There were no pavement distresses noted that may affect the accuracies of the WIM system. A visual observation of the trucks as they approach, traverse, and leave the sensor area did not indicate any adverse dynamics that would affect the accuracy of the WIM system. The trucks appear to track down the center of the lane. 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 – Validation Results – 31-Jul-12

Parameter	95% Confidence Limit of Error	Site Values	Pass/Fail
Steering Axles	±20 percent	-0.9 ± 9.6%	Pass
Tandem Axles	±15 percent	-1.3 ± 9.7%	Pass
GVW	±10 percent	-1.2 ± 7.9%	Pass
Vehicle Length	±3.0 percent (1.9 ft)	-0.6 ± 1.2 ft	Pass
Axle Length	± 0.5 ft [150mm]	0.1 ± 0.1 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 0.0 ± 4.0 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 0.1 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.

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 vehicle sample (Class 4 – 13) was due to the 1 cross-classification of a Class 5 vehicle.

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

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

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

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. Axle spacings were measured from the center hub of the each axle to the center hub of the subsequent 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 Validation test truck weights and measurements are provided in Table 1-2.

Table 1-2 – 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	79.1	12.8	16.3	16.3	16.8	16.8	17.5	4.4	36.9	4.1	62.9	68.0
2	69.0	11.5	14.6	14.6	14.1	14.1	18.8	4.4	29.3	4.1	56.6	57.5

The posted speed limit at the site is 75 mph. During the testing, the speed of the test trucks ranged from to 47 to 70 mph, a variance of 23 mph.

During test truck runs, pavement temperature was collected using a hand-held infrared temperature device. The Validation pavement surface temperatures varied from 74.1 to 129.7 degrees Fahrenheit, a range of 55.6 degrees Fahrenheit. The sunny weather conditions provided the desired 30 degree range in temperatures.

A review of the LTPP Standard Release Database 25 shows that there are 4 years of level “E” WIM data for this site. This site requires 1 year 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 traffic data, a pre-visit analysis was conducted by comparing a two-week data sample from July 10, 2012 (Data) to the most recent Comparison Data Set (CDS) from January 14, 2011. The assessments performed prior to the site visits are used to develop expected traffic flow characteristics 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 25 shows that there are 4 years of level "E" WIM data for this site. Table 2-1 provides a breakdown of the available data for years 2008 to 2011.

Table 2-1 – LTPP Data Availability

Year	Total Number of Days in Year	Number of Months
2008	226	8
2009	355	12
2010	361	11
2011	250	9

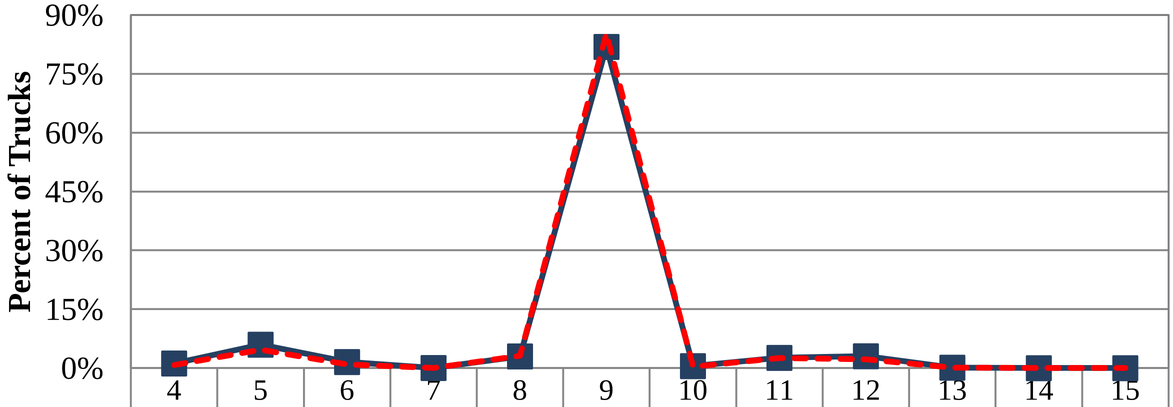
As shown in the table, this site requires 1 year of data to meet the minimum of five years of research quality data. Table 2-2 provides a monthly breakdown of the available data for years 2008 through 2011.

Table 2-2 – LTPP Data Availability by Month

Year	Month												No. of Months
	1	2	3	4	5	6	7	8	9	10	11	12	
2008					19	30	31	24	30	31	30	31	8
2009	30	28	31	30	31	30	31	31	30	31	27	25	12
2010	31		21	30	23	90	13	31	30	31	30	31	11
2011	31	28	31	21	29	30	31	31	18				9

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 between the sample dataset from July 10, 2012 (Data) and the most recent comparison Data Set (CDS) from January 14, 2011.



	4	5	6	7	8	9	10	11	12	13	14	15
Data	1.2%	6.0%	1.6%	0.0%	3.0%	81.9%	0.5%	2.6%	3.0%	0.1%	0.0%	0.0%
CDS	0.8%	4.6%	0.9%	0.0%	3.1%	85.2%	0.4%	2.6%	2.3%	0.1%	0.0%	0.0%

Figure 2-1 – Comparison of Truck Distribution

Table 2-3 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 two most frequent truck types crossing the WIM scale are Class 9 (81.9%) and Class 5 (6.0%) vehicles.

Table 2-3 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. The table indicates that 0.0 percent of the vehicles at this site are unclassified.

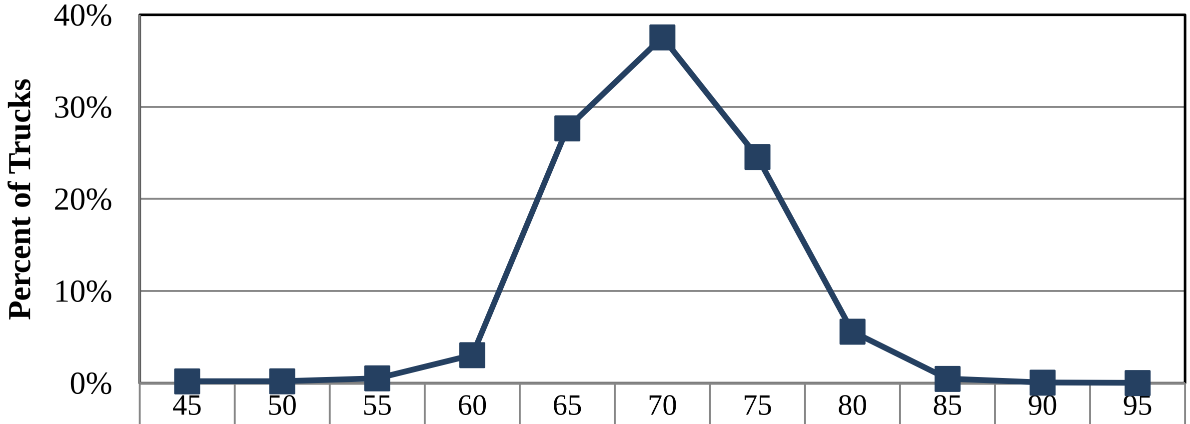
Table 2-3 – Truck Distribution from W-Card

Vehicle Classification	CDS		Data		Change
	Date				
	1/14/2011		7/10/2012		
4	334	0.8%	425	1.2%	0.4%
5	2057	4.6%	2124	6.0%	1.3%
6	410	0.9%	555	1.6%	0.6%
7	6	0.0%	17	0.0%	0.0%
8	1381	3.1%	1065	3.0%	-0.1%
9	37718	85.2%	29028	81.9%	-3.4%
10	172	0.4%	186	0.5%	0.1%
11	1133	2.6%	931	2.6%	0.1%
12	1001	2.3%	1079	3.0%	0.8%
13	38	0.1%	45	0.1%	0.0%
14	0	0.0%	0	0.0%	0.0%
15	0	0.0%	0	0.0%	0.0%

From the table it can be seen that the percentage of Class 9 vehicles has decreased by 3.4 percent from January 2011 and July 2012. Changes in the percentage of heavier trucks may be attributed to natural and seasonal variations in truck distributions and a change in goods movement during current economic cycle. During the same time period, the percentage of Class 5 trucks increased by 1.3 percent. These differences may be attributed to 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 will provide a basis for determining the speed of the test trucks during validation testing. The CDS distribution of speeds is shown in Figure 2-2.



	45	50	55	60	65	70	75	80	85	90	95
Data	0.2%	0.2%	0.5%	3.0%	27.7%	37.6%	24.6%	5.6%	0.5%	0.1%	0.0%

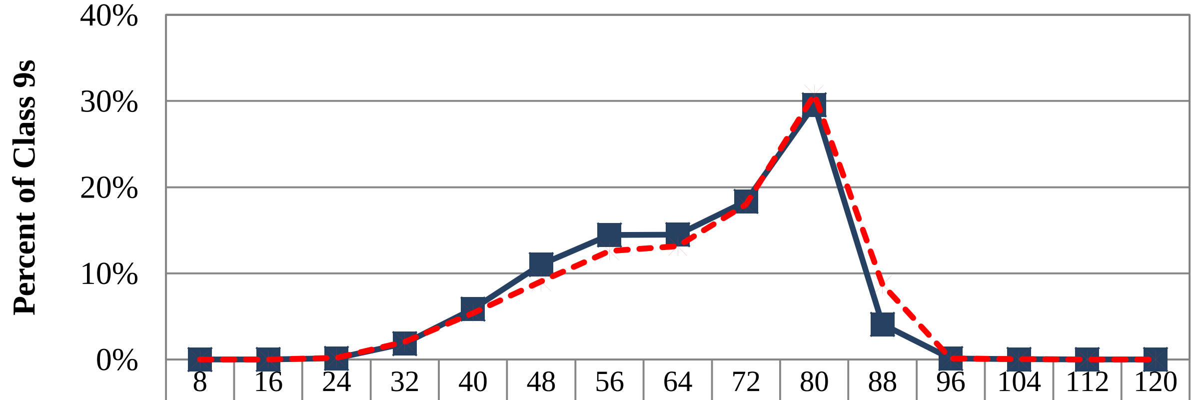
Figure 2-2 – Truck Speed Distribution – 10-Jul-12

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 73 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 July 2012 and the Comparison Data Set from January 2011.

