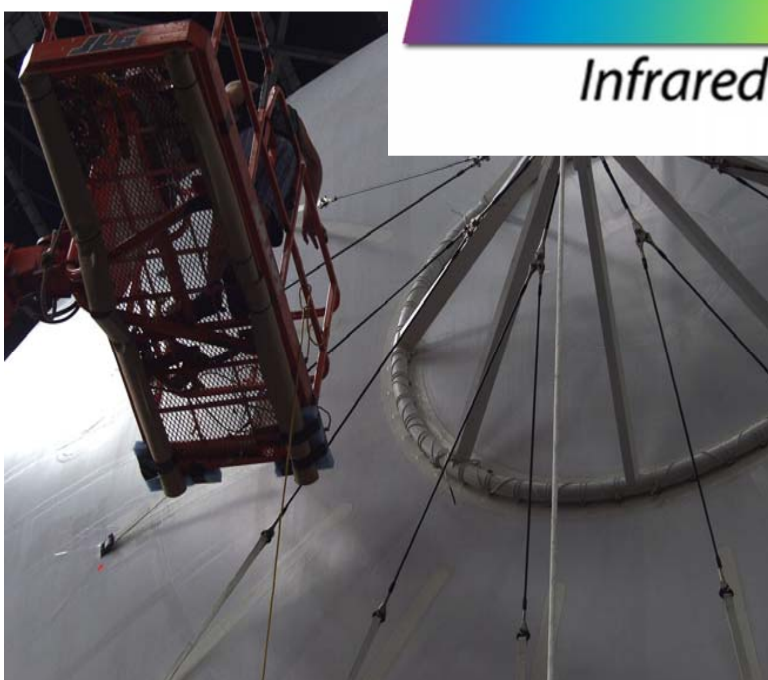
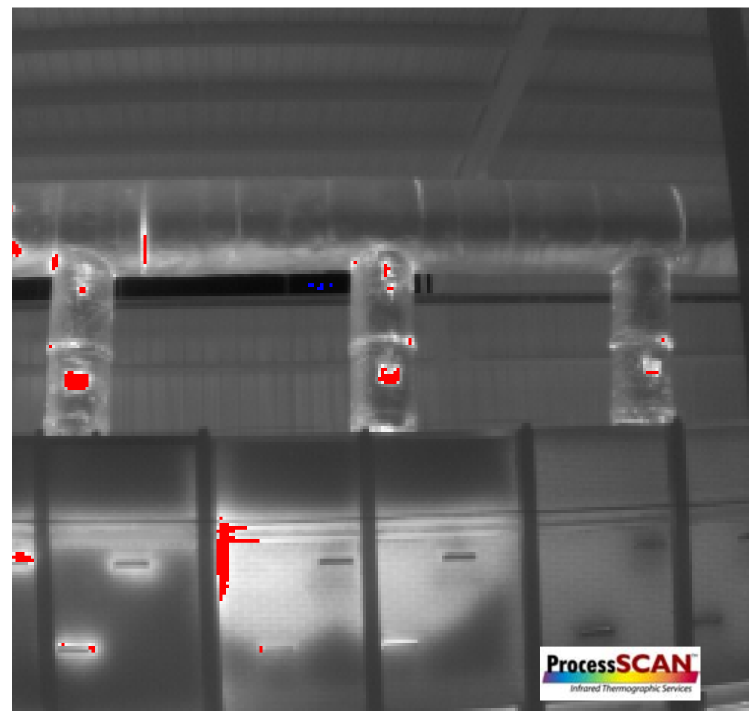
ProcessSCAN™

