APPENDIX A

PROFILE PROBLEM REPORT FORM

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APPENDIX A- PROFILER PROBLEM REPORT FORM

In an effort to provide for a more uniform way of reporting, handling and tracking problems associated with the LTPP pavement profile monitoring activities, the FHWA LTPP team has designed a "Profiler Problem Report (PROFPR)" form that is included in next page for use by the regional contractors.

The PROFPR form provides several major benefits including: a standard format for submitting problems associated with the profiler monitoring activities, a much easier means of tracking when a problem was submitted, who is responsible for resolving it, whether or not it has been resolved, and how and when it was resolved, and reduced probability of problems being forgotten or falling through the cracks.

A profiler problem report must be submitted whenever there are equipment problems in the profiler, problems with data collection or data processing software, problems with data collection guidelines, or other problems related to profiling activities or profile data. If a problem was encountered, and it was resolved, and the profiler operator/coordinator feels that this information would be useful to the other RSC's, an informational problem report should be submitted. When submitting an informational problem report, indicate that the problem report is being submitted for informational purposes in the description part of the form.

The Profiler Problem Report form is self explanatory except for the PROFPR number. The number consists of two parts as follows:

- A letter code representing the agency submitting the problem – F for FHWA LTPP Division, NA for North Atlantic RSC, NC for North Central RSC, S for Southern RSC, W for Western RSC, and TSSC for Technical Support Services Contractor and O for others.

- A number code representing the PROFPR number for the submitting agency, in sequential fashion starting from 1.

For example, F-07 represents the seventh problem reported by the FHWA LTPP Team; and NA-23 represents the 23rd problem reported by the North Atlantic RSC.

Completed PROFPR forms must be submitted to the FHWA LTPP Team, with copies to the Technical Support Services Contractor (TSSC) and to the profiler coordinator at each RSC office. Forms may be faxed or transmitted electronically via e-mail message, but the latter option is much preferred. A complete set of the PROFPR submittals will be maintained by the FHWA LTPP Team and LTPP TSSC. A copy of the report should be submitted to the RSC's for their information and action, as appropriate.

Agency:_____
PROFPR #:___

LONG-TERM PAVEMENT PERFORMANCE (LTPP)
PROFILE PROBLEM REPORT (PROFPR)

Attention: _____
_____
_____
_____
_____
_____

Type of Problem	Reported by: _____
Guidelines _____	Agency: _____
Equipment _____	
Software _____	Date: _____
Name _____	Urgent (Y/N) ____
Version _____	
Other _____	Page _of ____
Description:	

THIS SECTION FOR USE BY FHWA AND TSSC	
Received by: _____	Date Received: _____
Referred to: _____	Approved by: _____
Date Referred: _____	Date Approved: _____
Resolution:	
Notes:	

APPENDIX B

FREQUENCY OF PROFILE MEASUREMENTS AT TEST SECTIONS

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MEMORANDUM

FEDERAL HIGHWAY ADMINISTRATION
OFFICE OF INFRASTRUCTURE R&D

6300 GEORGETOWN PIKE
MCLEAN, VIRGINIA 22101-2296

SUBJECT: ACTION: LTPP Directive GO-21 — September 10, 1999
LTPP Pavement Performance Monitoring Adjustments

FROM: Monte G. Symons
Long-Term Pavement Performance Team

REPLY TO ATTN. OF: HRDI-13

TO: Dr. Frank Meyers - LTPP North Atlantic Regional Contract
Mr. Mark Gardner - LTPP Southern Regional Contract
Mr. Tom Wilson - LTPP North Central Regional Contract
Dr. Sirous Alavi - LTPP Western Regional Contract

Attached is the Long-Term Pavement Performance Program Directive GO-21: LTPP Pavement Performance Monitoring Adjustments. This directive contains instructions for making pavement performance monitoring adjustments based upon assessment of test section compliance with the minimum data completeness requirements contained in LTPP Directive GO-19: LTPP Data Completeness and Monitoring Adjustment Process. Implementation of this directive shall commence no later than October 1, 1999, which corresponds with the completion of the "Data Completeness Report," but an earlier start date is encouraged.

Please contact me if you require clarification or have any questions.

Monte Symons

Attachment
cc:
LAW PCS
SAIC
LTPP Staff
Directive File
Chron

LONG TERM PAVEMENT PERFORMANCE PROGRAM DIRECTIVE

For the Technical Direction of the LTPP Program

Program Area:	General Operations	Directive Number:	GO-21
Date:	October 1, 1999	Supersedes:	D-5,FWD-10,P-2
Subject:	LTPP Pavement Performance Monitoring Adjustments		

Background

This directive presents pavement performance monitoring adjustments intended to achieve a balance in the data available for a test section relative to their use in development, verification, evaluation and validation of pavement performance prediction procedures while preserving the ability to support other types of pavement related investigations and analyses.

Monitoring Guideline Summary

Table 1 summarizes the revised pavement performance monitoring guidelines for Long-Term Pavement Performance (LTPP) projects by experiment type. The measurements covered by these guidelines include profile, distress, and deflection data collection. These guidelines relate to frequency and intensity of data collection, not data quality. High data quality standards must be maintained for measurements performed regardless of test section or monitoring category.

The "Monitoring Category" shown in Table 1 is the key to the monitoring adjustment sequence. The recommended monitoring category is based upon assessment of test section compliance with the minimum data completeness requirements contained in LTPP Directive GO-19: LTPP Data Completeness and Monitoring Adjustment Process. For test sections that do not meet the data collection requirements or that have critical unresolvable deficiencies, monitoring adjustments shall be made in the following sequence:

S1 ☞ S2 ☞ G ☞ C

For example, if a test section in the S2 monitoring category has pavement performance monitoring less than S2, but greater than the C monitoring requirements, the recommended monitoring category would be G.

Every effort must be made to maintain test sections at their highest potential category in order to reap the benefits of the investment in LTPP. The monitoring categories were tailored around the level of highway agency investment in the test site and relative utility of the data. The following is a description of the nature of the various monitoring categories.

S1 These are high value flexible and rigid pavement experiments (SPS-1 and -2) which began with a new construction or reconstruction event. It is on these test sections that we have the opportunity to best measure the effects of pavement features such as drainable bases, widened lane, base type, etc. starting from construction within the context of a nationally coordinated experiment. Some agencies have estimated that they have invested up to $500,000 to construct, test and monitor these test sections. In keeping with this level of investment, these test sections have been assigned the highest level and intensity of monitoring. These test sections will be the primary candidates for future special monitoring studies.

S2 This category includes the SPS-8 experiment on environmental effects and the SPS-5 and 6 rehabilitation experiments. The SPS-8 experiment is an adjunct to the SPS-1 and 2 studies; two test sections from the SPS 1 and 2 studies were constructed on lower volume roadways where environmental effects are most likely to cause deterioration. The SPS-5 and -6 are the high value flexible and rigid rehabilitation experiments that start with construction of a specified series of treatments on contiguous test sections. These test sections are valuable since they are also based on a nationally coordinated experiment with similar test sections constructed in other parts of the country.

G The G category of pavements is mostly comprised of test sections in the General Pavement Study. These test sections are of vital importance to the program since they provide the greatest extent of coverage of environmental factors, paving materials and paving practices. Some of the monitoring requirements are less intensive than the S categories with provisions for performing measurements in response to changes in the pavement condition or other events.

C The C or close-out category of monitoring is still ***an active monitoring status category***. Close-out monitoring means that one more round of pavement performance measurements will be performed on existing test sections, preferably at the end of their current life cycle when a rehabilitation treatment is applied. The objective is to preserve the previous investment in these test sections by obtaining a minimum level of performance information over the current pavement life cycle. Test sections are assigned to this category due to either an uncorrectable or minimum data requirement deficiency which will not be corrected, or because they are part of an experiment with limited national impact, limited product potential or whose study time period has expired.

Table 1. Summary of data collection requirements and monitoring frequencies.

LTPP Experiment	Minimum Pavement Monitoring Intervals			Monitoring Category[1]
	Profile	Distress	FWD	
SPS 1 & 2	1-year	1- year manual and 2 -year photographic	2-year and responsive testing	S1
SPS 5 & 6				S2
SPS 8				
SPS Supplemental	Same as core sections	3-year manual, 2-year photographic, and responsive	5-year and responsive testing	
SPS 9 & GPS 1, 2, 3, 4, 5, 6B/C/D/S, 7B/C/D/F/R/S, 9	2 year			G
GPS 6A & 7A, SPS 3, 4, & 7	One last measurement	One last measurement	One last measurement	C

[1] Although required pavement monitoring activities for SPS-1, -2, -5, -6 and -8 project test sections are the same, the level of traffic monitoring and climatic data collection at SPS-1 and -2 project sites is more intensive, and hence the reason for subcategories (S1 and S2) within the S monitoring catgory. Traffic data collection requirements for the monitoring categories shown in the above table are being finalized and will be issued under a separate directive.

Pavement Performance Monitoring

Pavement performance monitoring addressed in this directive includes profile, distress and deflection measurements performed by LTPP contractors.

Definitions

In order to describe when pavement performance monitoring should be performed, the following definitions are used.

Rehabilitation Construction Event	Performance of rehabilitation activities on a test section. Rehabilitation activities include overlays and associated pretreatments (patching, milling, joint repair, etc.), inlays (mill and fill), pressure relief joints in PCC pavements, subsealing and undersealing, retrofitted subdrainage, joint load transfer restoration, and shoulder restoration.
Maintenance Construction Event	Performance of maintenance activities on a test section. Maintenance activities include seal coats, crack sealing, patching, crack and joint sealing, grinding, milling less than 25-mm deep, and grooving.
Out-of-Study	Monitoring is discontinued because a test section is either unsuitable for continued monitoring due to reconstruction, non-qualifying rehabilitation construction event, major deficiency or the respective highway agency is no longer willing to support the required monitoring activities. (Previously collected data will be retained by the LTPP program.)
Routine Monitoring	Pavement performance measurements (profile, distress, and deflection) taken at regularly established intervals, where the interval length is defined by the measurement type and test section monitoring category (S1, S2 or G). Routine measurements are repeated until one of the three following conditions are reached: 1. Test section goes out-of-study. 2. Application of rehabilitation activity. 3. End of LTPP program Routine monitoring after performance of rehabilitation activity will be continued if the test section does not go out-of-study. Such monitoring will be performed in accordance with the

requirements for the post-rehabilitation LTPP experiment designation monitoring category.

Routine measurements do not apply to test sections classified in the C monitoring category.

Responsive Monitoring

Non-routine monitoring measurements performed on test sections that are triggered by changes in pavement condition, construction events, or status change.

Responsive monitoring based on change in pavement condition applies primarily to those test sections in the G monitoring category which have longer routine monitoring intervals than those in the S categories. The primary trigger for pavement related response monitoring are measurements and observations by the profiler operator who visits the site on a bi-annual basis. One or more of the following conditions may trigger the need for responsive monitoring:

- A change in average IRI over a two year period in excess 0.40 m/km.
- A significant change in pavement distress condition; e.g. appearance of fatigue cracking, increased rutting, or increase or decrease in severity or extent of other distress types.
- Report by highway agency personnel that rate of pavement deterioration appears to be accelerating.

Responsive measurements triggered by a construction event include:

- Maintenance construction event -- Profile and distress surveys shall be performed within six months prior to maintenance activities such as seal coats which cover the entire surface of the test section; no responsive post-treatment monitoring measurements are required. Routine monitoring measurements should continue in accordance with pre-maintenance routine monitoring schedule.
- Rehabilitation construction event -- Profile, distress and deflection measurements are required within six months prior to rehabilitation activity. If monitoring measurements are to be continued on a test section after rehabilitation, i.e. the test section does not go out-of-study, then a full suite of pavement performance

measurements are also required within six months following completion of rehabilitation construction.

A full suite of pavement monitoring measurements shall be performed either:

- When it is determined that a test section will be taken out-of-study.
- At the end of the field monitoring portion of the LTPP program.

Close-Out Monitoring: For test sections in the close-out monitoring category, only one more suite of pavement monitoring measurements (profile, distress and deflection) will be performed either:

- When it is determined that a test section will be taken out-of-study. This could be due to a construction event or at the option of the highway agency.
- At the end of the field monitoring portion of LTPP program.

Profile Measurements

Profile measurements on LTPP test sections shall be performed in accordance with established data collection guidelines, protocols and directives. The three general categories of profile measurement frequency specified in Table 1 include:

1. Annual profile measurements
2. Profile measurements every 2 years
3. Close-out profile measurements

The frequency of profile surveys on supplemental SPS test sections shall be performed in accordance with that for the associated core sections.

Annual Profile Measurements

Routine profile measurements on test sections within this monitoring category shall be performed once per year. It is highly desirable that these measurements be performed at approximately the same time each year ($\pm$ 1 month). These measurements shall be repeated until one of the following conditions is reached: test section goes out-of-study, application of rehabilitation construction event, or end of field monitoring portion of LTPP program. Responsive profile measurements are required within six months prior to reaching any one of these conditions or within six months prior to application of maintenance construction event. Responsive profile measurements are also required within six months after application of a rehabilitation (not maintenance) construction event if that test section will continue to be

monitored. Routine profile measurements after application of a rehabilitation construction event will be done in accordance with requirements for the post-rehabilitation LTPP experiment designation monitoring category.

