Memorandum

U.S. Department
of Transportation

Federal Highway
Administration

6300 Georgetown Pike
McLean, Virginia 22101-2296

Subject: ACTION:LTPP Monitoring Directive P-10
Annual Profiler-Dipstick Comparisons

Date: December 18, 1996

From: Antonio Nieves Torres
Pavement Performance Division

Reply to
Attn. of: HNR-30

To: Mr. Ivan Pecnik, LTPP Regional Engineer (NA)
Mr. Morris Reinhardt, LTPP Regional Engineer (S)
Mr. Richard Ingberg, LTPP Regional Engineer (NC)
Mr. Cal Berge, LTPP Regional Engineer (W)

Attached is the Long-Term Pavement Performance (LTPP) Program Monitoring Directive P-10 that transmits Monitoring procedures for Annual Profiler-Dipstick Comparisons.

This directive should be transmitted to all Profilometer operators as soon as possible. The objective of these procedures is to initiate a formal program for Profiles - Dipstick Comparisons.

If you have any questions concerning this transmittal, please do not hesitate to call me at 703-285-2526.

Antonio Nieves Torres

Attachrnent

FHWA HNR-30:anieves:ant:285-2526:12/16/96
File: h:\data\anieves\wp\covdir3.doc
cc:
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LONG TERM PAVEMENT PERFORMANCE PROGRAM DIRECTIVE

For the Technical Direction of the LTPP Program

Program Area:	Monitoring	Directive Number: P-10
Date:	November 25, 1996	Supersedes: n/a
Subject:	Annual Profiler-Dipstick Comparisons	

Objective

The objective of this directive is to initiate a formal program for Profiler - Dipstick comparisons. These comparison tests should be performed as a minimum, on an annual basis, or within 90 days after major repairs to any of the LTPP profile measurement system components -- e.g., height sensors, accelerometer, DMI, data acquisition system, etc. The purpose of these comparisons is to provide the basis for periodic evaluation of the operational status of these devices over time. These data can also be used to study the relationship between pavement roughness and ride statistics based on measurements from each device.

Overview

The program consists of the selection of four test sections; two asphaltic concrete and two jointed portland cement concrete pavement test sections. Annual, or within 90 days after major profiler repairs, longitudinal profile measurements are performed on these test sections with both the Dipstick and LTPP Profiler. Roughness indices are computed using the PROFCheck program. A report is prepared by the RCOC and submitted to the FHWA documenting the results of the tests.

The following process shall be followed:

1 Locate and mark test sections.
2 Prior to commencement of profile testing with the profilers, perform the following initial calibrations:
   a. calibrate DMI on the DMI calibration test section
   b. calibrate static height sensors
   c. calibrate accelerometers
3 Within a two-week (14-consecutive day) period (weather permitting), perform the following profile measurements:
   a. longitudinal Dipstick measurements - 1 measurement per test section

b. longitudinal profiler measurements - 3 measurement sequences, on each test section — sequence per day

4. On each profiler measurement day, perform the following:
   a. one measurement sequence on the DMI test section
   b. static height measurements
   c. all calibration checks required for normal profile operations

Test Sections

Four profile and one DMI test section shall be used. Where convenient, one of the profile test sites maybe used for the DMI test section.

Profile Test Sections

The four profile test sections shall have the following attributes:

a. Section 1 (AC-1): Asphalt concrete pavement structure with an IRI <1.600 m/km (100 inches/mile)

b. Section 2 (AC-2): Asphalt concrete pavement structure with an IRI > 2.200 m/km (140 inches/mile)

c. Section 3 (PCC-1): Jointed portland cement concrete pavement structure with an IRI < 1.600 m/km (100 inches/mile)

d. Section 4 (PCC-2): Jointed portland cement concrete pavement structure with an IRI > 2.200 m/km (140 inches/mile)

e. The asphalt concrete pavement sections shall be reasonably consistent with the criteria for GPS 1, 2 and 6 test sections. AC overlays on PCC pavements shall not be used.

f. The jointed PCC test sections shall be reasonably consistent with GPS 3 and 4 guidelines. PCC overlay test sections shall not be used.

g. The test sections shall have a marked outside lane edge stripe that can be used as an outside lane edge reference.

h. All test sections shall be located on flat tangent sections with sufficient length at each end to allow for acceleration to a constant speed prior to the section and safe deceleration past its end.

l. Each test section shall be 152.4-m (500-ft) in length, with the beginning and end mark in compliance with LTPP test section marking guidelines. (There is no need for marking internal station locations.)