Infrared Thermographic Services

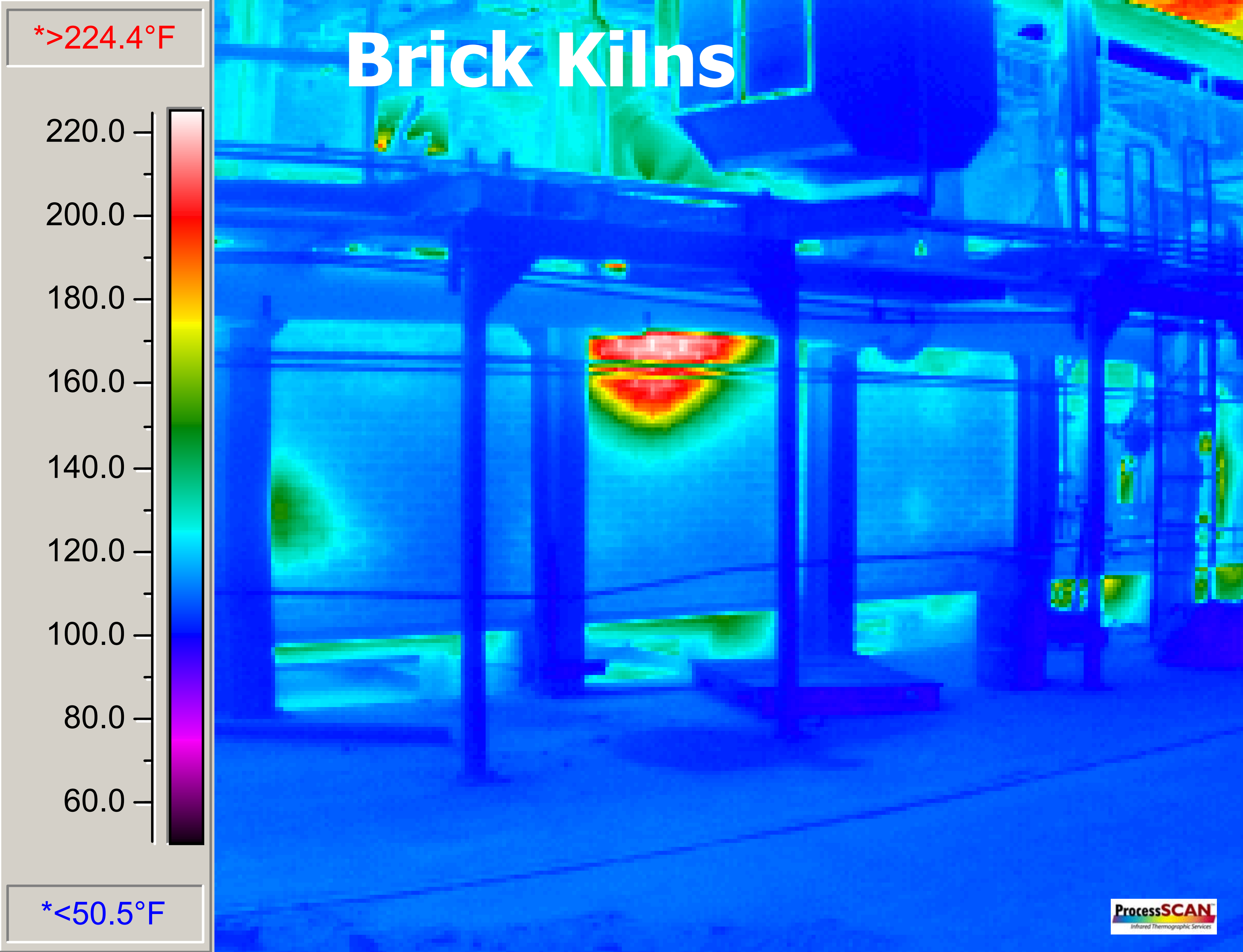


Brick Kilns

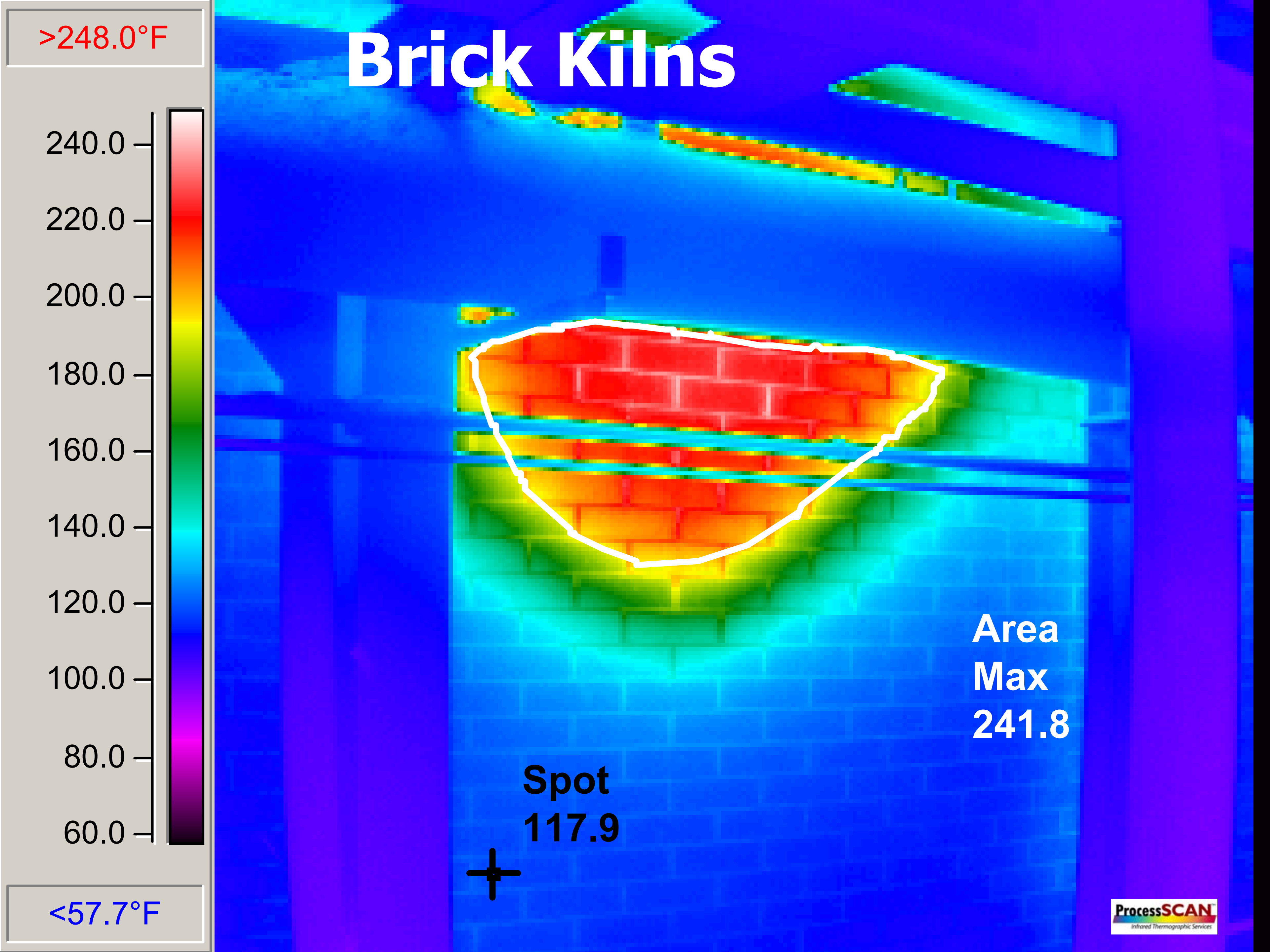

Line Profile


ProcessSCAN
Infrared Thermographic Services

Brick Kilns

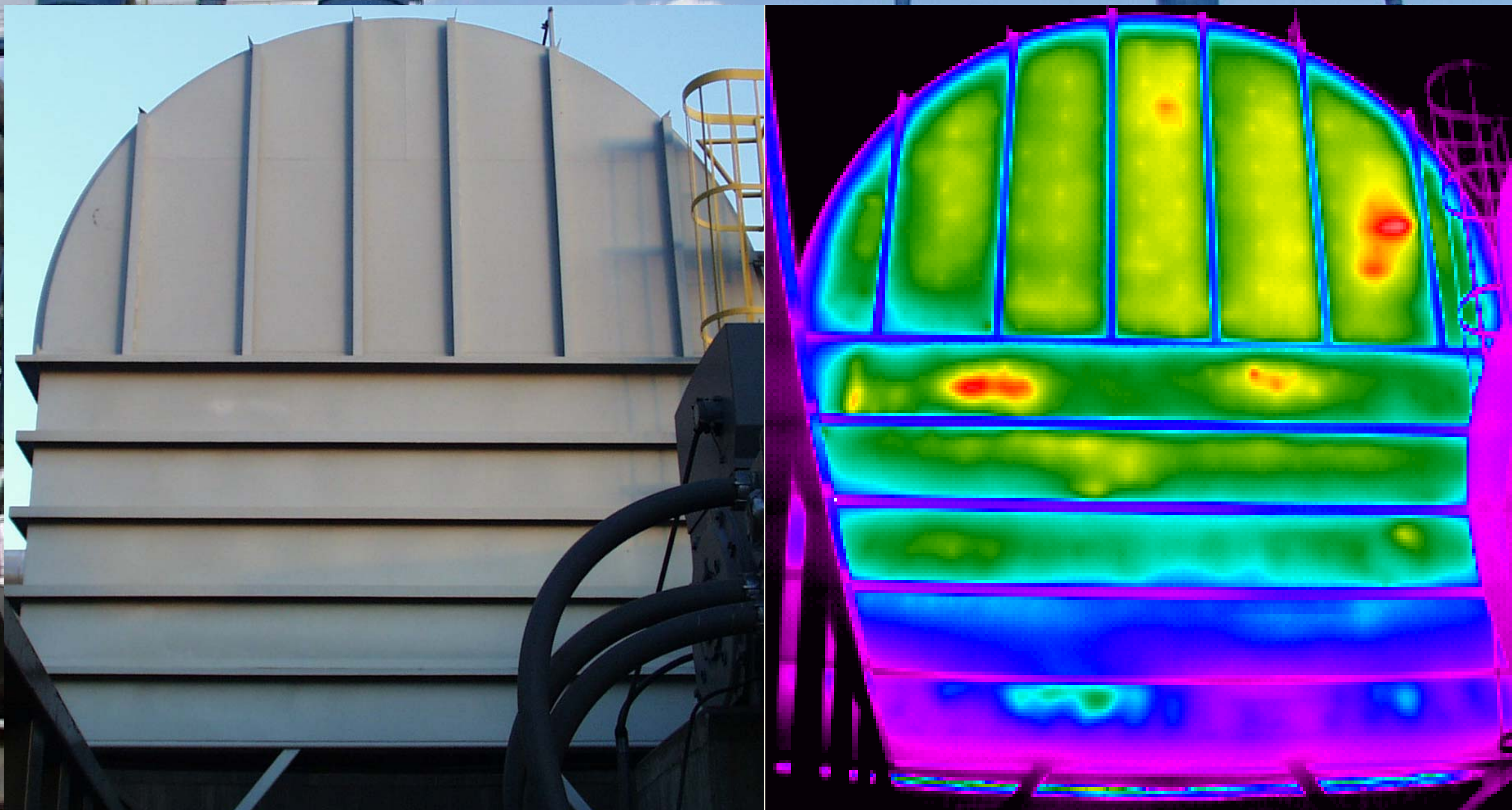

*>224.4°F
220.0
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
*<50.5°F
ProcessSCAN

