HOW TO CONDUCT A THERMAL PROFILE

1. Begin by turning the thermal camera on by pressing the on/off button. Allow the camera to remain on for a minimum of 5 minutes before beginning the thermal profile. If the tilde sign “~” is observed before the temperature reading in the top left corner of the screen, the camera has not had enough time to warm up. Open the shutter by sliding the lever above the trigger. Press the navigation pad. Select the settings icon and then press the navigation pad. Adjust the measurement parameters such that the emissivity is 1.00, the reflected temperature is 68°F, and the distance is 10 feet. The emissivity can be adjusted to 1.00 under the custom value setting. Return to the live image by pressing the cancel button twice. Adjust the language, time, and units by pressing the navigation pad. Select device settings and then press the navigation pad. Select language, time, and units and press the navigation pad. Adjust the language to English, the temperature unit to °F, the distance unit to feet, and enter the correct date and time. Return to the live image by pressing the cancel button three times. Adjust the image mode by pressing the navigation pad. Select the image mode icon and press the navigation pad. Select the Thermal MSX icon and press the navigation pad. Adjust the color by pressing the navigation pad. Select rainbow and press the navigation pad. Charge the camera as needed using the charger provided. A diagram of the camera showing the main functions is given in Figure 1.

Note—Do not point the camera at the sun; direct exposure can affect the accuracy and damage the detector.

1. Camera screen

2. Archive button
   Push to open the image archive.

3. Navigation pad
   Push to navigate in menu.
   Push center to confirm.

4. Cancel
   Push to cancel a choice or to go back.

5. Power button

Figure 1. Main Functions of the Thermal Camera
2. It is recommended that the pavement edge is marked according to the marker numbers discussed below, before the paver has paved the pavement (marks are placed ahead of the paver) as shown in Figure 2.

**Marker Numbers (MN)**

- **MN1**: identifies beginning of thermal profile (record station number as beginning)
- **MN2**: at a distance of 20 feet from Marker Number 1
- **MN3**: at a distance of 150 feet from Marker Number 1 (record station number as ending)

3.) Record the beginning and ending station numbers of all thermal profiles. The total length of the temperature profile is approximately 150 feet unless the paver stops for more than 60 seconds.

Note—If the paver stops for more than 60 seconds, exclude the area 2 feet behind and 8 feet in front of the paver (in the direction of travel) from the thermal profile. This distance needs to be added to the length of the overall temperature profile length. For example, if the paver stops once during the profile, for more than 60 seconds, the length of the thermal profile is increased from 150 feet to 160 feet.

4.) Return to the location of MN1. Press the navigation pad. Select the measurement icon and press the navigation pad. Select hot spot and press the navigation pad. Refer to Figure 1 for a description of the main functions.
5. As soon as the paver passes MN1, place a piece of wood (measuring 2 feet in length with a string attached) with one end on the near edge of the pavement and the other extending on the pavement surface. Using the 2-foot piece of wood will provide a reference point to exclude taking temperature measurements within 2 feet of the near edge of the uncompacted mat. The piece of wood should have a string attached to one end, so it can be removed when standing several feet away from the pavement edge. The wood should be placed in line with the pavement marker identifying the location of MN1. Refer to the photograph in Figure 3.

*Figure 3. Location of 2-Foot Piece of Wood with String on Pavement Surface*
6.) Hold the camera in hand with your elbow next to your side. Your arm should be bent approximately 135°, and your feet and body should be pointed parallel to the pavement near edge. Hold the end of the string in the other hand. Locate the end of the wood on the bottom of the screen on the thermal camera image as shown in Figure 4. Move towards or away from the pavement near edge and adjust the angle of your arm until the far edge of the pavement and the end of the wood is visible in the image as shown in Figure 4. Hold the camera at an angle that is comfortable, and position the camera close enough to be able to read the temperature in the top left corner on the screen. You should be approximately 3–4 feet from the pavement near edge. Refer to the photograph in Figure 5 below for the proper orientation.

![Figure 4. Thermal Image Showing the End of 2' Wood and the Far Edge of the Pavement](image1)

![Figure 5. Photograph Illustrating the Proper Orientation of the Person Performing the Thermal Profile](image2)
7. Once the far edge of the pavement and the end of the wood are observed on the thermal camera screen, make note of the distance between you and the near edge of the pavement (approximately 3–4 feet). Also make note of the clearance between the far edge of the pavement and the top of the screen on the thermal camera screen as shown in the thermal image in Figure 6. Throughout the thermal profile, keep the same distance between you and the near edge of the pavement with the same arm angle, while also maintaining the clearance shown in Figure 6.

Note—The temperature scale on the right-hand side of the thermal image is not used for conducting the thermal profile. Only the temperature recorded in the top left corner of the thermal image is used for the thermal profile.

Note—The temperature icon in the top left corner of the screen can be used as a guide to establish the clearance. For example, in Figure 6, the far edge of the pavement is apparent due to the distinct blue color associated with the low temperature. In Figure 6, the far edge of the pavement lines up with the degree (°) symbol. It is recommended that the clearance as shown in Figure 6 is minimized to ensure the middle of the pavement is analyzed. The far edge of the pavement as shown in Figure 6 should not extend below the black boxes surrounding the temperature and unit of measurement (black boxes surrounding “max 241” and °F).

8. Remove the wood from the pavement by pulling the string. Do not move away from the pavement near edge during this process. If the angle of the camera changed, reset the angle by closely matching the same clearance between the far edge of the pavement and the top of the screen on the thermal camera as shown in Figure 6.