Profile Measurements Every 2 Years

Test sections in this monitoring category shall be surveyed once every two years; i.e., every other year. It is highly desirable that these measurements be performed at approximately the same time each test year (± 1 month). These surveys shall be repeated until one of the following conditions is reached: test section goes out-of-study, application of rehabilitation construction event, or end of field monitoring portion of LTPP program. Responsive profile measurements are required within six months prior to reaching anyone of these conditions or within six months prior to application of maintenance construction event. Responsive profile measurements are also required within six months after application of a rehabilitation (not maintenance) construction event if that test section will continue to be monitored. Routine profile measurements after application of a rehabilitation construction event will be done in accordance with requirements for the post-rehabilitation LTPP experiment designation monitoring category.

Close-Out Measurements

For test sections within this monitoring category, one last round of profile measurements will be performed either when it is determined that the test section will be taken out-of-study (due to a construction event or at the option of the highway agency) or at the end of the field monitoring portion of the LTPP program, whichever comes first.

Distress Surveys

Two methods are used to document surface distresses on LTPP sections: photographic and manual surveys. Regardless of method, distress data shall be collected in accordance with current LTPP data collection guidelines, protocols and directives. Table 1 provides the survey frequency that shall be followed for the collection of distress data according to LTPP experiment. Three general distress monitoring categories are provided in this table:

1. Photographic surveys every 2 years and annual manual distress surveys
2. Photographic surveys every 2 years and manual distress surveys every 3 years
3. Close-out manual distress surveys

A more detailed description of these monitoring categories is provided next.

Photographic Surveys Every 2 Years and Annual Manual Distress Surveys

LTPP test sections classified in this monitoring category shall be surveyed once every two years (i.e., every other year) using the photographic method and once per year (i.e., annually) using the manual method. It is highly desirable that these measurements be performed at

approximately the same time each year (± 1 month). **When possible, photographic surveys shall be performed within one month of the manual survey for that year.** Both photographic and manual surveys shall be repeated until one of the following conditions is reached: test section goes out-of-study, application of rehabilitation construction event, or end of field monitoring portion of LTPP program. Responsive manual distress surveys are required within six months prior to reaching any one of these conditions or within six months prior to application of maintenance construction event which hides the existing pavement surface, such as a seal coat. Responsive manual distress surveys are also required within six months after application of a rehabilitation (not maintenance) construction event if that test section will continue to be monitored. Routine photographic and manual distress surveys after application of a rehabilitation construction event will be done in accordance with requirements for the post-rehabilitation LTPP experiment designation monitoring category.

Photographic Surveys Every 2-Years and Manual Distress Surveys Every 3-Years

Photographic distress surveys on test sections within this category shall be performed once every two years (i.e., every other year), and manual distress surveys on these same test sections shall be performed on a nominal three (3) year interval. It is highly desirable that these measurements be performed at approximately the same time each year (± 1 month). These surveys shall be repeated until one of the following conditions is reached: test section goes out-of-study, application of rehabilitation construction event, or end of field monitoring portion of LTPP program. Responsive manual distress surveys are required within six months prior to reaching any one of these conditions or within six months prior to application of maintenance construction event. Responsive manual distress surveys are also required within six months after application of a rehabilitation (not maintenance) construction event if that test section will continue to be monitored. Routine photographic and manual distress surveys after application of a rehabilitation construction event will be done in accordance with requirements for the post-rehabilitation LTPP experiment designation monitoring category.

Responsive manual distress surveys shall also be performed on test sections within this monitoring category based on changes in pavement condition as defined in the "Definitions" section of this directive.

Close-Out Manual Distress Surveys

For test sections within this monitoring category, one last manual distress survey will be performed either when it is determined that the test section will be taken out-of-study (due to a construction event or at the option of the highway agency) or at the end of the field monitoring portion of the LTPP program, whichever comes first.

Deflection Testing

Deflection testing on LTPP test sections shall be performed using Falling Weight Deflectometers (FWDs) in compliance with LTPP specifications following all applicable guidelines, protocols and directives. The revised deflection testing frequency guidelines are

provided in Table 1 according to LTPP experiment. Three general FWD monitoring categories are provided in this table:

1. Deflection testing every 2 years
2. Deflection testing every 5 years
3. Close-out deflection testing

A more expanded description of each of these three monitoring categories is provided next.

Deflection Testing Every 2 Years

Deflection testing on test sections in this monitoring category shall be performed on a nominal two (2) year interval. This testing shall be repeated every 2 years until one of the following conditions is reached: test section goes out-of-study, application of rehabilitation construction event, or end of field monitoring portion of LTPP program. Responsive deflection testing is required within six months prior to reaching any one of these conditions. Responsive deflection testing is also required within six months after application of a rehabilitation (not maintenance) construction event if that test section will continue to be monitored. Routine deflection testing after application of a rehabilitation construction event will be done in accordance with requirements for the post-rehabilitation LTPP experiment designation monitoring category.

Responsive deflection testing shall also be performed on test sections within this monitoring category based on changes in pavement condition as defined in the "Definitions" section of this directive.

Deflection Testing Every 5 Years

Deflection testing on test sections within this monitoring category shall be performed on a nominal five (5) year interval. These surveys shall be repeated every 5 years until one of the following conditions is reached: test section goes out-of-study, application of rehabilitation construction event, or end of field monitoring portion of LTPP program. Responsive deflection testing is required within six months prior to reaching any one of these conditions. Responsive deflection testing is also required within six months after application of a rehabilitation (not maintenance) construction event if that test section will continue to be monitored. Routine deflection testing after application of a rehabilitation construction event will be done in accordance with requirements for the post-rehabilitation LTPP experiment designation monitoring category.

Responsive deflection testing shall also be performed on test sections within this monitoring category based on changes in pavement condition as defined in the "Definitions" section of this directive.

Close-Out Deflection Testing

For test sections within this monitoring category, one last round of deflection testing will be performed either when it is determined that the test section will be taken out-of-study (due to a construction event or at the option of the highway agency) or at the end of the field monitoring portion of the LTPP program, whichever comes first.

Other Monitoring

Pavement performance monitoring by the RCOCs at times other than those specified in this directive (i.e., any standardized plan deviations) must first be approved by the appropriate FHWA COTR.

Questions concerning this directive should be addressed to the FHWA LTPP Team Leader.

Prepared by: TSSC Team

Approved by:

Monte Symons
LTPP Team Leader

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APPENDIX C

PROFILE TROUBLE SHOOTING GUIDE

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APPENDIX C - PROFILE TROUBLE SHOOTING GUIDE

This appendix contains a catalog of problems commonly encountered by LTPP operators when collecting and reviewing profile data. Knowledge of these problems will help operators to collect more accurate and valid profile data for the LTPP program. These commonly encountered problems can be grouped into the following four categories:

1. Spikes in Profile due to Equipment Problems;
2. Miscalibrated DMI;
3. Early Start of Data Collection; and
4. Different Profiles.

A brief description of each of these problem groups is provided next along with typical plots illustrating such conditions.

To detect most of these problems, the profile data in question must be compared to those collected during the previous site visit (see section 2.2.8). This requires that profile data from the previous site visit be available. Furthermore, in order to perform an accurate and valid comparison, profile data from the previous site visit must be error free. Descriptions and references made later in this appendix to the profile data comparisons assume that data from the previous site visit are error free.

1. Spikes in Profile Due to Equipment Problems

Spikes can be introduced in the profile data as a result of equipment problems. These spikes can be identified by comparing multiple profile runs at a section. Accordingly, once a set of profile runs has been collected, the operator should compare the data from the repeat runs using the multi-run plot option in ProQual (see ProQual User Manual). This comparison should be performed separately for the left, right and center path profile data. Figure C-1 illustrates the presence of a spike in the profile data. This figure shows five profile runs collected on the left wheel path. The profile data for run 4 indicates a spike that is not present in the other four runs. Profile data for run 4 has been offset in figure for clarity; in the ProQual multi-run plot option, these repeat profile runs are color-coded (i.e., different color for each run). Since the spike only occurs in one run of the data set, it is possible that this spike may not have been caused by a pavement feature. When such condition is encountered, the operator should determine if the spike is due to an equipment problem or if it is a pavement feature.

2. Miscalibrated Distance Measuring Instrument (DMI)

A miscalibrated DMI cannot be detected by comparing the five repeat profile runs obtained during a site visit. However, when those runs are compared with the profile runs collected during the previous site visit, the profile (elevation versus station) plot for the more recently collected data will appear squeezed or stretched in the x (station) direction if the vehicle has a miscalibrated DMI. The comparison of the current and the previous profile data should be

carried out using the multi-visit plot option in ProQual (see ProQual User Manual). An example of profile data associated with a miscalibrated DMI is shown in Figure C-2; data for May 2, 1990 was collected using a miscalibrated DMI.

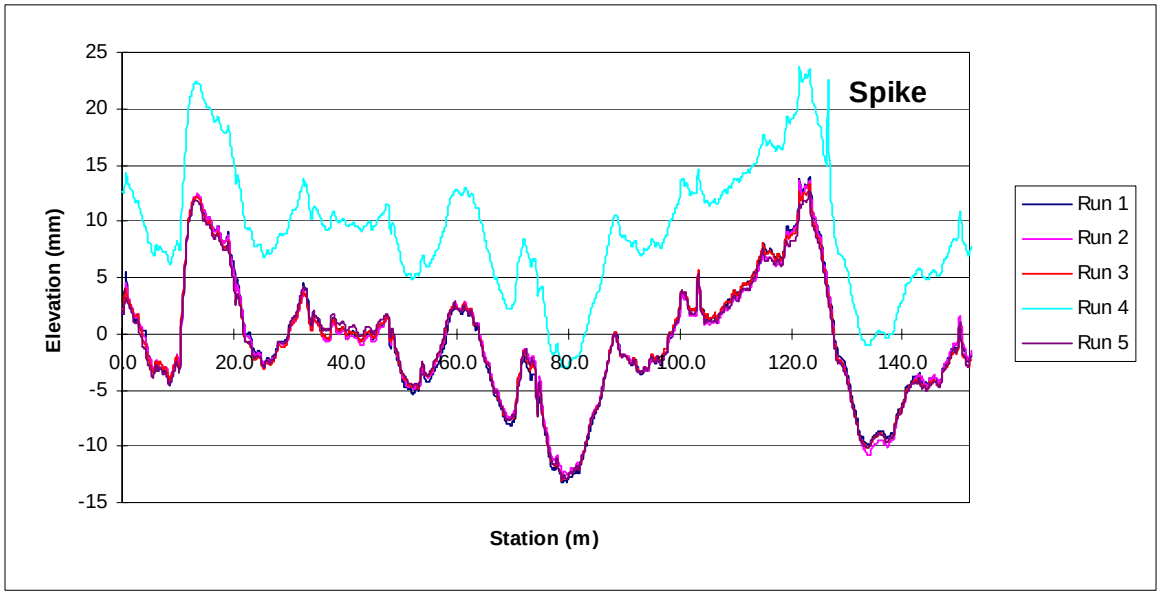

Figure C-1. Spike in profile data (profile data for run 4 has been offset for clarity).

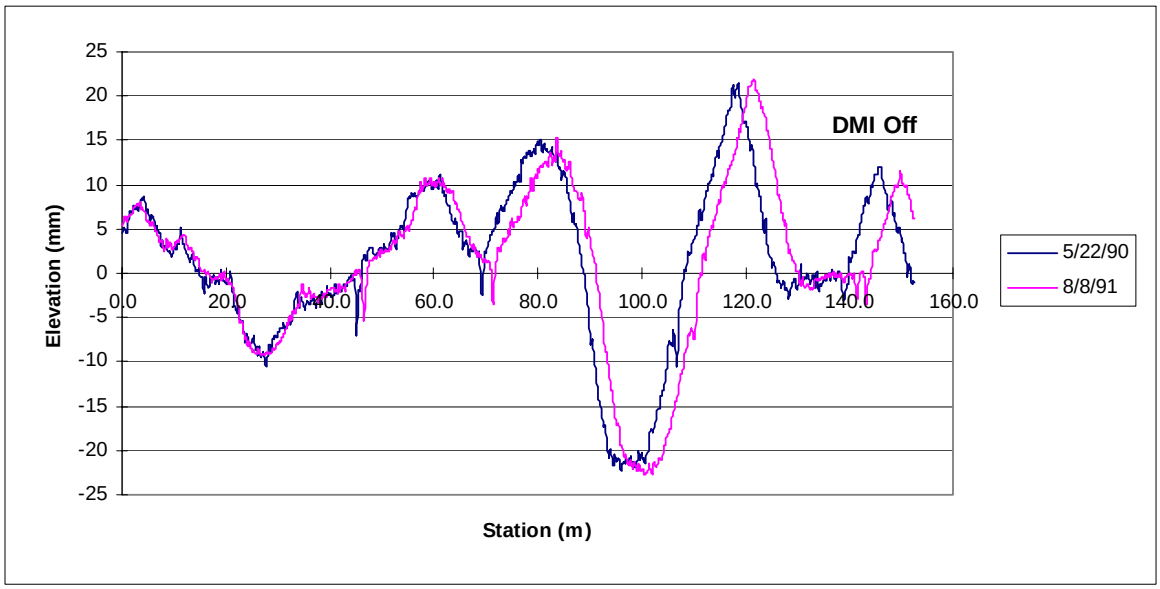

Figure C-2. Data collected with a correctly calibrated and a miscalibrated DMI.