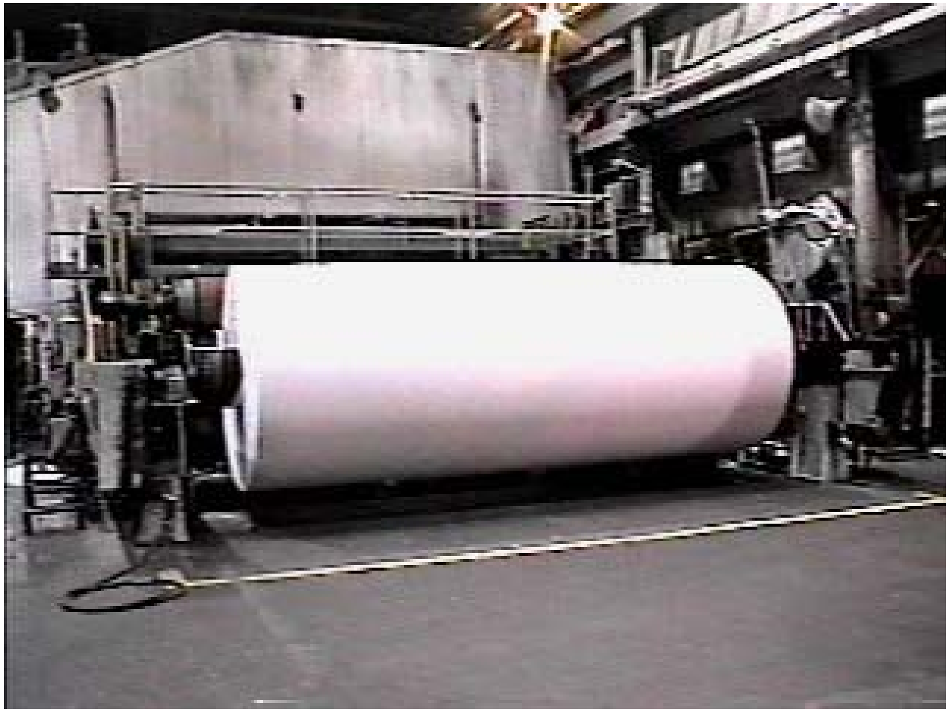
Brick Kilns

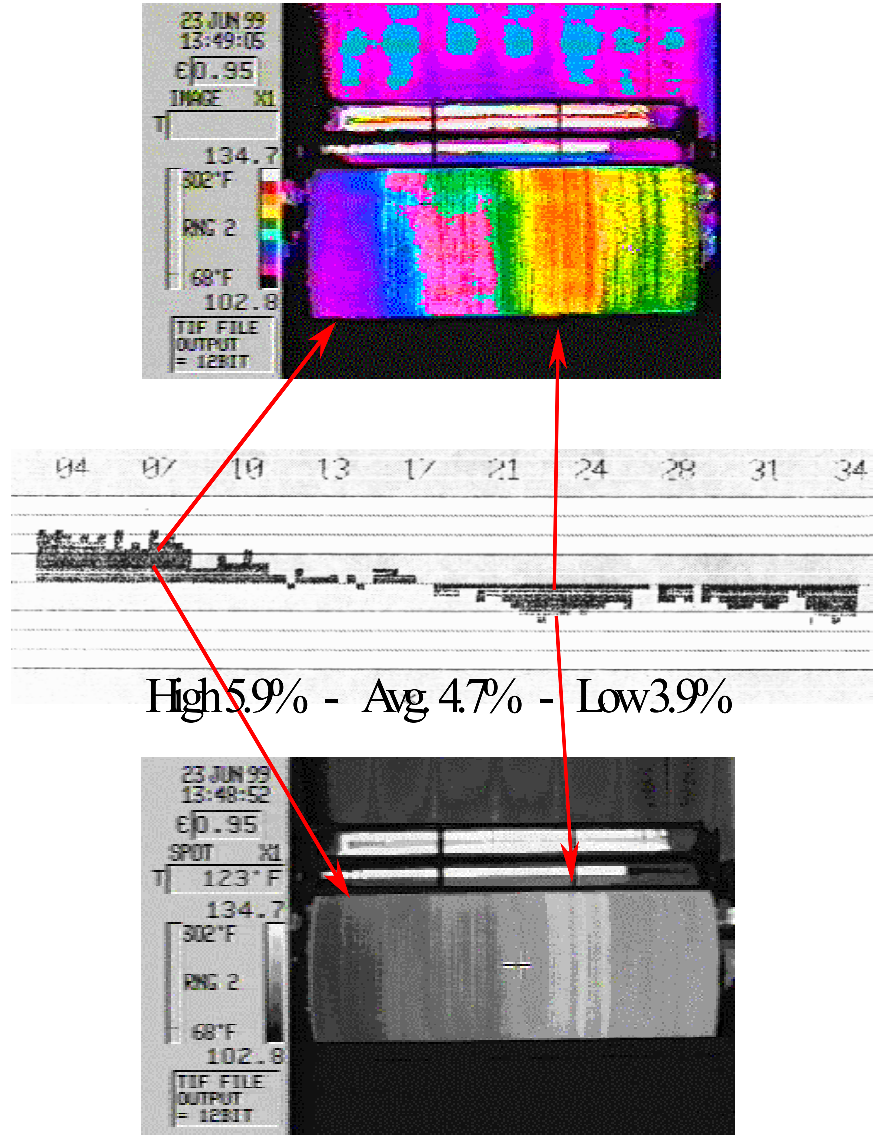

>248.0°F
240.0
220.0
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
<57.7°F
Area
Max
241.8
Spot
117.9
ProcessSCAN
Infrared Thermographic Services

RTOs (Recuperative Thermal Oxidizers)

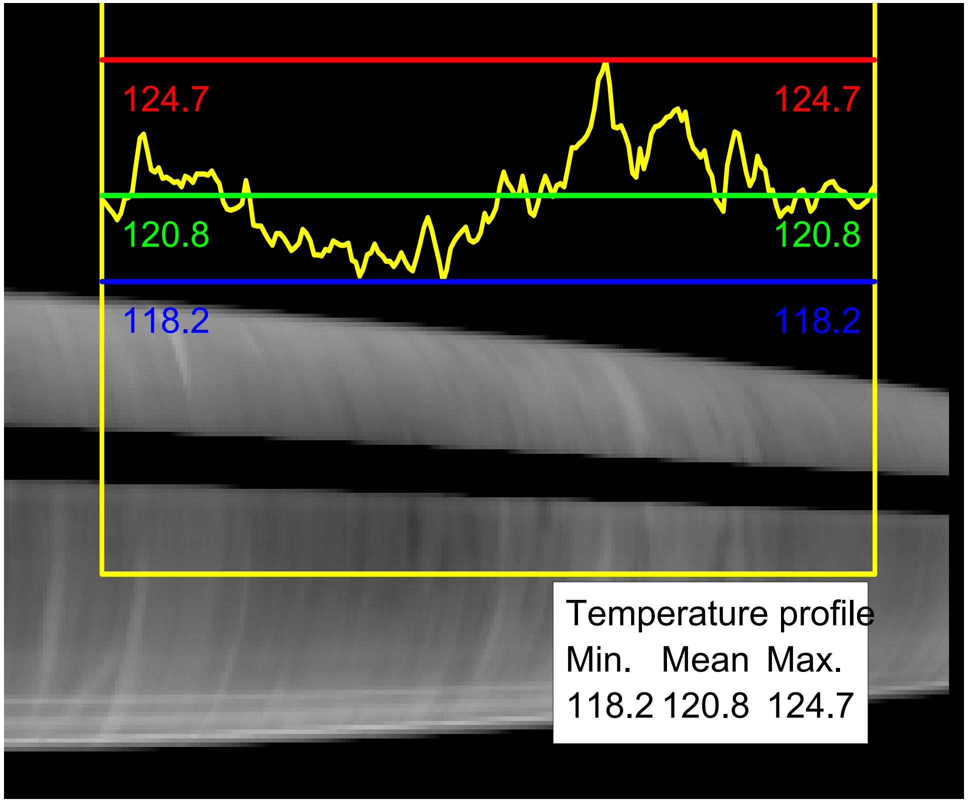
RTOs (Recuperative Thermal Oxidizers)

