

**TEXAS DEPARTMENT OF TRANSPORTATION**



## THERMAL IMAGING SYSTEMS


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**TxDOT's 2014 Specification Regarding Thermal Segregation**

- Use a hand-held thermal camera or a thermal imaging system to obtain a continuous thermal profile in accordance with Tex-244-F.




**TxDOT's Classification of Thermal Segregation**


None	Moderate	Severe
0° - 25.0°	25.1° - 50.0°	> 50.0°

**3 Methods for Identifying Thermal Segregation**


Pave-IR System



Thermal Camera



Pave-IR Scan System



**What Is the Pave-IR System?**

- Method initially developed by Texas Transportation Institute (TTI) to detect thermal segregation in newly placed uncompacted asphalt mixture
- Uses a series of infrared sensors mounted to the screed
- Sensors are connected to a computer with color display
- Continuous monitoring of time, pavement temperature, location, paver speed, stops, and stop durations
- Thermal information is available and displayed in real-time
- Data stored on flash drive for post processing on PC



### Example of Pave-IR System Thermal Profiles

- 2 inch DG-TY C mix
- Using MTV
- No thermal segregation
- Continuous Profile

### Example of Pave-IR System Thermal Profiles

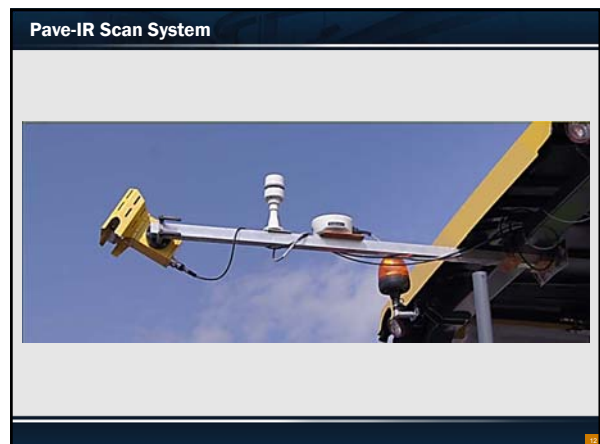
- 2 inch DG-TY C
- Using windrow pick-up device
- 73% moderate; 27% severe thermal segregation

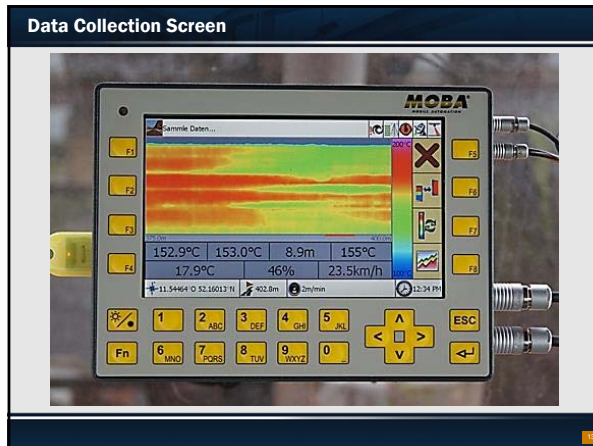
### Summary Screen

Collecting data . . .

Thermal Profile Results Summary					
Number of Profiles	Moderate >25°F to ≤50°F		Severe >50°F		Status
	Number	Percent	Number	Percent	
50	10	20	5	10	<span style="color: green;">✔</span>
Recent Test Result					
Beginning Location	Ending Location	Temp Differential	Status		
5550	5700	22	<span style="color: green;">✔</span>		
30.9222N 093.9943W		229.19 ft	39.2 ft/min	12:45	

