
Test Procedure for**THERMAL PROFILE OF HOT MIX ASPHALT**TxDOT Designation: **Tex-244-F****Effective Date: December 2015**

1. SCOPE

- 1.1 Use this test method to obtain a thermal profile that identifies the presence of thermal segregation of an uncompacted mat of hot mix asphalt. This method includes procedures for determining thermal profile using:
- a hand-held thermal camera immediately behind the paver during uninterrupted paving operations, or
 - a paver-mounted **thermal imaging** system.
- 1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.
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2. APPARATUS

- 2.1 *Thermal camera* **or thermal imaging system.**
- 2.1.1 Hand-held thermal camera must be capable of:
- measuring from 40°F to 475°F with an accuracy of $\pm 4^\circ\text{F}$ or $\pm 2\%$ of reading, whichever is greater;
 - **producing an IR image minimum resolution of 19,200 pixels;**
 - displaying the maximum temperature and minimum temperature using a LCD viewing screen with a minimum diagonal dimension of **3.0 in.;**
 - storing a minimum of 50 images and capable of opening images while in operation;
 - **a thermal sensitivity less than 0.15°F; and**
 - **a variable emissivity from 0.1 to 1.0.**
- 2.1.2 Paver-mounted **thermal imaging system** must be capable of:
- **measuring at a maximum transverse spacing of 12 ± 1 in.;**
 - using infrared sensors to measure from 40–475°F with an accuracy of **$\pm 3.5^\circ\text{F}$ or $\pm 1.5\%$** of reading, whichever is greater, **when the object temperature exceeds 32°F and the ambient temperature is $73 \pm 9^\circ\text{F}$;**
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- having temperature measurement repeatability of $\pm 1.8^{\circ}\text{F}$ or $\pm 0.75\%$ of reading, whichever is greater;
- measuring spots with a maximum size of 10 in. at the installed operating height;
- profiling the entire pavement width, up to at least 12 ft. wide, with provisions to prevent areas within 2 ft. of the edge of the uncompacted mat from influencing the thermal profile results;
- measuring distance using a Distance Measuring Instrument (DMI) and equipped with a Global Positioning System (GPS);
- collecting, displaying, saving, and analyzing temperature readings while in operation, using the latest software available;
- determining the low and high temperatures within each profile using the statistical 1 percentile and 98.5 percentile, respectively;
- producing output files of pavement temperatures for each day's placement and daily summary output files in an approved test report that identifies locations of thermal segregation with a recording of the temperature at such locations;
- providing software capable of developing and analyzing thermal profiles for the entire project; and
- providing an operating system with at least one USB port to save test results to a portable USB memory device.

3. REPORT FORMS

- 3.1 [Tx244-4.xlsm, "Thermal Profile of Hot Mix Asphalt \(4 Sublots Included\)."](#)
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4. PROCEDURE

- 4.1 Operate the thermal imaging camera or thermal imaging system in accordance with the manufacturer's recommendations.
- 4.2 Obtain a new maximum baseline temperature and minimum profile temperature for every thermal profile measured.
- 4.3 Record the beginning and ending station numbers of all thermal profiles.
Note 1—Instead of station numbers, use of GPS coordinates or other approved means of identifying the locations is acceptable.
- 4.4 Obtain all temperature measurements in units of degrees Fahrenheit.
- 4.5 Obtain all temperature measurements while the paver is moving.
- 4.6 If the paver stops for more than 60 sec., exclude the area 2 ft. behind and 8 ft. in front (in the direction of travel) of the last temperature measurement.

4.7 Proceed to Section 4.8 when using a thermal imaging camera. Proceed to Section 4.9 when using a thermal imaging system.

4.8 Using the Thermal Camera:

4.8.1 Mark the pavement edge at the beginning and ending location of each thermal profile using spray paint or a permanent marker. Refer to Figure 1.

