# LTPP Field Operations Guide for SPS WIM Sites

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# 1 INTRODUCTION

The Long-Term Pavement Performance (LTPP) program has been an important source of pavement data collection for the last 20 years. This effort has been led by the Federal Highway Administration (FHWA), in partnership with state departments of transportation, American Association of State Highway Transportation Officials (AASHTO), National Academy of Science, industry, and academia. Periodic updates on products delivered through LTPP are disseminated to FHWA partners, who are the users of the products. Users provide comments to the FHWA team on their successful application of products and on issues encountered during their implementation. Mid-way through the program, FHWA assembled an LTPP program assessment team to address concerns related to the LTPP program and its database. This field operations document provides guidance to correct deficiencies identified by the FHWA LTPP program assessment team related to the quality and quantity of traffic data collected by the LTPP program for the Specific Pavement Study (SPS) test sites.

With the support of the Transportation Research Board (TRB) Expert Task Group on Traffic Data Collection and Analysis (or Traffic ETG), FHWA revised the traffic data collection procedures for SPS-1, -2, -5, -6 and -8 experiments. The effort consisted of two principal elements: shifting the data collection from highway agencies to a national, centralized effort and standardizing data collection equipment and procedures. The effort has been successful in that state agencies have agreed to the establishment of a national pooled fund effort to support data collection and processing as well as equipment purchases. In addition to this field operations guide, there are other documents that address the pavement smoothness, equipment calibration checks, and equipment model specifications for a weigh-in-motion (WIM) system.

## 1.1 OBJECTIVE

This document contains the guidelines for traffic data collection at SPS sites. It covers all aspects of the process in the field. Some or all of the process may remain the responsibility of the highway agency depending on its degree of participation in the national pooled fund study for SPS Traffic Data Collection. This document is intended to be circulated and encouraged as standard practice at all SPS WIM sites whether or not the agency is a participant in the SPS Traffic Pooled Fund Study. The majority of the reporting requirements included in this document are specific to sites evaluated under FHWA direction. The Sheet 16 reporting requirement however is applicable to all sites with LTPP lane data submitted for inclusion in the LTPP database. Within this document there are three groups identified as participants in the process: FHWA, highway agencies and data collectors. Data collectors may be responsible for equipment testing, site assessment, site validation, downloading of data for LTPP use, site profiling or smoothness evaluation. The processing of data collected at these sites is documented separately in *SPS-1, -2, -5 and -6 Traffic Data Processing* for SPS-1, -2, -5 and -6 sites. Data processing for SPS-8 sites is discussed in *LTPP Monitored Traffic Data Processing*.

Although this document uses the term WIM equipment, many of the processes and forms are also applicable to Automated Vehicle Classification (AVC) equipment. Sites instrumented solely with AVC equipment (generally SPS-8s) are also evaluated using this guide using all elements except for those that refer to equipment or processes that assess the quality of loading data.

Throughout this document the terms SPS projects, SPS sites and SPS locations refer to the SPS-1, -2, -5 and -6 experiment projects and those SPS-8 experiment projects that have been targeted for intensive traffic monitoring activities. Intensive traffic monitoring activities implies installation of permanent traffic monitoring equipment to collect data on a continuous basis.

Although this document was developed as part of the effort to improve data quality and quantity at SPS-1, -2, -5, -6 and -8 locations, the material in here is applicable to any LTPP traffic data collection location.

## 1.2 Safety

Traffic data collection involves work in and adjacent to the traveled way. Data collectors and observers are to follow all FHWA, state and individual company policies for work on highway rights of way. Data collectors are responsible for keeping a list of policies applicable to each individual state. Where site-specific conditions involve special actions these should be included within that list.

## 1.3 Organization of Guide

This guide is divided into six major operational sections. These are Site Assessment, Site Validation – Weight, Site Validation – Classification, Pavement Smoothness, WIM Equipment Installation & Calibration Auditing, and Data for Use in LTPP Activities.

**Site Assessment** is the inventory or fact gathering visit to collect all site information on pavement, equipment, traffic, inputs to validations and contact names. It is performed on the first visit to any test site with an operational WIM or AVC. In the absence of installed equipment at a site, it is part of the site selection process.

**Site Validation for Weight** is the verification of a site's precision and bias in estimating truck weights. It is performed by running test trucks of known weights. It also includes an annual pavement smoothness evaluation and validation for classification. It is recommended that the weight validation be conducted once a year for bending plates and load cells and twice a year for quartz piezo sites.

**Site Validation for Classification** is a check on the accuracy of the equipment with respect to the installed classification algorithm. Speed and spacing checks are part of the process. It is recommended that this be done at least once a year.

**Pavement Smoothness** is an evaluation of the pavement's influence on WIM equipment precision. For in-service sites the evaluation is done using data from a high-speed profiler. At newly constructed sites, where lane closure is possible, a straightedge methodology is also available.

**Construction** outlines site selection and installation activities.

**WIM System Installation & Calibration Auditing** is the inspection and evaluation of SPS WIM installation activities in order to promote greater uniformity and quality in the installation, calibration and operation of the WIM systems installed at LTPP SPS test sections.

Additional sections are:

**Supporting Software** which discusses LTPP software tools associated with field operations.

**Forms** which includes the instructions for completing all of the forms and copies of each of the forms that is specific to the activities in this document. Some of the forms used are found in *Guide to LTPP Traffic Data Collection and Processing* (Ref. 3).

# 2 SITE ASSESSMENT

A site assessment is the first equipment evaluation visit to an SPS traffic data collection site. All SPS-1, -2, -5 and -6 sites require such a visit to provide a snapshot in time of site conditions whether the site is monitored by the agency or LTPP. Any SPS-8 identified for continuous monitoring will also require a site assessment. The outcome of an assessment is a report on the status of the equipment and a judgment on whether remediation or validation is the next step in the process of obtaining quality data.

As part of the site assessment, the field personnel should collect the site and equipment information and conduct a visual inspection of all WIM site support components. Field personnel should perform static electrical and electronic tests of the equipment. Pavement condition, in-road sensor condition, and any impact on truck motion should be recorded. Information on truck speeds, classification and route options for test trucks should be noted during each site assessment to allow for more efficient planning of subsequent validation activities.

The record of the assessment is documented in a number of forms. They are referenced in the sections that follow along with the data requirements for an assessment.

The first form to be completed is a LTPP Traffic Sheet 18, WIM Site Coordination. This sheet has agency contact information and site-specific operational conditions. The second form to be completed is a LTPP Traffic Sheet 17, WIM Equipment Inventory. These two sheets contain all the information necessary to complete a subsequent validation. Other forms that may be completed in the course of an assessment are LTPP Traffic Sheet 16, Site Calibration Summary; LTPP Traffic Sheet 20, Speed and Classification Studies; and LTPP Traffic Sheet 22A, Site Equipment Assessment with appropriate addenda. Each of these sheets may be found within Section 10 (Forms) of this document. They are generally referred to in the document as Sheet # (number) with their traffic data association being implied. There are other LTPP data sheets with the same numbers. None of them are applicable to LTPP traffic data collection.

## 2.1 PAVEMENT CONDITIONS

The smoothness of a WIM site can affect its ability to produce high quality data. An assessment will include checking the pavement smoothness using either the output from a high-speed profiler or a straightedge. It also includes a qualitative distress survey.

### 2.1.1 PROFILE DATA

Data collected with a high-speed profiler is the recommended method for evaluating smoothness of a WIM section. Guidelines on how to profile LTPP WIM sections are contained in the *LTPP Manual for Profile Measurements and Processing* (Ref. **Error! Reference source not found.**). Any profile data used for an assessment should be collected within a year of the site assessment visit.

The results of the profile smoothness evaluation using the LTPP WIM Smoothness Index software are to be reported in any assessment report. The current index thresholds are found in Section 5.1.1 (Reporting Results). A description of the software is found in Section 9.3 (WIM Smoothness Index Software).

This visit can also indicate if the 1000 foot (305 m) WIM section overlaps one of the SPS project sections, reducing the ability to improve smoothness by grinding or reconstruction. This length also applies to instances where a 400 foot PCC slab has been installed in an AC pavement for sensor installation.

If it is not possible to run a high-speed profiler at the site, the straightedge methodology discussed in Section 5.2 (Smoothness Determination through Use of a Straightedge) may be used as an option. This option requires traffic control during the smoothness evaluation.

### 2.1.2 Distress Identification

The distress survey provides a qualitative measure of surface anomalies that may affect truck motions across the sensors. This includes such items as potholes, patches, rutting, and asphalt-concrete transition.

The *Distress Identification Manual for the Long Term Pavement Performance Program* (Ref. 9) shall be used as the standard guide for interpretation, identification and rating of observed distresses.

Sheet 17 includes space to record distress photos taken at the site. At a minimum an assessment should include two photos of the area in the immediate vicinity of the WIM sensor location, one facing upstream and the other facing downstream from the sensor location. Additional photos showing distresses or pavement conditions such as asphalt to PCC transitions that may affect data collection are also to be included.

### 2.1.3 Vehicle-Pavement Interaction

Several trucks should be observed while they pass over the site to determine if truck traffic is showing adverse characteristics such as bouncing, swerving, braking, or accelerating within one hundred thirty-five feet (forty meters) of the sensors. If possible, it should be determined whether the truck tires are in full contact with the sensors.

A visual record of vehicle motion observations for a minimum fifteen minutes or thirty-five trucks whichever is longer is made. At low truck volume sites[1] no more than an hour of video is expected. The camera is to be positioned so that the entire vehicle can be observed as it crosses the sensors.

In the event that there are potential tire contact problems, video for a minimum of fifteen minutes or ten trucks at pavement level near the affected sensor(s) should be taken. At sites with low truck volumes this video is not expected. However the possibility of tire contact problems should be noted for investigation during any subsequent visits at the site.

The results are to be reported on Sheet 22A. They include a verbal description and reference to all video taken. The references include tape (or disk) names and times.

## 2.2 Traffic

Existing traffic and operational conditions are evaluated to determine equipment performance and to identify what vehicles are appropriate for a WIM validation. An additional element is the determination of a truck route and the number of trucks that will be required to efficiently evaluate the loading data for the WIM equipment.

[1] A low truck volume site is defined as twenty or fewer vehicles per hour during daylight hours in Class 4 and higher.

### 2.2.1 Classification Data

Classification information means the ability of the equipment to correctly classify vehicles according to its installed algorithm and thus to determine the vehicle distribution of the traffic at the site. A copy of the classification scheme and its associated algorithm for the equipment should be obtained either from the agency or by download from the equipment. A classification algorithm is used to assign vehicles to a classification scheme. Unless otherwise indicated, this document assumes the Traffic Monitoring Guide (TMG) 13-bin classification scheme in its discussions of vehicle classes.

While on site, a sample of vehicles is taken. The classifications of these vehicles are observed visually and compared to the classifier output in order to determine whether the equipment is classifying vehicles correctly. This sample should include a minimum of one hundred trucks unless such a sample would require more than three hours of collection effort. A systematic selection of vehicles should be employed (i.e. every fifth passenger vehicle and all vehicles visually identified in Class 4 and higher). Class 3 vehicles should be included in the population to determine if there is difficulty in distinguishing between Class 3 and Class 5 vehicles when classes 2 and 3 are collected separately by the equipment. Sheet 20 is to be used for collecting and reporting this data. The results of the classification verification are used to complete the Sheet 16 classification validation section.

Classification data should exist in the LTPP traffic database to give a preliminary indication of the predominant truck types. Weight data may exist to indicate their general loading characteristics. This information is used to choose the most appropriate test trucks for subsequent weight validations. A truck class is considered for inclusion in the test truck population if it comprises 10 percent or more of the truck population. Class 5 vehicles should only be included when they are 70 percent or more of the truck population and concurrence of the agency is obtained. Use of two trucks in Class 6 and higher is preferred since these heavier trucks have a greater impact on pavement performance. The loading characteristics are determined by using gross vehicle weight (GVW) graphs for the test truck classes. These may be obtained from LTPP traffic data.

If there is a conflict in vehicle distribution patterns between the database and the on-site observations, the on-site observations control the selection of vehicle types. Loading characteristics are then determined using the truck selection criteria in Section 3.4 (Trucks).

Speed measurements are to be taken with a laser or radar gun during the classification sampling operation for comparison with the equipment output. A laser gun is preferred.

### 2.2.2 Speed Data

Speed data serves two purposes, a diagnostic if problems exist in classifying trucks and to identify the appropriate range of test truck speeds for validation purposes. Precision of speed data impacts the investigation of classification discrepancies and spacing errors.

The speed data should be requested from the agency prior to an assessment since it is not an element collected or required by the LTPP program. If it cannot be obtained in advance of the visit, it will be collected on site. Speed measurement accuracy is preferred to be within 0.25 mph, but must be no less accurate than 1 mph.

The site speed limit is entered on Sheets 17 and 22. Sheet 17 contains the recommended test truck speed ranges. Sheet 22 has the 15$^{th}$ and 85$^{th}$ percentile truck speeds.

#### 2.2.3 TRUCK ROUTE

A route that can be successfully navigated by a 5-axle tractor-trailer is identified. The route is traveled at least three times to determine a typical travel time. The time and a written description of the route are included in the Comments section of the Sheet 17. In addition, a map showing the route is put in the Sheet 17 in the Site Map section.

### 2.3 EQUIPMENT

The items expected for equipment review are included on Sheet 22 and the associated addenda. The addenda are differentiated by sensor type.

Field personnel will perform a visual inspection of all WIM site support components, including the interior and exterior of the controller cabinet, service mast, solar panels, visible conduit and all other system support structures and equipment

Field personnel will perform the equipment static electrical and electronic tests. A series of static electronic readings of the WIM system components as well as supporting equipment are taken and recorded on Sheet 22. Proper safety measures are taken to ensure that all test equipment is used properly.

Field personnel will identify and record deficiencies involving the supporting equipment that will require repair. All items whose present or deteriorating condition will eventually adversely affect the operation and/or accuracy of the WIM equipment are to be documented. Any unsafe conditions existing at or near the site will also be noted.

The physical layout of the sensors and cabinet along with distances between them in relation to the travel lanes and the LTPP lane is included as a sketch in the section labeled Site Layout of the Sheet 17.

### 2.4 REPORTING OF RESULTS

A memo (letter report) is prepared after each site assessment visit. For assessments conducted under FHWA direction it is sent to the LTPP Traffic Team Lead with copies to the LTPP Team Leader, the appropriate Regional Support Contractor (RSC) and the relevant agency contacts. It is forwarded within 2 weeks of the assessment.

The memo should contain the following at a minimum:

- A WIM site assessment was done at the SPS *X* located on route *X* at mile point *X*, direction on *date*. The LTPP Lane is identified as lane *X in the WIM controller*. .
- This site *is/is not* recommended for validation.
- The site is equipped with *type of sensors and type of electronics*.
- The equipment *is/is not* in working order.
- The pavement smoothness *will not/ may or may not/ will* affect validation efforts.

The mandatory attachment is Sheet 17. For sites that are operational and collecting data a Sheet 16 is also included.

For sites that are probably not going to successfully produce the quality data LTPP needs, an analysis and supporting data must be included. The following conditions can define a site that is "not recommended" for a validation:

- ♦ Non-working equipment
- ♦ Speed errors exceeding ± 1 mph with overall errors in classification exceeding five percent
- ♦ Classification data that is not research quality for trucks in Class 6 and higher
- ♦ Smoothness that may or will affect validation efforts

# 3 SITE VALIDATION - WEIGHT

Scale accuracy is central to the acceptance of quality traffic weight data. Site validation is the process by which trucks with known static weights are run over a site without adjusting any of the WIM and AVC equipment's operational parameters. This gives an estimate of the precision and bias of the most recent data provided with the installed sensors and algorithms. After any required calibrations are concluded to reduce bias or improve precision, a final set of runs is made. These runs produce an estimate of the precision and bias of the data subsequently provided by the sensors until the next validation or termination of scale operation.

Scales that meet the tolerances in Table 3-1 below are considered to produce research quality loading data for LTPP. It is the expectation of the LTPP program that research quality data will be produced at all SPS-1, -2, -5, -6 and -8 locations. Failure to meet axle spacing tolerances is not grounds for denying a research quality label for loading data.

These tolerance levels are taken from ASTM E-1318-02. They apply with respect to the mean and standard deviation of the errors. The ASTM criteria of no more than five percent of the errors exceeding the tolerances for each element tested is not applied for determination of site performance for LTPP. LTPP does not consider wheel load errors. The results of applying the ASTM criteria should also be reported for informational purposes.

**Table 3-1 – WIM System Calibration Tolerances**

| SPS-1, -2, -5, -6 and -8 Sites | 95 Percent Confidence Limit of Error |
|---|---|
| Loaded single axles | ±20 percent |
| Loaded axle groups | ±15 percent |
| Gross vehicle weights | ±10 percent |
| Axle spacing length | ± 0.5 ft |

Any site validation for weight must also include a validation for classification as discussed in Section 4 (Site Validation-Classification).

## 3.1 BACKGROUND

Since collection of accurate traffic loading rates throughout the year is necessary to provide the loading rate estimates needed for SPS test section research, the WIM systems used in this effort must meet the criteria under a variety of conditions. Historically, many WIM systems have had problems accurately weighing vehicles when environmental conditions change from those present when the equipment was calibrated. Changes in pavement strength at the scale location (often caused by changes in pavement temperature or moisture content) are known to cause problems with WIM system sensor accuracy. Additionally, vehicle dynamics change with vehicle speed. Therefore it is also necessary to ensure that the WIM systems are able to accurately weigh trucks at the range of speeds at which trucks travel at each scale site.

In this document, the term "scale" is assumed to include all components involved in the collection of vehicle weight data, unless otherwise specifically stated. The term "scale" is assumed to be synonymous with "Scale System." The term "scale" is not restricted in meaning to those components (sensors) that physically measure axle forces. It includes sensors, the electronics and software that interpret sensor signals, and converts that data into estimates of axle weights.

All WIM systems currently on the market use one or more “calibration factors” as part of the process for converting axle sensor information into axle and vehicle weight estimates. Generally these “calibration factors” are increased if the scale under-estimates static weights or decreased if the scale over-estimates static weights. In addition, many scales use an “auto-calibration” process that adjusts scale calibration based on monitored inputs. These adjustments are designed to take into account changing sensitivity of the scale sensors and electronics to changing environmental conditions and the aging sensors.

The goal of the validation is to verify that the scale will produce accurate vehicle weights under expected operating and environmental conditions. This includes demonstrating that the scale system does not produce outputs that are biased by temperature and/or vehicle speed.

The recommended scale performance verification process involves weighing trucks of known weight with the WIM scale, and then comparing the WIM system’s measurements with the known weights. The conditions under which vehicles are weighed by the WIM system are controlled to demonstrate that the system operates accurately under the majority of conditions expected to occur during LTPP data collection. During testing, the site should be operated in its “normal” manner. That is, if auto-calibration settings are normally “on” then they should also be “on” during the verification tests. Sites which use auto-calibration are not considered appropriate for use in LTPP data collection. Additional verification of the selected auto-calibration target and a demonstrated ability to return to calibration operating condition parameters is expected. LTPP does not provide a method for validation of sites that use auto-calibration.

The primary verification testing can be done with a minimum of two test trucks of different weights. Once a weighing system has proved to be unaffected by vehicle speed and temperature over the course of a year, it is also permissible to verify sensor calibration by comparing the statically measured weights of vehicles pulled from the traffic stream at static scales with WIM system weights for those same trucks. This document describes only the use of test vehicles.

### 3.2 Performance Testing Procedure

The scale accuracy tests are designed to verify the performance of the scale when pavement temperature and vehicle speed vary. The test plan requires the test trucks to make multiple passes over the scale at different specified speeds. Whenever possible site visits are made during times of the year when the greatest daily temperature variations are likely to be found at the site. Statistical tests are performed to examine system accuracy for the entire data collection period and for subsets of the data that represent subsets environmental or operational conditions.

The accuracy and reliability of data produced by the scale are computed by comparing the measured axle weights collected under these varying conditions with the known axle weights of the test vehicles. Ideally validations are repeated two or three times during the year to make sure that the scale works accurately during all expected environmental conditions at that site. Additional validations may also be required if concerns about the accuracy of the scale under different temperature conditions are not fully resolved by the initial tests, or if calibration drift is detected by routine quality assurance tests.

Once the test trucks have been weighed at a certified static scale and the weights given to the WIM data collection staff, a preliminary determination of accuracy is made by making at least forty passes over the scale. If the agency agrees and the ability to change calibration factors is available, then the system should be calibrated so that its output will have less bias and greater precision. A Sheet 16 is required to document the data quality using the initial forty runs. After calibration, a minimum of ten passes should be made to check the WIM readings against the static weights. The runs should be done using the same test trucks operated at least two different speeds. At least ten verification passes (five per truck) should be made after each calibration adjustment. The calibration process is repeated until the ten post-calibration passes confirm the scale's accuracy is consistent with research quality data or it is determined that no further improvement can be obtained (generally three calibration iterations). All calibration adjustments should be made using procedures outlined in the scale vendor's documentation.

### 3.2.1 Speed Verification and Data Collection

Before the test runs are started, the data collection crew should use the radar gun or laser speed measurement system to determine whether the WIM system is correctly measuring speeds of the traffic. Speed measurement error is preferred to be within 0.25 mph, but must be no greater than 1 mph. The measurement of the speeds should be done according to the instructions provided by the equipment manufacturer. The data collection crew should also observe the reported spacings of the drive tandems on 3-axle tractors. The speed measurements are to be made of the normal traffic (cars and trucks) at the site. They do not require the test trucks.

If the average error for vehicle speeds is correct (within 1 mph), or if the average observed drive tandem spacing is between 4.2 and 4.4 feet, then test runs can begin. If both of these values are incorrect and there are frequent classification errors (in excess of five percent for trucks), the system may not be operating correctly, and the system's input variables should be adjusted.

Once the crew has established that the system is correctly measuring vehicle speed, additional speed data does not have to be collected other than for the test vehicles. The data collection staff should continue to record the speed values output by the WIM system for the test trucks because this maintains the record of vehicle conditions needed to analyze system performance under different truck operating speeds. Speed measurements of test trucks should continue to be collected.

Speed data for the speed verification process is entered on Sheet 20. Speed data for the test trucks while load data is collected is recorded on Sheet 21

### 3.2.2 Pavement Temperature Data Collection

Since not all test sites are expected to be equipped with accurate pavement temperature sensors, manual pavement temperature readings should be collected at each site with a validated infra-red temperature sensor. The suggested validation procedure is included in Section 10 (Forms) with the instructions for Sheet 30. The methodology is the same as that used for LTPP FWD hand-held infra-red temperature sensors (Ref. 6). Pavement temperature is preferred over air temperature as it more accurately reflects environmental impacts on the sensors. Because the use of air temperature data requires conversion to pavement temperature through generally accepted practices before doing temperature-based analyses it is not the preferred option.

If the WIM has temperature sensors that are not measuring surface temperatures the correlation between the surface temperature and the equipment's temperature probe(s) cannot be established without additional information to verify the reasonableness of the WIM temperature measurements. In this instance the surface temperature should be the temperature collected and used in the analysis.

Manual temperature measurements should be made near but not on the sensor. The temperature should be collected immediately after the trucks pass the scale. Prior to collecting temperature data a location within two feet of a WIM sensor will be selected and marked. If the materials for the shoulder and pavement are the same OR the LTPP lane has more than one vehicle every twenty seconds, the location will be on the shoulder. If the materials are different and the LTPP lane has less than one vehicle every twenty seconds, the location will be six inches into the lane from the shoulder marking and at least one foot from a WIM sensor. The area for temperature measurement will be marked with a 6 x 6 inch square using chalk. In taking the measurement the personnel will stand facing traffic and hold the sensor approximately 30 inches (about hip height) above the pavement. The measurement is recorded on Sheet 21.

To obtain a wide temperature variation[2], it may be necessary to collect data over more than 8 hours in a day. FHWA-LTPP and the agency should consult prior to the scheduling of the field tests on the timing and duration of the validation.

Where possible, at least 12 test runs should be performed for each temperature range. These should be performed to effectively cover the range of test speeds. For example, if time is available to make one additional pass per temperature condition, the additional run might be made at the speed at which the majority of trucks operate or at the speed with the fewest test runs.

It is also important to collect data after the temperature has started to decline to determine whether cooling of the upper pavement layers (while the lower layers stay warm) affects WIM output.

While every effort will be made to select a day when pavement temperatures will vary widely during the testing procedure, it is possible that during the selected test day(s) little temperature variation will occur. Successful tests taken under these “less than desired” conditions will still be considered validation of the scale’s calibration. However, it is expected that additional tests focusing on the scale’s temperature sensitivity will be conducted at that site subject to resources and scheduling opportunities. Validating the site during different seasons each year may be necessary.

### 3.2.3 Running Trucks

The required minimum test runs are:

- 40 initial runs at least two different speeds prior to any calibration efforts to determine the initial equipment performance
- 10 runs at two different speeds after each change in calibration, repeat until calibration is satisfactory
- 40 runs to validate the final calibration of the scale. The 10 runs performed after the last calibration change may be included in these 40 runs.

At the direction of FHWA if the site meets the loading tolerances with a bias of less than ±2 percent, the validation may be terminated after the initial 40 runs.

[2] A wide temperature variation is considered 30 degrees Fahrenheit or more. Ranges less than 30 degrees Fahrenheit may produce fewer temperature groups for analysis.

The use of three different speeds is preferred. A 30 degree Fahrenheit minimum pavement temperature range is the target for varying pavement temperatures.

Once the test trucks have been weighed at a calibrated, certified static scale that meets Handbook 44[3] specifications, they should make repeated passes over the sensors. When approaching the WIM scale, drivers should hold the vehicle speed constant. They should report after any runs where they were not able to maintain a constant speed. (This contact should take place after they have completely crossed the scale, as radio system broadcasts can cause interference with the WIM system outputs, causing false readings.) In most case trucks will drive a continuous loop around the scale following the pre-determined truck route. Drivers should contact the data collection crew prior to unscheduled breaks or when conditions warrant a change in the test schedule.

Target test speeds should be differentiated by at least 5 mph and preferably 10 mph. For optimum differentiation in test truck speed groups a minimum of a 15-mph spread should exist between the highest and lowest speed to be tested. Using only two speeds should be considered when the difference between the $15^{th}$ and $85^{th}$ percentile speeds is 10 mph or less OR the $85^{th}$ percentile speed exceeds the speed limit. Speeds below the $15^{th}$ percentile speed for trucks should not be used. Four speeds should be considered when the difference between the $15^{th}$ and $85^{th}$ percentile speeds exceeds 20 mph.

Drivers should switch from high to medium to low target speed with each pass, continually rotating among assigned target speeds. This pattern will increase the sample size for each of the speed-temperature combinations.

Sufficient time should be maintained between each truck pass in order to record the data for each truck. If trucks are run in platoons the ability to print or download the data after the set of runs or after system adjustments are made should be verified and tested before relying on post-run downloads for analysis data.

A total of forty runs is the minimum required to have an acceptable data set for analysis prior to the first calibration. If turnaround times are such that two trucks between them cannot complete forty runs in a 10-hour site visit (breaks included), additional trucks should be used.

It is important to note the following points –

- The test trucks should move at a constant speed across the sensors.
- Vehicle passes must be made at a variety of speeds.
  - The trucks should not be operated at speeds above the posted limits.
  - Truck operation should not cause safety problems by operating too slowly.
- Trucks should be as centered in the lane as much as possible when crossing the scale.

### 3.2.4 Loading Data Collection

For each vehicle pass, the data collection staff should record the WIM system's output for axle weights and axle spacings. Each test vehicle's speed when crossing the sensor (collected with the laser or radar

[3] "Specifications, Tolerances and Other Technical Requirements for Weighing and Measuring Devices": National Institute of Standards and Technology (NIST) Handbook 44, U.S. Government Printing Office Superintendent of Documents, Mail Stop: SSOP Washington, D.C. 20402-9328, ISBN 0-16-046313-7.

gun) may need to be obtained for comparison with the WIM system's output. The following data from the WIM system should be obtained:

- The sequence number of the test run
- The date of the test run
- The time of the test run
- Axle weights of the test trucks as they pass over the scale
- Spacing between each axle on the test truck
- Speed of the test truck
- Pavement temperature at the time of the test run

The sequence number is the reference number used by the WIM system software to indicate this particular weight record. It may also be called the "record number" or "WIM assigned vehicle number." If information can be downloaded (retrieved) at the completion of the runs, this number can be used to crosscheck data entered during the runs.

These measured test truck attributes can be obtained by reading the values off the WIM scale display screen. This data should also be stored permanently and retrieved later for confirmation that the data entry at the site was correct. Some WIM systems also allow these data to be printed from a portable printer or written to an ASCII file for later retrieval. An Excel spreadsheet described in Section 9.1 **(WIM 2 TRUCK)** has been created by FHWA-LTPP to assist in recording and analyzing the data collected. It is available from LTPP Customer Support. The preferred alternative is to use Sheet 21 if **WIM 2 TRUCK** is not being used.

Where differences in the weights recorded by the system and the observer occur (that is the screen of the computer on-site rounds up a value that is carried to more significant digits in the main WIM system record), the WIM system record should be used in the analysis effort.

Only records that correctly report the number of axles on a test truck should be included in the analysis. For example a 5-axle truck record must have five consecutive non-zero axle weights and four consecutive non-zero axle spacings to be valid for analysis. When wheel load data are used, only records with the correct number of sequential non-zero wheel loads should be used. Errors in identifying test trucks do not count towards the 40 run minimum. Errors in collecting test truck data by the equipment should be noted in the validation report. The specific type of error(s) should also be described.

### 3.2.5 Process by Which Required Number of Test Runs Was Determined

A minimum of thirty-six test runs is required based on the desired number of speed temperature combinations. Four test runs are needed at each of three test speeds within each of three temperature ranges (4 x 3 x 3 = 36) for ideal conditions. However this is an absolute minimum. Additional test runs are encouraged whenever possible. The forty run limit was established to improve the chances of getting at least twelve runs in each temperature and each speed subset. The total number of runs should be split evenly between all trucks used. This may result in making more than the minimum number of runs. The minimum number of test runs is not reduced for sites at which fewer speed ranges or temperature ranges are anticipated.

Additional runs may also be necessary if conditions at the site prevent some planned runs from being performed at the desired speeds or if traffic conditions cause improper test conditions to exist (for example the test vehicle must brake to avoid another vehicle while approaching the sensors).

### 3.3 WIM DATA ANALYSIS

Once the data have been collected in the field, statistics must be computed to determine whether the WIM site meets the accuracy standards for research quality data set by LTPP. The basic statistic required for this test is the error expressed as a percentage of the known value. The percentage of error calculated from the data collected for each run is then used to compute a series of summary statistics. These summary statistics are used to determine whether the scale is producing research quality data.

The first set of tests requires data from all of the 40 plus test runs performed at the site. It provides a general overview of system performance, given all of the environmental and vehicle speed conditions that were present during the testing. To perform these tests, the analyst should calculate the mean and standard deviation of the ‘percentage of errors’ for these variables:

- Front axle weights of the test trucks
- Weights of all non-front axle single axles
- Weights of all tandem axles[4]
- Weights of any other multi-axle groups by axle group type
- Weights of all single axles
- Weights of all multiple axle groups as a set
- Gross vehicle weights

The percentage error is computed as the equipment reported value less the static value and the result divided by the static value.

For each of the variables, the analyst should compute the 95% confidence limits for the percentage of error using $(X + 1.96\sigma)$ and $(X – 1.96\sigma)$ where:

$X$ = mean value of the percentage of error for the statistic
$\sigma$ = standard deviation of that percentage of error

This value (for each variable) should then be compared with the values shown in Table 3-2. If any of these values exceeds the associated range in Table 3-2, the WIM system does not produce research quality data. If all of the loading values are within the ranges in Table 3-2, the system produces research quality data.

[4] A tandem axle is an axle group in which the consecutive vehicle axles are at least 3.3 ft (1 m) and not more than 8 ft (2.4 m) apart. If the axle spacing of a pair of axles on the same suspension exceeds the maximum distance each axle is considered a single axle and the tandem called a split tandem.

**Table 3-2 – WIM System Calibration Tolerances – Large Sample**

| **For SPS WIM Sites** | **$X \pm 1.96\,\sigma$** |
|---|---|
| Single axles | ±20 percent |
| Tandem axles (and other axle groups) | ±15 percent |
| Gross vehicle weights | ±10 percent |
| Axle spacing length | ± 0.5 ft |

The analyst should also compute the mean and standard deviation of the error for the following variables:

- Drive tandem axle spacings
- All axle spacings

The 95% confidence limits for these variables should be computed using the same method as for the other variables and compared against the spacing value in Table 3-2. Not meeting the axle spacing criterion does not impact the decision on the research quality label for the loading data.

The scale being tested may pass the research quality test outlined above, but it still may not truly be able to produce research quality data for vehicles traveling at different speeds or under different temperature conditions. Subsets of data grouped by speed or temperature are also analyzed to determine of the subset is of research quality. The failure of a given subset to meet the research quality does not affect the determination of data quality for the site as whole. It is however, reason to consider additional validations with emphasis on those subset conditions.

### 3.3.1 Sample Size Influence on 95% Confidence Limits

The simple statistical tests presented in this document assume a normal distribution of errors and independence in the measurement of those errors. Neither of these assumptions is true. However, by developing a testing program that requires changing speeds (which change the effect of vehicle dynamics), temperatures (which affect pavement profile and strength), and different suspension types and or weights (through the use of more than one test vehicle), LTPP has created a test situation with a limited number of test vehicles that is likely to contain a greater degree of variation than would be found with a purely random sample of trucks. Therefore, the use of these statistical formulations is considered to be an acceptably conservative approach.

However, when the statistical tests are applied to subsets of the test data, the sample size involved can be quite small. As a result, the Students' *t* distribution has to be used rather than the normal distribution for statistical tests. Note that the sample size used to determine the appropriate number of degrees of freedom will change with each variable tested. This is because the test procedure assumes that each axle group is an independent measure of performance. Thus, if four test runs are made with 3-axle tractor, tandem axle trailer combination (3S2) trucks, the sample size for the GVW test will be four, but the sample size for the tandem axle test will be eight. Note, when the number of observations being tested reaches thirty, the Normal and Student's *t* distributions become similar. This will occur for tandem axles when fifteen 3S2 test runs have been made, since each 3S2 has two sets of tandem axles (assuming neither vehicle has a split tandem on the trailer).

The formula used to compute the test statistic is similar to that shown above with the exception that the critical value of $t$ is used for $\alpha = 0.05$ for a two-tailed test (Replace 1.96 with $t$).

Table 3-4 contains selected values of $t$ for a 95% confidence limit for n-1 degrees of freedom, up to thirty. While the computation of the test statistic changes to account for the smaller sample size, the criteria for determining research quality do not change as shown in Table 3-3.

**Table 3-3 - WIM System Calibration Tolerances – Small Sample**

| **For SPS-1, -2, -5 and -6 Sites** | **$X \pm (t * \sigma)$** |
|---|---|
| Single axles | ±20 percent |
| Tandem axles (and other axle groups) | ±15 percent |
| Gross vehicle weights | ±10 percent |
| Axle spacing length | ± 0.5 ft |

Where:

- $X$ = mean value of the percentage of error for each statistic
- $\sigma$ = standard deviation of those values
- $t$ = the Students' $t$ statistic for $\alpha = 0.05$ and n-1 degrees of freedom for a two-tailed test
- n = the sample size for that particular statistic under the conditions being tested.

The values for individual sample sizes may be found in standard statistics texts or generated by functions in most spreadsheets. To check that the correct *t*-statistic is being used, see the entries in Table 3-4 (from *Introduction to Probability and Statistics*, *4th Edition*, by William Mendenhall, 1975, Duxbury Press).

**Table 3-4 Values of Students' *t* Statistic for Different Sample Sizes**

| **Sample Size** | **n-1** | *t* |
|---|---|---|
| 12 | 11 | 2.201 |
| 14 | 13 | 2.16 |
| 16 | 15 | 2.131 |
| 18 | 17 | 2.11 |
| 20 | 19 | 2.093 |
| 22 | 21 | 2.08 |
| 24 | 23 | 2.069 |
| 26 | 25 | 2.06 |
| 28 | 27 | 2.052 |
| 30 | 29 | 2.045 |
| 31 or greater | | 1.96 |

### 3.3.2 Specialized Tests – Sensitivity to Speed

To perform this test, runs should be sorted by vehicle speed so that the data can be grouped by the speed ranges for the test runs. If three different test speeds were used (e.g., 65 mph, 55 mph, and 45 mph) three different accuracy computations will need to be made.

Each speed analysis will consist of a summary of errors for all test truck runs performed at the speed range in question. For each group of test vehicle runs, the mean and standard deviation of the percent error of each of the collected variables should be computed.

Since only a subset of test runs is performed at each speed range, there are fewer data points for this test than for the general performance test discussed above. To maintain confidence that the results of the test are still within the desired level of confidence, it may be necessary to use the Students' *t* distribution, rather than the normal distribution in the statistical test.

Lastly, in addition to the test discussed above, a plot of percent measurement error versus vehicle speed should be created for each of the test variables. A review of this plot will also indicate if and how speed affects weight measurements.

### 3.3.3 Specialized Tests – Sensitivity to Temperature

To perform these tests, the runs should be sorted and grouped by pavement temperature range. Typically three ranges would be analyzed: a "low", a "medium" and a "high" range. Use only two groups if the total temperature range is between 15 and 25 degrees Fahrenheit. Use only one group if the total temperature range is less than 15 degrees Fahrenheit. In defining groups, no group should have a sample size less than ten test runs. This may result in groups with unequal range widths or fewer than expected groups for the observed temperature range.

For each group, the mean and standard deviation of the percentage of error for each of the test variables should be computed. The formula and values shown in Table 3-2 or Table 3-3 depending on sample size are used to determine whether the errors measured by the field test fall within research quality tolerance levels.

In addition to the basic statistical tests, the analyst should look for specific trends. This can be accomplished by plotting percent error against pavement temperature. For example, the scale may be within acceptable error tolerances but show a marked bias at extremely hot temperature. Such a result would indicate that additional testing may be needed at higher temperature ranges. Such testing should be scheduled when hotter temperatures are expected.

#### 3.3.3.1 Seasonal Temperature Effects

To measure the effects of different environmental conditions on scale performance, the calibration of each scale that passes the validation should be verified again under different sets of environmental conditions. Tests should be performed in summer, winter, and spring where feasible, as these are times when:

- Pavement strength varies as a result of different temperature and moisture conditions and;
- Temperature variations (highs, lows, and maximum differences between highs and lows) differ significantly.

A maximum of three validation sessions (an installation verification or calibration along with two validations) are anticipated for the first year of operation at most scale sites. Where environmental conditions do not change significantly during the year, a minimum of two validations should be performed each year. Once tests have proved that a given scale system (as installed) operates accurately under the full range of environmental and highway operating conditions, only one validation test is needed per year. However, if the office monitoring process suggests calibration drift, additional system calibration will be required. A maximum of three checks a year is considered reasonable. If more checks are required due to drift then equipment replacement or additional validation resources will be required.

