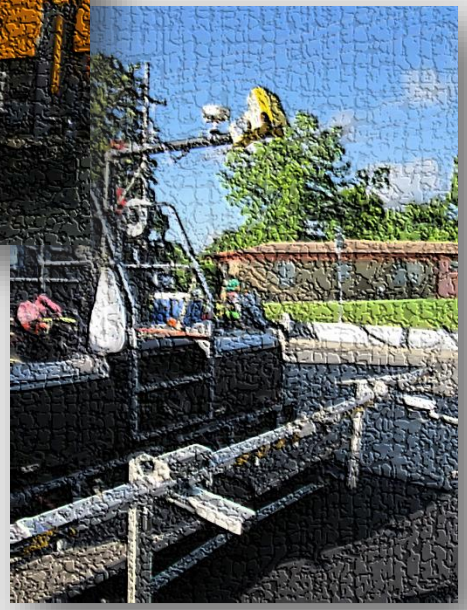
TEXAS DEPARTMENT OF TRANSPORTATION



THERMAL IMAGING SYSTEMS

Gisel Carrasco, P.E.

TxDOT, Construction Division

SHRP2 Infrared Scanner Pave-IR Scan Showcase

June 1, 2016

Timeline

No Thermal Evaluation Requirement

1993

Thermal Profile Requirement Added to the Specs

2000

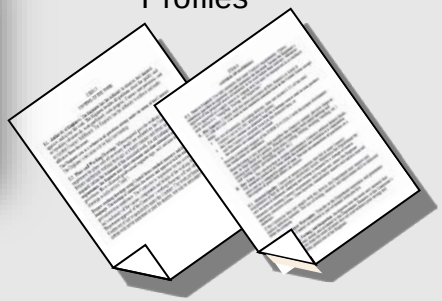
Research on Thermal Segregation

2004

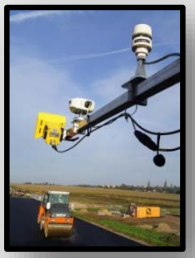
Research and Development of New Technology

Negotiating the Implementation of the Pave-IR with Industry

2011



Special Specs Allow Infrared Thermometer, Thermal Camera, and Pave-IR for Thermal Profiles