As shown in Figure 2-3, this is a heavily loaded site. The loaded peaks for the January 2011 Comparison Data Set (CDS) and the July 2012 two-week sample W-card dataset (Data) are similar.



	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
Data	0.0%	0.0%	0.1%	1.8%	5.9%	11.0	14.5	14.5	18.4	29.6	4.1%	0.1%	0.0%	0.0%	0.0%
CDS	0.0%	0.0%	0.2%	2.1%	5.4%	9.1%	12.6	13.2	18.0	30.8	8.7%	0.1%	0.0%	0.0%	0.0%

Figure 2-3 – Comparison of Class 9 GVW Distribution

Table 2-4 is provided to show the statistical comparison for Class 9 GVW between the Comparison Data Set and the current dataset.

Table 2-4 – Class 9 GVW Distribution from W-Card

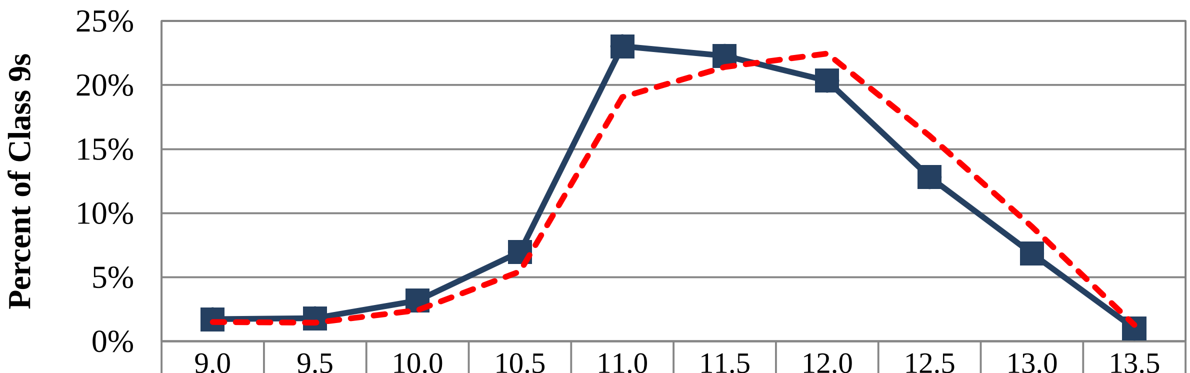
GVW weight bins (kips)	CDS		Data		Change
	Date				
	1/14/2011		7/10/2012		
8	0	0.0%	0	0.0%	0.0%
16	4	0.0%	3	0.0%	0.0%
24	60	0.2%	39	0.1%	0.0%
32	763	2.1%	527	1.8%	-0.2%
40	2001	5.4%	1674	5.9%	0.5%
48	3369	9.1%	3148	11.0%	1.9%
56	4676	12.6%	4131	14.5%	1.9%
64	4888	13.2%	4142	14.5%	1.3%
72	6678	18.0%	5244	18.4%	0.4%
80	11422	30.8%	8448	29.6%	-1.2%
88	3227	8.7%	1167	4.1%	-4.6%
96	38	0.1%	33	0.1%	0.0%
104	8	0.0%	5	0.0%	0.0%
112	1	0.0%	1	0.0%	0.0%
120	3	0.0%	2	0.0%	0.0%
Average =	64.0 kips		62.3 kips		-1.7 kips

As shown in the table, the percentage of unloaded class 9 trucks in the 32 to 40 kips range increased by 0.5 percent while the percentage of loaded class 9 trucks in the 72 to 80 kips range decreased by 1.2 percent. During this time period the percentage of overweight trucks decreased by 4.6 percent. Based on the average Class 9 GVW values from the per vehicle records, the GVW average for this site decreased by 2.8 percent, from 64.0 to 62.3 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 average front axle weight from the current data sample set with the expected average front axle weight average from the Data Comparison Set.

Figure 2-4 shows a comparison between Class 9 front axle weight plots generated by using the two week W-card sample from July 2012 and the Comparison Data Set from January 2011. The percentage of light axles (9.5 to 10.5 kips) increased by 2.3 percent and the percentage of heavy axles (11.5 to 12.5 kips) decreased by approximately 5.3%, indicating possible negative bias (underestimation of loads) in front axle measurement.



	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5
Data	1.7%	1.8%	3.2%	7.0%	23.0%	22.3%	20.3%	12.8%	6.9%	1.0%
CDS	1.5%	1.5%	2.4%	5.4%	19.1%	21.4%	22.5%	16.0%	9.0%	1.3%

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 measuring between 11.0 and 12.0 kips. The percentage of trucks in this range has decreased between the January 2011 Comparison Data Set (CDS) and the July 2012 dataset (Data).

Table 2-5 provides the Class 9 front axle weight distribution data for the January 2011 Comparison Data Set (CDS) and the July 2012 dataset (Data).

Table 2-5 – Class 9 Front Axle Weight Distribution from W-Card

F/A weight bins (kips)	CDS		Data		Change
	Date				
	1/14/2011		7/10/2012		
9.0	548	1.5%	489	1.7%	0.2%
9.5	536	1.5%	510	1.8%	0.3%
10.0	894	2.4%	904	3.2%	0.8%
10.5	2008	5.4%	1980	7.0%	1.5%
11.0	7028	19.1%	6540	23.0%	4.0%
11.5	7892	21.4%	6327	22.3%	0.9%
12.0	8280	22.5%	5777	20.3%	-2.1%
12.5	5908	16.0%	3640	12.8%	-3.2%
13.0	3301	9.0%	1947	6.9%	-2.1%
13.5	467	1.3%	282	1.0%	-0.3%
Average =	11.5 kips		11.3 kips		-0.2 kips

The table shows that the average front axle weight for Class 9 trucks has decreased by 0.2 kips, or 1.7 percent. According to the values from the per vehicle records, the average front axle weight for Class 9 trucks is 11.3 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 from the sample data (Data) with the expected average tractor tandem spacing from the comparison data set (CDS).

The Class 9 tractor tandem spacing plot in Figure 2-5 is provided to indicate possible shifts in WIM system distance and speed measurement accuracies.

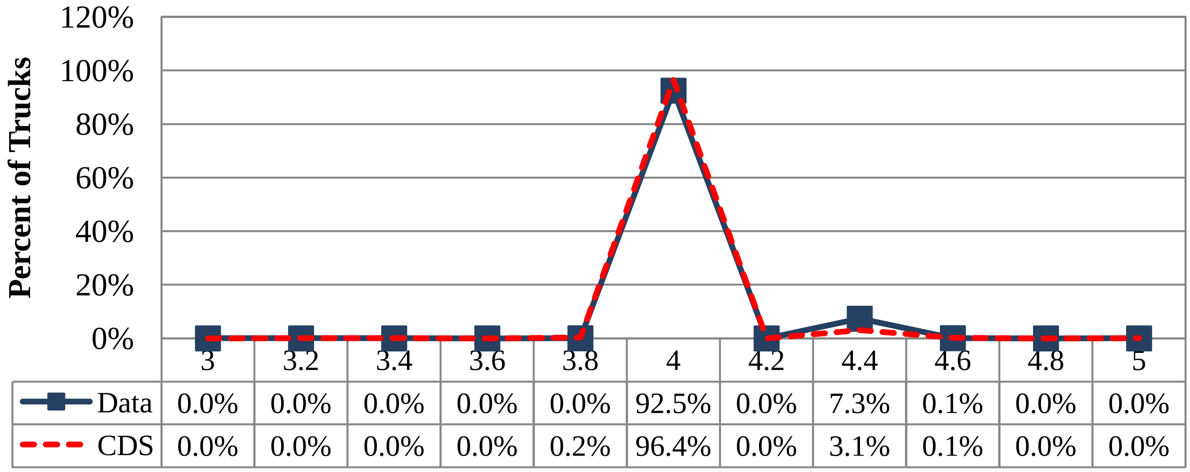


Figure 2-5 – Comparison of Class 9 Tractor Tandem Spacing

As seen in the figure, the Class 9 tractor tandem spacings for the January 2011 Comparison Data Set and the July 2012 Data are nearly identical.

Table 2-6 shows the Class 9 axle spacings between the second and third axles.   .

