LONG TERM PAVEMENT PERFORMANCE PROGRAM DIRECTIVE

For the Technical Direction of the LTPP Program

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Subject:	Profiler Air Temperature Probe: Installation, Checks and Measurement Procedures		

LTPP profilers shall be equipped with a temperature probe manufactured by Omega Engineering for measuring air temperature during profile operations. Guidelines for installation and checking of the air temperature probe as well as measurement procedures to be followed during profiling operations are contained in the attached document. These guidelines are to be implemented by the regions effective immediately in order to promote uniformity in air temperature measurements.

It is anticipated that the attached guidelines will be incorporated in the coming months as an appendix to Version 3.2 of the "LTPP Manual for Profile Measurements: Operational Field Guidelines," thus superseding this directive. Until then, it is recommended that the regions keep the guidelines together with the existing LTPP Profiler Manual (Version 3.1).

Questions concerning this directive should be addressed to Larry Wiser of the FHWA LTPP Team Office at (202) 493-3079.

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APPENDIX VII

Profiler Air Temperature Probe: Installation, Checks and Measurement Procedures

Introduction

The air temperature at time of profiling is entered into the K.J. Law software. This air temperature is subsequently uploaded into the IMS. To ensure consistent air temperature measurements between the regions, all profilers shall be equipped with an air temperature measurement probe manufactured by Omega Corporation The following components are required for the assembly and installation of the air temperature measurement system.

1. Mini-Panel Thermometer Display, Omega Model DP116-KC2-9/26
2. K-type 2 inch Thermocouple Probe, Omega Model KQSS-18U-2
3. K-Type Thermocouple Exterior Grade Wire, 25 feet, Omega Model EXTT-K-20-25.
4. 12 volt AC Adapter Power Supply, Radio Shack Model 273-1652D
5. Round Panel Mount Bracket, Omega Model RSACL
6. Seasonal Air Temperature Probe Radiation Shield

The temperature probe is capable of measuring temperatures between -199.9 and 199.9 /C, and has a resolution of 0.1 /C and an accuracy of $\pm$ 1 /C.

Procedures for installation and checking of the air temperature probe as well as measurement procedures to be followed during profiling operations are described in this document.

Installation of Air Temperature Probe

The following guidelines shall be followed for installing the air temperature probe.

1. Connect thermocouple wire and power supply to temperature display and attach display unit with velcro to electronics cabinet under computer monitor. The display includes two ferrite beads. One bead is for the power supply, while the other bead is for the thermocouple wire. The thermocouple wire and power supply wire shall be wound once through the corresponding EMI bead. This is done to prevent magnetic fields being conducted through two wires and into display, which can cause damage to the display. The beads should be within six inches of the display connections, and should be kept in place using an appropriate method so that they do not wander down the wires (away from the display) over time. Connect power supply to inverter. Run thermocouple wire to back of van, and then along driver side edge of double doors so that it comes out of van back doors. The thermocouple wire is then connected to the thermocouple probe. It is critical that the thermocouple wires are connected to the correct terminals of the probe and display.

2. Take seasonal radiation shield apart and remove seasonal air temperature probe clamping portion from bottom ring. This will leave a large diameter cylinder in the bottom ring to which the thermocouple probe can be fitted. The panel mount bracket is then heated to nearly orange hot, and is pushed into the top of the bottom ring so that the probe will be held firmly in the radiation shield. ***Please exercise care when heating panel mount bracket; it will get very hot and needs to be handled with care***. Note that the thermocouple probe should not be connected to the panel mount bracket when it is

heated. A portion of the thermocouple probe is plastic and would be damaged if it was connected to the panel mount bracket when it is heated. The goal of this operation is to melt the plastic with the bracket so that the bracket gets solidly formed into the radiation shield. Care should also be exercised to ensure bracket is in tight and straight. Once the hot bracket is installed into the radiation shield, the whole unit should be quenched in water to ensure a permanent fit. Once the bracket has been fitted to the radiation shield, fasten the probe to the panel mount bracket.

3. Bolt radiation shield to front of arrow bar that is at rear of van. Fix radiation shield on the drivers side (between the center of vehicle and gutter rail) to prevent possible effects of van exhaust on temperature measurements. End of arrow bar needs to be removed and at least one lamp slid out of housing in order to do this. It is recommended that two large diameter fender washers be put on each bolt, one on inside and one on outside of arrow board housing, and also lock washers to be used to keep bolts from coming loose. When radiation shield is secure, reassemble those parts of arrow bar that were disassembled, and check all connections and plugs. The temperature probe should now function when the system is powered up.

The procedure described in Step 2 has been successfully used by the Western Region for installing the temperature probe in the radiation shield. However, an alternative method to that outlined in Step 2 is acceptable for installing the temperature probe in the radiation shield. Sample photographs of an assembled temperature probe are shown in Figure 1.