Development and Evaluation of IR Scanner

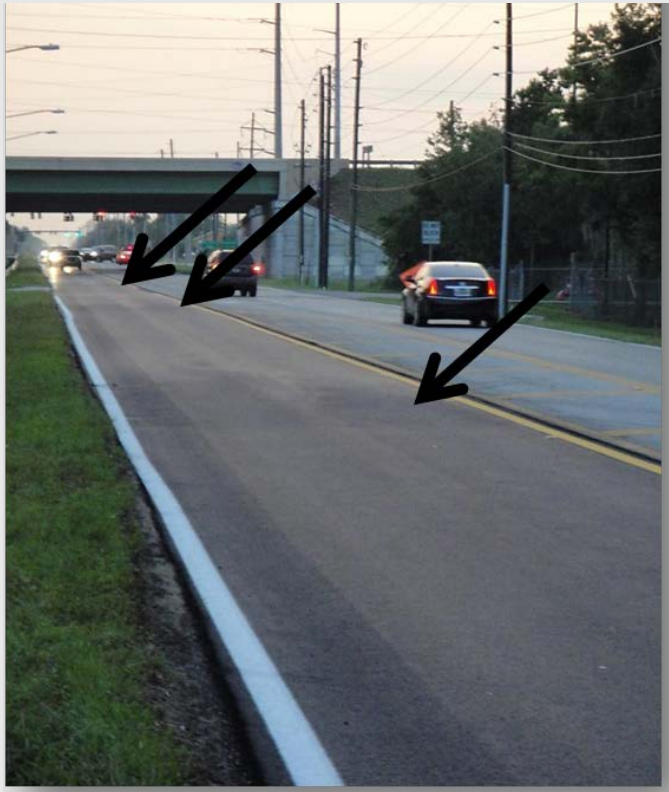
2014

Infrared Thermometer Not Allowed for Thermal Profiles

1993 Texas Standard Specifications

Early Observations

Coarser texture and holding water



Raveling and Cracking Follow

Thermal Segregation

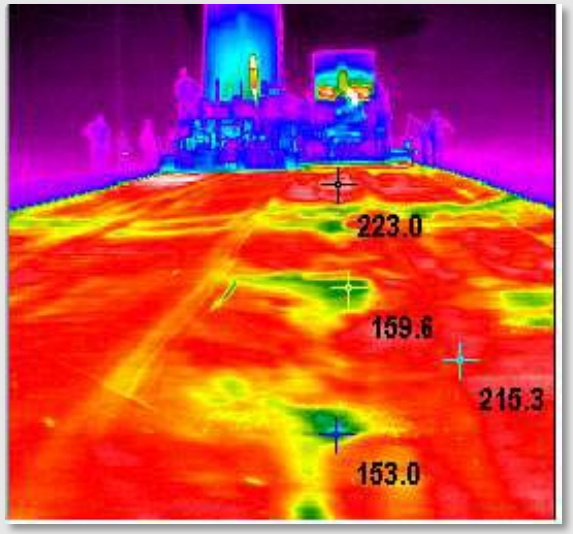
Thermal segregation can be an indicator of:

- Low Densities
- Physical Segregation
- Irregularities
- Poor Ride Quality

Thermal Segregation

HOW CAN WE DETECT THIS TYPE OF DISTRESS WHILE THE PROJECT IS BEING CONSTRUCTED?

1996 – WSDOT discovered that thermal imaging could detect segregation.

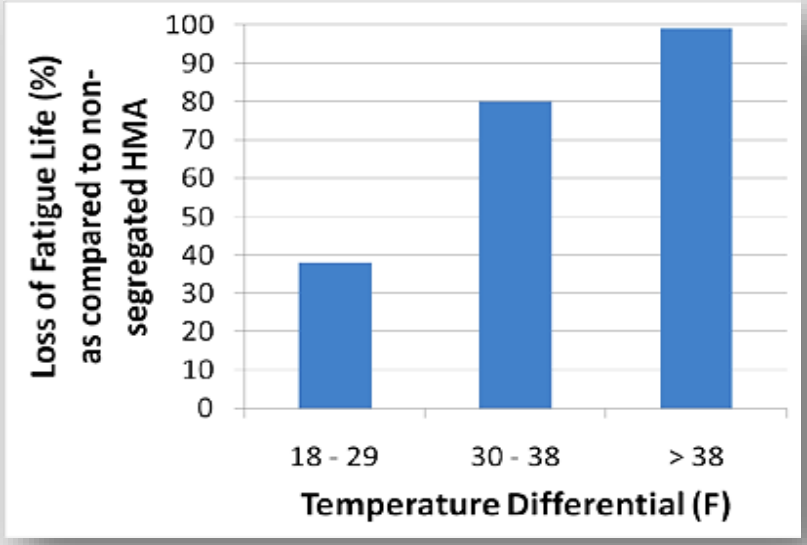


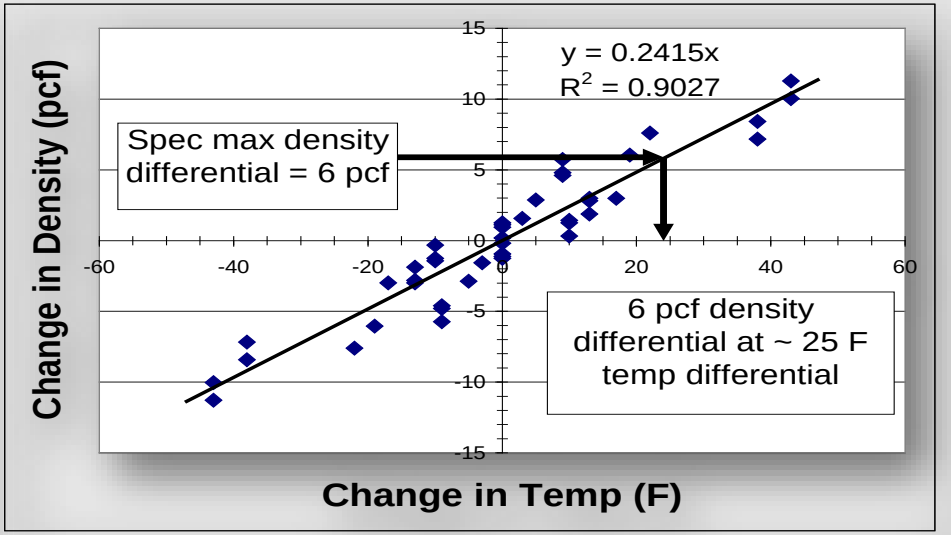
Research On Thermal Segregation

Fatigue Life Substantially Reduced

NCAT (2000) and TTI (2002) found thermal uniformity suitable for detecting segregation