9. Walk approximately 5 feet behind the paver at the same speed as the paver. Keep the same distance from the near edge of the pavement by walking parallel with the pavement near edge. With the same arm angle and clearance between the far edge of the pavement and the top of the screen, establish the maximum baseline temperature by recording the maximum temperature observed in the top left corner of the screen from the area between pavement markings MN1 and MN2. For documentation purposes, take a minimum of 2–3 photos throughout this section by pulling the trigger on the camera.

Note—The temperature shown in the top left corner of the screen is measured within the four angles as illustrated in the box drawn on the thermal image in Figure 7. When the same arm angle, clearance between the far edge of the pavement and the top of the screen, and distance away from the pavement near edge are maintained, the box in which the temperature is measured should be near the middle of the pavement.
Note—Thermal segregation may be observed during the establishment of the maximum baseline temperature. Thermal segregation should appear as an abrupt color change from white/red/yellow to green/blue. Refer to Sections 16 and 17 for the definition of thermal segregation. If an abrupt color change is observed during the establishment of the maximum baseline temperature on the pavement, press the navigation pad button and select the measurement icon. Press the navigation pad and select cold spot. Angle the camera such that box includes the area where the thermal segregation is observed. Take pictures by pulling the trigger on the camera. If thermal segregation is confirmed, refer to Section 12. An example of the appearance of thermal segregation is given in the thermal image in Figure 8. The cause of the thermal segregation in this case was the result of the steel roller after the screed, thus was not regarded as moderate or severe thermal segregation.

Figure 7. Thermal Image Illustrating the Box in which the Temperature is Measured by the Thermal Camera

Note—The temperature shown in the top left corner of the screen is measured within the four angles as illustrated in the box drawn on the thermal image in Figure 7. When the same arm angle, clearance between the far edge of the pavement and the top of the screen, and distance away from the pavement near edge are maintained, the box in which the temperature is measured should be near the middle of the pavement.

Figure 8. Example of the Appearance of Thermal Segregation

Example of what thermal segregation may look like. Notice the abrupt color changes.
10. As soon as you approach the mark identifying the location of MN2, press the navigation pad. Select the measurement icon and press the navigation pad. Select cold spot and press the navigation pad. Refer to Figure 1 for a description of the main functions. Determine the lowest allowable profile temperature by subtracting 25°F from the maximum baseline temperature determined between markings MN1 and MN2. This temperature is the minimum profile temperature.

11. Continue walking behind the paver at the same speed and at a distance of approximately 5 feet. Maintain the same distance from the near edge of the pavement. Maintain the same arm angle and clearance between the far edge of the pavement and the top of the thermal camera screen as observed in Figure 6. Observe the temperatures in the top left corner of the screen looking for temperatures below the minimum profile temperature. Take pictures by pulling the trigger on the camera. For documentation purposes, take a minimum of 13–15 photos between the markings MN2 and MN3 by pulling the trigger on the camera.

Note—As previously discussed, the temperature shown in the top left corner of the screen is measured within the four angles as illustrated in the box drawn on the thermal image in Figure 7. During the thermal profile, also observe if any abrupt color changes (from white/red/yellow to green/blue) are observed outside of this box on the pavement. If an abrupt color change is observed outside of the box, angle the camera such that the box includes the area where the abrupt color change is observed. Take pictures by pulling the trigger on the camera. If thermal segregation is confirmed, refer to Section 12.

12. If the minimum temperature observed is less than the minimum profile temperature, mark the near edge of the pavement or any area of the mat using spray paint. Record the temperature differential to identify the type of thermal segregation (moderate or severe) and the station number to identify the location on the mat where the thermal segregation was observed. Take pictures by pulling the trigger on the camera.

13. If you need to move away from the pavement for any reason, reset the distance between you and the pavement by using the piece of wood and the method previously discussed.

14. As stated before, the area 2 feet behind and 8 feet in front of the paver (in the direction of travel) is excluded from the thermal profile if the paver stops for more than 60 seconds. However, the thermal camera can be used to ensure the screed heaters do not overheat the mat as shown in the thermal image in Figure 9. Turn off the screed heaters as needed to prevent overheating of the mat.

Note—The engineer may require further testing according to the specification including the aging ratio if he/she suspects the area has experienced overheating. Mark the areas in question and record the station number. Take pictures as necessary for documentation.

Figure 9. Example of Screed Heaters Remaining on While Paver was Stopped
15. Continue the thermal profile until reaching the marking MN3. After completion of the thermal profile, close the shutter to protect the lens.

   Note—If the paver stopped for more than 60 seconds, add 10 feet to the length of the thermal profile for each stop.

16. If areas with recurring moderate thermal segregation (25.1–50.0°F temperature differential between the maximum baseline temperature and the minimum profile temperature) are observed, take immediate corrective action and mark the locations. Perform a density profile in the marked area and record the station numbers.

17. If an area with severe thermal segregation (greater than 50.0°F temperature differential between the maximum baseline temperature and the minimum profile temperature) is observed, suspend operations and take corrective action. Perform a density profile in the marked area and record the station number.

18. Provide the engineer with the thermal profile and density profiles (if applicable) of every sublot within one working day of the completion of each lot. Report the results of each thermal profile in accordance with the section “Reporting and Responsibilities” as outlined in the specification.

19. The engineer will use a hand-held thermal camera to obtain a thermal profile at least once per project.

20. Please contact Ryan Barborak with the Flexible Pavements Branch of the Construction Division at 512-506-5863 with any questions.