When this problem is encountered, operator should check tire pressure of vehicle to ensure it is at the values given in section 2.2.3.4 of this manual. If the tire pressure is outside those limits, operator should adjust tire pressure and obtain a new set of measurements at the section. If the difference in the distance between the current data and previous data at the end of the section is less than or equal to 0.5 m for a GPS section, the current data set is considered to be acceptable. If the differences in the distances between the current visit and the previous visit is greater than 0.5 m, the operator should determine if the difference is occurring because the DMI is incorrect during the current visit or if it was incorrect during the previous visit. The following procedures can be used by the operator to make this determination.

1. The operator can determine if the DMI is calibrated correctly by running the section and then noting the distance between the event mark at the start of the section and end of the section that will be displayed in the green color MDR Run Screen. The event mark at the start of the section will generate a Reference Reset, and an event mark will be generated when the profiler passes the end of the section. If the length of the section obtained when the section is profiled using this procedure is within $\pm$ 0.3 m of 152.4 m, the DMI can be assumed to be working properly. However, there may be cases where the actual length of the site is not 152.4 m. So if the distance obtained using the described procedure is outside the specified limit, it cannot be concluded that the DMI is working incorrectly. If such a case is encountered the operator should follow the procedure described in the next step.

2. Currently it is expected that all test sections would have at least two previous profile data sets. The operator can check on the accuracy of the DMI for the previous visit by calling the office and asking the office personnel to compare the previous year data with other data that is available for the site. The purpose of this comparison is to determine if there is any error in DMI associated with the data from the previous visit. The office personnel should compare the relative position of the profile at the end of the section for previous visits to the section by the profiler, and convey that information to the operator. The office personnel together with operator can then use the available information to judge the accuracy of the DMI for the current data. If all the available data indicates that the DMI for the previous visit is accurate, the indications are that the DMI in the unit is out of calibration. The operator should proceed to another site, and compare the profile plots following the procedures described previously. If the data at that site also indicates the DMI is out of calibration, the DMI should be calibrated before further profile data are collected.

For SPS sites differences between runs can occur because of wheel path wander. This effect will usually be more pronounced in the sections that are located towards the end of the SPS section. When comparing profile data between two site visits at a SPS section, close attention should be paid to the first two sections in a SPS site. If the profile for the current data and the previous site visit data satisfies the criteria that were described previously at the first two sites, it can be concluded that the DMI is functioning correctly for the current visit. In such a case, a difference in distance of up to 1 m can be considered to be acceptable for the other sections in the SPS site.

3. Early Start of Data Collection

An early profile start can occur when the photocell triggers a reference reset prior to the start of the test section. It is possible for all repeat profile runs during a site visit to have the same starting location, but all are early starts. This problem can occur if there is a mark on the pavement that triggers data collection to start at the same location, but this location is before the beginning of the test section. When the current profile data are compared with those collected during the previous site visit, the early start problem can be easily identified by a clear shift in the two profile data sets. This profile comparison should be carried out using the multi-visit plot option of ProQual (see ProQual user manual). The early start problem is illustrated in Figure C-3, which shows the profile plot for a single run along the left wheel path conducted on three different dates -- April 8, 1990; October 18, 1990; and August 10, 1994. The profile plot for the last two dates have similar start locations, but that for the earlier date (April 8, 1990) is shifted to the left because of an early start. If the early start problem is caused by a mark on the pavement that is located prior to the pavement section, the operator can use the horizontal photocell to initiate data collection.

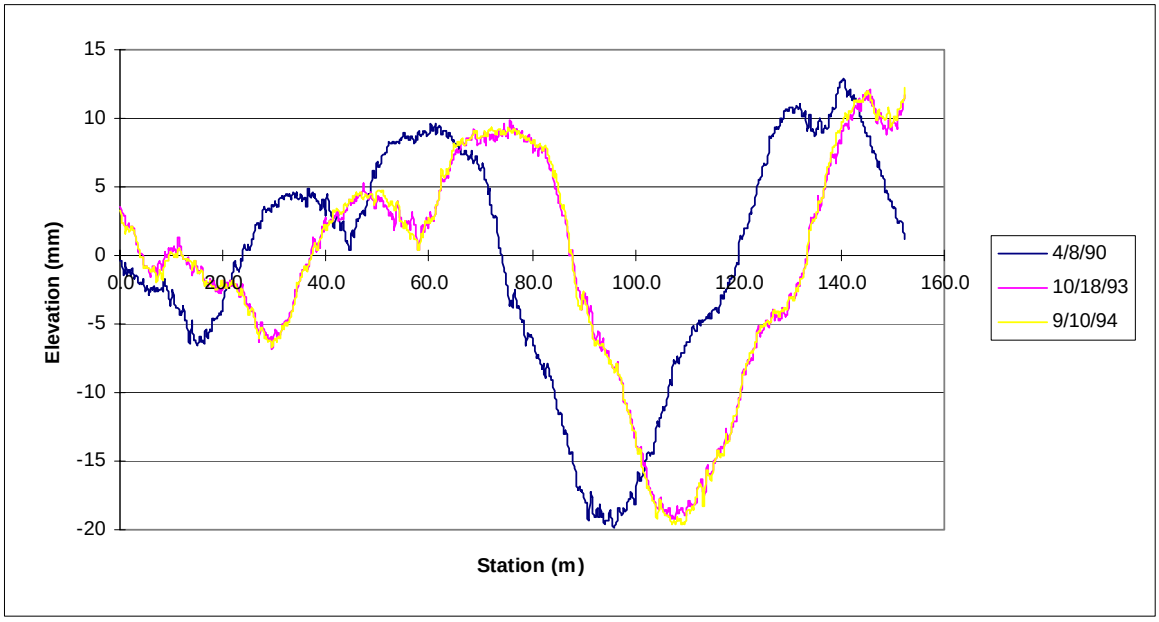

Figure C-3. Example of early profile start.

The early start problem can also occur in one or more runs within a profile data set collected during a single site visit. This problem can be easily identified by comparing the repeat profiler runs using the multi-run plot option in ProQual; one or more of runs will be shifted to left of the others if there is an early start. Although a plot illustrating the early start problem within a set of repeat runs is not included in this appendix, that plot is very similar to that shown in figure C-3. If an early start is detected in one or more profile runs, the operator should perform additional profile runs until a set of error free data (meeting the criteria described in section 2.2.8 of this manual) is obtained. If the early start problem is caused by a mark on the pavement that is

located prior to the pavement section, the operator can use the horizontal photocell to initiate data collection.

4. Different Profiles

The term “different profiles” is used to describe the occurrence of the following condition: (1) When operator compares repeat profile runs collected during single site visit, no problems are observed in the data (i.e., error free) and (2) when operator compares current data with that from previous site visit (also error free), the two sets of profiles appear to be different.

Such condition can be caused by rehabilitation or maintenance activities to the section between profiler site visits. It can also occur when the location of test section is incorrectly selected during one of the site visits.

Figure C-4 illustrates the case where rehabilitation has been performed on a test section between site visits. This figure shows a plot of the left wheel path profile obtained on two separate site visits -- September 10, 1991 and October 4, 1994. As can be observed, the two profiles are completely different. In this particular example, the profile differences were caused by placement of an overlay on the section some time between the two site visits. Figure C-4 can also be used to illustrate the case where the location of the test section has been incorrectly selected during one of the site visits; similar differences are seen in such a plot.

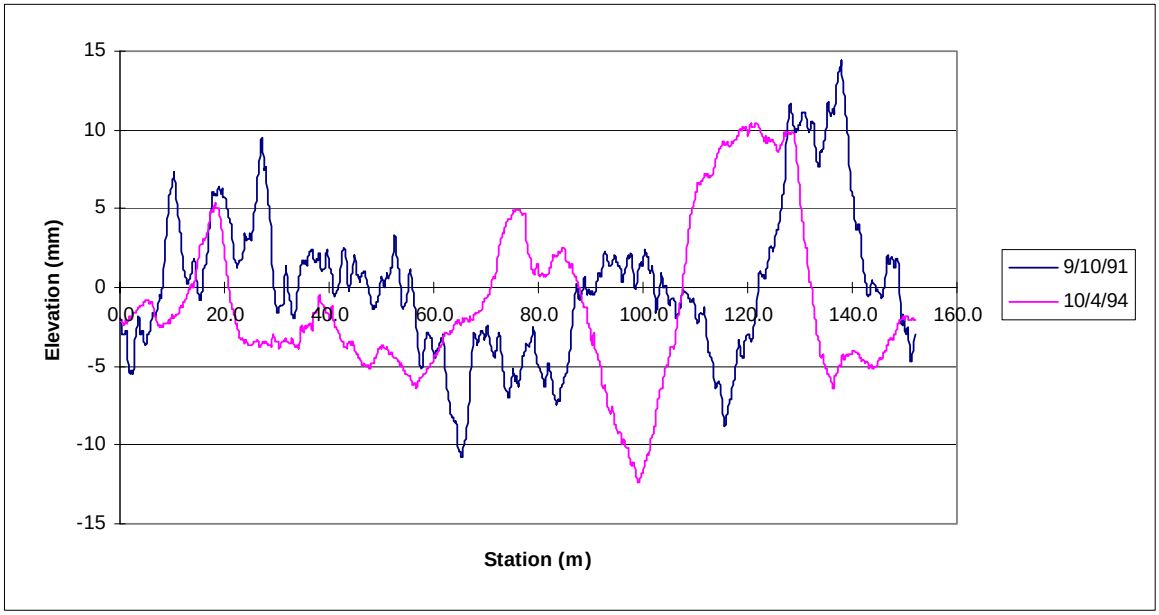

Figure C-4. Differences in profile due to rehabilitation of section.

If a case such as that shown in Figure C-4 is encountered, the operator should first verify that the test section location is correct. If such condition is encountered at a SPS section or at a GPS section that was profiled in conjunction with a SPS section, the operator should verify that the

stationing used for subsectioning is correct. If evidence of rehabilitation is noted at the section, it should be entered as an Operator Comment and also noted in the form Status of Regions Test Sections.

An example of the case where maintenance has occurred at a test section between site visits is illustrated in Figure C-5. This figure shows a plot of the left wheel path profile obtained on two separate site visits -- August 8, 1991 and August 5, 1992. As can be observed, the beginning of the profile for the two site visits are different indicating possible maintenance at the test section.

If a case such as that shown in Figure C-5 is encountered, the operator should look to see if there is evidence of maintenance activities such as patching within the test section. If evidence is found, the operator should indicate that maintenance has been performed on the test section in the Operator Comment Field (e.g., Possible maintenance in section) and also note it in the Status of Regions Test Sections Form.

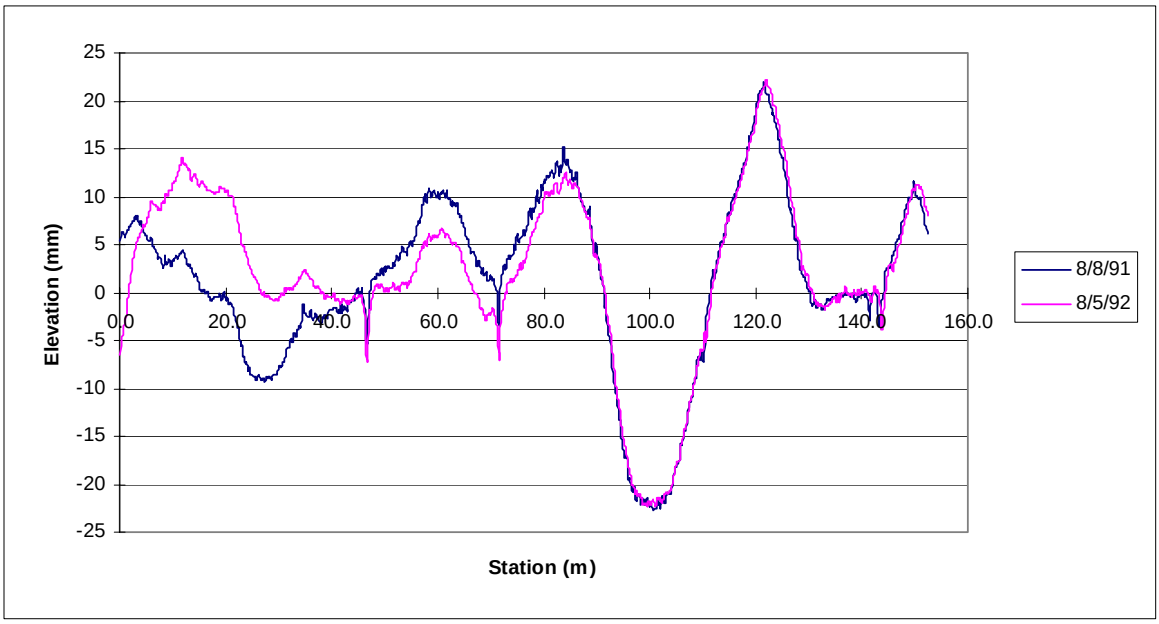

Figure C-5. Differences in profile due to maintenance of section.