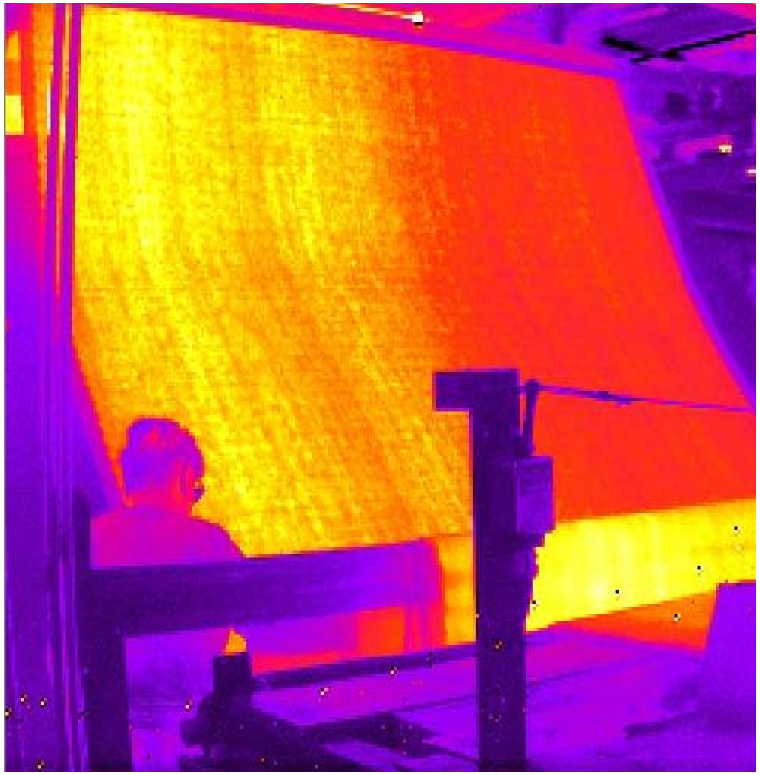


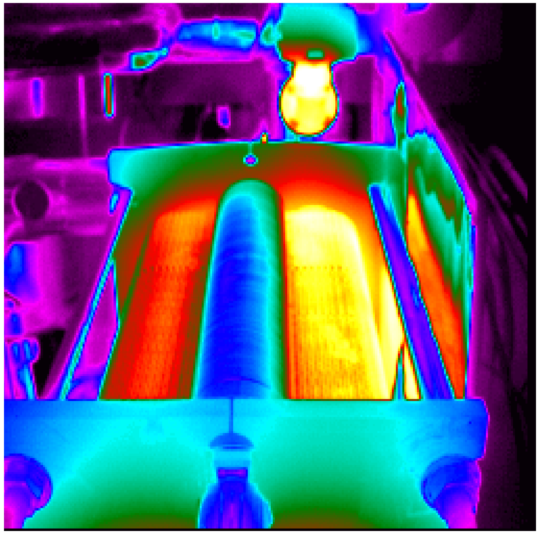




Pulp & Paper Machines



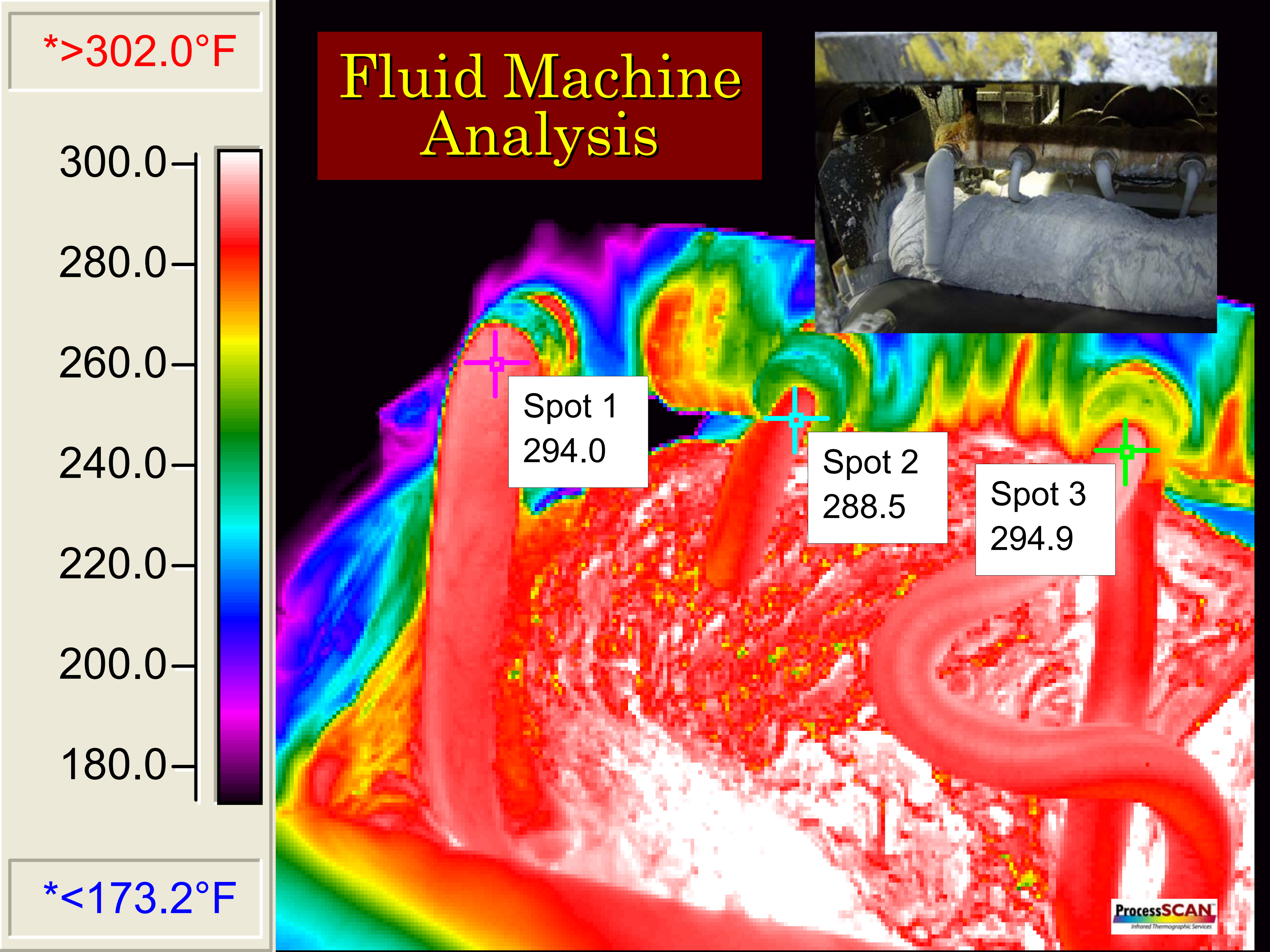




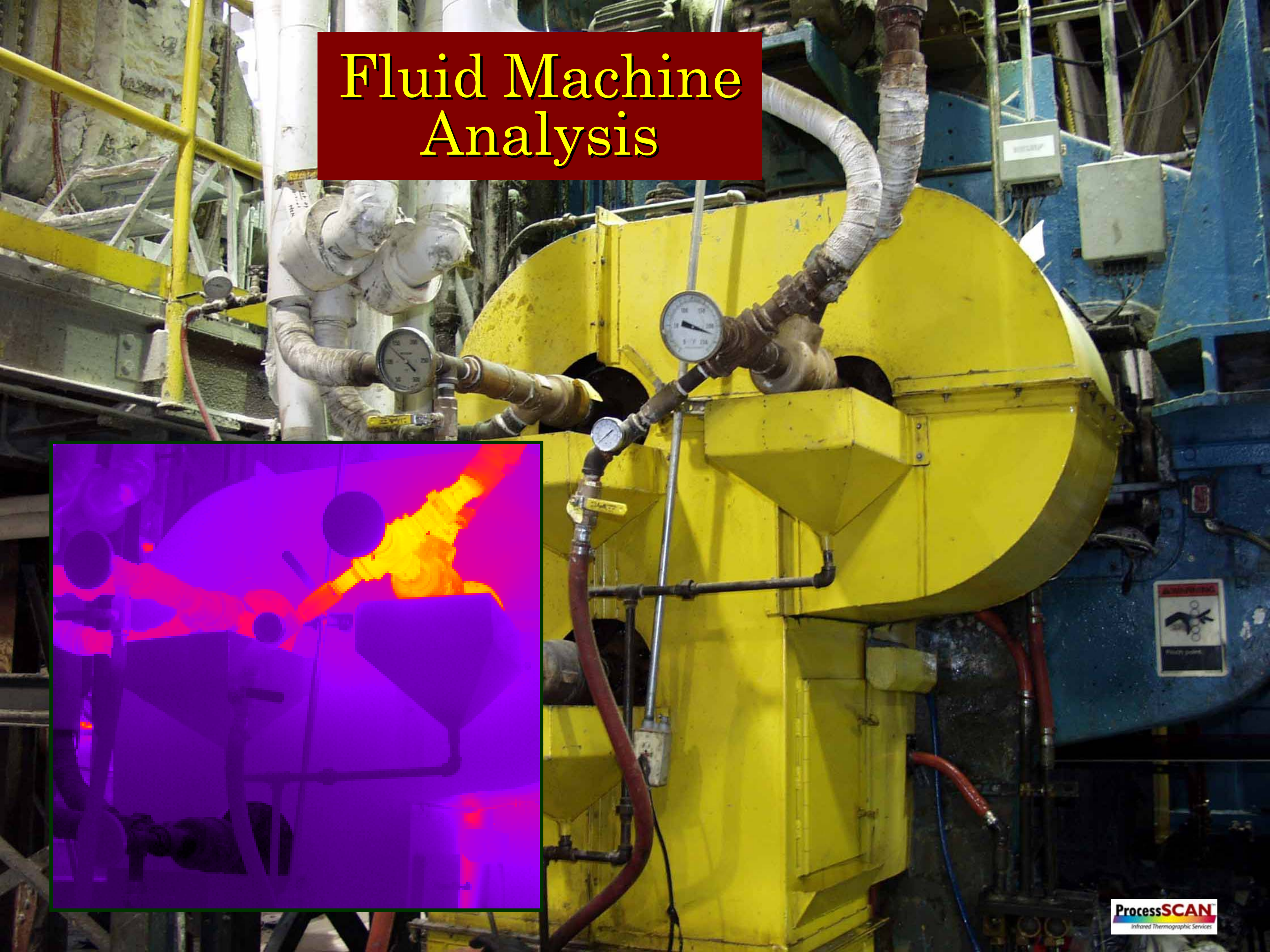
Heating process monitoring

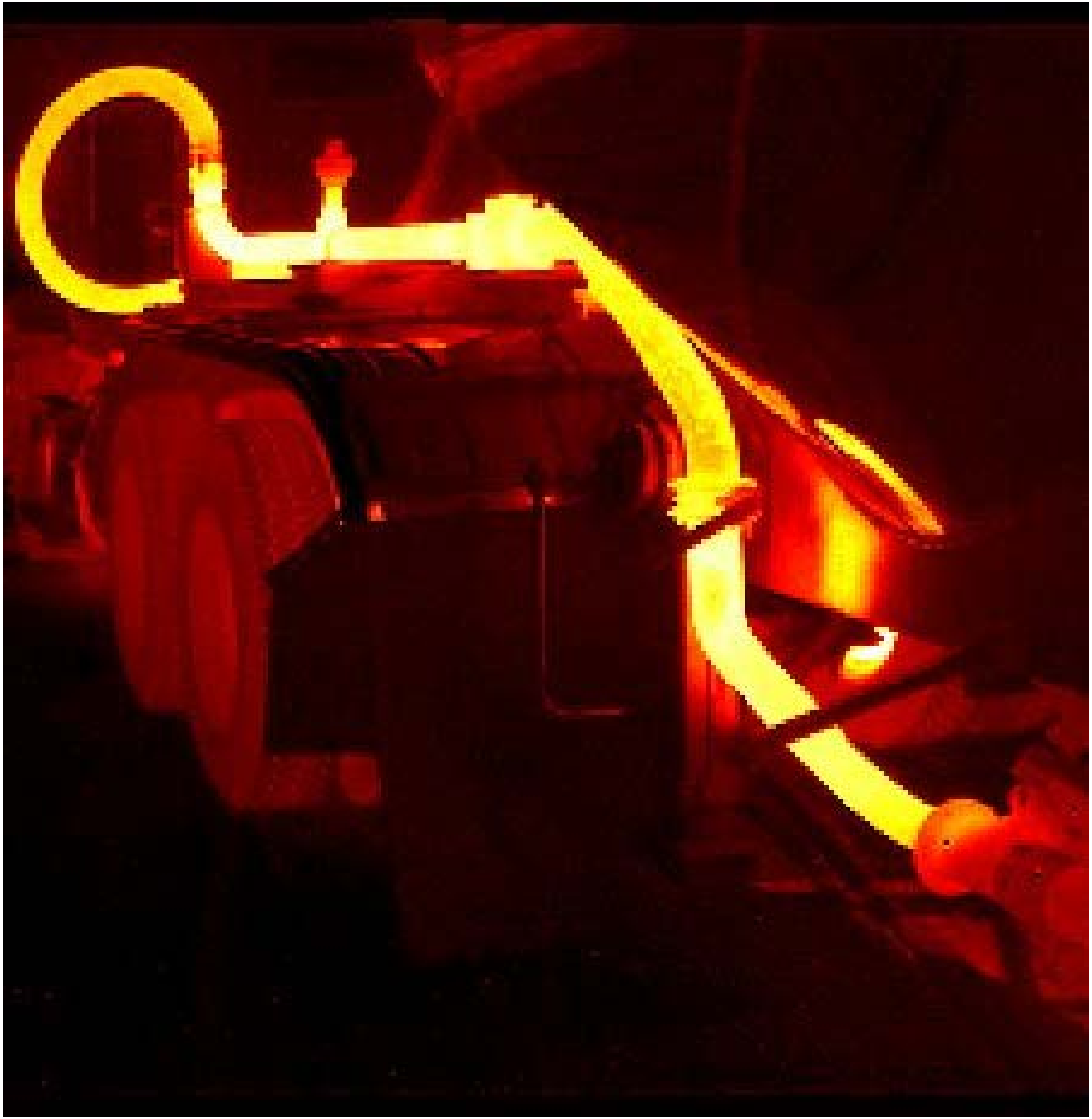
ProcessSCAN
Infrared Thermographic Services