Table 2-6 – Class 9 Axle 2 to 3 Spacing from W-Card

Tandem 1 spacing bins (feet)	CDS		Data		Change
	Date				
	1/14/2011		7/10/2012		
3.0	0	0.0%	1	0.0%	0.0%
3.2	4	0.0%	2	0.0%	0.0%
3.4	16	0.0%	1	0.0%	0.0%
3.6	0	0.0%	0	0.0%	0.0%
3.8	91	0.2%	14	0.0%	-0.2%
4.0	35818	96.4%	26420	92.5%	-4.0%
4.2	0	0.0%	0	0.0%	0.0%
4.4	1151	3.1%	2099	7.3%	4.2%
4.6	54	0.1%	26	0.1%	-0.1%
4.8	0	0.0%	0	0.0%	0.0%
5.0	4	0.0%	2	0.0%	0.0%
Average =	4.0 feet		4.0 feet		0.0 feet

From the table it can be seen that the majority of the drive tandem spacing of Class 9 trucks at this site is between 4.0 and 4.6 feet. Based on the average Class 9 drive tandem spacing values from the per vehicle records, the average tractor tandem spacing is 4.0, which is identical to to the expected average of 4.0 from the CDS per vehicle records. Further axle spacing analyses are performed during the validation and Validation analysis.

2.7 Data Analysis Summary

Historical data analysis involved the comparison of the most recent Comparison Data Set (January 2011) based on the last calibration with the most recent two-week WIM data sample from the site (July 2012). Comparison of vehicle class distribution data indicates a 3.4 percent decrease in the percentage of Class 9 vehicles. Analysis of Class 9 weight data indicates that front axle weights have decreased by 1.7 percent and average Class 9 GVW has decreased by 2.8 percent for the July 2012 data. The data indicates an average truck tandem spacing of 4.0 feet, which is identical to the expected average of 4.0 feet.

3 WIM Equipment Discussion

From a comparison between the report of the most recent validation of this equipment on January 13, 2011 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 an 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 after 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. 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

No unscheduled 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, there were no pavement distresses noted that may affect the accuracies of the WIM system.

4.2 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**	**Pass 5**	**Avg**
Left	LWP	LRI (m/km)	*0.390*	*0.453*	*0.449*			*0.431*
		SRI (m/km)	*0.355*	*0.272*	*0.239*			*0.289*
		Peak LRI (m/km)	*0.480*	0.554	*0.487*			0.507
		Peak SRI (m/km)	*0.433*	*0.452*	*0.460*			*0.448*
	RWP	LRI (m/km)	0.542	0.608	0.618			0.589
		SRI (m/km)	0.626	0.746	0.726			0.699
		Peak LRI (m/km)	0.634	0.664	0.707			0.668
		Peak SRI (m/km)	*0.635*	*0.747*	0.769			*0.717*
Center	LWP	LRI (m/km)	*0.455*	*0.437*	*0.485*	*0.448*	*0.439*	*0.453*
		SRI (m/km)	*0.246*	*0.362*	*0.257*	*0.245*	*0.256*	*0.273*
		Peak LRI (m/km)	0.530	*0.457*	0.519	*0.485*	*0.442*	*0.487*
		Peak SRI (m/km)	*0.296*	*0.465*	*0.264*	*0.283*	*0.343*	*0.330*
	RWP	LRI (m/km)	0.504	0.548	0.555	*0.434*	*0.498*	0.508
		SRI (m/km)	0.502	*0.335*	*0.442*	*0.481*	*0.460*	*0.444*
		Peak LRI (m/km)	0.569	0.558	0.555	*0.461*	0.509	0.530
		Peak SRI (m/km)	*0.557*	*0.590*	*0.722*	*0.498*	*0.482*	*0.570*
Right	LWP	LRI (m/km)	0.613	0.652	0.533			0.599
		SRI (m/km)	*0.386*	*0.458*	*0.341*			*0.395*
		Peak LRI (m/km)	0.622	0.732	0.571			0.642
		Peak SRI (m/km)	*0.534*	*0.563*	*0.511*			*0.536*
	RWP	LRI (m/km)	0.586	0.611	0.674			0.624
		SRI (m/km)	0.818	0.522	0.759			0.700
		Peak LRI (m/km)	0.601	0.629	0.682			0.637
		Peak SRI (m/km)	**0.880**	*0.595*	**0.888**			**0.788**

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. Indices that are below the lower thresholds are shown in italics. The highest valueis the Peak SRI values in the right wheel path of the right shift passes (shown in bold and italics).

4.3 Profile and Vehicle Interaction

Profile data was collected on April 11, 2012 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, beginning 900 feet prior to WIM scales and ending 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 98 in/mi and is located approximately 498 feet prior to the WIM scale. The highest IRI value within the 400 foot approach section was 54 in/mi and is located approximately 59 feet prior to the WIM scale. These areas of the pavement were closely investigated during the validation visit, and truck dynamics in this area were closely observed. There were no distresses observed at these locations 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.

4.4 Recommended Pavement Remediation

No pavement remediation is recommended.

5 Statistical Reliability of the WIM Equipment

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

5.3 Validation

The 41 Validation test truck runs were conducted on July 31 and August 1, 2012, beginning at approximately 9:43 AM and continuing until to 4:06 PM on July 31, and beginning at 9:21 AM and continuing until 12:07 PM on August 1.

The two test trucks consisted of:

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

- A Class 9 truck, loaded with rock, and equipped with air suspension on the tractor, air 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 Validation and re-weighed at the conclusion of the Validation. The average test truck weights and measurements are provided in Table 5-1.

Table 5-1 - 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	79.1	12.8	16.3	16.3	16.8	16.8	17.5	4.4	36.9	4.1	62.9	68.0
2	69.0	11.5	14.6	14.6	14.1	14.1	18.8	4.4	29.3	4.1	56.6	57.5

Test truck speeds varied by 23 mph, from 47 to 70 mph. The measured Validation pavement temperatures varied 55.6 degrees Fahrenheit, from 74.1 to 129.7. The sunny weather conditions provided the desired minimum 30 degree temperature range. Table 5-2 is a summary of post validation results.

Table 5-2 – Validation Overall Results – 31-Jul-12

Parameter	95% Confidence Limit of Error	Site Values	Pass/Fail
Steering Axles	±20 percent	-0.9 ± 9.6%	Pass
Tandem Axles	±15 percent	-1.3 ± 9.7%	Pass
GVW	±10 percent	-1.2 ± 7.9%	Pass
Vehicle Length	±3.0 percent (1.9 ft)	-0.6 ± 1.2 ft	Pass
Axle Length	± 0.5 ft [150mm]	0.1 ± 0.1 ft	Pass

Truck speed was manually collected for each test run using a radar gun and compared with the speed reported by the WIM equipment. For this site, the average error in speed measurement for all speeds was 0.0 ± 4.0 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 0.1 feet, and the speed and axle spacing length 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 similar acceptable ranges.

5.3.1 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.

Table 5-3 – Validation Results by Speed – 31-Jul-12

Parameter	95% Confidence Limit of Error	Low	Medium	High
		47.0 to 54.7 mph	54.8 to 62.4 mph	62.5 to 70.0 mph
Steering Axles	±20 percent	-1.6 ± 9.0%	-2.4 ± 11.3%	1.3 ± 9.3%
Tandem Axles	±15 percent	-1.1 ± 8.0%	-3.9 ± 11.0%	1.2 ± 9.2%
GVW	±10 percent	-1.2 ± 5.0%	-3.5 ± 9.9%	1.2 ± 6.5%
Vehicle Length	±3.0 percent (1.9 ft)	-0.5 ± 1.4 ft	-0.8 ± 1.4 ft	-0.4 ± 1.1 ft
Vehicle Speed	± 1.0 mph	0.1 ± 0.1 mph	0.1 ± 0.2 mph	0.1 ± 0.1 mph
Axle Length	± 0.5 ft [150mm]	-0.2 ± 0.8 ft	0.6 ± 7.1 ft	-0.4 ± 1.1 ft

From the table, it can be seen that the WIM equipment underestimates all weights at the low and medium speeds and overestimates all weights at the high speeds. The range in error appears to be greater at the medium speeds for all weight measurements. There appears to be a relationship between some of the weight estimates and speed at this site.

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

5.3.1.1 GVW Errors by Speed

As shown in Figure 5-1, the equipment bias for GVW is more positive at high speeds when compared to low and medium speeds. The range in error was the highest at medium speeds.

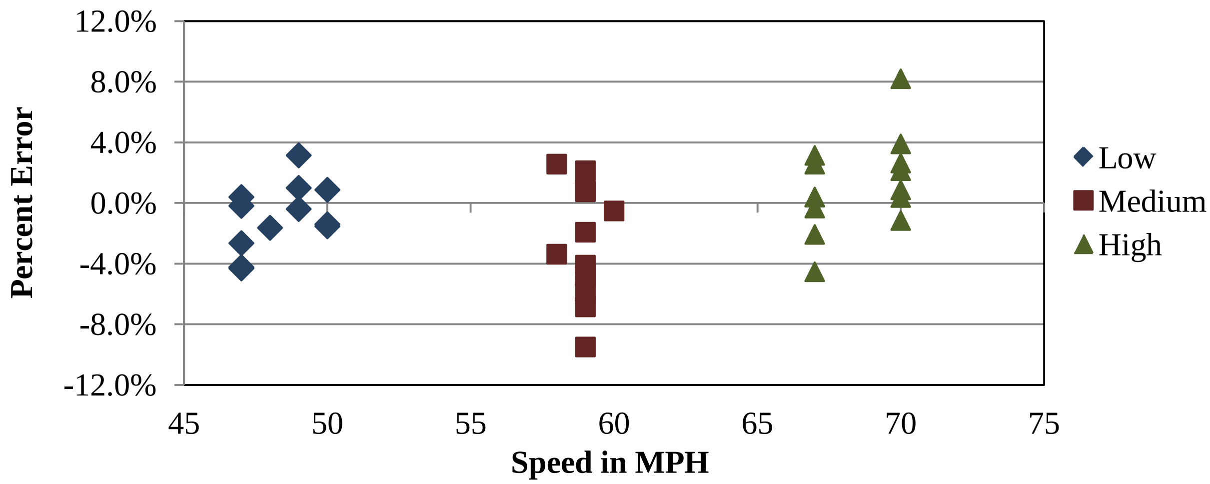


Figure 5-1 – Validation GVW Errors by Speed – 31-Jul-12

5.3.1.2 Steering Axle Weight Errors by Speed

As shown in Figure 5-2, the equipment estimated steering axle weights with similar accuracy at all speeds. The range in error is slightly greater at the medium speeds. There does not appear to be a strong correlation between speed and weight estimates at this site.