APPENDIX D

STANDARD FORMS FOR PROFILER OPERATIONS

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DAILY CHECK LIST

ITEM
Under Hood
Fluids
Engine Oil
Brake
Windshield Washer Fluid
Radiator Coolant
Transmission
Exterior
Lights
Front
Rear
Emergency
Turning Signals
Strobe Bar
Flashing Signal Bar
Glass Cleaning
Windshield
Laser Sensor
Photocell
Underbody
Tires Properly Inflated
Fluid Leaks
Interior
Temperature Range

LTPP Profiler Operations **LTPP Profiler Field Activity Report** **Form PROF-1**	**Region** **[___ ___]** **State Code** **[___ ___]** **LTPP Section ID** **[___ ___ ___ ___]**

File Name: [___ ___ ___ ___ ___ ___ ___ ___ ___] **Surface: [___ - ___ ___]** **LTPP Experiment Code: [___ ___ ___ - ___]**

Route/Highway Number: _____

Date: [___ ___ / ___ ___ ___ / ___ ___ ___ ___] **Time Zone: [___ ___ ___]** **Sheet Number:** _____

Laser Check Performed? _____ **(Initial)** **Values From Check (mm):** **Left** _____ **Center:** _____ **Right:** _____

Computer Time Set to Correct Local Time: _____ **(Initial)** **Accelerometer Calibration Values Checked:** _____ **(Initial)**

Tire Pressure: Left: _____ Right: _____ Comments: _____

Bounce Test

	Left	Center	Right
Static			
Dynamic			
Difference			

	Time	**Odometer**
Start Travel	___ ___ : ___ ___	_____
Begin Test	___ ___ : ___ ___	_____
End Test	___ ___ : ___ ___	_____
End Travel	___ ___ : ___ ___	_____

Down Time: _____ (Hours / Minutes) Reason(s): _____

Run Number	Average IRI
1	_____
2	_____
3	_____
4	_____
5	_____
6	_____
7	_____
8	_____
9	_____

10 % IRI Check After Testing

	Date	Left	Right	Average
Current Visit (R_{new}):	_____	_____	_____	_____
Prior Visit (R_{old}):	_____	_____	_____	_____
Percent Change [$100X(R_{new} - R_{old})/R_{old}$]:		_____	_____	_____

Comment: _____

Additional Remarks Regarding Testing: _____

Profile Crew: Driver: _____ Operator: _____

LTPP Profiler Operations
Status of Regions Test Section
Form PROF-2

LTPP ID Number	Experiment Type (e.g., GPS)	Date	Operator	Route	Direction	Mile Post	Current IRI			Paint Marks	Delineators	Signs	Comments (e.g., Any Rehab or Maintenance?
							Left	Right	Avg				

LTPP Profiler Operations
Profiler Log
Form PROF-3

Date	Noted Problem	Action Taken and Date

LTPP Profiler Operations **LTPP Major Maintenance/Repair** **Work Order** **Form PROF-4**	**Region** [___ ___] **Serial Number** [___ ___ ___ ___ ___] **Odometer** [___ ___ ___ ___ ___ ___] **Scheduled** [YES / NO]

Problem Identification / Scheduled Maintenance Equipment: _____ Description: _____	Performed By: _____ Date: [__ __ / __ __ __ / __ __ __ __] Start Time: [__ __ : __ __] End Time: [__ __ : __ __]
Troubleshooting Description: _____	Performed By: _____ Date: [__ __ / __ __ __ / __ __ __ __] Start Time: [__ __ : __ __] End Time: [__ __ : __ __] Hours: _____
Reporting Referred to: _____	Date: [__ __ / __ __ __ / __ __ __ __] Time: [__ __ : __ __]
Actions (Return/Order Parts): _____	Date: [__ __ / __ __ __ / __ __ __ __] Time: [__ __ : __ __]
Service Description (Repairs Performed/Replacement Part Information): _____ Agency Performing Maintenance: _____	Performed By: _____ Date: [__ __ / __ __ __ / __ __ __ __] Start Time: [__ __ : __ __] End Time: [__ __ : __ __] Hours: _____ Total Cost: [$ __ __ __ __ __ . __ __]
Verification Description (Check/Calibration): _____	Performed By: _____ Date: [__ __ / __ __ __ / __ __ __ __] Start Time: [__ __ : __ __] End Time: [__ __ : __ __] Hours: _____
Return to Service Status: _____	Performed By: _____ Date: [__ __ / __ __ __ / __ __ __ __]

LTPP Profiler Operations Calibration Form (Laser Sensors Checked Simultaneously) Form PROF-5	**Region** [___ ___] **Date** [___ ___ / ___ ___ ___ / ___ ___ ___ ___] **Time** [___ ___ : ___ ___] **Serial Number** [___ ___ ___ ___ ___]

Operator(s): _____ Location: _____

Accelerometer Calibration

Calibration Factor	Accel #1	Accel #2	Accel #3
Prior			
New			

Bounce Test After Accelerometer Calibration

	Left	Center	Right
Static			
Dynamic			
Difference			

Laser Calibration Check

Block Position	Parameter	Row Number	Sensor		
			Left #1	Right #2	Center #3
25 mm	Actual Height, Block A	(1)			
	Value Entered to Computer	(2)	25.00	25.00	25.00
	Adjustment Value (1) - (2)	(3)			
	Dif Blk from Computer	(4)			
	Adjusted Dif Blk (4) - (3)	(5)			
50 mm	Actual Height, Block A	(6)			
	Value Entered to Computer	(7)	50.00	50.00	50.00
	Adjustment Value (6) - (7)	(8)			
	Dif Blk from Computer	(9)			
	Adjusted Dif Blk (9) - (8)	(10)			
75 mm	Actual Height, Block A	(11)			
	Value Entered to Computer	(12)	75.00	75.00	75.00
	Adjustment Value (11) - (12)	(13)			
	Dif Blk from Computer	(14)			
	Adjusted Dif Blk (14) - (13)	(15)			
100 mm	Actual Height, Block A	(16)			
	Actual Height, Block B	(17)			
	Value Entered to Computer	(18)	100.00	100.00	100.00
	Adjustment Value (16) + (17) - (18)	(19)			
	Dif Blk from Computer	(20)			
	Adjusted Dif Blk (20) - (19)	(21)			

Air Temperature Probe Calibration Check

Verification Medium	ASTM Thermometer	Air Temperature Probe
Ambient Air		

Distance Measuring Instrument Calibration

Begin Time: [___ ___ : ___ ___] End Time: [___ ___ : ___ ___]

Air Pressure	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
Left						
Right						

Prior Distance Calibration Factor: [__ __ __ __] New Distance Calibration Factor: [__ __ __ __]

Comments: _____

LTPP Profiler Operations Calibration Form (Laser Sensors Checked Individually) Form PROF-6	**Region** [___ ___] **Date** [___ ___ / ___ ___ ___ / ___ ___ ___ ___] **Time** [___ ___ : ___ ___] **Serial Number** [___ ___ ___ ___ ___]

Operator(s): _____ Location: _____

Accelerometer Calibration

Calibration Factor	Accel #1	Accel #2	Accel #3
Prior			
New			

Bounce Test After Accelerometer Calibration

	Left	Center	Right
Static			
Dynamic			
Difference			

Laser Calibration Check

Block Position	Parameter	Sensor		
		Left #1	Right #2	Center #3
25 mm	Actual Height of Block			
	Dif Ht Value			
	Dif Blk Value			
50 mm	Actual Height of Block			
	Dif Ht Value			
	Dif Blk Value			
75 mm	Actual Height of Block			
	Dif Ht Value			
	Dif Blk Value			
100 mm	Actual Height Block 1			
	Actual Height Block 2			
	Dif Ht Value			
	Dif Blk Value			

Air Temperature Probe Calibration Check

Verification Medium	ASTM Thermometer	Air Temperature Probe
Ambient Air		

Distance Measuring Instrument Calibration

Begin Time: [___ ___ : ___ ___] End Time: [___ ___ : ___ ___]

Air Pressure	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
Left						
Right						

Prior Distance Calibration Factor: [__ __ __ __] New Distance Calibration Factor: [__ __ __ __]

Comments: _____

LTPP Profiler Operations

Profiling of WIM Sections

Data Summary Sheet

Form PROF-7

State Code: _____ SHRP ID Assigned to WIM Location: _____

Date Tested: __ __ / __ __ __ / __ __ __ __ Pavement Type: _____

Operator/Driver: _____

Test Reason: Verification _____ Acceptance Testing _____ Annual Check _____

_____ m distance from Station _____ + _____ m of LTPP Section _____

Profiler Photocell Offsets: Vertical: _____mm Horizontal: _____mm

Run Number	Location (Note 1)	Offset Reference and Distance (Note 2)	Time at Start of Run	File Name	Error Free?
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

Note 1: Indicate location of run -- WP for wheel path, Left for left of wheel path, Right for right of wheel path

Note 2: For runs obtained left and right of wheel path, indicate the offset and reference for the offset (e.g., for runs left of the wheel path - 0.75 m left of wheel path; for runs right of wheel path - 0.5 m from right shoulder stripe).

Pavement condition at time of data collection that may have influenced profile measurements (e.g., crack sealant condition, joint sealant condition, distresses within section).

Other information related to WIM site that may have influenced data collection (e.g., length of sensor array for multiple sensor configuration).

APPENDIX E

PROCEDURE FOR DETERMINING PHOTOCELL OFFSET

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APPENDIX E - PROCEDURE FOR DETERMINING PHOTOCELL OFFSET

INTRODUCTION

This appendix describes the procedure for determining the offsets of the vertical and horizontal photocells in the ICC profiler.

SITE PREPARATION

The test procedure involves attaching an artificial bump target to the pavement and then collecting a series of profiles with the center laser sensor passing over the bump. The testing location should be a straight stretch of road with very low traffic volume. As operator safety is of utmost concern, the site location should not place the operator in harm of traffic while attaching the target to the pavement, nor should the traffic at the location present the possibility of disturbing the target while the testing is being performed. The location should be selected where it is possible to safely attain a profile speed of 80 km/h. The ideal location would have a new or recently overlaid pavement surface with no significant pavement distresses within 15m of the target point. Rough surface textures such as chip seals or severe raveling should be avoided.

Once a location for testing has been selected, it is necessary to establish a beginning section mark. Place an appropriate 52 to 102 mm wide strip of white or silver adhesive tape at the testing location on the pavement, such that it is perpendicular to the direction of travel and in a location that will be detected by the vertical photocell when the profiler is driven over the location. Select a suitable bump target from a length of wood with the dimensions 13 mm thick, 38 mm wide and 750 mm long. Place the bump target on the pavement parallel to previously established starting stripe in a manner that the 13 mm dimension is vertical to the pavement, the approach edge of the 38 mm dimension is 114 mm from the leave edge of the starting stripe, and the target spans the path that will be traversed by the center laser sensor (approximately mid-lane). The bump should be positioned in such a way that the right or left tires will not run over the bump during profile runs. Affix the bump target to the pavement with an appropriate adhesive tape such that the adhesive tape will not affect the profile collected by the center laser. Figure E1 illustrates the positioning of the section stripe and bump target.

Thereafter, the horizontal photocell target has to be established in relation to the starting stripe. Place the horizontal photocell target on the shoulder of the road in a position that will minimize the potential for disruption during testing. Align the horizontal photocell target such that the leave edge of the reflector is in line with the leave edge of the stripe placed on the pavement. The placement of the vertical and horizontal photocell targets is intended to replicate standard profile operations. Figure E2 illustrates the proper placement of the horizontal photocell target in relation to the starting stripe and bump target.