Air Temperature Probe Checks

Two checks for the air temperature probe are described in this section, a monthly check and an annual check. The monthly check on the air temperature probe shall be carried out when the profiler sensors and accelerometers are calibrated. The procedures outlined in the annual check shall be used to check the accuracy of the probe prior to installation in the radiation shield and thereafter at yearly intervals. The procedures outlined in the monthly check shall be used to check the temperature probe whenever operator observes “suspicious” temperature readings. If the temperature probe fails to satisfy the acceptance criteria specified in the monthly check, the procedures specified in the annual check shall be used to check the accuracy of the temperature probe.

1. Monthly Check of Air Temperature Probe

A NIST traceable mercury thermometer is required to perform this test. This test shall be performed monthly when the sensors and the accelerometers are calibrated. This test shall be performed in the shade, using the following procedure.

1. Park the profiler in the shade, and allow some time for the vehicle to cool off if the profiler was exposed to the sun.

2. Place a thermometer close to the temperature probe and observe the reading of the thermometer.

3. Take a reading of the temperature displayed by the temperature probe.

4. If the difference between the two temperature readings are less than or equal to 2 /C, the temperature probe is considered to be acceptable.

5. If the difference between the two temperatures are greater than 2 /C, repeat steps 2 through 4. If the difference is still greater than 2 /C, repeat steps 2 through 4 again. If the difference between the temperatures is still greater than 2 /C consider the air temperature probe to be unacceptable, and perform the procedures outlined in Annual Check to check the temperature probe.

2. Annual Check of Air Temperature Probe

The procedures outlined in this section shall be used to check the accuracy of the air temperature probe before it is first installed into the radiation shield, and thereafter this check shall be performed annually. This check shall also be carried out if the temperature probe fails the monthly check. The following procedures shall be followed for the annual check.

Equipment and Materials Required

- NIST Traceable Mercury Thermometer
- Liter (1 Gallon) Bucket
- Large Wooden Spoon or Paint Stirrer
- Ice

Procedure

Temperature checks for the air temperature probe shall be performed at two different temperatures - one near 0 /C (cold temperature test) and one near ambient air temperature (ambient temperature check). Detailed steps for checking the sensor are as follows:

1. Cold Temperature Sensor Check

   Prepare ice water bath for cold temperature check by placing ice and water in 3.8 liter bucket and stirring with a wooden spoon. By agitating water, ice water temperature should fall between 0 to 1 /C. Place air temperature probe in ice water bath beside mercury thermometer. Once the temperature probe reading stabilizes, record temperature of ice water with mercury thermometer and air temperature probe simultaneously. Continue agitating ice water for one minute and record temperatures again.

   Next, calculate temperature difference between air temperature probe and mercury thermometer for each set of readings. If difference is less than or equal to 2 /C for both sets, air temperature probe shall be considered to be working properly at cold temperatures. If difference for both sets is greater than 2 /C, air temperature probe shall be considered unacceptable. If difference is greater than 2 /C for one of two sets, obtain a third set of temperature probe and mercury thermometer readings and if difference between those readings is within 2 /C, consider the air temperature probe to be acceptable. Otherwise, consider air temperature probe to be unacceptable. If temperature probe is considered to be unacceptable, install a new thermocouple probe and repeat the check. If the system is still unable to meet the check with a new probe, then the display should be returned to Omega for calibration.

2. Ambient Air Temperature Sensor Check

Replace ice water in bucket with luke warm tap water and allow water to sit for 10 minutes. Agitate water to allow excess heat to dissipate. After 10 minutes, place air temperature probe and mercury thermometer in water bath. Once air temperature probe reading stabilizes, record temperature of water with mercury thermometer and air temperature probe simultaneously. Wait for one minute and record temperatures again. Next, calculate temperature difference between air temperature probe and mercury thermometer for each set of readings. If difference is less than or equal to 2 /C for both sets, air temperature probe shall be considered to be working properly at ambient air temperature. If difference for both sets is greater than 2 /C, air temperature probe shall be considered unacceptable. If difference is greater than 2 /C for one of two sets, obtain a third set of air temperature probe and mercury thermometer readings and if difference between those readings is within 2 /C, consider air temperature probe to be acceptable. Otherwise, consider the air temperature probe unacceptable. If temperature probe is considered to be unacceptable, install a new thermocouple probe and repeat the check. If the system is still unable to meet the check with a new probe, then the display should be returned to Omega for calibration.

Measuring Air Temperature During Profiling

Air temperature measurements taken during profiling operations are entered into the K.J. Law software prior to the start of a profile run. At the end of each profile run, the temperature entered by the profiler operator is recorded in the data file that contains the profile data. If no changes to the temperature are made in the K.J. Law software during subsequent runs, the last temperature value entered by the operator is saved with the profile data for each of those subsequent runs. Accordingly, profiler operators shall note the air temperature prior to the start of each profile run. If the temperature probe indicates a temperature that is not within $\pm$ 2 /C of that measured during the previous run, profiler operators shall enter the new value into the K.J. Law software prior to commencing the profile run.

Figure 1. Photographs of Assembled Air Temperature Probe