- NCAT – low severity segregation when $\Delta t > 18\ ^\circ F$
- TTI – when $\Delta t > 25\ ^\circ F$, TxDOT density uniformity requirements not met





Source: NCAT (2000)

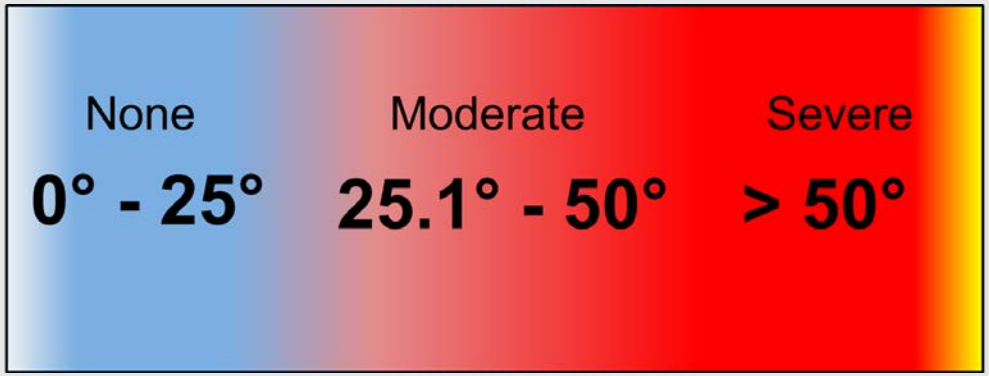
2004 TxDOT Standard Specifications

Tex-244-F- Thermal Profiles

Thermal profiles can determine:

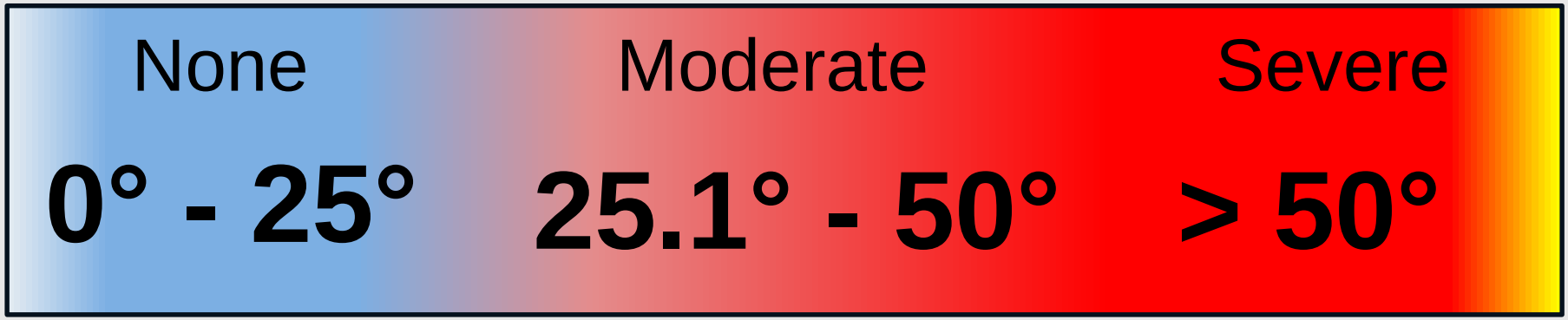
- If thermal segregation exists; and
- The degree of thermal segregation

