Validation Report

Minnesota, SPS-5
Task Order 15, CLIN 2
December 13, 2006

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1 Executive Summary

A visit was made to the Minnesota 0500 on December 13, 2006 for the purposes of conducting a validation of the WIM system located on US-2, located 21 miles west of Bemidji. The SPS-5 WIM system is located in the righthand, westbound lane of a four-lane divided facility. The validation procedures were in accordance with LTPP's SPS WIM Data Collection Guide dated August 21, 2001.

This is the first validation visit to this location. Installation of the site was completed on October 6, 2006 and was subsequently calibrated on October 31st and November 1st, 2006 by International Road Dynamics/PAT Traffic. This is a new WIM data location for the SPS-5. It was determined by others that the site originally selected to provide data did not have the same truck traffic stream.

This site meets all LTPP precision requirements except speed which is not considered sufficient to disqualify the site as having research quality data. The classification data is of research quality.

The site is instrumented with quartz piezo WIM sensors and an IRD/PAT Traffic iSINC controller. It is installed in asphalt concrete. At the time of installation, all four lanes were instrumented for WIM. The LTPP lane is designated as lane number 4 by the controller.

The validation used the following trucks:

1) 5-axle tractor-trailer with a tractor having an air suspension and trailer with a standard rear tandem and air suspension loaded to 78510 lbs., the "golden" truck.
2) 5-axle tractor semi-trailer with a tractor having air suspension and a trailer with split rear tandem and air suspension loaded to 67930 lbs., the "partial" truck.

Due to the unavailability of a certified truck weighing facility in the vicinity of the WIM site, alternative weighing procedures were developed and utilized during the Minnesota SPS-5 Validation.

The procedure was developed using the known weight of 1 gallon of diesel fuel, combined with the fuel usage during each phase of the validation and the fuel efficiency of each test vehicle to estimate the pre- and post-validation start and stop weights with reasonable accuracy.

The validation speeds ranged from 45 to 65 miles per hour. The pavement temperatures ranged from 13 to 37 degrees Fahrenheit. The desired speed range was achieved during this validation. The desired 30 degree Fahrenheit temperature range was not achieved.

Table 1-1 Post-Validation results – 270500 – 13-Dec-2006

SPS-1, -2, -5, -6 and -8	95 %Confidence Limit of Error	Site Values	Pass/Fail
Steering axles	±20 percent	-1.6 ± 6.8%	Pass
Single axles	±20 percent	-0.2 ± 6.6%	Pass
Tandem axles	±15 percent	4.6 ± 3.7%	Pass
GVW	±10 percent	3.0 ± 3.1%	Pass
Speed	±1 mph [2 km/hr]	**-0.1 ± 1.1 mph**	**Fail**
Axle spacing	± 0.5 ft [150mm]	0.0 ± 0.0 ft	Pass

The pavement condition appeared to be satisfactory for conducting a performance evaluation. There were no distresses observed that would influence truck motions significantly. A visual survey determined that there is no discernable bouncing or avoidance by trucks in the sensor area.

Profile data collected since the site installation does not exist. To our knowledge a site visit to collect profile data has not yet been scheduled. An amended report will be submitted when the profile data is available.

If this site had been evaluated using ASTM E-1318-02 it would have met the conditions for a Type I site exclusive of wheel loads. LTPP does not validate WIM performance with respect to wheel loads.

Table 1-2 Results Based on ASTM E-1318-02 Test Procedures

Characteristic	Limits for Allowable Error	Percent within Allowable Error	Pass/Fail
Single Axles	± 20%	100%	Pass
Axle Groups	± 15%	100%	Pass
GVW	± 10%	100%	Pass

This site needs five years of data to meet the goal of five years of research quality data.

2 Corrective Actions Recommended

No corrective actions are required at this site at this time.

3 Post Calibration Analysis

This final analysis is based on test runs conducted December 13, 2006 from late morning to late afternoon at test site 270500 on US-2, approximately 21 miles west of Bemidji. This SPS-5 site is at milepost 98 on the westbound, righthand lane of a four-lane divided facility. No auto-calibration was used during test runs. The two trucks used for the validation included:

1. 5-axle tractor-trailer with a tractor having an air suspension and trailer with a standard rear tandem and air suspension loaded to 78510 lbs., the “golden” truck.
2. 5-axle tractor semi-trailer with a tractor having air suspension and a trailer with split rear tandem and air suspension loaded to 67930 lbs., the “partial” truck.

Due to the unavailability of a certified truck weighing facility in the vicinity of the test site, alternative weighing practices were developed and utilized during this validation.

The pre-validation start weights were derived from weights taken at a facility near the trucks’ yard facility in St. Cloud after the trucks were completely fueled. Once the trucks were in the vicinity of the test area the trucks were completely refueled so that the weights from the weighing facility and the start weights would be nearly identical.

After each set of tests runs, the odometer readings from each test truck were recorded. Once testing was completed, the trucks were again completely refueled to discover the total fuel usage over the entire testing period. Fuel efficiency was derived from the total miles traveled and the amount of fuel consumed.

Using the odometer readings recorded at each testing milestone, weight loss from fuel consumption was computed and beginning and ending weight estimates for pre- and post-validations were derived.

Each truck made a total of 20 passes over the WIM scale at speeds ranging from approximately 45 to 65 miles per hour. The desired speed range was achieved during this validation. Pavement surface temperatures were recorded during the test runs ranging from about 13 to 37 degrees Fahrenheit. The desired 30 degree Fahrenheit temperature range was not achieved. The computed values of 95% confidence limits of each statistic for the total population are in Table 3-1.

As shown in Table 3-1, this site meets all LTPP precision requirements except speed which is not considered sufficient to disqualify the site as having research quality data.

Table 3-1 Post-Validation Results – 270500 – 13-Dec-2006

SPS-1, -2, -5, -6 and -8	95 %Confidence Limit of Error	Site Values	Pass/Fail
Steering axles	±20 percent	-1.6 ± 6.8%	Pass
Single axles	±20 percent	-0.2 ± 6.6%	Pass
Tandem axles	±15 percent	4.6 ± 3.7%	Pass
GVW	±10 percent	3.0 ± 3.1%	Pass
Speed	±1 mph [2 km/hr]	**-0.1 ± 1.1 mph**	**Fail**
Axle spacing	± 0.5 ft [150mm]	0.0 ± 0.0 ft	Pass

The test runs were conducted primarily during the evening and early morning hours, resulting in a limited range of pavement temperatures. The runs were also conducted at various speeds to determine the effects of these variables on the performance of the WIM scale. To investigate these effects, the dataset was split into three speed groups and three temperature groups. The distribution of runs by speed and temperature is illustrated in Figure 3-1. The figure indicates that the desired distribution of speed and temperature combinations was not achieved for this set of validation runs. Temperatures at this site during testing hours did not vary significantly due to cloud cover.

The three speed groups were divided as follows: Low speed - 45 to 51 mph, Medium speed - 52 to 60 mph and High speed - 61+ mph. The three temperature groups were created by splitting the runs between those at 13 to 20 degrees Fahrenheit for Low temperature, 21 to 29 degrees Fahrenheit for Medium temperature and 30 to 37 degrees Fahrenheit for High temperature.

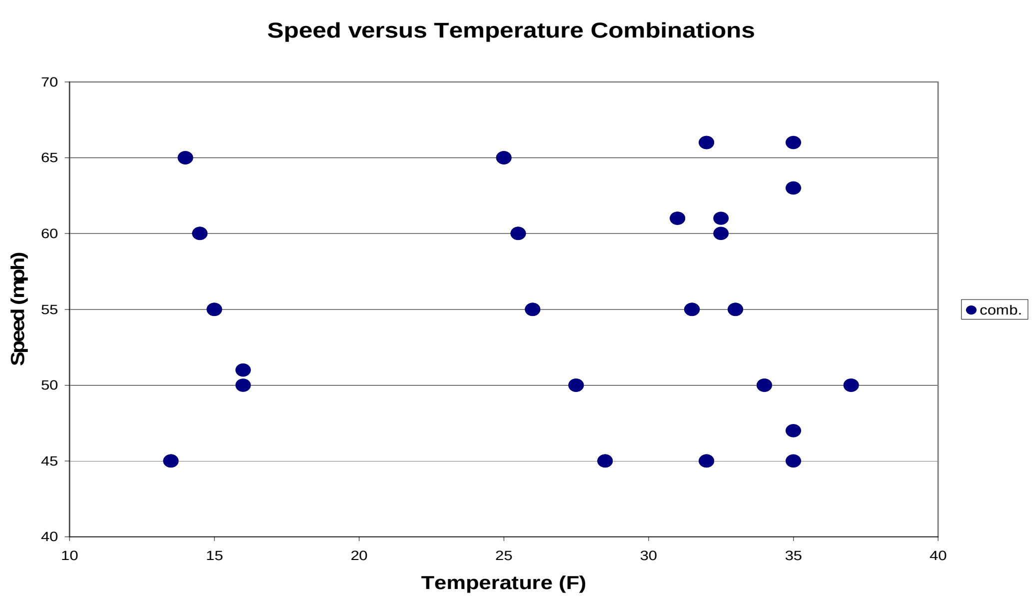

Figure 3-1 Post-Validation Speed-Temperature Distribution – 270500 – 13-Dec-2006

A series of graphs was developed to investigate visually any sign of a relationship between speed or temperature and the scale performance.

Figure 3-2 shows the GVW Percent Error vs. Speed graph for the population as a whole. From the figure, it appears that the equipment overestimates GVW at all speeds. There appears to be less variability in error at the medium speeds when compared with low and high speeds.

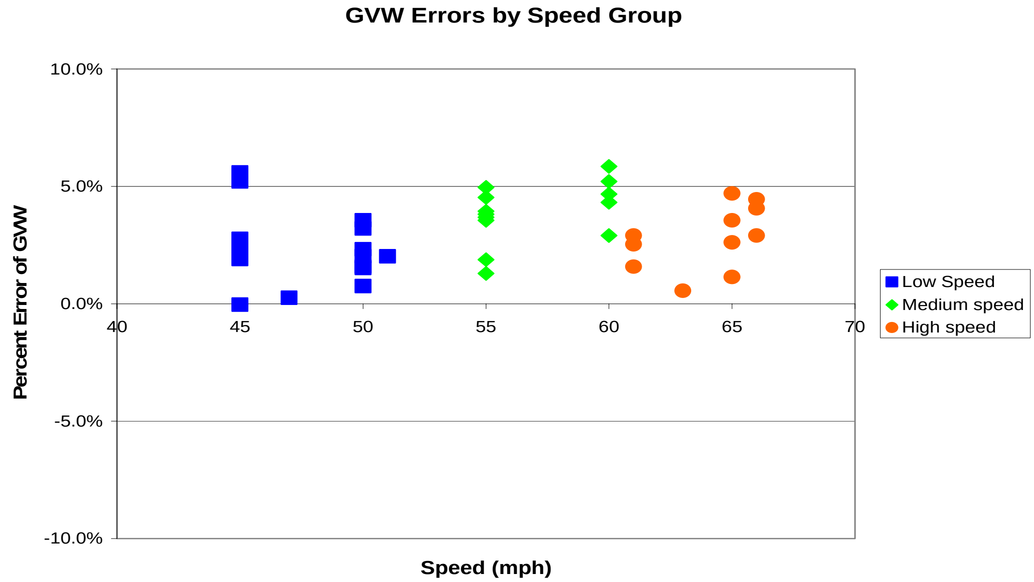

Figure 3-2 Post-Validation GVW Percent Error vs. Speed – 270500 – 13-Dec-2006

Figure 3-3 shows a lack of relationship between temperature and GVW percentage error.

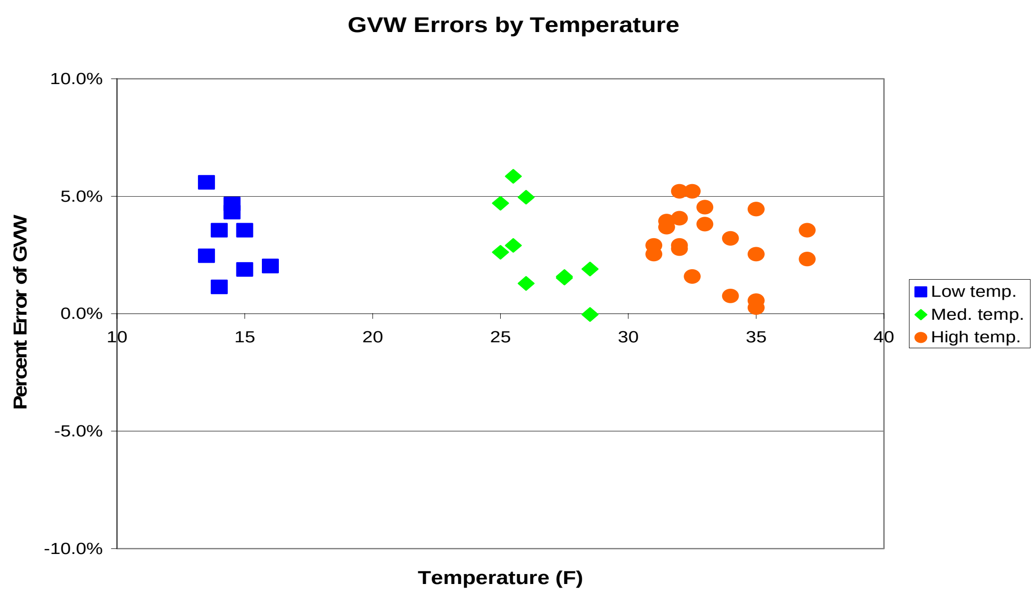

Figure 3-3 Post-Validation GVW Percent Error vs. Temperature – 270500 – 13-Dec-2006

Figure 3-4 shows the relationship between the drive tandem spacing errors in feet and speeds. This graph is used as a potential indicator of classification errors due to failure to correctly identify spacings on a vehicle. Since the most common reference value is the drive tandem on a Class 9 vehicle, this is the spacing evaluated and plotted for validations. The graph indicates that the errors in tandem spacings for the test trucks were not affected by changes in speed.

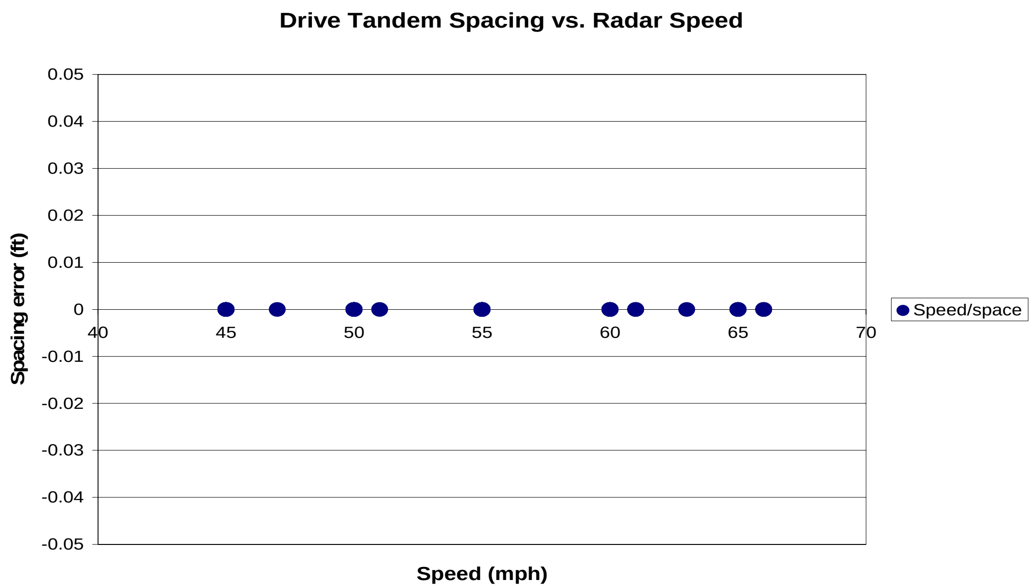

Figure 3-4 Post-Validation Spacing vs. Speed – 270500 – 13-Dec-2006

3.1 Temperature-based Analysis

The three temperature groups were created by splitting the runs between those at 13 to 20 degrees Fahrenheit for Low temperature, 21 to 29 degrees Fahrenheit for Medium temperature and 30 to 37 degrees Fahrenheit for High temperature.

Table 3-2 Post-Validation Results by Temperature Bin – 270500 – 13-Dec-2006

Element	95% Limit	Low Temperature 13-20 °F	Medium Temperature 21-29 °F	High Temperature 30-37 °F
Steering axles	±20 %	-1.3 ± 6.7%	-2.1 ± 6.8%	-1.6 ± 8%
Single axles	±20 %	0.1 ± 6.7%	-1.0 ± 5.6%	0.0 ± 7.3%
Tandem axles	±15 %	4.7 ± 4.3%	4.7 ± 4.8%	4.5 ± 3.2%
GVW	±10 %	3.1 ± 3.3%	2.7 ± 4.3%	3.0 ± 3.0%
Speed	±1 mph	-0.2 ± 1.0 mph	0.2 ± 1.0 mph	-0.2 ± 1.2 mph
Axle spacing	± 0.5 ft	0.0 ± 0.0 ft	0.0 ± 0.0 ft	0.0 ± 0.0 ft

From Table 3-2 it appears that the equipment underestimates GVW and overestimates single axle and tandem axle weights, except at medium temperatures where single axle weights were underestimated. The variability in error for GVW and tandem axle weights appears to be greater at medium temperatures when compared to low and high temperatures. For single axle weights, variability in error appears to be less at medium temperatures and for GVW, the variability in error appears to increase as temperatures increase.