Fluid Machine Analysis

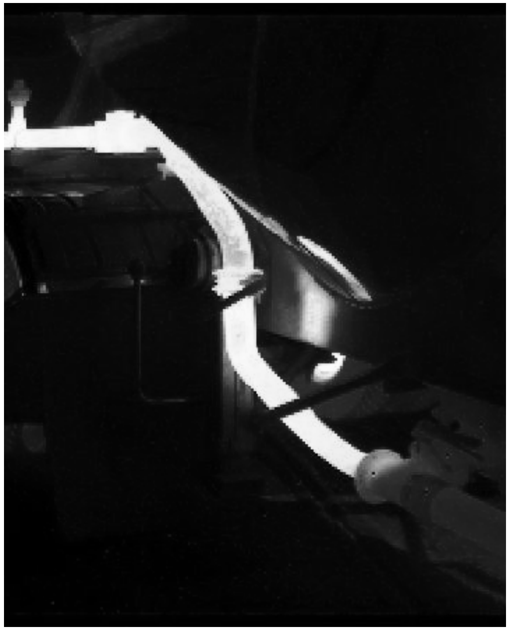


Fluid Machine Analysis

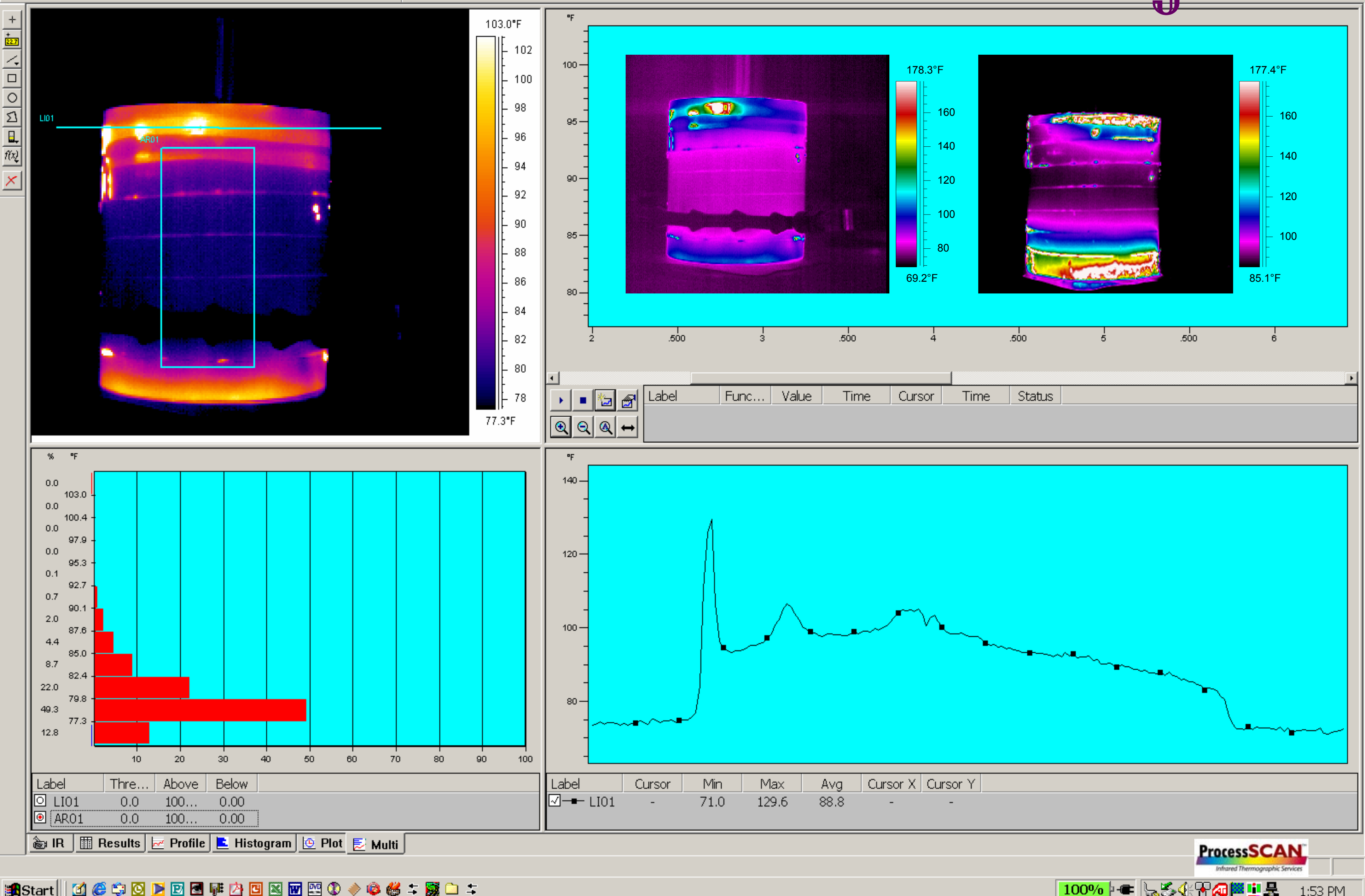




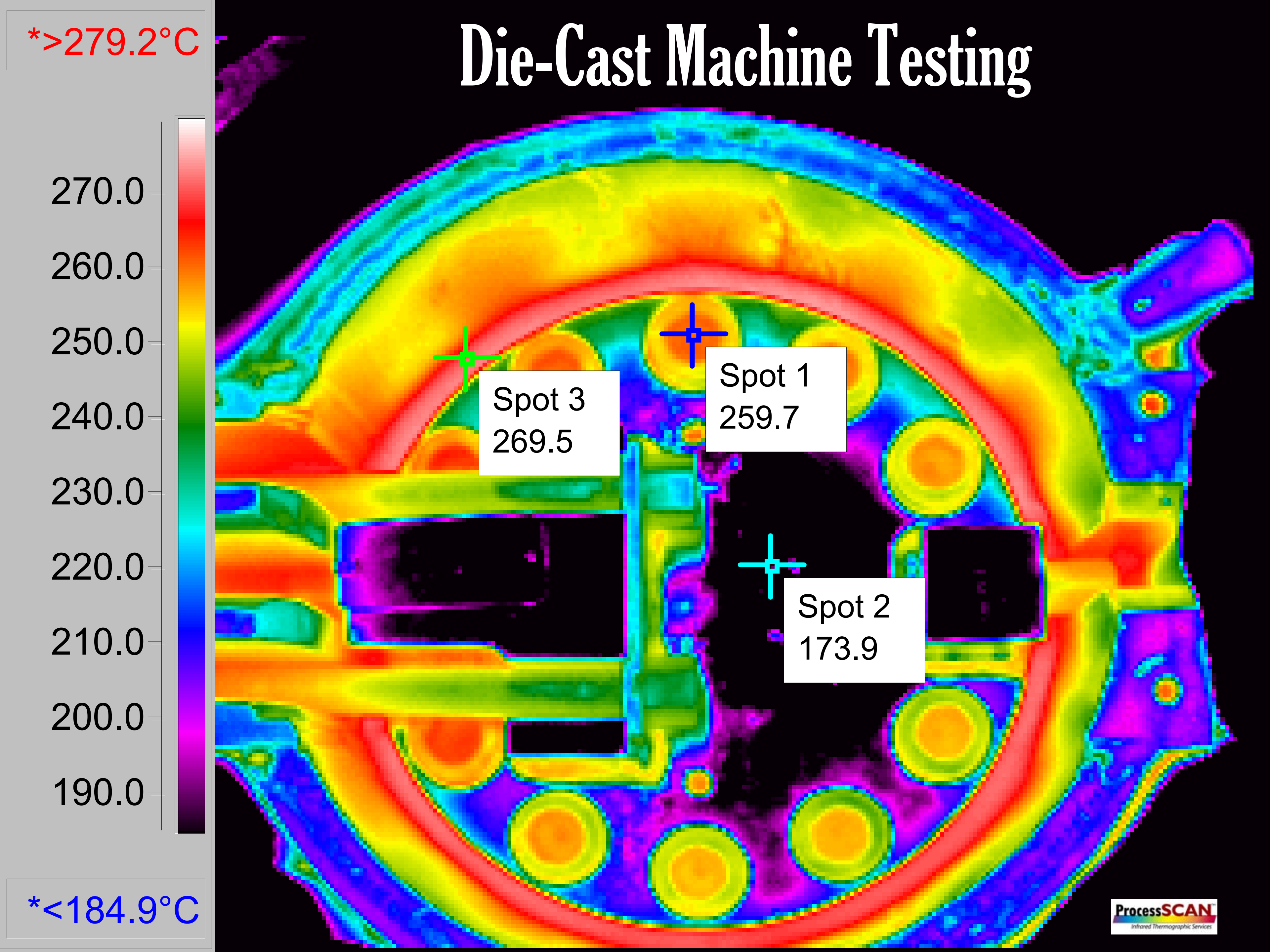
Dry Chemical Pumping Systems



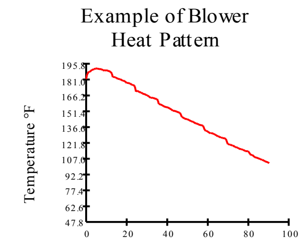
Ultrasonic Welding

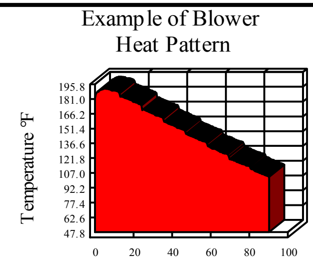


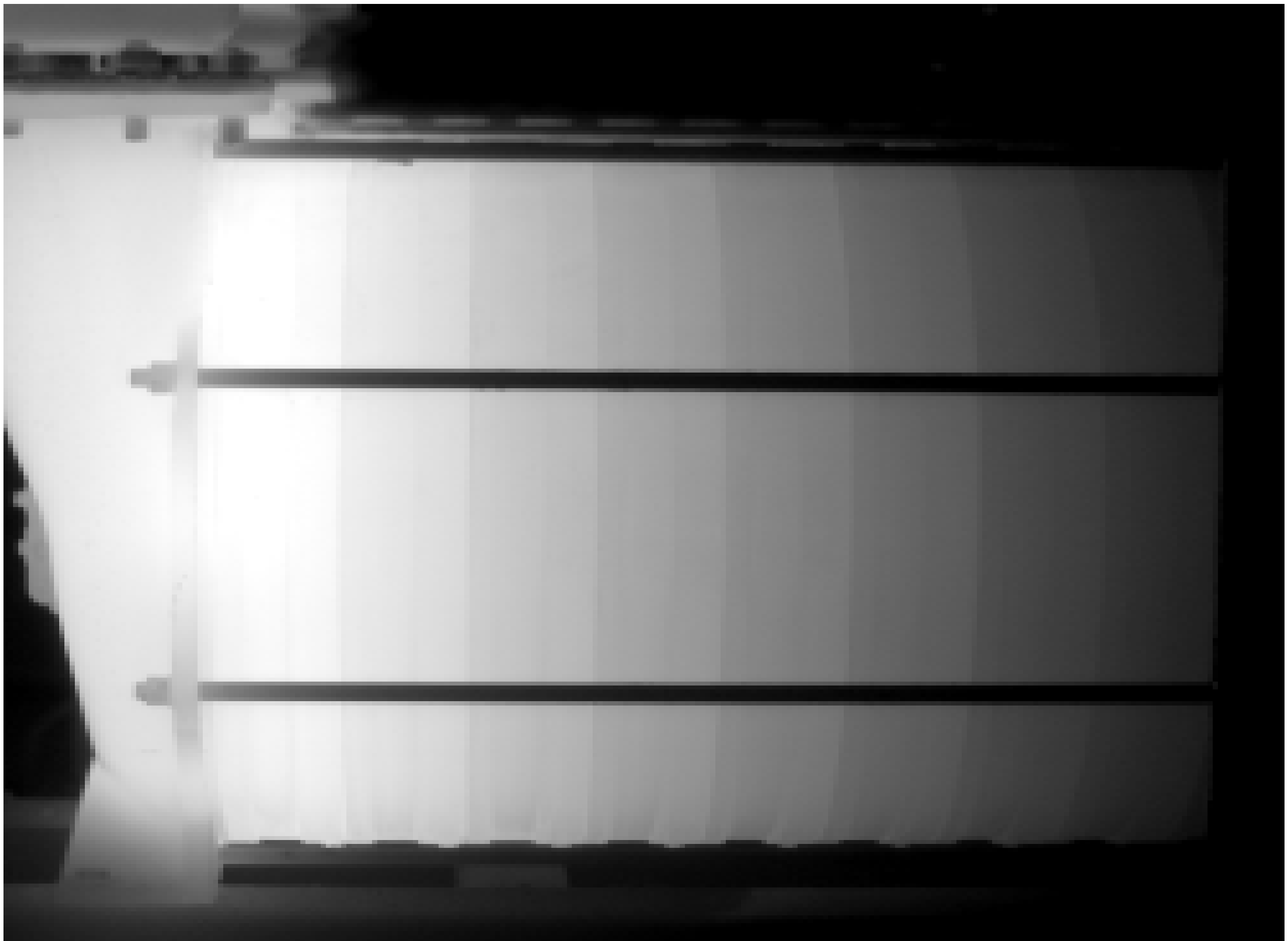
Die-Cast Machine Testing



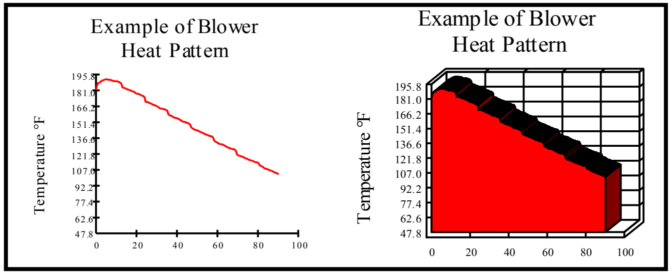
BLOWERS

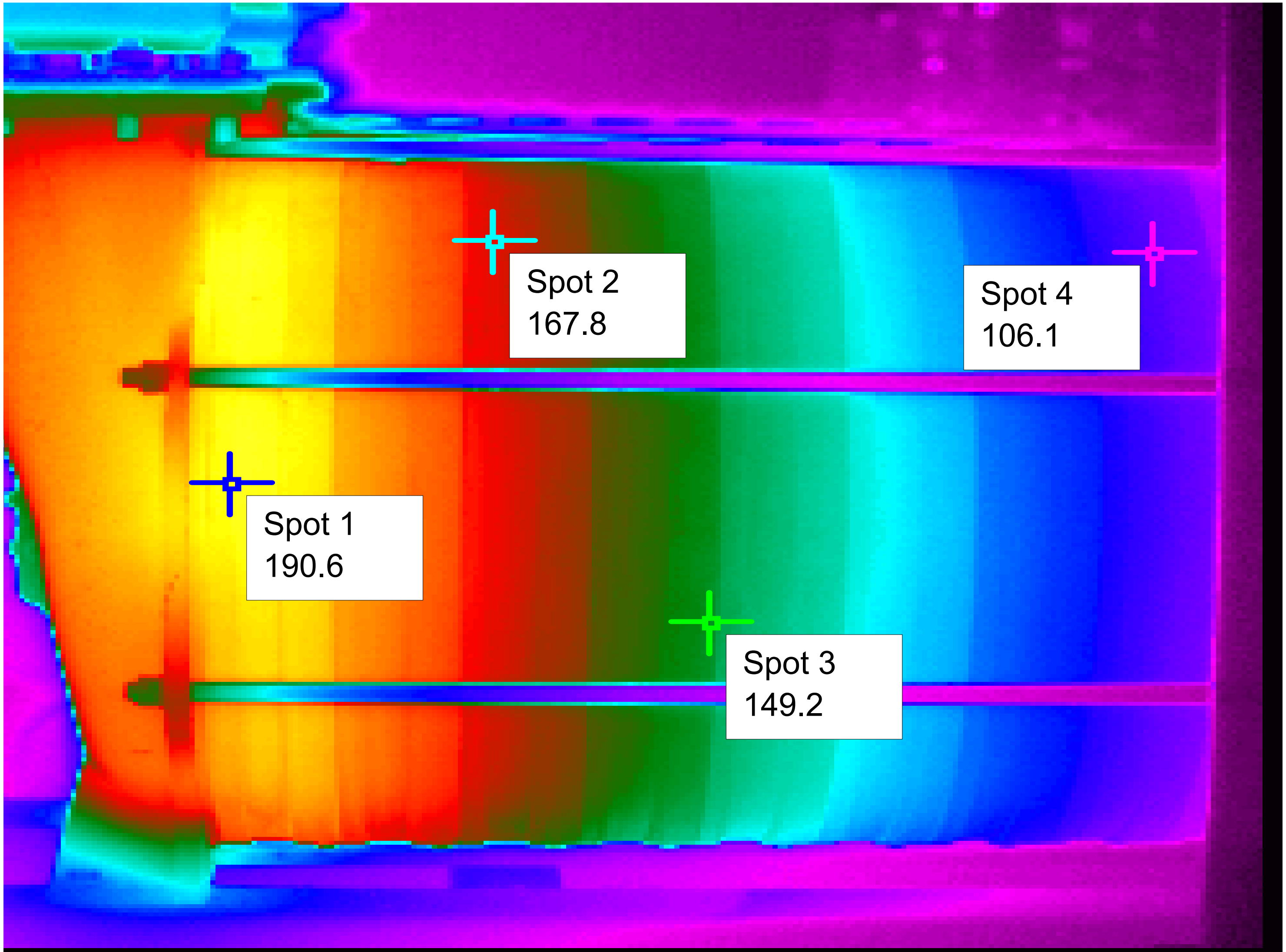

Example of Blower
Heat Pattern
Temperature °F
195.8
181.0
166.2
151.4
136.6
121.8
107.0
92.2
77.4
62.6
47.8
0
20
40
60
80
100


Example of Blower
Heat Pattern
Temperature °F
195.8
181.0
166.2
151.4
136.6
121.8
107.0
92.2
77.4
62.6
47.8
0
20
40
60
80
100