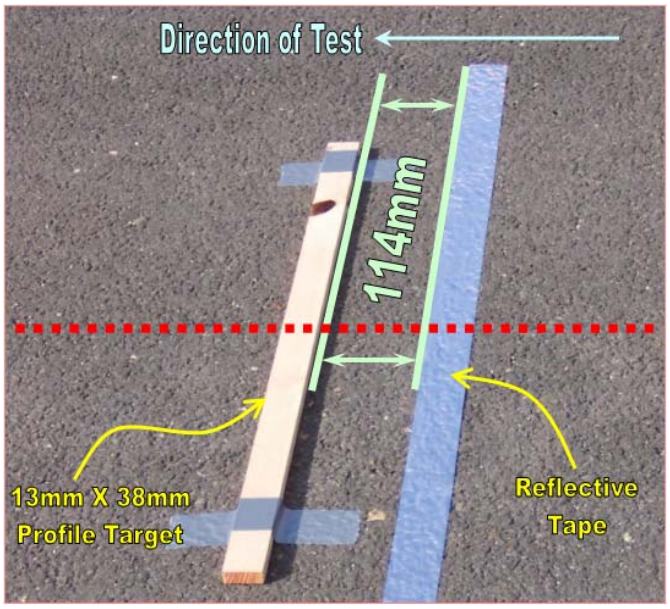

Figure E1. Section starting stripe and bump target placed on the pavement.

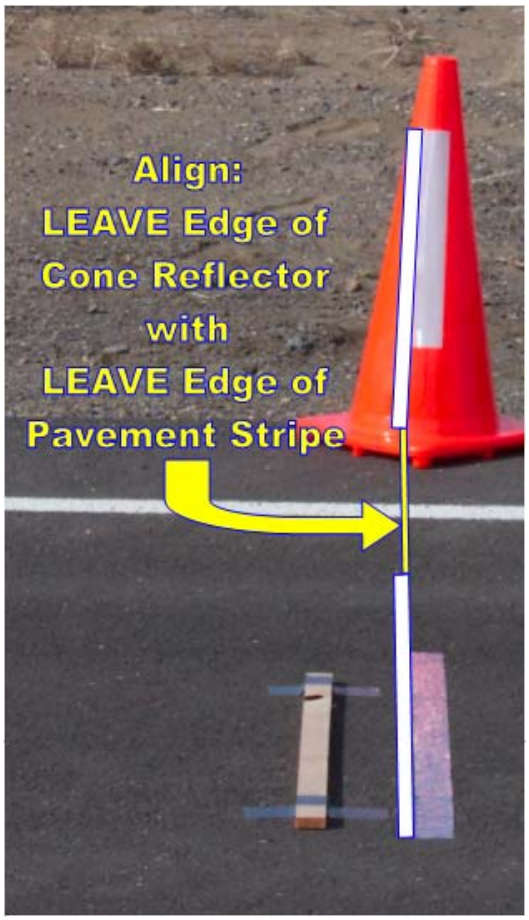

Figure E2. Placement of vertical photocell target in relation to section starting location.

PROFILE DATA COLLECTION FOR DETERMINING PHOTOCELL OFFSET

The photocell offset determination is performed in a manner consistent with standard LTPP profile data collection procedures. It is important that the distance measurement instrument (DMI) has been calibrated beforehand, in accordance with section 2.5.2 of this manual, and the tires in the profiler are sufficiently warmed up with air pressures matching the pressure noted during the DMI calibration. Ideally, the full range calibration check of the profiler's laser sensors will have been performed, in accordance with section 2.5.4 of this manual, prior to performing this testing. However, if the full calibration check has not been performed within two days of this testing, perform the standard daily height sensor check and bounce test in accordance with section 2.3.3 of this manual. For this testing, both photocells will be active simultaneously, but two sets of profiles (five runs each set) will be collected for computing offsets for each photocell. For this testing, the profile data of concern is primarily in the region of the bump target; therefore, it is not necessary to collect a large amount of profile data during each run. Only 40 to 50 m of profile data before and 20 m of profile data after the section start stripe need to be collected. Although processing of the profiles collected during this testing will be described in the next section, verification of the suitability of the profiles should be performed by reviewing the profiles in the ICC WinGraph software and by examining the occurrences of events in the MDR data collection software.

The following procedure should be followed for the collection of this data:

(A) From the "Options" menu of the ICC MDR data collection software, select the "ICC System Parameters…" option to set the desired photocell parameters. In the "Target…" option, set the photocell parameters as follows for the appropriate set of profiles:

Horizontal Photocell

For the horizontal photocell offset runs, set Target 4=F9 and Target 5=F5 as shown in figure E3.

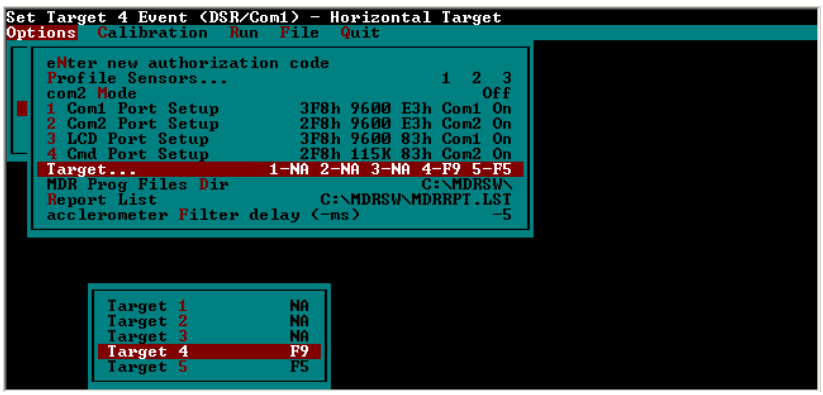

Figure E3. Photocell target parameters for performing horizontal photocell offset determination.

Vertical Photocell

For the vertical photocell offset runs, set Target 4=F5 and Target 5=F9 as shown in Figure E4.

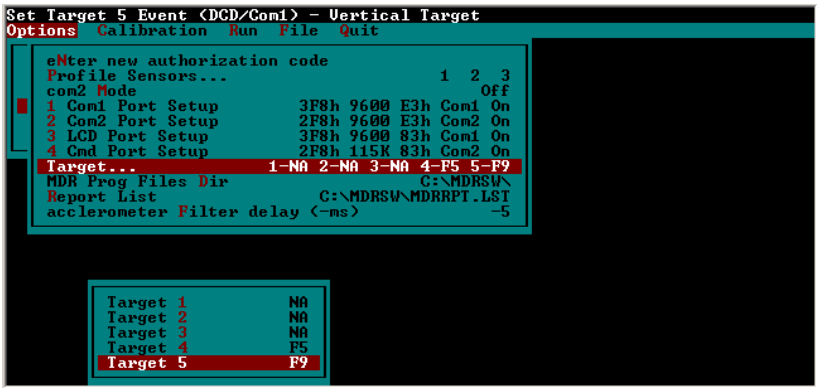

Figure E4. Photocell target parameters for performing vertical photocell offset determination.

(B) From the “Run” menu of the MDR software, specify an appropriate data directory where the profile data can be stored for easy access and backup.

(C) From the “Run” menu of the MDR software, specify an appropriate file name for the profiles to be collected. Although the format of the file name is not critical for the purpose of this testing, it is necessary that the file name be logical so that the analysis described in next section can be completed without the photocell offsets for each photocell being confused. It is recommended that the file name format from section 2.2.7.3 of this manual be used, with the visit identifier indicating which photocell is being tested.

(D) From the “Run” menu of the MDR software, any relevant parameters should be set in the “Edit parameters – LTPP…” option.

(E) Make five profile runs over the artificial bump target.

1. Attain a speed of 80 km/h at least 300 m before the bump target.
2. From the “Run” menu of the MDR software, select the “Go” option to enter the Run screen well in advance of the target.
3. At least 40 m prior to the start stripe, press the “F3” key to start the DMI, and the “F6” key to arm the photocells.
4. Profile over the bump target, and once the profiler is 20 m past the target, press the “F3” key to stop data collection.
5. In the run screen, review the Reference Reset and other events for logic and to assure that the assigned photocell in step A performed the reference reset.
6. Press the “F10” key to exit the run screen, and save the data files to the hard disk drive.

7. Repeat steps 1 through 6 until five acceptable runs for the assigned photocell have been collected.

(F) Repeat steps A through E for the other photocell.

PHOTOCELL OFFSET CALCULATION

Analysis of the profile data will be performed using the ICC Road Profiler Reporting Program, Winrp90l.EXE (WinReport) Version 1.09 that is stored on the profiler's System 2 (MDR) hard disk drive. WinReport is a Windows™ based program and requires that System 2 be booted in Windows 98 in order to run it. The program is capable of using configuration files to store frequently used report parameters, but this procedure does not require that a configuration file be used. The following steps indicate the process necessary to determine the horizontal and vertical photocell offset values:

(A) Launch the WinReport program by navigating to the C:\mdrsw\ directory and opening the Winrp90l.EXE program. The WinReport program launches a window that is similar to that shown in figure E5.

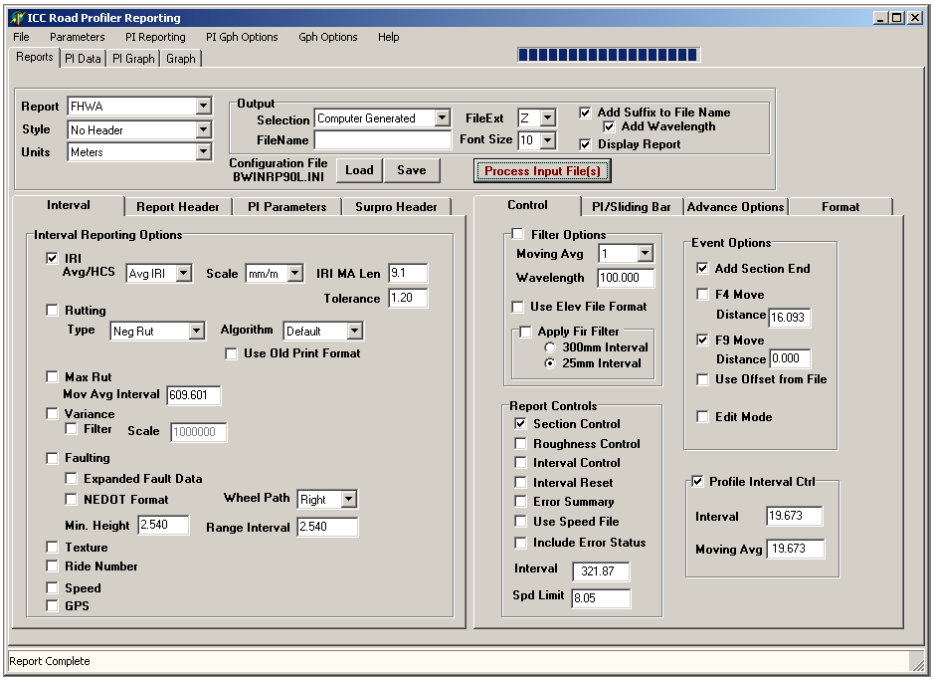

Figure E5. The WinReport program for analyzing profile data for the determination of photocell offset values.

(B) Set the following parameters in the WinReport program to perform the necessary analysis:

1. Select the following parameters on the "Reports," and "Interval" and "Control" tabs as shown in figure E5. (The "Reports" tab is the primary tab on this window - the only

primary tab used for this analysis - and the “Interval” and “Control” tabs are the left and right secondary tabs, respectively.):

(a) Select FHWA from the Report pull down list.
(b) Select No Header from the Style pull down list.
(c) Select Meters from the Units pull down list.
(d) Select Computer Generated from the Selection pull down list.
(e) Select Z from the FileExt pulldown list.
(f) Check the Display Report Box.
(g) Verify that Font Size is 10, the Add Suffix to File Name box is checked and the Add Wavelength box is checked.
(h) On the interval tab, verify that only the IRI box is checked. Items on the “Interval” tab are not essential and will not influence the outcome of this analysis - the IRI box is specified for selection because some versions of this software require at least one box on this tab to be checked, while some versions of this software may work with no boxes checked. “The Report Header,” “PI Parameters,” and “Surpro Header” tabs are not used for the purposes of this analysis.
(i) On the “Control” tab, verify that the Filter Options check box is not selected.
(j) On the “Control” tab, verify that the Section Control box is checked and all other items in the Report Controls section are not checked. The values for Interval and Spd Limit are not essential.
(k) On the “Control” tab, in the Event Options section, verify that the Add Section End and F9 Move boxes are selected. The F9 Move Distance should be 0.0. Verify that the F4 Move, Use Offset from File, and Edit Mode are not selected. The F4 Move Distance is not essential.
(l) Verify that the Profile Interval Ctrl section is checked and that the Interval and Moving Avg are set to 19.673.

2. Select the following parameters on the “Advanced Options” tab as shown in figure E6.
(a) Verify that the Height Data Only box is checked.
(b) Check the FromTo Section box and set the first value to -1 and the second value to 5.
(c) Verify that the Max Delta Profile value is 0.07620.
(d) Verify that all other boxes are not checked and that the Position SF value is left blank.

(C) Select the “Process Input File(s)” button.

(D) A file selection window will appear similar to figure E7, and the five profile data files for the appropriate photocell can be highlighted and the “Open” button selected. The software will perform the analysis on each data file individually.

(E) At the conclusion of the data analysis, the WinReport program will open WordPad windows to display the profile data in text format for the five runs similar to what is shown in figure E8.