FHWA-LTPP is responsible for selecting the dates on which field testing will take place by LTPP contractors. These will be selected after consultation with the agency. Ideally, early morning temperatures during the test dates will be significantly different from temperatures found in the late afternoon. Seasonal differences in temperature variation and moisture can be handled by collecting data during different times of the year.

## 3.4 TRUCKS

All validations are conducted with a minimum of two trucks.

### 3.4.1 TRUCK SELECTION

When acquiring trucks, the types to be acquired are as follows:

Truck #1 must be a 3S2 (FHWA class 9) with standard tandems and air suspensions on tractor and trailer tandems. It should have the capacity to be loaded between 76,000 and 80,000 pounds. All loads must be legal in terms of GVW and axle weights for the location.

Truck #2 should be a predominant truck type at the site. The truck population is defined as all vehicles that fall into FHWA Classes 4 through 13. The predominant truck should be loaded within 4,000 pounds of the maximum legal weight for the truck and location. Truck #2 should not be a dump truck unless such a truck is either the predominant type or 20 percent or more of the truck population at the site. Truck #2 should not be a Class 5 vehicle unless those constitute more than 70 percent of the truck population at the site and the agency concurs with the use of a light truck for validation. If the classification algorithm cannot differentiate between Class 3 and Class 5 vehicles consistently (misclassification errors of 2% or more for either class), a Class 5 is not recommended for the second truck.

One of the options below should be used for Truck #2 with the options in descending order of preference.

- ♦ FHWA Class 9 truck (3S2) similar to Truck #1 but loaded between 60,000 and 64,000 pounds.
- ♦ FHWA Class 9 truck (3S2) similar to Truck #1 but with steel suspension loaded to between 60,000 and 64,000 pounds.
- ♦ FHWA Class 9 truck (3S2) similar to Truck #1 but with steel suspension loaded to between 76,000 and 80,000 pounds.
- ♦ FHWA Class 9 truck (3S2) similar to Truck #1 but with a split tandem trailer (no load equalization required between axles) loaded between 76,000 and 80,000 pounds.
- ♦ FHWA Class 10 truck (3S3) with any suspension type loaded above 88,000 pounds.
- ♦ FHWA Class 9 truck (3S2) similar to Truck #1 but loaded between 35,000 and 42,000 pounds for an unloaded site or between 40,000 and 55,000 pounds for a partially loaded site.

- FHWA Class 9 truck (3S2) similar to Truck #1 but with steel suspension loaded between 35,000 and 42,000 pounds for an unloaded site or between 40,000 and 55,000 pounds for a partially loaded site.
- FHWA Class 9 truck (3S2) similar to Truck #1 but with a split tandem trailer (no load equalization required between axles) loaded between 35,000 and 42,000 pounds for an unloaded site or between 40,000 and 55,000 pounds for a partially loaded site.

If more than two test vehicles are used, the third vehicle may be configured and loaded as desired, although the use of three- or four-axle single-unit dump trucks is discouraged. It is recommended that additional trucks be added that do not match either of the previously selected trucks. Single unit trucks are also an option when they constitute 10 percent or more of the truck population.

The loads should be something that will not shift or change the axle weights during the test. Steel plates or beams or concrete blocks or beams securely attached so they do not move are recommended. Loads should be covered if bulk materials are used.

### 3.4.2 MEASURING TRUCKS

Static weights are obtained using certified scales. Certified scales should have been tested by the relevant agency within the past three years. Axle weight scales are preferred to platform scales.

The truck drivers should be briefed so that when weighing the vehicles, the trucks are motionless and brakes are not engaged. The approach to the scale should be as smooth and level as possible to reduce inconsistencies in the weighing process when using scales that do not allow the entire truck to be weighed at once and obtain all the axle weights.

The characteristics of each truck shall be measured and recorded. These items include all axle spacings (from centerline to centerline of each axle/tire), wheelbase, bumper to bumper length, body type, kingpin placement, and suspension type.

Axle spacing is measured from center to center of axle using a tape measure to obtain the precise longitudinal distances between each axle. Measuring each spacing sequentially is not recommended. Trucks should be parked on level ground when this measurement is made. If they are not, each of the axle centers should be marked on the pavement and the measurements made from the chalked points.

Wheelbase is the distance from the center of the first axle to the center of the last axle. It should be measured not computed from individual axle spacings.

Bumper to bumper distance is the length from the font bumper to the back of the trailer. This distance should be measured on both sides of the vehicle from the point where the front bumper is parallel to the tractor body to the outermost point on the trailer. It may be necessary to chalk these points on the pavement to obtain accurate measurements.

Kingpin offset from Axle B is found by measuring the distance from the center of axle B to the articulation point of the tractor-trailer combination. On five-axle combinations, this point will typically be between axles B and C. If the articulation point (kingpin) is behind axle B, the distance will be greater than zero.

Photographs should be used to document the suspensions as well as the tractor, trailer, and loading. The axle weight and spacing and GVW information should be reported to the WIM data collection staff before any runs over the WIM. Trucks measurements are entered on Sheet 19A.

### 3.5 Reporting of Results

A memo (letter report) is prepared after each site validation visit. For validations conducted under FHWA direction it is sent to the LTPP Traffic Team Lead with copies to the LTPP Team Leader, the appropriate RSC and the relevant agency contacts. It is forwarded within two weeks of the validation.

The memo should contain the following at a minimum:

- A WIM validation was done at the SPS *X* located on route *X* at mile point *X*, direction on *date*. The LTPP Lane is identified as lane *X in the WIM controller*.
- This site *is/is not* providing research quality loading data.
- This site *is/is not* providing research quality classification data.
- The site is equipped with *type of sensors and type of electronics*. The equipment *is/is not* in working order.
- The pavement smoothness *did / did not* affect validation efforts.
- Copies of all pre-and post calibration summary tables for the overall data set and for the speed and temperature subsets similar to those below.
- A pavement smoothness evaluation using any method accepted by LTPP.

The mandatory attachment is Sheet 16(s) for pre- and post-calibration conditions. If only a single validation is performed only one Sheet 16 is provided.

The memo should include commentary on reasons for failures or suggested corrective actions as appropriate.

Copies of all electronic files and data collection sheets are Ancillary Information Management System (AIMS) Data. They are kept by the originating contractor for future disposition at the direction of FHWA. The RSC is responsible for entering Sheet 16 data into the LTPP pavement performance database within thirty days of the site visit.

**Table 3-5 Example - All Vehicle Results vs. LTPP SPS WIM Tolerances**

| Characteristic | 95% Confidence Limit of Error | Computed Value | Pass/Fail |
|---|---|---|---|
| Axle Weights | | | |
| All single axles | ±20 percent | +3.2% ± 18.8% | FAIL |
| Steering axles | ±20 percent | -2.1% ± 5.1% | PASS |
| Other single axles | ±20 percent | +9.8% ± 21.4% | FAIL |
| Tandem axles | ±15 percent | -3.5% ± 28.9% | FAIL |
| Gross Vehicle Weights | ±10 percent | +3.0% ± 14.0% | FAIL |
| Drive tandem axles | ±0.5 feet | +0.1 ± 0.6 | FAIL |
| All Axle spacings | ±0.5 feet | +0.3 ± 0.7 | FAIL |

**Table 3-6 Example - Computations for LTPP SPS WIM Tolerances by Speed Range**

| Characteristic | 95% Confidence Limit of Error | Low Speed 45-50 mph | Medium Speed 51-57 mph | High Speed 58+ mph |
|---|---|---|---|---|
| Axle Weights | | | | |
| All single axles | ±20 percent | -3.1% ± 40.9% | -3.9% ± 32.8% | -4.2% ± 27.6% |
| Steering axles | ±20 percent | -18.0% ± 25.9% | -14.8% ± 25.0% | -12.3% ± 25.9% |
| Other single axles | ±20 percent | 17.1% ± 20.6% | 8.82% ± 23.9% | 5.5% ± 17.6% |
| Tandem axles | ±15 percent | -4.8% ± 23.7% | -3.1 ± 30.5% | -0.6% ± 40.4% |
| Gross Vehicle Weights | ±10 percent | 5.1% ± 16.5% | 2.4% ± 15.5% | 2.0% ± 12.1% |
| Drive tandem axles | ±0.5 feet | 0.1 ± 0.8 | 0.1 ± 0.9 | 0.2 ± 0.6 |
| All Axle spacings | ±0.5 feet | 0.1 ± 0.4 | -0.2 ± 0.5 | 0.2 ± 0.8 |

**Table 3-7 Computations for LTPP SPS WIM Tolerances by Temperature Range**

| Characteristic | 95% Confidence Limit of Error | Low Temperature (100-110 F) | Medium Temperature | High Temperature (110-120 F) |
|---|---|---|---|---|
| Axle Weights | | | | |
| All single axles | ±20 percent | -3.9% ± 33.7% | -- | -4.5% ± 33.6% |
| Steering axles | ±20 percent | -12.4% ± 24.0% | -- | -15.9% ± 26.5% |
| Other single axles | ±20 percent | 7.2% ± 21.1% | -- | -8.3% ± 23.5% |
| Tandem axles | ±15 percent | -2.6% ± 28.4% | -- | -1.2% ± 34.8% |
| Gross Vehicle Weights | ±10 percent | 1.6% ± 14.5% | -- | 2.6% ± 13.6% |
| Drive tandem axles | ±0.5 feet | 0.1 ± 0.6 | -- | 0.0 ± 0.8 |
| All Axle spacings | ±0.5 feet | 0.1 ± 0.5 | -- | -0.1 ± 0.7 |

### 3.5.1 Failure Conditions

If a site fails the classification check for vehicles in Class 6 and higher, the decision to continue with weight validation is left to the lead data collector in consultation with the agency and FHWA. If the classification errors do not affect the test vehicle population, the weight validation can proceed.

If the site fails the weight validation checks due to a consistent bias and the data collection team has permission to adjust the equipment on site, it should be done. If this action is taken, a series of at least ten validation runs at the same speed and temperature should be made to verify the adjustments. The agency should be notified immediately of the changes.

If the site fails the weight validation checks as a function of speed and or temperature, a recommendation on remedial action should be made.

### 3.5.2 Consequences of Other Than Research Quality Data

No single remedy or consequence is appropriate for all sites where the validation tests described in this document show that the WIM system's outputs are not research quality.

In those cases where a single minor adjustments to the existing scale calibration factors can be shown to place the WIM scale in proper calibration, those adjustments, (if agreed to by the agency) will be made and the validation process repeated. Where more than one adjustment is needed (for example, the scale appears to be temperature sensitive, and more than one temperature adjustment needs to be made), additional testing (calibration efforts under different environmental conditions) may be required.

Where tests results indicate that the current scale is not sufficiently accurate and a simple calibration adjustment does not bring the scale back into calibration, LTPP will work with the agency to determine the appropriate course of action. This could include, replacement of the scale sensors, modification of the pavement containing the sensors (e.g., grinding), or other improvements.

### 3.6 Administration and Support

Coordination with the FHWA, the agency and the appropriate regional contractor is the first step in the site validation process. Agreement will be reached on the validation schedule, Sheets 17 and 18 will be reviewed and arrangements will be made to verify that the equipment is functioning on the day of the test.

FHWA will issue notice to proceed and the lead contractor will make all necessary arrangements consistent with Sheet 18. It is expected that for the validation process a minimum of thirty days notice will be provided. For sites with calibration drift, two weeks notice is required. It is expected that when calibration drift triggers a validation, additional profiling will not be a part of the validation process so long as profiling has occurred for the section within the prior twelve months.

At least four people are needed for this effort. Two will collect data at the WIM system. The others will drive the test trucks. Note that these are minimum requirements and that some site validations will require a third person for data collection or additional drivers. Scheduling of runs and data collection must recognize the need for periodic breaks for all personnel.

All data collection should be done during daylight hours with consideration given to adjacent residences and expected periods of congestion.

It is strongly recommended that a briefing of all personnel be held prior to the site visit. Topics should include safety issues, scheduling, truck routes and profiling operations if applicable. Following the briefing, trucks should be loaded, weighed and measured.

In addition to the test trucks, the calibration team requires at least three radios (CBs are acceptable), an infrared pavement temperature measurement device, a computer, WIM interface software and appropriate cables to connect to the WIM processor for recording the WIM data. A laser (or radar) gun for collecting vehicle speeds is also required. A generic equipment list is included in Section 11 (Miscellaneous Forms).

# 4 SITE VALIDATION - CLASSIFICATION

The vehicle classification scheme and associated algorithm to be used at each LTPP test site should be supplied by the agency responsible for the equipment. The agency should perform a complete multi-hour evaluation of the classification algorithm underlying the scheme prior to the site validation to ensure it accurately classifies vehicles at that site.

The on-site test described below is not designed to test the algorithm. Instead, it will ensure that the installed equipment is functioning correctly and that no major mistakes have been made in the installation of a previously approved algorithm on that system. The field tests involve manually classifying vehicles crossing the sensors and comparing those classifications with the system's output. Classification verification must be done on a lane-by-lane basis.

To perform the analysis, the data collector must record classifications as vehicles cross the sensors, and then record the classifications reported by the WIM system for those same vehicles. The analysis should include the full vehicle stream on the test lane rather than just heavy trucks. Classification codes should be the standard TMG 13-bin codes as illustrated in Section 11 (Miscellaneous Forms). It is recommended that the data collector have a copy of this figure in the field while conducting this test.

If the agency uses a classification scheme that does not match the TMG 13-bin system a copy of it must be provided to the data collection team prior to arriving on-site.

The classification is verified with each validation set but not each calibration set. If calibration changes are made to length parameters, a complete classification verification is required after each length calibration up to a maximum of three calibrations.

The classification data collection process can be performed during a WIM validation when other tasks are not being performed. Thus, it is not necessary for the data collection staff to classify all vehicles crossing the sensors during any given time period. (For example during a validation the staff can classify vehicles until the test truck approaches, stop classifying to assist in the data collection associated with the test truck run, and then return to classifying vehicles when the test truck has passed.) It is necessary, however, to enter both the manual classification and the system's classification for each vehicle observed. While classification is proceeding, the staff should count all vehicles in Class 4 and higher rather than pick and choose. If the volume is too high to allow this, the data collector may have to call out the classes while an additional staff member records the results. The sample must contain at least one hundred trucks, by preference at least 100 trucks in Class 6 and higher. This size requirement may be time-limited (three hours) at low volume sites. If the classification check is done continuously, then the minimum sample size is an hour even if more than 100 trucks in Class 4 and higher are observed in the lane in the hour.

The classification data is recorded using Sheet 20. The results of the classification validation are recorded on Sheet 16. A record of the classification test can be made using video synchronized with the WIM (AVC) as a back up.

## 4.1 Research Quality Classification Data

While performing the data collection, the staff person should look for specific types of errors to identify specific limitations in the vehicle classification algorithm. For example, many automatic classification algorithms cannot correctly differentiate between specific vehicle types because the axle spacing characteristics of these vehicle types are similar. Consequently, the data collection crew should examine how well specific types of vehicles are classified, including the following:

- Recreational vehicles
- Passenger vehicles (and pick-ups) pulling light trailers
- Long tractor semi-trailer combinations.

The classifier is considered to produce research quality classification data when:

- No more that two percent of the vehicles in Class 4 and higher recorded are reported as "unclassified" by the WIM scale and;
- The number of classification errors involving <u>truck</u> classifications in vehicle classes 6 and higher is less than two percent of the truck volume for the same set of vehicles.

## 4.2 Speed Verification and Data Collection

The data collection crew should use the laser speed measurement system or radar gun to determine whether the WIM system is correctly measuring traffic speeds. It is not necessary to use trucks to evaluate vehicle speeds. The measurement of the speeds should be according to the manufacturer's instructions. Speed measurement accuracy is preferred to be within 0.25 mph, but must be no less accurate than 1 mph. If measurement accuracy is not within 0.25 mph, speed measurement statistics should only be reported where more than 5% of the trucks in Class 6 and higher are misclassified.

If the average vehicle speed error is acceptable (within 1 mph) then test runs can begin. If the average of the vehicle speed errors exceeds 1 mph, and the classification data is research quality, then test runs can begin. If the classification data is not research quality a determination must be made in consultation with FHWA as to whether the associated weight validation should proceed. Once the crew has established that the scale system is correctly classifying vehicles, additional speed data is collected only for test trucks and any other classification validations expected for the site visit.

Speed data for the verification process is entered on Sheet 20.

## 4.3 Reporting of Results

A memo (letter report) is prepared after each validation visit. For validations conducted at FHWA direction it is sent to the LTPP Traffic Team Lead with copies to the LTPP Team Leader, the appropriate RSC and the relevant agency contacts. It is forwarded within two weeks of the validation. If the validation has included weight validation activities the information is included in the same memo.

The memo should contain the following at a minimum:

- An AVC validation was done at the SPS *X* located on route *X* at mile point *X*, on *date*. The LTPP Lane is lane *X in the direction.*

- This site *is/is not* providing research quality classification data.
- The site is equipped with *type of sensors and type of electronics*. The equipment *is/is not* in working order.

The mandatory attachment is Sheet 16. If adjustments are made to the classification algorithm or length factors Sheet 16s for both before and after conditions are required.

The memo should include commentary on reasons for failures or suggested corrective actions as appropriate.

Copies of all electronic files and data collection sheets are kept by the originating contractor for future disposition (AIMS data).

### 4.3.1 Consequences of Other Than Research Quality Data

No single remedy or consequence is appropriate for all sites where the validation tests described in this document show that the classification data is not research quality.

In those cases where single minor adjustments to the existing calibration factors can be shown to place the system in proper calibration, those adjustments, (if agreed to by the agency) will be made and the validation repeated. Where more than one adjustment is needed additional testing may be required. LTPP and its contractors are not responsible for determining the suitability or accuracy of an algorithm for a specific site for agency installed equipment.

Where tests results indicate that the current system is not sufficiently accurate and a simple calibration adjustment does not bring it into calibration, LTPP will work with the agency to determine the appropriate course of action. This could include replacement of the sensors, algorithm revision or other improvements suggested by the LTPP, the agency, or consultants advising them.

## 4.4 Administration and Support

Coordination with the FHWA, state agency and appropriate regional contractor is the first step in the site validation process. At this time agreement will be reached on the validation date, Sheets 17 and 18 will be reviewed and arrangements will be made to verify that the equipment is functioning on the day of the test.

FHWA will issue notice to proceed and the lead contractor will make all necessary arrangements consistent with Sheet 18. It is expected that for the validation process a minimum of thirty days notice will be provided.

At least two staff people are needed for this effort. Scheduling of data collection must recognize the need for breaks for all personnel.

All data collection should be done during daylight hours with consideration given to adjacent residences and expected periods of congestion.

It is strongly recommended that a briefing of all personnel be held prior to the site visit. Topics will include safety issues, differences in scheme from the TMG 13-bin or algorithm from the LTPP standard and scheduling.

A laser (or radar) gun for collecting vehicle speeds is required. A generic equipment list is included in the Section 11 (Miscellaneous Forms) of this document.

# 5 PAVEMENT SMOOTHNESS

A WIM section is defined as a section of pavement that is 1000 feet (305 m) long, with the distance from the centerline of the WIM scale to the beginning of the section being 900 feet (275 m) and the distance from the centerline of the WIM to the end of the section being 100 feet (30 m). The centerline of the WIM scale is the center of the working weight sensor array.

To determine if the WIM section is smooth enough to produce research quality data, LTPP has developed two methods to evaluate the section's smoothness. One is straightedge based and the other, the WIM Smoothness Index methodology, is profiler based. These methods can be applied to any type of pavement. The same smoothness criteria apply to all pavement types. A Dipstick® may not be used for profiling WIM sections for the purpose of determining pavement smoothness.

There are three circumstances under which smoothness is checked:

1. Initial evaluation of existing WIM sites to determine if they satisfy the smoothness criteria and in the absence of calibration/validation information on the site, if the pavement smoothness supports provision of research quality data.

2. Acceptance of newly constructed WIM sites to determine if they can in fact support the production of research quality data.

3. Annual evaluation of all working WIM sites to determine if there have been changes in smoothness that might affect data quality.

The WIM Smoothness Index method is recommended for initial and annual evaluation. The straightedge method is preferable for acceptance of newly constructed sites since lane closure will probably be in place to support any necessary grinding activities. However, either method may be used for any of these circumstances.

If the high-speed profile option is used, it should be done within a year of an assessment or validation. It is preferred that profiling be done prior to rather than after a validation since the pavement smoothness may be an explanatory factor for the results. Typically the RSC will collect the profile in conjunction with a regularly scheduled project profile visit.

During the survey, safety is the first and foremost consideration, as with all field data collection activities. All participants must adhere to the practices and authority of the governing highway agency.

## 5.1 HIGH-SPEED PROFILING

The preferred equipment for collecting longitudinal profile data is an inertial profiler meeting the Class 1 standards as specified in ASTM Standard E950-98.

In addition to the requirements specified in E950, the profile equipment shall specifically meet the following requirements.

- Sensors: Profiler shall be equipped with either laser or infrared sensors.

- Number of Sensors: Profiler shall be equipped with two sensors located on either side of the center of the vehicle, equidistant from the center of the vehicle. The center-to-center distance between the two sensors shall be 1,676 mm ± 5 mm.
- Photocell: Profiler shall be equipped with either a horizontal or a vertical photocell that can automatically trigger profile data collection using a mark on the pavement (for vertical photocell) or a target placed on the shoulder of the pavement (for horizontal photocell).
- Sampling Interval: Profiler shall be capable of recording profile data at 25 mm intervals. A moving average shall not be performed on the data that is recorded. Note that the sampling interval *should be set to 25mm ONLY*.
- Distance Measuring System: Profiler shall be equipped with a distance measuring system.

The preferred protocol for profiling a WIM section is described in the profiling manual (Ref. **Error! Reference source not found.**). It includes the number of runs required, section marking, and data file content and labeling in Section 2.4.2 of that manual. Other sections of the manual describe the processes to be used to obtain suitable quality profile data for this application. Although some of the procedures described in the manual are specific to the profilers currently used by LTPP, most are applicable to any inertial profiler.

The WIM Smoothness Index software will accept data in ASCII text file formats as generated from ICC profilers or KJ Law profilers, in ERD format (with either 2 or 3 channels), or in the text file format described in AASHTO PP52-02.

### 5.1.1 Reporting Results

The ICC Road Profiler WindowsRP90L software is used to process the raw profile data files and the LTPP WIM Smoothness Index software is used to analyze the profile data. The present version of the WIM Smoothness Index software, version 1.1 was developed with four different indices: Long Range Index (LRI), Short Range Index (SRI), Peak LRI and Peak SRI. Also, a range for each of the indices was developed to provide the smoothness criteria.

Table 5-1 summarizes the smoothness index threshold values recommended for SPS sites.

**Table 5-1 Recommended WIM Smoothness Index Thresholds**

| Index | Lower Threshold (m/km) | Upper Threshold (m/km) |
|---|---|---|
| LRI | 0.50 | 2.1 |
| 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 5-1, it is presumed 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. Values above the upper threshold are assumed to influence the reported weights and (potentially) vehicle spacings. Sites with values above the upper threshold are not expected to produce research quality loading data.

The results from the software are presented in a tabular form as shown in Table 5-2. Averages are only computed when at least three passes have been made.

Based on the indices, the smoothness of the site will have one of three effects on the accuracy of the scale. "Will not affect accuracy" is the outcome when the value being compared is less than or equal to the lower threshold. "Will affect accuracy" is the outcome when the value being compared is greater than or equal to the upper threshold. "May or may not affect accuracy" is the outcome for values falling between the thresholds. The outcome for each index is based on where the average values fall with respect to the thresholds. When an average is not computed the determination is based on the worst case of among the individual values. If the outcomes fall in more than one range the worst condition governs the overall determination.

**Table 5-2 Long Range Index (LRI), Short Range Index (SRI) and Peak Values**

| Profiler Passes | | | Pass 1 | Pass 2 | Pass 3 | Avg. |
|---|---|---|---|---|---|---|
| Center | LWP | LRI (m/km) | | | | |
| | | SRI (m/km) | | | | |
| | | Peak LRI (m/km) | | | | |
| | | Peak SRI (m/km) | | | | |
| | RWP | LRI (m/km) | | | | |
| | | SRI (m/km) | | | | |
| | | Peak LRI (m/km) | | | | |
| | | Peak SRI (m/km) | | | | |
| Left Shift | LWP | LRI (m/km) | | | | |
| | | SRI (m/km) | | | | |
| | | Peak LRI (m/km) | | | | |
| | | Peak SRI (m/km) | | | | |
| | RWP | LRI (m/km) | | | | |
| | | SRI (m/km) | | | | |
| | | Peak LRI (m/km) | | | | |
| | | Peak SRI (m/km) | | | | |
| Right Shift | LWP | LRI (m/km) | | | | |
| | | SRI (m/km) | | | | |
| | | Peak LRI (m/km) | | | | |
| | | Peak SRI (m/km) | | | | |
| | RWP | LRI (m/km) | | | | |
| | | SRI (m/km) | | | | |
| | | Peak LRI (m/km) | | | | |
| | | Peak SRI (m/km) | | | | |



A graphical representation of the critical section of the pavement near the WIM should be included with the report to validate the distresses found in the field that might affect the scale accuracy.

There is no transverse profile requirement when site smoothness is determined using a high-speed profiler.

## 5.2 Smoothness Determination Through Use of a Straightedge

This section describes a procedure to determine if short wavelengths of dynamic vehicle motions are within acceptable limits by using a straightedge as the measuring device. It includes procedures for laying out the site, specifies the locations to place the straightedge, and requirements to determine if the site satisfies the smoothness criteria in the longitudinal and transverse directions.

Since lane closure is required to perform the measurements, straightedge profiling is not recommended for site assessment or validation visits. If the agency requests it, and provides for the lane closure, the procedures in this section should be followed.

A suggested equipment list is located in Section 11 (Miscellaneous Forms). Data for longitudinal smoothness evaluation is entered on Traffic Sheet A. Transverse profile evaluation data is entered on Traffic Sheet B.

As with all field data collection activities, safety is the first and foremost consideration.

### 5.2.1 Smoothness Criteria[5]

The smoothness of the pavement at each position of the straightedge is evaluated by determining if a circular plate that is 3 mm thick and 150 mm in diameter can be freely passed below the straightedge (i.e., between the straightedge and the pavement surface) at any position within the limits of the straightedge. If the specified plate can be passed below the straightedge, the location is considered to have failed the smoothness requirement. If the specified criteria fail at any location within the WIM section, the location of the failure and its probable effect on the scale performance must be considered in determining whether the smoothness criteria has been met. Such a determination should include the parties responsible for warranting system performance and pavement remediation.

### 5.2.2 Longitudinal Smoothness Determination

This procedure consists of:

1. Marking wheel paths on pavement using a chalk line.

2. Placing a 3.65 m straightedge at specified locations along each wheel path and at left and right offsets from each wheel path.

3. Determining if a circular plate, 3 mm thick and 150 mm in diameter, can be passed below a straightedge at locations where the straightedge is placed.

#### 5.2.2.1 Site Layout

The site layout consists of identifying the wheel paths, and then marking the wheel paths using a chalk line. All cases assume a 3.65 m lane. If this is not the case, then the measurements indicated below should be adjusted to correctly identify the center of the lane. The wheel paths are marked for 30 m after the scale sensor and 122 m prior to it. This distance is fixed even when pavement material transitions exist.

The pavement must be clean of any debris before the site layout is performed.

The wheel paths at a site are defined to be at a distance of 0.838 m from the center of the travel lane.

[5] The method described here was developed while the LTPP program was under direction to use S.I. units. The method and associated equipment have not been revised to use U.S. customary units.

Use following procedure to locate the center of the travel lane:

Case I: Where wheel paths are easily identified, the midway point between two wheel paths shall be used as center of lane. In a newly diamond ground pavement it will not be possible to identify the wheel paths, and either Case II or Case III shall be used to identify the center of the travel lane.

Case II: If wheel paths are not clearly identifiable, but two lane edges are well defined, the center of travel lane is considered to be midway between the two lane edges.

Case III: Where wheel paths are not apparent and only one lane edge can be clearly distinguished, center of lane should be established at 1.825 m from that edge.

Once the center of travel lane has been identified, use the following procedure to layout the site:

Determine location of start of WIM section.

*i.* If site is marked according to procedures described in the profiling manual (Ref. **Error! Reference source not found.**), station 153+00 for the evaluation section is referenced from the leave edge of the white stripe at the beginning of the WIM section.

*ii.* If site is not marked, the beginning of the section for straight edge testing shall be determined with respect to the scale itself. The beginning of the section to be evaluated is located 122 m from the center of the WIM sensors. This length of 122 m shall be accurately measured using a tape measure (measurement wheels are not acceptable).

Identify location of two longitudinal elevation survey lines 0.838 m from center of lane.

*i.* Mark these locations at intervals equal to length of chalk line used for marking.

*ii.* Use a chalk line to mark a straight line between previously established points.

*iii.* The chalk lines shall be marked till the end of the evaluation section, which is 152 m from the beginning of the section.

#### 5.2.2.2 Measurement Procedure

The measurement procedure consists of laying down the 3.65 m long straightedge on the pavement at locations that are described in this section, and determining if a circular plate that is 3 mm thick and 150 mm in diameter can be passed below the straightedge (i.e., between the straightedge and the pavement surface) at any location within the limits of the straightedge.

The following procedure shall be followed in obtaining measurements within the WIM section.

1. At the start of the straight edge test section (Station 153+00) and lay down straightedge on left wheel path on top of the chalk line, with one end of the straightedge (back end) at Station 153+00 and the other end (front end) extending into the WIM section. The position of the straightedge is shown as Position 1 in Figure 5-1. Mark location of front end of the straightedge on the chalk line using a lumber crayon. Determine if the specified disk can be freely passed below the straightedge, and note the result of the test in Sheet A.

2. Pick up straightedge and place it so that it is parallel to the wheel path but offset 0.3 m to the right of the wheel path, and with the center of the straightedge being in line with the mark that was placed on the pavement with lumber crayon in the previous step. The location of the straightedge shall correspond to Position 2 in Figure 5-1. At this position, 1.825 m of the straightedge overlaps into the previously

measured portion of the pavement. Use lumber crayon to put a mark in the wheel path that is in line with the front end of the straightedge. Determine if the specified disk can be freely passed below the straightedge, and note the result in Sheet A.

3. Pick up straightedge and place it so that it is parallel to the wheel path but offset 0.3 m left of the wheel path, with the center of the straightedge being in line with the mark on the pavement that was made with lumber crayon in the previous step. The location of the straightedge shall correspond to Position 3 in Figure 5-1. In this position, 1.825 m of the straightedge overlaps into the previously measured length of the pavement. Use lumber crayon to put a mark in the wheel path that is in line with the front end of the straightedge. Determine if the specified disk can be freely passed below the straightedge, and note the result in Sheet A.

4. Pick up straightedge and place it on the wheel path, such that the center of the straightedge is in line with the mark on the pavement that was made with lumber crayon in the previous step. The location of the straightedge shall correspond to Position 4 in Figure 5-1. In this position, 1.825 m of the straightedge overlaps into the previously measured length of the pavement. Use lumber crayon to put a mark in the wheel path that is in line with the front end of the straightedge. Determine if the specified disk can be freely passed below the straightedge, and note the result in Sheet A.

5. Repeat steps 2, 3 and 4 in sequence until the end of the WIM section is reached.

6. Repeat steps 1 through 5 for the right wheel path.

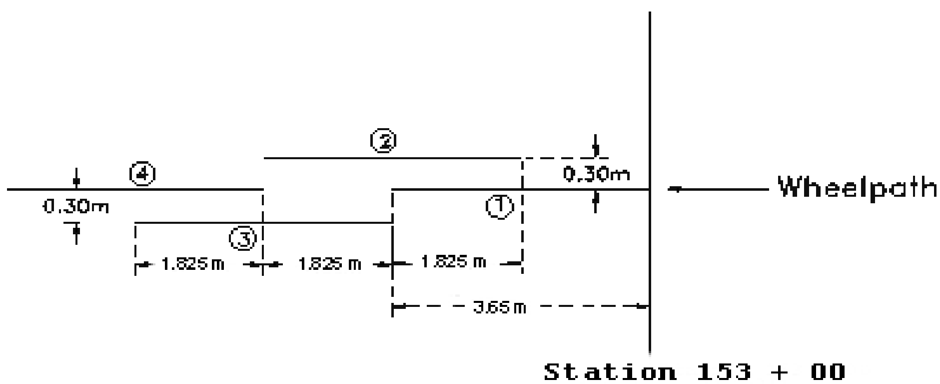


**Figure 5-1 Positioning of Straightedge**

If due to diamond grinding, multiple measurements are performed on the test section, submit the Sheet A for the final measurements that are performed at the WIM section.

### 5.2.3 Transverse Smoothness Determination

This section describes a procedure for checking the transverse profile at WIM sections using a straightedge to ensure that meets the specified profile criteria. Lane closure is required for performing this test. The measurements for this test shall be performed at the same time the section is being evaluated for longitudinal smoothness using a straightedge.

This specification describes procedures for laying out the site, specifies the locations where the straightedge is to be placed to obtain measurements, and the requirements that have to be met in order to pass the transverse profile criteria.

This procedure consists of:

1. Marking specified longitudinal distances from the centerline of the WIM scale.

2. Placing a 3.65 m long straightedge transversely across the lane at each of the specified longitudinal locations, in a direction that is perpendicular to the direction of travel.

3. Determine if a circular plate that is 150 mm in diameter and 3 mm thick can be passed below the straightedge (i.e., between the straightedge and the pavement) at any location within the limits of the straightedge.

#### 5.2.3.1 Site Layout

The site layout consists of marking off specified distances from the centerline of the WIM scale. The pavement must be clear of any debris before the site layout is performed.

Lumber crayon should be used to place marks on the pavement surface along the inside and outside lane edges at the following distances from the center line of the WIM scale in the direction upstream of the WIM (i.e., towards the beginning of the WIM section): 0 (centerline of the WIM scale), 5, 10, 15, 20, 25, 50, 75 and 100 m. The specified distances shall be measured using a measuring tape (a measuring wheel not acceptable).

#### 5.2.3.2 Measurement Procedure

The following procedure shall be used to check the transverse profile of the pavement.

1. At first longitudinal location that was marked on the pavement (station 0, centerline of the WIM scale), place one end of the straightedge at the inner edge of the lane and the other end of the straightedge on the outer edge of the lane, such that left face of the straightedge is flush with the lumber crayon markings on the inner and outer lane edges. At this position, the straightedge should be perpendicular to the traffic direction of the lane.

2. Determine if circular plate that is 3 mm in height and 150 mm in diameter can be freely passed below the straightedge (i.e., between the straightedge and the pavement surface) at any location within the limits of the straightedge. Note the result of this test on Sheet B.

3. Repeat procedure described in step 2 at all other locations marked on the pavement surface (i.e., 5, 10, 15, 20, 25, 50, 75, and 100 m). Note results of this test on Sheet B.

#### 5.2.3.3 Transverse Profile Requirements

The transverse profile at each position of the straightedge is evaluated by determining if a circular plate that is 3 mm thick and 150 mm in diameter can be freely passed below the straightedge (i.e., between the straightedge and the pavement surface), at any position within the limits of the straightedge. If the specified plate can be passed below the straightedge, the location is considered to have failed the transverse profile requirement. If the specified transverse profile criterion fails at any test location, the WIM section is considered to have failed the specification.

### 5.2.4 Equipment for Straight Edge Profiling

The straightedge measuring device specifications are based upon the following criteria:

- A straightedge that is 3.65 m in length and has a mark at its center.
  - The bottom rectangular surface of the straightedge shall be at least 19 mm but not more than 75 mm wide in the measurement plane.
  - The maximum out-of-trueness of the bottom surface of the straightedge in the measurement plane and along the width shall be less than ± 0.40 mm/m.
- A circular plate that is 3 mm in height and 150 mm in diameter.

FHWA-LTPP has constructed a Beta version from two engineered magnesium levels connected with a handle and cradle assembly made of aluminum. These are joined with four refastening screws. The 3mm x 150mm sizing disk is made from machined aluminum. The device is stored for shipment in a PVC carrying case. The shop drawings and specifications for the FHWA-LTPP device are available through LTPP Customer Support Service.

Note: The maximum out-of-trueness specification of the straightedge in the measurement plane is considered realistic for this type of field equipment. Nonetheless, temperature effects may result in false failures at locations or in acceptable results at locations that should have failed.

# 6 CONSTRUCTION

The construction process is both site and equipment specific. The following section is provided for informational use only.

## 6.1 SITE LOCATION (SELECTION)

Site selection should conform to guidelines in the State's Successful Practices for Weigh-in-Motion Handbook (Ref. 7) and ASTM E-1318-02 (Ref. 8). For LTPP purposes, several additional constraints exist:

- The site needs to be in the LTPP lane without any major traffic generators between the WIM equipment and the LTPP test sections;
- It cannot be installed within a test section; and
- Any correction of pavement conditions before and or after the sensors must be done outside of LTPP active test section limits.

## 6.2 SMOOTHNESS ACCEPTANCE

Site acceptance for smoothness following the construction of new pavement for WIM installation may be done with a straightedge or high-speed profiler. If lane closures are possible the straightedge method is recommended.

## 6.3 EQUIPMENT ACCEPTANCE

The selected WIM sensors shall be installed following acceptance of the pavement. The installer is responsible for the initial calibration of the equipment and for the verification of the classification algorithm. Calibration is done according to the methods recommended by the equipment manufacturer. FHWA-LTPP will specify the acceptance criteria for the equipment.

# 7 WIM System Installation and Calibration Audit

Quality data comes from quality installation processes. Review of installation activities includes quality assurance of various elements of the installation and initial calibration. While the process discusses the application to LTPP, the quality assurance elements included can be applied to most WIM installations.

The LTPP SPS WIM Pooled Fund Phase II contract is to install WIM systems using proven technologies that will provide research quality traffic data for five or more years. To represent the FHWA's interests on site during the equipment installation and validation processes, a Quality Assurance (QA) Auditor may be assigned by the Contracting Officer's Technical Representative (COTR) to perform a number of visual inspection and evaluation services, including:

- Close visual inspection of all aspects of the WIM Support Equipment Installation, WIM System Equipment Installation and WIM System Calibration.
- Observation of the SPS WIM Phase II Contractor's methods and practices to verify compliance with all relevant work documents including this document, the approved SPS WIM Phase II Contract's *Statement of Work* and all applicable manufacturers' installation instructions.
- Review of the equipment installation by measuring layout lengths and distances, observing performance practices, and noting compliance with the SPS WIM Phase II Contractor's *WIM System Installation Plan*.
- Recording of digital photographs throughout the installation and calibration processes as directed by this document.
- Documenting any improper, noncompliant or substandard installation practices and/or conditions that may be potential causes of site failure to include digital photographs of the elements of concern.
- Provide verbal and written summaries to the COTR at the conclusion of the visit on success and impending issues.

The goal is a complete inspection of the installation and calibration processes related to equipment layout, installation, wiring, and testing as well as system calibration. The audits should promote greater uniformity and quality in the processes associated with installing and calibrating weigh-in-motion systems.