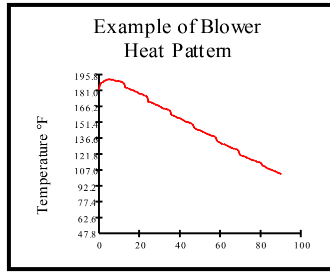
BLOWERS

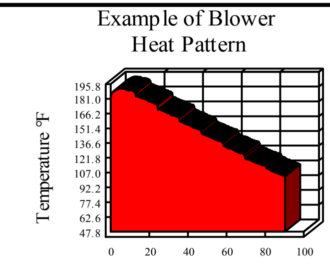


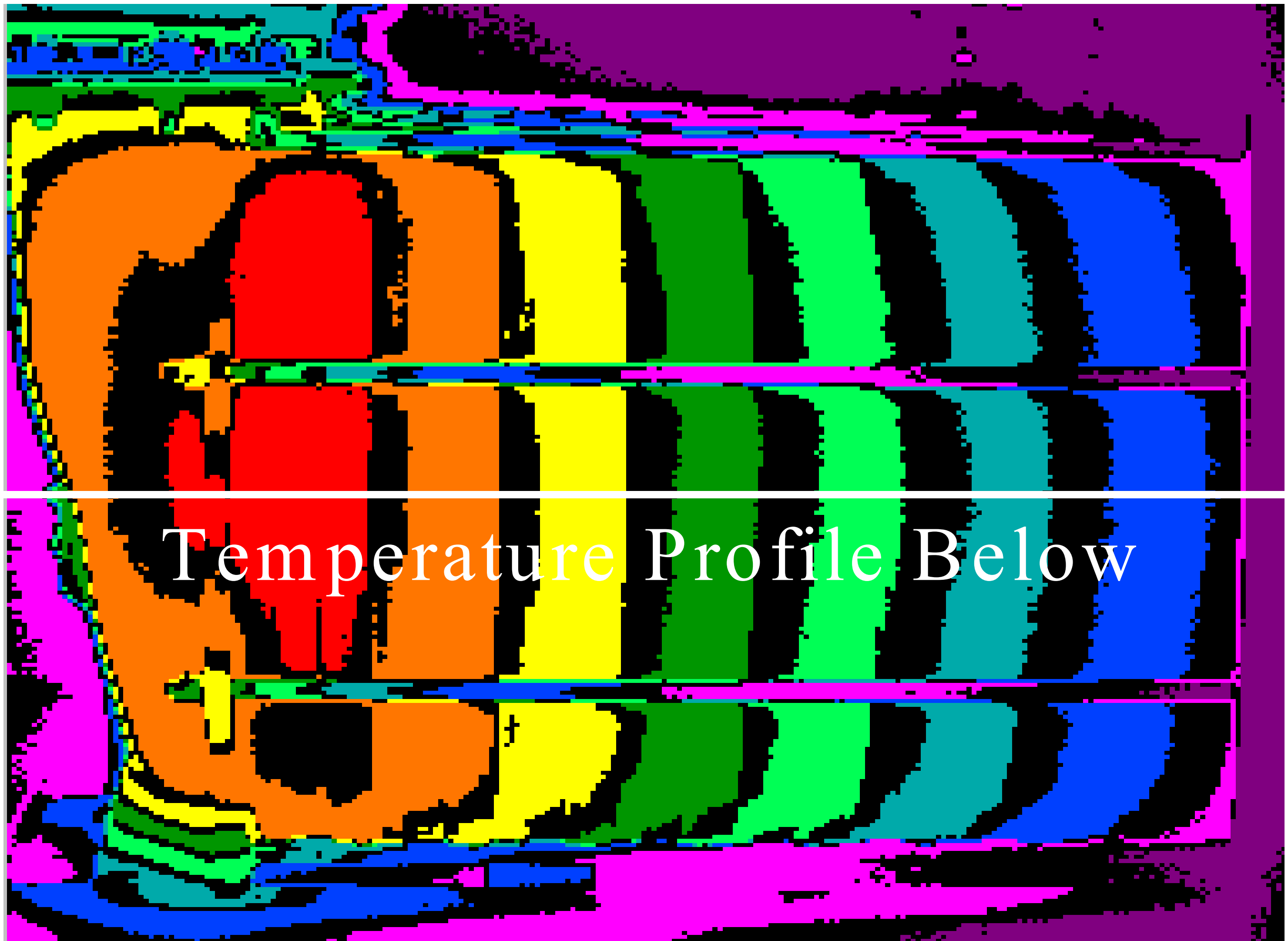


ProcessSCAN
Infrared Thermographic Services

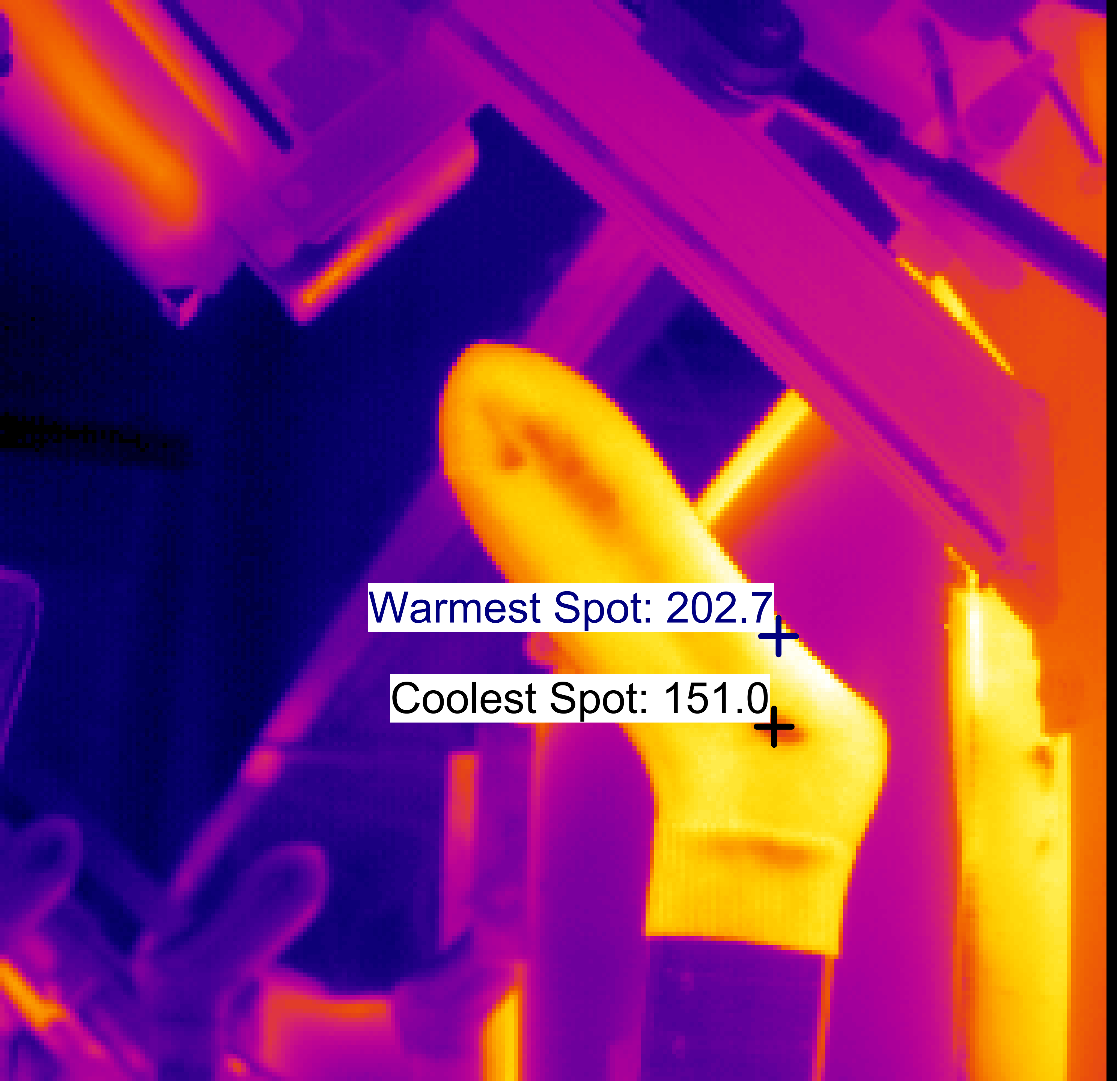
BLOWERS


Example of Blower
Heat Pattern
Temperature °F
195.8
181.0
166.2
151.4
136.6
121.8
107.0
92.2
77.4
62.6
47.8
0
20
40
60
80
100


Example of Blower
Heat Pattern
Temperature °F
195.8
181.0
166.2
151.4
136.6
121.8
107.0
92.2
77.4
62.6
47.8
0
20
40
60
80
100


Temperature Profile Below


ProcessSCAN™
Infrared Thermographic Services
Infrared
Surveying
for
Machine
Evaluation
ProcessSCAN™
Infrared Thermographic Services



ProcessSCAN™
Infrared Thermographic Services

Infrared Surveying for Machine Evaluation

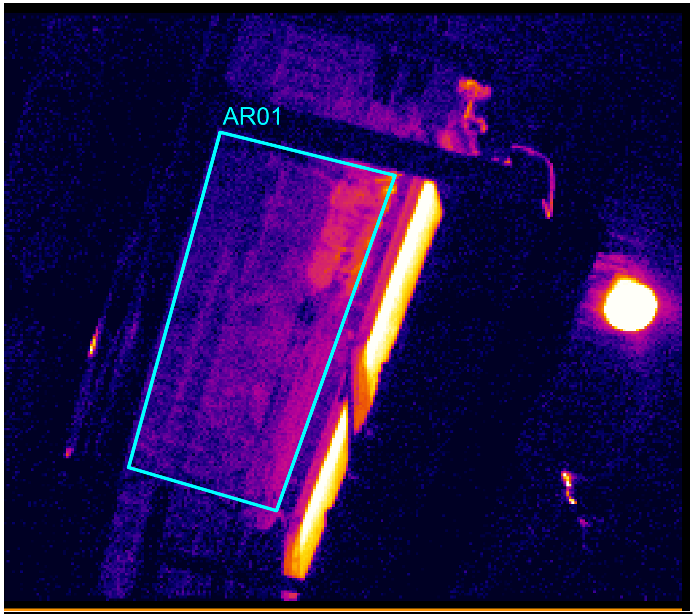
ProcessSCAN™
Infrared Thermographic Services

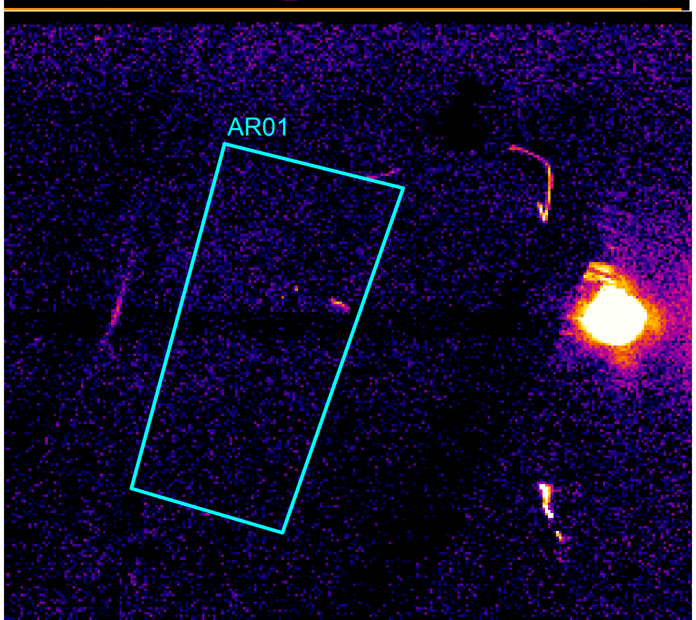
Infrared Surveying for Machine Evaluation