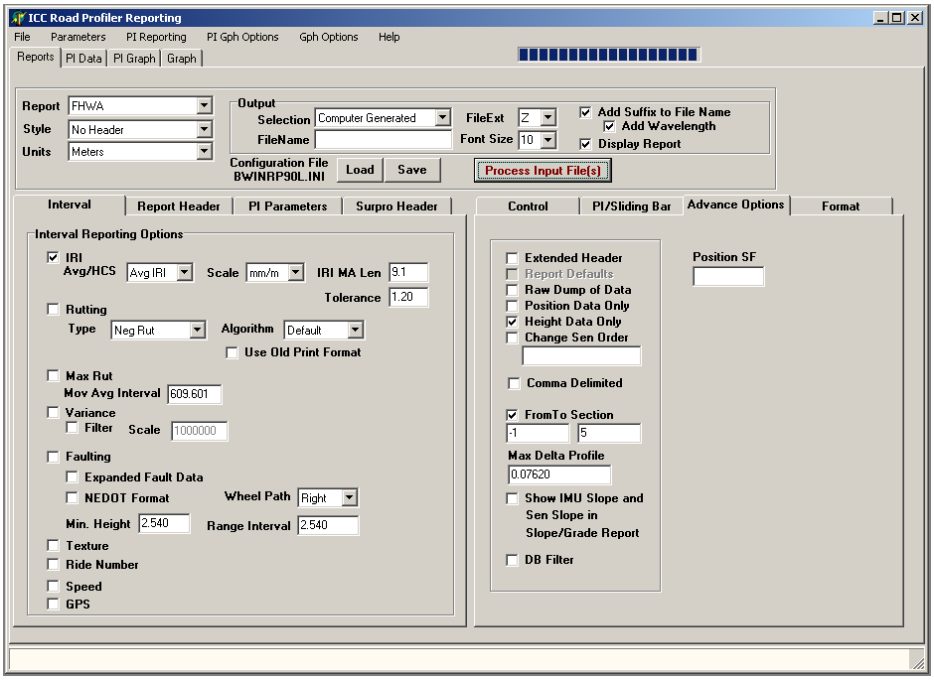

Figure E6. Parameters set in the WinReport program Advanced Options tab for analyzing profile data for the determination of photocell offset values.

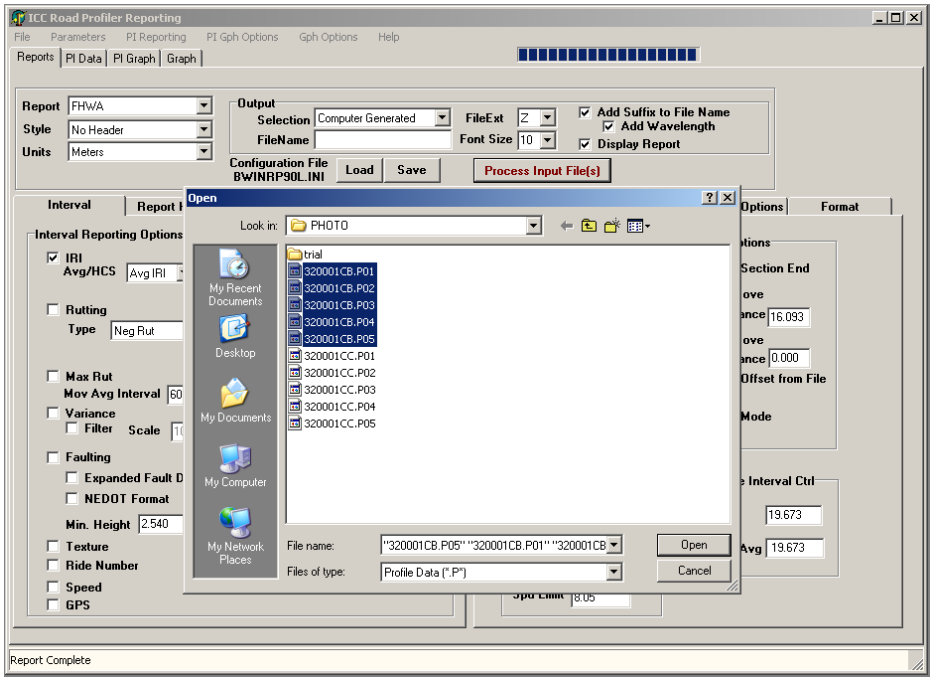

Figure E7. File selection window from WinReport program.

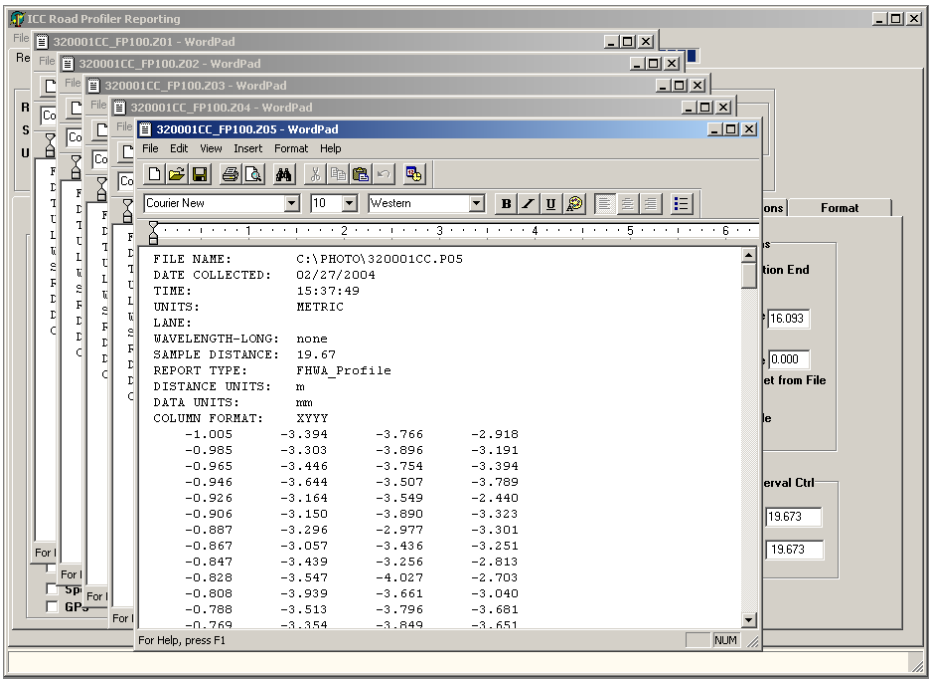

Figure E8. Text format profile data displayed in WordPad window resulting from analysis performed by WinReport program.

(F) Scroll down through the profile elevations in each WordPad window until the reference reset (REF_RST) event mark is visible as shown in figure E9.

(G) Scan the center profile elevations (third column from left in text file) for the point after the reference reset where the 13 mm bump is apparent in comparison to the remainder of the profile elevations (as highlighted in figure E9).

(H) Record the distance (first column from left in text file) for the first profile elevation that shows the elevation change for the bump target for each of the five profile runs. (Note: The REF_RST may appear on a line that precedes the actual 0.0m distance. For the purposes of this analysis, all distance measurements are referenced from the zero distance point indicated in the file.) In figure E9 this value is 0.256m.

(I) If all five distance values are within 20 mm of each other, average the five values. If one of the values differs by more than 20 mm from the other four values, discard that result and average the remaining four values. If more than one value differs by more than 20 mm from the remaining values, discard the data, assess the condition of the bump target and photocell target positioning, and perform the testing again as described in ‘Profile Data Collection For Determining Photocell Offset.’

(J) Repeat steps C through I for the second set of profiles relating to the other photocell. Another set of text files will be displayed for the other photocell similar to that shown in figure E10.

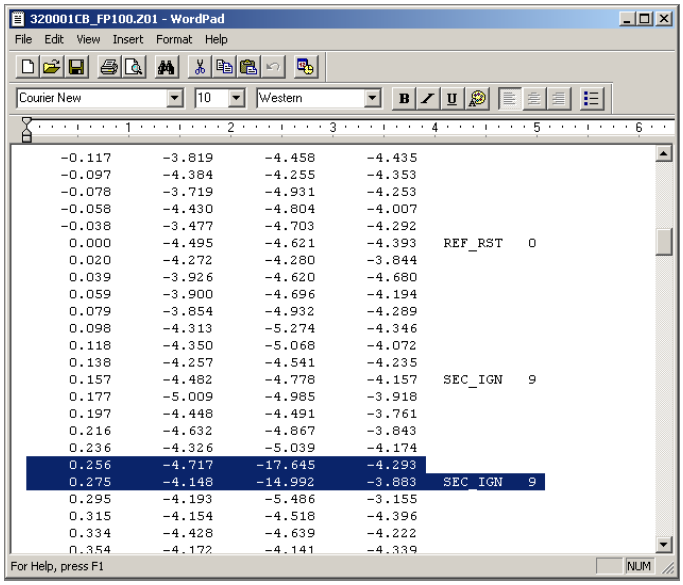

Figure E9. Text format profile data displayed in WordPad window showing event marks and elevation change resulting from bump target while testing the horizontal photocell.

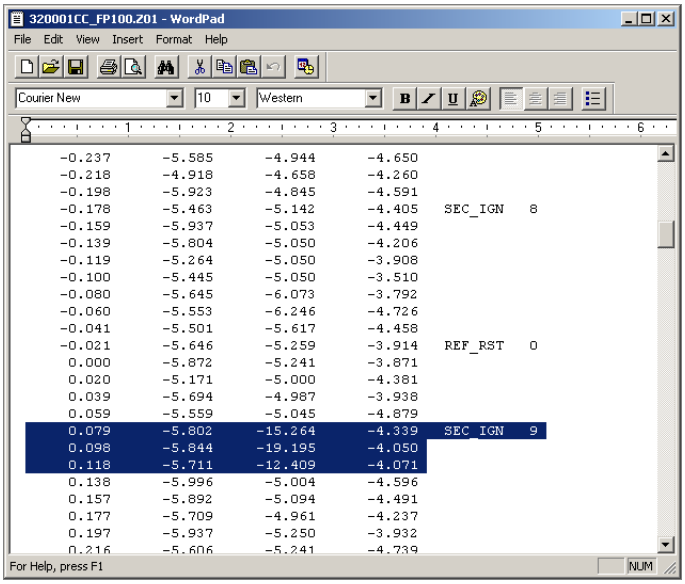

Figure E10. Text format profile data displayed in WordPad window showing event marks and elevation change resulting from bump target while testing vertical photocell.

(K) The results from step I provide the photocell offsets for each photocell. The target bump was placed on the pavement 114 mm upstream of the section starting stripe and the offset values obtained from this experiment reflects the distance at which the first profile elevation value fall on the bump (within an acceptable range). The computed offset values when rounded to the nearest 25 mm are the vertical and the horizontal photocell offsets.

APPENDIX F

PROCEDURE FOR DETERMINING DIPSTICK® FOOTPAD SPACING

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APPENDIX F - PROCEDURE FOR DETERMINING DIPSTICK® FOOTPAD SPACING

BACKGROUND

Testing performed in the field has indicated that the spacing between the centerline of the footpads in various Dipsticks® that are used in the LTPP program is not exactly 304.8 mm. Therefore, each RSC is required to perform a field test annually to determine the footpad spacing of each Dipstick® in their possession. This Appendix describes procedures for performing the field test and the procedure for computing the footpad spacing of the Dipstick® from the data obtained from the test.

TEST PLAN

This test should be performed on a smooth asphalt or portland cement concrete pavement that is free of distress. Use the following procedure to layout the section and perform the test.

1. Layout a 30.48 m long test section. Use a cloth tape that is in a good condition to layout the section. A longitudinal chalk line should be marked on the section. When marking the chalk line, extend the chalk line 0.3 m past the end on the test section. Two transverse chalk lines should be marked perpendicular to the longitudinal survey line at the start (0 m) and the end (30.48 m) of the section. Figure F1 shows the layout of the test section.

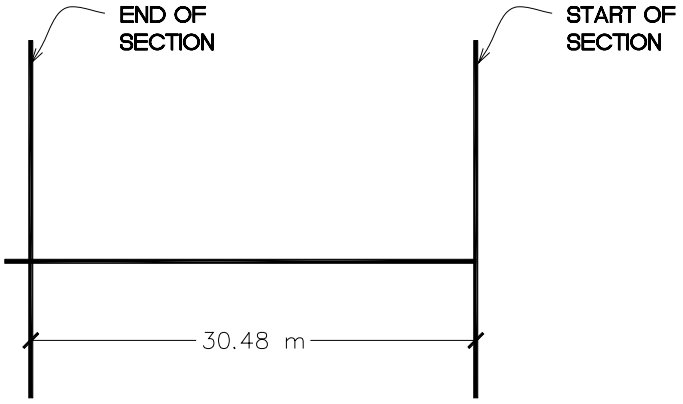

Figure F1. Test section layout.