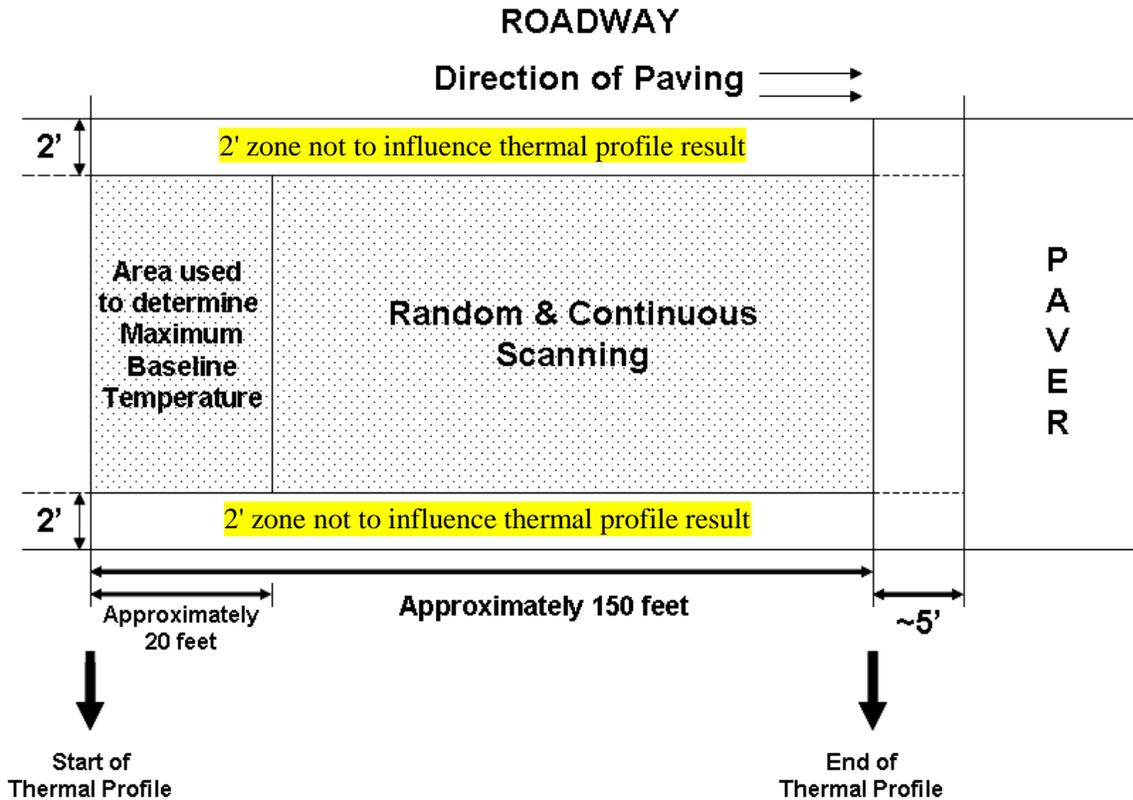


Figure 1—Thermal Profile when Using a Handheld Thermal Camera

4.8.2 Configure the thermal camera to achieve the optimum brightness and contrast of the display image and to adjust the minimum and maximum temperature levels automatically while performing thermal profiles. Do not manually enter the minimum and maximum temperature levels.

Note 2—Thermal cameras are generally equipped with an auto-adjusting feature, which automatically adjusts the minimum and maximum temperature levels, brightness, and contrast.

4.8.3 Observe the paving operations to determine the approximate distance the paver travels until the roller compacts the mat.

4.8.4 Determine the maximum baseline temperature over a paving distance of approximately 20 ft. (6.1 m).

Note 3—Each thermal profile will be approximately 150 ft. This distance includes the 20 ft. used to establish the maximum baseline temperature when profiling with a thermal imaging camera.

4.8.4.1 Stand at the edge of the uncompacted mat at a distance of approximately 5 ft. behind the paver, or stand on the paver screed.

Note 4—Follow all safety precautions and guidelines when standing on the paver screed.

4.8.4.2 Determine the lowest allowable profile temperature by subtracting 25°F from the maximum baseline temperature measured in Section 4.8.4.

4.8.5 Measure the temperature of the uncompacted mat in a zone approximately 5–15 feet behind the paver by pointing the thermal camera and squeezing the trigger. Avoid taking temperature measurements within 2 ft. of the edge of the uncompacted mat.

Note 5—When standing on the paver screed, refer to the manufacturer’s instructions for determining the relationship between the field of view and distance to determine the proper zone for evaluation within the thermal camera’s image. When standing at the edge of the uncompacted mat, pointing the thermal camera at a 90-degree angle to the direction of paving can ensure temperature data collected is within the required zone behind the paver.

Note 6—Avoid measuring high temperature areas caused by heating from the screed while the paver is stopped.

4.8.5.1 Save the image to the memory of the thermal camera.

Note 7—Additional images will be necessary to evaluate the total paving distance.

4.8.6 Following Section 4.8.5, determine the lowest temperature measured throughout the thermal profile over a paving distance of approximately 130 ft. Designate this as minimum profile temperature.

4.8.7 Record the low temperature obtained in Section 4.8.6, using spray paint or a permanent marker at the edge of the paving lane to indicate any area of the mat in which the profile is less than the lowest allowable profile temperature established in Section 4.8.4.2.

4.8.8 Record the station number to identify the location of the mat for the low temperature measured in Section 4.8.6.

Note 8—Instead of station numbers, GPS coordinates or other acceptable means may be used to identify the location.