Handheld Infrared Thermometer



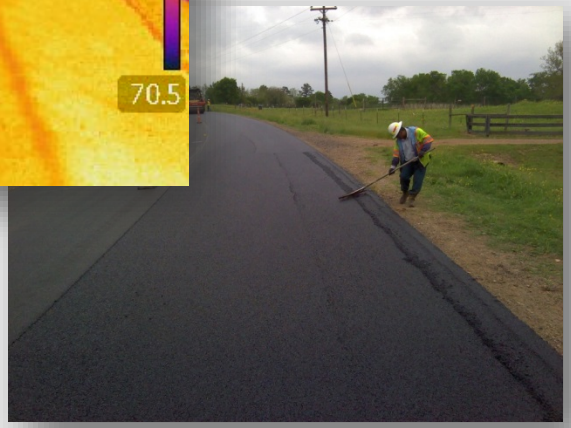
Thermal Profiles – Tex-244-F

- When Do I Perform Thermal Profiles?
  - Once per sublot
  - If moderate thermal segregation exists, perform a density profile in that area of the sublot
  - If severe thermal segregation exists, suspend operations and make changes to paving operations



How Effective is Tex-244-F?

- Federal Audit
  - Minimal failing thermal segregation reported
  - Test being waived
- Thermal Camera
- Pave-IR Development
  - TTI Research

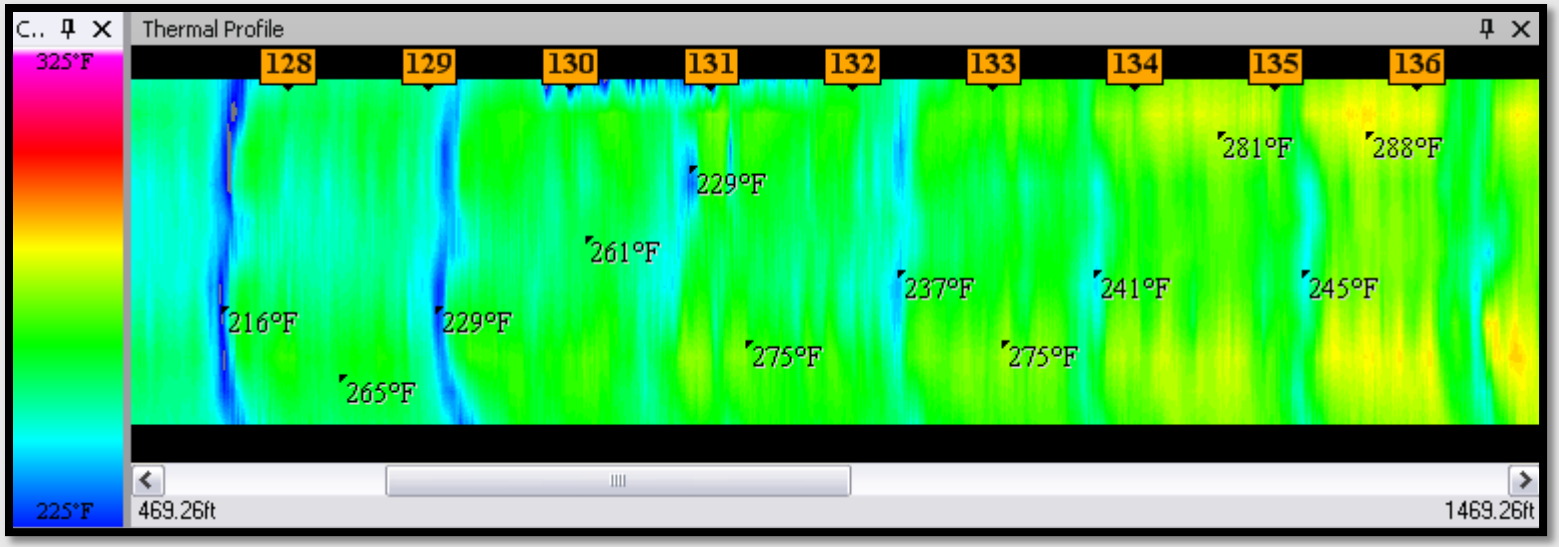


What If We Could . . .

- Take images of the pavement surface from a thermal camera;
- Put them together in sequential order to form sort of a thermal map;
- Tie the map to GPS coordinates;
- With analysis and reporting software; and
- Do all this in real time?