The Audit is documented with a series of checklists, traffic sheets and photographs sent to the COTR. They are provided electronically (on CD-ROM generally due to the number of files and their sizes). The transmission includes a memo describing the overall outcome of the audit.

## 7.1 Audit Supporting Materiel

To provide a framework for individuals with a variety of expertise in the installation of WIM equipment a series of checklists and forms exists. The checklists document activities to be accomplished in the installation and calibration of a site. The forms contain measurements, lists or locations of photos documenting activities.

All numbered forms must be signed and dated by the auditor.

Forms may be completed in hard copy or electronically. Hard copy forms are scanned and saved in .pdf format, then submitted electronically. All pages of the form should be included in a single .pdf file. Separately numbered data sheets differentiated by an alpha character are not considered separate forms (i.e. Sheet 25A, Sheet 25B). Names of files are limited to 50 characters.

The LTPP naming conventions discussed here are expected for the sites installed by LTPP contractors. File names for forms include the form name, the Audit Number assigned by the COTR, the state's FIPS code, and SPS test site identification (SHRP_ID), and the date the form was completed in the format MM_DD_YY.

A checklist filename example is shown below where the audit number is 05-001 and the state code and SHRP_ID are combined. Checklist A-01 has two pages so this file should have 2 pages in it.

A Checklist A-01 for Florida's SPS-5 site, completed on September 1st, 2005 would be saved and submitted as:

**Checklist_A-01_05-001_120500_09_01_05.pdf**

All pages of a Traffic Sheet should be included in the same file. An example is shown below where the audit number is 05-001 and the state code and SHRP_ID are concatenated. If it were necessary to use a Sheet 25A exclusively to list additional photographs of utilities, it would be included in the same file with its alpha designation included in the filename.

A Traffic Sheet 25C for Florida's SPS-5 site, completed on September 7th, 2005 would be saved and submitted as:

**Sheet_25C_05-001_120500_09_07_05.pdf**



### 7.1.1 Checklists for Audits

These checklists, included in this document, are completed as part of the relevant equipment installation or calibration audit process. Guidelines regarding which checklist(s) must be completed for specific processes are described under the individual audit procedure sections of this document. The checklists are:

- A-01 – SPS WIM QA – Pre-visit Preparation
- A-02 - SPS WIM QA – Support Equipment Installation
- A-03 - SPS WIM QA – WIM System Equipment Installation
- A-04 - SPS WIM QA – WIM System Calibration

Each of the Audit Checklists is completed in the same manner. For each line item, the question must be answered with either a yes or no by checking the appropriate box. No items shall be left unchecked. For elements that are not applicable, write N/A over the Yes and No boxes. A comments section is provided to allow for further annotation or clarification of an answer.

### 7.1.2 LTPP Traffic Sheets for Audits

One or more of these sheets are completed as part of the associated WIM Installation or Calibration auditing process. All audits should include a Traffic Sheet 25B with as many elements as applicable at the time of the visit.

The complete list of sheets is:

- Traffic Sheet 25A – Site Audit Photographs
- Traffic Sheet 25B – Site Audit Photographs – Overall Site
- Traffic Sheet 25C – Site Audit Photographs – Checklist A-02 - Utilities
- Traffic Sheet 25D – Site Audit Photographs – Checklist A-02 – Cabinet
- Traffic Sheet 25E – Site Audit Photographs – Checklist A-02 – Hardware
- Traffic Sheet 25F – Site Audit Photographs – Checklist A-03 – Layout
- Traffic Sheet 25G – Site Audit Photographs – Checklist A-03 – Sensor Excavation
- Traffic Sheet 25H – Site Audit Photographs – Checklist A-04
- Traffic Sheet 26A – Photomap of In-road Sensors
- Traffic Sheet 26B – Photomap of Cabinet
- Traffic Sheet 26C – Photomap – Other
- Traffic Sheet 27A – Site Audit Measurements – WIM Sensors and Layout
- Traffic Sheet 27B – Site Audit Measurements – Loops
- Traffic Sheet 27C – Site Audit Measurements – Depth Checks
- Traffic Sheet 28 – Non-Compliance Report (NCR)
- Traffic Sheet 29 – Audit Summary

### 7.1.3 Equipment List

The equipment checklist is a comprehensive inventory of all equipment, materials and tools that might be required by the Auditor in order to successfully audit the WIM system installation and/or calibration. The required equipment includes:

- Cellular phone
- Safety and comfort accessories
- Steel Measuring Tape (50 ft.) (for sensor installation audits)
- Thin measuring ruler (6 inch) (for sensor installation audits)
- Clipboard
- Digital camera (minimum 3.0 Mega pixel, 640 x 480 resolution)
- Digital camera memory sticks (for 200 images minimum)
- Laser (or radar) Gun (for calibration audits)
- Pavement temperature measurement device (for calibration audits)
- Batteries for Digital Camera
- 35mm camera(s) (single use is acceptable)

### 7.1.4 Document List

In addition to the documentation listed in Section 8, this document and construction plans and specifications, the following forms and their instructions for completion should be available as part of the QA Audit process:

- Traffic Sheet 14 – Equipment Installation Log Form and Instructions
- Traffic Sheet 15 – Log of Changes at Test Locations with Permanent AVC or WIM
- Traffic Sheet 16 – Site Calibration Summary
- Traffic Sheet 17 – WIM Site Inventory
- Traffic Sheet 19 – Calibration Test Truck Data
- Traffic Sheet 20 – Speed and Classification Checks
- Traffic Sheet 21 – WIM System Test Truck Records

Traffic Sheets 14-16 are found in the *Guide to LTPP Traffic Data Collection and Processing.*

## 7.2 Standard WIM QA Audit Procedures

An audit may be broken into multiple parts. For any individual part the information in this section is applicable.

### 7.2.1 Personnel

An Auditor who is experienced in the procedures being audited should make the inspection of the installation and calibration operations. The Auditor(s) will be from the FHWA LTPP Team, FHWA Division Office, the LTPP Technical Support Services Contractor and or the Regional Support Contractors. The Auditor(s) will perform three separate but closely related WIM System Installation and Calibration QA Audits using the WIM audit checklists. The WIM System Installation and Calibration Audit process will not vary by site.

### 7.2.2 Scheduling

The audit may be conducted during one visit or may require two or more visits for completion of cabinet and conduit work, sensor installation and equipment calibration.

### 7.2.3 Digital Photographs

Digital photographs will be taken during all installation and calibration processes as directed by this document. All photographs must be recorded using a digital camera capable of an image resolution of 640 x 480. The Auditor should have enough memory for the camera to record at least 200 images at this resolution. A 35mm camera may be substituted in the event of digital camera failure.

All photographs taken during the audit will be listed in Item 9 of a Sheet 25X – Site Audit Photographs.

Each photograph is uniquely numbered for a visit. The Auditor must ensure that the date and time settings on the digital camera are correct before taking any photos.

After the audit, the photographs will be downloaded and saved as JPEG files using a standard naming convention for inclusion in the audit report. The filename includes a description of the illustrated item, the Audit Number assigned by the COTR, the state's LTPP numerical code and SPS test site identification, and the date that the photograph was taken in the format of MM_DD_YY. Filenames are limited to 50 characters. An example is shown below where the audit number is 05-001 and the state code and SHRP_ID are concatenated. Where abbreviations are needed the same abbreviation should be used for all photographs of that item whether or not the 50-character limit requires the abbreviation.

A photograph of the Cabinet exterior at Florida's SPS-5 site, taken on September 7th, 2005 would be identified as:

**Cabinet_Exterior_05-001_120500_09_07_05.jpg**

The sequential number and location of all photographs indicating relative distance and perspective will be recorded on the applicable Sheet 26. These sheets are used to provide information on the location of the photograph with respect to permanent fixtures at the site. More than one copy of Sheet 26A, 26B or 26C can be used as needed for clarity in labeling, for different phases of the installation, or to accompany multiple Sheet 25s.

If a 35 mm camera is used, then all 35mm film images shall be converted to JPEG format. They will be named for storage and submission as if they were digital photographs.

### 7.2.4 Pre-visit Preparation

The Auditor's pre-visit preparation requires that they coordinate the visit with the prime installation contractor and complete Checklist A-01. This is to ensure that all necessary equipment is inventoried and in good working order. A check is also made that all applicable documentation, including the current Sheet 17, if available, is on hand.

Applicable documentation that requires review by the Auditor prior to the Audit visit may include the vendor's equipment manual(s) for installation, testing and calibration processes for the specific WIM equipment installed, and the SPS WIM Phase II Contractor's *Handout Guide for SPS WIM Installation*. The Auditor is responsible for reviewing the SPS WIM Phase II Contractor's approved *WIM System Installation Plan* for audits associated with installation activities. This should be done prior to the visit to determine if there are any conditions that warrant particular attention.

Elements for particular attention at any audit will be discussed with the COTR at least five working days prior to the visit.

### 7.2.5 Non-Compliance Report (NCR)

Traffic Sheet 28, Non-Compliance Report, provides a means for the Auditor to report improper, noncompliant or substandard installation practices and/or conditions that may be potential causes for equipment malfunctions or failure. It should be used to describe in detail all information regarding potential equipment failure(s) that may be attributed to the failure of the Contractor or Sub-Contractor to follow the requirements of the Installation or Calibration process being audited. It should also describe any corrective actions that may or could be taken toward resolving the non-compliance issue.

The lead Contractor or Sub-Contractor's representative on site should sign the NCR indicate that they were informed of the non-compliance issue. Their signature does not infer admission that they were non-compliant. The auditor must sign and date the form. All completed NCR forms are to be included in the final report. A copy of the form is provided to the lead Contractor by the COTR.

## 7.3 WIM System Support Equipment Installation

During installation of the support equipment, including cabinet, conduit, electrical and telephone services, pull-boxes and drainage, the Auditor will complete Checklist A-02 and Sheets 25B, 25C, 25D and 25E. Items identified for the Auditor to inspect or verify are included on Checklist A-02. The accompanying photographs are referenced to the appropriate Sheet 25.

If support equipment is installed prior to the Auditor's arrival, the equipment, as installed, will be documented in Sheet 29 including notes as to those items the Auditor was unable to evaluate.

### 7.3.1 Protection of Utilities

Before the installation of any support equipment such as cabinets, conduit, junction boxes or electrical service components, the Auditor will examine all existing utility markings. The Auditor will observe whether the Contractor(s) conduct their work with a minimum disturbance of existing utilities. The lead Contractor is responsible to contact the utility owners and the highway agency in the event of any damage to utilities.

The auditor will take photographs of any utility markings making sure that each marking is clearly visible and can be identified through photograph descriptions. The expected photos are listed on Sheet 25C,

A Photomap (Sheet 26C or 26A) should be used to document the location of photographs and markings.

### 7.3.2 Support Equipment

Examination of all electrical service components and their inspection labels will be conducted to determine if the equipment is new, with no visible damage, and is UL listed. Unless otherwise shown in the *WIM System Installation Plan*, all expansion joints and conduit fittings shall be fabricated from a material similar to the connecting conduit.

Photographs will be taken of the electrical and telephone service boxes (if installed) to include any identification markings specific to the WIM site. Photographs will be taken of the solar panel(s), fastening hardware and the service pole if the WIM System is solar powered. The expected photographs are documented on Sheet 25C and should be mapped using Sheet 26C.

### 7.3.3 Conduit

The Auditor shall note if the conduit is constructed of galvanized steel RMC, if all fittings are watertight.

The Auditor will note if set screw and pressure cast fittings were not used.

### 7.3.4 CABINET

Examination of the cabinet installation will be performed to distinguish whether it is an M-type cabinet (as shown in Figure 7-1) or equal, that it is NEMA approved and is dust tight with a weather resistant seal.

The Auditor shall note on Checklist A-02 whether or not the cabinet includes the following features:

- Hinged door
- Lock, with two sets of keys
- Louvered vent
- Standard filter
- Air exhaust through roof overhang
- Temperature activated forced air fan system
- Switched light
- GFCI duplex outlet
- Circuit breaker for AC input
- Surge suppression
- Communication equipment

The Auditor shall take photographs of the exterior and interior of the cabinet to verify that each component described above is included. All photographs will be clearly identified on the Sheet 25B or 25D. Sheet 26B should be used to locate photos.

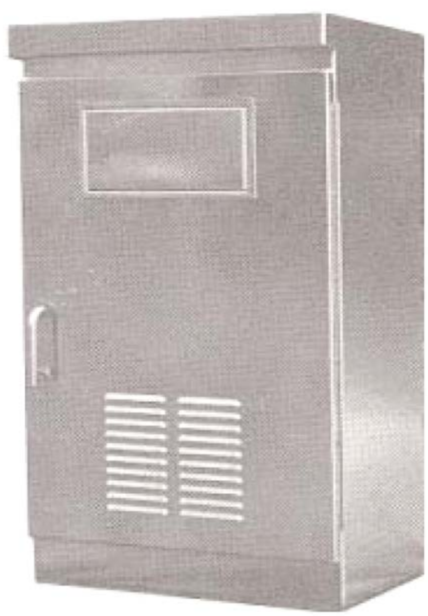

**Figure 7-1 - NEMA Type M Cabinet**

### 7.3.5 CABINET FOUNDATION

At least one photograph of the cabinet foundation that includes all mounting fasteners and/or hardware will be recorded (Sheet 25D).

### 7.3.6 PULL BOXES

Pull boxes shall be installed at locations shown on the *WIM System Installation Plan*. Their lids shall be flush with adjacent surfaces. All pull box installations must include proper drainage.

Photographs will be taken of each pull box to illustrate the drainage and the relationship between the pull boxes top edge and the surrounding surfaces (Sheet 25E). The photos should be mapped using either Sheet 26C or 26B.

## 7.4 WIM SYSTEM EQUIPMENT INSTALLATION

During the installation of the WIM System equipment, including the layout, installation and testing of in-road sensors and cabling the Auditor will complete Checklist A-03, and Sheets 25B, 25A, 25E, 25F, 27A, 27B and 27C.

### 7.4.1 LAYOUT

Close visual inspection of the equipment layout will be performed to ensure that it is completed in accordance with the WIM System Installation Plan. Photographs of the entire site layout in the LTPP lane will be taken ensuring that the square line and all painted and marked lines are clearly visible. The photographs are recorded on Sheet 25E and Sheet 26A.

There are three WIM sensor technologies that are approved for use under the SPS WIM Phase II contract. The expected layouts for each of these technologies are shown below. The sensor layouts that are shown in the Contractor's approved *WIM System Installation Plan* may differ from the layouts shown below and take precedence over the possible layouts shown in this document.

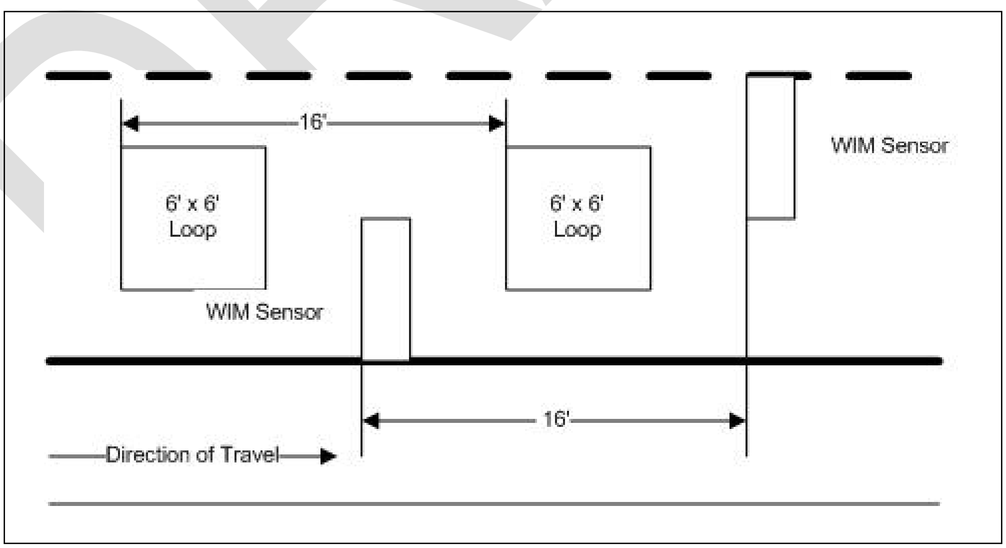


**Figure 7-2 – Typical Staggered Bending Plate – Dual Loop**

A bending plate WIM sensor is typically installed in a staggered array with the sensors separated by sixteen feet. There are either one or two inductive loops that are used for secondary speed and spacing measurement. In a two loop configuration the loops are also installed sixteen feet from leading edge to leading edge as shown in Figure 7-2. . The single loop array is shown in Figure 7-3. Bending plates in this configuration are generally installed twelve feet apart from leading edge to leading edge.

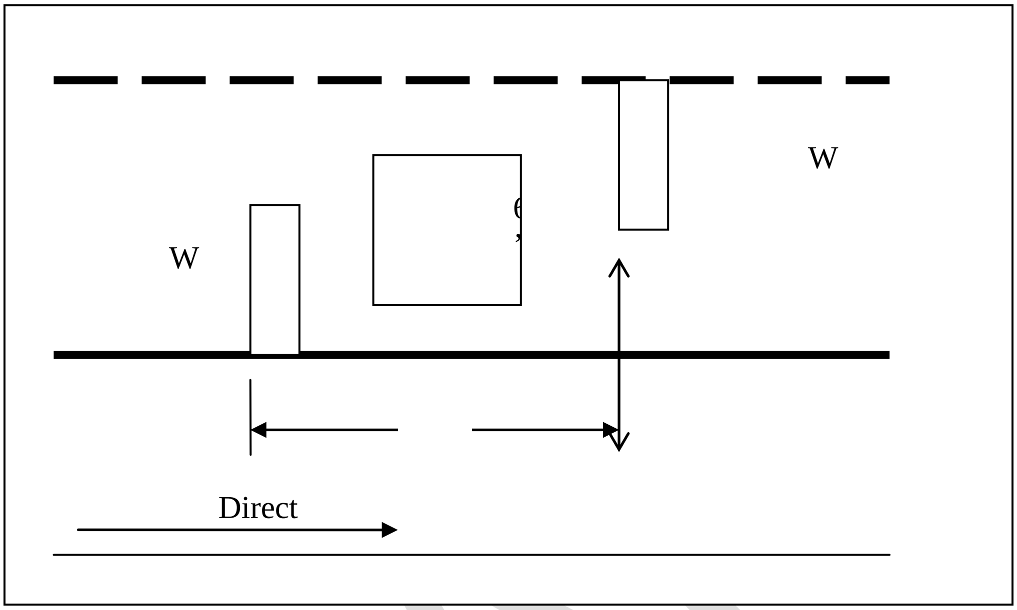


**Figure 7-3 – Typical Staggered Bending Plate – Single Loop**

A Load Cell is typically installed in line across the lane, with inductive loops preceding and following the WIM scales. There may also be an axle sensor installed between the WIM sensors and the second loop, as shown in Figure 7-4.

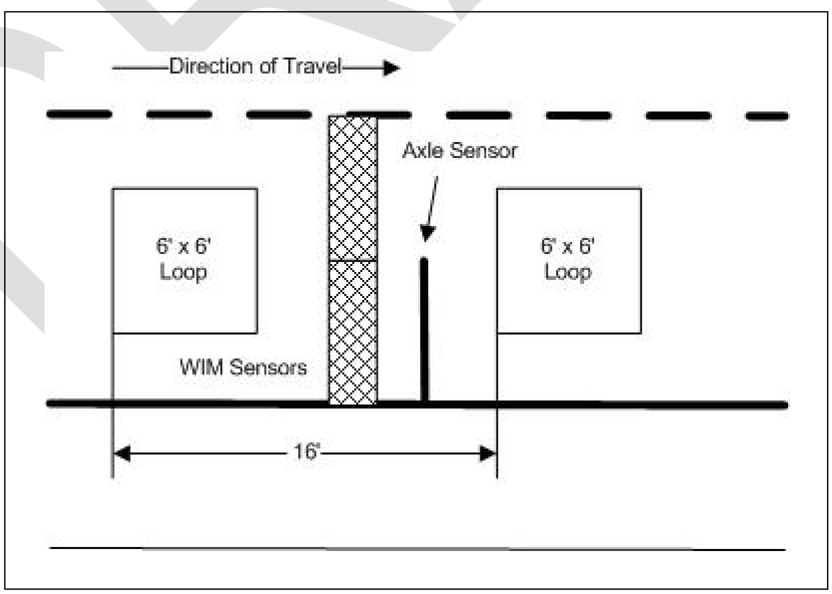


**Figure 7-4 - Typical Load Cell Layout**

Two different layouts of quartz sensors may be used. The full lane layout consists of two 12-foot sets of quartz sensors that are installed over the full width of the lane. The half-lane layout consists of two 6-foot sets of sensors, installed in a staggered array, each covering only one-half of the lane. An inductive loop is installed between the WIM sensors. Typical layouts for each are shown in Figure 7-5 and Figure 7-6 respectively.

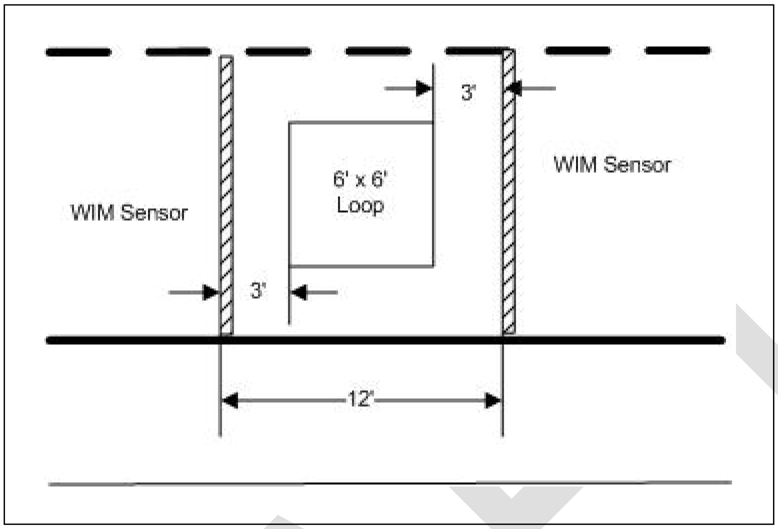


**Figure 7-5 - Typical Full-Lane Quartz Sensor Layout**

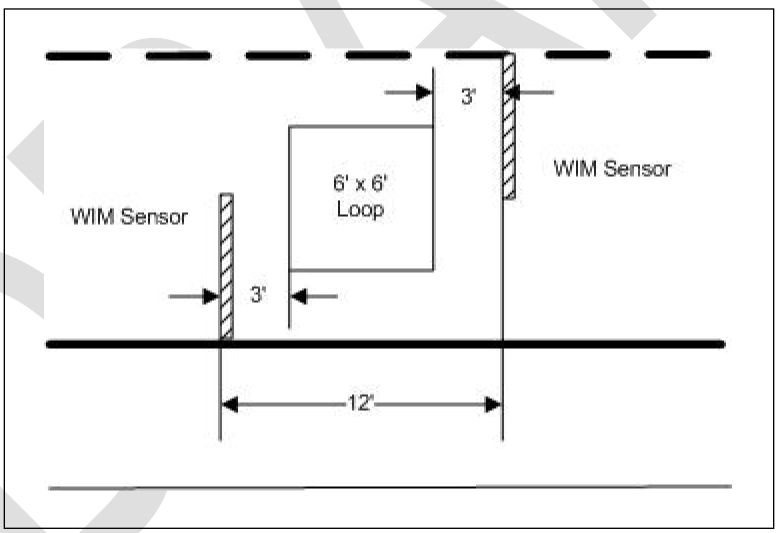


**Figure 7-6 - Typical Half-Lane Quartz Sensor Layout**

The Auditor must verify that the Contractor achieved squareness of the layout by using the 6-8-10 triangulation method, illustrated in Figure 7-7 or other acceptable means approved by the COTR. A square line should be drawn on the pavement from which all other layout measurements will be taken.

The accuracy of the layout prior to saw-cutting must be verified by measuring the various aspects of the layout and comparing the measured values with those illustrated on the *WIM System Installation Plan* and in the manufacturer's installation guide. All measurements should be made with a steel tape and should be accurate to within one-quarter inch unless otherwise directed. Record each of these measurements in Item 9 of Sheet 27A and 27B. Sheet 27A deals with loop related measurements. Sheet 27B deals with measurements for weigh sensors and the array as a whole.

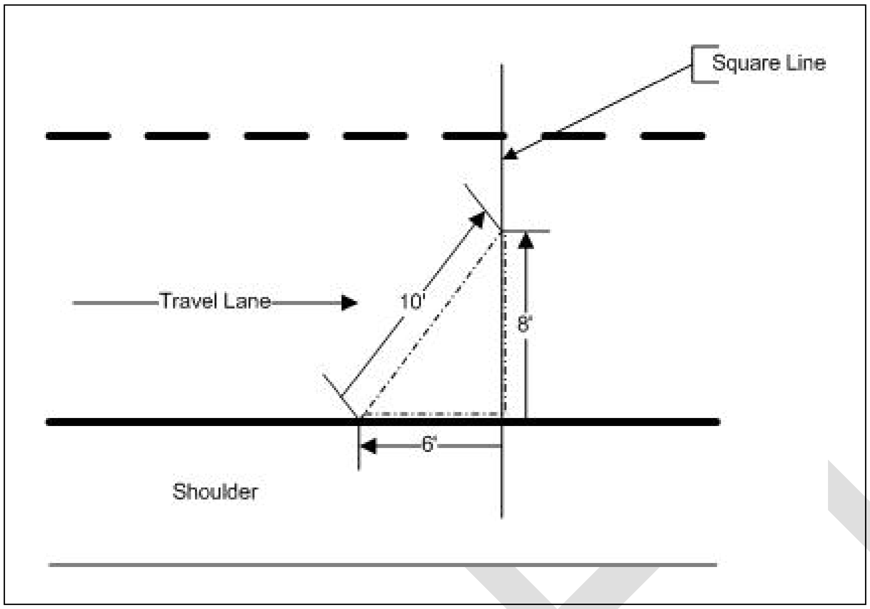


**Figure 7-7 - Square Line Setup**

### 7.4.2 Saw-cutting

The Auditor will observe that any existing concrete removed was wet saw cut and removed to the neat lines shown on WIM System Installation Plan and that any existing concrete that is to remain in place and is cut beyond the neat lines and is destroyed by these operations was replaced with like material. Photographs will be recorded of the saw-cutting while in progress, showing the saw and operator, and verifying that the wet-cutting method was used. The photographs are documented on Sheet 25F.

While observing all safety precautions, the Auditor will use the 6-inch ruler to take sample measurements of each saw cut to verify that the depths shown on the WIM System Installation plan are being properly maintained. For loops, depth measurements will be taken every two feet along each cut and at each corner. For WIM sensors, depth measurements will be taken after the saw cutting is completed and prior to excavation. Depth measurements will be recorded in Item 9 of Sheet 27C. If a measurement falls outside of the allowable values a photograph of that location will be included and listed on Sheet 25E and Sheet 26A.

The WIM sensor channels and recesses will be measured for proper depth at each end and in the middle of the perimeter cuts. All measurements will be recorded in Item 9 of Sheet 27C and should be drawn on Sheet 26A and labeled.

### 7.4.3 Excavation

During the excavation process, the Auditor will observe if the Contractor took care to only remove that material necessary for the installation of the in-road sensors. It will be noted if any excessive damage was repaired or replaced with like material or epoxy resin, and that any significant damage was inspected and all repair recommendations approved by the highway agency representative on site.

The Auditor will photograph each loop sensor and each WIM sensor channel or recess once excavation is completed and they have been completely cleaned of pavement material and moisture. The photographs will be documented using Sheet 25F and Sheet 26A.

### 7.4.4 Pre-Installation Clean up

The Auditor will verify that the Contractor cleaned each loop slot and weigh sensor channel or recess of all debris and pavement residue with water and high pressure air, and that the Contractor completely removed all residue and moisture to ensure proper adhesion of the epoxy resin to the pavement.

### 7.4.5 Installation

The auditor will verify that all sensors on site are identical to those shown on the WIM System Installation Plan. No substitutions will be permitted without written authorization from the COTR. The Auditor will observe the pre-installation electronic testing of all weigh sensors by the Contractor before installation. It is expected that Load Cell and Bending Plate sensors will undergo a series of resistance checks of all transducers. For quartz sensors there should be insulation resistance checks at a minimum. Photographs of the elements of the specific installation processes will be documented using Sheet 25A and Sheets 26A-C as applicable.

The Auditor will verify the following during the equipment installation:

- All conduit installed in the travel lane is galvanized rigid RMC conduit. Plastic or PVC tube was only used to run the loop wires into the weigh sensor recess or over pavement joints only as approved on the WIM System Installation Plan.
- Conduit openings were sealed with duct seal or other material to prevent the introduction of epoxy or loop sealant.
- Drain conduits in the weigh sensor recess were installed so that the opening is lower than the opening of the electrical conduits.
- Loop wires were installed into the loop slots carefully and without the use of sharp implements such as screwdrivers or putty knives.
- The loop wires were pushed down completely in the slot with each of the four complete turns.
- There was sufficient wire left over to run two leads to the pull box without any splices. The two lead-ins were twisted about one another at least every 6 inches from the output corner of the loop to the pull box.
- Each loop lead-in wire set was clearly marked with colored tape or a written label prior to being pulled through the conduit.
- Once all four loops of the wire were completed, the wires were secured into the loop slot with backer rod or other means to prevent any floating of the wires.
- The loop wires were completely covered with loop sealant until flush with the pavement surface.
- No voids or dips in the loop sealant are visible.
- WIM Sensors were installed in strict accordance with the manufacturer’s installation specifications.
- During the installation of the WIM bending plates or load cells, a specific process was used to ensure that the weighing platform is flush with the pavement surface to within 1/32”.

- For quartz sensors, once the installation epoxy has fully cured, the surface of the sensor was ground completely flush with the pavement surface, with no margin for error, as described in the manufacturer's installation guide.
- All voids in and around the WIM sensors or frames were filled in with an approved epoxy or caulking and no voids or dips were visible. All high epoxy spots were ground flat with the pavement surface.
- All sensor lead-in wires exited the pavement through metal conduit to the pull box.
- Once all wires were pulled through the conduit, the openings of the conduit were sealed to prevent the intrusion of epoxy resin or loop sealant.

Photographs will be recorded of each installed WIM System component separately including support structures, in-road sensors, and any site identifying signs or structures. Photographs of each lane's entire WIM scale installation will also be recorded, illustrating all sensors installed in that lane, taken from a position upstream of the sensors, facing as the direction of traffic. The photographs will be documented using Sheets 25A, 26A and 26C.

#### 7.4.6 Cabling/Terminations

The Auditor will observe that all cabling was carefully pulled through the conduit to the control cabinet to prevent damage to the wiring through pinching, scraping or smashing. They will also examine the pull box and cabinet to ensure that extra wire is left in each to allow for future repairs, and to verify that all wiring is clearly marked for easy identification at each location.

Observations will be made to ensure that all lead-in wires of insufficient length to reach the cabinet are spliced as described in the WIM System Installation Plan or in accordance with sensor manufacturer's specifications and that all loops are spliced at the closest pull box to shielded lead-in cable. It will be noted by the Auditor that all splices are of industrial quality, watertight and hermetically sealed with epoxy or other waterproof material and that all wire connections were made with bifurcated terminals to prevent shorting.

The Auditor is responsible for observing the testing of each sensor before final terminations are made, ensuring that each sensor is operating properly. It will be noted whether an authorized technician made the terminations in the cabinet and if the terminations are clearly marked with colored tape or written label. The Auditor will verify that a schematic that indicates all terminations and cabling is left in the cabinet.

Once all connections are completed, the Auditor will observe all system diagnostic tests that are performed to verify proper operation of all system components. Annotations of any improper readings or indications will be made.

#### 7.4.7 Documentation

The Auditor is responsible for verifying that Sheets 14, 15, and 17 are completed or updated, and that copies of Sheets 14 and 15 are left in the cabinet.

#### 7.4.8 Final Clean up

The Auditor will observe whether the entire site was cleared of all rubbish, all damaged property properly restored, and all equipment, materials and tools were removed from the job site.

## 7.5 WIM SYSTEM EQUIPMENT CALIBRATION

During the calibration of the WIM System the Auditor will complete Checklist A-04, Sheets 25A, 25H, and 26A-26C. Sheets 25A, 26A and 26B are not required if the installation and calibration are sequential without site modifications between them and the QA is done by the same person. If the QA tasks were assigned to different individuals or a site modification such as installation of power occurred between the initial installation activities and the calibration, additional equipment photographs must be taken.

### 7.5.1 TEST VEHICLES

It is the responsibility of the Auditor to verify that the equipment validation was performed according to the steps described in Section 3 (Site Validation – Weight).

The Auditor will examine each test truck provided by the Contractor to ensure that they are in good operating condition, with loads that are not susceptible to shifting, harmonics, moisture gain or loss and are securely anchored. Photographs of each test vehicle will be recorded including the tractor, trailer, load, and the suspension of each axle (Sheet 25H or 24B).

It will be verified by the Auditor that test vehicle number one is a 3S2 truck, fully loaded within legal limits, with air-suspension on the truck and trailer tandems and that additional test vehicles are of the same operational quality meeting truck selection requirements. Test vehicles other than test truck number one do not require air suspension or the same degree of loading.

Before beginning any test runs, the test trucks must be weighed at a certified weighing facility. A Sheet 19 must be completed during the initial test vehicle weighing prior to beginning pre-calibration evaluation runs by the calibration team. Axle spacing for drive tandems should be checked. The Auditor should get copies of the weigh tickets from the scale master or a copy of the Sheet 19 from the calibration team. If on-site installation activities requiring QA are occurring simultaneously with truck measurements, on-site installation activities have priority for QA.

### 7.5.2 PRE-CALIBRATION TEST RUNS

At least forty pre-calibration test runs, divided evenly among the test trucks, must then be conducted prior to any manipulation of system weight or speed calibration parameters. The Auditor must count the number of times that each of the test vehicles crosses the scale, take pavement temperature during each set of test vehicle runs, verify vehicle speeds by capturing the speed of test vehicles using the laser or radar gun and document them on Sheet 21. The distribution of truck runs, temperatures and speeds will be included in Sheet 29.

### 7.5.3 SYSTEM CALIBRATION/VERIFICATION

After the initial calibration following pre-calibration test runs, the Auditor will observe the post-calibration test runs. At least ten runs are required following each calibration attempt. The Auditor will observe all iterations of the calibration process until the Contractor has achieved an acceptable calibration or until a maximum of three repetitions of the calibration process are performed without attaining the quality of data required to meet the performance specifications. The Auditor will verify the number of runs made by each vehicle for each iteration and document the range of speeds and temperatures for each set of runs on a separate Sheet 21 for each calibration test run set. Run information will be documented on Sheet 29.

### 7.5.4 Post-Calibration Test Runs

Whether or not the Contractor was able to meet the performance parameters, they must complete the performance evaluation by performing at least forty test runs with an approximately equal number of runs for each of the test vehicles. Once these have been completed, the Auditor will observe the analysis of the data. The Auditor should request the final system calibration factors and error percentages respectively for inclusion in Sheet 29. Error percentages for both loading and classification should be requested so that a preliminary Sheet 16 could be prepared.

If the site does not meet the performance parameters, the failure must be reported to the COTR by phone before leaving the site. The Auditor will document the call on Sheet 29.

When all calibration iterations have been performed, pass or fail, the test vehicles must be reweighed and the data recorded on the Sheet 19 to be compared with pre-validation weights. The Auditor shall obtain copies of the weigh tickets from the scale master or a copy of each completed Sheet 19 from the calibration team.

### 7.5.5 Classification Verification

The Auditor should record at least one hour of manual classification data during the calibration process to determine the vehicle distribution in the LTPP lane. The distribution of passenger vehicles, buses, single unit trucks, tractor-trailer combinations and multiple trailer trucks should be reported on Sheet 29. Any heavy truck (Class 6 or higher) that is consistently misclassified should be noted and photographed.

## 7.6 Audit Reporting

As soon as possible after completion of the audit, Sheet 29 must be prepared. The completed audit report will summarize the results of the visit and, with the completed and signed Audit Checklists and Forms, Traffic Sheets and Non-Compliance Reports will be sent to the SPS WIM Phase II COTR for review and distribution.

The Auditor must provide a detailed account of the installation and calibration activities in the Audit Summary report. The Audit Summary, depending on the specific audit performed, must include the following as required:

- Executive summary of the Support Equipment Installation, WIM System Equipment Installation and/or the WIM System Calibration highlights, findings, and recommendations for any concerns noted during each of these processes.
- Summary of speed and temperature distribution verifications.
- A chronological journal of all installation events.
- A chronological journal of all calibration events.
- A list of contact information for Contractor, Sub-Contractor(s), Manufacturer, Highway Agency and any other agencies represented at the site.

The Auditor must also provide the following deliverables to the COTR in electronic form:

- Photographs listed on Traffic Sheet 25X, clearly identified, and submitted under the standard naming convention on CD ROM or DVD.
- Traffic Sheet 25s.
- Photomaps (Traffic Sheet 26s)

- Traffic Sheets 27A-C documenting measurements if applicable.
    - Traffic Sheet 28 if applicable.
    - Traffic Sheet 29.
    - Traffic Sheet 21 if applicable.
    - Pre and Post Calibration Weigh Tickets or completed Sheet 19s for test vehicles if applicable.

# 8 REFERENCES

The SPS traffic data collection effort builds on existing LTPP and other standard practices. Unless otherwise indicated in the directives under which they are issued, all changes to LTPP authored documents will automatically be incorporated in this document.

LTPP guidelines are available through either LTPP Customer Support Service or the LTPP web page at http://www.tfhrc.gov/pavement/ltpp/ltpp.htm. LTPP Customer Support Service can be reached via e-mail: ltppinfo@fhwa.dot.gov; phone: (202) 493-3035; or fax: (202) 493-3161.

Incorporated by reference are the following documents. The version listed was the current one as of this document's release. If any of the documents are updated, the versions listed will be superseded by revision. Items 1 through 6 are LTPP guidelines. Items 7 through 11 are documents produced by others that are relevant to LTPP traffic data collection.

1. LTPP Bending Plate Weigh-in-Motion System: Model Specifications for Equipment - Hardware and Software - Version 1.0, August 29, 2001.

2. LTPP Bending Plate Weigh-in-Motion System: Model Specifications for Pavement and Installation - Version 1.0, August 29, 2001.

3. Guide to LTPP Traffic Data Collection and Processing, *2009 version*.

4. Long-Term Pavement Performance Program Manual for Profile Measurements and Processing, FHWA, FHWA-HRT-08-056, November 2008.

5. LTPP WIM Index Software Manual Version 1.1, October 7, 2005.

6. LTPP Manual for Falling Weight Deflectometer Measurements, version 4.0, March 2005.

7. States' Successful Practices Weigh-in-Motion Handbook, FHWA, December 1997.

8. ASTM E1318-02: "Standard Specification for Highway Weigh-in-Motion (WIM) Systems with User Requirements and Test Methods".