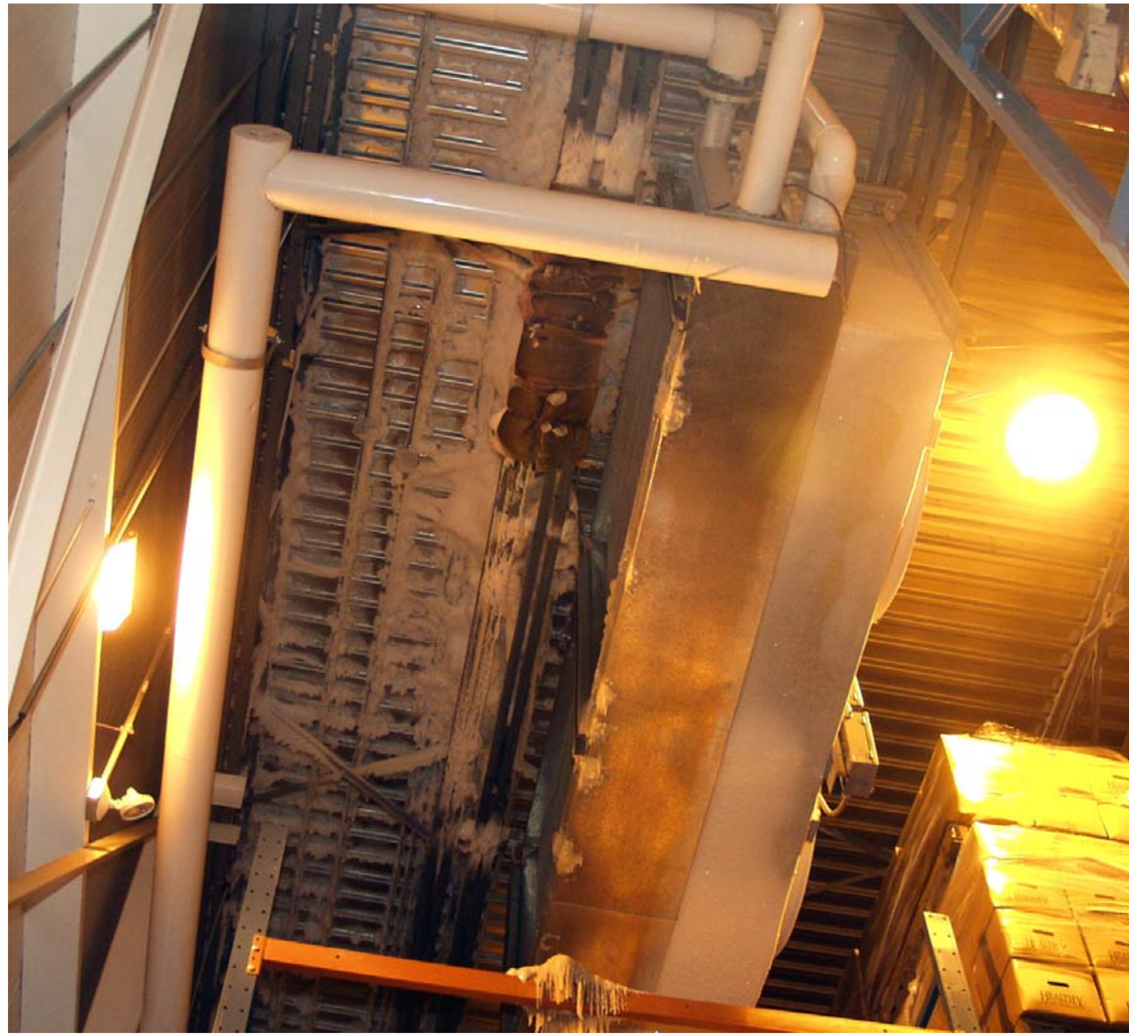
ProcessSCAN™
Infrared Thermographic Services

Infrared Surveying for Machine Evaluation

IR Surveying of Freezers/Coolers and Blast Chillers



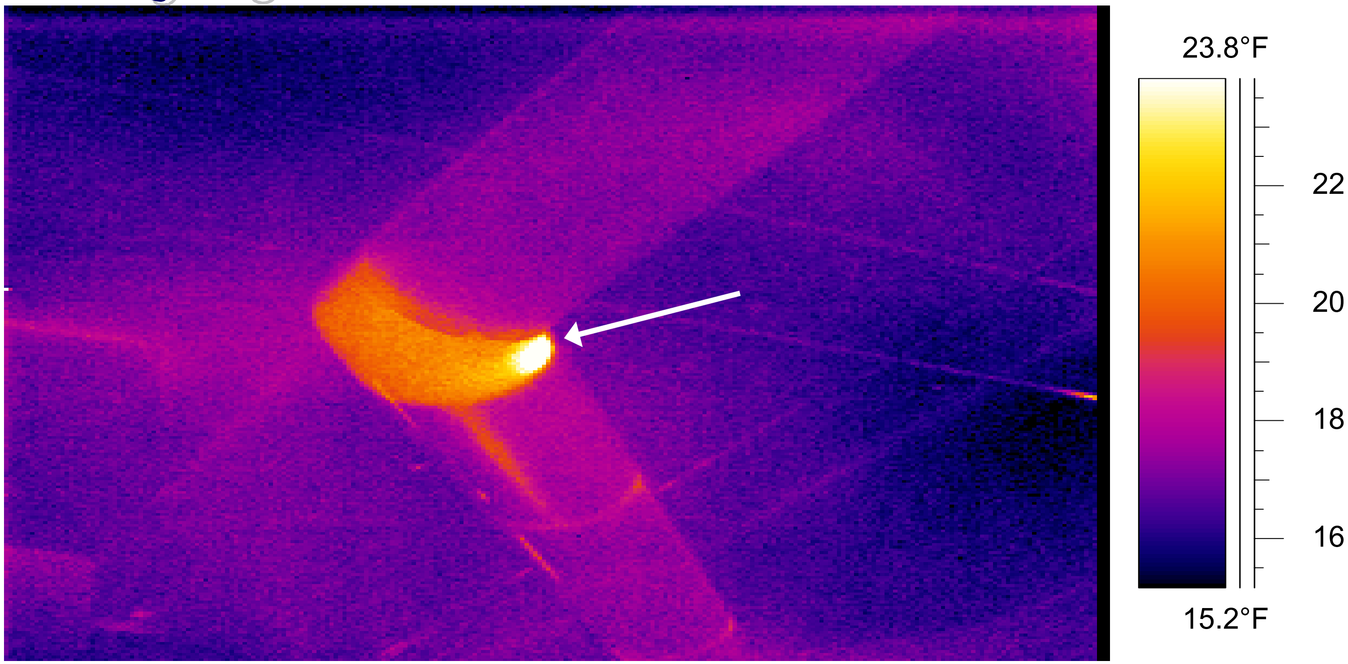




-20F Freezer Equipment

ProcessSCAN
Infrared Thermographic Services

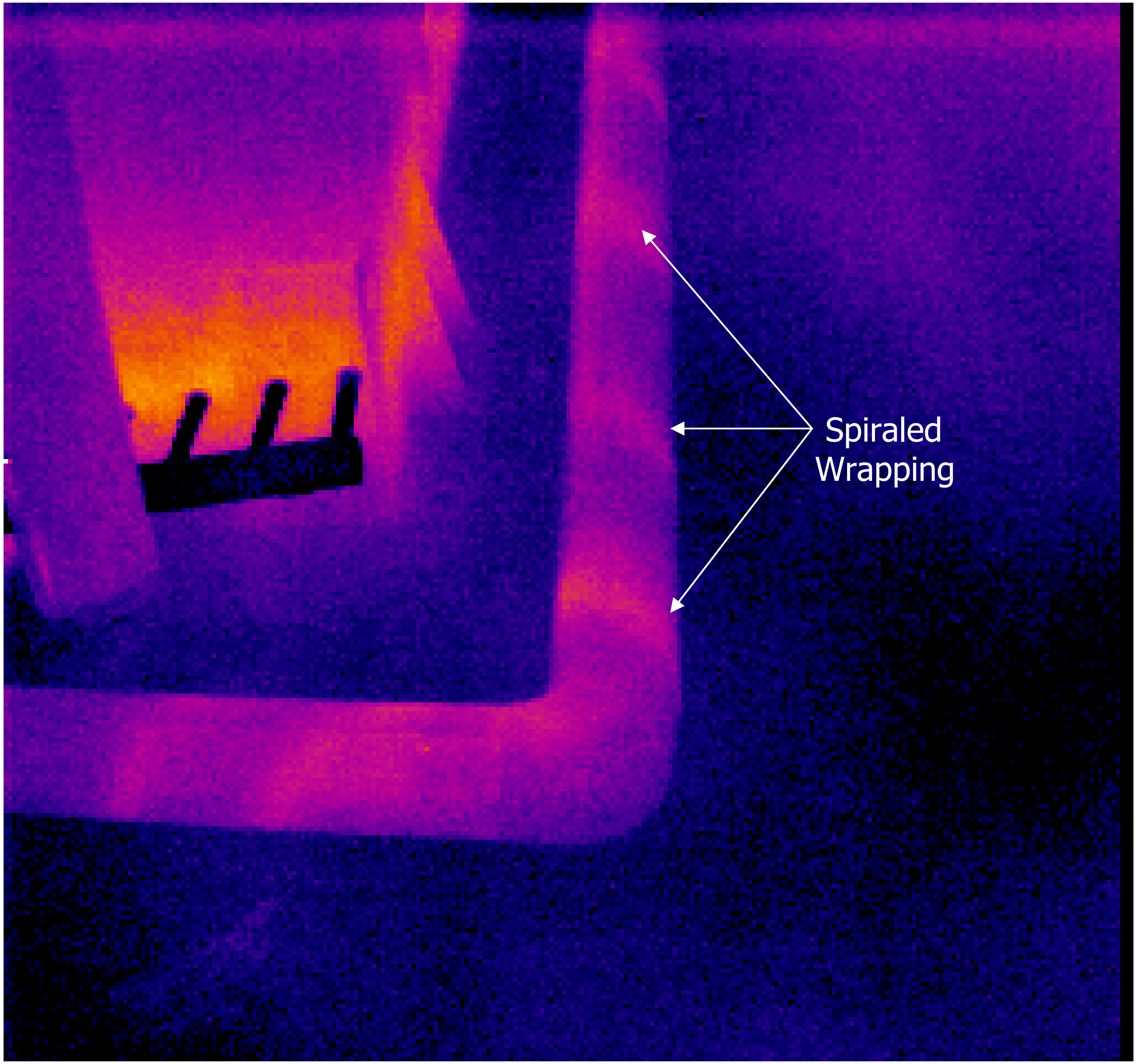
IR Surveying of Freezers/Coolers and Blast Chillers