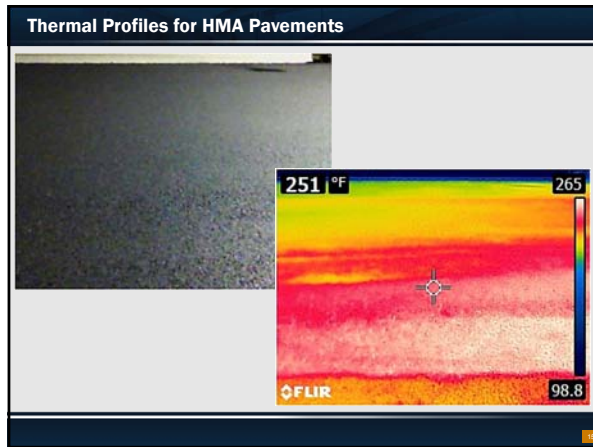
- ### What Is the Pave-IR Scan System?
- Method developed by Moba to detect thermal segregation in newly placed uncompacted asphalt mixture
  - Uses a temperature scanner mounted above the screed/paver deck
  - Continuous monitoring of time, pavement temperature, location, paver speed, stops, stop durations, wind speed, air temperature, and humidity.
  - Thermal information is available and displayed in real-time
  - Data stored on MOBA Operand Computer





**What is the Thermal Camera?**

- Camera requirements outlined in Tex-244-F, "Thermal Profile of Hot Mix Asphalt"
  - Minimum resolution of 19,200 pixels
  - Older cameras may not meet this requirement
- Camera on Blanket PO is FLIR E6
  - Handheld (not mounted, portable)
  - Thermal image is displayed in real time
  - Pull the trigger to take thermal images
  - A digital image is also taken
  - Use FLIR Tools to analyze images



**3 Goals for 2014 Specification to Address Thermal Segregation**

1. Remove the handheld Infrared thermometer from TxDOT's specification
2. Evaluate the Pave-IR Scan and compare it to the Pave-IR System
3. Develop a better procedure for using the thermal camera

**Goal 1 – Remove Language Allowing Handheld Thermometer**

- Then
 

Use a thermal camera or an infrared thermometer to obtain thermal profiles on each subplot in accordance with Tex-244-F. In lieu of obtaining thermal profiles on each subplot using a thermal camera or an infrared thermometer, the Contractor may use the Pave-IR system (paver mounted infrared bar) to obtain a continuous thermal profile in accordance with Tex-244-F.
- Now
 

Use a hand-held thermal camera or a thermal imaging system to obtain a continuous thermal profile in accordance with Tex-244-F.

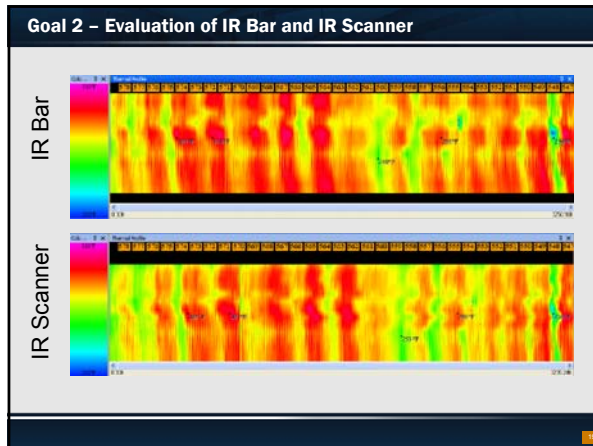
**Goal 2 – Evaluation of IR Bar and IR Scanner**

- Conducted by Texas Transportation Institute (TTI)
- Paired t-test shows scanner and beam results are equivalent
- Scanner slightly more favorable results in classification of profiles

Profile	Temp Differential		Profile	Temp Differential	
	Beam	Scanner		Beam	Scanner
1	43	42.7	16	41.8	38.9
2	26.8	23.8	17	41.9	37.1
3	18.7	16.2	18	30.1	30.2
4	32.4	31.9	19	43.6	42.8
5	25.6	23.9	20	27	22.9
6	41.6	39.6	21	24.1	26.6
7	27.4	24.1	22	42.5	44.1
8	20.9	20.5	23	52.6	55.6
9	49.9	43.6	24	41.9	58.4
10	36.7	27.4	25	37.4	34.6
11	30.4	28.1	26	50	53.8
12	50.2	52	27	27.4	27.7
13	27.4	26.6	28	37.6	34.9
14	38.2	32.4	29	34.4	31.9
15	22.5	18.9	30	25.4	27.7