Where possible, test sections should be located within a centralized locale with short travel distances between each test section to reduce travel time.

k. Test sections do not have to be located on LTPP test sections; however, LTPP test sections can be used when convenient.

DMI Test Section

An accurately measured section, 305-m (1,000-ft) long, shall be used as the DMI test section. A standard surveying tape, or equally accurate electronic method, shall be used in conformance with standard surveying practice to accurately locate the end point relative to the start point. The DMI test section shall be located on reasonably level pavement suitable for such testing (i.e. low traffic volume, adequate sight distances, operator safety, etc.).

Dipstick Measurements

Dipstick measurements shall be performed using non-automated procedures in compliance with LTPP Directive P-9. These measurements shall be performed within 14-days of the profiler measurements. On PCC test sections, the Dipstick measurements shall be performed at the same approximate time of day as expected for the collection of the profiler measurements. Only one set of Dipstick measurements, satisfying the P-9 Directive, are required on each profile test section.

Profiler Measurements

The comparison measurements between the Dipstick and profiler described in this directive should be made on an annual basis or within 90 days after any major repairs are performed on the profiler measurement system components (height sensors, accelerometers, data acquisition systems, etc.)

Profiler measurements shall be performed on each test section on the same day. On each profile survey day, routine checks and measurement procedures shall be performed in accordance with current LTPP operational field guidelines for profile measurements, protocols and directives, except as follows:

a. All data processing, including data from the Dipstick and the LTPP profiler, shall be performed using the latest active version of the PROQUAL software.

b. It is desired that a single measurement sequence be performed on each test section on three consecutive days (weather permitting). The measurement sequences should be performed at the same approximate time of day, particularly on the PCC test sections. Each measurement sequence shall consist of two run sets; one set of

runs at 56-kph (35-mph) and the other at 80-kph (50-mph). However, if severe overriding operational considerations make this infeasible, then it is permissible to perform all three measurement sequences on the same day on three of the test sections. However, on at least one test section, preferably one of the PCC sections, the three measurement sequences shall be conducted on consecutive days.

c. The number of runs to include in each run set shall be determined in accordance with standard LTPP practice on acceptability of runs as contained in section 2.2.4 Number of Runs, **Manual for Profile Measurement: Operational Field Guidelines,** Report SHRP-P-378, Strategic Highway Research Program, National Research Council, Washington, DC, 1994.

DMI Calibration and Measurements

Immediately preceding the collection of profiler measurements, an initial DMI calibration shall be performed following LTPP procedures. The DMI calibration factor should be reset to the computed value for this calibration if it is outside the stated tolerances. On each day that profiler measurements are performed, perform one measurement sequence on the DMI test section. The DMI measurement sequence shall consist of six repeat consecutive measurements. The DMI calibration factors computed as a result of these measurements should be reset if they are found to be outside of the tolerances. A log should be kept on the results of all distance measurements conducted on the DMI test section, and any changes to the DMI calibration coefficients.

Static Height Sensor Calibration and Measurements

Immediately preceding the collection of profiler measurements, static calibration of the height sensors shall be performed. These calibrations shall be performed indoors. On each profiler measurement day, static height sensor measurements shall be performed using the base plate, top leveling plate, and one of the calibration blocks provided with the LTPP profiler. These measurements should also be performed indoors, or in a location adequately sheltered from wind and other climate effects. Static measurements shall be performed for the following four positions:

Position 1. Base Plate + Block 1 (75 mm vertical) + Leveling Plate
Position 2. Base Plate + Block 1 (50 mm vertical) + Leveling Plate
Position 3. Base Plate + Block 1 (25 mm vertical) + Leveling Plate
Position 4. Base Plate + Leveling Plate

The average and standard deviation resulting from the measurements performed at each height shall be recorded and used for later analysis.

Accelerometer Calibration

At the same time that the static height sensors are calibrated prior to the start of profile measurements, the accelerometer on each profiler shall also be calibrated following standard

procedures. All calibrations shall be performed indoors. On each profile measurement day, accelerometer calibration checks shall be performed in accordance with standard LTPP guidelines. During this test period, the accelerometers should only be recalibrated if they are found to fall outside of tolerances.