9. Distress Identification Manual for the Long-Term Pavement Performance Program, FHWA, FHWA-RD-03-031, June 2003.

10. "Advancement of Smoothness Criteria for WIM Scale Approaches", Final Report June 2004, Steve Karamihas and Thomas D. Gillespie, Ph. D, The University of Michigan Transportation Research Institute.

11. FHWA, Traffic Monitoring Guide, 4th edition, May 1, 2001.

# 9 SUPPORTING SOFTWARE

There are five software applications used to analyze data for SPS WIM sites: WIM 2 TRUCK.xls, CLASSMACRO.xls, LTPP's WIM Smoothness Index software, LTPP's Traffic QC software (LTQC) and the LTPP Traffic Analysis software (LTAS). This section discusses the use of the two spreadsheet applications and general characteristics of the WIM Smoothness Index software. LTPP developed software is available through LTPP Customer Support Service. It is unsupported.

## 9.1 WIM 2 TRUCK.XLS

This spreadsheet is designed to store the data from the test truck runs across the scale and, at the end of the weighing session, compute differences for graphing. The spreadsheet is divided into four quadrants as shown in Figure 9-1. In the upper left corner, the data on the mandatory air suspension 5-axle combination vehicle are entered. In the upper right corner the data for the second truck are entered. These are the values from weighing the truck with a full tank and physically measuring the axle spacings. Note that the spreadsheet does not identify specific axle groups for the second truck. The user will need to label them as single, tandem, split tandem, tridem, and so forth. If additional vehicles are used, the sections of the spreadsheet for the 2nd truck should be copied as many times as necessary and the summary statistics modified accordingly.

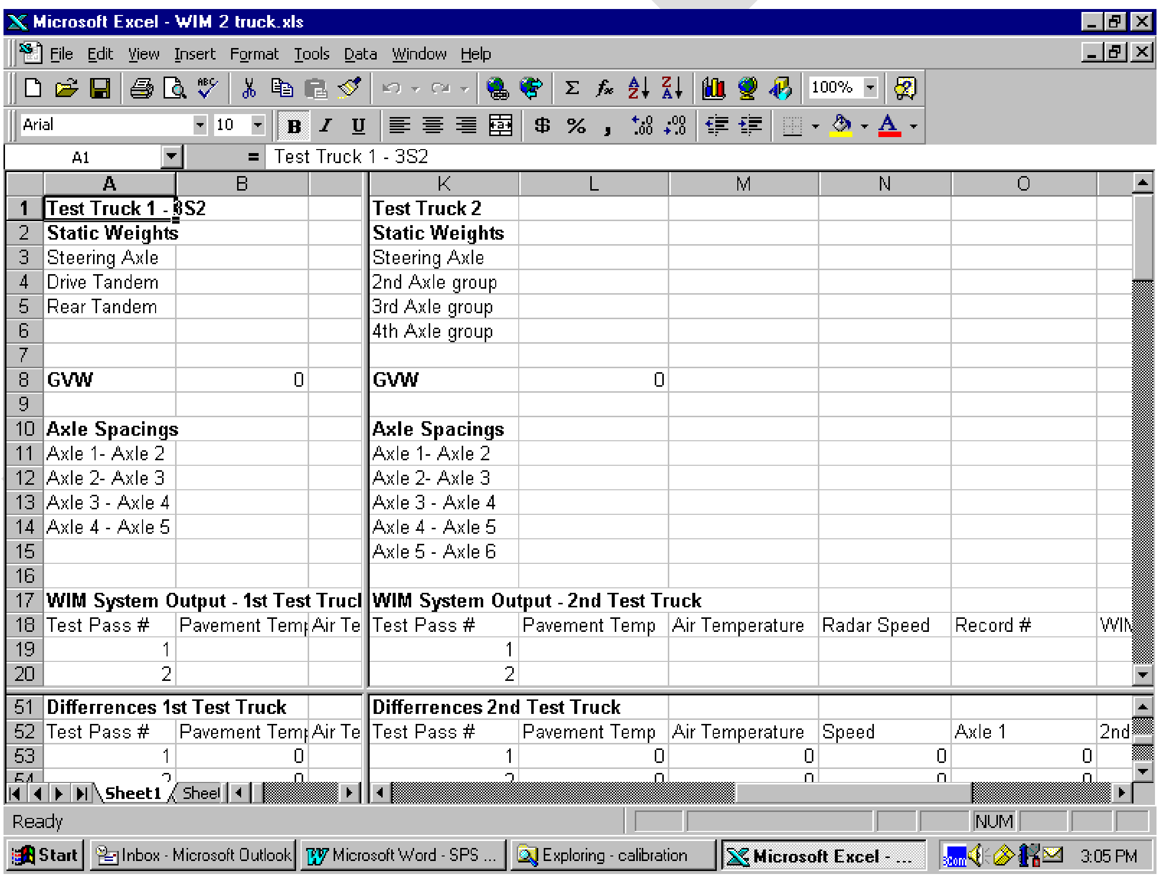


**Figure 9-1 WIM 2 Truck on Opening**

Below the static values are locations to enter the temperature, speeds and weights recorded as the trucks pass over the scale. Either pavement temperature and or air temperature may be entered. Pavement temperature is the preferred measurement. Pavement temperature must be derived from air temperature before using it for analysis of temperature groups. The user enters the speed of the vehicle from the laser (radar) gun, the record number assigned to the truck by the WIM system, the speed reported by the WIM system and the weights of the individual axles. The spreadsheet will compute the gross vehicle weight. To allow the user sufficient time to enter the data, the trucks should be widely spaced rather than following closely.

The spreadsheet should be saved after every other truck run. The naming convention for spreadsheets should be “WIM” followed by the state code and SHRP_ID of the site followed by the data collection date. If multiple spreadsheets are created on the same day the name should include either lane number or A, B following the date. For example if the SPS-6 site in Michigan were validated on July 15th, 2001, the file name would be WIM_260600_20010715.xls.

When data collection is complete, the user must ensure that the ranges for the means and standard deviations for the data set as a whole are correct. The computed differences with their associated temperatures and speeds may then be analyzed by subgroup in a separate work sheet and graphed if desired.

## 9.2 CLASSMACRO.XLS

This spreadsheet is used to summarize the combinations of observed and reported classifications using the TMG 13-bin classification scheme. The error statistics by class are computed at the bottom of the sheet. Additional rows and columns can be added as needed. (Adding a row requires adding a column as well for each additional vehicle class beyond 13.)

Before entering data a copy of the spreadsheet should be saved using “CLS” followed by the state code and SHRP_ID of the site followed by the data collection date. If multiple spreadsheets are created on the same day, the name should include lane number or A, B following the date.

The spreadsheet contains a macro, TabulateClass, to use in entering vehicle data as the vehicles are observed. In successive dialog boxes the user enters the actual class and then the class reported. After each number is entered, the user clicks on OK or hits enter. To stop the macro recording, the user clicks on Cancel and the data is saved and the spreadsheet closed. Opening the spreadsheet will permit the user to see the summary statistics. Additional data can be added to the same spreadsheet by restarting the macro. If more than 13 vehicle classes are used, the macro will need to be modified to account for them.

A paper copy of the form can be used in the field with check marks or other markers for each vehicle pair observed. The total number in each box can then be totaled and entered directly in the spreadsheet.

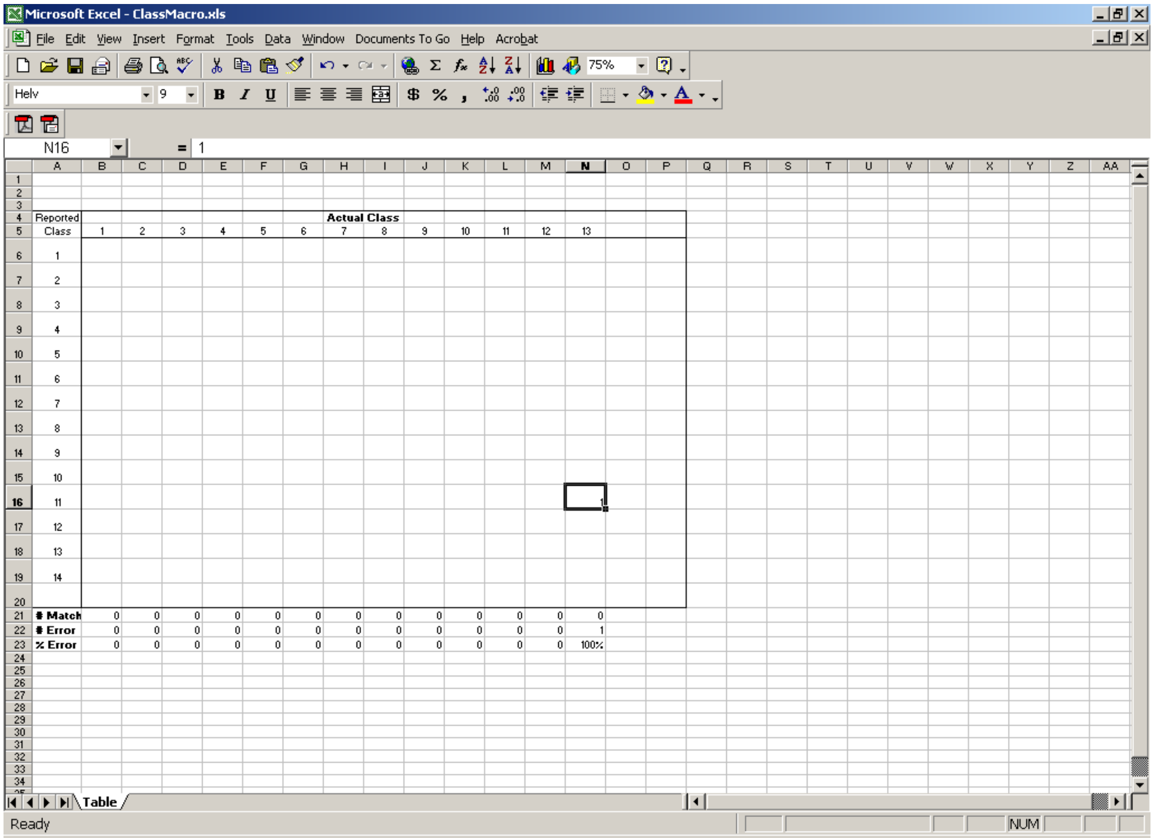


**Figure 9-2 CLASSMACRO spreadsheet**

## 9.3 WIM SMOOTHNESS INDEX SOFTWARE

The profile evaluation is done using the LTPP WIM Index Software as explained below. More detail may be found in the user's manual (Ref. 5).

### 9.3.1 PROCESSING OF RAW DATA FILES

1. Open the ICC Road Profiler WindowsRP90L software to process the raw data files for analysis. A window as shown in Figure 9-3 would appear.

2. On top left hand corner, in the **Report** frame click on FHWA to output profile data in FHWA format, in the **Units** window click on Meters[6].

3. In **FileExt**, give a conventional file extension (e.g. for SPS WIM project the file extension is W.)

4. In **Report Controls** frame, click on Section Control.

5. Click on **Profile Interval Ctrl** and in **Interval** input the value 25 and in **MovingAvg** input the value 50.

6. To generate the process file click on **Process Input File(s)**. Multiple files can be processed at once.



[6] LTPP profile data was and is expected to be collected in S.I. units.

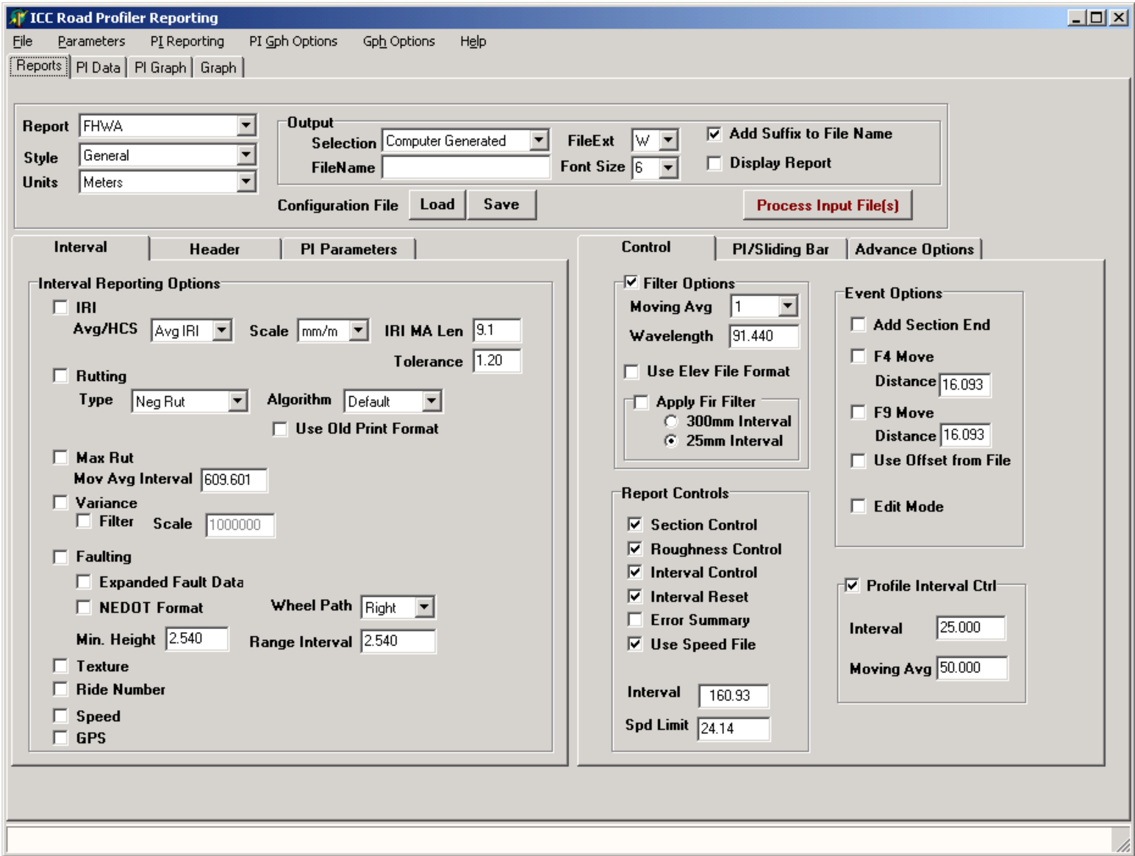


**Figure 9-3 Windows RP90L software to process raw files**



### 9.3.2 ANALYSIS OF DATA

1. Open **WIM Smoothness Index** software. A window as shown in Figure 9-4 would appear.

2. Based on results needed use **Site Evaluation** or **Location Selection**. Typically if the location of the WIM scale is known then the **Site Evaluation** is selected otherwise the **location selection** option is selected.

3. If **Site Evaluation** is clicked, then choose the file to analyze. Later, click on **OK** to proceed further. After new window comes up input the value **274.5** for **WIM Starting Location (m)**. Click on the boxes adjacent to Long Range Index and Short Range Index and then click on **Go**.

4. To perform location evaluation, click on **Location Evaluation** and then choose the file to analyze. Later, click on **OK** to proceed further. After new window comes up click on the boxes adjacent to Long Range Index (LRI) and Short Range Index (SRI) and then click on **Go**. After the graphical results are displayed then different types of graphs can be viewed by clicking on different buttons at the top left hand corner (e.g. LRI, SRI, Peak LRI and Peak SRI for left and right wheel path)

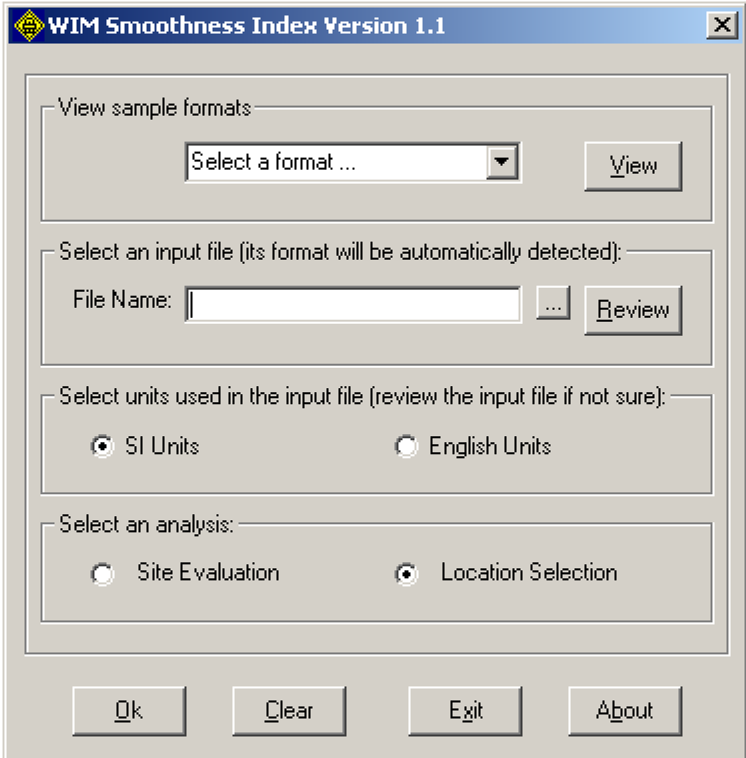


**Figure 9-4 WIM Smoothness Index Software**

# 10 FORMS

This section contains the forms referenced in the document and instructions on how to complete them. The forms included are:

Traffic Sheet 17 -WIM Site Inventory
Traffic Sheet 18 - WIM Site Coordination
Traffic Sheet 19A – Truck Characteristics
Traffic Sheet 19B.1 – Axle Group Scales
Traffic Sheet 19B.2 – Axle Scales
Traffic Sheet 19C.0 – Platform Scales (Running tire pressures)
Traffic Sheet 19C.1 – Long Platform Scale (5-axle Truck)
Traffic Sheet 19C.2 – Short Platform Scale – Axles (5-axle Truck)
Traffic Sheet 19C.3 – Short Platform Scale – Axle Groups (5-axle Truck)
Traffic Sheet 19C.4 – Long Platform Scale – Axles (6-axle Truck)
Traffic Sheet 20 - Speed and Classification Studies
Traffic Sheet 21 (Wheel Load) – WIM System Truck Records
Traffic Sheet 21 (Axle Load) – WIM System Truck Records
Traffic Sheet 22 – Site Equipment Evaluation
Traffic Sheet 22A – Site Equipment Evaluation – Classification Video
Traffic Sheet 22B – Site Equipment Assessment – System Accuracy
Traffic Sheet 22C Addendum - Weigh Pad – Site Equipment Assessment
Traffic Sheet 22D Addendum – Kistler Quartz – Site Equipment Assessment
Traffic Sheet 22E Addendum – Load Cell – Site Equipment Assessment
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Traffic Sheet 23 – WIM System Troubleshooting Outline
Traffic Sheet 24A – Site Photo Log – Equipment and Pavement
Traffic Sheet 24B – Site Photo Log - Trucks
Traffic Sheet 24C - Site Photo Log -
Traffic Sheet 25A – Site Audit Photographs
Traffic Sheet 25B – Site Audit Photographs – Overall Site
Traffic Sheet 25C – Site Audit Photographs – Checklist A-02 - Utilities
Traffic Sheet 25D – Site Audit Photographs – Checklist A-02 – Cabinet
Traffic Sheet 25E – Site Audit Photographs – Checklist A-02 – Hardware
Traffic Sheet 25F – Site Audit Photographs – Checklist A-03 – Layout
Traffic Sheet 25G – Site Audit Photographs – Checklist A-03 – Sensor Excavation
Traffic Sheet 25H – Site Audit Photographs – Checklist A-04
Traffic Sheet 26A – Photomap of In-road Sensors
Traffic Sheet 26B – Photomap of Cabinet
Traffic Sheet 26C – Photomap – Other

Traffic Sheet 27A – Site Audit Measurements – WIM Sensors and Layout

Traffic Sheet 27B – Site Audit Measurements – Loops

Traffic Sheet 27C – Site Audit Measurements – Depth Checks

Traffic Sheet 28 – Non-Compliance Report (NCR)

Traffic Sheet 29 – Audit Summary

Traffic Sheet 30 – Infrared Temperature Sensor Validation

Traffic Sheet A - Longitudinal Straightedge Record

Traffic Sheet B - Transverse Straightedge Record

Checklist A-01 – SPS WIM QA – Pre-visit Preparation

Checklist A-02 - SPS WIM QA – Support Equipment Installation

Checklist A-03 - SPS WIM QA – WIM System Equipment Installation

Checklist A-04 - SPS WIM QA – WIM System Calibration

## 10.1 AIMS DATA

AIMS (Auxiliary Information Management System) data consists of information collected by LTPP for documentation of site conditions or subsequent processing into more commonly used statistics. All data classified as AIMS is available on request by data users subject to the data release policies of the LTPP program.

Traffic data collection sheets 14 through 21 are currently considered AIMS data. As such, these paper sheets or their electronic copies are to be retained by the originating contractors for future disposition and cataloguing. The spreadsheets used for evaluating classification and WIM results are also AIMS data. Additionally, the p files containing the output of the LTPP profilers are considered offline data although of interest to a very limited number of researchers. These data are available in electronic form and stored according to the profiling manual (Ref. **Error! Reference source not found.**).

## 10.2 IDENTIFYING LTPP WIM SITES

Each WIM site will be assigned a unique SHRP ID number. This numbering scheme applies to section marking in the field, labeling of traffic data sheets and storage of profile data. Generally sites have retained their pavement section IDs as their SHRP ID numbers. It is preferred that they be identified with the following convention to simplify the identification of equipment changes. If there is more than one sensor installation in the lane or being monitored, the number of the installations will start with the first unused value from 99 in descending order beginning with 99.

SHRP ID is a 4-character code; the first two characters denote the experiment and the last two will be ‘99’ for a WIM location. If the WIM sensors are relocated, then the second of these two characters will decrease by one. Similarly, it will decrease by one if the current sensors are replaced by anything but the original sensor type. It remains the same if the same sensors are replaced at the same location.

Example 1

An agency wishes to conduct a side by side evaluation of WIM technologies. Only one will provide data for the site to the LTPP database. The primary site has been designated with the Project ID - A500. The secondary site is labeled with the A599 SHRP_ID.

Example 2
WIM equipment at SPS-6 project (0600) must be replaced because it falls within a pavement rehabilitation project. The agency elects to put the replacement system closer to the SPS project. The new installation receives the SHRP ID of 0699.

LTPP WIM sites may be marked permanently or temporarily depending on agency preference. The marking guidelines are in the profiling manual (Ref. **Error! Reference source not found.**).

### 10.3 COMMON DATA SHEET ITEMS

All data sheets have header blocks with varying items. The most common items are completed as follows:

1. STATE_CODE – The two digit FIPS (Federal Information Processing System) number by which the state is identified. See Table 11-3 for a listing.
2. SPS Project ID – The SHRP ID ending in 00 that identifies the experiment to which the test section belongs and which project of that type it is in the state.
3. SPS WIM ID – The SHRP_ID ending in 99 (98, 97...) that identifies a specific sensor and location combination. This will be blank if the site is referred to by its project ID.
4. State Assigned ID – The code assigned by the agency to identify the equipment in their data collection program.
5. Date – The date the data was collected written in mm/dd/yyyy format.

All items within a data sheet that are marked with an asterisk are mandatory. Enter “N/A” when a numerical value or text is not applicable to these items. Do not leave them items blank.

LTPP Traffic Sheets 25-29 are completed as part of the associated WIM Installation or Calibration auditing process. To the extent possible, Items 1-8 and the header block on each sheet should be completed electronically prior to the site visit. Specific instructions for completing the rest of each form are included in later sections. For the LTPP program SPS WIM Pooled Fund Project the project specific information is included with the item description.

- Item 1, Contractor, lead contractor for the activity being audited. It is International Road Dynamics for the SPS WIM Phase II Contract.
- Item 2, Audit Number, is assigned by the COTR.
- Item 3, Contract Number is DTFH61-04-R-00029 for the SPS WIM Phase II Contract.
- Item 4 is the date range of the Audit, i.e. March 4-12, 2005.

- Item 5, Location, include information such as GPS position, route, mile marker and the distance from the site to the closest intersection or highway exit.
- Item 6, Audit Type, will be one of the following; WIM Support Equipment Installation, WIM System Equipment Installation or WIM System Calibration.
- Item 7 identifies any Sub-Contractor and their lead representative.
- Item 8 identifies the Auditor’s name and organization.

## 10.4 TRAFFIC SHEET 17 -WIM SITE INVENTORY

Traffic Sheet 17, WIM Site Inventory, is to be completed for each WIM or AVC equipment installation where an LTPP contractor is responsible for data validation or collection. It should be reviewed for changes at each subsequent site visit. A Sheet 17 will be updated whenever equipment is replaced at a project **except when sensors or electronics are reinstalled in exactly the same location**. Such maintenance information is to be reported using Traffic Sheet 15 (Ref. 3).

All measurements may be done with a measuring wheel. If more precise measurements are needed than indicated in these guidelines, they are to be deferred until lane closure is made available for the project.

Each Sheet 17 developed should be retained to provide a history of site conditions over time.

*Item 1 -* LTPP WIM SITE LOCATION (required)

*Item a.* Route - Identified by alphanumeric designation ex. I-10, US 101.

*Item b.* Milepost - Identified using agency conventions with the units included.

*Item c.* Direction - Direction of travel for the road on which the LTPP lane is located, not the compass direction of travel for the lane.

*Item 2 -* Speed Data

*Item a.* Speed limit - in mph to determine upper end of speed range for validation

*Item b.* $15^{th}$ percentile speed – in mph; all vehicles, except on grades of 1% or more where only truck speeds should be used

*Item c.* $85^{th}$ percentile speed – in mph, all vehicles, except on grades of 1% or more where only truck speeds should be used

*Item d.* Speed range for validation

*Item 3 -* WIM Site Description

WIM site description information should identify elements of the location that may positively or negatively affect WIM performance.

If safety issues preclude personnel from accessing the travel lane, distance measurements may be taken from other LTPP data sheets. Note how the estimates were obtained in the Comments section.

*Item a.* Grade is taken from construction drawings if available. It is estimated otherwise.

*Item b.* Vertical sag is marked “Yes” if the grade is nonzero and the WIM section is located within a dip in the roadway. It is marked “No” otherwise.

*Item c.* The intent of locating and identifying this section is to determine whether there are obstacles to treating a WIM site for smoothness or whether LTPP materials sampling activities may affect the section. Underline upstream or downstream as appropriate. Upstream and downstream SPS sections are referenced with respect to the direction of the traffic stream over the WIM. Unmarked or out-of-study SPS sections are not counted. If the WIM section is between SPS sections the nearest section is the closest one to the sensors. If the equipment is installed within a test section, that is the closest section.

*Item d.* The distance from the center of the site to the nearest section is measured from the longitudinal center of the WIM sensors to the closest end of the nearest section. If that distance is more than half a mile then units of miles should be substituted for feet and the distance reported to the nearest tenth of a mile. If the WIM system is within a SPS section then this value is zero.

*Item 4 -* Lane Configuration

*Item a.* The LTPP lane numbers are the designated lane numbers from the LTPP database regardless of the WIM or AVC controller designations at the site. (The controller designation for the LTPP lane is an item on Sheet 22.)

*Item b.* Record the number of through lanes in the same travel direction as the LTPP lane.

*Item c.* Measure the width of the LTPP study lane. If the surface pavement is concrete, the measurement is to be taken from the centerline longitudinal expansion joint to the joint that separates the travel lane and the shoulder. If the surface pavement is asphalt, or if the expansion joint between the travel lane and shoulder is located greater than 6” from the painted shoulder stripe, the measurement is taken from the outside edge of the painted shoulder stripe, to the outside edge of the painted centerline solid or dashed stripe.

*Item d.* Measure the shoulder width from the outside edge of the lane to where the concrete or asphalt pavement meets loose gravel material or unpaved surface. If the LTPP lane is not the rightmost travel lane, measure with respect to the outermost travel lane.

*Item e.* The shoulder type refers to the shoulder adjacent to the LTPP lane. Unpaved shoulders are defined as a compacted, hardened material installed as part of the roadway construction. Mark “None” if the paved travel lane meets loose gravel, grass or dirt.

*Item f.* The median marks the separation between traffic directions with more than a double yellow stripe. It is not necessarily adjacent to the LTPP lane. A painted median consists of two sets of double painted lines that separate the leftmost travel lane from lanes traveling in the opposite direction including a two-way left turn lane or other markings on the pavement designed to separate opposing traffic streams. A physical barrier is a concrete or metal railing or raised curb that separates opposing travel lanes. A grass median is selected opposing lanes are separated only by vegetation. If a combination of any of the three median types exists, mark each applicable box (example: grass median with metal railing). Select “None” if there is no discernable barrier separating opposing travel lanes or if they are separated by double yellow lines (solid, dashed or solid dashed pairs) only.

*Item 5 -* Pavement Type

This item refers to the pavement layer characteristics at the location where the WIM sensor is installed. Options are: AC (asphalt concrete), PCC (portland cement concrete) or AC overlay of PCC.

*Item 6 -* Pavement Surface Condition – Distress Survey

Minimum requirements are the date of the survey and the photo filenames for the upstream and downstream views of the pavement at the sensors. The actual distresses observed that may affect equipment performance are entered in the "Site Conditions – Pavement" section of Sheet 22.

*Item 7 -* Sensor Sequence

Sensors installed in the road should be listed in sequence in the direction of traffic. For example, in a configuration using two piezo sensors installed on either side of a loop, the first item is a piezo, followed by the loop, and then the second piezo. Therefore, the entry would read piezo--loop-- piezo.

*Item 8 -* Replacement or Grinding

A replacement is defined as a full lane width treatment with length of 50 ft or more within the WIM section. Describe the type of replacement (overlay, seal coat, full depth patch or reconstruction) or grinding. If the treatment did not cover the entire WIM section, describe its limits and location.

*Item 9 -* Ramps and Intersections

An intersection or heavily used driveway close to the section or within its limits implies that vehicles could be accelerating or decelerating over the scale. A heavily used driveway is one used by 15 or more vehicles per hour. Underline "intersection" or "driveway" as appropriate.

*Item a.* For the upstream location mark "Yes" if this condition exists and "No" otherwise. Measure the distance in feet from the first sensor to the closest point of the intersection or driveway.

*Item b.* For the downstream location mark "Yes" if this condition exists and "No" otherwise. Measure the distance in feet from the last sensor to the closest point of the intersection or driveway.

*Item c.* The use of the shoulder for turns or passing indicates the potential for vehicles to bypass the scale or pass with only one wheel load measured. Mark "Yes" if this condition exists and "No" otherwise.

*Item 10 -* Drainage

Fill out this section only for bending plates or load cells.

*Item a.* Mark "Open to ground" if dedicated drainage conduit is installed from the scale pit area to a ground slope or open-air drainage ditch. If conduit runs from the scale pit area to a manufactured drainage culvert, either off to the side or through the pavement and base material, mark "Pipe to culvert". "None" if the scale pit area is not drained.

*Item b.* A measurement from the bottom of the weighing platform to the lowest point of the scale pit or frame.

*Item c.* If it is not possible to clean out the space under bending plates and load cell installations then the sensors may respond poorly. Mark "Yes" to indicate is accessibility to the pit area beneath the weighing platform through a manhole or other personnel access. "No" if there is no access.

*Item 11* - Cabinet Location and Access

*Item a.* Mark "Yes" if the LTPP lane is the first travel lane visible when standing at the cabinet. Mark "No" otherwise. At sites with LTPP sections in multiple lanes, the lane in which the traffic data is collected for core sections of an SPS project is the LTPP lane for this purpose. If there are different GPS LTPP sections in both directions, the LTPP lane is refers to the GPS section for which this Sheet 17 is being completed.

*Item b.* Located in the median is marked "Yes" if the cabinet is between lanes of travel in opposing directions. It is marked "No" otherwise.

*Item c.* Protected behind barriers means a fixed structure such as guide rail or concrete barrier exists between the cabinet and the traveled way. Mark "Yes" if there is a structure in place intended to prevent vehicles from hitting the cabinet. "No" otherwise.

*Item d.* The distance between the cabinet and edge of traveled lane is from the centerline of the cabinet on the edge nearest the roadway to the edge of the nearest travel lane even if it is not the LTPP lane. The measurement should be to the nearest foot.

*Item e.* The distance between the cabinet and the in-road sensors is measured from the centerline of the cabinet on the edge nearest to the roadway to the center of the sensor array. The measurement should be to the nearest foot. If the data is being collected in both directions for an SPS project, the distance to the sensor array in the LTPP lane should be provided first and labeled "LTPP lane". The distance to the other sensor array should be provided second and labeled "other LTPP sections". If there are different GPS LTPP sections in both directions, the distance is to the sensor array for the GPS section for which this Sheet 17 is being completed.

*Item f.* Cabinet type is the standard traffic engineering description i.e. "M". If the specific type cannot be identified, provide a description with dimensions (length, width and height) and installation characteristics (concrete pad, pole mounted etc.)

*Item g.* Indicate the entity that has primary access control to the inside of the cabinet. Options are "LTPP", "State" or "Joint". Joint applies only if an LTPP contractor equally controls access to the cabinet with the agency in the sense that no coordination is required or both parties do not have to be on-site for work in or on the cabinet.

*Item h.* Provide the contact information (name and phone) for the person with the most direct control of access to the cabinet, even if control of the cabinet is "Joint".

*Item i.* Provide the information for an alternative contact (name and phone) should the primary contact not be available.

*Item 12* - Power

This item provides information the availability of electrical power on site. It also provides contact information in the event of power failure.

*Item a.* Mark “Overhead” if power is supplied to the equipment via overhead power lines. Mark “Underground” if the power service is provided by underground wiring. Mark “Solar” if all equipment including the controller and communications equipment is powered by solar energy.

*Item b.* The distance from drop to cabinet is the measured distance from the cabinet centerline closest to the power source to the pole or box controlled by the local power service provider. This value is “N/A” if the power is solar and the panel is at or on the cabinet or the power is underground and has no above ground connection outside of the cabinet pad.

*Item c.* The point of contact to get service restored in the event of power failure.

*Item 13* - Telephone

*Item a.* Mark “Overhead” if the connection is supplied to the equipment via overhead lines. Mark “Underground” if the lines cannot be observed and the connection is not cellular. Mark “Cellular” for all wireless types of communication.

*Item b.* The measured distance from cabinet centerline closest to the phone source to the last connection controlled by the telephony service provider. This is “N/A” if data can only be retrieved on site or the service is “Cellular”. This is 0 if the service is “Cellular”.

*Item c.* A point of contact to get service restored in the event of communications failure. It is “N/A” if data is downloaded on-site only.

*Item d.* The site phone number may be “N/A” if LTPP is not downloading data. It may also be on IP address depending on the method of access.

*Item 14* - System Communication and Data Reporting

*Item a.* Software and version numbers should have sufficient information to be able to troubleshoot the site in consultation with the vendor or manufacturer.

*Item b.* This indicates what kind of ports and cables must be available on the laptop brought to the site. “Other” is used for new or wireless connections.

*Item 15* - Test Truck Turnaround

Based on these values, a determination will be made on the number of trucks required to complete forty runs for a validation in a single day. If trucks cannot be run at the site both entries are “N/A”.

*Item a.* Total time is the average of at least three runs on the proposed or actual route.

*Item b.* Total distance is the length of the travel undertaken by trucks to complete a “loop” (from lead sensor to lead sensor).

*Item 16* - Photos

A series of digital photographs is required and are to include the location of power and phone, the interior and exterior of the cabinet, and each sensor installed in the road.

These photographs are to be included with the Sheet 17 when the LTPP contractor goes to the site to investigate or verify conditions.

Equipment changes should be reflected on Sheet 15. New photographs are to be taken as required.

It is strongly recommended that a picture of the LTPP lane, clearly labeled with the LTPP lane number and direction, be posted in the cabinet on site.

*Item 17* - Sketch of Equipment Layout

The equipment layout includes the dimensions and spacing of the sensors and cabinet location. All instrumented lanes should be included. The LTPP lane should be identified. The sketch needs to be labeled with the direction of travel. It need not be to scale.

It is strongly recommended that a copy of the sketch with controller lane designations be posted in the cabinet on site.

*Item 18* - Site Map

This is a map of the WIM site geographical area at a suitable scale to locate the route the test trucks will follow. The map should show the locations of staging areas. Nearby static scale locations should be shown or a larger scale map of the site and the static scales must be included.

*Item 19* - Additional Comments

Note other pieces of useful information about the immediate vicinity of the WIM scale. Amenities like lodging, restaurants and so forth should be noted. The following is by no means an inclusive list.

- Where are facilities for adjusting loads to get correct (legal) axles weights?
- Where is a suitable staging area for measuring trucks?
- For certified scale location(s) are the hours of operation compatible with the validation schedule?
- Will the truck route allow sufficient runs in 1 day?
- Can the trucks get to test speed prior to entering the WIM section?
- Is the site congested? Will it allow the chosen truck speeds?
- Will the site allow operation without acceleration or deceleration (impact of grades and alignment?
- Is there room at the site to set up next to the cabinet?
- Is there space to park vehicles at the site?
- How is the site marked for profiling?
- Is the working WIM location is known?
- Is AC power available at the site?

## 10.5 TRAFFIC SHEET 18 – WIM SITE COORDINATION

This sheet has six sections that document the division of responsibilities between FHWA-LTPP and a highway agency for any SPS project subject to intensive monitoring. It is a project specific sheet. The date in the header should be updated every time the sheet is modified. Only the most recent version of this sheet is expected to be retained.

*Item 1* - Data Processing

Complete this item for each SPS-1, -2, -5, -6 and -8 location. The responsible party and conditions in each case is marked.

*Item a.* Download refers to taking the data directly from the machine. Mark “State Only” if the agency has exclusive control of the downloading process. Mark “LTPP read only” if LTPP has read only access to the data. Mark “LTPP download” if LTPP can download and process the data independent of the agency. Mark “LTPP download and copy to state” if LTPP downloads the data and provides a copy of each data file to the agency.

*Item b.* Data review is the process of verifying that the equipment is operational and that the information passes QC. Mark the “State per LTPP guidelines” if the agency reviews the site data in accordance with LTPP directives for data quality. Mark the “State” box if the agency conducts data reviews in compliance with its own QC standards. Mark the applicable box to indicate the frequency of the agency data reviews. Mark the “LTPP” box if LTPP exclusively performs all QC reviews on the collected data.

*Item c.* Data submission for QC identifies the party that is responsible for delivering the data to the RSC for processing up to and including entry into the IMS. Mark “State” if the agency is solely responsible for all data submission to the RSC. Mark the appropriate box to indicate the frequency of the agency’s data submissions. If LTPP is the sole party downloading data, mark the “LTPP” box.

*Item 2 -* Equipment

*Item a.* Purchase - Mark the “LTPP” box if the equipment was purchased through the SPS Pooled Fund. Mark “State” if it was purchased under an agency contract.

*Item b.* Installation - Mark “Included with purchase” if the cost of the installation was paid by the agency and included in the original equipment purchase agreement. Mark “Separate contract by state” if the installation cost was not included with the equipment purchase. Mark “State personnel” if the agency employees installed the equipment. Mark “LTPP contract” if the equipment was installed under the SPS Pooled Fund contract.