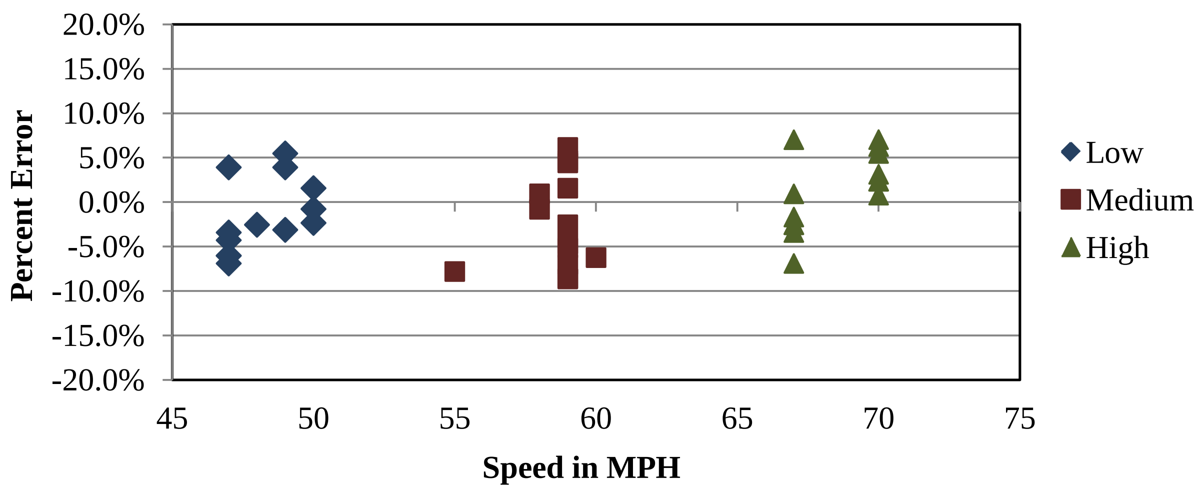


Figure 5-2 – Validation Steering Axle Weight Errors by Speed – 31-Jul-12

5.3.1.3 Tandem Axle Weight Errors by Speed

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

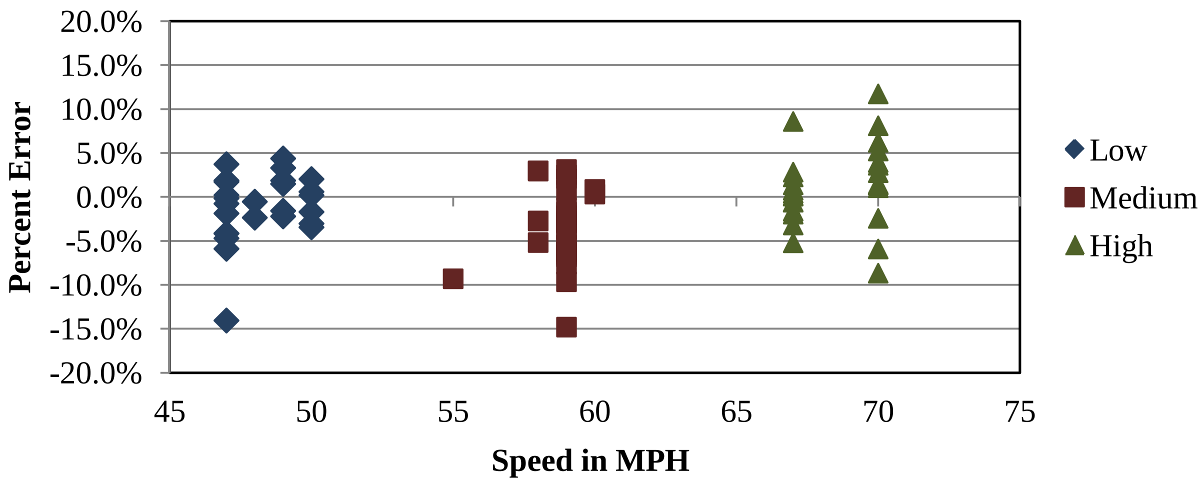


Figure 5-3 – Validation Tandem Axle Weight Errors by Speed – 31-Jul-12

5.3.1.4 GVW Errors by Speed and Truck Type

It can be seen in Figure 5-4 that when the GVW errors are analyzed by truck type, the WIM equipment precision and bias is similar for both the heavily loaded (Primary) truck and the partially loaded (Secondary) truck at low and medium speeds. At high speeds the WIM equipment bias for the heavily loaded (Primary) is slightly more positive than the partially loaded (Secondary) truck.

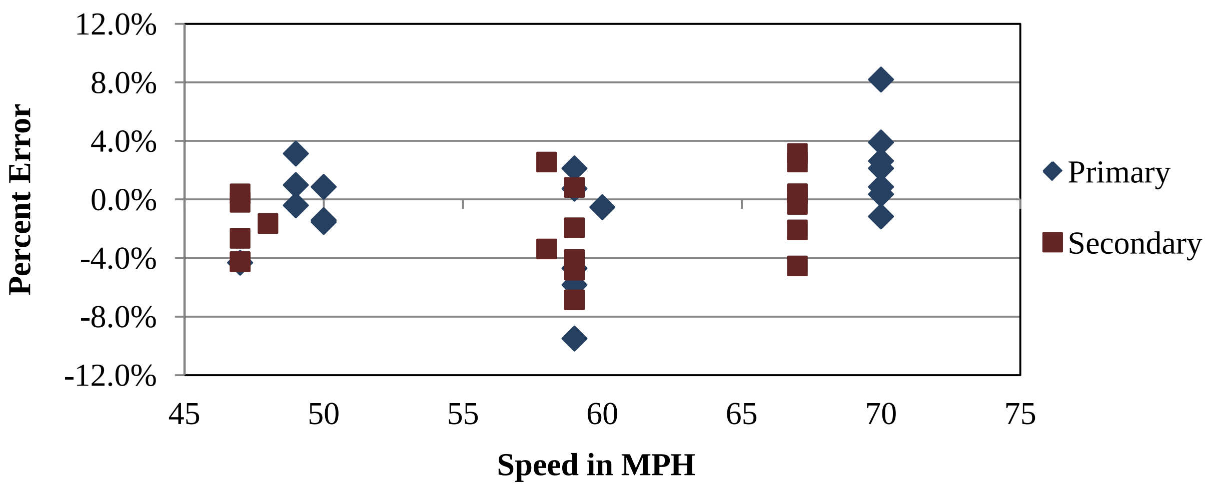


Figure 5-4 – Validation GVW Error by Truck and Speed – 31-Jul-12

5.3.1.5 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 was from 0.0 feet to 0.2 feet. Distribution of errors is shown graphically in Figure 5-5.

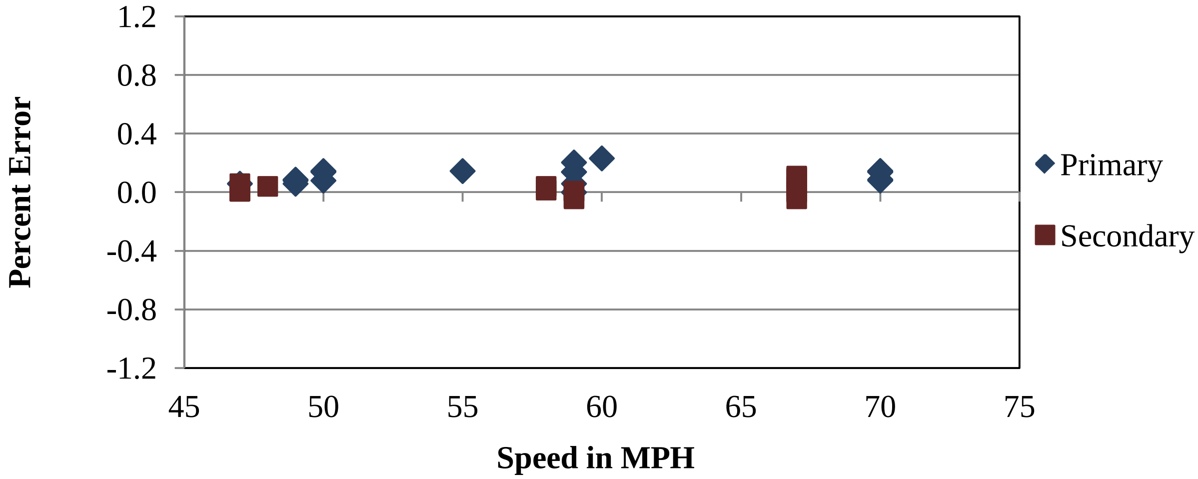


Figure 5-5 – Validation Axle Length Error by Speed – 31-Jul-12

5.3.1.6 Overall Length Errors by Speed

For this system, the WIM equipment measures overall length consistently over the entire range of speeds, with errors ranging from -1.5 to 0.0 feet. Distribution of errors is shown graphically in Figure 5-6.