Figure 3-5 is the distribution of GVW Errors versus Temperature by Truck graph. From the figure it can be seen that GVW for both trucks is overestimated at all temperatures. Variability in error is fairly constant over the entire temperature range.

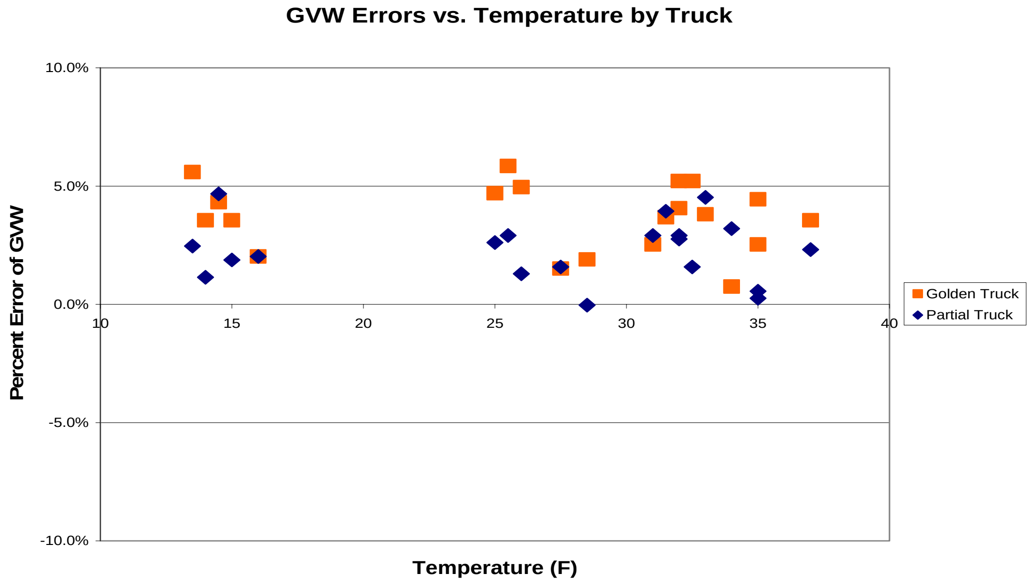

Figure 3-5 Post-Validation GVW Percent Error vs. Temperature by Truck – 270500 – 13-Dec-2006

Figure 3-6 shows the relation between steering axle errors and temperature. This graph is included due to the frequent use of steering axle weights of Class 9 vehicles for calibration. This site does not use auto-calibration. The steering axles in this graph are associated only with Class 9 vehicles.

From the figure, it can be seen that the equipment underestimates steering axle weights at all temperatures. Variability in error is greater at the higher temperatures when compared with variability at low and medium temperatures.

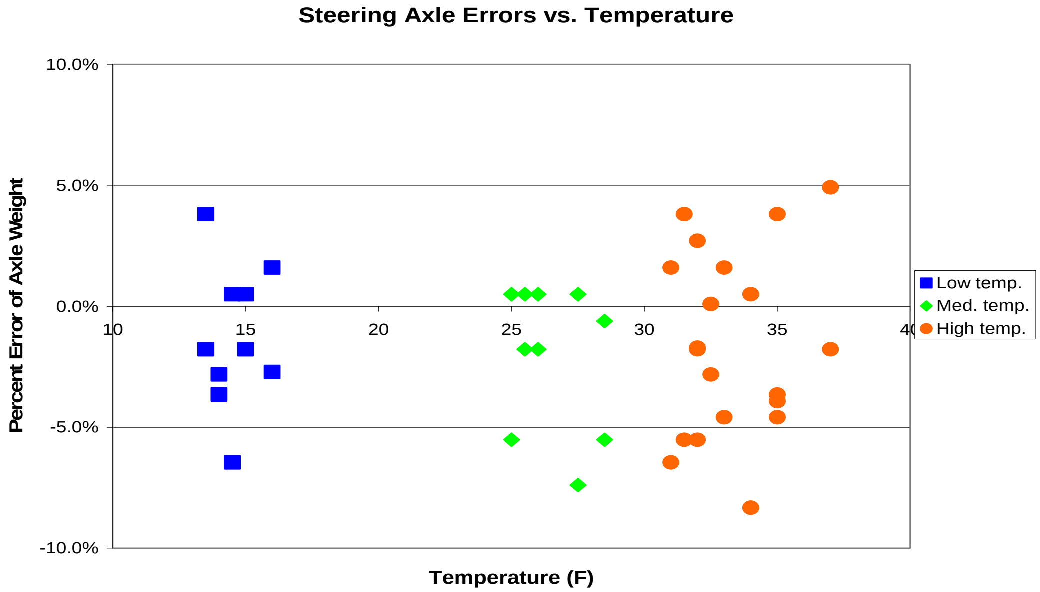

Figure 3-6 Post-Validation Steering Axle Error vs. Temperature by Group – 270500 – 13-Dec-2006

Figure 3-7 shows that the temperature effects for different single axles on a vehicle are similar.

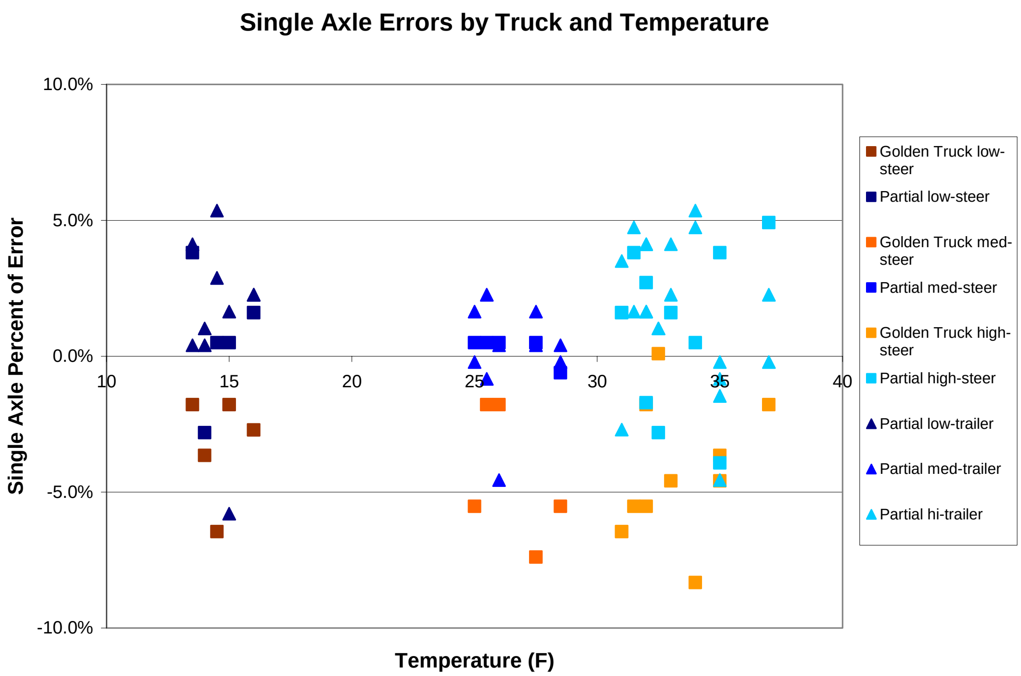

Figure 3-7 Post-Validation Single Axle Errors by Truck and Temperature – 270500 – 13-Dec-2006

3.2 Speed-based Analysis

The three speed groups were divided using 45 to 51 mph for Low speed, 52 to 60 mph for Medium speed and 61+ mph for High speed.

Table 3-3 Post-Validation Results by Speed Bin – 270500 – 13-Dec-2006

Element	95% Limit	Low Speed 45-51 mph	Medium Speed 52-60 mph	High Speed 61+ mph
Steering axles	±20 %	-1.0 ± 8.4%	-1.1 ± 6.4%	-3.2 ± 5.6%
Single axles	±20 %	0.3 ± 7.1%	0.0 ± 6.9%	-1.1 ± 6.1%
Tandem axles	±15 %	3.3 ± 3.9%	5.9 ± 2.1%	5.0 ± 2.8%
GVW	±10 %	2.4 ± 3.3%	3.9 ± 2.8%	2.8 ± 3%
Speed	±1 mph	-0.1 ± 0.9 mph	0 ± 0.9 mph	-0.2 ± 1.7 mph
Axle spacing	± 0.5 ft	0.0 ± 0.0 ft	0.0 ± 0.0 ft	0.0 ± 0.0 ft

From Table 3-3, it can be seen that the equipment generally tends to overestimate all weights except steering axle weights. The variability in error decreases for steering and single axle weights as speed increases. Variability for tandem axle weights and GVW is less at medium speeds when compared with low and high speeds.

Figure 3-8 illustrates the tendency for the equipment to overestimate GVW at all speeds for both trucks. Variability is fairly constant over the entire speed range for the population as a whole as well as for each truck individually.

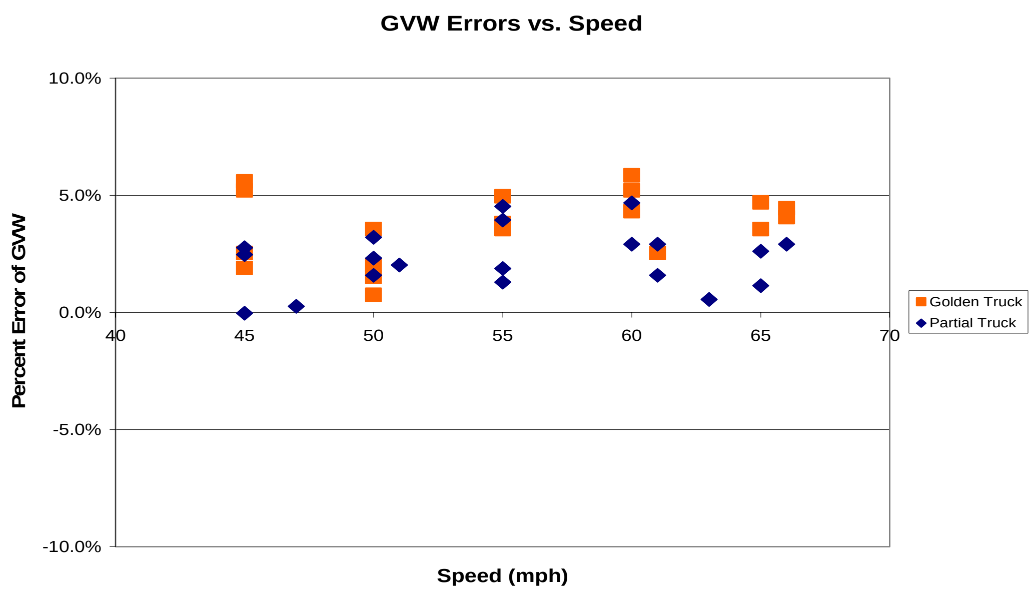

Figure 3-8 Post-Validation GVW Percent Error vs. Speed by Truck – 270500 – 13-Dec-2006

Figure 3-9 shows the relation between steering axle errors and speed. This graph is included due to the frequent use of steering axle weights of Class 9 vehicles for auto-calibration. This site does not use auto-calibration. The steering axles in this graph are associated only with Class 9 vehicles.

From the figure, it appears that the WIM equipment underestimates steering axle weights fairly consistently at all speeds. The variability in error appears to decrease as speed increases. The underestimation increases as speed increases.

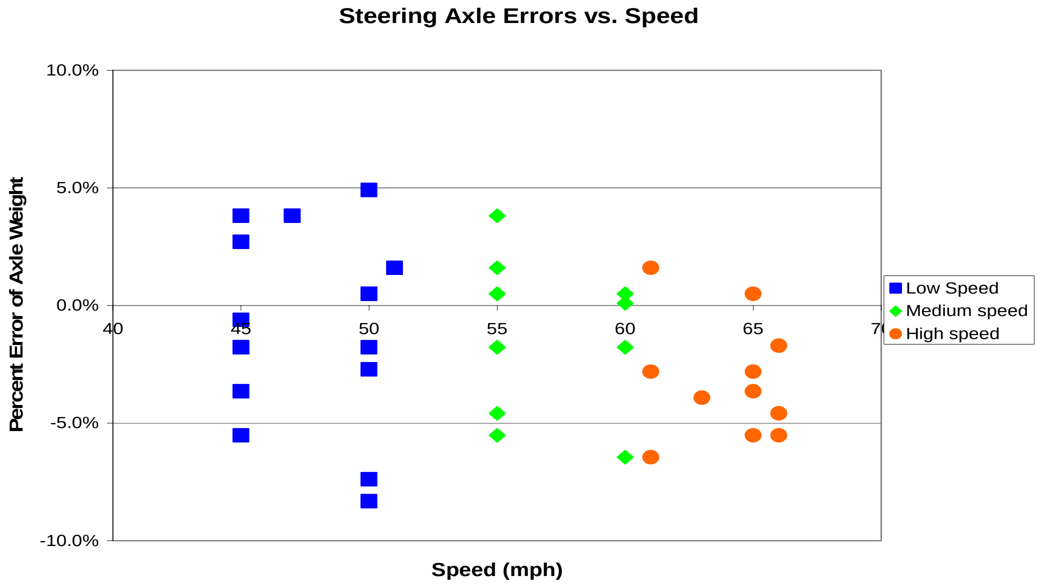

Figure 3-9 Post-Validation Steering Axle Percent Error vs. Speed by Group – 270500 – 13-Dec-2006

Figure 3-10 shows that the errors associated with multiple single axles on a truck are somewhat different. Those associated with the rear tandem seem to be closer to unbiased or an overestimate of the error in weight where the steering axle is generally underestimated.

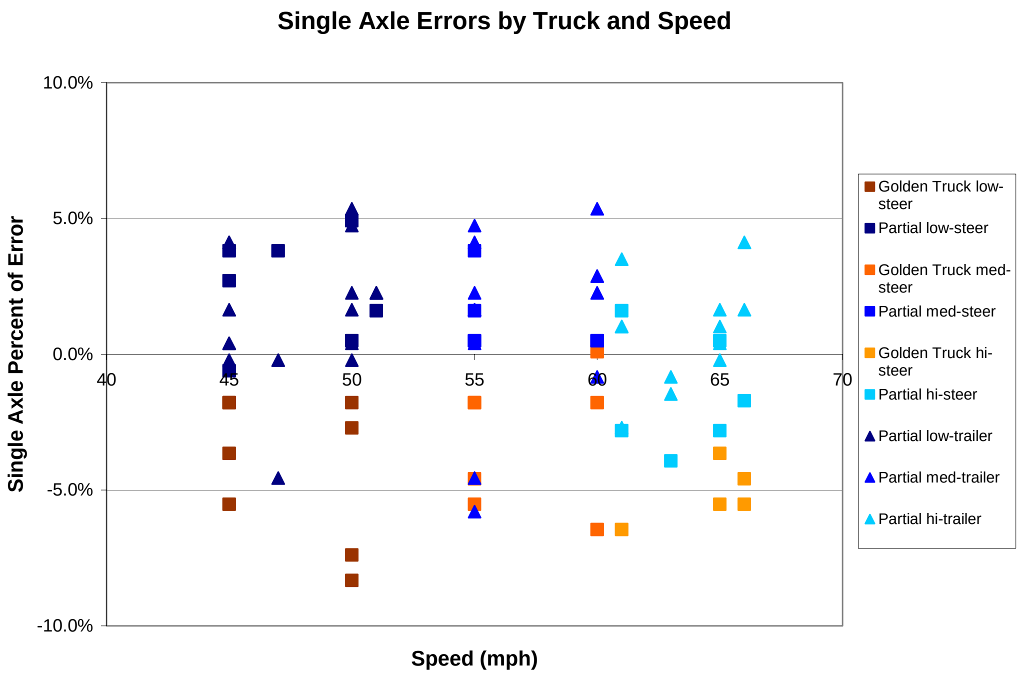

Figure 3-10 Post-Validation Single Axle Errors by Truck and Speed – 270500 – 13-Dec-2006

3.3 Classification Validation

This LTPP installed site uses the FHWA 13-bin classification scheme and the LTPP classification algorithm, mod 3. Classification 15 has been added to account for unclassified vehicles.

The classification validation is intended to find gross errors in vehicle classification, not to validate the installed algorithm. A sample of 3 hours of data was collected at the site. Three hours is the maximum sample length for this element of the validation. Video was taken at the site to provide ground truth for the evaluation. Based on the 3 hour sample with 40 trucks, it was determined that there are 0 percent unknown vehicles and 0 percent unclassified vehicles.

The second check is the ability of the algorithm to correctly distinguish between truck classes with no more than 2% errors in such classifications. Table 3-4 has the classification error rates by class. The overall misclassification rate is .0 percent.

Table 3-4 Truck Misclassification Percentages for 270500 – 13-Dec-2006

Class	Percent Error	Class	Percent Error	Class	Percent Error
4	0	5	0	6	0
7	N/A				
8	N/A	9	0	10	0
11	N/A	12	N/A	13	N/A

The misclassification percentage is computed as the probability that a pair containing the class of interest does NOT include a match. Thus if there are eight pairs of observations with at least one Class 9 and only six of them are matches, the error rate is 25 percent. The percent error and the mean differences reported below do not represent the same statistic. It is possible to have error rates greater than 0 with a mean difference of zero.

Table 3-5 Truck Classification Mean Differences for 270500 – 13-Dec-2006

Class	Mean Difference	Class	Mean Difference	Class	Mean Difference
4	0	5	0	6	0
7	N/A				
8	N/A	9	0	10	0
11	N/A	12	N/A	13	N/A

These error rates are normalized to represent how many vehicles of the class are expected to be over or under-counted for every hundred of that class observed by the equipment. Thus a value of 0 means the class is identified correctly on average. A number between –1 and –100 indicates at least that number of vehicles either missed or not assigned to the class by the equipment. It is not possible to miss more than all of them or one hundred out of one hundred. Numbers 1 or larger indicate at least how many more vehicles are assigned to the class than the actual “hundred observed”. Classes marked Unknown are those identified by the equipment but no vehicles of the type were seen the observer. There is no way to tell how many vehicles of that type might actually exist. N/A means no vehicles of the class were recorded by either the equipment or the observer.

