Memorandum

U.S. Department
of Transportation

**Federal Highway
Administration**

6300 Georgetown Pike
McLean, Virginia 22101-2296

Subject: ACTION: LTPP Directive P-43
Accelerometer Signal Conditioning Electronics Test and
Accelerometer Calibration Factor Range

Date: April 3, 2006

From: Larry Wiser
Highway Research Engineer

Reply to
Attn of: HRDI-13

To: Mr. Frank Meyer, LTPP North Atlantic Regional Contract
and LTPP North Central Regional Contract
Mr. Kevin Senn, LTPP Western Regional Contract
Mr. Mark Gardner, LTPP Southern Regional Contract

Attached is LTPP Directive P-43, Accelerometer Signal Conditioning Electronics Test and Accelerometer Calibration Factor Range. This directive should be transmitted to all appropriate personnel as soon as possible.

If you have any questions concerning this transmittal, please do not hesitate to call me at (202) 493-3079.

Attachments (2)

FHWA:HRDI-13:LWiser:mad:493-3079:4/03/06
File: mdeeney/directives/P-43.doc
cc:
LTPP Staff
G. Rada, TSSC
Directive File
Official File (190.20)
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LONG TERM PAVEMENT PERFORMANCE PROGRAM DIRECTIVE

For the Technical Direction of the LTPP Program

Program Area:	Monitoring	Directive Number:	P-43
Date:	April 3, 2006	Supersedes:	N/A
Subject:	Accelerometer Signal Conditioning Electronics Test and Accelerometer Calibration Factor Range		

INTRODUCTION

This directive addresses two issues: Accelerometer Signal Conditioning Electronics Test and Accelerometer Calibration Factor Range.

ACCELEROMETER SIGNAL CONDITIONING ELECTRONICS TEST

The accelerometer test tool can be used to test the power supply, accelerometer filters, and cables to ensure that the analog-digital accelerometer interface card in the profiler is working properly. This test should be performed annually, when problems are encountered with accelerometer readings, or if any repairs have been carried out on the accelerometers or any components associated with the accelerometers. A photograph of the accelerometer test tool is shown below.

The test tool consists of a switch with resistors. After the accelerometer is unplugged, the test tool is plugged into the accelerometer circuit, and a test is performed to determine if the accelerometer signal conditioning electronics are working properly.

The following procedure shall be followed when performing the test:

1. Park the profiler on a level surface and power up computer system following the procedures outlined in Section 2.2.5.3 and 2.2.5.4 of the LTPP Manual for Profile Measurements and Processing, Version 4.1 (hereafter referred to as the Profiler Manual). Allow electronics to warm up for fifteen (15) minutes per normal operating procedure.

2. Calibrate the accelerometers following the procedure described in Section 2.5.3 of the Profiler Manual, and accept the new Accelerometer Calibration Factors (ACF).

3. Record the accepted ACF values for the left, right, and center accelerometers in row number 1 on form PROF-8, which is included at the end of this directive.

4. Turn off the profiler computer system following the procedures described in Section 2.2.5.5 of the Profiler Manual.

5. Carefully unplug the cable from each accelerometer (located under the front bumper near the laser sensors). Attach an accelerometer test tool to each accelerometer cable for the left (driver side), right (passenger side), and center accelerometers, with the switch in position "C" (or middle position).

6. Reboot computer system and launch the MDR program. Ignore the "Invalid Accelerometer Configuration" message and do not recheck system. Enter "Y" to operate “with probable error conditions.”

7. Perform an accelerometer calibration following the procedure described in Section 2.5.3 of the Profiler Manual, but do not accept Accelerometer Calibration Factor (ACF) values.

8. Record the ACF values for the left, right, and center accelerometers in row number 2 on form PROF-8.

9. Move switch in accelerometer tool to position "A". Perform an accelerometer calibration following the procedure described in Section 2.5.3 of the Profiler Manual, but do not accept calibration values. ACF values should be negative. If not already indicated on the test tool, mark this position on each accelerometer test tool with permanent ink or with an identification sticker for future tests.

10. Record the ACF values for the left, right, and center accelerometers in row number 3 on form PROF-8.

11. Move switch in accelerometer tool to position "B". Perform an accelerometer calibration following the procedure described in Section 2.5.3 of the Profiler Manual, but do not accept calibration values. ACF values should be positive.

12. Record the ACF values for the left, right, and center accelerometers in row number 4 on form PROF-8.

13. Move switch in accelerometer tool back to position "C". Perform an accelerometer calibration following the procedure described in Section 2.5.3 of the Profiler Manual, but do not accept calibration values.

14. Record the ACF values for the left, right, and center accelerometers in row number 5 on form PROF-8.

15. Turn off the computer system in the profiler following the procedure described in Section 2.2.5.5 of the Profiler Manual.

16. Remove all three accelerometer test tools and reconnect each cable to the accelerometer.

17. Turn on the profiler computer system (using the procedure described in Section 2.2.5.3 and 2.2.5.4 of the Profiler Manual) and wait for 10 minutes. Calibrate the accelerometers following the procedure described in Section 2.5.3 of the Profiler Manual, and accept the new ACF values.

18. Record the ACF values for the left, right, and center accelerometers in row number 6 on form PROF-8.

19. Perform calculations 1 through 5 indicated on form PROF-8, and record the values for left, right, and center accelerometers in rows numbered 7 through 11, respectively.

The following procedure shall be followed for analyzing the test results:

1. Under Calculation 1 (row number 7), the computed difference in offset values should be within ±10. If not, this may mean that the internal electronics could be drifting and the RTI-X may need to be replaced. If offset values are not within range, repeat this test. If accelerometers fail the test again, contact ICC for advice (the accelerometer board may need to be replaced).