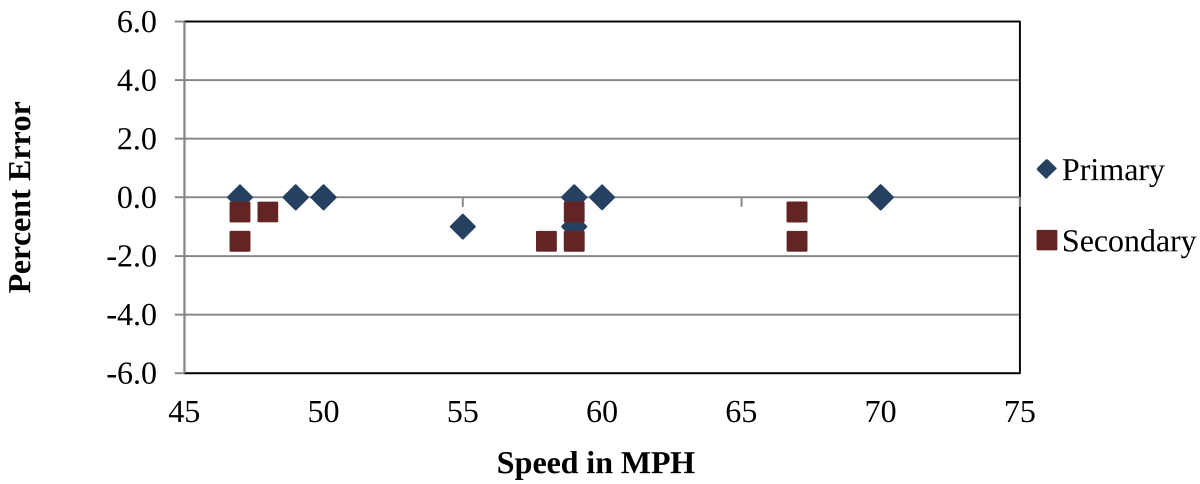


Figure 5-6 – Validation Overall Length Error by Speed – 31-Jul-12

5.3.2 Statistical Temperature Analysis

Statistical analysis was performed for the test truck run data to investigate whether a relationship exists between pavement temperature and WIM equipment weight and distance measurement accuracy. The range of pavement temperatures was 55.6 degrees, from 74.1 to 129.7 degrees Fahrenheit. The Validation test runs are reported under three temperature groups – low, medium and high, as shown in Table 5-4 below.

Table 5-4 – Validation Results by Temperature – 31-Jul-12

Parameter	**95% Confidence Limit of Error**	**Low**	**Medium**	**High**
		74.1 to 92.6 degF	**92.7 to 111.3 degF**	**111.4 to 129.7 degF**
Steering Axles	±20 percent	1.0 ± 9.1%	-0.4 ± 10.3%	-3.9 ± 9.4%
Tandem Axles	±15 percent	0.5 ± 8.9%	-1.0 ± 8.2%	-4.0 ± 11.7%
GVW	±10 percent	0.6 ± 6.1%	-0.8 ± 6.9%	-3.8 ± 10.0%
Vehicle Length	±3.0 percent (1.9 ft)	-0.6 ± 1.4 ft	-0.5 ± 1.4 ft	-0.6 ± 1.2 ft
Vehicle Speed	± 1.0 mph	0.1 ± 0.1 mph	0.1 ± 0.2 mph	0.1 ± 0.1 mph
Axle Length	± 0.5 ft [150mm]	-0.3 ± 1.0 ft	0.8 ± 7.3 ft	-0.3 ± 1.1 ft

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

5.3.2.1 GVW Errors by Temperature

From Figure 5-7, it can be seen that the equipment appears to transition from an accurate estimation of GVW at the low and medium temperatures ranges to an underestimation of GVW at the higher temperatures. The range in GVW errors is slightly greater at the higher temperatures.

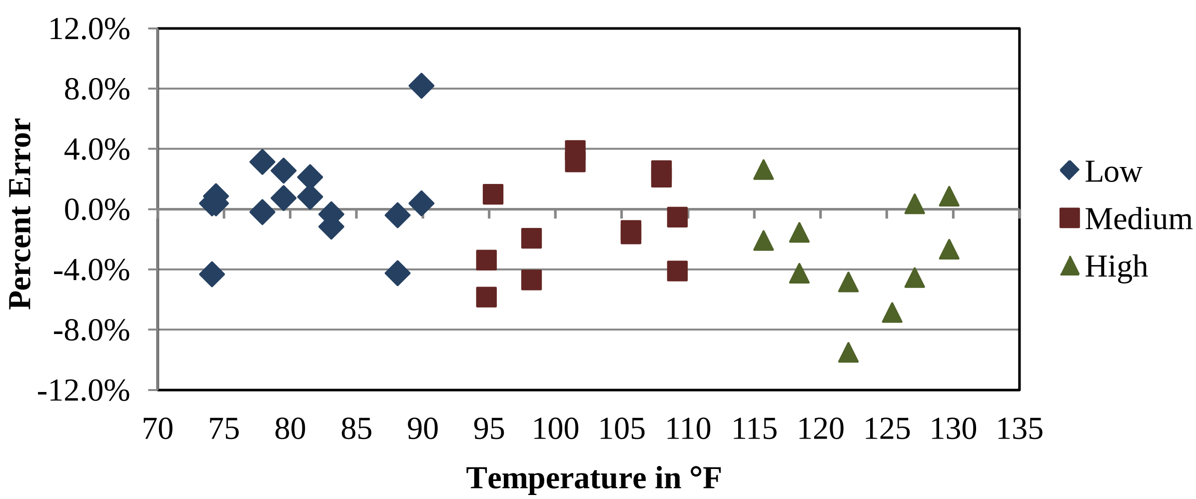


Figure 5-7 – Validation GVW Errors by Temperature – 31-Jul-12

5.3.2.2 Steering Axle Weight Errors by Temperature

Figure 5-8 demonstrates that for steering axles, there does appear to be a slight correlation between temperature and steering axle weight estimates at this site. The WIM equipment appears to estimate weights accurately at the lower temperatures, and then progressively underestimate weights with greater negative bias as temperature increases. The range in error is similar for different temperature groups.

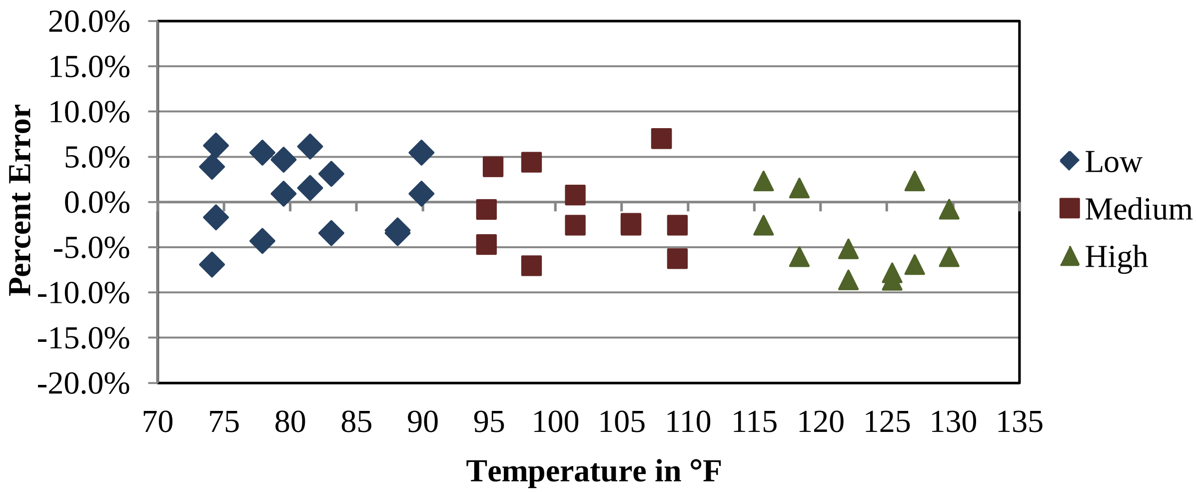


Figure 5-8 – Validation Steering Axle Weight Errors by Temperature – 31-Jul-12

5.3.2.3 Tandem Axle Weight Errors by Temperature

As shown in Figure 5-9, the WIM equipment appears to estimate tandem axle weights accurately at the low temperatures and progressively move toward an underestimation of tandem axle weights at the higher temperatures. The range in GVW errors is similar at all temperatures.