3.4 Evaluation by ASTM E-1318 Criteria

The ASTM E-1318 criteria for a successful validation of Type I sites is 95% of the observed errors within the limits for allowable errors for each of the relevant statistics. If this site had been evaluated using ASTM E-1318-02 it would have met the conditions for a Type I site exclusive of wheel loads. LTPP does not validate WIM performance with respect to wheel loads.

Table 3-6 Results of Validation Using ASTM E-1318-02 Criteria

Characteristic	Limits for Allowable Error	Percent within Allowable Error	Pass/Fail
Single Axles	± 20%	100%	Pass
Axle Groups	± 15%	100%	Pass
GVW	± 10%	100%	Pass

4 Pavement Discussion

The pavement condition did not appear to influence truck movement across the sensors.

4.1 Profile Analysis

Profile data collected since the site installation does not exist. A site visit to collect profile data has not been scheduled yet. An amended report will be submitted when the data is available.

4.2 Distress Survey and Any Applicable Photos

During a visual survey of the pavement no distresses that would influence truck movement across the WIM scales were noted.

4.3 Vehicle-pavement Interaction Discussion

A visual observation of the trucks as the 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 wheel path and daylight cannot be seen between the tires of any of the sensors for the equipment.

5 Equipment Discussion

The traffic monitoring equipment at this location includes quartz piezo WIM sensors and an IRD/PAT Traffic iSINC controller. These sensors are installed in asphalt concrete pavement.

5.1 Pre-Evaluation Diagnostics

A complete electronic and electrical check of all system components including in-road sensors, electrical power, and telephone service were performed immediately prior to the evaluation. All sensors and system components were found to be within operating parameters.

5.2 Calibration Process

The equipment required no iterations of the calibration process between the initial 40 runs and the final 40 runs.

5.3 Summary of Traffic Sheet 16s

This site has validation information from the current visit in the tables below. There is no validation information for previous visits since this is the original installation at this site. However; there should have been a Sheet 16 completed at the time of the initial calibration of the site. If one was prepared, it was not available for inclusion in this report. Therefore, Table 5-1 has only the information this validation.

Table 5-1 Classification Validation History – 270500 – 13-Dec-2006

Date	Method	Mean Difference				Percent Unclassified
		Class 9	Class 8	Other 1	Other 2	
13-Dec-06	Manual	0	0			0
13-Dec-06	Manual	0	0			0

Table 5-2 has the information for Sheet 16s submitted for this validation visit.

Table 5-2 Weight Validation History – 270500 – 13-Dec-2006

Date	Method	Mean Error and (SD)		
		GVW	Single Axles	Tandem Axles
13-Dec-06	Test Trucks	3.0 (1.5)	-1.6 (3.3)	4.6 (1.8)
13-Dec-06	Test Trucks	-0.6 (3.1)	-5.2 (3.6)	1.6 (5.4)

5.4 Projected Maintenance/Replacement Requirements

Semi-annual preventive maintenance is to be performed at this site under provisions of the Phase II contract. There are no corrective maintenance actions required at this site at this time.

6 Pre-Validation Analysis

This pre-validation analysis is based on test runs conducted December 13, 2006 during the morning hours at 270500 on US-2, approximately 21 miles west of Bemidji. This SPS-5 site is at milepost 98 on the westbound, righthand lane of a four-lane divided facility. No auto-calibration was used during test runs. The two trucks used for initial validation included:

1. 5-axle tractor semi-trailer combination with a tractor having an air suspension and trailer with standard rear tandem and an air suspension loaded to 78820 lbs., the “golden”” truck.
2. 5-axle tractor semi-trailer with a tractor having air suspension and a trailer with standard rear tandem and air suspension loaded to 68260 lbs., the “partial” truck.

Due to the unavailability of a certified truck weighing facility in the vicinity of the test site, alternative weighing procedures were developed and utilized during this validation.

The pre-validation start weights were derived from weights taken at a facility near the trucks’ yard facility in St. Cloud after the trucks were completely fueled. Once the trucks were in the vicinity of the test area the trucks were completely refueled so that the weights from the weighing facility and the start weights would be nearly identical.

After each set of tests runs, the odometer readings from each test truck were recorded. Once testing was completed, the trucks were again completely refueled to discover the total fuel usage over the entire testing period. Fuel efficiency was derived from the total miles traveled and the amount of fuel consumed.

Using the odometer readings recorded at each testing milestone, weight loss from fuel consumption was computed and beginning and ending weight estimates for pre- and post-validations were derived.

For the initial validation each truck made a total of 20 passes over the WIM scale at speeds ranging from approximately 45 to 65 miles per hour. The desired speed range was achieved during this validation. Pavement surface temperatures were recorded during the test runs ranging from about 15 to 32 degrees Fahrenheit. The desired 30 degree Fahrenheit temperature range was not achieved. The computed values of 95% confidence limits of each statistic for the total population are in Table 6-1.

As shown in Table 6-1 this site meets all LTPP precision requirements except speed which is not considered sufficient to disqualify the site as having research quality data.

Table 6-1 Pre-Validation Results – 270500 – 13-Dec-2006

SPS-1, -2, -5, -6 and -8	95 %Confidence Limit of Error	Site Values	Pass/Fail
Steering axles	±20 percent	-5.2 ± 7.3%	Pass
Single axles	±20 percent	-4.3 ± 10.4%	Pass
Tandem axles	±15 percent	1.6 ± 5.4%	Pass
GVW	±10 percent	-0.6 ± 6.3%	Pass
Speed	±1 mph [2 km/hr]	**-0.4 ± 1.3 mph**	**Fail**
Axle spacing	± 0.5 ft [150mm]	-0.0 ± 0.0 ft	Pass

The test runs were conducted primarily during the morning hours, resulting in a narrow range of pavement temperatures. The runs were also conducted at various speeds to determine the effects of these variables on the performance of the WIM scale. To investigate these effects, the dataset was split into three speed groups and two temperature groups. The distribution of runs within these groupings is illustrated in Figure 6-1. The figure indicates that the desired distribution of speed and temperature combinations was not achieved for this set of validation runs. Temperatures at this site during testing hours remained very low, without much increase throughout the day.

The three speed groups were divided into 45 to 51 mph for Low speed, 52 to 60 mph for Medium speed and 61+ mph for High speed. The two temperature groups were created by splitting the runs between those at 14 to 25 degrees Fahrenheit for Low temperature and 26 to 32 degrees Fahrenheit for High temperature.

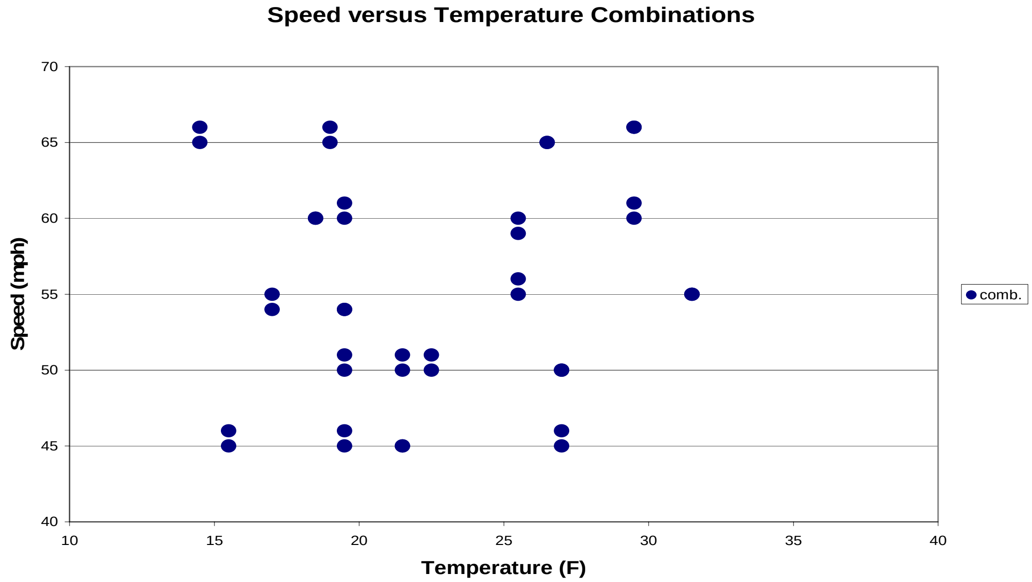

Figure 6-1 Pre-Validation Speed-Temperature Distribution – 270500 – 13-Dec-2006

A series of graphs was developed to investigate visually for any sign of any relationship between speed or temperature and the scale performance.

Figure 6-2 shows the GVW Percent Error vs. Speed graph for the population as a whole. The figure illustrates the tendency for the equipment to underestimate GVW at low speeds and transition toward an overestimation at high speeds. Variability appears to remain fairly consistent over the entire speed range with the exception of a couple outliers. Both of the outliers where GVW was underestimated by nearly 10 percent were associated with lighter weights on the right side of the rear tandem. It is possible that the tires were not completely on the sensors as they crossed the WIM area.

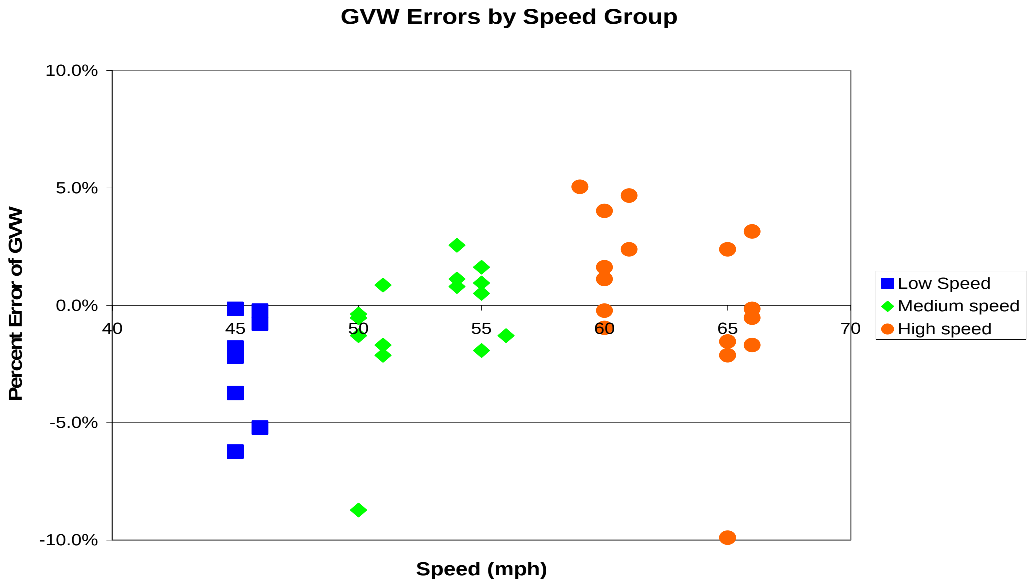

Figure 6-2 Pre-validation GVW Percent Error vs. Speed – 270500 – 13-Dec-2006

Figure 6-3 shows the relationship between temperature and GVW percentage error. As can be seen in the figure, the equipment tends to underestimate GVW at low temperatures and overestimate GVW at high temperatures. The outliers are not thought to be associated with temperature but with vehicle tracking.

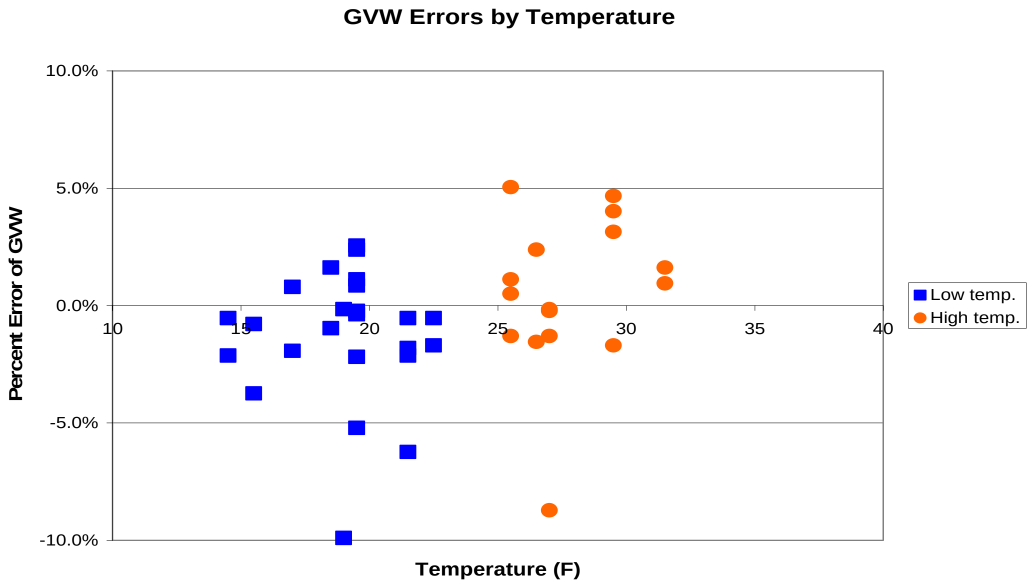

Figure 6-3 Pre-Validation GVW Percent Error vs. Temperature – 270500 – 13-Dec-2006

Figure 6-4 shows the relationship between the drive tandem spacing errors in feet and speeds. This graph is used as a potential indicator of classification errors due to failure to correctly identify spacings on a vehicle. Since the most common reference value is the drive tandem on a Class 9 vehicle, this is the spacing evaluated and plotted for validations. The graph indicates that the errors in tandem spacings for the test trucks were not affected by changes in speed.

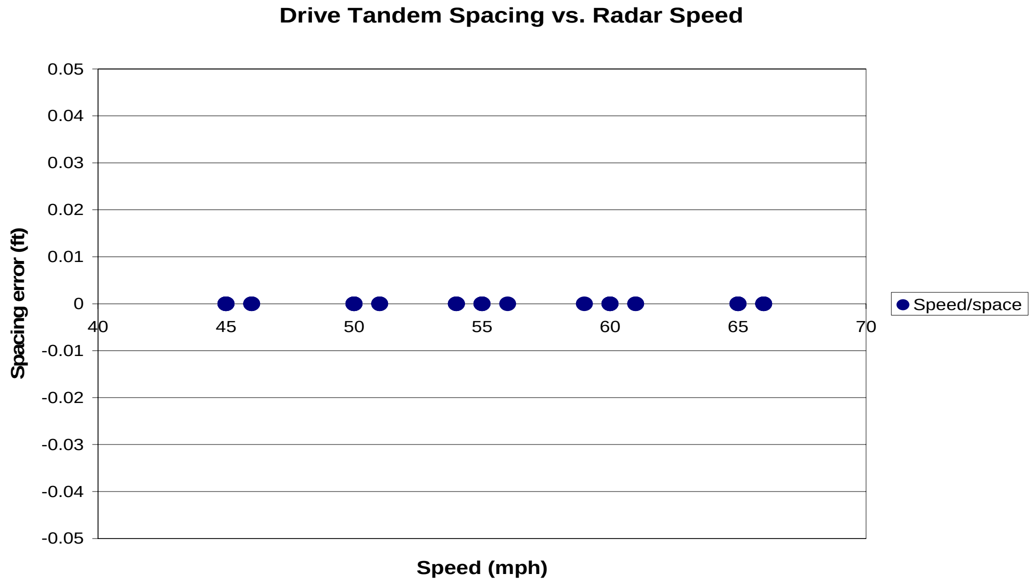

Figure 6-4 Pre-Validation Spacing vs. Speed - 270500 – 13-Dec-2006

6.1 Temperature-based Analysis

The two temperature groups were created by splitting the runs between those at 14 to 25 degrees Fahrenheit for Low temperature and 26 to 32 degrees Fahrenheit for High temperature.

Table 6-2 Pre-Validation Results by Temperature Bin – 270500 – 13-Dec-2006

Element	95% Limit	Low Temperature 14-25 °F	High Temperature 26-32 °F
Steering axles	±20 %	-5.5 ± 7.5%	-4.7 ± 7.8%
Single axles	±20 %	-4.9 ± 10.1%	-3.5 ± 11.2%
Tandem axles	±15 %	0.8 ± 4.6%	2.7 ± 6.2%
GVW	±10 %	-1.3 ± 5.8%	0.5 ± 7.1%
Speed	±1 mph	-0.3 ± 1.5 mph	-0.4 ± 1.3 mph
Axle spacing	± 0.5 ft	0.0 ± 0.0 ft	0.0 ± 0.0 ft

From Table 6-2, it appears that the equipment underestimates steering and single axle weights at all temperatures, overestimates tandem axle weights at all temperatures. For GVW, the equipment underestimates at low temperatures, and overestimates at high temperatures. The variability in error appears to increase for all weights as temperature increases.

Figure 6-5 shows the distribution of GVW Errors versus Temperature by Truck. The equipment appears to transition from an underestimation at low temperatures to an overestimation at high temperatures for the population as a whole as well as for each truck individually. Variability in error appears to be slightly greater for the Partial truck (diamonds) at all temperatures when compared with the variability in error for the Golden truck (squares).