2. The values from Calculations 3 and 4 (rows 9 and 10) should be within ±48. If the resulting value is outside these limits for an accelerometer, a possible problem exists with that accelerometer. Contact ICC to resolve this issue.

3. The value obtained from Calculation 5 (row number 11), which indicates the difference between post and pre test ACF values, should be within ±24 for each accelerometer. If not, there may be too much drift in the accelerometer. Repeat the test, and if an accelerometer fails the test again, ICC should be contacted for further testing/monitoring with the test tool and possible board or accelerometer replacement.

4. The values obtained when the accelerometer test tool is connected in position “A” (row number 3) and “B” (row number 4) should satisfy the following ICC provided criteria:

(a) ACF values for Position A should be between -2552 and -2088 (±10% of -2320), and

(b) ACF values for Position B should be between 1908 and 2332 (±10% of 2120).

If any accelerometer fails to satisfy the previously described two criteria, additional observations or testing should be done as described below:

(a) If the reason for the failure cannot be determined, contact ICC.

(b) If one channel fails while the others pass, examine the wiring for that accelerometer to determine if an open power wire is creating a problem.

(c) If all channels are failing, examine all wiring to ensure that a short circuit between the connector pins is not causing the failure. These types of failures generally will change the numbers over 25%. If the numbers are less than 25% different, but greater than 10%, the power supply could be drifting, which indicates an RTI-X problem. Determine the drift using the following procedure:

(1) reinstall the test tools (if already removed) following the procedures described previously in this directive,

(2) repeat the tests for positions “A” and “B” two times at two-minute intervals to determine the drift.

Once drift has been determined, contact ICC to determine if additional testing is required or if any parts need to be replaced.

5. After the first test is performed with the accelerometer test tool, each subsequent test result for offset 1 and offset 2 should be compared with the prior test value. The test values should be within ±32 (ICC’s current estimate). Contact ICC if the difference is outside the allowable range.

ACCELEROMETER CALIBRATION FACTOR RANGE

The Profiler Manual indicates the accelerometer calibration factors must be checked to ensure that they fall within the allowable range of 1710 and 1790 during: (1) the daily accelerometer check (see section 2.3.3.2 of the Profiler Manual) and (2) after calibrating the accelerometers (see section 2.5.3 of the Profiler Manual).

When the ICC profilers started collecting data for the LTPP program, the accelerometer calibration factors of all accelerometers were not close to the mid-point of the allowable range (i.e., 1750). Some accelerometers had calibration factors that were between the lower bound of 1710 and the mid-range value of 1750. Over time, the accelerometer calibration factors in some accelerometers have been drifting towards the lower bound of the allowable range and may fall below the allowable value of 1710.

If the accelerometer calibration factor of an accelerometer falls below the lower limit of 1710 or exceeds the upper limit of 1790, the following procedure should be followed:

1. Perform the Accelerometer Signal Conditioning Electronics Test described earlier in this directive. If one or more accelerometers fail the criteria established for that test, follow the recommended procedures to address and resolve the issue.

2. If an accelerometer passes the criteria indicated in the Accelerometer Signal Conditioning Electronics Test, but the calibration factor falls outside the allowable range of 1710 and 1790, follow the procedure described in steps 3 to 5 below to establish a new accelerometer calibration factor range.

3. Go through the records and obtain the calibration factors for the first ten (10) times the accelerometer was calibrated. If the accelerometer has not been replaced, the values will correspond to the ten (10) calibration values after the region started to operate the ICC profiler. If an accelerometer has been replaced, the values will correspond to the ten (10) calibration values after the new accelerometer was installed.

4. Average the ten (10) calibration values to obtain an average initial calibration factor value for the accelerometer.

5. Compute the allowable accelerometer calibration factor range for the accelerometer as: average initial calibration factor value (from step 4 above) ± 40.

6. When performing the daily accelerometer check (see section 2.3.3.2 of the Profiler Manual) and checking the range of the accelerometer calibration factors after calibrating the accelerometers (see section 2.5.3 of the profiler manual), use the accelerometer calibration factor range computed in step 5 above instead of the 1710 to 1790 range indicated in the Profiler Manual.

Question concerning this directive should be addressed to the FHWA LTPP Team staff member responsible for profiling operations, with a copy to the TSSC. If there are any problems, please submit a profiler problem report (PROFPR) form in accordance with instructions provided in the current version of the Profiler Manual.

Prepared by: TSSC

Approved by:

Aramis López
LTPP Team Leader

LTPP Profiler Operations **Accelerometer Test** **Form PROF-8**	**Region** [___ ___] **Date** / ___ ___ ___ / ___ ___ ___ ___] **Time** [___ ___ : ___ ___] **Serial Number** [___ ___ ___ ___ ___]

Operator(s): _____ Location: _____

Parameter	**Row Number**	**Accelerometer Calibration Factors (ACF)**		
		Left #1	Right #2	Center #3
Pre-Test	(1)			
Switch at Position C - Offset 1	(2)			
Switch at Position A (negative value) [valid range within -2552 and -2088]	(3)			
Switch at Position B (positive value) [valid range within 1908 and 2332]	(4)			
Switch at Position C - Offset 2	(5)			
Post-Test	(6)			
Calc 1: Difference in Offset Values (Row 2 - Row 5) [±10]	(7)			
Calc 2: Offset 1 -1638 (Row 2 - 1638)	(8)			
Calc 3: Range Check for Pre-Test (Row 8 - Row 1) [±48]	(9)			
Calc 4: Range Check for Post-Check (Row 8 - Row 6) [±48]	(10)			
Calc 5: Difference in Pre and Post Values (Row 6 - Row 1) [±24]	(11)			

Comments: _____