Report

Within 30-days after completion of the comparison testing, a report shall be submitted to the FHWA LTPP Office containing the following information:

Test Section Description: Provide a description of the pavement test section location, physical and structural attributes, distress condition, and type of facility. Details should be given on those attributes of the test section which are suspected of influencing the profile measurements, such as meandering cracks in the wheel paths, highly variable transverse profile, etc. Detailed measurements are not required. Subjective based descriptions are satisfactory.

Equipment Description: Provide a brief description of the equipment used for the various measurements performed. In addition to the profile instrument, include a description of the distance measurement device used on the DMI test section.

Test Procedure: Provide a calendar and summary description of all tests performed and procedures used.

Test Results: Provide tables containing the following information based on statistics computed using the latest active version of the PROQUAL software for the five runs that would have been normally selected for upload to the LTPP IMS in accordance with standard procedures:

1. IRI summary table - for each test section, measured IRI values in each wheel path, average and standard deviation of the measurements conducted at the same speed on the same day.

2. DMI measurements table - for each test date, individual length measurements of DMI test section and average and standard deviation from the six individual runs.

3. Static height sensor measurements table - for each test date, average of 200 readings for the four required positions and calculated height of blocks for Positions 1 through 3. (Note:

subtract average of readings for Positions 1 through 3 from average of readings for Position 4 to determine measured block heights).

Analysis of Results: Review the results generated and compare with the following bias and precision criteria:

IRI Values

Bias:	± 0.16 m/km relative to Dipstick value
Precision:	$2\sigma \leq 0.08$ m/km

DMI Values

Bias:	≤ 0.05% over 305-m (1,000-ft) test section
Precision:	$2\sigma \leq$ 0.05% over 305-m (1,000-ft) test section
t-test:	five-sample bias from absolute distance measurements should be within confidence limits of $-2.78 \leq t \leq 2.78$

Static Height Test Values

Bias:	± 0.25 mm
Precision:	$2\sigma \leq 0.25$ mm

On completion, discuss the results of the review and comparison; i.e., do the Dipstick and profiler yield similar IRI values on both wheel paths?, has the bias and precision criteria specified above been met?, etc.

Other Data and Files: Provide paper work normally required for field profile operations, including Profiler Field Activity Report, Profiler Calibration Log, Daily Check List, Major Maintenance or Repair Report (during the test period). Also submit printed out and computer files generated by the PROQUAL software and the on-board profiler software. Also submit profiler calibration log files from the profiler.

Raw Data: Submit the collected raw data on diskette. Provide documentation permitting identification of data files with device and measurement date. A copy of all data and forms from these tests shall be kept at the RCOC offices for future reference.

The length of the report shall be kept to a minimum unless major problems are encountered. If major problems are encountered, they shall also be reported using the profiler problem report (PROFPR) form. **All results shall be reported in SI (metric) units.**

Prepared for: Antonio Nieves Torres

Approved by: Monte Symons,
LTPP Team Leader

LONG TERM PAVEMENT PERFORMANCE PROGRAM DIRECTIVE

For the Technical Direction of the LTPP Program

Program Area:	Monitoring	Directive Number:	P-10
Date:	May 15, 1995	Supersedes:	n/a
Subject:	Annual Profiler-Dipstick Comparisons		

Objective

The objective of this directive is to initiate a formal program for Profiler - Dipstick comparisons. These comparison tests should be performed as a minimum, on an annual basis, or after major repairs to the LTPP profiler measurement system. The purpose of these comparisons is to provide the basis for periodic evaluation of the operational status of these devices over time. These data can also be used to study the relationship between pavement roughness and ride statistics based on measurements from each device. A secondary function is to help support the efforts of the Road Profile Users Group (RPUG) where possible.

Overview

The program consists of the selection of a minimum of two test sections, preferably a jointed portland cement concrete pavement (JPCP) and a Hot-Mixed Asphalt (HMA) pavement structure over a granular base. Annual, or more frequent depending upon circumstances, longitudinal profile measurements are performed on these test sections with both the Dipstick and LTPP Profiler. Roughness indices are computed using the PROFCheck program. A short report is prepared by the RCOC and submitted to the FHWA documenting the results of the tests.

Test Sections

Two test sections must be used for these comparisons. The test sections should be selected according to the following considerations:

1. It is preferred that one test section be a jointed portland cement concrete pavement (either plain or reinforced) and the other a HMA pavement structure.