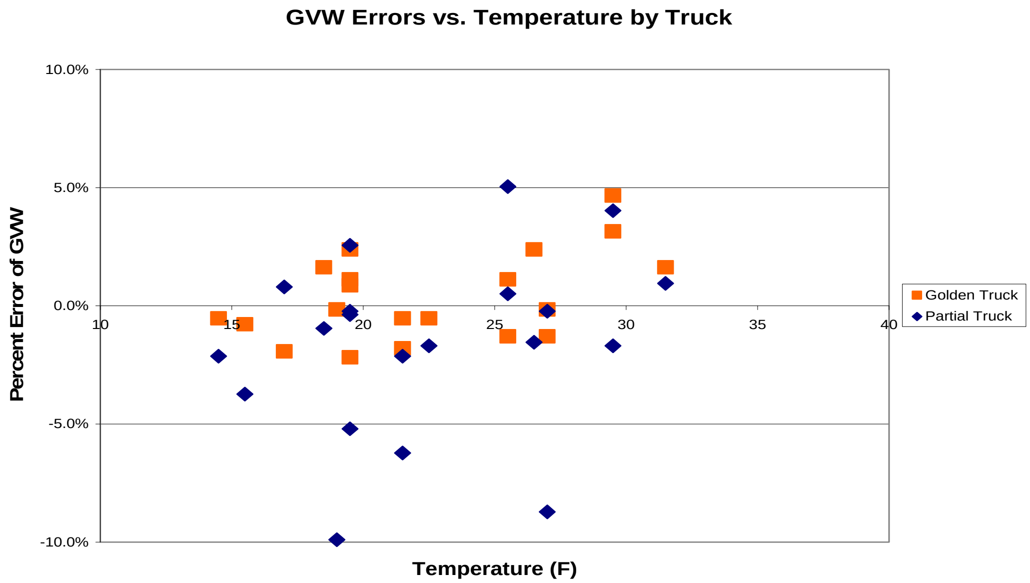

Figure 6-5 Pre-Validation GVW Percent Error vs. Temperature by Truck – 270500 – 13-Dec-2006

Figure 6-6 shows the relation between steering axle errors and temperature. This graph is included due to the frequent use of steering axle weights of Class 9 vehicles for auto-calibration. This site does not use auto-calibration. The steering axles in this graph are associated only with Class 9 vehicles. The figure shows that steering axle weights are consistently underestimated by the equipment over the entire temperature range.

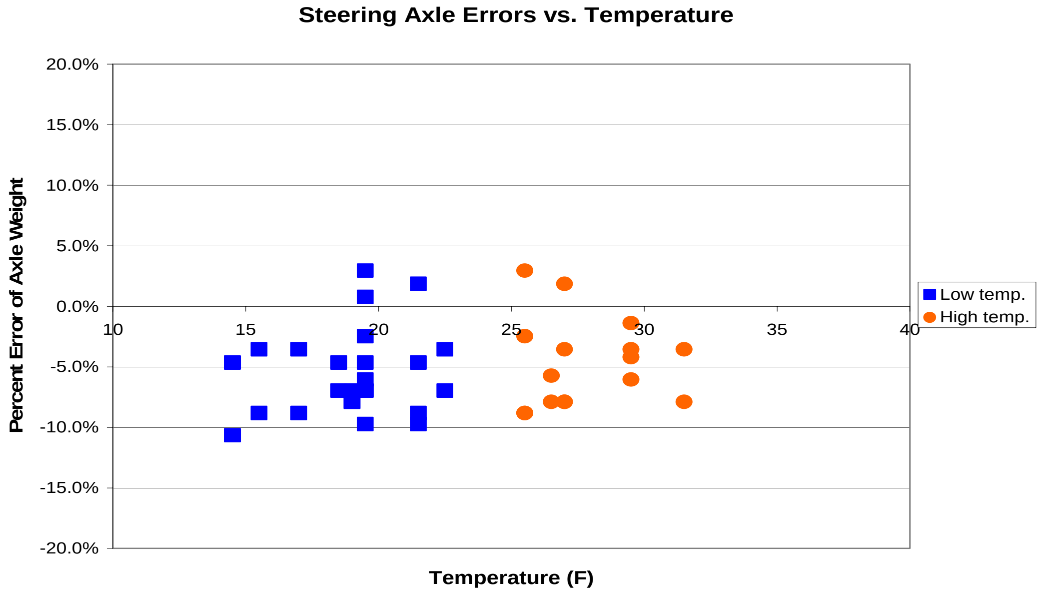

Figure 6-6 Pre-Validation Steering Axle Error vs. Temperature by Group – 270500 – 13-Dec-2006

Figure 6-7 indicates that the errors associated with different single axles on a truck are not particularly influenced by temperature.

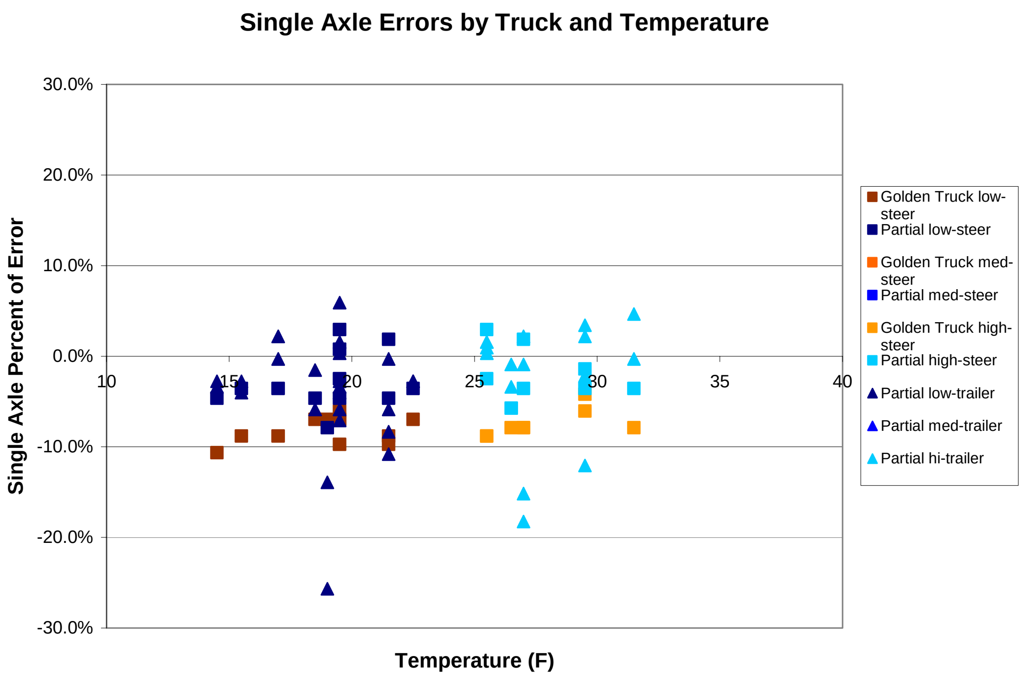

Figure 6-7 Pre-Validation Single Axle Errors by Truck and Temperature – 270500 – 13-Dec-2006

6.2 Speed-based Analysis

The speed groups were divided as follows: Low speed - 45 to 51 mph, Medium speed - 52 to 60 mph and High speed - 61+ mph.

Table 6-3 Pre-Validation Results by Speed Bin – 270500 – 13-Dec-2006

Element	95% Limit	Low Speed 45-51 mph	Medium Speed 52-60 mph	High Speed 61+ mph
Steering axles	±20 %	-4.9 ± 9%	-4.6 ± 8%	-6.4 ± 4.7%
Single axles	±20 %	-5.1 ± 9.9%	-1.9 ± 8.7%	-7.1 ± 12.2%
Tandem axles	±15 %	-0.3 ± 3.9%	2.7 ± 5.6%	3 ± 4.8%
GVW	±10 %	-2.2 ± 5.5%	1.1 ± 4.2%	-0.3 ± 9.2%
Speed	±1 mph	-0.7 ± 1.3 mph	0 ± 1.2 mph	-0.3 ± 1.5 mph
Axle spacing	± 0.5 ft	0.0 ± 0.0 ft	0.0 ± 0.0 ft	0.0 ± 0.0 ft

From Table 6-3, it can be seen that the equipment underestimates tandem weights at low speeds and overestimates at medium and high speeds. Steering axle and single axle weights are underestimated at all speeds. Variability in steering axle error appears to increase as speed increases while the error spread for steering axle weight error appears to decrease as speeds increase. Variability in tandem axles and GVW appears to fairly consistent over the entire speed range.

Figure 6-8 illustrates the tendency of the equipment to underestimate GVW at low speeds. The equipment appears to estimate GVW reasonably well at other speeds, with a slight overestimation at 60 mph. Variability in error appears to greater for the Partial truck at low and high speeds when compared with the Golden truck. The outliers in the figure are a result of low trailer tandem weights on the right side. This may result from tires partly missing the WIM sensor.

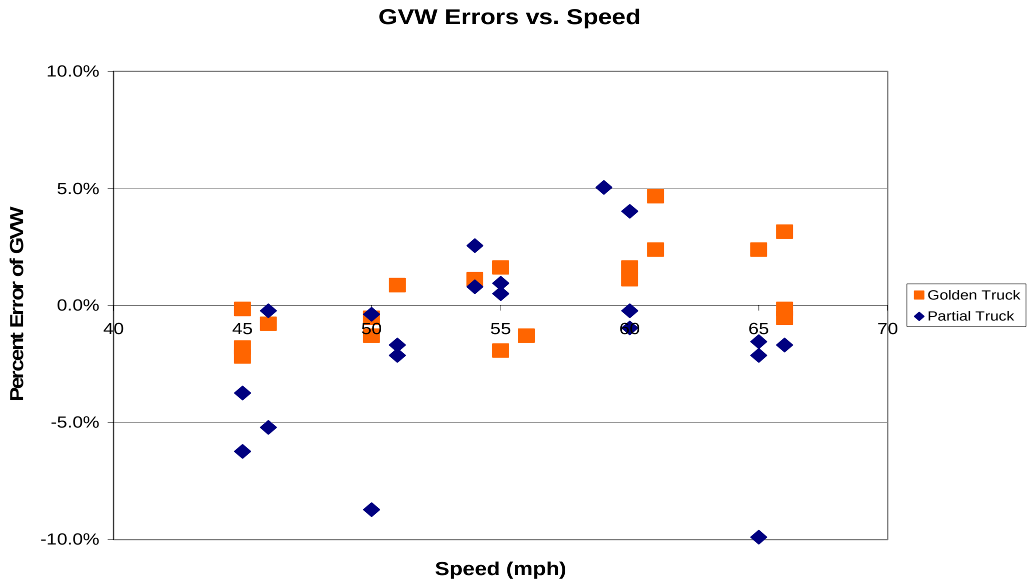

Figure 6-8 Pre-Validation GVW Percent Error vs. Speed Group - 270500 –13-Dec-2006

Figure 6-9 shows the relation between steering axle errors and speed. This graph is included due to the frequent use of steering axle weights of Class 9 vehicles for calibration. This site does not use auto-calibration. The steering axles in this graph are associated only with Class 9 vehicles.

From the figure, it appears that the equipment underestimates steering axle weights at all speeds. The underestimation appears to decrease slightly as speed increases. Variability in error appears to decrease as speed increases.

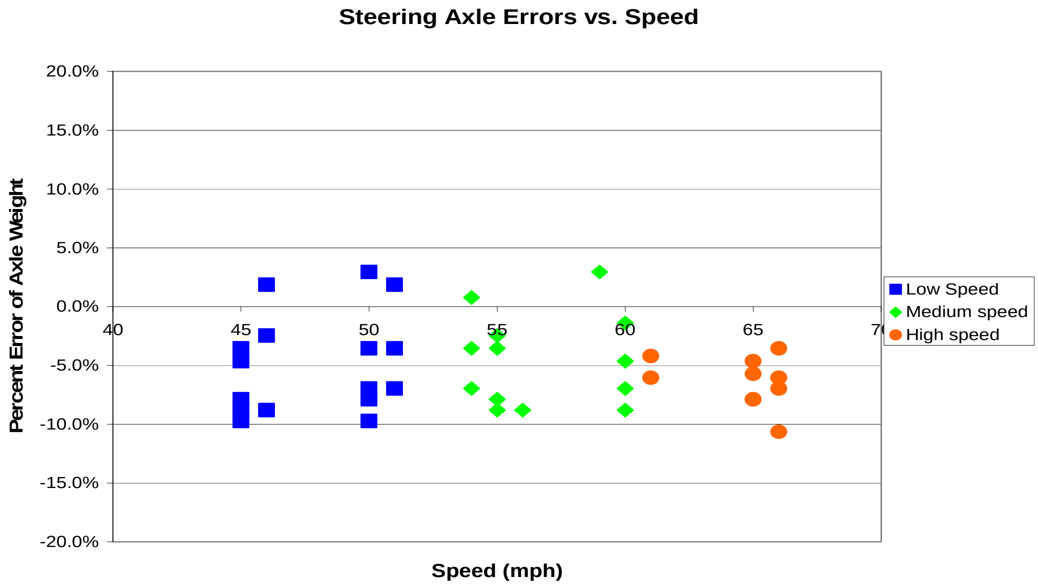

Figure 6-9 Pre-Validation Steering Axle Percent Error vs. Speed Group - 270500 – 13-Dec-2006

Figure 6-10 shows the distribution of single axle errors for multiple single axles on a vehicle. The axles on the split tandem for the "partial" truck have both larger and smaller weight errors with respect to the steering axle errors at the various speeds.

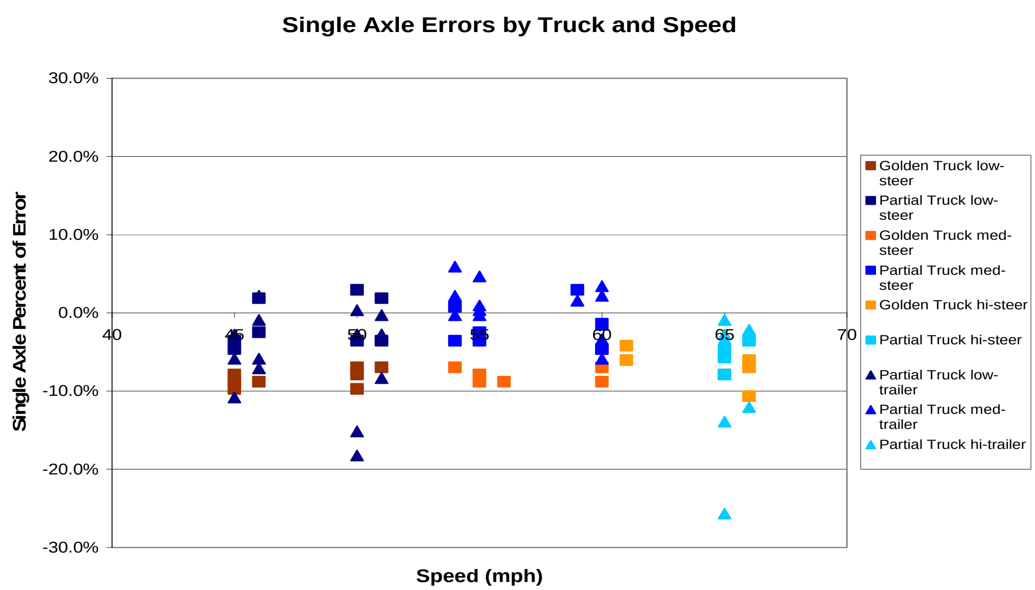

Figure 6-10 Pre-Validation Single Axle Errors by Truck and Speed 270500 – 13-Dec-2006

6.3 Classification Validation

This LTPP installed site uses the FHWA 13-bin classification scheme and the LTPP classification algorithm, mod 3. Classification 15 has been added to account for unclassified vehicles.

The classification validation is intended to find gross errors in vehicle classification, not to validate the installed algorithm. A sample of 3 hours of data was collected at the site. This is the maximum amount of time allowed for this part of the validation. The classification identification is to identify gross errors in classification, not validate the classification algorithm. Video was taken at the site to provide ground truth for the evaluation. Based on a 3 hour sample with 20 trucks, it was determined that there are 0 percent unknown vehicles and 0 percent unclassified vehicles.

The second check is the ability of the algorithm to correctly distinguish between truck classes with no more than 2% errors in such classifications. Table 6-4 has the classification error rates by class. The overall misclassification rate is 0 percent.

Table 6-4 Truck Misclassification Percentages for 270500 – 13-Dec-2006

Class	Percent Error	Class	Percent Error	Class	Percent Error
4	0	5	0	6	0
7	N/A				
8	N/A	9	0	10	0
11	N/A	12	N/A	13	N/A

The misclassification percentage is computed as the probability that a pair containing the class of interest does NOT include a match. Thus if there are eight pairs of observations with at least one Class 9 and only six of them are matches, the error rate is 25 percent. The percent error and the mean differences reported below do not represent the same statistic. It is possible to have error rates greater than 0 with a mean difference of zero.

Table 6-5 Truck Classification Mean Differences for 270500 – 13-Dec-2006

Class	Mean Difference	Class	Mean Difference	Class	Mean Difference
4	0	5	0	6	0
7	N/A				
8	N/A	9	0	10	0
11	N/A	12	N/A	13	N/A

These error rates are normalized to represent how many vehicles of the class are expected to be over- or under-counted for every hundred of that class observed by the equipment. Thus a value of 0 means the class is identified correctly on average. A number between –1 and –100 indicates at least that number of vehicles either missed or not assigned to the class by the equipment. It is not possible to miss more than all of them or one hundred out of one hundred. Numbers 1 or larger indicate at least how many more vehicles are assigned to the class than the actual "hundred observed". Classes marked Unknown are those identified by the equipment but no vehicles of the type were seen the observer. There is no way to tell how many vehicles of that type might actually exist. N/A means no vehicles of the class were recorded by either the equipment or the observer.