4.8.9 Proceed to Section 5.1.

4.9 *Using the Thermal Imaging System:*

4.9.1 Refer to the summary output file for locations when using the thermal imaging system. Refer to Figure 2.

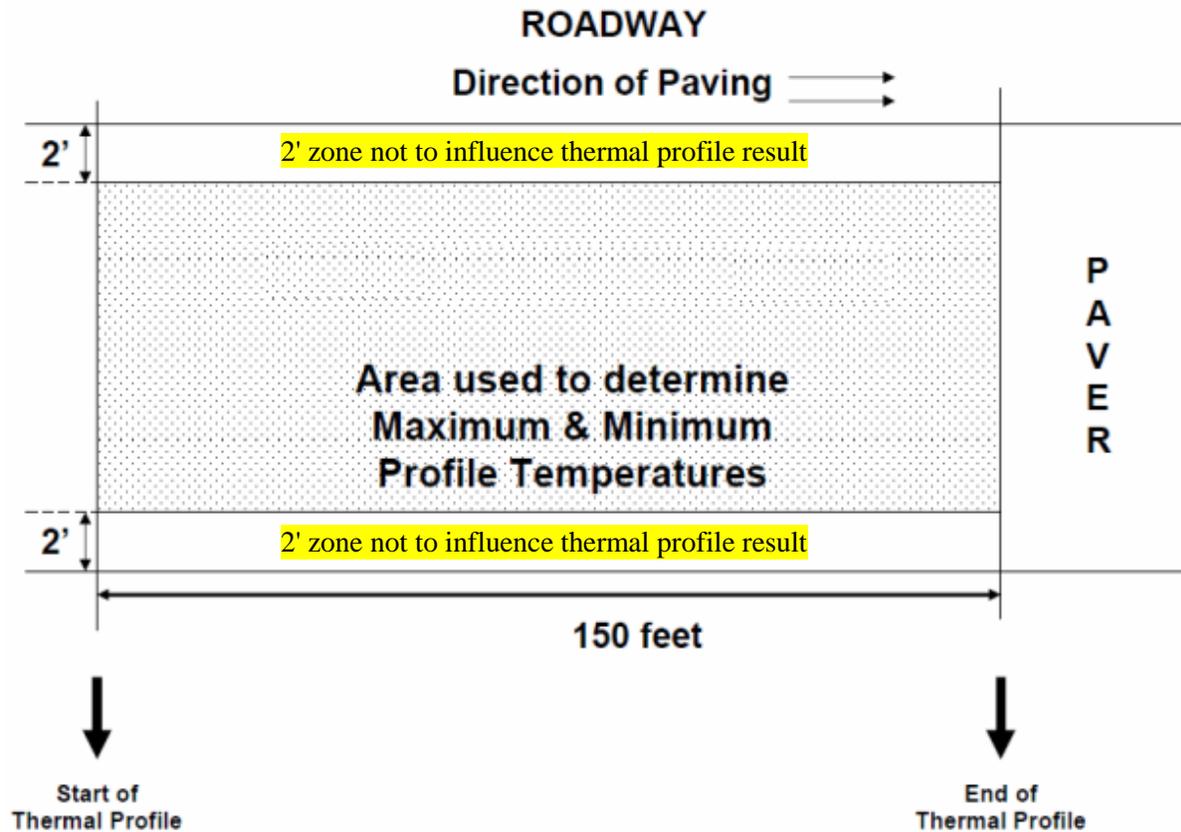


Figure 2—Thermal Profile when Using a Thermal Imaging System

- 4.9.2 Obtain the maximum baseline temperature when using the thermal imaging system by analyzing the temperature readings recorded throughout the entire 150-ft. length.
- 4.9.3 Install and operate the thermal imaging system on the paver following the manufacturer’s recommendations.
- 4.9.4 Verify the calibration for each temperature sensor prior to collecting temperature measurements per manufacturer’s recommendations.
Note 9—Check calibration of each temperature sensor to a known standard on an annual basis and recalibrate if necessary. Document the yearly check/calibration result.
- 4.9.5 Configure the thermal imaging system to record pavement temperatures at increments of no more than 12 in. of forward movement.
- 4.9.6 Generate the automated test report produced by the thermal imaging system from the temperature readings measured in Section 4.9.4.
Note 10—The test report must include the temperatures and locations (station numbers, GPS coordinates, or other acceptable means) where moderate or severe thermal segregation exists.
- 4.9.7 Proceed to Section 5.2.

5. CALCULATIONS

- 5.1 Calculate and record the temperature differential of the uncompacted mat surface when using a thermal camera:

Temperature Differential = Maximum Baseline Temperature - Minimum Profile Temperature

Note 11—Designate the Temperature Differential as having no thermal segregation, moderate thermal segregation, or severe thermal segregation.

- 5.2 Calculate and record the temperature differential of the uncompacted mat surface when using a thermal imaging system:

Temperature Differential = Maximum Temperature Recorded - Minimum Temperature Recorded

Note 12—The minimum and maximum temperatures within each profile are determined using the statistical 1 percentile and 98.5 percentile, respectively

6. ARCHIVED VERSIONS

- 6.1 Archived versions are available.