*Item c.* Maintenance - Mark the “Contract with purchase” box if a maintenance agreement was included with the equipment purchase. This includes systems installed under the SPS Pooled Fund contract. Mark “Separate contract LTPP” if an LTPP contractor performs the equipment maintenance but did not install the equipment. Mark “Separate contract state” if the agency has purchased a maintenance agreement separately from the equipment purchase. Mark “State personnel” if the agency is solely responsible for maintenance of the equipment.

*Item d.* Calibration - Mark “Vendor” if the agency contracts directly with a vendor to conduct calibrations. Mark “State” if the agency conducts the calibrations themselves. Mark “LTPP” if LTPP is responsible for calibration (as opposed to validation). If LTPP is responsible, then complete item 5.

*Item e.* Documentation - The manuals and software control item identifies which party has the most current system support publications and technical manuals. LTPP includes LTPP contractors and FHWA.

*Item f.* Power type is for identifying equipment needed on site visits. If a site is solar powered alternative power sources required on site to run laptops, test equipment, etc.

*i.* Mark “Overhead” if power is supplied to the equipment via overhead power lines. Mark “Underground” if the power service is provided by underground wiring. Mark “Solar” if all equipment including the controller and communications equipment is powered by solar energy.

*ii.* Mark the appropriate box to indicate the party responsible for remitting payment for the power services. Mark “N/A” for all solar powered sites.

*Item g.* Communication type is for reference for contractors downloading data.

*i.* Mark the appropriate box to indicate if the site’s communication equipment is connected to landline service or utilizes cellular technology. If another type of service is used, mark the “Other” box and note the type of service (include web access as other).

*ii.* Mark the appropriate box to indicate the party responsible for remitting payment for the communication services. “N/A” if no communication service is connected (on-site download only). If equipment is installed but service is not established or has been discontinued, note this condition next to the “N/A” selection.

*Item 3 -* Pavement

This section indicates the options for pavement corrective actions and general site conditions.

*Item a.* Type provides description of the current pavement type on the surface. The options to be marked are either Portland Concrete Cement or Asphalt Concrete.

*Item b.* Mark “Always new” if the pavement will always be replaced to correct deficiencies affecting data collection. Mark “Replacement as needed” if replacement is among the options to correct deficiencies affecting data collection. Mark “Grinding and maintenance as needed” if spot corrections will be done. Mark “Maintenance only” if only surface level maintenance of minor distresses will be done. Mark “No remediation” if there will be no corrective actions for conditions affecting data collection.

*Item c.* This item identifies if the state allows the site to be permanently marked. The item is included so a profiler operator will know if temporary markings are necessary. If the run up to a WIM site overlaps a SPS section then marking it for profiling may create data quality problems for LTPP’s pavement section profiling operations.

*Item 4 -* On Site Activities

Every active SPS-1, -2, -5, -6 and -8 site with working equipment should be visited at least once to provide baseline information on system operations and equipment, and may be visited up to three times a year for validation. These visits are conducted with agency consent.

*Item a.* Indicate the minimum amount of advance notice required for validation. Circle days or weeks.

*Item b.* Indicate the minimum amount of advance notice required for straightedge and grinding. Circle days or weeks.

*i.* Mark the appropriate block for on site lead. The party who has responsibility for the grinding contract is the on site led.

*ii.* The party to accept grinding is the one with the authority to determine if it is “smooth enough” or to otherwise halt grinding.

*Item c.* Indicate the party(s) allowed to make factor changes to the equipment.

*Item d.* Indicate the party responsible for the calibration routine. Mark the desired/expected frequency of calibrations. Mark "LTPP" if all calibrations are part of an installation or validation by LTPP contractors. Mark "State per LTPP protocol" if the agency uses LTPP's validation methodology. Mark the expected frequency of calibrations. Mark "State other" if the calibration or validation process is different. Describe any alternate calibration processes. If the site is not calibrated or validated other than at installation, indicate "None" after "State other".

*Item e.* Test vehicles for validations are identified here.

*i.* Mark the appropriate box to indicate the party responsible for providing each of the test trucks. List the 2nd (and 3rd and 4th if necessary) type of trucks that will be required to perform a system validation. The 1st truck is always the "golden" truck, Truck #1. If this truck is not going to be used for validation then that should be noted here.

*ii.* Loads are marked for each party providing them. Both boxes may be marked if both parties are providing loads.

*iii.* Drivers are marked for each party providing them. Both boxes may be marked if both parties are providing drivers.

*Item f.* Describe pertinent details about any contractor(s) that have successfully calibrated the WIM site for the state. If no contractor has calibrated the site before the date of validation then "N/A" is written in for this item.

*Item g.* Cabinet access information is identified here.

*i.* Indicate the entity that has primary access control to the inside of the cabinet. Mark "LTPP" if access primarily controlled by an LTPP representative or contractor. Mark "State" if the agency has primary access control. Mark "Joint" if access to the cabinet is equally controlled by an LTPP contractor and the agency in the sense that both parties do not have to be on-site for work in or on the cabinet.

*ii.* For physical access to the cabinet, mark the box(es) that indicates the means used to access the cabinet, either with a "Key" or the "Combination".

*Item h.* Mark "Yes" if agency personnel are required to be on site during any on site activities. Indicate what activities require agency personnel on site. Provide contact information under Section 6, item a. Mark "No" otherwise.

*Item i.* Mark "Yes" if traffic control services are required for any on site activities. Indicate which activities require traffic control services next to the "Yes" box. Provide contact information under Section 6, item f. Mark "No" otherwise.

*Item 5 -* Site Specific Conditions

If there are any conditions, including the agency's or the LTPP program's involvement that will affect contractor work, they will appear in this section.

*Item a.* Funds accountability identifies what special actions not covered by contractual agreements are needed with respect to monies spent on the site.

*Item b.* Reports indicate what types of summaries for a site visit are needed beyond those required by contract.

*Item c.* Other conditions may include restrictions on night work, the number of site visits permitted or the protocols for contacting agency personnel for support.

*Item 6 -* Contacts

This section provides for the inclusion of contact information that will be used to coordinate all assessment, evaluation and construction efforts. All items must be filled in or marked as N/A.

*Item a.* Equipment (operational status, access) – Individual who can verify that the equipment is working properly prior to an assessment or validation.

*Item b.* Maintenance (Equipment) – Individual to contact for on site troubleshooting or report repairs identified.

*Item c.* Data Processing and Pre-Visit Data – Individual who can provide data on speed, vehicle distributions, classification scheme and algorithms.

*Item d.* Construction Schedule and Verification – Individual issuing construction contract.

*Item e.* Test Vehicles – Individual to contact for trucks, loads and drivers.

*Item f.* Traffic Control – Individual responsible for traffic control activity onsite.

*Item g.* Enforcement Coordination – Individual to contact for on-site enforcement presence.

*Item h.* Nearest Static Scale – Weigh master and location of nearest static scale.

## 10.6 Traffic Sheet 19 Series – Test Truck Information

This sheet consists of two parts. Part I is the summary information on the vehicle and Part II is the raw weight data and computations. Part I is found on Traffic Sheet 19A Part II varies by the type of scale being used and the weighing method. Part II is documented on Traffic Sheets 19B-1, 19B-2, 19C-0, 19C-1, 19C-2, 19C-3 and 19C-4.

The header information identifies this as a project specific sheet (SPS Project ID). The same data will be used in comparisons of side-by-side equipment installations. It is entered as for any other Traffic data sheet.

Either U.S. or S.I. customary units may be used. U.S. customary units are preferred. Consistent units should be used for weights and dimensions. Weights and dimensions do not need to be in the same system.

A separate Sheet 19 packet must be completed for each test truck used in the WIM validation or verification process. The packet will include a 19A and a 19B or 19C for every day that weighing occurs. Weigh tickets should be attached to verify all data entry.

The header block includes TEST TRUCK # __ to identify the vehicle to which the measurements apply. Typically, truck numbers will be single digit identifiers beginning with #1 and increasing in increments of 1. Truck #1 is always the loaded, air suspension Class 9. If that vehicle is not used, there is no Truck #1 in the data set. If a truck is replaced during the weight runs, it receives a new number, not the number of the vehicle it replaced.

The footer block includes 3 items: Recorded by:, Verified by:, and pagination. The individuals making the measurements or transferring data from weigh tickets should initial each sheet. Pages should be numbered consecutively for each truck as they are completed. The total number of pages should be entered after the data collection is completed. The expected number of pages is the number of days of data collection plus one for axle scales. The expected number of pages is the number of days of data collection plus two for platform scales.

### 10.6.1 TRAFFIC SHEET 19A

This is the basic sheet for fixed truck characteristics. It is identified as Part I of a Sheet 19 set for any given truck.

PART I

*Item 1 -* FHWA Class

Identify the truck's classification. Use the TMG 13-bin classification scheme.

*Item 2 -* Number of Axles is the total number of axles on the test truck

*Item 3 -* Number of weight days – Total number of days weight runs were conducted.

GEOMETRY

This section describes the vehicle its load and linear measurements. The axle spacings are used in validating the speed and spacing capabilities of the WIM equipment.

*Item 4 -* Truck Description

*Item a.* Circle the applicable description to indicate the tractor type, either "Cab Over Engine" if the tractor's cab is positioned over the engine or "Conventional" if the engine is positioned ahead of the driver's compartment.

*Item b.* Circle "Y" if the tractor cab is equipped with sleeping facilities for the driver; circle "N" otherwise.

*Item c.* Write in make. The tractor's make will usually be found on a sticker at the back edge of the driver's door

*Item d.* Model of vehicle. The model information will usually be found on a sticker at the back edge of the driver's door. The driver should be able to supply this information if it cannot be found on the truck.

*Item e.* Photos of the truck are required that show all of the elements listed on Sheet 24B – Site Photo Log – Validation. They include pictures the full vehicle and of all suspensions. Check box when photos are complete. Identify photos by number or photo log sheet.

*Item 5 -* Trailer Load Description and photo. Indicate the type of trailer (box, flatbed, dump, etc.) Describe the load and the way in which it is distributed. Specifically, try to describe how the load is distributed longitudinally and if it is concentrated at any particular location. Note how high the load is stacked and whether the height is even along the trailer's length.

*Item 6 -* Specify the Axle Spacing. Circle the units of measurement being used. Use a tape measure to obtain the precise longitudinal distances between each axle. Note that axle A denotes the front steering axle of the truck with axles B and C, etc. being the subsequent axles as you move toward the rear. Measuring each spacing individually is not recommended. Trucks should be parked on level ground when this measurement is made. If they are not, each of the axle centers should be marked on the pavement and the measurements made from the chalked points. Space is been provided for trucks with up to six axles.

*Item 7 -* Wheelbase is the distance from the center of the first axle to the center of the last axle. Include both the measurement from the first to the last and the computed total. The allowable difference between the two values is 0.3 feet, 4 inches or 100 mm. If difference is larger, repeat all measurements.

*Item 8 -* Bumper to bumper distance is the length from the font bumper to the back of the trailer. This distance should be measured on both sides of the vehicle from the point where the front bumper is parallel to the tractor body to the outermost point on the trailer. It may be necessary to chalk these points on the pavement to obtain accurate measurements. Report the average of the two values.

*Item 9 -* Kingpin offset from Axle B is found by measuring the distance from the center of axle B to the articulation point of the tractor-trailer combination. On five-axle combinations, this point will typically be between axles B and C. If the articulation point (kingpin) is behind axle B, the distance will be greater than zero. Record this measurement in item l and be sure that the units are in parentheses on the line. Measurements greater than zero should be prefaced by a + (plus sign).

SUSPENSION

*Item 10 -* Tire Size - Record the nominal tire size for each axle. These can usually be found stamped on the tire and will resemble "11R22.5" or "345/65R22.5".

*Item 11 -* Suspension type. Note whether the axle is a single or part of a tandem group. Determine the suspension type (air, leaf spring, etc.). If it is a leaf spring suspension, count the leaves and determine if it they are flat or tapered. Tapered leaf springs are thinner near their ends and flat springs have constant thickness. Photos of these parts are required. Check the box to confirm that they have been taken

*Item 12 -* Cold Tire Pressures – a. Left and b. Right. For each test truck, measure cold tire pressures prior to any test runs. Record the pressures for each axle starting with the rightmost tire and moving left. Left is the driver's side of the vehicle. There should be four measurements per axle, except the steering axle which will have two. Axles with super singles should have their data entered in the outer space and the inside tire pressure marked "N/A".

#### 10.6.2 TRAFFIC SHEET 19B-N

This set of sheets contains the daily record of the variable characteristics of the test trucks, the weights, when collected using an axle scale.

PART II

In this section the individual static axle weights are determined. Two weights are collected each axle or axle group. The average is used in the validation process. Individual axle weights are preferred to axle group weights. Individual axle weights must be obtained if the vehicle used has a split tandem or split tridem. If the difference between the two GVW values is greater than 500 lbs, a third weighing is recommended.

Axles - Circle the units used in all weight entries for this section.

Day # - Enter the number of the day in the days on site for this validation.

*Item 13* - (14 on Sheets 19B-1 and B-2 respectively)

*Item a.* Average Pre-Test Loaded Weight – Transfer the computed average GVW from the pre-test table.

*Item b.* Average Post-Test Loaded Weight – Transfer the computed average GVW from the post-test table.

*Item c.* Difference Pre-Test and Post-Test Weights – Subtract the post-test weight from the pre-test weight. This difference should be between 150 and 1000 lbs. If it outside these bounds the cause must be determined and its influence on the analysis evaluated.

Compute the average weight of each truck axle prior to the WIM performance testing. Do this after the truck has been fully loaded. After the trucks are weighed, the mean and standard deviation are computed for the GVW and the mean for the axle weights. Standard deviations of GVW in excess of 3% require that additional passes be made to achieve an acceptable GVW standard deviation.

Ensure that the truck's configuration does not change through adjustment of fifth wheel or axle positions between weighing and WIM performance testing. If the GVW or axle weights exceed legal limits make any necessary adjustments, then reweigh the truck. All weight measurements should be done on certified scales and reported to at least the nearest 100 lbs. The nearest 50 lbs is acceptable for scales with that level of precision. No rounding should be done to averages used in computations with scale outputs.

Tables 13.1(pre-), 13.2(mid-run), 13.3(post-) – Raw Measurements –Scale with axle group outputs (Traffic Sheet 19B-1).

These tables are used to record the measurements from a typical commercial scale as found at a truck stop. The scales will report by axle group. These tables have eight columns. The first column identifies the pass so that the weight ticket can be matched to the data entry. The next four columns are typically encountered axle groups for 5- and 6- axle trucks. For a 5-axle truck, the Axle DEF column should be crossed out. For a 6-axle truck the DE column should be crossed out. The last column is for GWV. It may be available on the weigh ticket or need to be computed from axle weights. The two blank columns are available for other axle combinations such as split tandems, split tridems or axle groups of 2-, 3-, 4- or 7-axle trucks. The unnumbered row is for use when a third weighing is required. Table 13.2 is available for use if trucks need to be reweighed after being fueled in the middle of a day’s validation.

Table 13.4 is for recording Running Tire pressures. This data should be measured during an extended break in the validation runs or at the end of the day. The rightmost tire is in the first row.

Tables 14.1(pre-), 14.2(mid-run), 14.3(post-) – Raw Measurements –Scale with axle outputs (Traffic Sheet 19B-2).

These tables are used to record the measurements from a typical enforcement scale. The scales will report by axle. These tables have eight columns. The first column identifies the pass so that the weight ticket can be matched to the data entry. The next six columns are individual axle entries. If the scale provides wheel loads, the individual wheel loads should be entered, not summed before entry. Any unused columns should be crossed out. The last column is for GWV. It may be available on the weigh ticket or need to be computed from axle weights. The unnumbered row is for use when a third weighing is required. Table 14.2 is available for use if trucks need to be reweighed after being fueled in the middle of a day's validation.

Table 14.4 is for recording Running Tire pressures. This data should be measured during an extended break in the validation runs or at the end of the day. The rightmost tire is in the first row.

### 10.6.3 TRAFFIC SHEETS 19C-N

This set of sheets contains the daily record of the variable characteristics of the test trucks, the weights, using platform scales that do not report weights by axle or axle group.

PART II

In this section the individual static axle weights are determined. Two weights are collected or computed for each axle or combination of axles. The average is used in the validation process. Combinations of axle weights are preferred to axle group weights. If the difference between the two GVW values is greater than 3%, a third weighing is recommended. The third weight is identified with a (3) on the affected 19C.

Axles - Circle the units used in all weight entries for this section.

Day # - Enter the number of the day in the days on site for this validation.

*Item 15* - (15, 16, 17, 18 Sheets 19C-1, 19C-2, 19C-3, and 19C-4 respectively)

*Item a.* Average Pre-Test Loaded Weight – Transfer the computed average GVW from the pre-test table.

*Item b.* Average Post-Test Loaded Weight – Transfer the computed average GVW from the post-test table.

*Item c.* Difference Pre-Test and Post-Test Weights – Subtract the post-test weight from the pre-test weight. This difference should be between 150 and 1000 lbs. If it outside these bounds the cause must be determined and its influence on the analysis evaluated.

Compute the average weight of each truck axle prior to the WIM performance testing. Do this after the truck has been fully loaded. After the trucks are weighed, the mean and standard deviation are computed for the GVW and the mean for the axle weights. Standard deviations of GVW in excess of 3% require that additional passes be made to achieve an acceptable GVW standard deviation.

Ensure that the truck's configuration does not change through adjustment of fifth wheel or axle positions between weighing and WIM performance testing. If the GVW or axle weights exceed legal limits make any necessary adjustments, then reweigh the truck. All weight measurements should be done on certified scales and reported to at least the nearest 100 lbs. The nearest 50 lbs is acceptable for scales with that level of precision. No rounding should be done to averages used in computations with scale outputs.

A long platform scale is a scale capable of weighing all axles of a 5-axle tractor semi-trailer at the same time. When using a long platform scale, each combination of axles is weighed as the truck advances across the scale. This gives at least two estimates for each axle's weight. Two GVW measurements are needed. The truck should drive completely off of the scale and then back onto the scale between GVW measurements. GVW is calculated by summing all axle weights in the first pass across the scale. Individual axle weights are not required when getting the second GVW measurement.

Tables 15.1(Raw Axle and GVW Measurements), 15.2(pre-), 15.3(post-) – Long Platform Scale – 5-axle Truck (Traffic Sheet 19C-1).

Table 15.1 shows the sequence of axle combinations as the vehicle is advanced across the scale in the first column. The second column labels each measurement for use in axle weight and GVW computations. The third and fifth columns are used to record pre- and post-test weights respectively. The last row has space for a third GVW measurement if needed. Tables 15.2 and 15.3 are used to make the actual axle weight calculations. There is no table for a mid-day weighing computation although space exists to enter mid-day weights in the fourth column of Table 15.1.

To record running tire pressures for trucks with weights recorded on Traffic Sheet 19C-1, Traffic Sheet 19C-0, Tables _.4 for a 5-axle truck are used. There is space for two days of weights. A third day will require a second Sheet 19C-0.

Tables 18.1(Raw Axle and GVW Measurements), 18.2(pre-), 18.3(post-) – Long Platform Scale – 6-axle Truck (Traffic Sheet 19C-4).

Table 18.1 shows the sequence of axle combinations as the vehicle is advanced across the scale in the first column. The second column labels each measurement for use in axle weight and GVW computations. The third and fifth columns are used to record pre- and post-test weights respectively. The last row has space for a third GVW measurement if needed. Tables 18.2 and 18.3 are used to make the actual axle weight calculations. There is no table for a mid-day weighing computation although space exists to enter mid-day weights in the fourth column of Table 18.1.

To record running tire pressures for trucks with weights recorded on Traffic Sheet 19C-4, Traffic Sheet 19C-0, Tables 18.4 for a 6-axle truck are used. There is space for two days of weights. A third day will require a second Sheet 19C-0.

A short platform scale is a scale capable of weighing all axles of a single unit truck (Class 6 or 7) but not all those of a 5-axle tractor semi-trailer at the same time. When using a short platform scale, various combinations of axles are weighed as the truck advances across the scale. This gives at least two estimates for each axle's weight. The GVW must be computed from pairs of axle measurements.

Tables 16.1(Raw Axle and GVW Measurements), 16.2(pre-), 16.3(post-) – Short Platform Scale – Axles - 5-axle Truck (Traffic Sheet 19C-2).

Table 16.1 shows the sequence of axle combinations as the vehicle is advanced across the scale in the first column. This incremental approach assumes that the scale is long enough (approximately 40 feet) to hold both the trailing axle of the drive tandem and the trailer tandem. It is the preferred method for short platform scales. The second column labels each measurement for use in axle weight and GVW computations. The third and fifth columns are used to record pre- and post-test weights respectively. The last row has space for a third GVW measurement if needed. Tables 16.2 and 16.3 are used to make the actual axle weight calculations. There is no table for a mid-day weighing computation although space exists to enter mid-day weights in the fourth column of Table 16.1.

To record running tire pressures for trucks with weights recorded on Traffic Sheet 19C-2, Traffic Sheet 19C-0, Tables _.4 for a 5-axle truck are used. There is space for two days of weights. A third day will require a second Sheet 19C-0.

Tables 17.1(Raw Axle and GVW Measurements), 17.2(pre-), 17.3(post-) – Short Platform Scale – Axle Groups - 5-axle Truck (Traffic Sheet 19C-3).

Table 17.1 shows the sequence of axle combinations as the vehicle is advanced across the scale in the first column. This incremental approach assumes that the scale cannot hold both the trailing axle of the drive tandem and the trailer tandem. Since each group is weighed separately, three measurements rather than the typical two are required. The second column labels each measurement for use in axle weight and GVW computations. The third and fourth columns are used to record pre- and post-test weights respectively. Tables 17.2 and 17.3 are used to make the actual axle weight calculations. There is no provision for a mid-day weighing. An additional Sheet 19C-3 would be needed in that case.

To record running tire pressures for trucks with weights recorded on Traffic Sheet 19C-3, Traffic Sheet 19C-0, Tables _.4 for a 5-axle truck are used. There is space for two days of weights. A third day will require a second Sheet 19C-0.

Running Tire Pressures for Platform Scales are entered on Sheet 19C-0. A separate sheet is required for each truck, but multiple days for the same truck are included. The data is entered using the same conventions as Part I 12a. Left and b. Right. For each test truck, measure hot (running) tire pressures during and extend break in the test runs or at the end of the day. Record the pressures for each axle starting with the rightmost tire and moving left. Left is the driver's side of the vehicle. There should be four measurements per axle, except the steering axle which will have two. Axles with super singles should have their data entered in the outer space and the inside tire pressure marked "N/A".
With a smaller scale, or scale that is not a single platform, adjust this procedure as necessary to get two estimates of each axle's weight and three estimates of GVW.

The approach and departure of the scale must be at the same level as the scale itself, and not be ramped.

Table 10-1 has incremental weighing methods for 2-, 3-, and 4- axle trucks as well as an axle group alternative for 6-axle tractor semi-trailer combinations.

**Table 10-1 Alternatives for Varying Numbers of Axles (Sheet 19C)**

| Meas. | 2-axles | 3-axles | 4-axles | 6-axles |
|---|---|---|---|---|
| I | A | A | A | A |
| II | A+B (1) | A+B | A+B | B+C |
| III | B | A+B+C (1) | A+B+C | D+E+F |
| IV | A+B (2) | B+C | A+B+C+D (1) | A (2) |
| V | A+B (3) | C | B+C+D | B+C (2) |
| VI | | A+B+C (2) | C+D | D+E+F (2) |
| VII | | A+B+C (3) | D | A (3) |
| VIII | | | A+B+C+D (2) | B+C (3) |
| IX | | | A+B+C+D (3) | D+E+F (3) |

### 10.7 TRAFFIC SHEET 20 – SPEED AND CLASSIFICATION CHECKS

Use Sheet 20 to record the observed classification and speed of the vehicles. The information will later be used to evaluate the WIM or AVC equipment classification schemes. It is critical to collect the record number assigned to each observed vehicle by the system. The output from the system can be entered later using the permanent record or by a second individual watching the on-screen equipment output.

The speed and classification checks should be done for the LTPP lane only unless otherwise specified.

The sheet header is entered as for any other LTPP data sheet. This is an equipment specific sheet so the header includes SPS WIM ID. More than one sheet will be required to record all the observations needed for a minimum sample size so it is important to record the number of sheets in a set and the sheet order.

Descriptions of misclassified vehicles should be annotated in the margins, at the bottom of the sheet, or on a separate page to assist in classification accuracy and algorithm studies.

### 10.8 TRAFFIC SHEET 21 SERIES – WIM TRUCK RECORD DATA

Sheet 21 is provided as an alternative to using **WIM 2 TRUCK.xls** for recording truck data in real time. There are two versions of this sheet, Axle Load (21A) and Wheel Load (21B). The axle load is for use with equipment that displays axle weights in real time. The wheel load version is used when wheel loads can be displayed. If both options are available, the wheel load display is preferred.

The minimum information is the truck number (e.g. #1, #2 etc.), the time and the record number from the WIM system. All information must be entered if there is doubt about the ability to retrieve the data at the end of the validation session. If the wheel load option is used the data should be entered consistently as left/right or right/left depending on the equipment's output. If the system uses left/right instead of left/right as entered on the data sheet, the data sheet should be marked accordingly.

The pavement temperature and independent speed (Pvmt temp, Obs(served) Speed) may be kept initially on the same sheet or done on two separate sheets and then consolidated. If separate sheets are used all sheets must be retained as part of the raw data packet. Someone other than the individual transferring the data must check the transfer from the original sheet.

The information from the WIM system may be entered in real time or from the permanent record from the equipment. In either case, the data recorded on this sheet must be independently checked by another individual against the permanent record.

This sheet may be used to support entries for “Space and Weight” on Sheet 22 for site assessments. In this case, the independent speed, observed class, WIM class, time, record number, WIM speed, Axle A weight, GVW, and B-C space for TYPE 9 vehicles are required. The observed class is entered in the Truck column. The WIM class from the equipment is entered in the Pass column. These values will be used to verify the classification, speed and spacing, and weight accuracies of the WIM system.

### 10.9 Traffic Sheet 22 Series - Site Equipment Assessment

The basic Sheet 22A consists of seven sections that document the assessment of an LTPP SPS WIM site. They are Site Equipment Information, Site Conditions, Truck Observations, System Accuracy Tests, Support Equipment/Structures, Static and Dynamic Electronic Equipment Tests, and General Comments. The Sheet is supplemented by additional pages. The first set of pages is used for video data documentation. For WIM site assessments a sheet on WIM system accuracy is available. The third set of supplemental pages is for equipment specific electronics tests. The supplemental sheets are 22C for bending plates and other weigh pads, 22D for Quartz Piezo as manufactured by Kistler, 22E for load cells and 22F for ceramic piezo sensors. All supplemental sheets include space to document testing of loop sensors. If only loop sensors exists (classification only site), then Sheet 22C should be used.

This set of sheets is to be completed for each site visit. Copies from prior visits should be available as reference on site.

*Section 1* – Site Equipment Information

This section provides general information pertaining to the equipment type, lane references, and type of weight sensor and equipment software versions. It also documents the time frame of the classification video. Each item of information must be verified on site.

Mark the Type of Equipment according to the highest function. The “Both” option is selected only if there are two separate pieces of equipment operating at a single site, performing the two separate functions of weighing and classifying vehicles. If two sets of WIM or AVC equipment (sensors and electronics) occupy the same cabinet, a separate Sheet 22 is required for each. If multiple sensor types are controlled through the same electronics, multiple supplemental sheets will be required.

The vendor is the equipment maker. The model should be identified on the controller or on the Traffic Sheet 14 (Installation Log) in the cabinet. The serial number is found on the vendor’s manufacturing plate affixed to the WIM electronics controller if a Sheet 14 is not present.

The lane number on site is the number of the LTPP lane as defined by the controller.

The direction on site is the direction of the LTPP lane according to the agency road inventory, not the lane’s compass direction.

Software versions may be obtained directly from the unit's circuit boards, from equipment labels, from vendor technical manuals, on site maintenance records, from agency or vendor personnel or from the Sheet 14.

*Section 2 – General Comments*

This section is used to summarize all deficiencies discovered during site visit. It may be used to make initial recommendations for repairing or replacing system components, any required pavement rehabilitation, or repairs required to any in-road equipment or support structures. The actual recommendations should be detailed in the appropriate sections.

This section also includes all information not identified for inclusion other places such as any rodent, insect or reptile problems that may affect site activities.

*Section 3 – Site Conditions*

This section documents deficiencies of the pavement (such as a change of pavement type just prior to the sensors) or the in-road sensors that may affect the performance and accuracy of the system. All deficiencies are photographed and logged on Traffic Sheet 24C – Site Photo Log Any sections that have no deficiencies should be marked "None" or "N/A".

The pavement section documents pavement distress discovered during a survey of the WIM section. The WIM section is defined as the area of pavement from 900 feet (275 meters) prior to the center of the weight sensors to 100 feet (30 meters) beyond the center of the weight sensors. Distress on the shoulder on in an adjacent oncoming lane that might affect data quality should also be indicated here.

The in-road sensors section documents any deficiencies with the actual weighing equipment installed in the pavement. Missing, broken or loose components, epoxy or pavement breakout, or the removal of any component should be recorded. Document any severe wear of the protective coating of bending plates or other sensors. Note any icing that may affect sensor movement. Note any water that may affect signals.

*Section 4 – Truck Observations*

Record any adverse truck interaction with the weighing equipment in this section. The critical area is located within one hundred thirty feet (forty meters) of the center of the WIM sensor array. The area reviewed should have the WIM array about 100 feet from the start of the area.

Close observation of several trucks must be made to determine if truck traffic is showing adverse characteristics such as bouncing, swerving, braking, or accelerating just prior to entering the sensor area. Additionally, if a significant portion of the trucks are traveling outside of the wheel path or if their tires are not fully touching the sensors, and are therefore not being detected that should be recorded. Record such movement with videotape for a minimum of fifteen minutes or thirty-five trucks (but not to exceed one hour).. The tape name and time interval should be noted on the assessment sheet. Downloads of the tape to digital media for storage are also noted here.

The classification verification video (downloaded files section is used to record conversions to digital format for permanent storage the associated file names and intervals are noted here. If the video is recorded digitally, the file name will be recorded here as tape name. The interval sections will only be used if the file is split for later storage. Additional copies of page 3 may be included for additional "tapes" or the remaining digital file names added to the bottom of the page.

*Section 5 – Support Equipment/Structures*

This section is used to identify and record any deficiencies with the supporting equipment that will be reported as needing repair. Document all items whose present condition or degrading condition will eventually adversely affect the operation and/or accuracy of the WIM equipment. Also note any unsafe condition for any person working at or near the area.

### 10.9.1 TRAFFIC SHEET 22A

This sheet identifies the classification video collected for checking the installed scheme. The information recorded includes the time frame of the classification verification samples. Date should be recorded in mm/dd/yy format. Times From and To should be recorded using a 24-hour clock. As video may be recorded on tape or disk, file names for digitally recorded video should be recorded for later reference. File names should include site and date time information.

Classification verification video is a listing of tapes from an assessment including the digital files created from them. File names should include tape, site and date time information.

### 10.9.2 TRAFFIC SHEET 22B

The system accuracy tests recorded on Sheet 22B are only performed at Site Assessments. More complete information on speed, spacing and weight are obtained in the course of a validation. Once the necessary amount of traffic sample video and data has been recorded, it must be reviewed along with the current traffic data downloaded from the controller to determine the classification and weighing accuracy of the WIM equipment.

Speed Accuracy - Use Sheet 20 to record the independent speed, the observed class, the WIM record number, the equipment's class and the equipment's speed of at least one hundred vehicles.

To determine the WIM system's speed accuracy, average the difference in speeds between the speed gun and the speeds reported by the WIM system. Calculate the mean and standard deviation of the differences. The mean difference is the average difference between the observed and WIM speeds for individual vehicles. The standard deviation of the mean uses the mean difference and the individual truck differences. Record the results in the Speed Accuracy item on Sheet 22. Hypothesis testing may be done to determine if the difference is significant.

Record the speed limit posted at or near the site.

From the Sheet 20 speed data; determine the $15^{th}$ and $85^{th}$ percentile values for truck traffic at the site. Record the results under the Speed Range item. Only data for vehicles in FHWA Class 4 and higher is to be used for this data entry.

Spacing Accuracy - Use Sheet 21 to record spacing and weight for a sample of traffic the WIM record number, front axle and GVW weights, and axle B to axle C spacing of at least fifty three-axle tractors from tractor-trailer combinations.

Since the speed accuracy of the system is proportional to spacing accuracy, the average distance reported by the WIM equipment between the drive tandem axles of the sample trucks can be used to estimate the speed accuracy of the system. Record the average B-C axle distance reported by the WIM system for 3-axle tractors on tractor-trailer combinations. Calculate the percentage error of this distance from the industry standard average of 4.25 feet and record this result on Sheet 22.

To determine weight accuracy of the WIM system, average the front axle weights of this sample and record on the sheet. Calculate the percent error from the industry standard of 10,300 lbs or the known average front axle weight based on calibrated data for this site. Record the results in the Speed Accuracy item on Sheet 22.

### 10.9.3 Traffic Sheets 22C, 22D, 22E, 22F

These sheets contain results of equipment specific electronics tests. Complete and attach the appropriate Sheet 22 Addendum for the actual WIM sensors installed at the site (Sheet 22C – Bending Plate/ Weigh Pad, Sheet 22D – Quartz Piezo (Kistler), Sheet 22E – Load Cells, Sheet 22F – Piezo Ceramic). Carefully follow all procedures described in the manufacturers' technical guides for testing. Observe all manufacturers' safety warnings.

Before applying power to the WIM electronics, take several static readings of the WIM system components as well as supporting equipment. Refer to vendor operation and maintenance guides for testing procedures, proper values, and acceptable tolerances. Each component must be disconnected from the equipment or terminal strips to ensure that it is properly isolated before any measurement is taken. Once static measurements have been taken, reconnect all sensors and restore the system power.

Dynamic measurements of each sensor must now be taken. Care should be taken to ensure that all test equipment is used properly. Improper use may result in equipment damage or personal injury. Ensure that proper ground references are used.

## 10.10 Traffic Sheet 23 – WIM System Troubleshooting Outline

This sheet consists of five sections and is used to document the results of potential step-by-step troubleshooting procedures. This is an equipment specific sheet. It serves as a tool by providing a record of tests that are conducted, results of the tests and the conclusions drawn from these results. The proper use of this sheet can greatly reduce redundancy and save time.

This section serves only as a guideline for completing the Sheet 23. Carefully follow all troubleshooting and equipment testing procedures described in the manufacturers' technical guides and observe all manufacturers' safety warnings.

*Step 1 – Problem Description*

This section provides for the documenting of a detailed description of the problem as reported by the agency or others. The more information that can be provided in this section, the easier the problem can be identified and corrected. Use additional sheets of paper and attach, if required.

*Step 2 – System Data Collection*

After collecting all available site-specific system documentation and operating parameters as required, use the blank areas to note any suspicious system operating parameters.

Record all site-specific sensor operating values as required in this section. Use the blank areas to note any suspicious sensor values.

*Step 3 – Finding the Source of the Problem*

This section is used to document specific system tests and draw a conclusion as to the most probable faulty function.

List all symptoms discovered during performance of Steps 1 & 2, then record the most probable faulty function based on the analysis of these symptoms in the space provided.

Indicate the test points that were tested by circling the test point number in the TP# column.

Use the blank space to indicate any suspect readings of these test points. Include the test point number, the expected reading and the actual reading.

Record the most probable faulty component that was concluded based on the analysis of the test performed in the space provided.

*Step 4 – Determining the Corrective Action*

This section is used to provide documentation on the recommended actions that will be required to restore the system to a fully operational state. Include all factors that were considered in determining the corrective action including cost, loss of data, availability of replacement parts and degree of difficulty of the repair. Include explanation of repairs that are not within the scope of the on-site staff's expertise.

*Step 5 – Repairing the System*

This section is used to provide documentation on the actions that were taken to restore the system to a fully operational state.

Include all actions taken, which may include but will not be limited to making changes to the system parameters or adjusting a system hardware setting, or recalibration. Any repairs requiring the replacement or repair of system components must be recommended, but not performed.

Once the corrective action has been performed, the proper operation of the system must be verified. This is done by retaking measurements from suspected faulty components, verifying communications, or observing real time traffic for correct weight and classification reporting. If the symptom remains, or new symptoms have been discovered, the troubleshooting process must be restarted. When proper system operation has been verified the Sheet 15 (3) must be updated.

## 10.11 Traffic Sheet 24 Series – Site Photo Log

These sheets provide a record of the number and description of mandatory and additional photographs that are taken during a site assessment or evaluation. The sheet is identified for use during an assessment or an evaluation or as a blank form used for additional photos by the information provided on the top of the form in the sheet header. This is an equipment-specific form as indicated by use of SPS WIM ID in the header block

The photo number of each photograph is recorded in the Photo # column with respect to the number assigned to that photograph by the photography equipment. This provides easy identification of the photo by office personnel.

### 10.11.1 Traffic Sheet 24A

On the equipment and pavement photo log form, the first twelve photo descriptions are already filled in. These photos must be taken during each site visit. Other photos may be taken and recorded as required.

### 10.11.2 Traffic Sheet 24B

During site validations, all items on truck photo log form are required for each test truck on site, including a photo of the scale used to weigh the test vehicles. This photo is included on the Sheet 19. Provision has been made for six axles on every truck but Truck #1. The truck numbers on this sheet must correspond to those on the Sheet 19 for the same truck. Photos for additional trucks are recorded on an additional Sheet 24B. Additional photos for the same trucks should be recorded on Sheet 24C.

### 10.11.3 Traffic Sheet 24C

Additional photographs during either an assessment or evaluation visit may be required if the discovery of pavement distress, equipment damage, or adverse environmental conditions such as flooded cabinets is made. Sheet 24C is used to track additional photos after Sheets 24A and 24B are filled up or when neither is relevant.

## 10.12 Traffic Sheet 25 Series - Site Audit Photographs

These sheets provide a record of the number and description of expected and site-specific photographs that are taken during audits of WIM equipment installation or calibration.

On most of the photo log forms the description fields are already filled in. This indicates that the photos are expected and should be taken during the audit. Other photos may be taken and recorded as required. Photographs will be downloaded and saved as JPEG files using a standard naming convention.

Ensure that the date and time settings on the digital camera are correct before taking any photos. The photo number of each photograph is recorded in the Photo # column with respect to the number assigned to that photograph by the photography equipment. This provides easy identification of the photo by office personnel. Each photograph is to be uniquely numbered for a visit across all sheets used.

Each photograph listed shall include the following by the time the audit report is completed:

- The number assigned on the Photomap (Traffic Sheet 26X)
- A description of the items illustrated in the photograph
- The filename assigned by the camera
- The filename used for the photograph in the audit report.

### 10.12.1 Traffic Sheet 25A

Sheet 25A has blank description fields and is to be used for recording photos taken in addition to the typical ones or when additional photos are needed for a topical area after the basic photo sheet is filled up.

Additional photographs during either any audit may be taken at the discretion of the auditor and are encouraged but all photos must be recorded. Additional copies of sheets 25B may be submitted as required.