6.4 Evaluation by ASTM E-1318 Criteria

The ASTM E-1318 criteria for a successful validation of Type I sites is 95% of the observed errors within the limits for allowable errors for each of the relevant statistics. If this site had been evaluated using ASTM E-1318-02 it would have met the conditions for a Type I site exclusive of wheel loads. LTPP does not validate WIM performance with respect to wheel loads.

Table 6-6 Results of Validation Using ASTM E-1318-02 Criteria

Characteristic	Limits for Allowable Error	Percent within Allowable Error	Pass/Fail
Single Axles	± 20%	99%	Pass
Axle Groups	± 15%	100%	Pass
GWV	± 10%	100%	Pass

7 Data Availability and Quality

As of December 13, 2006, this site does not have at least 5 years of research quality data. Research quality data is defined to be at least 210 days in a year of data of known calibration meeting LTPP's precision requirements.

Data that has validation information available has been reviewed in light of the patterns present in the two weeks immediately following a validation/calibration activity. A determination of research quality data is based on the consistency with the validation pattern. Data that follows consistent and rational patterns in the absence of calibration information may be considered nominally of research quality pending validation information with which to compare it. Data that is inconsistent with expected patterns and has no supporting validation information is not considered research quality.

This site is a new installation. A study performed on July 30 and 31, 2002 recommended that the site be relocated due to the finding that the traffic stream at the WIM site was not representative of the traffic stream at the LTPP pavement test location. Therefore, there is no data for this site. An additional 5 years of data is needed to meet the goal of a minimum of 5 years of research weight data.

Current data for truck speed, weight and distribution analysis was not available at the time of this report.

8 Data Sheets

The following is a listing of data sheets incorporated in Appendix A.

Sheet 19 – Truck 1 – 3S2 loaded air suspension (4 pages)
Sheet 19 – Truck 2 – 3S2 partially loaded air suspension (4 pages)

Sheet 20 – Classification and Speed Verification – Pre-Validation (1 page)
Sheet 20 – Classification and Speed Verification – Post-Validation (2 pages)

Sheet 21 – Pre-Validation (3 pages)
Sheet 21 – Post-Validation (3 pages)

System Parameters (1 page)

Installed Class Scheme (1 page)

Truck Photographs (7 pages)

9 Updated Handout Guide and Sheet 17

A copy of the handout has been included following this page. It includes a current Sheet 17 with all applicable maps and photographs. There are no significant changes in the information provided.

10 Updated Sheet 18

A current Sheet 18 indicating the contacts, conditions for assessments and evaluations has been attached following the updated handout guide.

11 Traffic Sheet 16(s)

Sheet 16s for the Pre-Validation and Post-Validation conditions are attached following the current Sheet 18 information at the very end of the report.

POST-VISIT HANDOUT GUIDE FOR SPS WIM FIELD VALIDATION

STATE: Minnesota

SHRP ID: 270500

Figures

1. General Information

SITE ID: *270500*

LOCATION: *US-2, 21 miles west of Bemidji*

VISIT DATE: *December 13, 2006*

VISIT TYPE: *Validation*

2. Contact Information

POINTS OF CONTACT:

Validation Team Leader: *Dean J. Wolf, 301-210-5105, djwolf@mactec.com*

Highway Agency: *Mark Novak, 651-296-2607,*
mark.novak@dot.state.mn.us

George Cepress, 651-296-0217,
george.cepress@dot.state.mn.us

Ben Worel, 651-779-5522,
ben.worel@dot.state.mn.us

FHWA COTR: *Debbie Walker, 202-493-3068, deborah.walker@fhwa.dot.gov*

FHWA Division Office Liaison: *William Lohr, 651-291-6122,*
william.lohr@fhwa.dot.gov

LTPP SPS WIM WEB PAGE: *http://www.tfhrc.gov/pavement/ltpp/spstraffic/index.htm*

3. Agenda

BRIEFING DATE: *No briefing requested for this visit.*

ON SITE PERIOD: *December 13, 2006*

TRUCK ROUTE CHECK: *Completed at Installation Calibration.*

4. Site Location/ Directions

NEAREST AIRPORT: *Bemidji National Airport*

DIRECTIONS TO THE SITE: *21 miles west of Bemidji on US-2*

MEETING LOCATION: *On site beginning at 9:00 a.m.*

WIM SITE LOCATION: *US-2, Latitude 47.5302° N, Longitude -95.3302° W*

WIM SITE LOCATION MAP: *See Figure 4.1*

Figure 4-1 – Site 270500 in Minnesota

5. Truck Route Information

ROUTE RESTRICTIONS: *None*

SCALE LOCATION: *CAT Scale; I-94, exit 171 near St. Cloud, MN*

Figure 5-1 – Truck Scale Location for 270500 in Minnesota

TRUCK ROUTE:

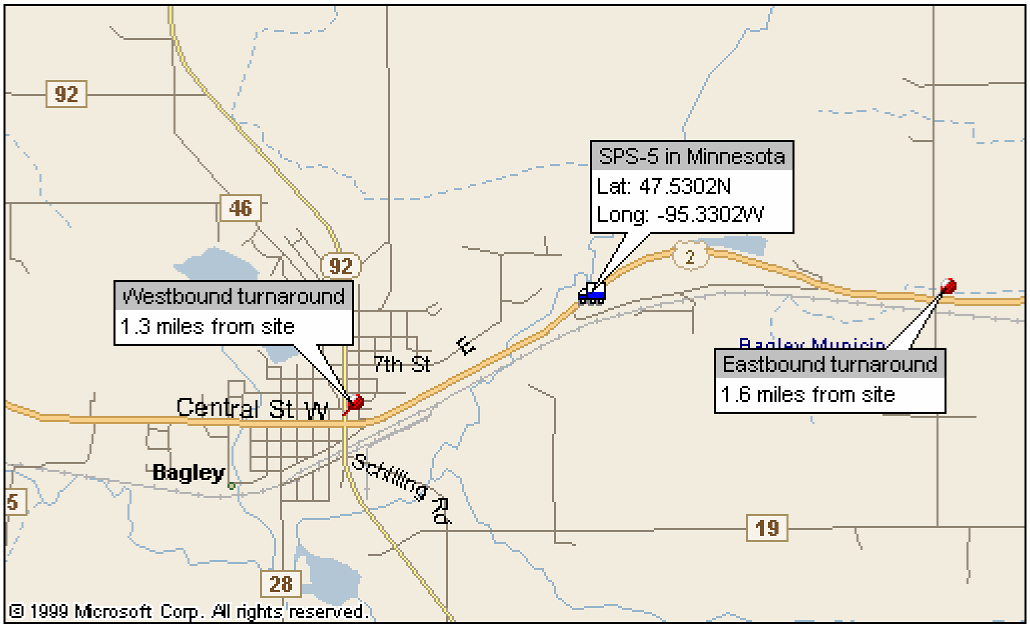

Figure 5-2 – Truck Route for 270500 in Minnesota

EB distance = 1.6 miles
WB distance = 1.3 miles

Total distance = 5.8 miles (10 minutes)

6. Sheet 17 – Minnesota (270500)

1.* ROUTE ___US-2______ MILEPOST _91.8____ LTPP DIRECTION - N S E W

2.* WIM SITE DESCRIPTION - Grade ___<1___ % Sag vertical Y / N
Nearest SPS section upstream of the site ___ ___ ___ ___
Distance from sensor to nearest upstream SPS Section ___ ___ ___ ___ ft

3.* LANE CONFIGURATION
Lanes in LTPP direction __2_ Lane width _1_2_ ft

Median -
1 – painted
2 – physical barrier
3 – grass
4 – none

Shoulder -
1 – curb and gutter
2 – paved AC
3 – paved PCC
4 – unpaved
5 – none

Shoulder width __1_2__ ft

4.* PAVEMENT TYPE ___Asphalt_______________

5.* PAVEMENT SURFACE CONDITION – Distress Survey
Date: _12/13/06_
Filename:
_6420040020_SPSWIM_TO_15_27_2.73_0500_Downstream_12_13_06.jpg
Date: _12/13/06_
Filename: _6420040020_SPSWIM_TO_15_27_2.73_0500_Upstream_12_13_06.jpg
______

6. * SENSOR SEQUENCE ______loop-quartz piezo-quartz piezo-loop_________________

7. * REPLACEMENT AND/OR GRINDING __ __ __ / __ __ / __ __ __ __
REPLACEMENT AND/OR GRINDING __ __ __ / __ __ / __ __ __ __
REPLACEMENT AND/OR GRINDING __ __ __ / __ __ / __ __ __ __

8. RAMPS OR INTERSECTIONS
Intersection/driveway within 300 m upstream of sensor location Y / N distance ______
Intersection/driveway within 300 m downstream of sensor location Y / N distance _____
Is shoulder routinely used for turns or passing? Y / N

9. DRAINAGE (*Bending plate and load cell systems only)*
1 – Open to ground
2 – Pipe to culvert
3 – None

Clearance under plate ___ ___ . ___ in
Clearance/access to flush fines from under system Y / N

10. * CABINET LOCATION

Same side of road as LTPP lane Y / N Median Y/ N Behind barrier Y / N
Distance from edge of traveled lane _4_7_ ft
Distance from system __5_3__ ft
TYPE ____________________________

CABINET ACCESS controlled by LTPP / STATE / JOINT ?
Contact - name and phone number _Mark Novak, MnDOT, 651-296-2607______
Alternate - name and phone number _Roy Czinku, IRD, 306-653-6627_________

11. * POWER

Distance to cabinet from drop ___ __4 ___ ft Overhead / underground / solar / AC in cabinet?
Service provider ______________________ Phone number ______________________

12. * TELEPHONE

Distance to cabinet from drop __9_2__ ___ ft Overhead / under ground / cell?
Service provider ______________________ Phone Number ______________________

13.* SYSTEM (software & version no.)- ______iSINC______________________________
Computer connection – RS232 / Parallel port / USB / Other ____________________

14. * TEST TRUCK TURNAROUND time __1_0___ minutes DISTANCE __8 . 5___ mi.

15. PHOTOS FILENAME

Power source:
6420040020_SPSWIM_TO_15_27_2.73_0500_Power_Service_Box_12_13_06.jpg
Phone source:
6420040020_SPSWIM_TO_15_27_2.73_0500_Telephone_Box_12_13_06.jpg
Cabinet exterior:
6420040020_SPSWIM_TO_15_27_2.73_0500_Cabinet_Exterior_12_13_06.jpg
Cabinet interior:
6420040020_SPSWIM_TO_15_27_2.73_0500_Cabinet_Interior_front_12_13_06.jpg
6420040020_SPSWIM_TO_15_27_2.73_0500_Cabinet_Interior_back_12_13_06.jpg
Weight sensors:
6420040020_SPSWIM_TO_15_27_2.73_0500_Leading_WIM_Sensor_12_13_06.jpg
6420040020_SPSWIM_TO_15_27_2.73_0500_Trailing_WIM_Sensor_12_13_06.jpg
Other sensors (Loop):
6420040020_SPSWIM_TO_15_27_2.73_0500_Leading_Loop_Sensor_12_13_06.jpg
6420040020_SPSWIM_TO_15_27_2.73_0500_Trailing_Loop_Sensor_12_13_06.jpg
Downstream direction at sensors on LTPP lane:
6420040020_SPSWIM_TO_15_27_2.73_0500_Downstream_12_13_06.jpg
Upstream direction at sensors on LTPP lane:
6420040020_SPSWIM_TO_15_27_2.73_0500_Upstream_12_13_06.jpg

COMMENTS ______ all amenities in Bemidji, approximately 21 miles east of the site ________

____________ GPS – Lat: 47.5302 N; Long: -95.3302 W _______________________________

___________ LTPP lane is lane 4 ____

COMPLETED BY __Dean J. Wolf______________________________

PHONE _301-210-5105_________ DATE COMPLETED _1_2_ /_1_3_ / _2_0_0_6

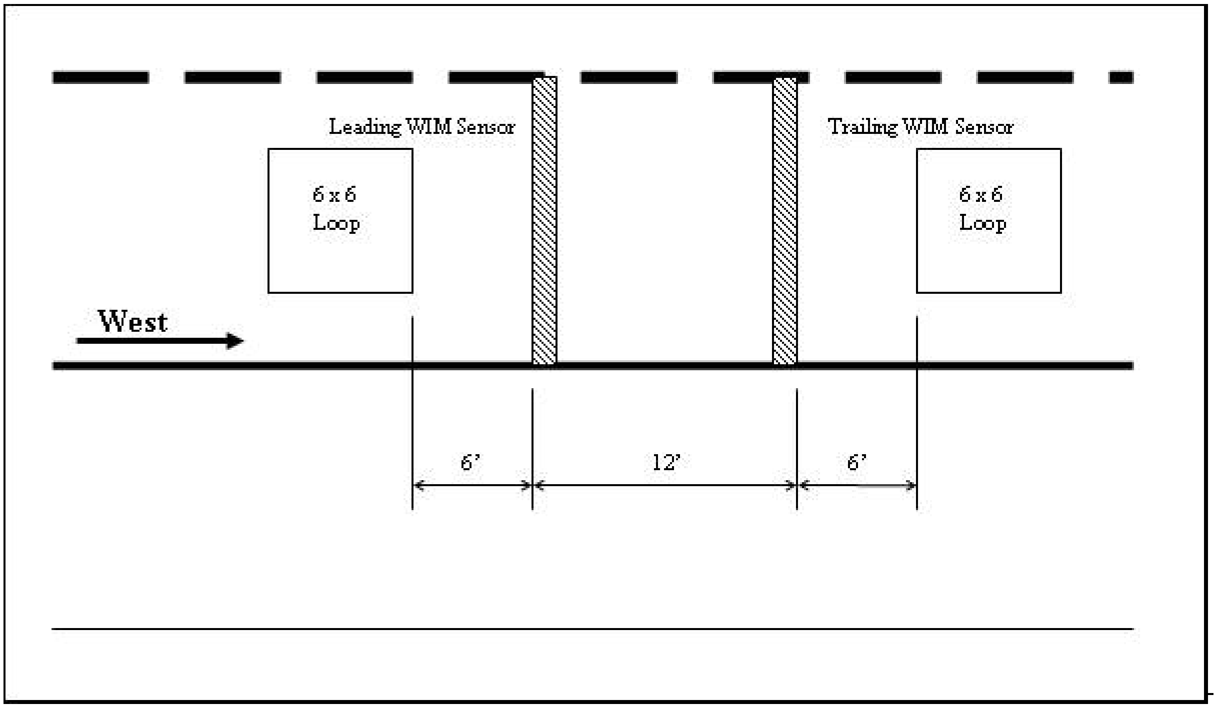

Figure 6-1 - Sketch of Equipment Layout at SPS-5 in Minnesota

Figure 6-2 - Site map of SPS-5 in Minnesota

Figure 6-3 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Downstream_12_13_06.jpg

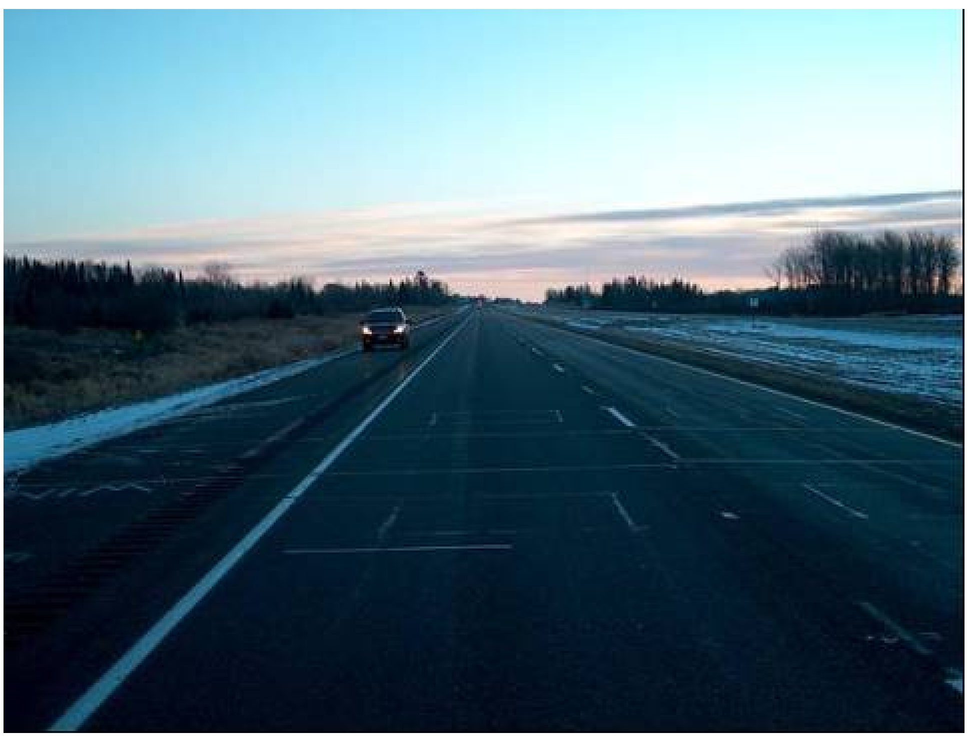

Figure 6-4 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Upstream_12_13_06.jpg

Figure 6-5 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Cabinet_Exterior_12_13_06.jpg

Figure 6-6 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Cabinet_Interior_12_13_06.jpg

Figure 6-7 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Power_Meter_12_13_06.jpg

Figure 6-8 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Power_Service_Box_12_13_06.jpg

Figure 6-9 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Telephone_Box_12_13_06.jpg

Figure 6-10 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Leading_Loop_ Sensor_12_13_06.jpg