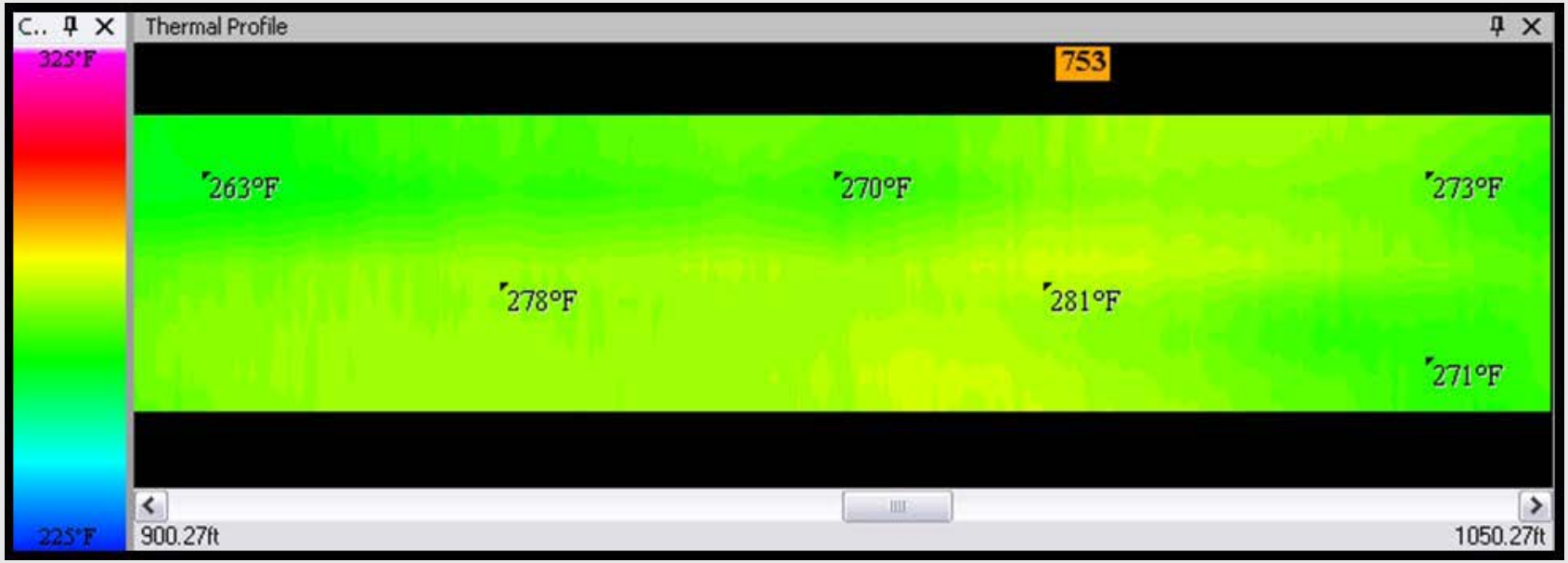
Example Thermal Profiles

- 2-inch dense-graded Type C
- Using windrow pick-up device
- 73% moderate; 27% severe thermal segregation



Example Thermal Profiles

- 2-inch dense graded TY C
- Using MTV
- No thermal segregation



Story Time – How to Implement the Pave-IR System?

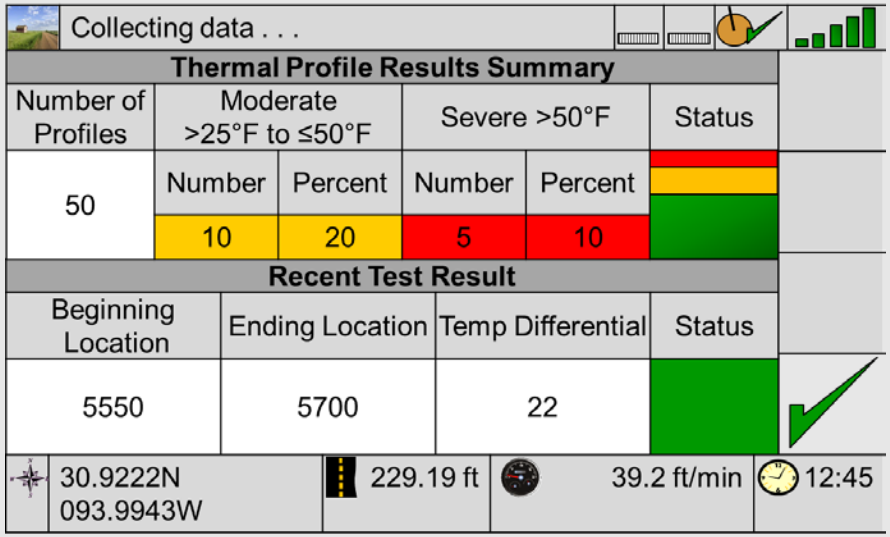
Implementation of the Pave-IR system

Goal: Improve pavement performance by encouraging Contractors to optimize paving operations