### 10.12.2 Traffic Sheet 25B

Sheet 25B lists all of the general photos that describe the basic site characteristics. It is completed for each separate visit to the site.

#### 10.12.3 Traffic Sheet 25C

Sheet 25C lists the various utilities needed or possibly located in the vicinity of the WIM site. The items listed on it are included in Checklist A-02 activities.

#### 10.12.4 Traffic Sheet 25D

Sheet 25D is associated with the cabinet and its subsystems. The items listed on it are included in Checklist A-02 activities.

#### 10.12.5Traffic Sheet 25E

Sheet 25E focuses on pull boxes. It should also be used for drainage elements. The items listed on it are included in Checklist A-02 activities.

Photographs will be taken of each pull box illustrate the drainage and the relationship between the pull boxes top edge and the surrounding surfaces.

Photographs of drainage outfall locations for bending plate and load cell sensors are appropriate to add to this sheet.

#### 10.12.6Traffic Sheet 25F

Sheet 25F is associated with sensor layout and installation. The information here is supported by Sheet 27A-C. The items listed on it are included in Checklist A-03 activities.

#### 10.12.7Traffic Sheet 25G

Sheet 25G is associated with excavation of sensor slots. The items listed on it are included in Checklist A-03 activities.

#### 10.12.8 Traffic Sheet 25H

During site audits of WIM calibration events, the truck numbers on Sheet 25H must correspond to those for the same trucks on the Sheet 19. Additional photos may be recorded on a blank photo log.

This is part of the Checklist A-04 activities.

### 10.13 Traffic Sheet 26 Series – Photomaps

Photomaps are used in recording the orientation of the camera while taking site audit photographs. . On each of these sheets, a plan view sketch of the subject of each photographed area is drawn. The camera position for each photo is to be indicated by a circle with the Photo # inside while the direction of the camera lens is to be indicated by an arrow extending from the circle. These will be used in completing sheet 27A – 27C.

Additional copies of these photomap sheets may be made if necessary to record large numbers of images and/or camera positions.

It is not necessary to use a photomap for all photographs. Those where the camera position and orientation is self-evident are not required to be recorded on any of these sheets.

#### 10.13.1 TRAFFIC SHEET 26A

Each sensor and loop should be sketched on sheets 26A and labeled with a unique number. This serves as a reference for photos dealing with issues in sensor installation.

Sheet 26A is pre-labeled with the expected position of the upstream and downstream photos.

#### 10.13.2 TRAFFIC SHEET 26B

This sheet is used to document elements in and around the cabinet. It is pre-labeled for the cabinet interior and exterior shots.

#### 10.13.3 TRAFFIC SHEET 26C

This is a blank sheet for any other mapping that needs to be done of photos including trucks if they are very similar in the color or characteristics.

### 10.14 TRAFFIC SHEETS 27 SERIES - SITE AUDIT MEASUREMENTS

These sheets are to be used to record measured loop and WIM sensor positions and dimensions and to check for deviations from acceptable values. Refer to figures Figure 10-1 through Figure 10-6 for definitions of each term in the Measurement field. Refer to Sheet 26A for the sensor and loop labels. Record the value of each measurement for all sensors and loops.

A number of measurement comparisons are listed under the Check fields. If any of these comparisons fails, then the auditor is required to complete a non-compliance report (Sheet 28).

#### 10.14.1 TRAFFIC SHEET 27A

The data sheet contains measurements for WIM sensors and between sensors in the entire array. Label Sensors and Loops on Traffic Sheet 26A. Add any additional measurements.

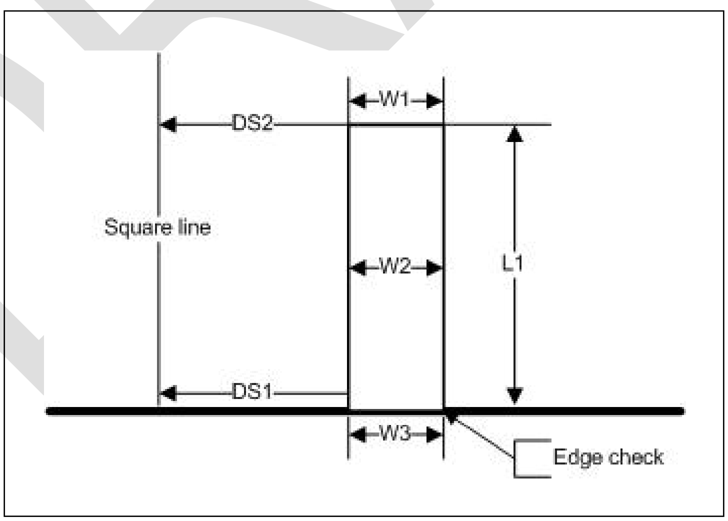


**Figure 10-1 - WIM Sensor Measurement**

Step 1 (using Figure 10-1) -

- ♦ Measure the length (L1) and width (W2) of each WIM sensor.

- ♦ Verify that the sensor layout is perpendicular to the pavement edge by measuring each end of the leading edge of the sensor layout (ds1, ds2) to the square line
- ♦ Verify that they (DS1, DS2) are within one-quarter inch of one another.
- ♦ Measure the width of the sensor layout at each end (W1, W3) and in the middle (W2).
- ♦ Verify that they are within one-quarter inch of one another (The difference between any two does not exceed one-quarter inch).
- ♦ Verify that the outside edge of the sensor is aligned with outside edge of painted lane markings (edge).

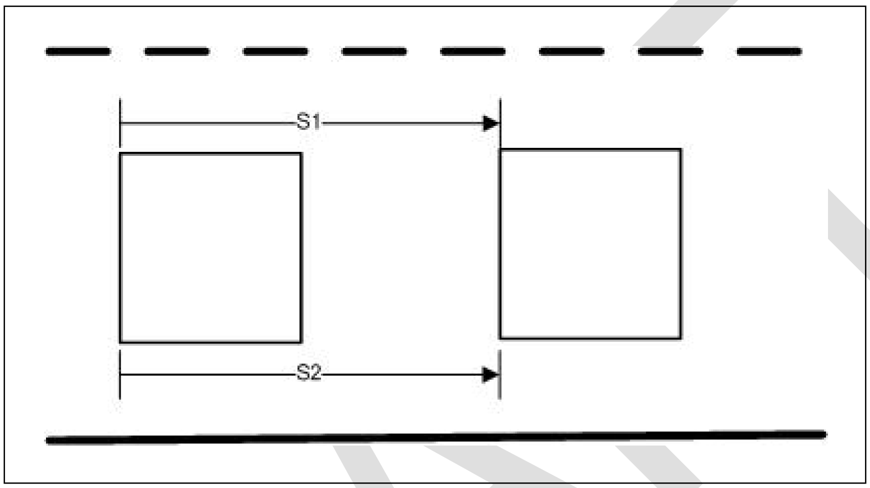


**Figure 10-2 – Loop Distance Measurement**

Step 2 (using Figure 10-2) -

- ♦ Measure the distance from the leading edge of the first loop sensor to the leading edge of the second loop (S1, S2) at the outside ends.
- ♦ Verify that the loops are square in relation to each other (S1=S2).

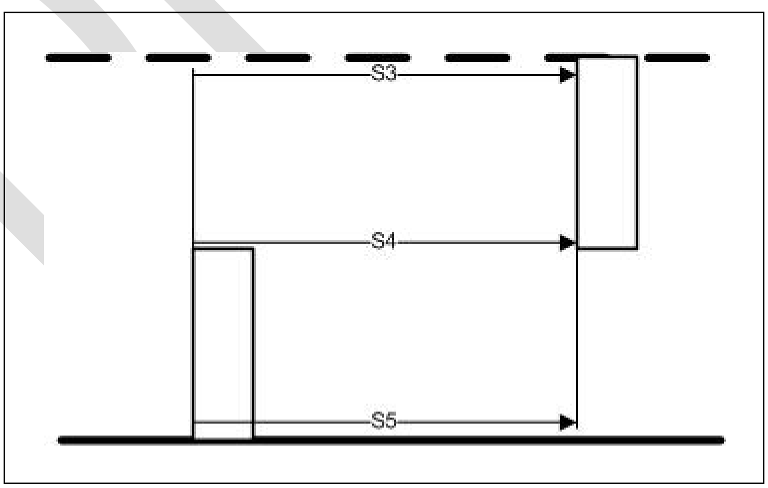


**Figure 10-3 - WIM Distance Measurement**

- Measure the distance from the leading edge of the first WIM sensor to the leading edge of the second WIM sensor at each end (S3, S4, and S5)
- Verify that they are square in relation to one another (S3=S4=S5).

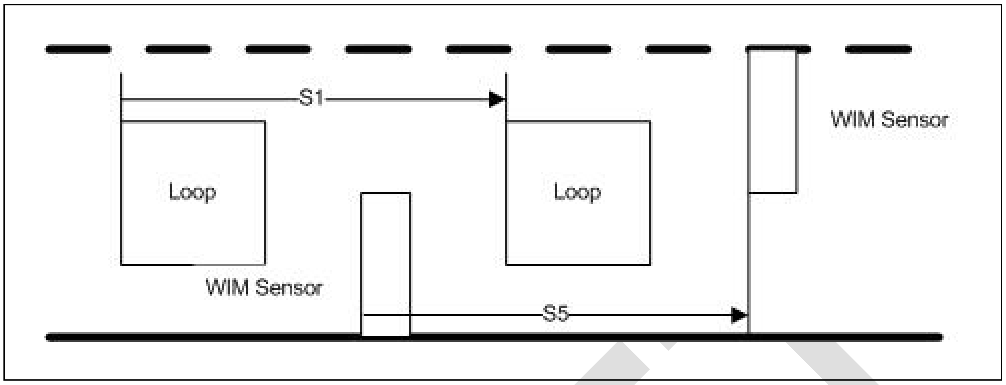


**Figure 10-4 - Loop and WIM Sensor Distance Comparison**

Step 4 (ref Figure 10-4)

- Verify that the measurements taken in steps 2 and 3 (S1 and S5) are identical if there are two loops and two weighing sensors being installed as shown in Figure 10-4 and the loops are being used for secondary speed and spacing measurements.

### 10.14.2 TRAFFIC SHEET 27B

This data sheet is used to verify that the loops are square. All measurements should be made with a steel tape and should be accurate to within one-quarter inch unless otherwise directed.

Specific pre-approval to use circular loops must be provided by the WIM Controller manufacturer and the COTR.

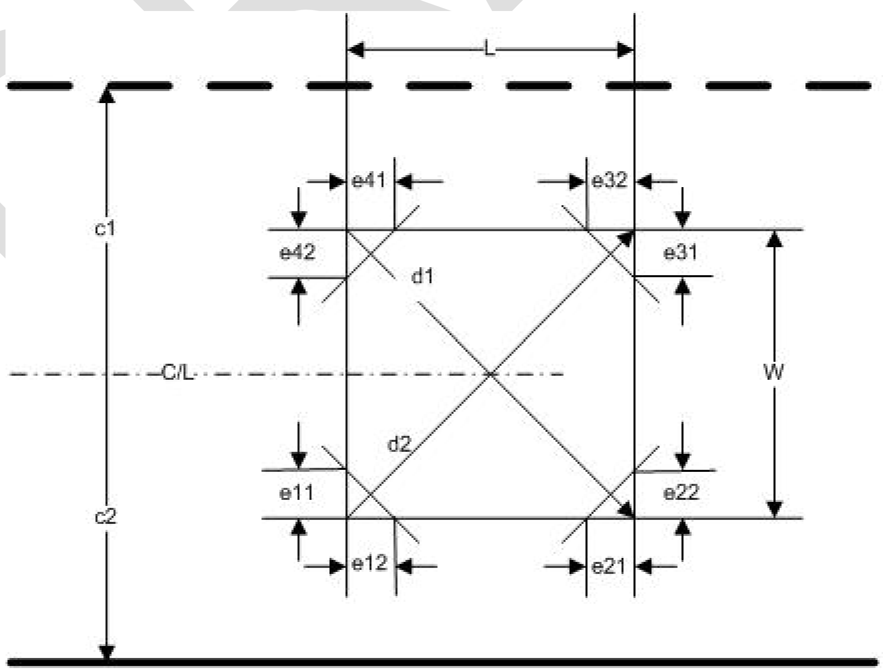

**Figure 10-5 - Loop Measurement Locations**

- Measure the length (L) and width (W).
- Verify that it is square by measuring diagonally (d1, d2) across the loop in each direction.
- Compare these measurements to verify that they are within 1 inch of one another.
- Verify that the loops are centered in the lane by measuring from the inside edge of the painted pavement markings to the center (c1, c2) of the loop
- Compare these values to verify they are within 1 inch of each other.
- Verify that corner cuts are at approximately forty-five degree angles, 6 to 12 inches out from the corners of the loop (e11, e12, e21, e22, e31, e32, e41, e42), and identical for each corner of the loop (e11=e12, e21=e22, e31=e32, e41=e42).

### 10.14.3 TRAFFIC SHEET 27C

The 6-inch ruler is used for sample measurements of each saw cut to verify that the depths shown on the WIM System Installation plan are being properly maintained.

Figure 10-6 illustrates typical depth measurement locations. For loops, depth measurements will be taken every two feet along each cut and at each corner. For WIM sensors, depth measurements will be taken after the saw cutting is completed and prior to excavation.

The WIM sensor channels and recesses will be measured for proper depth at each end and in the middle of the perimeter cuts. All measurements will be recorded in Item. If measurements are taken at other than the suggested locations in Figure 10-6 they should be drawn on Sheet 26A and labeled.

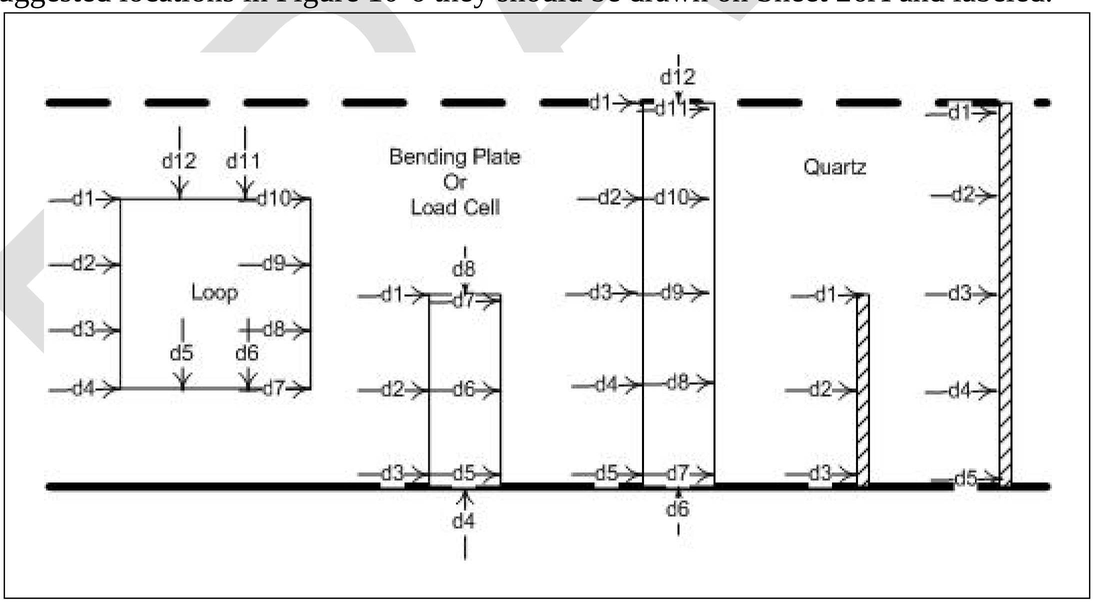


**Figure 10-6 – Suggested Depth Check Locations**

## 10.15 TRAFFIC SHEET 28 – NON COMPLIANCE REPORT

A non-compliance report documents any improper, non-compliant or substandard installation or calibration practices and/or conditions that may potentially cause malfunction or failure of the WIM.

Item 9 provides for specific information regarding the documentation and the section, paragraph, and/or page number of the plans, contract or guidelines that was not followed. Provide a detailed description of the non-compliance issue in Item 10. In Item 11 describe in detail all information regarding the potential equipment failure(s) that may be attributed to the failure of the Contractor or Sub-Contractor to follow the directives of the Installation or Calibration process being audited. Describe any corrective actions that may or could be taken toward resolving the non-compliance issue in Item 12.

The lead Contractor or Sub-Contractor representative on site should sign the report in item 13 to indicate that they were informed of the non-compliance issue. Their signature does not infer admission that they were non-compliant.

The auditor must sign and date the form in Item 14.

### 10.16 Traffic Sheet 29 – Audit Summary

This summary must be completed as soon as possible after completion of the audit. It should include a timeline of activities, deviations from planned activities and discussions of any non-compliant or unfinished activities. As many sheets as necessary may be used for this summary.

The Audit Summary, depending on the specific audit performed, must include the following as required:

- Executive summary of the Support Equipment Installation, WIM System Equipment Installation and/or the WIM System Calibration highlights, findings, and recommendations for any concerns noted during each of these processes.
- Summary of speed and temperature distribution verifications.
- A chronological journal of all installation events.
- A chronological journal of all calibration events.
- A list of contact information for Contractor, Sub-Contractor(s), Manufacturer, Highway Agency and any other agencies represented at the site.

The distribution of truck runs, temperatures and speeds will be included in the Sheet 29. Sample text is as follows:

> Test trucks 1 and 2 made 21 runs each at speeds from 53 to 65 mph. Runs were made in approximately equal numbers at all speeds in the range (i.e. 2 @53 mph, 3@54 mph, 2@55 mph,...4@65 mph.) The temperature range was from 70 to 85 degrees. Runs were made for the full range of speeds at both the low and high ends of the temperature range.

When the Auditor has the final system calibration factors and error percentages information for a preliminary Sheet 16 should be included. The text might look like the following:

> The site is instrumented with a half-lane quartz sensor array and inductive loops. Both the WIM and Classifier were calibrated as a part of a new equipment installation. There were two test trucks. The first was a 3S2 fully loaded with air suspension on both tandems. The second was a 3S2 fully loaded with steel suspension on both tandems. *(Speed and temperature information previously discussed.)* The mean error and standard deviation for GVW was 0.5% and 2.3% respectively. The mean error and standard deviation for single axles was -1.2% and 5.4% respectively. The mean error and standard deviation for tandem axles was 0.2% and 3.4%

respectively. There were no unclassified or misclassified vehicles as a part of the manual classification check that used a two hour sample of the complete vehicle stream.

If the site does not meet the performance parameters, the call to the COTR is documented on this sheet with time, date, and whether a personal contact or a message on voice mail occurred.

### 10.17 Traffic Sheet 30 – Infrared Pavement Temperature Sensor

The IR pavement temperature sensor should have its accuracy verified on a monthly interval. Data shall not be collected using such a sensor unless it has been verified during the previous 60 days.

The procedure that follows is a verification procedure. It should not be used as a calibration procedure. If a temperature sensor fails this procedure it shall be returned to the manufacturer for repair or recalibration, or it shall be replaced with a new sensor.

The following equipment is required for this procedure:

- NIST traceable mercury thermometer ("reference thermometer")
- 4 liter (1 gallon) bucket
- Hot Plate
- Large wooden spoon or paint stirrer
- Medium size cooking pot, approximately 125 mm (5 inches) in diameter
- Leather heat resistant gloves
- Cooking oil
- Ice

Prepare ice water bath. Place ice and water in the 4 liter bucket, and stir with wooden spoon. Stir until the temperature as recorded by the reference thermometer is less than or equal to 1 degree Celsius.

Hold the IR temperature sensor 30 inches above the ice bath. Once the reading from the IR temperature stabilizes, record the temperature from both the IR sensor and the reference thermometer on the Traffic Sheet 30. Stir the ice bath for one minute, and record the measurements from both sensors again. If the recorded temperatures vary by more than 2 degrees Celsius for either data set, stir for another minute and then record both temperatures again. If the IR temperature sensor varies by more than 2 degrees Celsius from the reference thermometer for two or more data sets, then the IR temperature sensor is unacceptable.

Prepare the room temperature water bath. Empty the bucket, and fill with warm tap water, and allow it to sit for 10 minutes. Stir for one minute.

Place the bucket under IR temperature sensor. Once the reading from the IR temperature stabilizes, record the temperature from both the IR sensor and the reference thermometer on Sheet 30. Stir the water for one minute, and record the measurements from both sensors again. If the recorded temperatures vary by more than 2 degrees Celsius for either data set, stir for another minute and then record both temperatures again. If the IR temperature sensor varies by more than 2 degrees Celsius from the reference thermometer for two or more data sets, then the IR temperature sensor is unacceptable.

If the temperature sensor was determined to be unacceptable in the low temperature or ambient temperature check, then it need not be checked at the high temperature. The high temperature check is optional if it is being performed in the field.

Prepare the high temperature oil bath. Pour cooking oil into the cooking pot to a depth of approximately 2 inches. Place cooking pot on hot plate and under the IR temperature sensor. Warm on the hot plate while stirring, until is stabilizes at a temperature of 60 +/- 5 degrees Celsius, as determined using the IR temperature sensor. Place the reference thermometer in the oil bath without letting it touch the sides or bottom of the pan. The individual doing this portion of the test must be wearing heat-resistant gloves.

Record the IR Sensor and reference thermometer temperatures. Wait 5 minutes, and then record both sensors again. If the recorded temperatures vary by more than 2 degrees Celsius for either data set, then, after another 5 minutes, record both temperatures again. If the IR temperature sensor varies by more than 2 degrees Celsius from the reference thermometer for two or more data sets, then the IR temperature sensor is unacceptable.

The results of the most recent validation (pass/fail) should be noted when discussing temperature related items for the evaluation.

## 10.18 Traffic Sheet A – Straightedge Measurements – Longitudinal

This sheet is for recording the result of using a straightedge to check WIM section smoothness. It identifies sequentially each straightedge placement to be tested in the WIM section. For each placement the only information required is whether the disk passed freely beneath the straightedge. The location(s) or pass and the applicable length are not recorded.

## 10.19 Traffic Sheet B – Straightedge Measurements – Transverse

This sheet is for recording the result of using a straightedge to check WIM section smoothness. It identifies sequentially each transverse straightedge location to be tested in the WIM section. For each placement the only information required is whether the disk passed freely beneath the straightedge. The location(s) or pass and the applicable length are not recorded.

## 10.20 WIM QA Checklist Series

Each of the Audit Checklists is completed in the same manner. For each line item, the question must be answered with either a yes or no by checking the appropriate box. No items shall be left unchecked. For elements that are not applicable, write N/A over the Yes and No boxes. A comments section is provided to allow for further annotation or clarification of an answer.

### 10.20.1 Checklist A-01

This checklist is a tool for the auditor to assemble all of the required materials prior to the site visit. It is not a mandatory part of the submission of the audit report.

### 10.20.2Checklist A-02

This checklist is a tool for the auditor to assemble all of the required materials prior to the site visit. It is not a mandatory part of the submission of the audit report.

### 10.20.3 CHECKLIST A-03

This checklist is a tool for the auditor to assemble all of the required materials prior to the site visit. It is not a mandatory part of the submission of the audit report.

### 10.20.4 CHECKLIST A-04

This checklist is a tool for the auditor to assemble all of the required materials prior to the site visit. It is not a mandatory part of the submission of the audit report.

1. * LTPP WIM SITE LOCATION –

   a. Route – _________ b. Milepost – ___________ c. Direction – ☐N ☐S ☐E ☐W

2. SPEED DATA

   * a. Speed limit - _________mph

   b. 15th percentile speed - ________mph   c. 85th percentile speed - _________mph

   d. Speed Range for validation __________________

3. *WIM SITE DESCRIPTION –

   a. Grade – ________ %
   b. Vertical Sag? – ☐ Yes ☐ No
   c. Nearest SPS section upstream/downstream of the site – _________________
   d. Distance from center of site to nearest SPS Section – ___________ ft

4. *LANE CONFIGURATION –

   a. LTPP lane number(s) ______, _______
   b. Lanes in LTPP direction – ______
   c. Lane width – _______ft
   d. Shoulder width – _______ft
   e. Shoulder – ☐ – Curb and gutter ☐ – Paved AC ☐ – Paved PCC ☐ – Unpaved ☐ – None
   f. Median – ☐ – Painted ☐ – Physical barrier ☐ – Grass ☐ – None

5. *PAVEMENT TYPE – ☐ Asphalt ☐ Portland Cement Concrete ☐ AC overlay of PCC

6. PAVEMENT SURFACE CONDITION – Distress Survey

   a. *Date – _____________ Distress Photo Filename – _________________
   b. *Date – _____________ Distress Photo Filename – _________________
   c. Date – _____________ Distress Photo Filename – _________________

7. *SENSOR SEQUENCE – ______________________________________________

8. REPLACEMENT AND/OR GRINDING –

   a. Event 1 – Date ____ / _____ / ______ Description ______________________
   b. Event 2 – Date ____ / _____ / ______ Description ______________________
   c. Event 3 – Date ____ / _____ / ______ Description ______________________

9. *RAMPS OR INTERSECTIONS –

   b. Is there an intersection or heavily used driveway located within 1000 feet upstream of the sensor location? ☐Yes / distance _________ ft ☐ No
   c. Is there an intersection or heavily used driveway located within 1000 feet downstream of the sensor location? ☐Yes / distance ________ ft ☐ No
   d. Is the shoulder routinely used for turns or passing? ☐Yes ☐ No

10. DRAINAGE (Bending plate and load cell systems only) –

   a. Type –
      ☐ – Open to ground ☐ – Pipe to culvert ☐ – None
   b. Clearance under plate – _____.__ in
   c. Is there clearance/access to flush fines from under system? ☐Yes ☐No

11. *CABINET LOCATION AND ACCESS

   a. Located on same side of road as LTPP lane? ☐Yes ☐No
   b. Located in the median? ☐Yes ☐No
   c. Protected behind barrier? ☐Yes ☐No
   d. Distance between cabinet and edge of traveled lane – ______ ft
   e. Distance between cabinet and in-road sensors – _______ ft
   f. Cabinet Type – ________________
   g. Cabinet access controlled by: ☐ LTPP ☐ STATE ☐ JOINT
   h. Contact - name and phone number – _____________________________
   i. Alternate - name and phone number – ____________________________

12. *POWER –

   a. Service type – ☐ Overhead ☐ Underground ☐ Solar
   b. Distance to cabinet from drop – ______ ft
   c. Power service provider – _________________ Phone number – _____________

13. *TELEPHONE –

   a. Service type – ☐ Overhead ☐ Underground ☐ Cellular
   b. Distance to cabinet from drop – ______ ft
   c. Telephone service provider – ______________ Phone Number –_____________
   d. Site Phone number – _________________

14. *SYSTEM COMMUNICATION AND DATA REPORTING –

   a. Software & version nos. – ____________________________________________
   b. Computer connection – ☐ RS232 ☐ Parallel port ☐ USB
      ☐ Other _______________________

15. * TEST TRUCK TURNAROUND –

   a. Total time – _______ minutes b. Total Distance – _____ mi

16. PHOTOS – FILENAME

a. ☐ Power source (drop or panel) ______________________
b. ☐ Power source (solar mast) ______________________
c. ☐ *Phone source (drop) ______________________
d. ☐ Phone source ______________________
e. ☐ *Cabinet exterior ______________________
f. ☐ *Cabinet interior (front) ______________________
g. ☐ *Cabinet interior (back) ______________________
h. ☐ Weight sensors (leading) ______________________
i. ☐ Weight sensors (trailing) ______________________
j. ☐ Classification sensors (leading) ______________________
k. ☐ Classification sensors (trailing) ______________________
l. ☐ Other sensors - ______________________ ______________________
m. ☐ *Upstream direction at sensors on LTPP lane ______________________
n. ☐ *Downstream direction at sensors on LTPP lane ______________________
o. ☐ Upstream asphalt/concrete interface ______________________
p. ☐ Downstream asphalt/concrete interface ______________________

17. SKETCH OF EQUIPMENT LAYOUT –

| Traffic Sheet 17 | *STATE_CODE __ __ |
|---|---|
| **LTPP Traffic Data** | *SPS WIM ID __ __ __ __ |
| **WIM SITE INVENTORY** | *DATE (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 4/20/2009

d. SITE MAP (With truck route) –



COMMENTS –

COMPLETED BY – ______________________________ PHONE – __________________

| Traffic Sheet 18 | *STATE_CODE __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | *SPS PROJECT ID __ __ __ __ |
| **WIM SITE COORDINATION** | *DATE __ __ / __ __ / __ __ __ __ |

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

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

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

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

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

   c. Maintenance –
      - ☐ Contract with purchase – Expiration Date _______________
      - ☐ Separate contract LTPP – Expiration Date _______________
      - ☐ Separate contract State – Expiration Date _______________
      - ☐ State personnel

   d. Calibration –
      - ☐ Vendor
      - ☐ State
      - ☐ LTPP

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

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

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

g. Communication –
   i. Type –
      - ☐ Landline
      - ☐ Cellular
      - ☐ Other ______________________

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

3. PAVEMENT –

a. Type –
   - ☐ Portland Concrete Cement
   - ☐ Asphalt Concrete

b. Allowable rehabilitation activities –
   - ☐ Always new
   - ☐ Replacement as needed
   - ☐ Grinding and maintenance as needed
   - ☐ Maintenance only
   - ☐ No remediation

c. Profiling Site Markings –
   - ☐ Permanent
   - ☐ Temporary

4. ON SITE ACTIVITIES –

a. * WIM Validation Check - advance notice required _____ days / weeks

b. Notice for straightedge and grinding check - ______ days / weeks
   i. On site lead –
      - ☐ State
      - ☐ LTPP

   ii. Accept grinding –
      - ☐ State
      - ☐ LTPP

c. Authorization to calibrate site –
   - ☐ State
   - ☐ LTPP

d. Calibration Routine –
   - ☐ LTPP – ☐ Semi-annually ☐ Annually
     ☐ Every 9-12 months ☐ Every 15-18 months
   - ☐ State per LTPP protocol – ☐ Semi-annually ☐ Annually
   - ☐ State other – __________________________

e. * Test Vehicles
   i. Trucks –
      1st – Air suspension 3S2 ☐ State ☐ LTPP
      2nd – ____________________________ ☐ State ☐ LTPP
      3rd – ____________________________ ☐ State ☐ LTPP
      4th – ____________________________ ☐ State ☐ LTPP

   ii. Loads – ☐ State ☐ LTPP

   iii. Drivers – ☐ State ☐ LTPP

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

____________________________________________________________

g. Access to cabinet
   i. * Personnel with access –
      ☐ State only
      ☐ Joint
      ☐ LTPP

   ii. Physical Access –
      ☐ Key
      ☐ Combination

h. * State personnel required on site – ☐Yes Activities - ___________________ ☐No

i. * Traffic Control Required – ☐Yes Activities - ___________________ ☐No

5. SITE SPECIFIC CONDITIONS –

a. Funds and accountability – ____________________________________________

b. Reports – _______________________________________________________________

c. Other – _______________________________________________________________

6. * CONTACTS –

a. Equipment (operational status, access, etc.) –

   Name: _________________________ Phone: ___________________

   Agency: _______________________________________________

b. Maintenance (Equipment) –

Name: ________________________ Phone: __________________

Agency: ___________________________________________

c. Data Processing and Pre-Visit Data –

Name: ________________________ Phone: __________________

Agency: ___________________________________________

d. Construction Schedule and Verification –

Name: ________________________ Phone: __________________

Agency: ___________________________________________

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

Name: ________________________ Phone: __________________

Agency or Firm: __________________________________________

f. Traffic Control –

Name: ________________________ Phone: __________________

Agency or Firm: ___________________________________________

g. Enforcement Coordination –

Name: ________________________ Phone: __________________

Agency: ___________________________________________

h. Nearest Static Scale –

Name: ________________________ Phone: __________________

Location: ___________________________________________

Completed by: ________________________________ Date: ______________________

| Traffic Sheet 19A – Truck Characteristics | *STATE_CODE __ __ |
|---|---|
| LTPP MONITORED TRAFFIC DATA | *SPS PROJECT ID __ __ __ __ |
| TEST TRUCK # _____ DATA | *DATE (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 4/20/2009

PART I.

1.* FHWA Class ________ 2.* Number of Axles ____ 3. Number of weight days _____

**GEOMETRY**

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

c) Make: _____________ d) Model: _______________ e) ☐ Photo _________________________

5.* Trailer Load Description: ☐ Photo

____________________________________________________________________________

____________________________________________________________________________

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

A to B _____________ B to C _____________ C to D _____________

D to E _____________ E to F _____________

7. Wheelbase (measured A to last) ______________ Computed _____________

8. Bumper-to-bumper ______________________

9. *Kingpin Offset from Axle B (units) ______________ (_feet and tenths / feet and inches__)
[+ is to the rear]

**SUSPENSION**

| Axle | 10. Tire Size | 11.* Suspension Description (leaf, air, no. of leaves, taper or flat leaf, etc.) | | 12. Cold Tire Pressure (psi) a. Left | | b. Right | |
|---|---|---|---|---|---|---|---|
| A | | ______________________ | ☐ Photo | _________ | | _________ | |
| B | | ______________________ | ☐ Photo | ________ | _______ | _______ | _______ |
| C | | ______________________ | ☐ Photo | ________ | _______ | _______ | _______ |
| D | | ______________________ | ☐ Photo | ________ | _______ | _______ | _______ |
| E | | ______________________ | ☐ Photo | ________ | _______ | _______ | _______ |
| F | | ______________________ | ☐ Photo | ________ | _______ | _______ | _______ |

Recorded By ________________________ Verified By __________________________

Page ____ of _____

| Traffic Sheet 19B-1 – Axle Group Scales | *STATE_CODE __ __ |
|---|---|
| LTPP MONITORED TRAFFIC DATA | *SPS PROJECT ID __ __ __ __ |
| TEST TRUCK # _____ DATA | *DATE (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 4/20/2009

PART II AXLES - units - lbs / 100s lbs / kg Day #___

13. *a) Average Pre-Test Loaded weight _______________
*b) Average Post-Test Loaded Weight _______________
*c) Difference Pre-Test – Post-test _______________

Table 13.1 Raw data – Axle scales – pre-test

| Pass | Axle A | Axle B-C | Axle D-E | Axle DEF | | | GVW |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| | | | | | | | |
| Average | | | | | | | |

Table 13.2 Raw data – Axle scales –

| Pass | Axle A | Axle B-C | Axle D-E | Axle DEF | | | GVW |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| | | | | | | | |
| Average | | | | | | | |

Table 13.3 Raw data – Axle scales – post-test

| Pass | Axle A | Axle B-C | Axle D-E | Axle DEF | | | GVW |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| | | | | | | | |
| Average | | | | | | | |

Table 13.4 Running Tire Pressures (psi) – from right to left

| Steering Axle | Axle B | Axle C | Axle D | Axle E | Axle F |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Recorded By ______________________ Verified By ________________________

Page ____ of _____

| Traffic Sheet 19B-2 – Axle Scales | *STATE_CODE __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | *SPS PROJECT ID __ __ __ __ |
| **TEST TRUCK # _____ DATA** | *DATE (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 4/20/2009

PART II AXLES - units - lbs / 100s lbs / kg Day #___

14. *a) Average Pre-Test Loaded weight _______________
*b) Average Post-Test Loaded Weight _______________
*c) Difference Pre-Test – Post-test _______________

Table 14.1 Raw data – Axle scales – pre-test

| Pass | Axle A | Axle B | Axle C | Axle D | Axle E | Axle F | GVW |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| | | | | | | | |
| Average | | | | | | | |

Table 14.2 Raw data – Axle scales –

| Pass | Axle A | Axle B | Axle C | Axle D | Axle E | Axle F | GVW |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| | | | | | | | |
| Average | | | | | | | |

Table 14.3 Raw data – Axle scales – post-test

| Pass | Axle A | Axle B | Axle C | Axle D | Axle E | Axle F | GVW |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| | | | | | | | |
| Average | | | | | | | |

Table 14.4 Running Tire Pressures (psi) – from right to left

| Steering Axle | Axle B | Axle C | Axle D | Axle E | Axle F |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Recorded By ______________________ Verified By ________________________
Page ____ of _____

| Traffic Sheet 19C-0 – Platform Scales | *STATE_CODE __ __ |
|---|---|
| LTPP MONITORED TRAFFIC DATA | *SPS PROJECT ID __ __ __ __ |
| TEST TRUCK # _____ DATA | *DATE (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 4/20/2009

PART II 5-axle Truck Day #___

Table __.4 Running Tire Pressures (psi) – from right to left

| Steering Axle | Axle B | Axle C | Axle D | Axle E |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

5-axle Truck Day #___

Table __.4 Running Tire Pressures (psi) – from right to left

| Steering Axle | Axle B | Axle C | Axle D | Axle E |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

PART II 6-axle Truck Day #___

Table _18.4 Running Tire Pressures (psi) – from right to left

| Steering Axle | Axle B | Axle C | Axle D | Axle E | Axle F |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

6-axle Truck Day #___

Table _18.4 Running Tire Pressures (psi) – from right to left

| Steering Axle | Axle B | Axle C | Axle D | Axle E | Axle F |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Recorded By ______________________ Verified By ________________________

Page ____ of _____

| Traffic Sheet 19C-1 – Long Platform Scale – 5-axle Truck | *STATE_CODE __ __ |
|---|---|
| LTPP MONITORED TRAFFIC DATA | *SPS PROJECT ID __ __ __ __ |
| TEST TRUCK # _____ DATA | *DATE (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 4/20/2009

PART II AXLES - units - lbs / 100s lbs / kg Day #___

15 * a) Average Pre-Test Loaded weight _______________

*b) Average Post-Test Loaded Weight _______________

*c) Difference Pre-Test – Post-test _______________

Table 15.1 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 15.2 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 | |
| | | | | | | | | | | | |
| Avg. | | | | | | | | | | | |

Table 15.3 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 | |
| | | | | | | | | | | | |
| Avg. | | | | | | | | | | | |

Recorded By ________________________ Verified By __________________________

Page ____ of _____

| **Traffic Sheet 19C-2 – Short Platform Scale - Axles – 5-axle Truck** | *STATE_CODE __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | *SPS PROJECT ID __ __ __ __ |
| **TEST TRUCK # _____ DATA** | *DATE (mm/dd/yyyy) _ __ / __ __ / __ __ __ __ |

Rev. 4/20/2009

PART II AXLES - units - lbs / 100s lbs / kg Day #___

16 * a) Average Pre-Test Loaded weight ________________
*b) Average Post-Test Loaded Weight ________________
*c) Difference Pre-Test – Post-test ________________

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

Table 16.2 Axle and GVW computations - pre-test

| Axle A | | Axle B | | Axle C | | Axle D | | Axle E | | GVW | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I | | II-I | | III-II | | V-IV | | VI-V+ II-1 | | II+VI | |
| III-IV | | V-VI+ VII | | VI-VII | | VII-VIII | | VIII | | IX+X | |
| Avg. | | | | | | | | | | | |

Table 16.3 Axle and GVW computations - post-test

| Axle A | | Axle B | | Axle C | | Axle D | | Axle E | | GVW | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I | | II-I | | III-II | | V-IV | | VI-V+ II-1 | | II+VI | |
| III-IV | | V-VI+ VII | | VI-VII | | VII-VIII | | VIII | | IX+X | |
| Avg. | | | | | | | | | | | |