Figure 6-11 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Leading_WIM_Sensor_12_13_06.jpg

Figure 6-12 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Trailing_WIM_Sensor_12_13_06.jpg

Figure 6-13 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Trailing_Loop_ Sensor_12_13_06.jpg

SHEET 18	STATE CODE [_2_7_]
LTPP MONITORED TRAFFIC DATA	SPS PROJECT ID [_0_5_0_0_]
WIM SITE COORDINATION	DATE: (mm/dd/yyyy) _1_2_ / _1_2_ / _2_0 _0_6_

Rev. 05/25/04

1. DATA PROCESSING –
   a. Down load –
      - State only
      - LTPP read only
      - LTPP download
      - X LTPP download and copy to state

   b. Data Review –
      - X State per LTPP guidelines
      - State – Weekly Twice a Month Monthly Quarterly
      - LTPP

   c. Data submission –
      - State – Weekly Twice a month Monthly Quarterly
      - X LTPP

2. EQUIPMENT –
   a. Purchase –
      - State
      - X LTPP

   b. Installation –
      - X Included with purchase
      - Separate contract by State
      - State personnel
      - LTPP contract

   c. Maintenance –
      - X Contract with purchase – Expiration Date _______
      - Separate contract LTPP – Expiration Date _______
      - Separate contract State – Expiration Date _______
      - State personnel

   d. Calibration –
      - Vendor
      - State
      - X LTPP

   e. Manuals and software control –
      - X State
      - LTPP

   f. Power –
      i. Type –
         - Overhead
         - X Underground
         - Solar

      ii. Payment –
         - X State
         - LTPP
         - N/A

g. Communication –
   i. Type –
      X Landline
      □ Cellular
      □ Other
   ii. Payment –
      □ State
      □ LTPP
      □ N/A

3. PAVEMENT –
   a. Type –
      □ Portland Concrete Cement
      X Asphalt Concrete
   b. Allowable rehabilitation activities –
      □ Always new
      □ Replacement as needed
      □ Grinding and maintenance as needed
      X Maintenance only
      □ No remediation
   c. Profiling Site Markings –
      □ Permanent
      X Temporary

4. ON SITE ACTIVITIES –
   a. WIM Validation Check - advance notice required ___2___ □ days X weeks
   b. Notice for straightedge and grinding check - ___4___ □ days X weeks
      i. On site lead –
         X State
         □ LTPP
      ii. Accept grinding –
         X State
         □ LTPP
   c. Authorization to calibrate site –
         X State only
         □ LTPP
   d. Calibration Routine –
         X LTPP – □ Semi-annually X Annually
         □ State per LTPP protocol – □ Semi-annually □ Annually
         □ State other – ___________________________

e. Test Vehicles
   i. Trucks –
      1st – Air suspension 3S2 ☐ State X LTPP
      2nd – ____3S2 _______ ☐ State X LTPP
      3rd – _______________ ☐ State ☐ LTPP
      4th – _______________ ☐ State ☐ LTPP
   ii. Loads – ☐ State X LTPP
   iii. Drivers – ☐ State X LTPP

f. Contractor(s) with prior successful experience in WIM calibration in state:
   ___________IRD____

g. Access to cabinet
   i. Personnel Access –
      ☐ State only
      X Joint
      ☐ LTPP
   ii. Physical Access –
      X Key
      ☐ Combination

h. State personnel required on site – X Yes ☐ No

i. Traffic Control Required – ☐ Yes X No

j. Enforcement Coordination Required – ☐ Yes X No

5. SITE SPECIFIC CONDITIONS –
   a. Funds and accountability – ____
   b. Reports – ____
   c. Other – ____
   d. Special Conditions – ____

6. CONTACTS –
   a. Equipment (operational status, access, etc.) –
      Name: __Roy Czinku____________ Phone: ___306-653-6627___
      Agency: _________IRD_____________________________

b. Maintenance (equipment) –

Name: __Roy Czinku_____________ Phone: ___306-653-6627___

Agency: __________IRD________________________________

c. Data Processing and Pre-Visit Data –

Name: __Basel Abukhater_________ Phone: ___716-632-0804___

Agency: ____Stantec___________________________________

d. Construction schedule and verification –

Name: ___Mark Novak___________ Phone: ___651-296-2607___

Agency: ____Minnesota DOT___________________________

e. Test Vehicles (trucks, loads, drivers) –

Name: __Mark Dockendorf________ Phone: __320-252-1494____

Agency: ___Landwehr Trucking________________________

f. Traffic Control –

Name: _________________________ Phone: __________________

Agency: ____

g. Enforcement Coordination –

Name: _________________________ Phone: __________________

Agency: ____

h. Nearest Static Scale

Name:___CAT Scale__________ Location: ___St. Cloud, MN___________

Phone: ____

SHEET 16 LTPP MONITORED TRAFFIC DATA SITE CALIBRATION SUMMARY	*STATE ASSIGNED ID [__ __ __ __] *STATE CODE [_2_7_] *SHRP SECTION ID [_0_5_0_0_]

SITE CALIBRATION INFORMATION

1. * DATE OF CALIBRATION (MONTH/DAY/YEAR) [_1_2_ / _1_2_ / _2_0_0_6_]

2. * TYPE OF EQUIPMENT CALIBRATED __ WIM __ CLASSIFIER _x_ BOTH

3. * REASON FOR CALIBRATION
____ REGULARLY SCHEDULED SITE VISIT ____ RESEARCH
____ EQUIPMENT REPLACEMENT ____ TRAINING
____ DATA TRIGGERED SYSTEM REVISION ____ NEW EQUIPMENT INSTALLATION
_x__ OTHER (SPECIFY) ___LTPP Validation______________________

4. * SENSORS INSTALLED IN LTPP LANE AT THIS SITE (CHECK ALL THAT APPLY):
____ BARE ROUND PIEZO CERAMIC ____ BARE FLAT PIEZO ____ BENDING PLATES
____ CHANNELIZED ROUND PIEZO ____ LOAD CELLS __x_ QUARTZ PIEZO
____ CHANNELIZED FLAT PIEZO __x_ INDUCTANCE LOOPS ____ CAPACITANCE PADS
____ OTHER (SPECIFY) ______________________

5. EQUIPMENT MANUFACTURER ____IRD/PAT Traffic______________________

WIM SYSTEM CALIBRATION SPECIFICS**

6.**CALIBRATION TECHNIQUE USED:
____ TRAFFIC STREAM -- ____STATIC SCALE (Y/N) __x_ TEST TRUCKS

__ __ __ NUMBER OF TRUCKS COMPARED __ _2 __ NUMBER OF TEST TRUCKS USED

__ 2_0__ PASSES PER TRUCK

TYPE PER FHWA 13 BIN SYSTEM
SUSPENSION: 1 - AIR; 2 - LEAF SPRING
3 - OTHER (DESCRIBE)

TRUCK	TYPE	SUSPENSION
1	____9___	__1________________
2	____9___	__1________________
3	________	___________________

7. SUMMARY CALIBRATION RESULTS (EXPRESSED AS A PERCENT)
MEAN DIFFERENCE BETWEEN ---
DYNAMIC AND STATIC GVW ___ ___ - 0 . 6 _ STANDARD DEVIATION __ 3 . 1 _
DYNAMIC AND STATIC SINGLE AXLES ___ ___ - 4 . 3 _ STANDARD DEVIATION __ 5 . 2 _
DYNAMIC AND STATIC DOUBLE AXLES ___ ___ _ 1 . 6 _ STANDARD DEVIATION __ 2 . 7 _

8. ___5____ NUMBER OF SPEEDS AT WHICH CALIBRATION WAS PERFORMED

9. DEFINE THE SPEED RANGES USED (MPH) ______45, 50, 55, 60, 65 ______ ______ ______ ______ ______
______ ______ ______ ______ ______ ______ ______ ______ ______ ______

10. CALIBRATION FACTOR (AT EXPECTED FREE FLOW SPEED) ___ ___3_3_0_0___ ___

11.** IS AUTO-CALIBRATION USED AT THIS SITE? (Y/N) __N__
IF YES, LIST AND DEFINE AUTO-CALIBRATION VALUE: ____________________
____
____

CLASSIFIER TEST SPECIFICS***

12.*** METHOD FOR COLLECTING INDEPENDENT VOLUME MEASUREMENT BY VEHICLE CLASS:
___ VIDEO _x_ MANUAL ___ PARALLEL CLASSIFIERS

13. METHOD TO DETERMINE LENGTH OF COUNT __x_ TIME ____ NUMBER OF TRUCKS

14. MEAN DIFFERENCE IN VOLUMES BY VEHICLES CLASSIFICATION:
*** FHWA CLASS 9 ____ __0_ ____ FHWA CLASS ____ ____ ____ ____ ____
*** FHWA CLASS 8 ____ __0_ ____ FHWA CLASS ____ ____ ____ ____ ____
FHWA CLASS ____ ____ ____ ____ ____
FHWA CLASS ____ ____ ____ ____ ____
*** PERCENT "UNCLASSIFIED" VEHICLES: ____ ___0 . 0____

PERSON LEADING CALIBRATION EFFORT: ___Dean J. Wolf, MACTEC Engineering & Consulting, Inc._________
CONTACT INFORMATION: _____301-210-5105_____________________________________ rev. November 9, 1999

SHEET 16 LTPP MONITORED TRAFFIC DATA SITE CALIBRATION SUMMARY	*STATE ASSIGNED ID [__ __ __ __] *STATE CODE [_2_7_] *SHRP SECTION ID [_0_5_0_0_]

SITE CALIBRATION INFORMATION

1. * DATE OF CALIBRATION (MONTH/DAY/YEAR) [_1_2_ / _1_3_ / _2_0_0_6_]

2. * TYPE OF EQUIPMENT CALIBRATED __ WIM __ CLASSIFIER _x_ BOTH

3. * REASON FOR CALIBRATION
____ REGULARLY SCHEDULED SITE VISIT ____ RESEARCH
____ EQUIPMENT REPLACEMENT ____ TRAINING
____ DATA TRIGGERED SYSTEM REVISION ____ NEW EQUIPMENT INSTALLATION
_x__ OTHER (SPECIFY) ___LTPP Validation____

4. * SENSORS INSTALLED IN LTPP LANE AT THIS SITE (CHECK ALL THAT APPLY):
____ BARE ROUND PIEZO CERAMIC ____ BARE FLAT PIEZO ____ BENDING PLATES
____ CHANNELIZED ROUND PIEZO ____ LOAD CELLS __x_ QUARTZ PIEZO
____ CHANNELIZED FLAT PIEZO __x_ INDUCTANCE LOOPS ____ CAPACITANCE PADS
____ OTHER (SPECIFY) ____

5. EQUIPMENT MANUFACTURER ____IRD/PAT Traffic____

WIM SYSTEM CALIBRATION SPECIFICS**

6.**CALIBRATION TECHNIQUE USED:
____ TRAFFIC STREAM -- ____STATIC SCALE (Y/N) __x_ TEST TRUCKS

__ __ __ NUMBER OF TRUCKS COMPARED __ _2 __ NUMBER OF TEST TRUCKS USED

__ 2_0__ PASSES PER TRUCK

TYPE PER FHWA 13 BIN SYSTEM
SUSPENSION: 1 - AIR; 2 - LEAF SPRING
3 - OTHER (DESCRIBE)

TRUCK	TYPE	SUSPENSION
1	____9___	__1________________
2	____9___	__1________________
3	________	____________________

7. SUMMARY CALIBRATION RESULTS (EXPRESSED AS A PERCENT)
MEAN DIFFERENCE BETWEEN ---
DYNAMIC AND STATIC GVW ___ ___ _ 3 . 0 _ STANDARD DEVIATION __ 1 . 5 _
DYNAMIC AND STATIC SINGLE AXLES ___ ___ - 0 . 2 _ STANDARD DEVIATION __ 3 . 3 _
DYNAMIC AND STATIC DOUBLE AXLES ___ ___ _ 4 . 6 _ STANDARD DEVIATION __ 1 . 8 _

8. ___5____ NUMBER OF SPEEDS AT WHICH CALIBRATION WAS PERFORMED

9. DEFINE THE SPEED RANGES USED (MPH) ______45, 50, 55, 60, 65 ______ ______ ______ ______ ______
______ ______ ______ ______ ______ ______ ______ ______ ______ ______

10. CALIBRATION FACTOR (AT EXPECTED FREE FLOW SPEED) ___ ___3_3_0_0___ ___

11.** IS AUTO-CALIBRATION USED AT THIS SITE? (Y/N) __N__
IF YES, LIST AND DEFINE AUTO-CALIBRATION VALUE: ________________________________
____
____

CLASSIFIER TEST SPECIFICS***

12.*** METHOD FOR COLLECTING INDEPENDENT VOLUME MEASUREMENT BY VEHICLE CLASS:
___ VIDEO _x_ MANUAL ___ PARALLEL CLASSIFIERS

13. METHOD TO DETERMINE LENGTH OF COUNT __x_ TIME ____ NUMBER OF TRUCKS

14. MEAN DIFFERENCE IN VOLUMES BY VEHICLES CLASSIFICATION:
*** FHWA CLASS 9 ____ __0_ ____ FHWA CLASS ____ ____ ____ ____ ____
*** FHWA CLASS 8 ____ __0_ ____ FHWA CLASS ____ ____ ____ ____ ____
FHWA CLASS ____ ____ ____ ____ ____
FHWA CLASS ____ ____ ____ ____ ____
*** PERCENT "UNCLASSIFIED" VEHICLES: ____ ___0 . 0____

PERSON LEADING CALIBRATION EFFORT: ___Dean J. Wolf, MACTEC Engineering & Consulting, Inc._________
CONTACT INFORMATION: _____301-210-5105______________________________________ rev. November 9, 1999

APPENDIX A

Sheet 19	* STATE_CODE	2 7
LTPP Traffic Data	* SPS PROJECT ID	0 5 0 0
*CALIBRATION TEST TRUCK # 1	* DATE	1 2 / 1 3 / 2 0 0 6

Rev. 08/31/01

PART I.

1.* FHWA Class 9 2.* Number of Axles 5

AXLES - units - lbs / 100s lbs / kg

	3. Empty Truck Axle Weight	4.* Pre-Test Average Loaded Axle Weight	5.* Post-Test Average Loaded Axle Weight	6.* Measured D)irectly or C)alculated?
A				D / C
B				D / C
C				D / C
D				D / C
E				D / C
F				D / C

GVW (same units as axles)

7. a) Empty GVW ______________

*b) Average Pre-Test Loaded weight ______________
*c) Post Test Loaded Weight ______________
*d) Difference Post Test – Pre-test ______________

GEOMETRY

8 a) * Tractor Cab Style - Cab Over Engine / Conventional b) * Sleeper Cab? Y / N

9. a) * Make: Kenworth b) * Model: unk

10.* Trailer Load Distribution Description:

Concrete blocks distributed evenly along trailer

11. a) Tractor Tare Weight (units): ______________

b). Trailer Tare Weight (units): ______________

Sheet 19	* STATE CODE	2 7
LTPP Traffic Data	* SPS PROJECT ID	0 5 0 0
*CALIBRATION TEST TRUCK # 1	* DATE	1 2 / 1 3 / 2 0 0 6

Rev. 08/31/01

12.* Axle Spacing – units m / feet and inches / feet and tenths

A to B 15.3 B to C 4.5 C to D 32.9

D to E 4.1 E to F ______

Wheelbased (measured A to last) ______ Computed 56.8

13. *Kingpin Offset From Axle B (units) + (2.8)
(+ is to the rear)

SUSPENSION

Axle	14. Tire Size	15.* Suspension Description (leaf, air, no. of leaves, taper or flat leaf, etc.)
A	11R22.5	leaf, 3 full
B	11R22.5	air
C	11R22.5	air
D	75R22.5	air
E	75R22.5	air
F		

16. Cold Tire Pressures (psi) – from right to left

Steering Axle	Axle B	Axle C	Axle D	Axle E

Sheet 19	* STATE_CODE	2 7
LTPP Traffic Data	* SPS PROJECT ID	0 5 0 0
*CALIBRATION TEST TRUCK # 1	* DATE	1 2 / 1 3 / 2 0 0 6

Rev. 08/31/01

PART II

Table 1. Axle and GVW computations - pre-test

Axle A		Axle B		Axle C		Axle D		Axle E		GVW	
I		II -I		III -II		IV -III		V -IV		V	
V -VI		VI- VII		VII- VIII		VIII- IX		IX`		X	
										XI	
Avg.											

Table 2. Raw Axle and GVW measurements

Axles	Meas.	Pre-test Weight			Post-test Weight
A	I				
A + B	II				
A + B + C	III				
A + B + C + D	IV				
A + B + C + D + E (1)	V				
B + C + D + E	VI				
C + D + E	VII				
D + E	VIII				
E	IX				
A + B + C + D + E (2)	X				
A + B + C + D + E (3)	XI				

Table 3. Axle and GVW computations - post -test

Axle A		Axle B		Axle C		Axle D		Axle E		GVW	
I		II -I		III -II		IV -III		V -IV		V	
V -VI		VI- VII		VII- VIII		VIII- IX		IX`		X	
										XI	
Avg.											

Sheet 19	* STATE_CODE	27
LTPP Traffic Data	* SPS PROJECT ID	0500
*CALIBRATION TEST TRUCK # 1	* DATE	12/13/2006

Rev. 08/31/01

Table 4 . Axle and GVW computations -

Axle A		Axle B		Axle C		Axle D		Axle E		GVW	
I		II -I		III -II		IV -III		V -IV		V	
V -VI		VI-VII		VII-VIII		VIII-IX		IX`		X	
										XI	
Avg.											