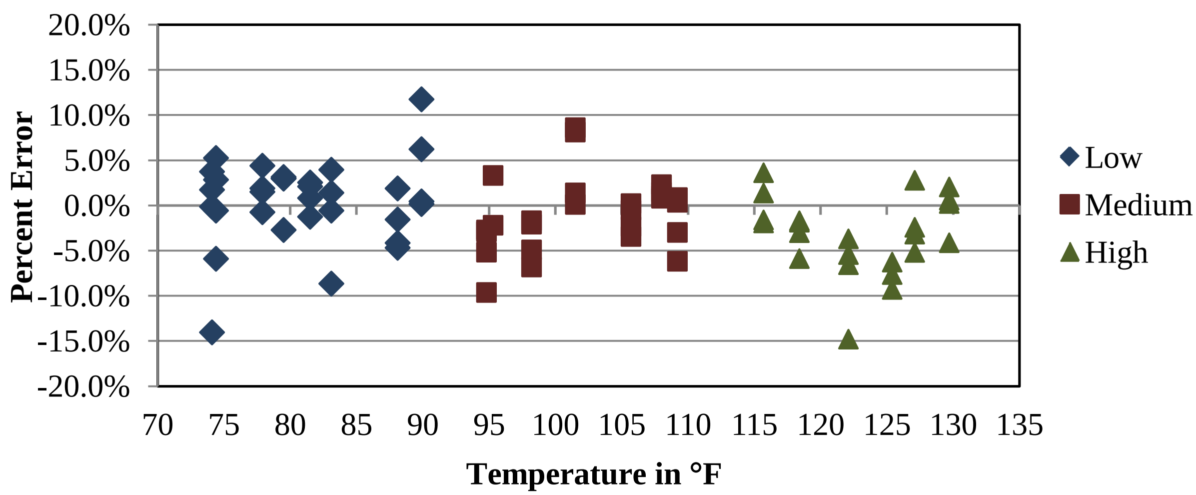


Figure 5-9 – Validation Tandem Axle Weight Errors by Temperature – 31-Jul-12

5.3.2.4 GVW Errors by Temperature and Truck Type

As shown in Figure 5-10, when analyzed by truck type, trends in GVW measurement errors for both trucks are similar at all temperatures. For both trucks, the range of errors reasonably consistent over the range of temperatures.

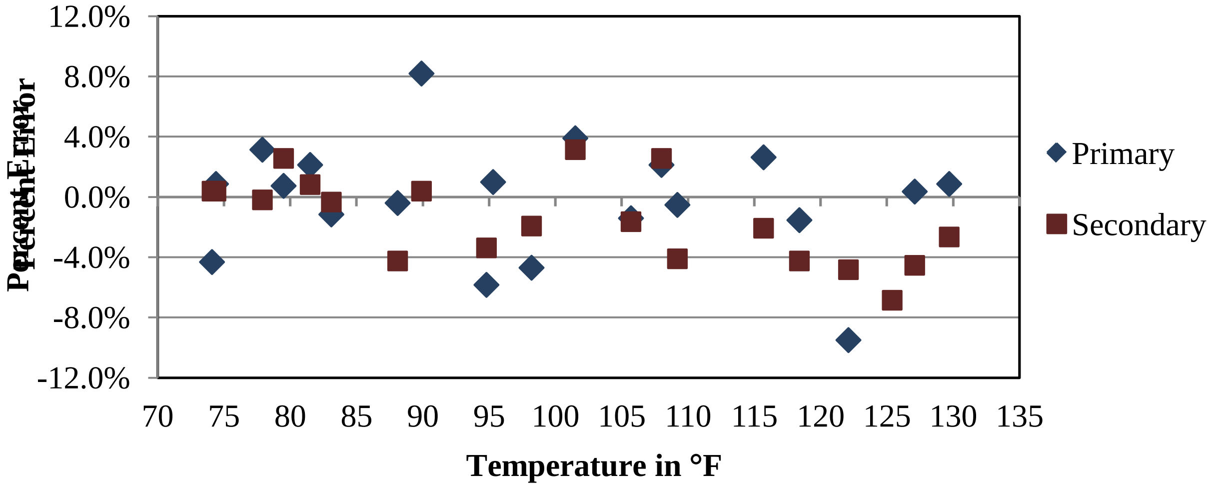


Figure 5-10 – Validation GVW Error by Truck and Temperature – 31-Jul-12

5.3.3 Classification and Speed Evaluation

The 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 Validation classification study at this site, a manual sample of 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.

Misclassified vehicles are defined as those vehicles that are manually classified by observation as one type of vehicle but identified by the WIM equipment as another type of vehicle. The misclassifications by pair are provided in Table 5-5. The table illustrates the breakdown of vehicles observed and identified by the equipment for the manual classification study. As shown in Table 5-5, one Class 5 vehicle was misclassified as a Class 8 vehicle by the equipment.

Table 5-5 – Validation Misclassifications by Pair – 31-Jul-12

		WIM											
		3	4	5	6	7	8	9	10	11	12	13	14
Observed	3	-											
	4		-										
	5			-			1						
	6				-								
	7					-							
	8						-						
	9							-					
	10								-				
	11									-			
	12										-		
	13											-	-

As shown in the table, one heavy truck (6 – 13) was misclassified by the equipment, which was a Class 9 truck that was not classified by the equipment (Class 15). This is not represented in the misclassification table. Based on the vehicles observed during the Validation study, the misclassification percentage is 1.1% for heavy trucks (vehicle classes 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 percent.

The causes for the misclassifications were not investigated in the field. A post-visit investigation of misclassified vehicles was performed using the collected video.

The combined results of the misclassifications and non-classification resulted in an undercount of one Class 5, and one Class 9 vehicle and an overcount of one Class 8, as shown in Table 5-6. The misclassified percentage represents the percentage of the misclassified vehicles in the manual sample.

Table 5-6 – Validation Classification Study Results – 31-Jul-12

Class	3	4	5	6	7	8	9	10	11	12	13
Observed Count	0	2	6	1	0	0	83	0	7	1	0
WIM Count	0	2	5	1	0	1	82	0	7	1	0
Observed Percent	0.0	2.0	6.0	1.0	0.0	0.0	83.0	0.0	7.0	1.0	0.0
WIM Percent	0.0	2.0	5.0	1.0	0.0	1.0	82.0	0.0	7.0	1.0	0.0
Misclassified Count	0	0	1	0	0	0	0	0	0	0	0
Misclassified Percent	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unclassified Count	0	0	0	0	0	0	1	0	0	0	0
Unclassified Percent	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0

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 – Validation Unclassified Trucks by Pair – 31-Jul-12

Observed Class	Unclassified	Observed Class	Unclassified	Observed Class	Unclassified
3	0	7	0	11	0
4	0	8	0	12	0
5	0	9	1	13	0
6	0	10	0		

Based on the manually collected sample of the 100 trucks, 1.0 percent 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 0.2 mph; the range of errors was 0.8 mph.

Since the equipment is measuring all weight and distance parameters within the LTPP requirements for SPS WIM sites and with a very low bias (the average measurement error for GVW is -1.2 percent), a calibration of the system was not required and therefore was not carried out.

5.3.4 Final WIM System Compensation Factors

The final factors left in place at the conclusion of the validation are provided in Table 5-8.

Table 5-8 – Final Factors

Speed Point	MPH	Left		Right	
		1	2	3	4
88	55	3630	3630	3107	3107
96	60	3563	3563	3082	3082
104	65	3613	3613	3092	3092
112	70	3684	3684	3153	3153
120	75	3657	3657	3130	3130
Axle Distance (cm)		307			
Dynamic Comp (%)		100			
Loop Width (cm)		200			

6 Post-Visit Data Analysis

A post-visit data analysis is conducted to further evaluate the validation truck data to determine if any relationships exist between WIM system weight and distance measurement error based on speed, temperature and/or truck type. Additionally, an analysis of the post-visit misclassifications noted during the Validation classification and speed study is conducted to possibly determine the cause of each truck misclassification.

If necessary, a traffic data sample from the days immediately following the validation to the date of the report submission may be conducted to further investigate anomalies in the traffic data that may have resulted from the calibration of the system or any other changes to the WIM system

6.1 Regression Analysis

This section provides additional results for the analysis carried out to determine the influence of truck type, speed and pavement temperature on WIM measurement errors. Multivariable linear regression analysis was applied to WIM data collected during calibration procedures. The same calibration data analyzed and discussed previously was used for this analysis; however a more comprehensive statistical methodology was applied. 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 analysis provides additional insight on how factors like speed, temperature, and truck type may affect weight measurement errors for a specific WIM site. It is expected that multivariable analysis done systematically for many sites may reveal overall trends.

6.1.1 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. 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 47 to 70 mph.
- Pavement temperature. Pavement temperature ranged from 74.1 to 129.7 degrees Fahrenheit.

6.1.2 Results

For analysis of GVW weights, the value of regression coefficients and their statistical properties are summarized in Table 6-1. 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 6-1 are for the null hypothesis that assumes that the regression coefficients are equal to zero. The p-value reported in Table 6-1 is for the probability that the regression coefficient, given in Table 5-5, occur by chance alone.

Table 6-1 – Table of Regression Coefficients for Measurement Error of GVW

Parameter	Regression coefficients	Standard error	Value of t-distribution	Probability value (p-value)
Intercept	0.3888	4.8919	0.0795	0.9371
Speed	0.1360	0.0655	2.0759	0.0451
Temp	-0.0925	0.0298	-3.1039	0.0037
Truck	-0.7503	1.0914	-0.6875	0.4962

The lowest probability value given in Table 6-1 is 0.0037 for temperature. This means that there is only about 0.4 percent chance that the value of the regression coefficient for speed (-0.0925) can occur by chance alone. Overall, speed and temperature have the most significant effect on the GVW measurement errors.

The relationship between speed and measurement errors is shown in Figure 6-1. The figure includes a trend line for the predicted percent error. Besides the visual assessment of the relationship, Figure 6-1 provides quantification and statistical assessment of the relationship.