Recorded By ________________________ Verified By __________________________
Page ____ of _____

| **Traffic Sheet 19C-3 – Short Platform Scale – Axle Groups – 5-axle Truck** | *STATE_CODE __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | *SPS PROJECT ID __ __ __ __ |
| **TEST TRUCK # _____ DATA** | *DATE (mm/dd/yyyy) _ __ / __ __ / __ __ __ __ |

Rev. 4/20/2009

PART II AXLES - units - lbs / 100s lbs / kg Day #___

17 * a) Average Pre-Test Loaded weight _______________

*b) Average Post-Test Loaded Weight _______________

*c) Difference Pre-Test – Post-test _______________

Table17.1 Raw Axle and GVW measurements

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

Table 17.2 Raw data – Axle scales – pre-test

| Pass | Axle A | | Axle B-C | | Axle D-E | | GVW | |
|---|---|---|---|---|---|---|---|---|
| 1 | I | | II | | III | | I+II+III | |
| 2 | IV | | V | | VI | | IV+V+VI | |
| 3 | VII | | VIII | | IX | | VII+VIII+IX | |
| Average | | | | | | | | |

Table 17.3 Raw data – Axle scales – pre-test

| Pass | Axle A | | Axle B-C | | Axle D-E | | GVW | |
|---|---|---|---|---|---|---|---|---|
| 1 | I | | II | | III | | I+II+III | |
| 2 | IV | | V | | VI | | IV+V+VI | |
| 3 | VII | | VIII | | IX | | VII+VIII+IX | |
| Average | | | | | | | | |

Recorded By ______________________ Verified By ________________________

Page ____ of _____

| Traffic Sheet 19C-4– Long Platform Scales – Axles 6-axle Truck | *STATE_CODE __ __ |
|---|---|
| LTPP MONITORED TRAFFIC DATA | *SPS PROJECT ID __ __ __ __ |
| TEST TRUCK # _____ DATA | *DATE (mm/dd/yyyy) _ __ / __ __ / __ __ __ __ |

Rev. 4/20/2009

PART II AXLES - units - lbs / 100s lbs / kg Day #___

18 * a) Average Pre-Test Loaded weight _______________

*b) Average Post-Test Loaded Weight _______________

*c) Difference Pre-Test – Post-test _______________

Table 18.1 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 | V | | | |
| A + B + C + D + E + F (1) | VI | | | |
| B + C + D + E + F | VII | | | |
| C + D + E + F | VIII | | | |
| D + E + F | IX | | | |
| E + F | X | | | |
| F | XI | | | |
| A + B + C + D + E + F (2) | XII | | | |
| A + B + C + D + E + F (3) | XIII | | | |

Table 18.2. Axle and GVW computations – pre-test

| Axle | | | | |
|---|---|---|---|---|
| A | I | | VI-VII | |
| B | II-I | | VII-VIII | |
| C | III-II | | VIII-IX | |
| D | IV-III | | IX-X | |
| E | V-IV | | X- XI | |
| F | VI-V | | XI | |
| GVW | VI | | XII | |

Table 18.3. Axle and GVW computations – post-test

| | | | |
|---|---|---|---|
| I | | VI-VII | |
| II-1 | | VII-VIII | |
| III-II | | VIII-IX | |
| IV-III | | IX-X | |
| V-IV | | X-XI | |
| VI-V | | XI | |
| VI | | XII | |

Recorded By ________________________ Verified By __________________________

Page ____ of _____

| Traffic Sheet 20 | *STATE_CODE __ __ |
|---|---|
| LTPP MONITORED TRAFFIC DATA | *SPS PROJECT ID __ __ __ __ |
| SPEED AND CLASSIFICATION STUDIES | *DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 5/18/2004

| WIM speed | WIM class | WIM Record | Obs. Speed | Obs. Class | WIM speed | WIM class | WIM Record | Obs. Speed | Obs. Class |
|---|---|---|---|---|---|---|---|---|---|
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Recorded By ________________________ Verified By __________________________

Page ____ of _____

| | |
|---|---|
| **Traffic Sheet 21A (AXLE LOAD)** | *STATE CODE __ __ |
| **LTPP MONITORED TRAFFIC DATA** | *SPS WIM ID __ __ __ __ |
| **WIM SYSTEM TRUCK RECORDS** | *DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 5/18/2004

| Pvmt. temp | Obs. 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | |
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Recorded By ______________________ Verified By ________________________ Run Set _____________________ Page ___ of ___

| Traffic Sheet 21B (WHEEL LOAD) | *STATE CODE __ __ |
| --- | --- |
| LTPP MONITORED TRAFFIC DATA | *SPS WIM ID __ __ __ __ |
| WIM SYSTEM TRUCK RECORDS | *DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 5/18/2004

| Pvmt temp | Obs. Speed | Truck | Pass | Time | Record No. | WIM Speed | Axle A left/ right weight | Axle B left/ right weight | Axle C left/ right weight | Axle D left/ right weight | Axle E left/ right weight | Axle F left/ right weight | GVW | A-B space | B-C space | C-D space | D-E space | E-F space |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
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Recorded By ________________________ Verified By __________________________ Run Set _____________________Page ___ of ___

| Traffic Sheet 22<br>**LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
|---|---|
| **SITE EQUIPMENT EVALUATION** | STATE ASSIGNED ID __ __ __ __ |
| **LANE # ________** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 4/21/2009

SITE EQUIPMENT INFORMATION

TYPE OF EQUIPMENT ☐ WIM ☐ VC ☐ BOTH

LANE NUMBER ON SITE __________ DIRECTION ON-SITE – ☐ N ☐ S ☐ E ☐ W

VENDOR __________ MODEL __________ SERIAL NO.____________

WEIGHING SENSOR TYPE –

☐ QUARTZ PIEZO ☐ LOAD CELL ☐ WEIGHPAD ☐ PIEZO CERAMIC

SYSTEM SOFTWARE VERSIONS:

CPU ___________

LOOP ___________

PIEZO ___________

WEIGHPAD/ LOAD CELL ___________

COMMUNICATION ___________

GENERAL COMMENTS



Assessor: ______________________ Page ___ of ___

| Traffic Sheet 22<br>**LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
|---|---|
| **SITE EQUIPMENT EVALUATION** | STATE ASSIGNED ID __ __ __ __ |
| **LANE # ________** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 4/21/2009

SITE CONDITIONS

PAVEMENT:

INDICATE ANY DEFICIENCIES THAT MAY AFFECT THE PERFORMANCE OF THE WIM SYSTEM. LIST ALL PHOTOS THAT SUPPORT THE EVALUATION.

IN-ROAD SENSORS:

DESCRIBE ANY DEFICIENCIES REGARDING THE SENSOR INSTALLATION. INDICATE SENSORS THAT SHOW ANY SIGN OF BEING BROKEN, SEVERELY WORN, MISSING, REMOVED OR LOOSE. LIST PHOTOS FOR EACH OCCURANCE.

TRUCK OBSERVATIONS

INDICATE ANY IRREGULAR TRUCK BEHAVIORS SUCH AS BOUNCING, SWERVING, OR BRAKING NEAR THE WEIGHING AREA (WITHIN 130 FEET OR 40 METERS). NOTE THE DISTANCE FROM THE WEIGHING SENSORS.

MINIMUM 15 MINUTE OR 35 TRUCK SAMPLE VIDEO FOR PAVEMENT INTERACTION TAPE: ______________________________

FILE NAME: ____________________ TIME FROM: _______TO: ____________

SUPPORT EQUIPMENT/STRUCTURES



Assessor: _______________________ Page ___ of ___

| | |
|---|---|
| **Traffic Sheet 22**<br>**LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
| **SITE EQUIPMENT EVALUATION** | STATE ASSIGNED ID __ __ __ __ |
| **LANE # ________** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 4/21/2009

INDICATE ANY DEFICIENCIES WITH ANY SITE EQUIPMENT OTHER THAN THE IN-ROAD SENSORS. INCLUDE PHOTOS OF EACH OCCURRENCE.

CABINET/FOUNDATION NONE _____

PULL-BOXES NONE _____

MAST NONE _____

SOLAR PANELS NONE _____

TELEPHONE D-MARK BOX NONE _____

POWER SERVICE BOX NONE _____

GROUNDING NONE _____



SUPPORT EQUIPMENT/STRUCTURES (CONT)

Assessor: ______________________ Page ___ of ___

| Traffic Sheet 22<br>**LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
|---|---|
| **SITE EQUIPMENT EVALUATION** | STATE ASSIGNED ID __ __ __ __ |
| **LANE # ________** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 4/21/2009

CONDUIT NONE _____

________________________________________________________________

________________________________________________________________

STATIC AND DYNAMIC ELECTRONIC EQUIPMENT TESTS

COMPLETE AND ATTACH THE SHEET 22 ADDENDUM APPLICABLE TO THE INSTALLED IN-ROAD EQUIPMENT. IF ONLY LOOPS ARE PRESENT, USE SHEET 22C.

Sheet 22C – Bending Plate/ Weigh Pad
Sheet 22D – Quartz Piezo (Kistler)
Sheet 22E – Load Cells
Sheet 22F – Piezo Ceramic



Assessor: ______________________ Page ___ of ___

| **Traffic Sheet 22A**<br>**LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
|---|---|
| **SITE EQUIPMENT EVALUATION**<br>**- CLASSIFICATION VIDEO** | STATE ASSIGNED ID __ __ __ __ |
| **LANE # ________** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 4/21/2009

CLASSIFICATION VIDEO:

| **Tape/ Disk** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
|---|---|---|---|---|---|---|---|---|
| Date | | | | | | | | |
| From | | | | | | | | |
| To | | | | | | | | |

Disk 1 – File Name: ________________________________

Disk 2 – File Name: ________________________________

Disk 3 – File Name: ________________________________

Disk 4 – File Name: ________________________________

Disk 5 – File Name: ________________________________

Disk 6 – File Name: ________________________________

Disk 7 – File Name: ________________________________

Disk 8 – File Name: ________________________________



Assessor: ______________________

| | |
|---|---|
| **Traffic Sheet 22A**<br>**LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
| **SITE EQUIPMENT EVALUATION**<br>**- CLASSIFICATION VIDEO** | STATE ASSIGNED ID __ __ __ __ |
| **LANE # ________** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 4/21/2009

CLASSIFICATION VERIFICATION VIDEO (DOWNLOADED FILES):

TAPE 1- NAME: ____________________________________________

Interval 1 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 2 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 3 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 4 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 5 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 6 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 7 - FILE: _______________ TIME FROM: _____________ TO: ______________

TAPE 2- NAME: ____________________________________________

Interval 1 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 2 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 3 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 4 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 5 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 6 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 7 - FILE: _______________ TIME FROM: _____________ TO: ______________

TAPE 3- NAME: ____________________________________________

Interval 1 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 2 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 3 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 4 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 5 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 6 - FILE: _______________ TIME FROM: _____________ TO: ______________

Interval 7 - FILE: _______________ TIME FROM: _____________ TO: ______________



Assessor: ______________________

| Traffic Sheet 22B<br>**LTPP MONITORED TRAFFIC DATA** | * STATE CODE<br>* SPS WIM ID | __ __<br>__ __ __ __ |
|---|---|---|
| **SITE EQUIPMENT ASSESSMENT**<br>**SYSTEM ACCURACY** | STATE ASSIGNED ID | __ __ __ __ |
| **LANE # ________** | * DATE: (mm/dd/yyyy) | __ __ / __ __ / __ __ __ __ |

Rev. 4/21/2009

SYSTEM ACCURACY TESTS (Site Assessment Only)

CONDUCT THE FOLLOWING SYSTEM ACCURACY TESTS EITHER ON-SITE OR IN OFFICE.

SPEED ACCURACY – COMPLETE SHEET 20 AND ATTACH

AVERAGE OBSERVED SPEED ________mph     AVERAGE WIM SPEED ________mph

MEAN DIFFERENCE _________ mph     SD of mean _________

SPEED LIMIT ON SITE – ________ mph

SPEED RANGE – $15^{th}$ percentile- ______ mph     $85^{th}$ percentile - _______ mph

SPACING AND WEIGHT – COMPLETE SHEET 21 AND ATTACH

AVERAGE DISTANCE BETWEEN AXLES OF DRIVE TANDEM _________ □FT/ □m

% ERROR FROM 4.25/_____ (from system average) FEET _________ % ERROR

AVERAGE FRONT AXLE WEIGHT FOR CLASS 9 VEHICLES _________ □LBS/□kg

% ERROR FROM 10,300/ __________ (known site value) LBS _________ % ERROR



Assessor: ______________________     Page ___ of ___

| Traffic Sheet 22C – WEIGHPAD<br>LTPP MONITORED TRAFFIC DATA | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
|---|---|
| SITE EQUIPMENT ASSESSMENT | STATE ASSIGNED ID __ __ __ __ |
| LANE # ______ | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 05/21/2004

STATIC EQUIPMENT VALUES (SYSTEM OFF)

POWER

SOLAR PANEL _______ WATTS _______ VDC

EQUIP POWER _______ VAC

BATTERY 1 _______ VDC BATTERY 2 _______ VDC

REGULATED _______ VDC

POWER SUPPLY _______ VDC

SYSTEM INPUT _______ VAC _______ VDC

MODEM POWER _______ VAC _______ VDC

TELEPHONE _______ VDC

LOOP SENSORS

L1 (LEAD) RES _______ Ω; IND _______ μH; SHLD _______ MΩ

L2 (TRAIL) RES _______ Ω; IND _______ μH; SHLD _______ MΩ

WEIGHPAD SENSORS

WP1 (LEAD) INPUT _______ Ω; OUTPUT _______ Ω; SHLD _______ MΩ

WP2 (TRAIL) INPUT _______ Ω; OUTPUT _______ Ω; SHLD _______ MΩ

DYNAMIC EQUIPMENT VALUES (SYSTEM ON)

LOOP SENSORS

L1 (LEAD) FREQ _______ KHz

L2 (TRAIL) FREQ _______ KHz

WEIGHPAD SENSORS

WP1 (LEAD) ZERO POINT _______ mV

WP2 (TRAIL) ZERO POINT _______ mV

NOTES –

______________________________________________________________________

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______________________________________________________________________

Assessor: ______________________

Page ___ of ___

| Traffic Sheet 22D –QUARTZ PIEZO (KISTLER)<br>LTPP MONITORED TRAFFIC DATA | * STATE CODE __ __<br>* SPS PROJECT ID __ __ __ __ |
|---|---|
| SITE EQUIPMENT ASSESSMENT | * STATE ASSIGNED ID __ __ __ __ __ __ |
| LANE #_______ | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ |

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STATIC EQUIPMENT VALUES (SYSTEM OFF)

POWER

SOLAR PANEL _______ WATTS _______ VDC

EQUIP POWER _______ VAC

BATTERY 1 _______ VDC

BATTERY 2 _______ VDC

REGULATED _______ VDC

POWER SUPPLY _______ VDC

SYSTEM INPUT _______ VAC _______ VDC

MODEM POWER _______ VAC _______ VDC

TELEPHONE _______ VDC

LOOP SENSORS

L1 (LEAD) RES _______ Ω; IND _______ µH; SHLD _______ MΩ

L2 (TRAIL) RES _______ Ω; IND _______ µH; SHLD _______ MΩ

KISTLER SENSORS

K1 (LEAD L) RES _______ Ω; CAP _______ ηF

K2 (LEAD ML) RES _______ Ω; CAP _______ ηF

K3 (LEAD MR) RES _______ Ω; CAP _______ ηF

K4 (LEAD R) RES _______ Ω; CAP _______ ηF

K5 (TRAIL L) RES _______ Ω; CAP _______ ηF

K6 (TRAIL ML) RES _______ Ω; CAP _______ ηF

K7 (TRAIL MR) RES _______ Ω; CAP _______ ηF

K8 (TRAIL R) RES _______ Ω; CAP _______ ηF



Assessor: ______________________

Page ___ of ___

| Traffic Sheet 22D –QUARTZ PIEZO (KISTLER)<br>LTPP MONITORED TRAFFIC DATA | * STATE CODE __ __<br>* SPS PROJECT ID __ __ __ __ |
|---|---|
| **SITE EQUIPMENT ASSESSMENT** | * STATE ASSIGNED ID __ __ __ __ __ __ |
| **LANE #_______** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ |

Rev. 05/21/2004

DYNAMIC EQUIPMENT VALUES (SYSTEM ON)

LOOP SENSORS

L1 (LEAD) FREQ _______ KHz

L2 (TRAIL) FREQ _______ KHz

KISTLER SENSORS

DUE TO THE INCOMPATABILITY OF THE KISTLER QUARTZ SENSOR AND STANDARD TEST EQUIPMENT, DYNAMIC TESTING IS NOT RECOMMENDED.

NOTES –

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Assessor: ______________________ Page ___ of ___

| **Traffic Sheet 22E – LOAD CELLS**<br>**LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
|---|---|
| **SITE EQUIPMENT ASSESSMENT** | STATE ASSIGNED ID __ __ __ __ |
| **LANE # _____** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

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STATIC EQUIPMENT VALUES (SYSTEM OFF)

POWER

SOLAR PANEL _______ WATTS _______ VDC

EQUIP POWER _______ VAC

BATTERY 1 _______ VDC

BATTERY 2 _______ VDC

REGULATED _______ VDC

POWER SUPPLY _______ VDC

SYSTEM INPUT _______ VAC _______ VDC

MODEM POWER _______ VAC _______ VDC

TELEPHONE _______ VDC

LOOP SENSORS

L1 (LEAD) RES _______ Ω; IND _______ μH; SHLD _______ MΩ

L2 (TRAIL) RES _______ Ω; IND _______ μH; SHLD _______ MΩ

LOAD CELL SENSORS

LEAD PLATFORM

SENSOR 1 INPUT _______ Ω; OUTPUT _______ Ω; SHLD _______ MΩ

SENSOR 2 INPUT _______ Ω; OUTPUT _______ Ω; SHLD _______ MΩ

SENSOR 3 INPUT _______ Ω; OUTPUT _______ Ω; SHLD _______ MΩ

TRAILING PLATFORM

SENSOR 1 INPUT _______ Ω; OUTPUT _______ Ω; SHLD _______ MΩ

SENSOR 2 INPUT _______ Ω; OUTPUT _______ Ω; SHLD _______ MΩ

SENSOR 3 INPUT _______ Ω; OUTPUT _______ Ω; SHLD _______ MΩ



Assessor: ______________________

| Traffic Sheet 22E – LOAD CELLS<br>LTPP MONITORED TRAFFIC DATA | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
|---|---|
| **SITE EQUIPMENT ASSESSMENT** | STATE ASSIGNED ID __ __ __ __ |
| **LANE # _____** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

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DYNAMIC EQUIPMENT VALUES (SYSTEM ON)

LOOP SENSORS

L1 (LEAD) FREQ _______ KHz

L2 (TRAIL) FREQ _______ KHz

LOAD CELL SENSORS

LEAD PLATFORM

SENSOR 1 STATIC OUTPUT _______ mV

SENSOR 2 STATIC OUTPUT _______ mV

SENSOR 3 STATIC OUTPUT _______ mV

TRAILING PLATFORM

SENSOR 1 STATIC OUTPUT _______ mV

SENSOR 2 STATIC OUTPUT _______ mV

SENSOR 3 STATIC OUTPUT _______ mV

NOTES –

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Assessor: ______________________ Page ___ of ___

| | |
|---|---|
| **Traffic Sheet 22F – PIEZO**<br>**LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
| **SITE EQUIPMENT ASSESSMENT** | STATE ASSIGNED ID __ __ __ __ |
| **LANE # _____** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

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## STATIC EQUIPMENT VALUES (SYSTEM OFF)

POWER

SOLAR PANEL _______ WATTS _______ VDC

EQUIP POWER _______ VAC

BATTERY 1 _______ VDC

BATTERY 2 _______ VDC

REGULATED _______ VDC

POWER SUPPLY _______ VDC

SYSTEM INPUT _______ VAC _______ VDC

MODEM POWER _______ VAC _______ VDC

TELEPHONE _______ VDC

LOOP SENSORS

L1 (LEAD) RES _______ Ω; IND _______ μH; SHLD _______ MΩ

L2 (TRAIL) RES _______ Ω; IND _______ μH; SHLD _______ MΩ

PIEZO SENSORS

PZ1 (LEAD) RES _______ Ω; CAP _______ ηF

PZ2 RES _______ Ω; CAP _______ ηf

PZ3 RES _______ Ω; CAP _______ ηf

PZ4 (TRAIL) RES _______ Ω; CAP _______ ηf

## DYNAMIC EQUIPMENT VALUES (SYSTEM ON)

LOOP SENSORS

L1 (LEAD) FREQ _______ KHz

L2 (TRAIL) FREQ _______ KHz

Assessor: ______________________

| Traffic Sheet 22F – PIEZO<br>LTPP MONITORED TRAFFIC DATA | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
|---|---|
| **SITE EQUIPMENT ASSESSMENT** | STATE ASSIGNED ID __ __ __ __ |
| **LANE # _____** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

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PIEZO SENSORS

PZ1 (LEAD) AMPLITUDE (CLASS 9) _______ mV

PZ2 AMPLITUDE (CLASS 9) _______ mV

PZ3 AMPLITUDE (CLASS 9) _______ mV

PZ4 (TRAIL) AMPLITUDE (CLASS 9) _______ mV

NOTES –

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Assessor: ______________________ Page ___ of ___

| Traffic Sheet 23<br>LTPP MONITORED TRAFFIC DATA | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
|---|---|
| **WIM SYSTEM TROUBLESHOOTING** | STATE ASSIGNED ID __ __ __ __ __ __ |
| **SINGLE LANE** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

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## STEP 1 – PROBLEM DESCRIPTION

PROVIDE A DETAILED DESCRIPTION OF THE PROBLEM.

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

## STEP 2 – COLLECT SYSTEM DATA

### 2A – SYSTEM PARAMETERS

REVIEW ALL EQUIPMENT OPERATIONAL PARAMETERS SUCH AS CLASSIFICATION ALGORITHMS, DATE/TIME, WEIGHT AND SPEED/SPACING ERROR COMPENSATION FACTORS, AS WELL AS SENSOR LANE ASSIGNMENTS AND THRESHOLD SETTINGS.

MAKE NOTE OF ANY SUSPECT VALUES. DO NOT CHANGE ANY VALUES AT THIS TIME.

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

### 2B – DOWNLOAD SYSTEM DATA

DOWNLOAD SYSTEM TRAFFIC DATA FOR THE DAY OR TIME PERIOD IN QUESTION. SITE PROBLEMS THAT CAN ONLY BE DETERMINED BY REVIEWING DATA FILES WILL MOST LIKELY REQUIRE A SECOND VISIT UNLESS THE FILES CAN BE PROCESSED ON SITE.

**2C – RECORD SYSTEM DIAGNOSTIC MODE VALUES**

RECORD ALL SENSOR VALUES GIVEN IN THE SYSTEMS' DIAGNOSTIC MODE FOR THE LANE BEING INVESTIGATED IF AVAILABLE. MAKE NOTE OF ANY DEFICIENCIES OR SUSPECT OR INCONSISTENT VALUES.

LOOP SENSORS

| LOOP | VALUE |
|---|---|
| LEADING | |
| TRAILING | |

WEIGHPAD/LOAD CELL SENSORS

| SENSOR | VALUE |
|---|---|
| LEADING/SENSOR 1 | |
| LEADING/SENSOR 2 | |
| LEADING/SENSOR 3 | |
| TRAILING/SENSOR 1 | |
| TRAILING/SENSOR 2 | |
| TRAILING/SENSOR 3 | |

PIEZO SENSORS

| PIEZO | VALUE |
|---|---|
| LEADING | |
| 2nd | |
| 3rd | |
| TRAILING | |

Assessor ____________________________

KISTLER QUARTZ SENSORS

| SENSOR | VALUE |
|---|---|
| LEADING | |
| TRAILING | |

TEMPERATURE

___________

**2D – ANALYZE THE INFORMATION COLLECTED**

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

**STEP 3 – FINDING THE SOURCE OF THE PROBLEM**

**3A – PROBABLE FAULTY FUNCTION**

LIST THE DEFICIENCIES DISCOVERED IN STEPS 1 & 2 BELOW. INDICATE THEIR ASSOCIATED WIM SYSTEM PRIMARY FUNCTIONS (POWER, COMMUNICATIONS, WEIGHT & CLASSIFICATION, EC.)

| SYMPTOM | FUNCTION |
|---|---|
| | |
| | |
| | |
| | |

BASED ON THE SYMPTOMS LISTED ABOVE, MAKE A CONCLUSION AS TO THE MOST PROBABLE FAULTY SYSTEM FUNCTION. ADD ANY CLARIFYING NOTES.

MOST PROBABLE FAULTY FUNCTION

_______________________________

**3B – FAULTY COMPONENT**

USE THE STANDARD EQUIPMENT MAINTENANCE FORM (SHEET 22) TO RECORD ALL SYSTEM COMPONENT STATIC AND DYNAMIC VALUES USING THE TEST POINTS INDICATED BELOW FOR THE SYSTEM FUNCTION IN QUESTION.

| TP# | TEST POINT DESCRIPTION | SYSTEM FUNCTION |
|---|---|---|
| 1 | WIM SYSTEM POWER INPUT | POWER |
| 2 | DC MODEM INPUT | POWER/ COMMUNICATION |
| 3 | TEL SURGE SUPPRESSOR OUTPUT | COMMUNICATION |
| 4 | TEL TERMINAL STRIP OUTPUT | COMMUNICATION |
| 5 | TEL D-MARK BOX OUTPUT | COMMUNICATION |
| 6 | SENSOR TERMINAL STRIP INPUTS | CLASSIFICATION AND WEIGHING |
| 7 | PULL BOX INPUTS | CLASSIFICATION AND WEIGHING |
| 8 | DC POWER TERMINAL STRIP OUTPUTS | POWER |
| 9 | DC REGULATOR OUTPUT | POWER |
| 10 | BATTERY OUTPUT | POWER |
| 11 | SOLAR SURGE SUPPRESSOR OUPUT | POWER |
| 12 | SOLAR PANEL OUPUT | POWER |
| 13 | AC POWER TERMINAL STRIP | POWER |
| 14 | AC SERVICE DROP OUTPUT | POWER |
| 15 | AC CIRCUIT BREAKER OUTPUT | POWER |
| 16 | AC OUTLET OUTPUT | POWER |
| 17 | EXTERNAL POWER SUPPLY OUTPUT | POWER |

DESCRIBE ANY SUSPECT TEST RESULTS:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

BASED ON THE TEST READINGS MADE, DRAW A CONCLUSION AS TO THE MOST PROBABLE FAULTY COMPONENT AND INDICATE BELOW.

MOST PROBABLE FAULTY COMPONENT:

___________________________________

**STEP 4 – DETERMINE THE CORRECTIVE ACTION**

CONSIDERING ALL FACTORS ASSOCIATED WITH THE REPAIR OF THE FAULTY COMPONENT, DETERMINE THE CORRECTIVE ACTION.

DESCRIBE THE CORRECTIVE ACTIONS TAKEN BELOW:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

**STEP 5 – REPAIRING THE SYSTEM**

| Traffic Sheet 23<br>LTPP MONITORED TRAFFIC DATA | * STATE CODE __ __<br>* SPS WIM ID __ __ __ __ |
|---|---|
| **WIM SYSTEM TROUBLESHOOTING** | STATE ASSIGNED ID __ __ __ __ __ __ |
| **SINGLE LANE** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

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DESCRIBE THE ACTIONS TAKEN TO REPAIR THE SYSTEM, OR MAKE RECOMMENDATIONS ON THE REPAIRS THAT NEED TO BE TAKEN TO CORRECT THE SYSTEM DEFICIENCY:

____________________________________________

____________________________________________

____________________________________________

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Assessor ____________________________

| Traffic Sheet 24A | * STATE CODE __ __ |
|---|---|
| LTPP MONITORED TRAFFIC DATA | * SPS WIM ID __ __ __ __ |
| SITE PHOTO LOG - EQUIPMENT AND PAVEMENT | * DATE: (mm/dd/yyyy __ __ / __ __ / __ __ __ __ |

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| Item | Photo # | Description |
|---|---|---|
| 1 | | Power Source / Solar Panel |
| 2 | | Solar Mast |
| 3 | | Telephone Source |
| 4 | | Modem |
| 5 | | Cabinet Exterior |
| 6 | | Cabinet Interior (front) |
| 7 | | Cabinet Interior (back) |
| 8 | | Weight Sensor (Leading) – configuration order # ____ |
| 9 | | Weight Sensor (Trailing) – configuration order # ____ |
| 10 | | Classification Sensor (Leading) – configuration order # ____ |
| 11 | | Classification Sensor (Trailing) – configuration order # ____ |
| 12 | | Loop Sensor (Leading) – configuration order # ____ |
| 13 | | Loop Sensor (Trailing) – configuration order # ____ |
| 14 | | Upstream from Site |
| 15 | | Downstream from Site |
| 16 | | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |
| 21 | | |
| 22 | | |
| 23 | | |
| 24 | | |
| 25 | | |

Photographer ________________________

| Traffic Sheet 24B | * STATE CODE __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | * SPS WIM ID __ __ __ __ |
| **SITE PHOTO LOG – TRUCKS** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

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| Item | Photo # | Description |
|---|---|---|
| 1 | | Tractor, Truck #1 |
| 2 | | Trailer/Load, Truck #1 |
| 3 | | Kingpin Offset, Truck #1 |
| 4 | | Suspension A, Truck #1 |
| 5 | | Suspension B, Truck #1 |
| 6 | | Suspension C, Truck #1 |
| 7 | | Suspension D, Truck #1 |
| 8 | | Suspension E, Truck #1 |
| 9 | | |
| 10 | | Tractor, Truck #2 |
| 11 | | Trailer/Load, Truck #2 |
| 12 | | Kingpin Offset, Truck #2 |
| 13 | | Suspension A, Truck #2 |
| 14 | | Suspension B, Truck #2 |
| 15 | | Suspension C, Truck #2 |
| 16 | | Suspension D, Truck #2 |
| 17 | | Suspension E, Truck #2 |
| 18 | | Suspension F, Truck #2 |
| 19 | | Tractor, Truck #3 |
| 20 | | Trailer/Load, Truck #3 |
| 21 | | Kingpin Offset, Truck #3 |
| 22 | | Suspension A, Truck #3 |
| 23 | | Suspension B, Truck #3 |
| 24 | | Suspension C, Truck #3 |
| 25 | | Suspension D, Truck #3 |
| 26 | | Suspension E, Truck #3 |
| 27 | | Suspension F, Truck #3 |
| 28 | | Scale Photo |

Photographer ____________________________

| | |
|---|---|
| **Traffic Sheet 24C** | * STATE CODE __ __ |
| **LTPP MONITORED TRAFFIC DATA** | * SPS WIM ID __ __ __ __ |
| **SITE PHOTO LOG – _____________** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

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| Item | Photo # | Description |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | | |
| 16 | | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |
| 21 | | |
| 22 | | |
| 23 | | |
| 24 | | |
| 25 | | |



Photographer _________________________

| Traffic Sheet 25A | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __ |
| **SITE AUDIT PHOTOGRAPHS** | * SECTION ID __ __ __ __ |

Rev. 7/21/2005

| | |
|---|---|
| 1. Contractor | 2. Audit No.: |
| 3. Contract No.: | 4. Audit Date: |
| 5. Location: | 6. Audit Type: |
| 7. Installation Sub-Contractor: | |
| 8. Auditor/ Organization: | |

9. Photographs:

| Photo # | Description | Filename (Camera/CD-ROM) |
|---|---|---|
| | | |
| | | |
| | | |
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| | | |
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| | | |

10. Auditor's Signature........................................................ Date.................... Sheet ___ of ____

| Traffic Sheet 25B | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| LTPP MONITORED TRAFFIC DATA | * STATE CODE __ __ |
| SITE AUDIT PHOTOGRAPHS – Overall Site | * SECTION ID __ __ __ __ |

Rev. 7/21/2005

| | |
|---|---|
| 1. Contractor: | 2. Audit No.: |
| 3. Contract No.: | 4. Audit Date: |
| 5. Location: | 6. Audit Type: |
| 7. Installation Sub-Contractor: | |
| 8. Auditor/ Organization: | |

9. Photographs:

| Photo # | Description | Filename (Camera/CD-ROM) |
|---|---|---|
| 1 | Power Source | |
| 2 | Telephone Source | |
| 3 | Cabinet Exterior | |
| 4 | Cabinet Interior | |
| 5 | Weight Sensor (Leading or Left) | |
| 6 | Weight Sensor (Trailing or Right) | |
| 7 | Loop Sensor (Leading) | |
| 8 | Loop Sensor (Trailing) | |
| 9 | Downstream from Site | |
| 10 | Upstream from Site | |
| | | |
| | | |
| | | |
| | | |
| | | |

10. Auditor's Signature....................................................... Date.................... Sheet ___ of ____

| Traffic Sheet 25C | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| LTPP MONITORED TRAFFIC DATA | * STATE CODE __ __ |
| SITE AUDIT PHOTOGRAPHS – Checklist A-02 - Utilities | * SECTION ID __ __ __ __ |

Rev. 12/13/2005

| | |
|---|---|
| 1. Contractor: | 2. Audit No.: |
| 3. Contract No.: | 4. Audit Date: |
| 5. Location: | 6. Audit Type: |
| 7. Installation Sub-Contractor: | |
| 8. Auditor/ Organization: | |

9. Photographs:

| Photo # | Description | Filename (Camera/CD-ROM) |
|---|---|---|
| | Electrical utility markings | |
| | Phone lines markings | |
| | Cable markings | |
| | Water line markings | |
| | Sewer Line markings | |
| | Gas Lines markings | |
| | Electrical components - | |
| | Electrical components - | |
| | Electrical box | |
| | Phone box | |
| | Solar panel | |
| | Solar panel fastening hardware | |
| | Solar panel service pole | |
| | | |
| | | |

10. Auditor's Signature....................................................... Date.................... Sheet ___ of ____

| Traffic Sheet 25D | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __ |
| **SITE AUDIT PHOTOGRAPHS – Checklist A-02 - Cabinet** | * SECTION ID __ __ __ __ |

Rev. 12/13/2005

| | |
|---|---|
| 1. Contractor: | 2. Audit No.: |
| 3. Contract No.: | 4. Audit Date: |
| 5. Location: | 6. Audit Type: |
| 7. Installation Sub-Contractor: | |
| 8. Auditor/ Organization: | |

9. Photographs:

| Photo # | Description | Filename (Camera/CD-ROM) |
|---|---|---|
| | Cabinet exterior door and lock | |
| | Cabinet exterior - grounding | |
| | Cabinet foundation – right rear | |
| | Cabinet foundation – left front | |
| | Cabinet foundation - | |
| | Cabinet interior ventilation - | |
| | Cabinet interior ventilation - | |
| | Cabinet interior –light | |
| | Cabinet interior – outlets | |
| | Cabinet interior – circuit breaker | |
| | Cabinet interior – surge suppressor | |
| | | |
| | | |
| | | |
| | | |

10. Auditor's Signature....................................................... Date.................... Sheet ___ of ____

| Traffic Sheet 25E | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __ |
| **SITE AUDIT PHOTOGRAPHS – Checklist A-02 - Hardware** | * SECTION ID __ __ __ __ |

Rev. 12/13/2005

| | |
|---|---|
| 1. Contractor: | 2. Audit No.: |
| 3. Contract No.: | 4. Audit Date: |
| 5. Location: | 6. Audit Type: |
| 7. Installation Sub-Contractor: | |
| 8. Auditor/ Organization: | |

9. Photographs:

| Photo # | Description | Filename (Camera/CD-ROM) |
|---|---|---|
| | Pull box 1 – drainage | |
| | Pull box 1 – top and surface | |
| | Pull box 2 – drainage | |
| | Pull box 2 – top and surface | |
| | | |
| | | |
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| | | |

10. Auditor's Signature....................................................... Date.................... Sheet ___ of ____

| Traffic Sheet 25F | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| LTPP MONITORED TRAFFIC DATA | * STATE CODE __ __ |
| SITE AUDIT PHOTOGRAPHS – Checklist A-03 - Layout | * SECTION ID __ __ __ __ |

Rev. 7/21/2005

| | |
|---|---|
| 1. Contractor: | 2. Audit No.: |
| 3. Contract No.: | 4. Audit Date: |
| 5. Location: | 6. Audit Type: |
| 7. Installation Sub-Contractor: | |
| 8. Auditor/ Organization: | |

9. Photographs:

| Photo # | Description | Filename (Camera/CD-ROM) |
|---|---|---|
| | Square line layout | |
| | Loop 1 layout | |
| | Loop 2 layout | |
| | Sensor 1 layout | |
| | Sensor 2 layout | |
| | Layout looking upstream | |
| | Layout looking downstream | |
| | Saw cutting loop 1 | |
| | Saw cutting loop 2 | |
| | Saw cutting sensor 1 | |
| | Saw cutting sensor 2 | |
| | Representative depth loop 1 | |
| | Representative depth loop 2 | |
| | Representative depth sensor 1 | |
| | Representative depth sensor 2 | |

10. Auditor's Signature....................................................... Date.................... Sheet ___ of ____

| Traffic Sheet 25G | * STATE ASSIGNED ID _ __ __ _ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __ |
| **SITE AUDIT PHOTOGRAPHS – Checklist A-03 – Sensor Excavation** | * SECTION ID __ __ __ __ |

Rev. 12/13/2005

| | |
|---|---|
| 1. Contractor: | 2. Audit No.: |
| 3. Contract No.: | 4. Audit Date: |
| 5. Location: | 6. Audit Type: |
| 7. Installation Sub-Contractor: | |
| 8. Auditor/ Organization: | |

9. Photographs:

| Photo # | Description | Filename (Camera/CD-ROM) |
|---|---|---|
| | Loop 1 excavated 1 | |
| | Loop 1 excavated 2 | |
| | Loop 1 excavated 3 | |
| | Loop 1 excavated 4 | |
| | Loop 2 excavated 1 | |
| | Loop 2 excavated 2 | |
| | Loop 3 excavated 3 | |
| | Loop 4 excavated 4 | |
| | Sensor 1 excavated 1 | |
| | Sensor 1 excavated 2 | |
| | Sensor 2 excavated 1 | |
| | Sensor 2 excavated 2 | |
| | | |
| | | |
| | | |

10. Auditor's Signature....................................................... Date.................... Sheet ___ of ____

| | |
|---|---|
| **Traffic Sheet 25H** | * STATE ASSIGNED ID __ __ __ __ |
| **LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __ |
| **SITE AUDIT PHOTOGRAPHS – Checklist A-04** | * SECTION ID __ __ __ __ |

Rev. 7/21/2005

| | |
|---|---|
| 1. Contractor: | 2. Audit No.: |
| 3. Contract No.: | 4. Audit Date: |
| 5. Location: | 6. Audit Type: |
| 7. Installation Sub-Contractor: | |
| 8. Auditor/ Organization: | |