2. Two HMA surfaced pavement structures can be used if a JPCP pavement structure is not conveniently available.

3. The difference in the average International Roughness Index (IRI) (both wheel paths) between the two test sections should be greater than 40 inches per mile.

4. Although it is not required that the test sections used for these comparison measurements be active LTPP test sections, the following priority should be used in their selection

    1. GPS or SPS test sections
    2. RPUG test sections
    3. Other convenient test sections

5. The test section should be selected at a location that is convenient for measurements by the RCOC.

6. Traffic control must be available during the manual Dipstick™ measurements. For sections selected on in-service highways, the RCOC must get assurances from the responsible highway authority that traffic control will be provided as needed.

Test Section Layout

If the test sections are located on either GPS, SPS or other non-RPUG sections, the standard LTPP test section layout should be used.

If RPUG test sections are used, they should be laid out in conformance with the RPUG guidelines as presented in Rohan W. Perera and Kohn, Starr, **Road Profiler Data Analysis, Road Profiler User Group, Sixth Annual Meeting, Lake Tahoe, Nevada, Final Report**, Soils and Materials Engineers, Inc., Plymouth Michigan, February, 1995.

Measurements

The comparison measurements between the Dipstick and profiler described in this directive should be made on an annual basis or as soon as practical after any major repairs are performed on the profiler measurement system components (height sensors, accelerometers, data acquisition systems, etc.)

Longitudinal profile measurements in each wheel path using the Dipstick and LTPP profiler are the primary measurements to be performed. The conduct of these measurements includes all required calibration and operational checks before and after the measurements. The Dipstick and profiler measurements on each test section must be made within one week of each other at the same approximate time of day.

On jointed portland cement concrete test sections, fault height measurements using the Georgia digital faultmeter should also be performed at the same time that Dipstick measurements are performed.

Sensor and Calibration Checks

For all testing, sensor and calibration checks on the Dipstick and profiler should be performed following the procedures contained in the **Manual for Profile Measurement: Operational Field Guidelines**, SHRP-P-378, Strategic Highway Research Program, February, 1994 (SHRP Profile manual) and/or following all current directives and updates related to the calibration and operation of this equipment.

If fault height measurements are performed with the Georgia digital faultmeter, the calibration check procedures contained in the **Distress Identification Manual for the Long-Term Pavement Performance Project**, SHRP-P-338, Strategic Highway Research Program, May 1993 (SHRP DIM) must also be performed.

LTPP Test Sections

On LTPP test sections, the current LTPP procedures should be followed for all measurements. On jointed portland cement concrete pavement test sections, fault height measurements should be performed at the same time as the Dipstick measurements. LTPP data forms and data collection standards should be used for recording the results of all measurements.

RPUG Test Sections

On RPUG test sections, longitudinal profile measurements with the Dipstick and LTPP profiler should be made following RPUG guidelines. LTPP data forms and data collection standards should be used for recording the results of all measurements.

Data Processing and Storage

The roughness indices and other measurement information should be computed from the longitudinal profile measurements using the LTPP PROFCheck program. The resulting data files created by these programs should not be input into the LTPP IMS, unless the measurements are performed on active LTPP test sections. The raw measurement data and files created from processing should be stored in a convenient location within the RCOC office that allows future access by interested parties.

Report

A short report should be prepared by the RCOCs that presents the results of these tests and analyses. These reports should be submitted to the FHWA within three (3) months after completion of the measurements. These reports should contain the following information:

Description of test sections

Identification of measurement equipment, including serial numbers as appropriate

Date of conduct of each measurement

LTPP region

Table presenting a comparison of roughness statistics computed by the PROFCheck program (IRI, RMSVA, MO and SV) from the profiler and Dipstick measurements.

On jointed portland cement concrete pavements, comparison of fault height measurements from the Georgia Digital Faultmeter and the LTPP Profiler (when available).

Comments on potential sources of any significant differences found between the indices computed from the two devices.

Comment on any anomalies or problems in operation and function of the test equipment.

Appendices

A. Profiler forms (from measurement days)
   + Daily Check List
   + Major Maintenance/Repair Activity Report (if occurring during testing)
   + Profilometer Calibration Log
   + Profilometer Field Activity Report

B. Dipstick Forms
   + Longitudinal Profile Form DS-7, Pre/Post Measurement Zero and Calibration Checks (LTPP Directive P-9 Non-automated Dipstick Longitudinal Profile Measurement Procedure)
   + Dipstick Field Activity report

C. Output from the PROFCheck program