Pave-IR System	Number of Profiles	Moderate		Severe	
		Number	Percent	Number	Percent
Beam	30	23	77	3	10
Scanner	30	20	67	3	10

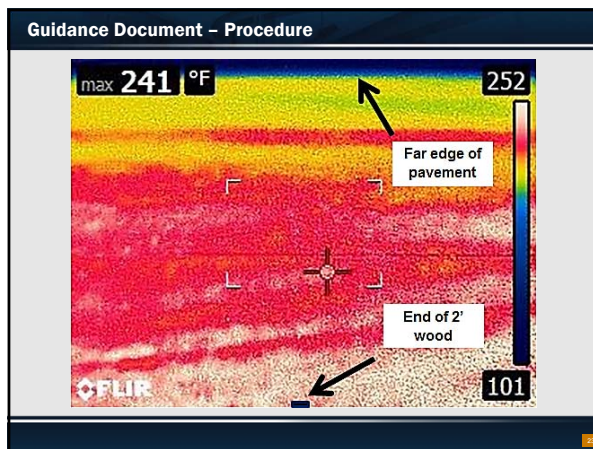
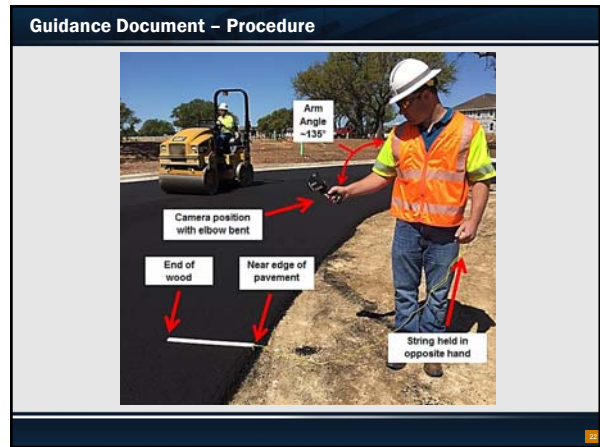




### Goal 3 – Develop a Procedure for Using Thermal Camera

- Thermal Camera Guidance Document is a descriptive procedure for how to conduct a thermal profile
  - TxDOT website Construction and Materials TIPS
    - <http://ftp.dot.state.tx.us/pub/txdot-info/cst/tips/thermal-camera.pdf>
- CST held a webinar recording in April 2016 to answer questions
  - Webinar was recorded and is available
- CST and TxAPA provide training including a demonstration
  - Part of Level 1B certification

- ### Goal 3 – Thermal Camera Guidance Document
- Three goals when conducting a temperature profile
    - Keep the same distance between you and the near edge of the pavement while walking parallel to the mat.
    - Keep the same arm angle
    - Maintain the same clearance at the top of the images
  - Goal is to have a formal procedure that everyone can follow step by step to obtain the same thermal profile
    - Consistency is key



- ### Thermal Camera Notes
- Obtaining thermal images is the “proof” needed to justify the decisions made
    - Recommendation is 2 to 3 photos for the first 20 feet
    - 13 to 15 photos for the remaining 130 feet
  - Decision to suspend operations and take corrective action if severe segregation is observed (greater than 50.0°F temperature differential) is made before analyzing the thermal images
  - Camera should be used to mark areas of concern, which can be followed up with a density profile
  - Temperatures added to SiteManager are those recorded in the top left of the screen during the temperature profile (maximum baseline temperature during the first 20 feet and minimum profile temperature during the remaining 130 feet section)
    - Analyzing images using FLIR Tools is typically not needed