Optional for all paving projects
Specification incentives

- No density profiles or thermal profiles
- Can pave at lower temperatures
- Bonuses not waived for non compliance
- Automated documentation
- Contractor's ticket taker not required to measure mix temperature and record station # on haul tickets

Reporting



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	

Recent Test Result

Beginning Location	Ending Location	Temp Differential	Status
5550	5700	22	

30.9222N
093.9943W
229.19 ft
39.2 ft/min
12:45

Tex-244-F Part II

Thermal Profile Summary Report

Profile ID:	Demo - severe thermal segregation	Profile Date:	6/16/2010 5:07:33 AM
Profile Number:	1	Letting Date:	
Status:	severe	Controlling CSJ:	
County:	Demonstration	Spec Year:	
Tested By:	SDS	Spec Item:	
Test Location:	eb	Special Provision:	
Material Code:	SP 12.5	Mix Type:	
Material Name:	Superpave 12.5 PG 64-22		
Producer:			
Area Engeneer:		Project Manager:	

Course/Lift:	1	Temperature Differential Threshold:	25.0
Segment Length (ft):	150	Sensors Ignored:	-

Thermal Profile Results Summary

Number of Profiles	Moderate 25.0°F < differential <= 50.0°F		Severe differential > 50.0°F	
	Number	Percent	Number	Percent
9	0	0	9	100

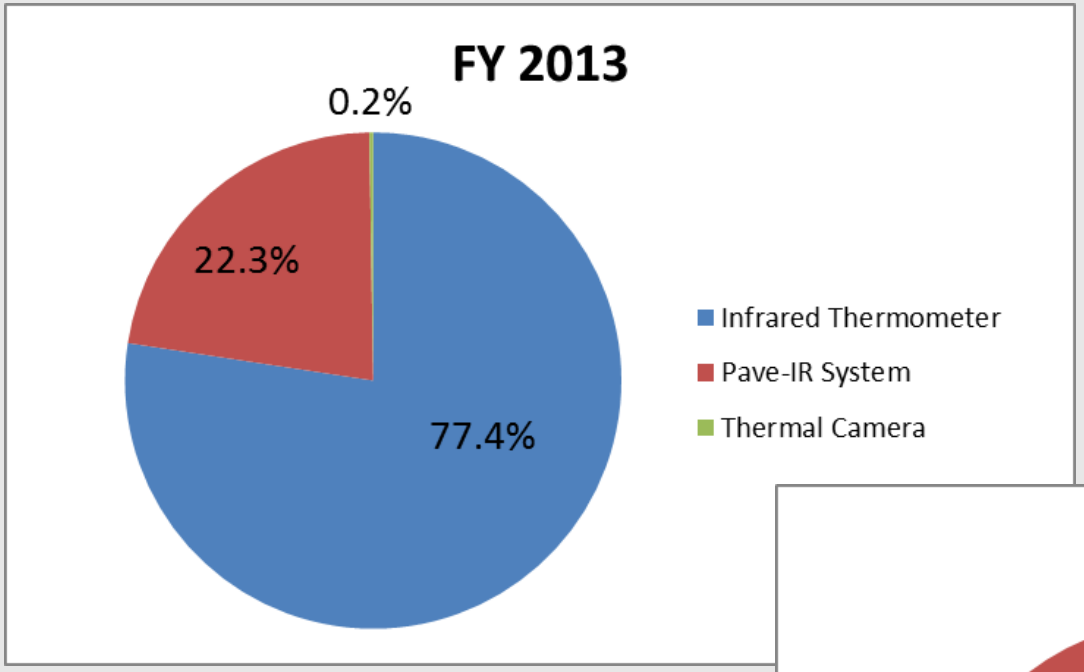
ID: Demo - severe thermal segregation Page: 1