Table 5. Raw data – Axle scales – pre-test

Pass	Axle A	Axle B	Axle C	Axle D	Axle E	Axle F	GVW
1	10940	17140	17140	16870	16870	–	78960
2	10960	17190	17190	16840	16840	–	79020
3	10960	17190	17190	16840	16840		79020
Average	10950	17170	17170	16850	16850		79000

Table 6. Raw data – Axle scales – post pre / pre post

Pass	Axle A	Axle B	Axle C	Axle D	Axle E	Axle F	GVW
1							
2							
3							
Average	10760	17100	17100	16840	16840		78660

Table 7. Raw data – Axle scales – post-test

Pass	Axle A	Axle B	Axle C	Axle D	Axle E	Axle F	GVW
1							
2							
3							
Average	10620	17050	17050	16830	16830		78400

Measured By DJW Verified By ____________

6420040020_SPSWIM_TO_14_27_2.73_0500_Truck_1_Sheet_19.doc

Sheet 19	* STATE_CODE	2 7
LTPP Traffic Data	* SPS PROJECT ID	0 5 0 0
*CALIBRATION TEST TRUCK # 2	* DATE	1 2 / 1 3 / 2 0 0 6

Rev. 08/31/01

PART I.

1.* FHWA Class 9 2.* Number of Axles 5

AXLES - units - lbs / 100s lbs / kg

	3. Empty Truck Axle Weight	4.* Pre-Test Average Loaded Axle Weight	5.* Post-Test Average Loaded Axle Weight	6.* Measured D)irectly or C)alculated?
A				D / C
B				D / C
C				D / C
D				D / C
E				D / C
F				D / C

GVW (same units as axles)

7. a) Empty GVW ______

*b) Average Pre-Test Loaded weight ______
*c) Post Test Loaded Weight ______
*d) Difference Post Test – Pre-test ______

GEOMETRY

8 a) * Tractor Cab Style - Cab Over Engine / Conventional b) * Sleeper Cab? Y / N

9. a) * Make: Mack b) * Model: ______

10.* Trailer Load Distribution Description:

Concrete blocks distributed evenly along trailer

11. a) Tractor Tare Weight (units): ______

b). Trailer Tare Weight (units): ______

Sheet 19	* STATE_CODE	2 7
LTPP Traffic Data	* SPS PROJECT ID	0 5 0 0
*CALIBRATION TEST TRUCK # 2	* DATE	1 2 / 1 3 / 2 0 0 6

Rev. 08/31/01

12.* Axle Spacing – units m / feet and inches / feet and tenths

A to B 13.4 B to C 4.3 C to D 31.7

D to E 10.1 E to F ______

Wheelbased (measured A to last) ______ Computed 59.5

13. *Kingpin Offset From Axle B (units) + (2.3)
(+ is to the rear)

SUSPENSION

Axle	14. Tire Size	15.* Suspension Description (leaf, air, no. of leaves, taper or flat leaf, etc.)
A	11R22.5	full leaf, 3 leaves
B	11R22.5	air
C	11R22.5	air
D	70R22.5	air
E	70R22.5	air
F		

16. Cold Tire Pressures (psi) – from right to left

Steering Axle	Axle B	Axle C	Axle D	Axle E

6420040020_SPSWIM_TO_14_27_2.73_0500_Truck_2_Sheet_19.doc

Sheet 19	* STATE_CODE	2 7
LTPP Traffic Data	* SPS PROJECT ID	0 5 0 0
*CALIBRATION TEST TRUCK # 2	* DATE	1 2 / 1 3 / 2 0 0 6

Rev. 08/31/01

PART II

Table 1. Axle and GVW computations - pre-test

Axle A		Axle B		Axle C		Axle D		Axle E		GVW	
I		II -I		III -II		IV -III		V -IV		V	
V -VI		VI- VII		VII- VIII		VIII- IX		IX`		X	
										XI	
Avg.											

Table 2. Raw Axle and GVW measurements

Axles	Meas.	Pre-test Weight			Post-test Weight
A	I				
A + B	II				
A + B + C	III				
A + B + C + D	IV				
A + B + C + D + E (1)	V				
B + C + D + E	VI				
C + D + E	VII				
D + E	VIII				
E	IX				
A + B + C + D + E (2)	X				
A + B + C + D + E (3)	XI				

Table 3. Axle and GVW computations - post -test

Axle A		Axle B		Axle C		Axle D		Axle E		GVW	
I		II -I		III -II		IV -III		V -IV		V	
V -VI		VI- VII		VII- VIII		VIII- IX		IX`		X	
										XI	
Avg.											

Sheet 19	* STATE_CODE	2 7
LTPP Traffic Data	* SPS PROJECT ID	0 5 0 0
*CALIBRATION TEST TRUCK # 2	* DATE	1 2 / 1 3 / 2 0 0 6

Rev. 08/31/01

Table 4 . Axle and GVW computations -

Axle A		Axle B		Axle C		Axle D		Axle E		GVW	
I		II -I		III -II		IV -III		V -IV		V	
V -VI		VI- VII		VII- VIII		VIII- IX		IX`		X	
										XI	
Avg.											

Table 5. Raw data – Axle scales – pre-test

Pass	Axle A	Axle B	Axle C	Axle D	Axle E	Axle F	GVW
1	9260	13440	13440	16140	16140	–	68420
2	9380	13370	13370	16170	16170	–	68460
3	9340	13400	13400	16150	16150	–	68440
Average	9330	13400	13400	16150	16150		68440

Table 6. Raw data – Axle scales – post pre / pre post

Pass	Axle A	Axle B	Axle C	Axle D	Axle E	Axle F	GVW
1							
2							
3							
Average	9130	13370	1330	16140	16140		68080

Table 7. Raw data – Axle scales – post-test

Pass	Axle A	Axle B	Axle C	Axle D	Axle E	Axle F	GVW
1							
2							
3							
Average	8980	13270	13270	16130	16130		67810

Measured By DJW Verified By ____________

Sheet 20	* STATE_CODE 27
LTPP Traffic Data	*SPS PROJECT_ID 0500
Speed and Classification Checks * 1 of* 2	* DATE 12/13/2006

Rev. 08/31/2001

WIM speed	WIM class	WIM Record	Obs. Speed	Obs Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs Class
44	9	16538	45	9	68	9	17980	68	9
45	9	16539	46	9	65	9	17995	65	9
49	9	116600	51	9	66	9	18452	67	9
49	9	116601	50	9	60	9	18468	60	9
66	6	16703	66	6	62	6	18480	63	6
63	4	16858	62	4	72	9	18501	71	9
66	5	16903	66	5	60	9	18548	61	9
58	9	16927	59	9	55	9	18557	55	9
71	10	17021	72	10	55	9	18558	55	9
9	68	17043	69	9	62	9	18584	63	9
9	70	17262	70	9	64	9	18899	64	9
9	60	17301	61	9	60	9	19023	60	9
9	60	17302	60	9	60	9	19024	61	9
6	67	17314	67	6	66	9	19077	66	9
5	64	17319	64	5	66	9	19079	65	9
9	68	17323	69	9	61	9	19173	61	9
9	60	17331	60	9	68	9	19180	69	9
9	59	17334	59	9	66	9	19213	66	9
5	52	17709	53	5	64	9	19250	63	9
9	65	17794	64	9	65	10	19259	66	10
9	64	17796	64	9	68	9	19280	67	9
9	60	17816	60	9	65	9	19283	65	9
9	65	17883	65	9	63	5	19317	64	5
9	69	17902	70	9	70	9	19365	70	9
4	62	17911	63	4	60	5	19377	61	5

6420040020_SPSWIM_TO_14_27_2.73_0500_Pre_Val_Sheet_20.doc start: 7:30 a.m

End: 3:14 p.m

Sheet 20	* STATE_CODE 27
LTPP Traffic Data	*SPS PROJECT_ID 0500
Speed and Classification Checks * 1 of* 2	* DATE 12/13/2006

Rev. 08/31/2001

WIM speed	WIM class	WIM Record	Obs. Speed	Obs Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs Class
44	9	16538	45	9	68	9	17980	68	9
45	9	16539	46	9	65	9	17995	65	9
49	9	16600	51	9	66	9	18452	67	9
49	9	16601	50	9	60	9	18468	60	9
66	6	16703	66	6	62	6	18480	63	6
63	4	16858	62	4	72	9	18501	71	9
66	5	16905	66	5	60	9	18548	61	9
58	9	16928	59	9	55	9	18557	55	9
71	10	17021	72	10	55	9	18558	55	9
9	68	17043	69	9	62	9	18584	63	9
9	70	17262	70	9	64	9	18899	64	9
9	60	17301	61	9	60	9	19023	60	9
9	60	17302	60	9	60	9	19024	61	9
6	67	17314	67	6	66	9	19077	66	9
5	64	17319	66	5	66	9	19079	65	9
9	68	17323	69	9	61	9	19173	61	9
9	60	17331	60	9	68	9	19180	69	9
9	59	17334	59	9	66	9	19213	66	9
5	52	17709	53	5	64	9	19250	63	9
9	65	17794	64	9	65	10	19259	66	10
9	64	17796	64	9	68	9	19280	67	9
9	60	17816	60	9	65	9	19283	65	9
9	65	17883	65	9	63	5	19317	64	5
9	69	17902	70	9	70	9	19365	70	9
4	62	17911	63	4	60	5	19377	61	5

7:30

 Start: 7:30 a.m

End: 3:14 p.m

Sheet 20	* STATE_CODE 2 7
LTPP Traffic Data	*SPS PROJECT_ID 0 5 0 0
Speed and Classification Checks * 2 of* 2	* DATE 1 2 / 1 ~~3~~ 2 / 2 0 0 6

Rev. 08/31/2001

WIM speed	WIM class	WIM Record	Obs. Speed	Obs Class	WIM speed	WIM class	WIM Record	Obs. Speed	Obs Class
62	9	19397	63	9					
63	5	19403	63	5					
45	9	19488	45	9					
45	9	19492	45	9					
50	9	19528	50	9					
50	9	19530	50	9					
55	9	19566	55	9					
56	9	19568	55	9					
60	9	19623	60	9					
60	9	19624	60	9					

Beg - 3:15

End ~~3:15~~ 4:00

79
68.4

Sheet 21	* STATE_CODE	2 7
LTPP Traffic Data	*SPS PROJECT_ID	0 5 0 0
WIM System Test Truck Records 1 of 3	* DATE	1 2 / 1 3 / 2 0 0 6

Rev. 08/31/2001

Pvmt temp	Radar Speed	Truck	Pass	Time	Record No.	WIM Speed	Axle A weight.	Axle B weight.	Axle C weight.	Axle D weight.	Axle E weight.	Axle F weight	GVW	A-B space	B-C space	C-D space	D-E space	E-F space
X 19.5	45	1	17	7:22:06	16538	44	4.4/5.4 ~~16.9~~	7.4/9.2 ~~17.0~~	7.7/9.2 ~~16.9~~	7.6/9.4 ~~16.6~~	7.6/9.3 ~~9.8~~		77.1	15.4	4.5	33.0	4.1	
X 19.5	46	2	17	7:22:10	16539	45	4.4/4.9 ~~15.1~~	5.9/7.2 ~~14.9~~	6.3/6.3 ~~12.5~~	7.3/7.8 ~~13.2~~	6.3/8.9 9.0		64.7	13.4	4.3	31.6	10.0	
19.5	51	1	~~2~~1	7:29:56	16600	49	4.5/5.6	8.3/9.3	8.3/9.0	8.1/9.1	8.9/9.2		79.5	15.4	4.5	32.9	4.1	
19.5	50	2	~~2~~1	7:29:58	16601	49	4.6/4.9	5.7/7.6	6.3/7.1	7.3/8.9	6.6/9.1		68	13.4	4.3	31.7	10.0	
17.0	55	1	~~3~~2	7:38:48	16656	55	4.6/5.3	7.6/9.2	7.6/9.1	7.3/9.7	7.3/9.5		77.3	15.3	4.5	32.9	4.1	
17.0	54	2	~~3~~2	7:38:59	16658	55	4.0/4.9	5.8/7.9	6.6/7.1	7.4/9.1	7.0/9.1		68.8	13.4	4.3	31.7	10.0	
18.5	60	1	~~4~~3	7:48:09	16731	60	4.7/5.4	8.3/9.6	8.2/9.1	8.1/9.3	8.9/9.3		80.1	15.3	4.5	32.8	4.1	
18.5	60	2	~~4~~3	7:48:11	16733	60	3.9/4.9	5.7/7.5	6.8/7.7	7.5/7.7	6.8/9.1		67.6	13.4	4.3	31.6	10.0	
14.5	66	1	4	7:59:58	16822	66	4.4/5.3	8.2/9.1	8.0/9.0	7.7/9.5	7.6/9.6		78.4	15.3	4.5	32.9	4.1	
14.5	65	2	4	8:00:06	16823	65	3.9/4.9	5.4/7.5	6.6/7.2	7.3/8.4	6.7/8.9		66.8	13.4	4.3	31.7	10.0	
15.5	46	1	5	8:10:03	16875	45	4.6/5.3	7.6/9.3	7.9/9.1	7.8/9.4	7.8/9.4		78.2	15.3	4.5	32.9	4.1	
15.5	45	2	5	8:10:08	16876	45	4.1/4.8	5.6/7.6	5.9/6.7	7.0/8.5	6.8/8.9		65.7	13.5	4.3	31.6	10.0	
21.5	50	1	6	8:17:45	16943	50	4.7/5.1	7.8/9.1	7.9/9.3	7.9/9.5	7.7/9.3		78.4	15.4	4.5	33.0	4.1	
21.5	51	2	6	8:17:50	16944	50	4.5/4.9	5.7/7.4	6.3/7.1	6.3/8.5	7.0/9.1		66.8	13.4	4.3	31.7	10.0	
19.5	54	1	7	8:28:03	17000	55	4.9/5.2	8.3/9.1	8.1/9.6	8.2/9.0	8.2/8.9		79.7	15.3	4.5	33.0	4.1	
19.5	54	2	7	8:28:16	17001	54	4.4/4.9	5.7/7.9	6.4/7.4	7.7/9.4	7.0/9.4		70.0	13.4	4.3	31.6	10.0	

Recorded by Amkie   Checked by [signature]

Sheet 21

LTPP Traffic Data

WIM System Test Truck Records 2 of 3

* STATE_CODE	27
*SPS PROJECT_ID	0500
* DATE	12 / 12 / 2006

Rev. 08/31/2001

Pvmt temp	Radar Speed	Truck	Pass	Time	Record No.	WIM Speed	Axle A weight.	Axle B weight.	Axle C weight.	Axle D weight.	Axle E weight.	Axle F weight	GVW	A-B space	B-C space	C-D space	D-E space	E-F space
19.5	61	1	8	8:40:51	17064	60	4.8/5.4	8.3/9.6	8.4/9.5	8.3/9.2	8.2/9.1		80.7	15.3	4.5	32.9	4.1	
19.5	60	2	8	8:40:57	17065	60	4.7/4.8	6.9/8.2	6.6/7.4	7.1/8.4	6.5/9.1		68.1	13.4	4.3	31.7	10.0	
18.5	66	1	9	8:53:16	17120	66	4.7/5.4	7.5/10.0	7.6/9.4	7.3/9.8	7.5/9.6		78.7	15.2	4.5	32.9	4.0	
18.5	65	2	9	8:53:38	17124	65	3.7/4.8	5.9/7.2	6.8/7.1	7.4/6.3	7.2/4.8		61.5	13.4	4.3	31.6	10.0	
21.5	45	1	10	9:03:08	17166	45	4.6/5.3	7.7/9.2	7.6/9.2	7.6/9.5	7.5/9.3		77.4	15.3	4.5	32.9	4.1	
21.5	45	2	10	9:03:17	17170	45	3.9/4.9	5.4/7.7	5.7/6.9	6.2/8.2	6.6/8.6		64.0	13.5	4.3	31.6	10.0	
22.5	50	1	11	9:09:37	17209	49	5.9/5.1	8.9/9.4	7.9/9.4	7.9/8.9	8.0/8.9		78.4	15.3	4.5	33.0	4.1	
22.5	51	2	11	9:09:44	17210	50	4.0/4.9	5.5/7.8	6.3/7.4	6.7/9.0	6.8/8.9		67.1	13.4	4.3	31.6	10.0	
25.5	56	1	12	9:20:37	17270	55	4.6/5.3	7.2/9.8	7.5/9.5	7.3/9.6	7.5/9.5		77.8	15.4	4.5	33.0	4.1	
25.5	55	2	12	9:20:42	17271	55	4.1/4.9	5.7/7.5	6.5/7.2	7.1/9.1	6.9/9.4		68.6	13.5	4.3	31.7	10.0	
25.5	60	1	13	9:32:23	17331	60	4.6/5.3	7.4/10.4	7.5/10.0	7.7/9.8	7.5/9.5		79.7	15.3	4.5	32.9	4.1	
25.5	59	2	13	9:32:39	17334	59	4.7/4.8	6.9/7.6	7.5/7.3	8.2/8.2	7.8/8.6		71.7	13.4	4.3	31.6	10.0	
26.5	65	1	14	9:45:13	17408	66	4.5/5.5	8.4/9.5	8.3/9.1	8.4/9.4	8.1/9.4		80.7	15.3	4.5	32.9	4.1	
26.5	65	2	14	9:45:20	17409	64	3.9/4.8	5.8/7.5	6.4/7.2	7.1/8.9	6.6/9.0		67.2	13.4	4.3	31.6	10.0	
27.0	45	1	15	9:55:48	17464	45	5.0/5.0	8.0/9.3	7.8/9.5	8.1/9.0	8.9/8.9		78.7	15.3	4.5	32.1	4.1	
27.0	46	2	15	9:55:54	17465	45	4.4/5.0	5.8/7.3	6.4/7.2	7.8/9.1	7.1/8.9		68.1	13.4	4.3	31.6	10.0	