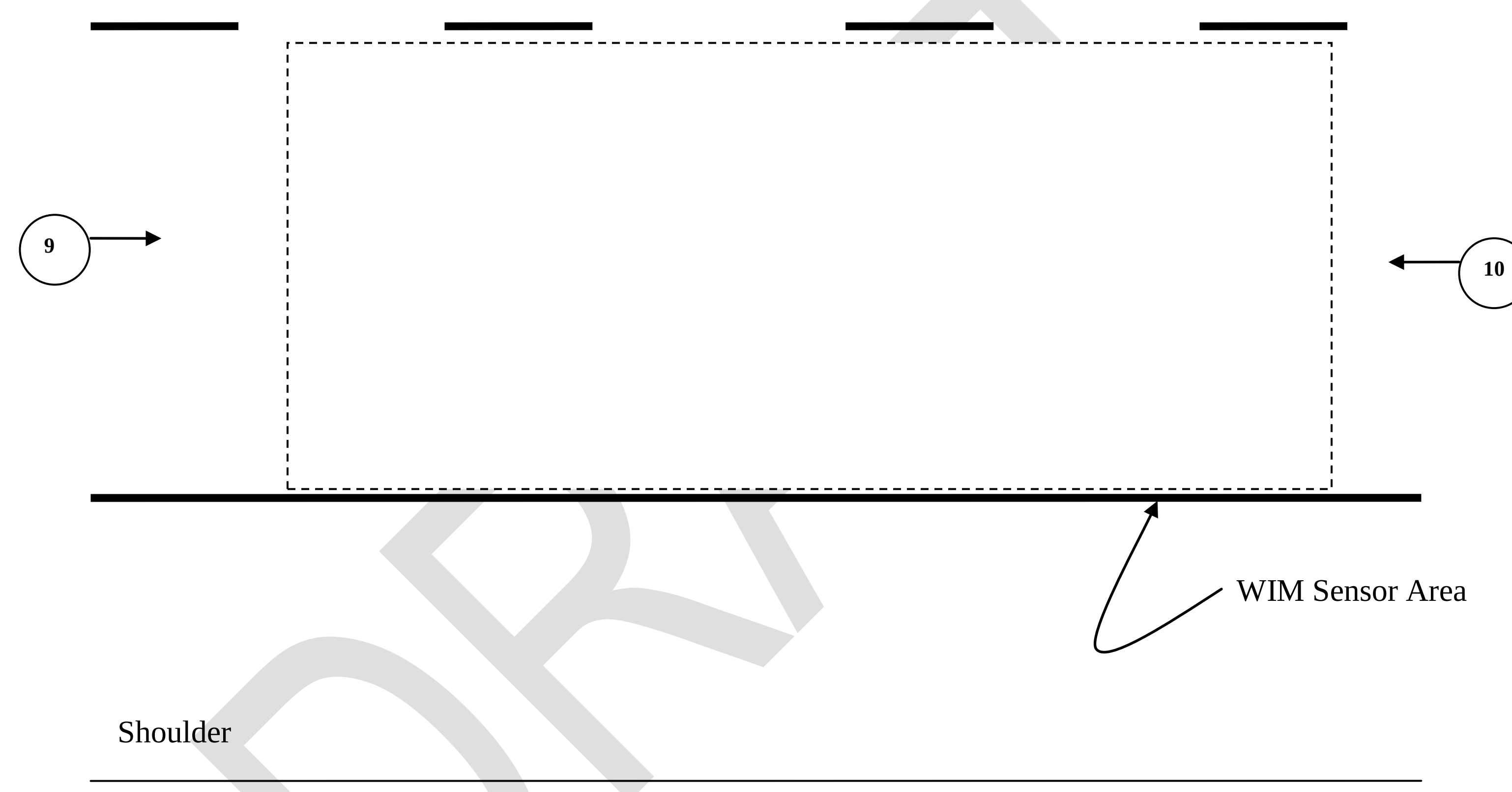
9. Photographs:

| **Photo #** | **Description** | **Filename (Camera/CD-ROM)** |
|---|---|---|
| | Truck 1 – tractor | |
| | Truck 1 – trailer | |
| | Truck 1 – steering axle suspension | |
| | Truck 1 – drive axle suspension | |
| | Truck 1 – trailer axle suspension | |
| | Truck 1 – load | |
| | Truck 2 – tractor | |
| | Truck 2 – trailer | |
| | Truck 2 – steering axle suspension | |
| | Truck 2 – drive axle suspension | |
| | Truck 2 – trailer axle suspension | |
| | Truck 2 – load | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

10. Auditor's Signature....................................................... Date.................... Sheet ___ of ____

| | |
|---|---|
| **Traffic Sheet 26A** | * STATE ASSIGNED ID __ __ __ __ |
| **LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __ |
| **PHOTOMAP OF IN-ROAD SENSORS** | * SECTION ID __ __ __ __ |

Rev. 7/21/2005

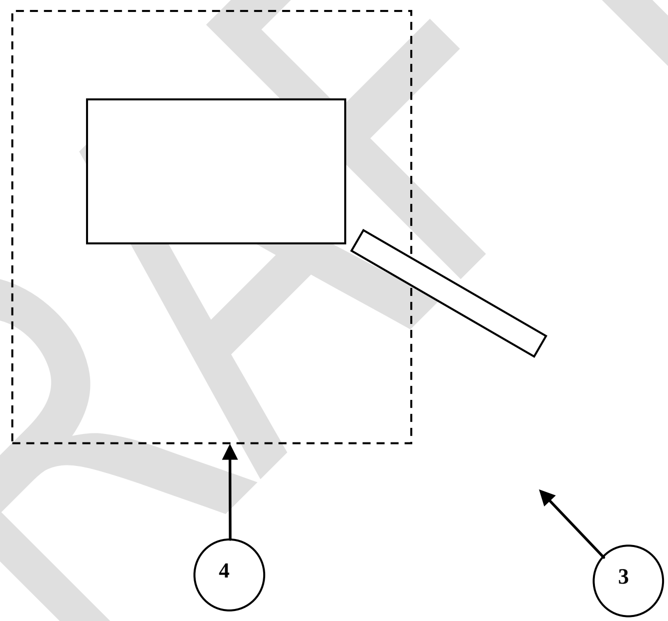





Auditor's Signature ______________________________________ Date _____________ Page ___ of ___

| | |
|---|---|
| **Traffic Sheet 26B** | * STATE ASSIGNED ID __ __ __ __ |
| **LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __ |
| **PHOTOMAP OF CABINET** | * SECTION ID __ __ __ __ |

Rev. 7/21/2005






Auditor's Signature ______________________________________ Date _____________ Page ___ of ___

| Traffic Sheet 26C | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __ |
| **PHOTOMAP - OTHER** | * SECTION ID __ __ __ __ |

Rev. 7/21/2005



Auditor's Signature ______________________________________ Date _____________ Page ___ of ___

| Traffic Sheet 27A | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __ |
| **SITE AUDIT MEASUREMENTS** | * SECTION ID __ __ __ __ |
| **WIM SENSORS AND LAYOUT** | |

Rev. 7/21/2005

| | |
|---|---|
| 1. Contractor: | 2. Audit No.: |
| 3. Contract No.: | 4. Audit Date: |
| 5. Location: | 6. Audit Type: |
| 7. Installation Sub-Contractor: | |
| 8. Auditor/ Organization: | |

9. Measurements: Label Sensors and Loops on Traffic Sheet 26A. Add any additional measurements.

See Figure 10-1 for the locations of the measurements in table below.

| Measurement | Sensor 1 | Sensor 2 | Sensor 3 | Check |
|---|---|---|---|---|
| L1 | | | | |
| | | | | |
| W1 | | | | |
| W2 | | | | Difference between any two W is <= 0.25 inch |
| W3 | | | | |
| Y/N | | | | |
| DS1 | | | | |
| DS2 | | | | |
| Y/N | | | | -0.25” <=DS1-DS2 <= 0.25” |

See Figure 10-2 for the locations of measurements in table below.

| Measurement | Loop 1 | Loop 2 | Loop 3 | Check |
|---|---|---|---|---|
| S1 | | | | |
| S2 | | | | |
| Y/N | | | | S1=S2 |

See Figure 10-3 and Figure 10-4 for the locations of measurements in table below.

| Measurement | Sensor 1 | Sensor 2 | Sensor3 | Check |
|---|---|---|---|---|
| S3 | | | | |
| S4 | | | | |
| S5 | | | | |
| Y/N | | | | S3=S4=S5 |
| Y/N | | | | S1=S5 |

10. Auditor’s Signature............................................................ Date........................

| **Traffic Sheet 27B** | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __ |
| **SITE AUDIT MEASUREMENTS** | * SECTION ID __ __ __ __ |
| **LOOPS** | |

Rev. 7/21/2005

| | |
|---|---|
| 1. Contractor: | 2. Audit No.: |
| 3. Contract No.: | 4. Audit Date: |
| 5. Location: | 6. Audit Type: |
| 7. Installation Sub-Contractor: | |
| 8. Auditor/ Organization: | |

9. Measurements:

See Figure 10-5 for the locations of measurements.

| **Measurement** | **Loop 1** | **Loop 2** | **Loop 3** | **Check** |
|---|---|---|---|---|
| L | | | | |
| W | | | | |
| | | | | |
| D1 | | | | |
| D2 | | | | |
| Y/N | | | | -1.0 “ <=D1-D2 <= 1.0” |
| C1 | | | | |
| C2 | | | | |
| Y/N | | | | -1.0 “ <=C1-C2 <= 1.0” |
| E11 | | | | |
| E12 | | | | |
| Y/N | | | | E11=E12 & 6”<= E11 <= 12” |
| E21 | | | | |
| E22 | | | | |
| Y/N | | | | E21=E22 & 6”<= E21 <= 12” |
| E31 | | | | |
| E32 | | | | |
| Y/N | | | | E31=E32 & 6”<= E31 <= 12” |
| E41 | | | | |
| E42 | | | | |
| Y/N | | | | E41=E42 & 6”<= E41 <= 12” |

10. Auditor’s Signature............................................................ Date........................

| Traffic Sheet 27C | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| LTPP MONITORED TRAFFIC DATA | * STATE CODE __ __ |
| SITE AUDIT MEASUREMENTS | * SECTION ID __ __ __ __ |
| DEPTH CHECKS | |

Rev. 7/21/2005

1. Contractor: 2. Audit No.:

3. Contract No.: 4. Audit Date:

5. Location: 6. Audit Type:

7. Installation Sub-Contractor:

8. Auditor/ Organization:

9. Measurements:

See Figure 10-6 the locations of measurements.

| Measurement | Loop 1 | Loop 2 | Loop 3 | Sensor 1 | Sensor 2 | Sensor 3 |
|---|---|---|---|---|---|---|
| d1 | | | | | | |
| d2 | | | | | | |
| d3 | | | | | | |
| d4 | | | | | | |
| d5 | | | | | | |
| d6 | | | | | | |
| d7 | | | | | | |
| d8 | | | | | | |
| d9 | | | | | | |
| d10 | | | | | | |
| d11 | | | | | | |
| d12 | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

10. Auditor's Signature............................................................ Date.........................

| Traffic Sheet 28 | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __ |
| **NON-COMPLIANCE REPORT (NCR)** | * SECTION ID __ __ __ __ |

Rev. 7/21/2005

| | |
|---|---|
| 1. Contractor: | 2. Audit No.: |
| 3. Contract No.: | 4. Audit Date: |
| 5. Location: | 6. Audit Type: |
| 7. Installation Sub-Contractor: | |
| 8. Auditor/ Organization: | |
| 9. Non-Compliance reference document/item: | |
| 10. Non-Compliance Detail: | |
| 11. Potential Associated Equipment Problem(s): | |
| 12. Corrective Action (if any): | |
| 13. Contractor Rep Signature............................................... <br> 14. Auditor's Signature................................................ Date........................... | |

| | |
|---|---|
| **Traffic Sheet 29** | * STATE ASSIGNED ID __ __ __ __ |
| **LTPP MONITORED TRAFFIC DATA** | * STATE CODE __ __ |
| **AUDIT SUMMARY** | * SECTION ID __ __ __ __ |

Rev. 7/21/2005

| | |
|---|---|
| 1. Contractor: | 2. Audit No.: |
| 3. Contract No.: | 4. Audit Date: |
| 5. Location: | 6. Audit Type: |
| 7. Installation Sub-Contractor: | |
| 8. Auditor/ Organization: | |
| 9. Audit Summary: | |
| 10. Auditor's Signature............................................................ Date....................... | Sheet ____ of _____ |

| Traffic Sheet 30 | Hand-Held IR Sensor Serial No. _______________ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | |
| **Hand-Held IR Sensor Validation** | Date Performed __ __ / __ __ / __ __ __ __ |

Rev. 4/20/2009

| Check | Reading | Reference Therm. (C) | Hand-held IR Sensor | | |
|---|---|---|---|---|---|
| | | | Reading (C) | Error | Pass? |
| Cold | 1 | | | | Y / N |
| | 2 | | | | Y / N |
| | 3 (opt.) | | | | Y / N |
| Room Temp. | 1 | | | | Y / N |
| | 2 | | | | Y / N |
| | 3 (opt.) | | | | Y / N |
| Hot | 1 | | | | Y / N |
| | 2 | | | | Y / N |
| | 3 (opt.) | | | | Y / N |
| Acceptable? | | | YES / NO | | |

Location Performed: ___________________________________

Performed By: ___________________________________

| Traffic Sheet A | * STATE CODE __ __ |
|---|---|
| **LTPP MONITORED TRAFFIC DATA** | * SPS WIM ID __ __ __ __ |
| **Straightedge Measurements - Longitudinal** | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 7/12/2004

Route:

| Station for Back End of Straightedge | Location of Straightedge | Can Disk be freely Passed (Y/N?) | Station for Back End of Straightedge | Location of Straightedge | Can Disk be freely passed (Y/N?) |
|---|---|---|---|---|---|
| 153.000 | Wheel Path | | 227.825 | 0.3 m Left | |
| 154.825 | 0.3 m Right | | 229.650 | Wheel Path | |
| 156.650 | 0.3 m Left | | 231.475 | 0.3 m Right | |
| 158.475 | Wheel Path | | 233.300 | 0.3 m Left | |
| 160.300 | 0.3 m Right | | 235.125 | Wheel Path | |
| 162.125 | 0.3 m Left | | 236.950 | 0.3 m Right | |
| 163.950 | Wheel Path | | 238.775 | 0.3 m Left | |
| 165.775 | 0.3 m Right | | 240.600 | Wheel Path | |
| 167.600 | 0.3 m Left | | 242.425 | 0.3 m Right | |
| 169.425 | Wheel Path | | 243.250 | 0.3 m Left | |
| 171.250 | 0.3 m Right | | 246.075 | Wheel Path | |
| 173.075 | 0.3 m Left | | 247.900 | 0.3 m Right | |
| 174.900 | Wheel Path | | 249.725 | 0.3 m Left | |
| 176.725 | 0.3 m Right | | 251.550 | Wheel Path | |
| 178.550 | 0.3 m Left | | 253.375 | 0.3 m Right | |
| 180.375 | Wheel Path | | 255.200 | 0.3 m Left | |
| 182.200 | 0.3 m Right | | 257.025 | Wheel Path | |
| 184.025 | 0.3 m Left | | 258.850 | 0.3 m Right | |
| 185.850 | Wheel Path | | 260.675 | 0.3 m Left | |
| 187.675 | 0.3 m Right | | 262.500 | Wheel Path | |
| 189.500 | 0.3 m Left | | 264.325 | 0.3 m Right | |
| 191.325 | Wheel Path | | 266.150 | 0.3 m Left | |
| 193.150 | 0.3 m Right | | 267.975 | Wheel Path | |
| 194.975 | 0.3 m Left | | 269.800 | 0.3 m Right | |
| 196.800 | Wheel Path | | 271.625 | 0.3 m Left | |
| 198.625 | 0.3 m Right | | 273.450 | Wheel Path | |
| 200.450 | 0.3 m Left | | 275.275 | 0.3 m Right | |
| 202.275 | Wheel Path | | 277.100 | 0.3 m Left | |
| 204.100 | 0.3 m Right | | 278.925 | Wheel Path | |
| 205.925 | 0.3 m Left | | 280.750 | 0.3 m Right | |
| 207.750 | Wheel Path | | 282.575 | 0.3 m Left | |
| 209.575 | 0.3 m Right | | 284.400 | Wheel Path | |
| 211.400 | 0.3 m Left | | 286.225 | 0.3 m Right | |
| 213.225 | Wheel Path | | 288.050 | 0.3 m Left | |
| 215.050 | 0.3 m Right | | 290.875 | Wheel Path | |
| 216.875 | 0.3 m Left | | 291.700 | 0.3 m Right | |
| 218.700 | Wheel Path | | 293.525 | 0.3 m Left | |
| 220.525 | 0.3 m Right | | 295.350 | Wheel Path | |
| 222.350 | 0.3 m Left | | 297.175 | 0.3 m Right | |
| 224.175 | Wheel Path | | 299.000 | 0.3 m Left | |
| 226.000 | 0.3 m Right | | 300.825 | Wheel Path | |

Note: Station 153.00 is at the beginning of the section being evaluated

Completed by ________________________________ Verified by ________________________________

| Traffic Sheet B | * STATE CODE __ __ |
|---|---|
| LTPP MONITORED TRAFFIC DATA | * SPS WIM ID __ __ __ __ |
| Straightedge Measurements - Transverse | * DATE: (mm/dd/yyyy) __ __ / __ __ / __ __ __ __ |

Rev. 05/21/2004

Route:

| Distance from Centerline of WIM (m) | Can Disk Be Freely Passed Below Straightedge? |
|---|---|
| 0.0 | Y / N |
| 5.0 | Y / N |
| 10.0 | Y / N |
| 15.0 | Y / N |
| 20.0 | Y / N |
| 25.0 | Y / N |
| 50.0 | Y / N |
| 75.0 | Y / N |
| 100.0 | Y / N |



Completed by ________________________________ Verified by ________________________________

| Checklist A-01 | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| **SPS WIM QA – Pre-Visit Preparation** | * STATE CODE __ __ |
| | * SECTION ID __ __ __ __ |

Rev. 7/21/2005



| Question/Item | Yes | No | Comments |
|---|---|---|---|
| Are the following pieces of equipment available for performing the WIM System Installation and Calibration audit? | | | |
| Cellular Phone | | | |
| Steel measuring tape, 25’ | | | |
| Thin measuring rule, 6” | | | |
| Clipboard | | | |
| Digital Camera (resolution 480 x 640) | | | |
| Digital Camera memory sticks | | | |
| AA Batteries for Digital Camera | | | |
| Radar gun | | | |
| Pavement temperature measurement device | | | |
| Handheld GPS device | | | |
| 35mm camera | | | |
| Carbon paper | | | |
| | | | |
| Are the following documents available for performing the WIM System Installation and Calibration audit? | | | |
| SPS WIM Phase II Statement of Work | | | |
| Vendor Equipment Installation manual | | | |
| SPS WIM Phase II Contractor’s Handout Guide for SPS WIM Installation | | | |
| SPS WIM Phase II Contractor’s WIM System Installation Plan | | | |
| Traffic Sheet 17, (current completed) if available | | | |
| Blank Traffic Sheet 14 | | | |
| Blank Traffic Sheet 15 | | | |
| Blank Traffic Sheet 19s | | | |
| Blank Traffic Sheet 20 (multiple copies) | | | |
| Blank Traffic Sheets 21 (multiple copies) | | | |

Auditor’s Signature ________________________________ Date _____________________

| Checklist A-01 | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| **SPS WIM QA – Pre-Visit Preparation** | * STATE CODE __ __ |
| | * SECTION ID __ __ __ __ |

Rev. 7/21/2005



| Question/Item | Yes | No | Comments |
|---|---|---|---|
| Traffic Sheets 25 completed with basic audit information | | | |
| Traffic Sheets 26 completed with basic audit information | | | |
| Traffic Sheets 27 completed with basic audit information | | | |
| Blank Traffic Sheets 25 | | | |
| Blank Traffic Sheets 26 | | | |
| Blank Traffic Sheets 27 | | | |
| Blank Traffic Sheet 28 | | | |
| Blank Traffic Sheets 29 | | | |
| Blank Checklist A-02 | | | |
| Blank Checklist A-03 | | | |
| Blank Checklist A-04 | | | |
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Auditor’s Signature ________________________________ Date ____________________

| Checklist A-02 | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| SPS WIM QA – Support Equipment Installation | * STATE CODE __ __ |
| | * SECTION ID __ __ __ __ |

Rev. 7/21/2005



| Question/Item | Yes | No | Comments |
|---|---|---|---|
| Are all utilities in the construction area clearly marked? | | | |
| Did the Contractor conduct their work with a minimum disturbance of existing utilities? | | | |
| In the event of damage to utilities, did the Contractor contact the utility owners and the highway agency? | | | |
| Is all of the electrical service equipment new, with no visible damage? | | | |
| Are all conduit junctions, expansion joints, and fittings fabricated from a similar material to the connecting conduit? | | | |
| Are all conduits constructed of galvanized steel RMC? | | | |
| Are all conduits installed as shown on the WIM System Installation Plan? | | | |
| Are all fittings watertight? | | | |
| Were set screw and/or pressure cast fittings used? | | | |
| If installed, were photographs recorded of the telephone and electrical service boxes? | | | |
| If solar powered, has solar installation been photographed? | | | |
| Is the type of cabinet a NEMA M-type or better? | | | |
| Is the cabinet dust tight, with a weather resistant seal? | | | |
| Does the cabinet include the following features: | | | |
| Hinged door? | | | |
| Lock, with 2 sets of keys? | | | |
| Louvered vent? | | | |
| Standard filter? | | | |
| Air exhaust through roof overhang? | | | |
| Temperature activated forced air fan system? | | | |
| Switched light? | | | |
| GFCI duplex outlet? | | | |
| Circuit breaker for AC input? | | | |
| Surge suppression? | | | |

Auditor's Signature ____________________________________ Date _______________________

| Question/Item | Yes | No | Comments |
|---|---|---|---|
| Were adequate photographs taken and documented of the interior and exterior of the cabinet to ensure that each component above is included? | | | |
| Was a photograph of the cabinet foundation, including any mounting, anchoring and/or fastening hardware recorded? | | | |
| Were all pull-boxes installed as shown on the WIM System Installation Plan? | | | |
| Do all pull-box installations include proper drainage? | | | |
| Are all pull-box lids flush with adjacent surfaces, when installed? | | | |



Auditor's Signature ______________________________________ Date ________________________

| Checklist A-03 | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| **SPS WIM QA – WIM System Equipment Installation** | * STATE CODE __ __ |
| | * SECTION ID __ __ __ __ |

Rev. 7/21/2005



| Question/Item | Yes | No | Comments |
|---|---|---|---|
| Did the Contractor establish squareness with the travel lane? | | | |
| Are the Loop Sensors laid out as shown on the WIM System Installation Plan? | | | |
| Are the loop sensors laid out so that they are square with the travel lane and centered in the lane? | | | |
| Are corner cuts drawn at 45 degree angles, within 12" of the corner of the loop? | | | |
| Are WIM sensors laid out as shown in the WIM System Installation Plan? | | | |
| Are the WIM sensor layouts perpendicular with the pavement edge? | | | |
| Are the outside edges of the WIM Sensor layouts aligned with the outside edges of the painted lane markings? | | | |
| Is the distance from the leading edge of the first loop sensor to the leading edge of the second loop sensor identical to same measurement for the WIM Sensors? | | | |
| Were photographs of the entire WIM System layout recorded? | | | |
| Were all pavement cuts performed using the wet-cutting method? | | | |
| Were loop cuts made to the proper depth? | | | |
| Were WIM sensor cuts made to the proper depth? | | | |
| Were photographs recorded of the saw-cutting in progress? | | | |
| During excavation, did the Contractor only remove existing concrete to the neat lines? | | | |
| If damaged, did the Contractor repair the concrete by replacing it with like material? | | | |
| Did the Contractor clean all loop sensor slots, WIM channels or recesses and lead-in slots with water and high-pressure air? | | | |
| Were photographs of each Loop Sensor and WIM Sensor channel or recess recorded once all saw cutting and excavating was completed and they were cleaned of all debris and moisture? | | | |

Auditor's Signature ____________________________________ Date _______________________

| Checklist A-03 | * STATE ASSIGNED ID __ __ __ __ |
|---|---|
| SPS WIM QA – WIM System Equipment Installation | * STATE CODE __ __ |
| | * SECTION ID __ __ __ __ |

Rev. 7/21/2005



| Question/Item | Yes | No | Comments |
|---|---|---|---|
| Are all sensors on site identical to those prescribed by the WIM System Installation Plan? | | | |
| Were the WIM sensors electronically tested prior to installation? | | | |
| Are all conduits installed in the travel lane of RMC construction? | | | |
| Is plastic conduit used for WIM sensor recess entry for the loops, or through pavement expansion joints? | | | |
| Were all conduit openings sealed prior to pouring any loop sealant or epoxy? | | | |
| Were drain conduits installed below electrical conduits? | | | |
| Were the loop wires installed into the slots without the use of sharp implements such as screwdrivers or putty knives? | | | |
| Were the loop wires pushed down into the slot completely after each complete turn? | | | |
| Was there sufficient wire left to run both leads to the pull-box without splicing? | | | |
| Was each set of loop wires clearly marked with colored tape or written label? | | | |
| Were the loop wires secured in the slot with backer rod or similar means to prevent "floating"? | | | |
| Were the loop wires completely covered with loop sealant, without dips or voids, and flush with the pavement surface? | | | |
| Were the WIM sensors installed in strict accordance with the manufacturer's specifications? | | | |
| Was a specific process performed by the contractor to verify that the weighing platform would be completely flush with the pavement surface (to within 1/32"), once installed? | | | |
| If installed, were the quartz sensors ground completely flush with the pavement surface, as prescribed by the manufacturer? | | | |
| Were all voids or dips in the epoxy around the WIM sensor and/or frames completely filled in with epoxy? | | | |



Auditor's Signature ______________________________ Date ____________________

| Question/Item | Yes | No | Comments |
|---|---|---|---|
| Were all epoxy high spots ground until flush with the pavement surface? | | | |
| Did all sensor lead-ins exit the pavement through metal conduit to the pull-box? | | | |
| Once all of the sensor leads were pulled through, did the Contractor seal all conduit openings to prevent the intrusion of epoxy or loop sealant? | | | |
| Once the epoxy and loop sealant had cured, did the Contractor unseal the conduit openings? | | | |
| Were photographs recorded of each installed sensor? | | | |
| Were photographs recorded of support structures and any site identifying signs or structures? | | | |
| Was a photograph recorded that illustrated the entire WIM System Installation? | | | |
| Was all cabling carefully pulled through the conduit to the cabinet? | | | |
| Was extra lead wire left in each pull-box and the cabinet? | | | |
| Were all lead-in cables clearly identified in each pull-box and in the cabinet? | | | |
| Were all sensor lead-ins of insufficient length to reach the cabinet properly spliced in the pull-box? | | | |
| Are all loop sensors spliced in the closest pull-box? | | | |
| Are all loop-wires spliced to a shielded or jacketed 2-conductor cable? | | | |
| Are all splices watertight, sealed with epoxy or other waterproof material? | | | |
| Were all spliced connections made with bifurcated connectors? | | | |
| Was each component of the WIM System, including in-road sensors, electronically tested before power was applied? | | | |
| Are all terminations clearly marked in the cabinet? | | | |
| Is a schematic of the WIM system available in the cabinet? | | | |

Auditor's Signature ______________________________________ Date ________________________

| Question/Item | Yes | No | Comments |
|---|---|---|---|
| Did the Contractor perform diagnostics on the WIM System once power was applied? | | | |
| Were annotations of improper readings or indications made? | | | |
| Did the Contractor repair any or all system failures while on site? | | | |
| Were Traffic Sheets 14 and 15 completed, with copies left in the cabinet? | | | |
| Was the Traffic Sheet 17 updated? | | | |
| Did the Contractor clear the construction site of all rubbish, equipment, materials and tools? | | | |
| Did the Contractor properly restore all damaged property? | | | |



Auditor’s Signature ____________________________________ Date _______________________

| Checklist A-04 | * STATE ASSIGNED ID __ __ __ __ |
| --- | --- |
| SPS WIM QA – WIM System Calibration | * STATE CODE __ __ |
| | * SECTION ID __ __ __ __ |

Rev. 7/21/2005



| Question/Item | Yes | No | Comments |
| --- | --- | --- | --- |
| Was the WIM System Calibrated according to the steps described in the Data Collection Guide for SPS WIM sites? | | | |
| Are all test vehicles in good operating condition? | | | |
| Are all test vehicle load not susceptible to shifting, harmonics, moisture gain or loss and adequately anchored? | | | |
| Were photographs recorded of each test vehicle, including the entire vehicle, and of the truck, trailer, load and the suspension of each axle? | | | |
| Is the first test vehicle a type 3S2? | | | |
| Are all other test vehicles as identified by the Equipment Installation Handout Guide? | | | |
| Was each of the test vehicles weighed at certified truck weighing facilities prior to any test runs? | | | |
| Were copies of the pre-calibration weigh tickets obtained from the scale master? | | | |
| Was a Traffic Sheet 19 for each truck properly filled out prior to beginning any test runs? | | | |
| Were the original WIM System weight compensation parameters recorded prior to starting the test runs? | | | |
| Were at least forty test runs, divided equally among all test vehicles, conducted before any system calibrations were performed? | | | |
| Was a pavement temperature reading taken each time the set of test vehicles passed? | | | |
| Did the Contractor perform an analysis of the Pre-calibration test runs to calculate a calibration factor for the WIM System? | | | |
| Were any changes to the WIM System weight compensation factors recorded? | | | |
| Did the Contractor validate the effectiveness of the calibration by running a minimum of 10 test vehicle runs, divided equally among the test vehicles? | | | |
| If the system data failed to meet the performance parameters, did the Contractor re-calibrate the WIM system to a total of 3 calibrations? | | | |

Auditor's Signature ______________________________________ Date ________________________

| Question/Item | Yes | No | Comments |
|---|---|---|---|
| Whether the system met the performance parameters or not, did the Contractor perform at least forty post-calibration test runs, divided equally among all of the test vehicles. | | | |
| Were the final WIM System weight compensation factors recorded? | | | |
| If the WIM System failed to meet the performance parameters, was the failure verbally communicated to the COTR before the Contractor left the site? | | | |
| Once all test runs were completed, did the Contractor perform an on-site analysis to determine the statistical reliability of the data? | | | |
| Did the Contractor re-weigh all of the test vehicles once the calibration process was completed? | | | |
| Were copies of the post-calibration weigh tickets obtained from the scale master? | | | |
| Has the Contractor provided a copy of the complete Traffic Sheet 19s? | | | |
| Has the Contractor provided a copy of the final weight statistics? | | | |
| Has a classification count been done to assess the vehicle distribution? | | | |
| Has a check been made by the Contractor for vehicle misclassification issues? | | | |



Auditor's Signature ____________________________________ Date ________________________

# 11 MISCELLANEOUS FORMS

**Table 11-1 General Equipment for WIM Site Validation**

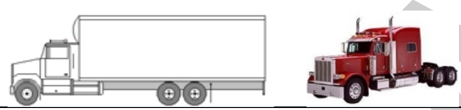
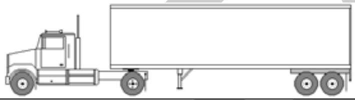
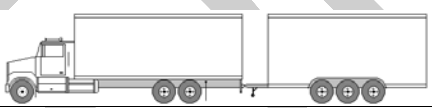
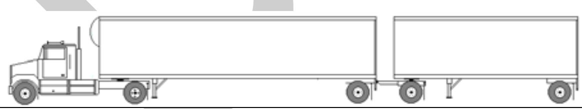
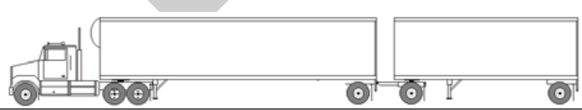
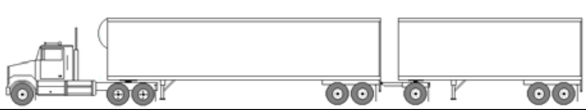
| **Item** | **Check** |
|---|---|
| | |
| Generator (If no A/C site power available) | |
| Canopy and or sun shade | |
| Pavement marking paint | |
| Tape (duct, electrical tape) | |
| Clipboards & marking pens | |
| 81/2 x 11 inch white board (for truck window ID ref. numbering) | |
| Metric/US Customary cloth and metal tape measures [6m. (20')] | |
| Chalk line and spare chalk – yellow keel markers | |
| Electrical extension power cords (110v.) | |
| Electrical power strip adapter with surge protection (110v.) | |
| Video camera with tripod and 4 tapes (minimum) | |
| Digital camera or 35mm camera with 2 rolls of 100 ASA film | |
| Handheld IR temperature device | |
| Laser or Radar gun for speed measurement | |
| Tire pressure gauges (2) | |
| Notebook PC with Windows OS and MS Excel | |
| WIM equipment software to interpret sensor readings | |
| Serial cable or appropriate cable to connect to the WIM processor | |
| Air temperature thermometer | |
| SPS WIM protocols and data collection sheets | |
| First Aid kit | |
| Utility knife, pliers, adjustable wrench, small screwdriver set, etc. | |
| Electrical multi-meter | |
| Hard hats, fluorescent safety vests and necessary safety equipment | |
| Appropriate clothing, sun block, bug spray, portable chairs | |
| Timepiece (set to local time zone) | |
| Sufficient drinking fluids to prevent dehydration | |
| Hand cleaner and paper towels | |
| Traffic control (if required) | |
| LTPP truck info cards | |
| LTPP Distress Identification Manual (DIM) | |

**Table 11-2 Equipment Checklist for Straightedge Smoothness Testing of Newly Constructed Pavements**

| Item | Check |
|---|---|
| Data Collection Guide for SPS WIM Sites | |
| Extra blank data sheets | |
| Sufficient writing implements (pens/pencils) | |
| Clipboard | |
| 3.65m (12ft.) Straightedge device & sizing disk | |
| Chalk line (include spare chalk) | |
| Pavement marking keel (1 box yellow) | |
| Two tape measures, one at least 30m (100ft) and a metric ruler | |
| Calculator | |
| Hardhat, safety vest and other necessary safety equipment | |
| 35mm camera | |
| Video camera with blank tapes | |
| Hand cleanser and paper towels | |
| Sufficient drinking fluids to prevent dehydration | |
| Traffic Control | |
| First Aid kit | |

**Table 11-3 State FIPS Codes**

| State/Province | FIPS Code | State/Province | FIPS Code |
|---|---|---|---|
| Alabama | 1 | New Mexico | 35 |
| Alaska | 2 | New York | 36 |
| Arizona | 4 | North Carolina | 37 |
| Arkansas | 5 | North Dakota | 38 |
| California | 6 | Ohio | 39 |
| Colorado | 8 | Oklahoma | 40 |
| Connecticut | 9 | Oregon | 41 |
| Delaware | 10 | Pennsylvania | 42 |
| District of Columbia | 11 | Rhode Island | 44 |
| Florida | 12 | South Carolina | 45 |
| Georgia | 13 | South Dakota | 46 |
| Hawaii | 15 | Tennessee | 47 |
| Idaho | 16 | Texas | 48 |
| Illinois | 17 | Utah | 49 |
| Indiana | 18 | Vermont | 50 |
| Iowa | 19 | Virginia | 51 |
| Kansas | 20 | Washington | 53 |
| Kentucky | 21 | West Virginia | 54 |
| Louisiana | 22 | Wisconsin | 55 |
| Maine | 23 | Wyoming | 56 |
| Maryland | 24 | Puerto Rico | 72 |
| Massachusetts | 25 | Alberta | 81 |
| Michigan | 26 | British Columbia | 82 |
| Minnesota | 27 | Manitoba | 83 |
| Mississippi | 28 | New Brunswick | 84 |
| Missouri | 29 | Newfoundland | 85 |
| Montana | 30 | Nova Scotia | 86 |
| Nebraska | 31 | Ontario | 87 |
| Nevada | 32 | Prince Edward Island | 88 |
| New Hampshire | 33 | Quebec | 89 |
| New Jersey | 34 | Saskatchewan | 90 |

| Class | Illustration | Description |
|---|---|---|
| 1 |  | Motorcycles |
| 2 |  | Passenger Cars |
| 3 |  | Pickups/Vans |
| 4 |  | Buses |
| 5 |  | 6 tire two-axle single unit trucks |
| 6 |  | Three axle single unit trucks |
| 7 |  | Four or more axle single unit trucks |
| 8 |  | Four or fewer axle truck and trailer combinations |
| 9 |  | Five axle truck and trailer combinations |
| 10 |  | Six or more axle truck and trailer combinations |
| 11 |  | Five or fewer axle multi trailer combinations |
| 12 |  | Six axle multi trailer combinations |
| 13 |  | Seven or more axle multi trailer combinations |
| 14 |  | Errors/Unknown |

# FHWA VEHICLE CLASSES WITH DEFINITIONS

1. ***Motorcycles*** **–** All two or three-wheeled motorized vehicles. Typical vehicles in this category have saddle type seats and are steered by handlebars rather than steering wheels. This category includes motorcycles, motor scooters, mopeds, motor-powered bicycles, and three wheel motorcycles. This vehicle type may be reported at the option of the State.

2. ***Passenger Cars*** **–** All sedans, coupes, and station wagons manufactured primarily for the purpose of carrying passengers and including those passenger cars puling recreational or other light trailers.

3. ***Other Two-Axle, Four-Tire Single Unit Vehicles*** **–** All two axle, four-tire vehicles, other than passenger cars. Included in this classification are pickups, panels, vans, and other vehicles such as campers, motor homes, ambulances, hearses, carryalls, and minibuses. Other two axle, four-tire single-unit vehicles pulling recreational or other light trailers are included in the classification.

4. ***Buses*** **–** All vehicles manufactured as traditional passenger- carrying buses with two axles and six tires or three or more axles. This category includes on traditional buses (including school buses) functioning as passenger-carrying vehicles. Modified buses should be considered to be a truck and should be appropriately classified.

5. ***Two-Axle, Six-Tire, Single-Unit Trucks*** **–** All vehicles on a single frame including trucks, camping and recreational vehicle, motor homes, etc., with two axles and dual rear wheels.

6. ***Three-Axle, Single-Unit Trucks*** **–** All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., with three axles.

7. ***Four or More axle Single-Unit Trucks*** **–** All trucks on a single frame with four or more axles.

8. ***Four or Fewer Axle Single-Trailer Trucks*** **–** All vehicles with four or fewer axles consisting of two units, one of which is a tractor or straight truck power unit.

9. ***Five Axle Single-Trailer Trucks*** **–** All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power unit.

10. ***Six or More Axle Single-Trailer Trucks*** **–** All vehicles with six or more axles consisting of two units, one of which is a tractor or straight truck power unit.

11. ***Five or fewer Axle Multi-Trailer Trucks*** **–** All vehicles with five or fewer axles consisting of three or more units, one of which is a tractor or straight truck power unit.

12. ***Six-Axle Multi-Trailer Trucks*** **–** All six-axle vehicles consisting of three or more units, one of which is a tractor or straight truck power unit.

13. ***Seven or More Axle Multi-Trailer Trucks*** **–** All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or straight truck power unit.