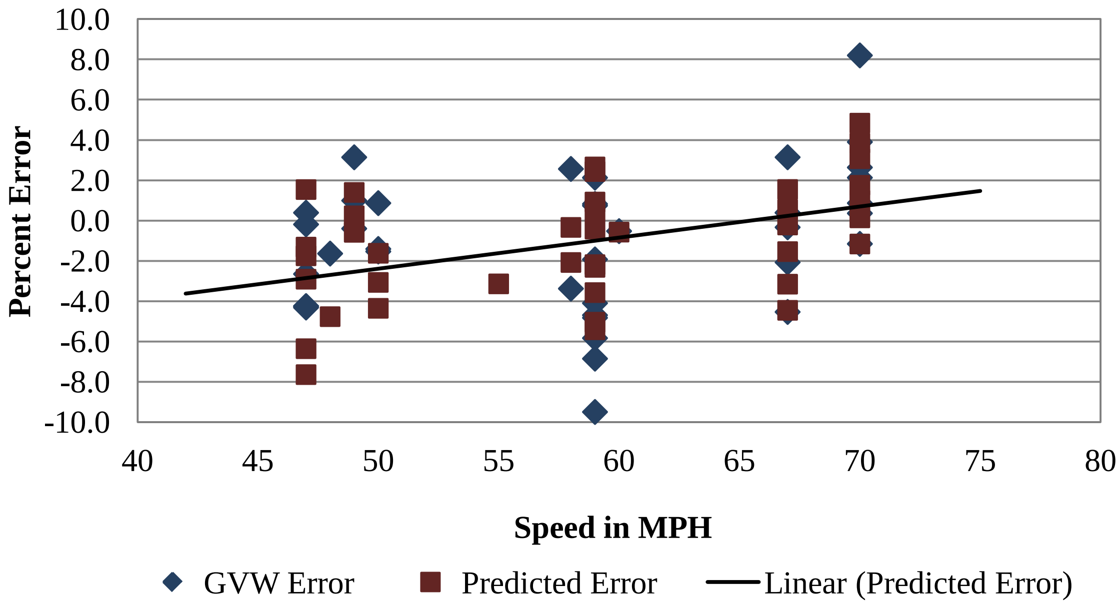


Figure 6-1 – Influence of Speed on the Measurement Error of GVW

The quantification of the relationship is provided by the value of the regression coefficient, in this case 0.1360 (in Table 6-1). This means, for example, that for a 10 mph increase in speed, the error is increased by 1.3 percent (0.1360 x 10). The statistical assessment of the relationship is provided by the probability value of the regression coefficient (0.0451) and is statistically significant.

6.1.3 Summary Results

Table 6-2 lists regression coefficients and their probability values for all combinations of factors and % errors evaluated. Entries in the table are provided only if the probability value was smaller than 0.20. The dash in Table 6-2 indicates that the relationship was not statistically significant (the probability that the relationship can occur by chance alone was greater than 20 percent).

Table 6-2 – Summary of Regression Analysis

Parameter	**Factor**					
	Speed		**Temperature**		**Truck type**	
	Regression coefficient	Probability value (p-value)	Regression coefficient	Probability value (p-value)	Regression coefficient	Probability value (p-value)
GVW	0.1360	0.0451	-0.0925	0.0037	-	-
Steering axle	0.1448	0.0544	-0.1138	0.0015	-2.8566	0.0240
Tandem axle tractor	0.0821	0.0828	-0.1149	$3.3\ 10^{-6}$	-2.2665	0.0054
Tandem axle trailer	0.1952	0.1017	-0.0695	0.1971	-	-

6.1.4 GVW and Steering Axle Trends

This section provides additional discussion regarding the effect of speed on measurement errors. This section is included to investigate if and how the (statistically significant) influence of speed on measurement errors differs for the two calibration trucks. Figure 6-2 and Figure 6-3 are provided to illustrate the trend in GVW and steering axle weight errors with respect to speed separately for the Primary and Secondary trucks. Figure 6-2 shows GVW measurement errors; Figure 6-3 shows steering axle measurement errors.

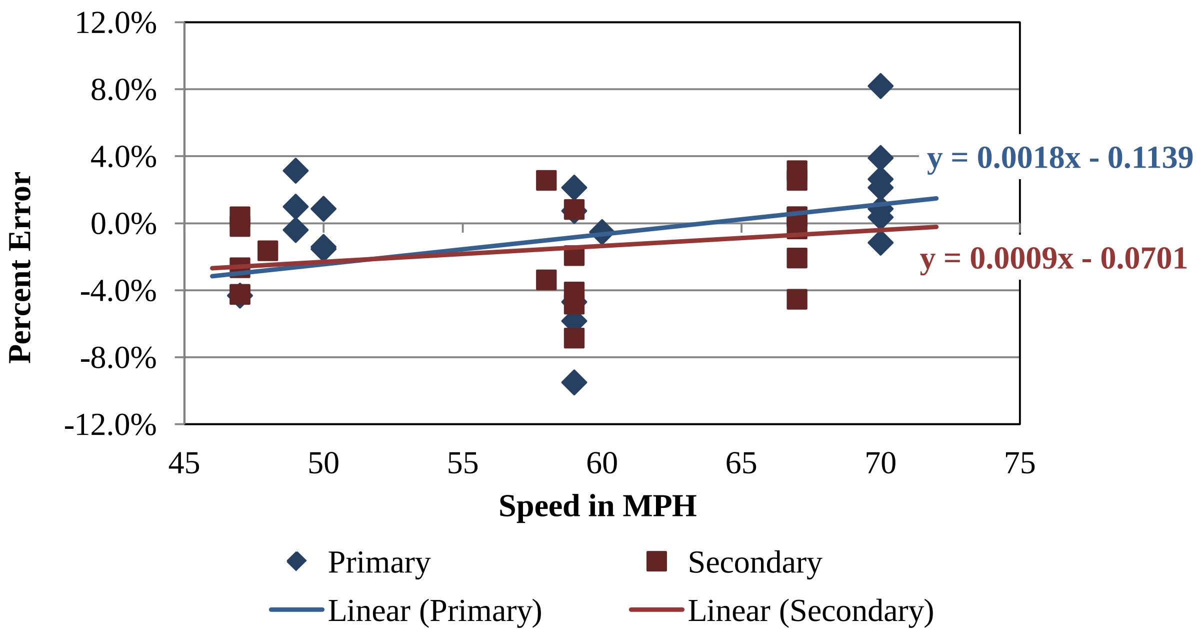


Figure 6-2 – GVW Trend by Truck and Speed

The two trend lines shown in Figure 6-2, for the Primary and Secondary trucks, are very similar and have statistical significance. The trend line for the Primary truck has the slope of 0.0018 and the probability that the slope is zero is less than one percent. The slope for the Secondary truck is 0.0009 and the probability that the slope is zero is less than 0.1 percent

The relationship between speed and steering axle weight measuring errors, given in Figure 6-3, shows similar statistically significant results for the Primary and Secondary trucks. The slope of the trend line for the Secondary truck is 0.0019, and the probability that the slope is zero is less than 0.1 percent. The trend line for the Primary truck is 0.0019, and the probability that the slope is zero is less than 0.1 percent.

The <u>difference</u> in the slopes of the Primary and Secondary trucks, for both the GVW and steering axle weight measurement errors, was not statistically significant. Consequently, the influence of speed on the measurement errors was the same for both calibration trucks.

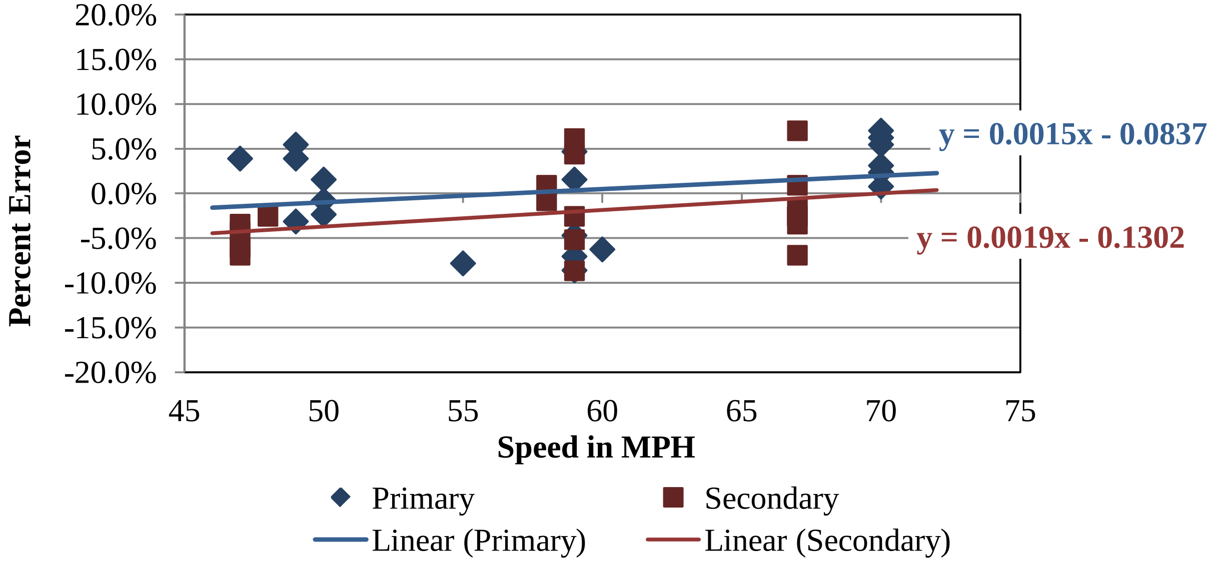


Figure 6-3 – Influence of Speed on Measurement Error of Steering Axle Weight

For simplicity, the trend lines used in the previous four figures were linear. The relationship between measurement errors and speed may not be linear, particularly for speeds above 60 mph. It is recalled that about 68% of all speed observations for trucks at this site had speed over 60 mph.

6.1.5 Conclusions

1. According to Table 6-2, speed had statistically significant effect on the measurement errors of GVW and steering axle weights (assuming that the statistical significance requires $p < 0.05$).