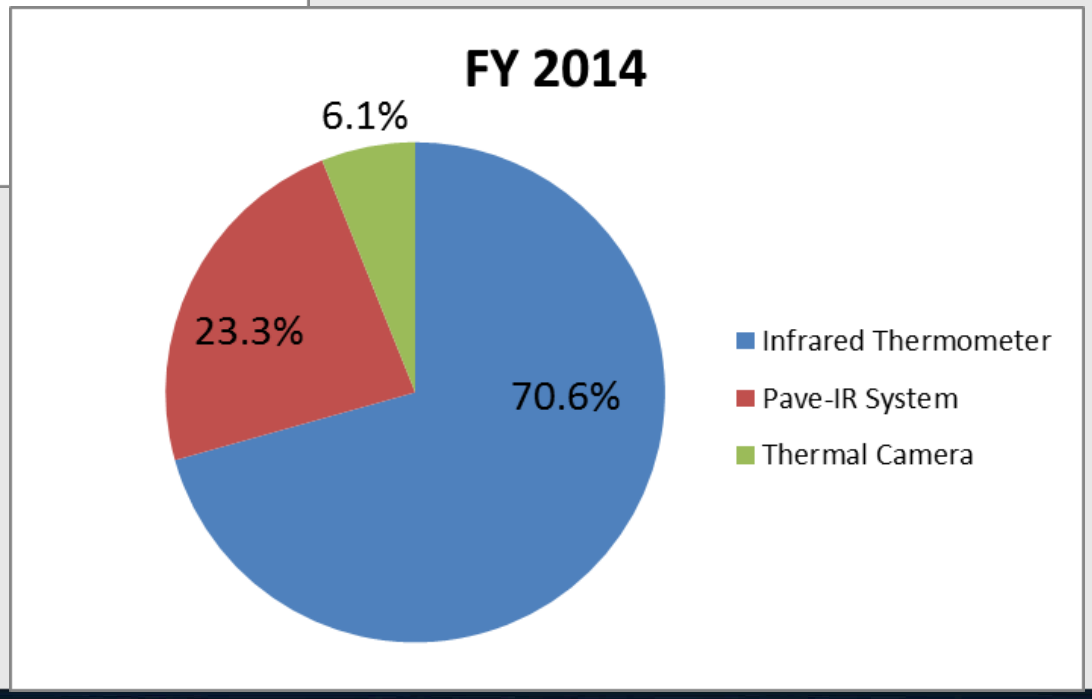
Special Specifications

Special Specifications

- No longer allows to waive the thermal profile requirement;
- Addresses the contractor using the Pave-IR system for specification compliance and stipulates reporting requirements.
- Provide incentives to contractors that uses the Pave-IR for specification compliance.