2. Measure the diameter (in mm) of each footpad in the Dipstick® using a caliper and record the values.

3. Place the back end of the back footpad of the Dipstick® in line with the transverse line marked at the beginning of the test section (see figure F2).

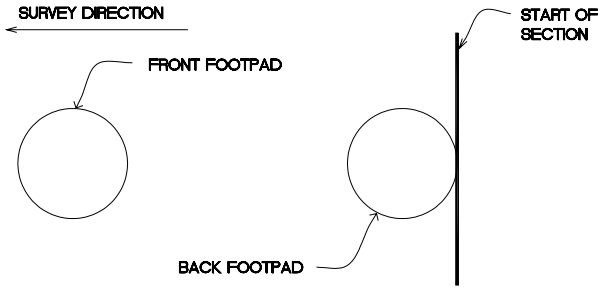

Figure F2. Location of back footpad of Dipstick® at start of the section.

4. Walk the Dipstick® along the section following the procedures outlined in section 3.3.3 of this manual. After taking the 100th reading, measure the distance (in mm) from the back end of the front footpad of the Dipstick® to the transverse line that was marked at the end of the section. The following possible scenarios can occur:

   (a) Back end of front footpad is past the transverse line at the end of the test section (see figure F3). The distance to be measured is the distance 'X' indicated in figure F3. Measure this distance (in mm).
   (b) Back end of the front footpad is before the transverse line at the end of the section (see figure F4). The distance to be measured is the distance 'X' indicated in figure F4. Measure this distance (in mm).
   (c) Back end of the front footpad is exactly on the transverse line at the end of the section, in which case the offset 'X' is zero.

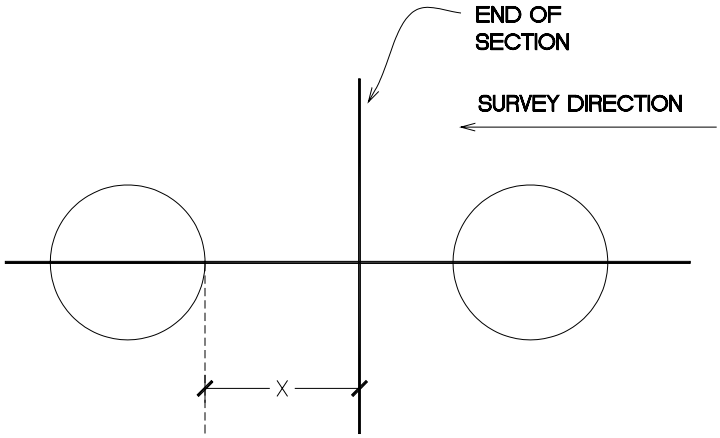

Figure F3. Back end of front footpad is past the end of the test section when last reading is obtained.

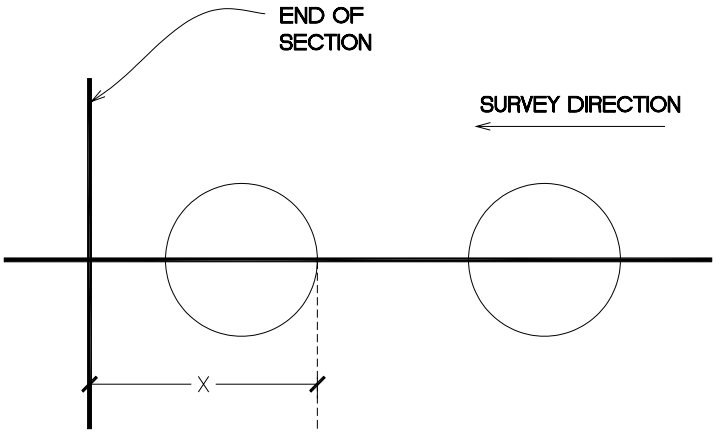

Figure F4. Back end of the front footpad is before the end of the test section when last reading is obtained.

5. Repeat steps 3 and 4 two additional times.

COMPUTATION OF DIPSTICK FOOTPAD SPACING

1. Compute the footpad spacing for the Dipstick® for each run using the following procedure:

   If back edge of front footpad was past the end of the section when the last reading was obtained (case shown in figure F3), use the following formula to compute footpad spacing.

   Footpad spacing (mm) = (30,480 + X) / 100, where X is in mm.

   If back edge of front footpad was before the end of the test section when the last reading was obtained (case shown in figure F4), use the following formula to compute footpad spacing.

   Footpad spacing (mm) = (30,480 - X)/100, where X is in mm.

   If the back edge of the front footpad is exactly in line with the end of the section, the footpad spacing is 304.8 mm.

   Compute the average footpad spacing for each Dipstick® by averaging the values obtained for the three runs (to two decimal places).

2. Maintain a log in the RSC office that indicate the following information: date when testing was performed, Dipstick® model number, diameter of the Dipstick® footpads, results from the field tests, footpad spacing, for each run and the average footpad spacing. The suggested

format of the log is shown in the following table (date of testing should be included in the log).

Dipstick Model	Serial Number	Diameter of Footpad (mm)		Test Number	Offset at End of Section[(1)] (mm)	Footpad Spacing (mm)	Average Footpad Spacing (mm)
		Front	Back				
				1			
				2			
				3			
				1			
				2			
				3			
				1			
				2			
				3			

Note 1: Offset is positive if back end of front footpad is past end of section at last reading,
offset is negative if back end of front footpad is before end of the section when last reading is obtained

3. Write the average Dipstick® footpad spacing and date when testing was performed on a sheet of paper and securely tape it to the inside of the Dipstick® carrying case.

APPENDIX G

STANDARD FORMS FOR DIPSTICK® MEASUREMENTS

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LTPP Dipstick Data Collection Form Longitudinal Profile Form DS-1 Measurement Information and Closure Computation	State Code [__ __] LTPP Section [__ __ __ __] Date (dd/mmm/yy) __ __ / __ __ __ / __ __

Dipstick Serial Number: [_ _ _ _ _] Dipstick Model Number: 1500/2000 Dipstick Fitted With 32 mm footpads? ___

Footpad Spacing (mm): [_ _ _ . _ _] Operator: [_ _] Recorder: [_ _]

Site Type: GPS/SPS Surface Type: [_ - _ _] Pavement Condition: V.GOOD/GOOD/FAIR/POOR

Road Name:_____ Lane: Inside/Outside

Direction: NORTH/EAST/SOUTH/WEST Cloud Conditions: CLEAR/P. CLOUDY/CLOUDY Temperature: ____ °C

Weather Comment: _____

Start Time (military): __ __ : __ __ Stop Time (military): __ __ : __ __

Closure Error Computation

Right Wheel Path		Left Wheel Path		
No	Elevation Sum	No	Elevation Sum	
O1		I1		
O2		I2		
O3		I3		**Traffic Control**
O4		I4		**Crew:**
O5		I5		
O6		I6		
O7		I7		
O8		I8		
O9		I9		
O10		I10		
O11		I11		
O12		I12		
O13		I13		**Other Personnel**
O14		I14		**At Site:**
O15		I15		
O16		I16		
O17		I17		
O18		I18		
O19		I19		
O20		I20		
Total O1 to O20	OA	Total I1 to I20	IA	
Transverse Sum T2	OB	Transverse Sum T1	IB	**Closure Error**
Total OA+OB	OC	Total IA + IB	IC	OC+IC

LTPP Dipstick Data Collection Form Longitudinal Profile Form DS-2 Reading 1 to 100	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Reading No.	Reading (mm)		Reading No.	Reading (mm)		Reading No.	Reading (mm)		Reading No.	Reading (mm.)	
	RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑
1			26			51			76		
2			27			52			77		
3			28			53			78		
4			29			54			79		
5			30			55			80		
6			31			56			81		
7			32			57			82		
8			33			58			83		
9			34			59			84		
10			35			60			85		
11			36			61			86		
12			37			62			87		
13			38			63			88		
14			39			64			89		
15			40			65			90		
16			41			66			91		
17			42			67			92		
18			43			68			93		
19			44			69			94		
20			45			70			95		
21			46			71			96		
22			47			72			97		
23			48			73			98		
24			49			74			99		
25			50			75			100		
Sum	O1	I1		O2	I2		O3	I3		O4	I4

Transverse Closure Measurements from Left Wheel Path to Right Wheel Path at Station 0+00

	Transverse Position							Sum
	LWP-1	1-2	2-3	3-4	4-5	5 - CC	CC - RWP	
Reading (mm)								T1

LTPP Dipstick Data Collection Form Longitudinal Profile Form DS-3 Reading 101 to 200	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Reading No	Reading (mm)		Reading No	Reading (mm)		Reading No	Reading (mm)		Reading No	Reading (mm)	
	RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑
101			126			151			176		
102			127			152			177		
103			128			153			178		
104			129			154			179		
105			130			155			180		
106			131			156			181		
107			132			157			182		
108			133			158			183		
109			134			159			184		
110			135			160			185		
111			136			161			186		
112			137			162			187		
113			138			163			188		
114			139			164			189		
115			140			165			190		
116			141			166			191		
117			142			167			192		
118			143			168			193		
119			144			169			194		
120			145			170			195		
121			146			171			196		
122			147			172			197		
123			148			173			198		
124			149			174			199		
125			150			175			200		
Sum	O5	I5		O6	I6		O7	I7		O8	I8

LTPP Dipstick Data Collection Form Longitudinal Profile Form DS-4 Readings 201 to 300	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Reading No.	Reading (mm)		Reading No.	Reading (mm)		Reading No.	Reading (mm)		Reading No.	Reading (mm)	
	RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑
201			226			251			276		
202			227			252			277		
203			228			253			278		
204			229			254			279		
205			230			255			280		
206			231			256			281		
207			232			257			282		
208			233			258			283		
209			234			259			284		
210			235			260			285		
211			236			261			286		
212			237			262			287		
213			238			263			288		
214			239			264			289		
215			240			265			290		
216			241			266			291		
217			242			267			292		
218			243			268			293		
219			244			269			294		
220			245			270			295		
221			246			271			296		
222			247			272			297		
223			248			273			298		
224			249			274			299		
225			250			275			300		
Sum	O9	I9		O10	I10		O11	I11		O12	I12

LTPP Dipstick Data Collection Form Longitudinal Profile Form DS-5 Readings 301 to 400	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Reading No.	Reading (mm)		Reading No	Reading (mm)		Reading No	Reading (mm)		Reading No.	Reading (mm)	
	RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑
301			326			351			376		
302			327			352			377		
303			328			353			378		
304			329			354			379		
305			330			355			380		
306			331			356			381		
307			332			357			382		
308			333			358			383		
309			334			359			384		
310			335			360			385		
311			336			361			386		
312			337			362			387		
313			338			363			388		
314			339			364			389		
315			340			365			390		
316			341			366			391		
317			342			367			392		
318			343			368			393		
319			344			369			394		
320			345			370			395		
321			346			371			396		
322			347			372			397		
323			348			373			398		
324			349			374			399		
325			350			375			400		
Sum	O13	I13		O14	I14		O15	I15		O16	I16

LTPP Manual Dipstick Data Collection Form Longitudinal Profile Form DS-6 Station 401 to 500	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Reading No	Reading (mm)		Reading No	Reading (mm)		Reading No	Reading (mm)		Reading No	Reading (mm)	
	RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑		RWP ⇓	LWP ⇑
401			426			451			476		
402			427			452			477		
403			428			453			478		
404			429			454			479		
405			430			455			480		
406			431			456			481		
407			432			457			482		
408			433			458			483		
409			434			459			484		
410			435			460			485		
411			436			461			486		
412			437			462			487		
413			438			463			488		
414			439			464			489		
415			440			465			490		
416			441			466			491		
417			442			467			492		
418			443			468			493		
419			444			469			494		
420			445			470			495		
421			446			471			496		
422			447			472			497		
423			448			473			498		
424			449			474			499		
425			450			475			500		
Sum	O17	I17		O18	I18		O19	I19		O20	I20

Transverse Closure Measurements from Right Wheel Path to Left Wheel Path at Station (152.40 m)

	Transverse Position							Sum
	RWP-1	1-2	2-3	3-4	4-5	5 - CC	CC -LWP	
Reading (mm)								T2

LTPP Dipstick Data Collection Form Longitudinal Profile Form DS-7 Pre/Post Measurement Zero and Calibration Checks	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Operator: _____ Employer: _____

Dipstick Serial Number: _____Diameter of Dipstick Foot Pad: __ __ . __ __ mm

Pre Measurement Checks

Time (military): __ __ : __ __ **Automated Dipstick** - Zero Check Performed:_____

Zero Check - Manual Dipstick		Calibration Check	
Measurement	Reading (mm)	Measurement	Reading (mm)
First Reading		First Reading	
Second Reading after 180° Rotation		Second Reading on Calibration Block	
First + Second Reading	[A]	Second Reading - 3.2 - First Reading	[B]

Notes:
A. First + Second Reading must be less than ± 0.1. If not, adjust the start pin as suggested in the LTPP Profile Measurement Manual and repeat zero check.
B. Second Reading - 3.2 - First Reading must be less than ± 0.1. If not, notify the RSC office and contact Face Company for repair.