2. Temperature affected measurement error of GVW, steering axles, and tractor tandem axles. The values of the corresponding regression coefficients ranged from -0.0925 to -0.1149.

3. Truck type had statistically significant effect on steering axle and tandem axle on trailers measurement errors. Because the truck type was as an indicator variable (with values 1 or 0), the regression coefficients for truck type in Table 6-2 represent the difference between the mean errors for the Primary and Secondary trucks.

4. Even though speed, temperature and truck type had statistically significant effects on measurement errors of some of the parameters, the practical significance of these effects on WIM system calibration tolerances reported in Table 5-16 was relatively small. This conclusion is valid for the range of speed, temperature and truck type used or encountered during the calibration. In addition, the speed and truck type are used in the

calibration process and that their influence on measurement errors is mitigated by the selection of compensation factors during calibration (see Table 5-8).

7 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 Validation results.

7.1 Classification

The information in Table 7-1 data was extracted from the most recent previous validation and was updated to include the results of this validation.

Table 7-1 – Classification Validation History

Date	Misclassification Percentage by Class											Pct Unclass
	3	4	5	6	7	8	9	10	11	12	13	
18-Aug-08	-	0	33	0	-	50	0	0	0	0	-	1.0
19-Aug-08	-	-	50	-	-	33	0	-	0	0	-	1.0
13-Jan-11	-	0	25	0	-	0	0	-	-	0	-	0.0
31-Jul-12	0	0	17	0	0	0	0	0	0	0	0	1.0

7.2 Weight

Table 7-2 data was extracted from the previous validation and was updated to include the results of this validation. The table provides the mean error and standard deviation for GVW, steering and single axles and tandems for prior pre- and post-validations.

Table 7-2 – Weight Validation History

Date	Mean Error and 2SD		
	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
31-Jul-12	-1.2 ± 7.9	-0.9 ± 9.6	-1.3 ± 9.7

The overall accuracy of the weight errors appears to have remained reasonably consistent since the site was first validated. However, the precision has been slowly decreasing with time, possibly reflecting the increase in pavement roughness at the WIM site.

8 Additional Information

The following information is provided in the attached appendix:

- Site Photographs
    - Equipment
    - Test Trucks
    - Pavement Condition
- Validation Sheet 16 – Site Calibration Summary
- 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 – Validation 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: July 31, 2012

Photo 1 – Cabinet Exterior

Photo 2 – Cabinet Interior (Front)

Photo 3 – Cabinet Interior (Back)

Photo 4 – Leading Loop

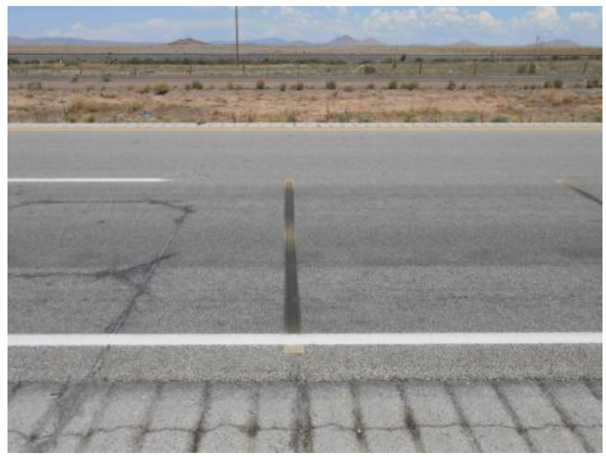


Photo 5 – Leading WIM Sensor

Photo 6 – Trailing WIM Sensor

Photo 7 – Trailing Loop Sensor

Photo 8 – Solar Panel

Photo 9 – Telephone Service Box

Photo 10 – Downstream

Photo 11 – Upstream

Photo 12 – Truck 1

Photo 13 – Truck 1 Tractor

Photo 14 – Truck 1 Trailer and Load

Photo 15 – Truck 1 Suspension 1

Photo 16 – Truck 1 Suspension 2

Photo 17 – Truck 1 Suspension 3

Photo 18 – Truck 1 Suspension 4

Photo 19 – Truck 1 Suspension 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

Photo 25 – Truck 2 Suspension 3

Photo 26 – Truck 2 Suspension 5

Photo 27 – Truck 2 Suspension 4

Traffic Sheet 16	STATE CODE:	35
LTPP MONITORED TRAFFIC DATA	SPS WIM ID:	350500
SITE CALIBRATION SUMMARY	DATE (mm/dd/yyyy)	7/31/2012

SITE CALIBRATION INFORMATION

1. DATE OF CALIBRATION {mm/dd/yy} 7/31/12

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
c.
b. Quartz Piezo
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	steel spring
Truck 3:			

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

Mean Difference Between -

Dynamic and Static GVW:	-1.2%	Standard Deviation:	3.9%
Dynamic and Static Single Axle:	-0.9%	Standard Deviation:	4.8%
Dynamic and Static Double Axles:	-1.3%	Standard Deviation:	4.8%

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

9. DEFINE SPEED RANGES IN MPH:

			Low		High	Runs
a.	Low	-	47.0	to	54.7	13
b.	Medium	-	54.8	to	62.4	14
c.	High	-	62.5	to	70.0	14
d.		-		to		
e.		-		to		

Traffic Sheet 16	STATE CODE:	35
LTPP MONITORED TRAFFIC DATA	SPS WIM ID:	350500
SITE CALIBRATION SUMMARY	DATE (mm/dd/yyyy)	7/31/2012

10. CALIBRATION FACTOR (AT EXPECTED FREE FLOW SPEED) 3657 | 3130

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:	-1.0	FHWA Class		-	
FHWA Class 8:	Unk	FHWA Class		-	
		FHWA Class		-	
		FHWA Class		-	

Percent of "Unclassified" Vehicles: 1.0%

Validation Test Truck Run Set - Pre

Person Leading Calibration Effort:

Contact Information: Phone:

E-mail:

Traffic Sheet 20 LTPP MONITORED TRAFFIC DATA SPEED AND CLASSIFICATION STUDIES	STATE CODE: 35 SPS WIM ID: 350500 DATE (mm/dd/yyyy) 7/31/2012

Count - 100 Time = 1:25:00 Trucks (4-15) - 100 Class 3s - 0

WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class
71	9	47889	70	9	64	9	47979	65	9
69	9	47902	69	9	53	5	47981	52	5
64	9	47908	65	9	64	9	47983	65	9
67	9	47909	67	9	69	12	47985	68	12
70	9	47910	71	9	69	9	47987	69	9
72	9	47911	71	9	73	9	47988	72	9
65	9	47913	65	9	70	5	47989	70	5
75	9	47915	74	9	67	4	48001	66	4
65	9	47917	65	9	70	9	48002	70	9
64	9	47920	64	9	72	9	48009	71	9
68	9	47921	69	9	73	9	48011	72	9
67	8	47923	67	5	72	9	48012	72	9
72	9	47927	71	9	68	9	48013	68	9
72	9	47928	72	9	68	9	48018	67	9
71	15	47929	72	9	70	9	48020	70	9
64	9	47930	64	9	63	9	48021	62	9
61	9	47931	61	9	70	9	48022	70	9
73	9	47933	73	9	70	9	48023	70	9
67	11	47934	66	11	75	9	48025	76	9
65	9	47937	65	9	60	9	48026	60	9
65	9	47939	65	9	64	5	48027	63	5
70	9	47944	70	9	74	5	48028	74	5
76	9	47973	76	9	65	11	48034	65	11
72	9	47975	71	9	66	9	48035	65	9
65	9	47977	65	9	74	9	48036	72	9

Sheet 1 - 0 to 50 Start: 10:40:00 Stop: 11:15:00

Recorded By: djw Verified By: djw

Validation Test Truck Run Set - Pre

Traffic Sheet 20 **LTPP MONITORED TRAFFIC DATA** **SPEED AND CLASSIFICATION STUDIES**	STATE CODE: 35 SPS WIM ID: 350500 DATE (mm/dd/yyyy) 7/31/2012

WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs. Class
68	9	48041	67	9	67	11	48148	67	11
72	11	48044	72	11	73	9	48153	73	9
71	9	48045	70	9	70	9	48157	70	9
75	9	48046	74	9	68	9	48159	68	9
65	9	48048	65	9	71	9	48160	70	9
67	9	48050	66	9	71	9	48162	71	9
75	5	48051	73	5	62	9	48164	63	9
65	11	48053	65	11	65	9	48165	63	9
67	11	48054	66	11	84	9	48166	82	9
68	9	48058	68	9	67	9	48168	67	9
62	9	48059	62	9	70	9	48170	70	9
69	9	48064	68	9	75	9	48171	75	9
73	9	48065	73	9	40	9	48176	43	9
66	9	48091	66	9	67	9	48177	65	9
77	9	48095	78	9	65	9	48179	65	9
65	9	48096	65	9	75	4	48182	76	4
64	11	48101	64	11	72	9	48185	71	9
67	9	48109	67	9	64	9	48187	64	9
62	9	48111	62	9	64	9	48197	64	9
61	6	48112	61	6	70	9	48202	70	9
65	9	48131	65	9	64	9	48205	65	9
62	9	48139	63	9	71	9	48206	70	9
72	9	48140	70	9	70	9	48207	70	9
68	9	48143	68	9	70	9	48208	70	9
64	9	48144	65	9	70	9	48209	70	9

Sheet 2 - 51 to 100 Start: 11:16:00 Stop: 12:05:00

Recorded By: djw Verified By: djw

Validation Test Truck Run Set - Pre