Recorded by Ambie

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Sheet 21	* STATE_CODE	2 7
LTPP Traffic Data	*SPS PROJECT_ID	0 5 0 0
WIM System Test Truck Records 3 of 3	* DATE	1 2 / 1 3 / 2 0 0 6

Rev. 08/31/2001

Pvmt temp	Radar Speed	Truck	Pass	Time	Record No.	WIM Speed	Axle A weight.	Axle B weight.	Axle C weight.	Axle D weight.	Axle E weight.	Axle F weight	GVW	A-B space	B-C space	C-D space	D-E space	E-F space
27.0	50	1	16	10:02:59	17500	50	4.7/5.3	7.4/9.3	7.4/9.3	7.5/9.6	7.4/9.5		77.8	15.3	4.5	32.9	4.1	
27.0	50	2	16	10:02:11	17502	49	3.8/5.1	5.8/7.4	6.4/6.9	6.6/7.1	7.2/6.0		62.3	13.5	4.3	31.7	10.0	
31.5	55	1	18	10:12:09	17564	55	4.4/5.4	8.4/9.3	8.9/9.2	8.3/9.4	8.1/9.4		80.1	15.3	4.5	32.9	4.0	
31.5	55	2	18	10:12:16	17565	55	4.0/4.9	5.7/7.5	6.6/7.4	7.7/9.2	6.9/9.2		68.9	13.4	4.3	31.5	10.0	
29.5	61	1	19	10:24:32	17639	60	4.9/5.5	8.6/9.7	8.7/9.4	8.7/9.2	8.6/9.2		82.5	15.3	4.5	32.9	4.1	
29.5	60	2	19	10:24:40	17640	59	4.3/4.8	6.3/7.8	6.9/7.7	7.4/9.3	7.1/9.4		71.0	13.5	4.3	31.8	10.0	
29.5	66	1	20	10:38:10	17734	66	4.8/5.4	8.2/9.6	8.2/9.4	8.2/9.9	7.9/9.7		81.3	15.3	4.5	33.0	4.1	
29.5	66	2	20	10:38:15	17735	65	3.9/5.0	6.1/7.7	7.0/7.4	7.6/8.2	7.3/6.9		67.1	13.4	4.3	31.7	10.0	

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6420040020_SPSWIM_TO_14_27_2.73_0500_Pre_Val_Sheet_21.doc

229240 292420 class 660841 - Dave. After Run 4
After Run 4

Sheet 21	* STATE_CODE 27
LTPP Traffic Data	*SPS PROJECT_ID 0500
WIM System Test Truck Records 1 of 3	* DATE 12 / 13 / 2006

Rev. 08/31/2001

Pvmt temp	Radar Speed	Truck	Pass	Time	Record No.	WIM Speed	Axle A weight.	Axle B weight.	Axle C weight.	Axle D weight.	Axle E weight.	Axle F weight	GVW	A-B space	B-C space	C-D space	D-E space	E-F space
13.5	45	1	1	11:32:58	18027	45	4.8/5.7	8.5/9.9	8.7/9.7	8.6/9.3	8.4/9.3		82.9	15.3	4.5	32.9	4.1	
13.5	45	2	1	11:33:03	18029	45	4.4/5.0	5.9/7.6	6.3/7.3	7.7/9.1	7.2/9.0		69.6	13.5	4.3	31.8	10.0	
16.0	50	1	2	11:40:19	18079	50	4.9/5.5	7.5/9.8	7.6/10.0	7.9/9.8	7.5/9.5		80.1	15.3	4.5	32.9	4.1	
16.0	51	2	2	11:40:28	18081	50	4.4/4.8	5.9/7.5	6.4/7.3	7.3/9.2	7.2/9.3		69.3	13.4	4.3	31.6	10.0	
36.0	55	1	3	11:48:11	18137	55	4.9/5.6	7.7/10.1	7.7/10.0	7.8/9.9	7.8/9.9		81.3	15.3	4.5	33.0	4.1	
36.0	55	2	3	11:48:25	18138	55	4.3/4.9	6.3/8.0	6.6/7.7	7.4/7.8	7.1/9.3		69.2	13.4	4.3	31.6	10.0	
14.5	60	1	4	12:00:13	18207	60	4.7/5.3	8.4/9.7	8.3/9.8	8.3/9.6	8.1/9.7		81.9	15.2	4.5	32.9	4.0	
14.5	60	2	4	12:00:24	1820	59	4.4/4.7	6.9/7.3	7.2/7.0	7.4/9.0	7.7/9.3		71.1	13.4	4.3	31.7	10	
14.0	65	1	5	12:12:11	18269	65	4.7/5.6	7.8/10.0	7.7/9.8	7.6/10.1	7.7/10.2		81.3	15.3	4.5	33.0	4.1	
14.0	65	2	5	12:12:21	18273	65	4.2/4.8	5.8/7.7	6.5/7.4	6.4/9.8	7.0/9.3		68.7	13.4	4.3	31.7	10.0	
32.0	45	1	6	12:20:48	18328	45	4.8/5.7	8.7/9.8	8.5/9.8	8.6/9.2	8.4/9.2		82.6	15.3	4.5	32.9	4.1	
32.0	45	2	6	12:20:55	18331	46	4.5/4.8	6.9/7.5	6.4/7.3	7.2/9.6	7.3/9.1		69.8	13.5	4.3	31.7	10.0	
37.0	50	1	7	12:57:54	18520	50	5.9/5.5	7.7/9.8	8.2/9.7	8.3/9.4	8.3/9.3		81.3	15.3	4.5	33.0	4.1	
37.0	50	2	7	12:57:59	18521	50	4.6/4.9	5.8/7.8	6.3/7.5	7.4/9.1	7.1/9.0		69.5	13.4	4.3	31.6	10.0	
31.5	55	1	8	13:05:21	18557	55	5.1/5.0	8.1/9.9	8.1/10.0	8.3/9.4	8.3/9.2		81.4	15.3	4.5	32.9	4.1	
31.5	55	2	8	13:05:24	18558	55	4.6/4.8	6.2/7.9	6.6/7.4	7.9/9.0	7.3/9.1		70.6	13.4	4.3	31.7	10.0	

Recorded by Ambie. Checked by [signature]

Sheet 21	* STATE_CODE 27
LTPP Traffic Data	*SPS PROJECT_ID 0500
WIM System Test Truck Records 2 of 3	* DATE 12 / 13 / 2006

Rev. 08/31/2001

Pvmt temp	Radar Speed	Truck	Pass	Time	Record No.	WIM Speed	Axle A weight.	Axle B weight.	Axle C weight.	Axle D weight.	Axle E weight.	Axle F weight	GVW	A-B space	B-C space	C-D space	D-E space	E-F space
31.0	61	1	9	13:13:03	18598	60	4.5/5.5	7.8/9.8	7.9/9.6	7.7/10.1	7.6/9.8		80.5	15.2	4.5	33.0	4.1	
31.0	61	2	9	13:13:12	18600	60	4.4/4.8	5.9/7.7	6.7/8.1	7.2/8.5	7.3/9.4		69.9	13.4	4.3	31.6	10.0	
35.0	66	1	10	13:25:27	18674	66	4.8/5.4	8.4/9.8	8.4/9.7	8.2/9.9	8.9/9.7		82.0	15.3	4.5	32.9	4.0	
35.0	63	2	10	13:25:34	18677	64	3.8/4.9	6.0/7.3	6.7/7.6	7.5/8.5	7.7/8.2		68.3	13.4	4.3	31.6	10.0	
35.0	45	1	11	14:03:09	18911	45	4.7/5.6	7.6/10.0	7.7/9.8	7.9/9.7	7.9/9.5		80.5	15.3	4.5	33.0	4.1	
35.0	47	2	11	14:03:15	18913	46	4.5/4.9	5.6/7.9	6.6/7.2	7.6/7.8	7.0/9.1		68.1	13.4	4.3	31.8	10.0	
7 34	50	1	12	14:08:16	18940	50	4.4/5.4	7.7/9.8	7.7/9.5	7.6/9.9	7.5/9.7		79.1	15.3	4.5	33.0	4.1	
7 34	50	2	12	14:08:19	18942	50	4.2/4.9	5.8/7.6	6.6/7.2	7.3/9.7	7.6/9.5		70.1	13.4	4.3	31.5	10.0	
33	55	1	13	14:13:48	18986	55	4.6/5.6	8.4/9.6	7.9/9.7	8.2/9.8	8.9/9.7		81.5	15.3	4.5	33.0	4.1	
33	56	2	13	14:13:51	18988	55	4.3/4.9	6.0/8.3	6.7/7.4	7.6/9.2	7.2/9.2		71.0	13.4	4.3	31.7	10.0	
32.5	60	1	14	14:19:20	19023	60	5.1/5.6	8.1/9.9	8.4/9.8	8.6/9.4	8.5/9.3		82.6	15.3	4.5	33.0	4.1	
32.5	61	2	14	14:19:23	19024	60	4.0/4.8	5.7/7.7	6.6/7.7	6.9/9.4	6.9/9.4		69.0	13.4	4.3	31.7	10.0	
32.0	66	1	15	14:27:41	19077	66	4.6/5.5	8.2/9.8	8.2/9.5	8.0/9.9	7.9/9.9		81.7	15.3	4.5	32.9	4.1	
32.0	66	2	15	14:27:50	19079	65	3.9/5.0	6.9/7.8	6.4/7.6	6.9/9.9	7.1/9.3		69.9	13.4	4.3	31.7	10.0	
28.5	45	1	16	15:28:10	19488	45	4.6/5.5	8.0/10.1	7.6/9.5	7.8/9.7	7.7/9.5		80.0	15.3	4.5	32.9	4.0	
28.5	45	2	16	15:28:32	19492	45	4.2/4.8	5.8/7.9	6.0/6.8	7.2/9.0	7.2/8.9		67.9	13.5	4.3	31.6	10.0	

Recorded by ______ Checked by ______

Sheet 21	* STATE CODE 2 7
LTPP Traffic Data	*SPS PROJECT ID 0 5 0 0
WIM System Test Truck Records 3 of 3	* DATE 1 2 / 1 3 / 2 0 0 6

Rev. 08/31/2001

Pvmt temp	Radar Speed	Truck	Pass	Time	Record No.	WIM Speed	Axle A weight.	Axle B weight.	Axle C weight.	Axle D weight.	Axle E weight.	Axle F weight	GVW	A-B space	B-C space	C-D space	D-E space	E-F space
27.5	50	1	17	15:33:18	19528	50	4.7/5.2	7.7/9.9	7.5/9.7	7.8/9.7	7.8/9.7		79.7	15.4	4.5	32.9	4.0	
27.5	50	2	17	15:33:20	19530	50	4.1/5.0	5.7/8.1	6.3/7.1	6.8/9.6	7.9/9.2		69.0	13.5	4.3	31.7	10.0	
26.0	55	1	18	15:37:51	19566	55	5.9/5.5	8.3/9.7	8.1/10.2	8.5/9.4	8.5/9.1		82.4	15.3	4.5	32.9	4.1	
26.0	55	2	18	15:37:55	19568	56	4.2/4.9	6.3/7.7	6.9/9.1	7.7/7.7	7.3/9.1		68.8	13.5	4.3	31.7	10.0	
25.5	60	1	19	15:44:21	19623	60	5.9/5.5	8.5/9.9	8.4/10.0	8.8/9.6	8.3/9.5		83.1	15.3	4.5	32.9	4.1	
25.5	60	2	19	15:44:33	19624	60	4.3/4.8	6.2/7.8	6.7/7.5	7.6/8.4	7.1/9.4		69.9	13.4	4.3	31.7	10.0	
25.0	65	1	20	15:53:50	19689	66	4.7/5.4	8.8/9.7	8.4/9.4	8.2/9.8	8.2/9.6		82.2	15.3	4.5	32.9	4.1	
25.0	65	2	20	15:53:05	19691	65	4.3/4.8	6.1/7.7	6.9/7.5	7.5/8.6	7.1/9.3		69.7	13.5	4.3	31.7	10.0	

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System Operating Parameters

Minnesota SPS-5

Validation Visit – 13 December 2006

Calibration factors for Sensor #1

Dynamic (front axle) – 104
65 kph – 3230
80 kph – 3320
95 kph – 3390
110 kph – 3390
125 kph – 3300

Calibration factors for Sensor #2

Dynamic (front axle) – 104
65 kph – 3230
80 kph – 3320
95 kph – 3390
110 kph – 3390
125 kph – 3300

ETG LTPP CLASS SCHEME, MOD 3

Class	Vehicle Type	No. Axles	Spacing 1	Spacing 2	Spacing 3	Spacing 4	Spacing 5	Spacing 6	Spacing 7	Spacing 8	Gross Weight Min-Max	Axle 1 Weight Min *
1	Motorcycle	2	1.00-5.99								0.10-3.00	
2	Passenger Car	2	6.00-10.10								1.00-7.99	
3	Other (Pickup/Van)	2	10.11-23.09								1.00-7.99	
4	Bus	2	23.10-40.00								12.00 >	
5	2D Single Unit	2	6.00-23.09								8.00 >	2.5
2	Car w/ 1 Axle Trailer	3	6.00-10.10	6.00-25.00							1.00-11.99	
3	Other w/ 1 Axle Trailer	3	10.11-23.09	6.00-25.00							1.00-11.99	
4	Bus	3	23.10-40.00	3.00-7.00							20.00 >	
5	2D w/ 1 Axle Trailer	3	6.00-23.09	6.30-30.00							12.00-19.99	2.5
6	3 Axle Single Unit	3	6.00-23.09	2.50-6.29							12.00 >	3.5
8	Semi, 2S1	3	6.00-23.09	11.00-45.00							20.00 >	3.5
2	Car w/ 2 Axle Trailer	4	6.00-10.10	6.00-30.00	1.00-11.99						1.00-11.99	
3	Other w/ 2 Axle Trailer	4	10.11-23.09	6.00-30.00	1.00-11.99						1.00-11.99	
5	2D w/ 2 Axle Trailer	4	6.00-26.00	6.30-40.00	1.00-20.00						12.00-19.99	2.5
7	4 Axle Single Unit	4	6.00-23.09	2.50-6.29	2.50-12.99						12.00 >	3.5
8	Semi, 3S1	4	6.00-26.00	2.50-6.29	13.00-50.00						20.00 >	5.0
8	Semi, 2S2	4	6.00-26.00	8.00-45.00	2.50-20.00						20.00 >	3.5
3	Other w/ 3 Axle Trailer	5	10.11-23.09	6.00-25.00	1.00-11.99	1.00-11.99					1.00-11.99	
5	2D w/ 3 Axle Trailer	5	6.00-23.09	6.30-35.00	1.00-25.00	1.00-11.99					12.00-19.99	2.5
7	5 Axle Single Unit	5	6.00-23.09	2.50-6.29	2.50-6.29	2.50-6.30					12.00 >	3.5
9	Semi, 3S2	5	6.00-30.00	2.50-6.29	6.30-65.00	2.50-11.99					20.00 >	5.0
9	Truck+FullTrailer (3-2)	5	6.00-30.00	2.50-6.29	6.30-50.00	12.00-27.00					20.00>	3.5
9	Semi, 2S3	5	6.00-30.00	16.00-45.00	2.50-6.30	2.50-6.30					20.00 >	3.5
11	Semi+FullTrailer, 2S12	5	6.00-30.00	11.00-26.00	6.00-20.00	11.00-26.00					20.00 >	3.5
10	Semi, 3S3	6	6.00-26.00	2.50-6.30	6.10-50.00	2.50-11.99	2.50-10.99				20.00 >	5.0
12	Semi+Full Trailer, 3S12	6	6.00-26.00	2.50-6.30	11.00-26.00	6.00-24.00	11.00-26.00				20.00 >	5.0
13	7 Axle Multi's	7	6.00-45.00	3.00-45.00	3.00-45.00	3.00-45.00	3.00-45.00	3.00-45.00			20.00 >	5.0
13	8 Axle Multi's	8	6.00-45.00	3.00-45.00	3.00-45.00	3.00-45.00	3.00-45.00	3.00-45.00	3.00-45.00		20.00 >	5.0
13	9 Axle Multi's	9	6.00-45.00	3.00-45.00	3.00-45.00	3.00-45.00	3.00-45.00	3.00-45.00	3.00-45.00	3.00-45.00	20.00 >	5.0

Spacings in feet

Weights in kips (Lbs/1000)

* Suggested Axle 1 minimum weight threshold if allowed by WIM system's class algorithm programming

TEST TRUCK PHOTOGRAPHS FOR SPS WIM FIELD VALIDATION

STATE: Minnesota

SHRP ID: 270500

Figures

Figure 1 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Truck_1_Tractor

Figure 2 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Truck_1_Trailer.jpg

Figure 3 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Truck_1_Suspension_1.jpg

Figure 4 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Truck_1_Suspension_2.jpg

Figure 5 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Truck_1_Suspension_3.jpg

Figure 6 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Truck_2_Tractor.jpg

Figure 7 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Truck_2_Trailer.jpg

Figure 8 – 6420040020_SPSWIM_TO_15_27_2.73_0500_ Truck_2_ Suspension_1.jpg

Figure 9 – 6420040020_SPSWIM_TO_15_27_2.73_0500_ Truck_2_ Suspension_2.jpg

Figure 10 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Truck_2_ Suspension_3.jpg

Figure 11 – 6420040020_SPSWIM_TO_15_27_2.73_0500_Truck_2_ Suspension_4.jpg