Post Measurement Checks

Time (military): __ __ : __ __

Zero Check		Calibration Check	
Measurement	Reading (mm)	Measurement	Reading (mm)
First Reading		First Reading	
Second Reading after 180° Rotation		Second Reading on Calibration Block	
First + Second Reading	[A]	Second Reading - 3.2 - First Reading	[B]

Notes:
A. First + Second Reading must be less than ± 0.1. If not, discard data as suspect, adjust the start pin as suggested in the LTPP Profile Measurement Manual, repeat zero check until it passes, perform calibration check and if it passes, resurvey section.
B. Second Reading - 3.2 - First Reading must be less than ± 0.1. If not, notify the RSC office and contact Face Company for repair.

Comments:_____

LTPP Dipstick® Data Collection Form
Transverse Profile
Form DS-8

Dipstick® Serial #: [___ ___ ___ ___ ___] Dipstick® Model #: [___ ___ ___ ___]
Operator: [___ ___] Recorder: [___ ___] Site Type: [___ ___ ___] Visit: [___ ___]
Surface Type: [___ - ___ ___] Condition: _____

State Code [___ ___]
LTPP Section ID [___ ___ ___ ___]
Date (dd/mmm/yy) __ __ / __ __ __ / __ __]
Time [___ ___ : ___ ___]

Road Name: _____ Lane: Outside / Inside (Circle One) Direction: [___ ___ ___ ___ ___]
Clouds: _____ Temperature: [___ ___ . ___] Weather Comment: _____

Location	Dipstick® Readings																Sum	Closure
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
0.00																		
Difference																		
15.24																		
Difference																		
30.48																		
Difference																		
45.72																		
Difference																		
60.96																		
Difference																		
76.20																		
Difference																		
91.44																		
Difference																		
106.68																		
Difference																		
121.92																		
Difference																		
137.16																		
Difference																		
152.40																		
Difference																		

COMMENTS: _____

There is no Form DS-9

LTPP Dipstick Operations **LTPP Major Maintenance/Repair** **Form DS-10**	**Region** [___ ___] **Serial Number** [___ ___ ___ ___ ___] **Scheduled** [YES / NO]

Problem Identification / Scheduled Maintenance Equipment: _____ Description: _____	Performed By: _____ Date: [__ __ / __ __ __ / __ __ __ __] Start Time: [__ __ : __ __] End Time: [__ __ : __ __]
Troubleshooting Description: _____	Performed By: _____ Date: [__ __ / __ __ __ / __ __ __ __] Start Time: [__ __ : __ __] End Time: [__ __ : __ __] Hours: _____
Reporting Referred to: _____ Actions (Return/Order Parts): _____	Date: [__ __ / __ __ __ / __ __ __ __] Time: [__ __ : __ __] Date: [__ __ / __ __ __ / __ __ __ __] Time: [__ __ : __ __]
Service Description (Repairs Performed/Replacement Part Information): _____ Agency Performing Maintenance: _____	Performed By: _____ Date: [__ __ / __ __ __ / __ __ __ __] Start Time: [__ __ : __ __] End Time: [__ __ : __ __] Hours: _____ Total Cost: [$ __ __ __ __ __ . __ __]
Verification Description (Check/Calibration): _____	Performed By: _____ Date: [__ __ / __ __ __ / __ __ __ __] Start Time: [__ __ : __ __] End Time: [__ __ : __ __] Hours: _____
Return to Service Status: _____	Performed By: _____ Date: [__ __ / __ __ __ / __ __ __ __]

APPENDIX H

DATA COLLECTION FORM FOR ROD AND LEVEL PROFILE MEASUREMENTS

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LTPP Rod and Level Data Collection Form Longitudinal Profile Measurements Form RL-1

LTPP Code	[_ _]
LTPP Section	[_ _ _ _]
Date (dd/mmm/yy)	_ _ /_ _ _ / _ _

Reading Number	I.S.	B.S.	F.S.	Reading Number	I.S.	B.S.	F.S.	Reading Number	I.S.	B.S.	F.S.
Stn 0+00				34				68			
1				35				69			
2				36				70			
3				37				71			
4				38				72			
5				39				73			
6				40				74			
7				41				75			
8				42				76			
9				43				77			
10				44				78			
11				45				79			
12				46				80			
13				47				81			
14				48				82			
15				49				83			
16				50				84			
17				51				85			
18				52				86			
19				53				87			
20				54				88			
21				55				89			
22				56				90			
23				57				91			
24				58				92			
25				59				93			
26				60				94			
27				61				95			
28				62				96			
29				63				97			
30				64				98			
31				65				99			
32				66				100			
33				67							

B.S. = Back Sight, F.S. = Foresight

Comments:

LTPP Rod and Level Data Collection Form Longitudinal Profile Measurements Form RL-2	LTPP Code [_ _] LTPP Section [_ _ _ _] Date (dd/mmm/yy) _ _ /_ _ _ /_ _

Reading Number	I.S.	B.S.	F.S.	Reading Number	I.S.	B.S.	F.S.	Reading Number	I.S.	B.S.	F.S.
101				135				169			
102				136				170			
103				137				171			
104				138				172			
105				139				173			
106				140				174			
107				141				175			
108				142				176			
109				143				177			
110				144				178			
111				145				179			
112				146				180			
113				147				181			
114				148				182			
115				149				183			
116				150				184			
117				151				185			
118				152				186			
119				153				187			
120				154				188			
121				155				189			
122				156				190			
123				157				191			
124				158				192			
125				159				193			
126				160				194			
127				161				195			
128				162				196			
129				163				197			
130				164				198			
131				165				199			
132				166				200			
133				167							
134				168							

B.S. = Back Sight, F.S. = Foresight

Comments:

LTPP Rod and Level Data Collection Form Longitudinal Profile Measurements Form RL-3	LTPP Code [_ _] LTPP Section [_ _ _ _] Date (dd/mmm/yy) _ _ /_ _ _ /_ _

Reading Number	I.S.	B.S.	F.S.	Reading Number	I.S.	B.S.	F.S.	Reading Number	I.S.	B.S.	F.S.
201				235				269			
202				236				270			
203				237				271			
204				238				272			
205				239				273			
206				240				274			
207				241				275			
208				242				276			
209				243				277			
210				244				278			
211				245				279			
212				246				280			
213				247				281			
214				248				282			
215				249				283			
216				250				284			
217				251				285			
218				252				286			
219				253				287			
220				254				288			
221				255				289			
222				256				290			
223				257				291			
224				258				292			
225				259				293			
226				260				294			
227				261				295			
228				262				296			
229				263				297			
230				264				298			
231				265				299			
232				266				300			
233				267							
234				268							

B.S. = Back Sight, F.S. = Foresight

Comments:

LTPP Rod and Level Data Collection Form Longitudinal Profile Measurements Form RL-4

LTPP Code	[_ _]
LTPP Section	[_ _ _ _]
Date (dd/mmm/yy)	_ _ /_ _ _ / _ _

Reading Number	I.S.	B.S.	F.S.	Reading Number	I.S.	B.S.	F.S.	Reading Number	I.S.	B.S.	F.S.
301				335				369			
302				336				370			
303				337				371			
304				338				372			
305				339				373			
306				340				374			
307				341				375			
308				342				376			
309				343				377			
310				344				378			
311				345				379			
312				346				380			
313				347				381			
314				348				382			
315				349				383			
316				350				384			
317				351				385			
318				352				386			
319				353				387			
320				354				388			
321				355				389			
322				356				390			
323				357				391			
324				358				392			
325				359				393			
326				360				394			
327				361				395			
328				362				396			
329				363				397			
330				364				398			
331				365				399			
332				366				400			
333				367							
334				368							

B.S. = Back Sight, F.S. = Foresight

Comments:

LTPP Rod and Level Data Collection Form
Longitudinal Profile Measurements
Form RL-5

LTPP Code [_ _]
LTPP Section [_ _ _ _]
Date (dd/mmm/yy) _ _ /_ _ _ / _ _

Reading Number	I.S.	B.S.	F.S.	Reading Number	I.S.	B.S.	F.S.	Reading Number	I.S.	B.S.	F.S.
401				437				473			
402				438				474			
403				439				475			
404				440				476			
405				441				477			
406				442				478			
407				443				479			
408				444				480			
409				445				481			
410				446				482			
411				447				483			
412				448				484			
413				449				485			
414				450				486			
415				451				487			
416				452				488			
417				453				489			
418				454				490			
419				455				491			
420				456				492			
421				457				493			
422				458				494			
423				459				495			
424				460				496			
425				461				497			
426				462				498			
427				463				499			
428				464				500			
429				465				501			
430				466				502			
431				467				503			
432				468				504			
433				469				505			
434				470				506			
435				471				507			
436				472				508			

B.S. = Back Sight, F.S. = Foresight

Comments:

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APPENDIX H

FORMS FOR INTER-REGIONAL PROFILER COMPARISON TESTS

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STATIC HEIGHT SENSOR MEASUREMENTS

RSC: _____
Date: _____

Distance from Ground to Sensor Glass (mm): Left: _____ Center_____ Right _____

Left Sensor

Position	Height of Block (Note 1)					Avg. of Heights (mm)	Actual Block Height (Note 3) (mm)	Actual Minus Average (mm)	Std Dev. of Heights (mm) (Note 4)
	Test 1	Test 2	Test 3	Test 4	Test 5				
Base Plate + 25 mm Block + Calibration Plate									
Base Plate + 50 mm Block + Calibration Plate									
Base Plate + 75 mm Block + Calibration Plate									
Base Plate + 100 mm Block + Calibration Plate									

Center Sensor

Position	Height of Block (Note 1)					Avg. of Heights (mm)	Actual Block Height (Note 3) (mm)	Actual Minus Average (mm)	Standard Dev. of Heights (mm) (Note 4)
	Test 1	Test 2	Test 3	Test 4	Test 5				
Base Plate + 25 mm Block + Calibration Plate									
Base Plate + 50 mm Block + Calibration Plate									
Base Plate + 75 mm Block + Calibration Plate									
Base Plate + 100 mm Block + Calibration Plate									

Right Sensor

Position	Height of Block (Note 1)					Avg. of Heights (mm)	Actual Block Height (Note 3) (mm)	Actual Minus Average (mm)	Standard Dev. of Heights (mm) (Note 4)
	Test 1	Test 2	Test 3	Test 4	Test 5				
Base Plate + 25 mm Block + Calibration Plate									
Base Plate + 50 mm Block + Calibration Plate									
Base Plate + 75 mm Block + Calibration Plate									
Base Plate + 100 mm Block + Calibration Plate									

Sequence for Performing Test: Do Test 1 for each block position. Then repeat procedure for other tests.
Note 1: Let computer take at least 500 readings
Note 2: 'Height of Block' is value shown for Dif Ht on the monitor..
Note 3: Record actual height of block stamped on block in this column
Note 3: Calculate standard deviation using the STDEV function in Excel

DMI MEASUREMENTS

RSC _____

Date _____

Left Rear Tire Pressure Prior to Test (psi): _____

Right Rear Tire Pressure Prior to Test (psi): _____

Left Rear Tire Pressure After Last Run (psi): _____

Right Rear Tire Pressure After Last Run (psi): _____

Note: Calibrate DMI before performing DMI Measurements.

Run Number	Air Temp. (°C)	Distance (m) See Note 1
1		
2		
3		
4		
5		
6		
Average		
Std Dev		

Note 1: Record values shown under "Distance old DCF"

Note 2: Use the STDEV function in Excel to calculate Std. Deviation

DMI VERIFICATION

RSC _____

Date _____

Left Rear Tire Pressure Prior to Test (psi): _____

Right Rear Tire Pressure Prior to Test (psi): _____

Left Rear Tire Pressure After Last Run (psi): _____

Right Rear Tire Pressure After Last Run (psi):_____

Note: Do Not Calibrate DMI Before Performing Measurements.

Run Number	Air Temp. (°C)	Distance (m) See Note 1
1		
2		
3		
4		
5		
6		
Average		
Std Dev		

Note 1: Record values shown under "Distance old DCF"

Note 2: Use the STDEV function in Excel to calculate Std.Deviation

IRI VALUES

Left Wheel Path

Site Number	Description	Left Wheel Path IRI (m/km) Run Number					Average IRI (m/km)	Standard Deviation (m/km) (Note 1)
		1	2	3	4	5		
1	Smooth AC							
2	Rough AC							
3	Smooth PCC							
4	Rough PCC							
5	Chip Seal							

Right Wheel Path

Site Number	Description	Right Wheel Path IRI (m/km) Run Number					Average IRI (m/km)	Standard Deviation (m/km) (Note 1)
		1	2	3	4	5		
1	Smooth AC							
2	Rough AC							
3	Smooth PCC							
4	Rough PCC							
5	Chip Seal							

Note: Use the STDEV function in Excel to calculate Std. Deviation