Tons Tested


FY 2013
0.2%
22.3%
77.4%
Infrared Thermometer
Pave-IR System
Thermal Camera


FY 2014
6.1%
23.3%
70.6%
Infrared Thermometer
Pave-IR System
Thermal Camera

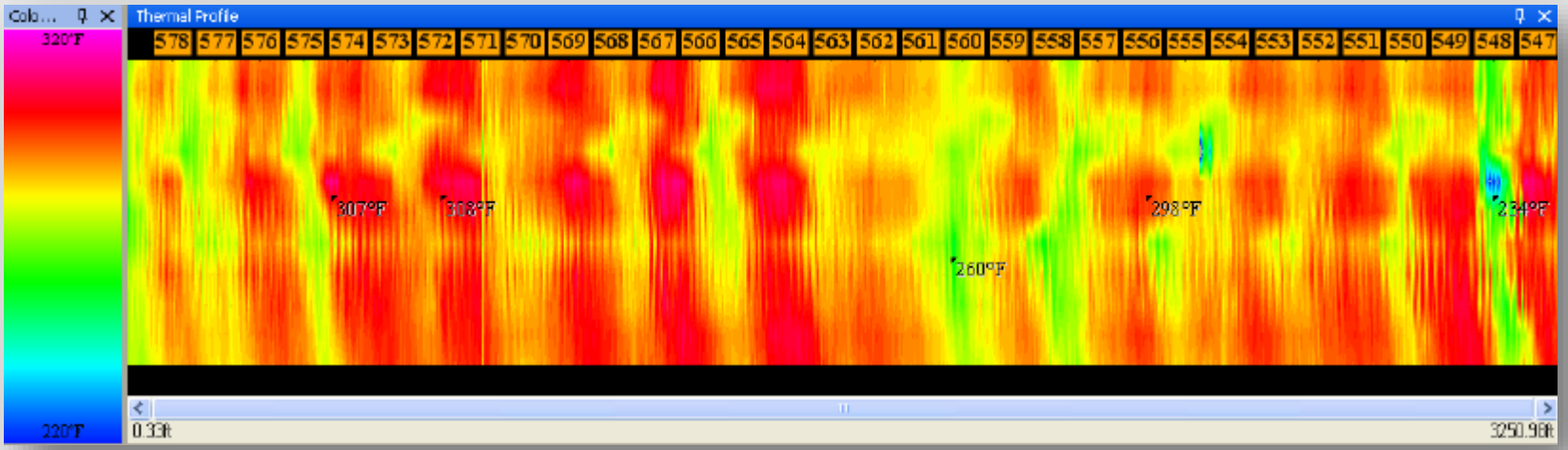
2014 Standard Specifications

HMA Specifications

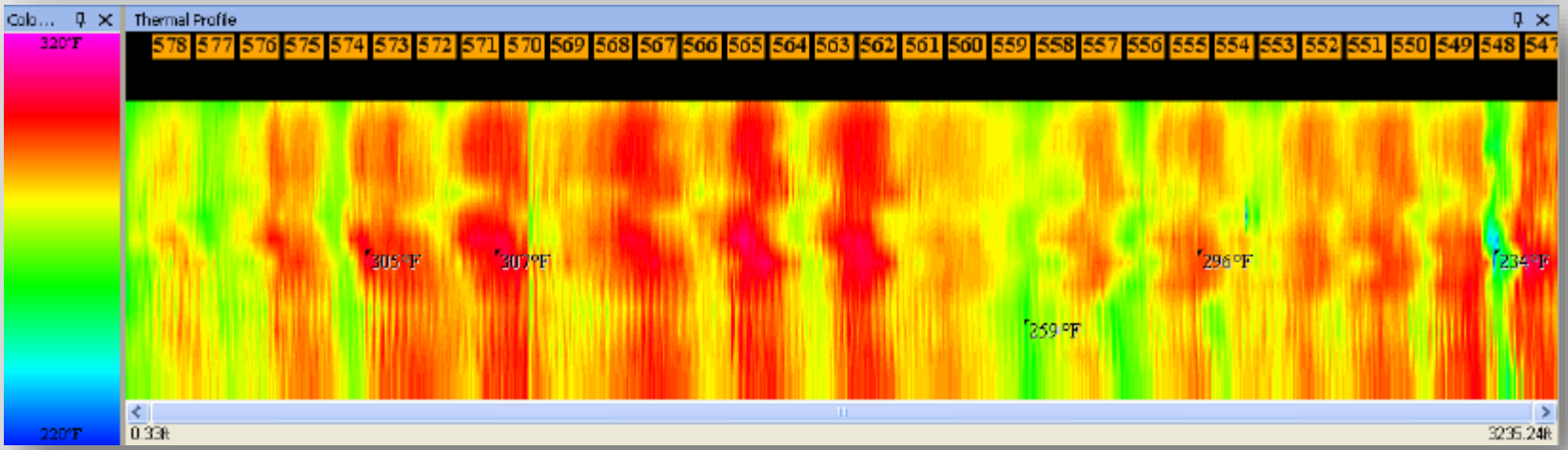
- “Pave-IR” replaced with “Thermal Imaging” system to include the scanner
- Removes the option of using the thermal gun to perform thermal profiles.
- Updated thermal camera testing procedure

Results from Thermal Imaging Systems Evaluation

IR Bar



IR Scanner



Experience To Date

- Eliminates the QC technician from having to perform segregation density profiles, and thermal profiles;
- Improves placement and ride bonus opportunities and minimizes penalties, resulting in a prompt return on investment cost;
- Data can be viewed locally at the paver and remotely in real time;
- Improves QC/QA confidence level when paving and compacting mix in cooler temperatures;
- Knowledge gained provides instantaneous feedback from the paver back to the plant.


QUESTIONS?