Leak in Drain Lines

ProcessSCAN

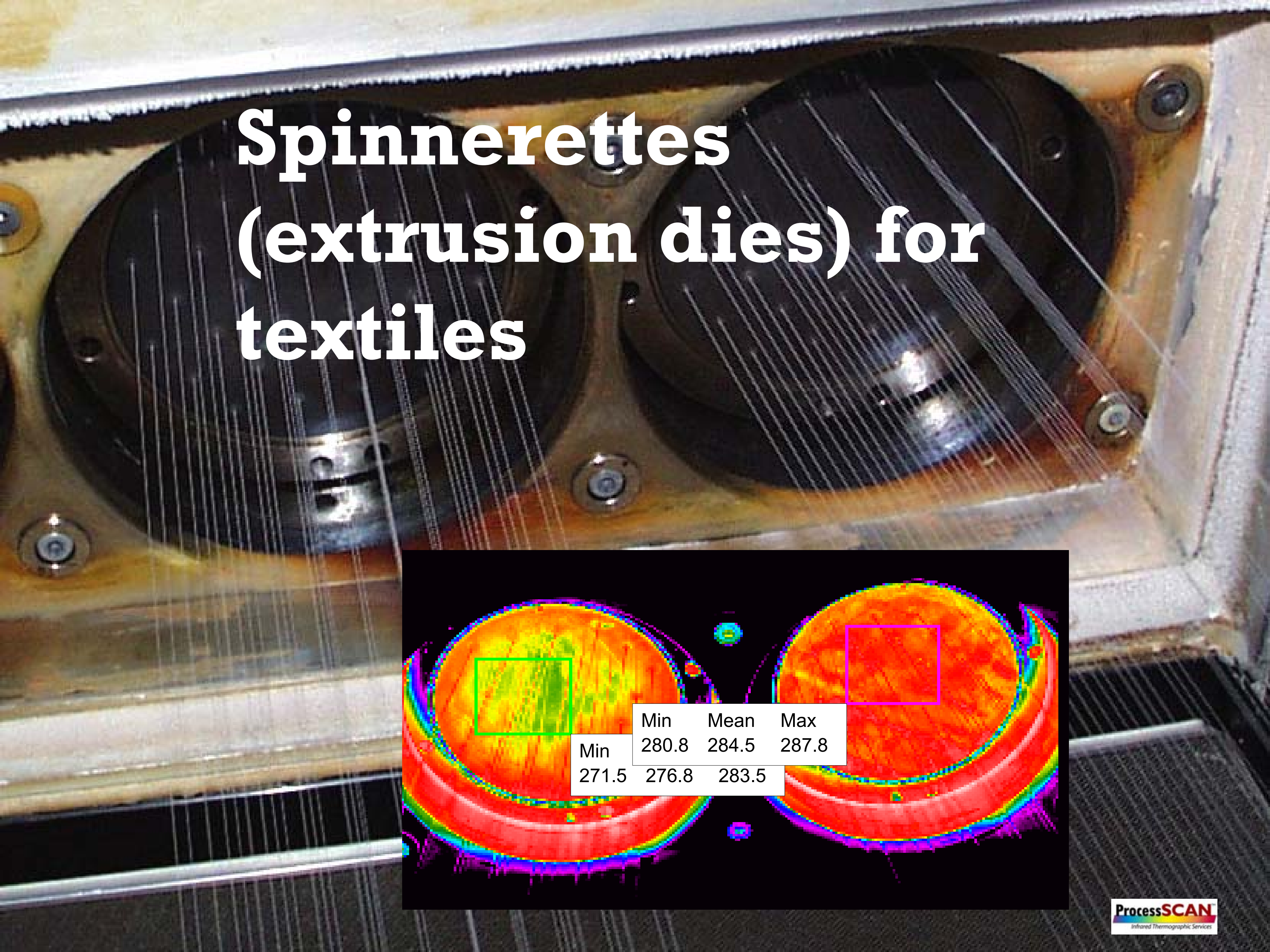
IR Surveying of Freezers/Coolers and Blast Chillers



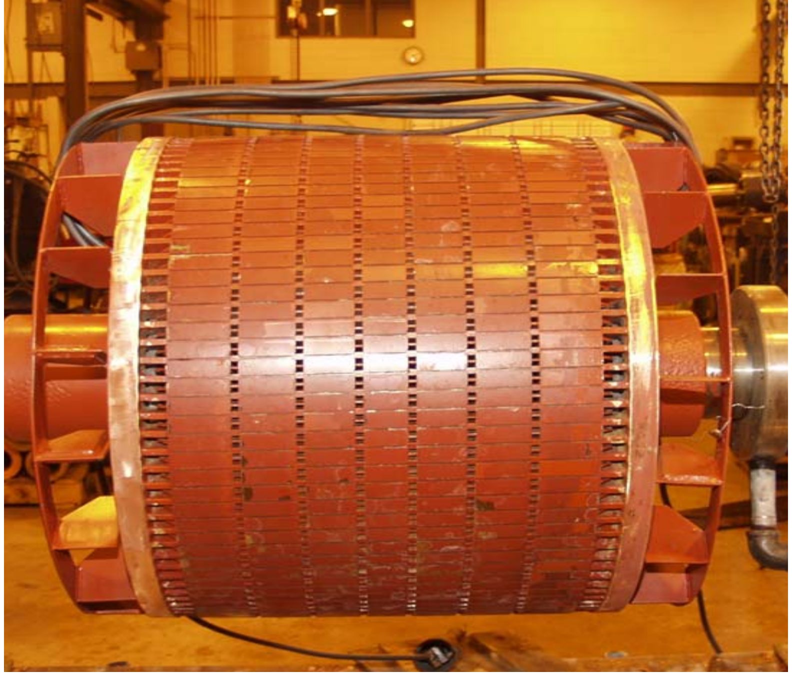
Heat Trace in Condensate Lines

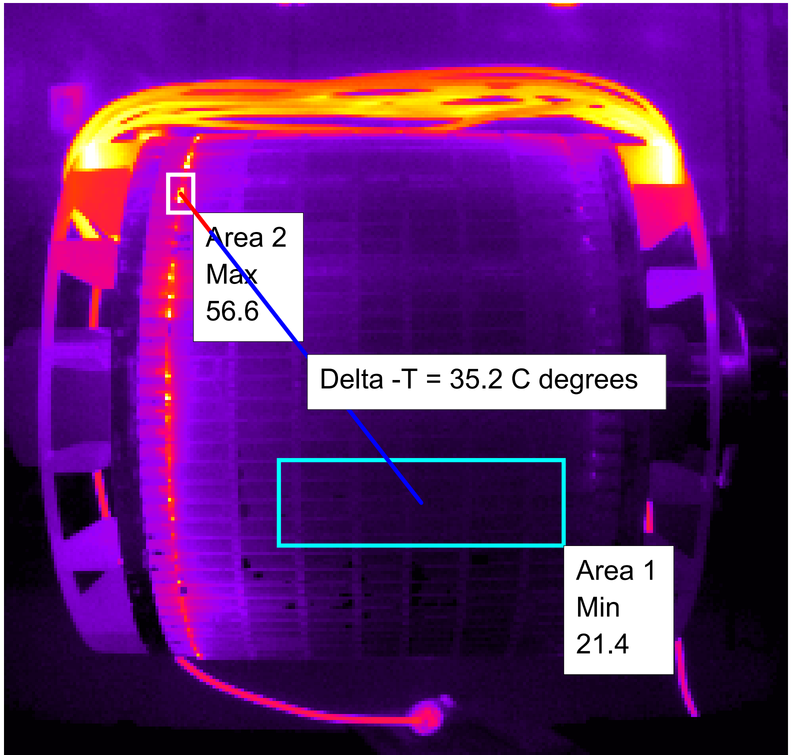
ProcessSCAN
Infrared Thermographic Services

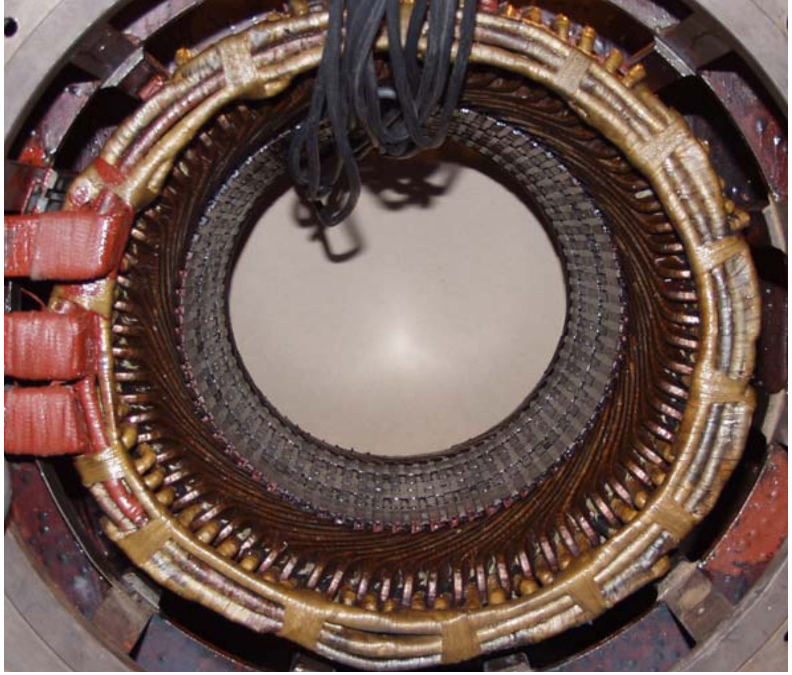
Spinnerettes (extrusion dies) for textiles



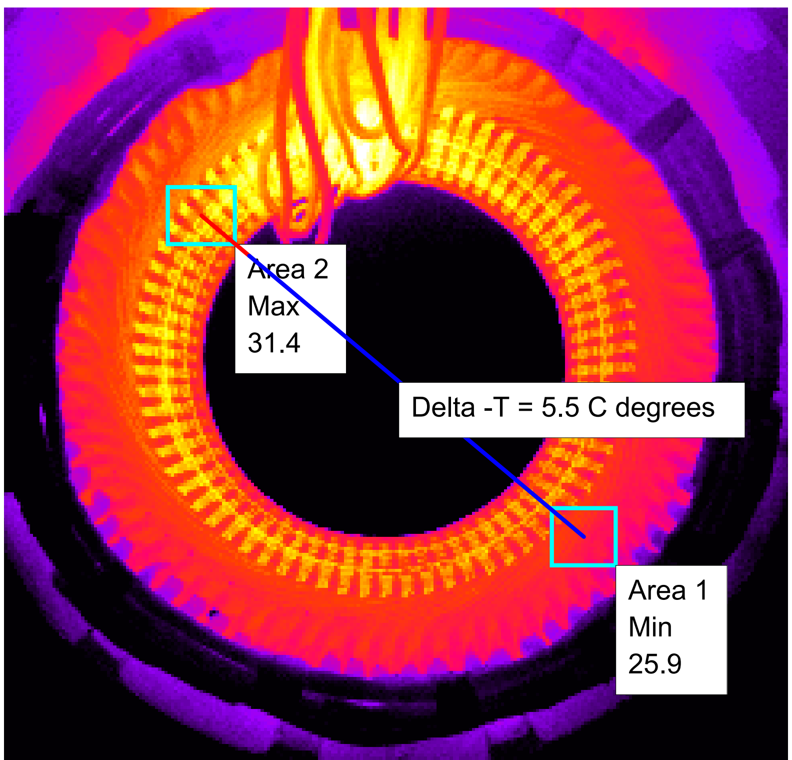
Motor Rotor Testing



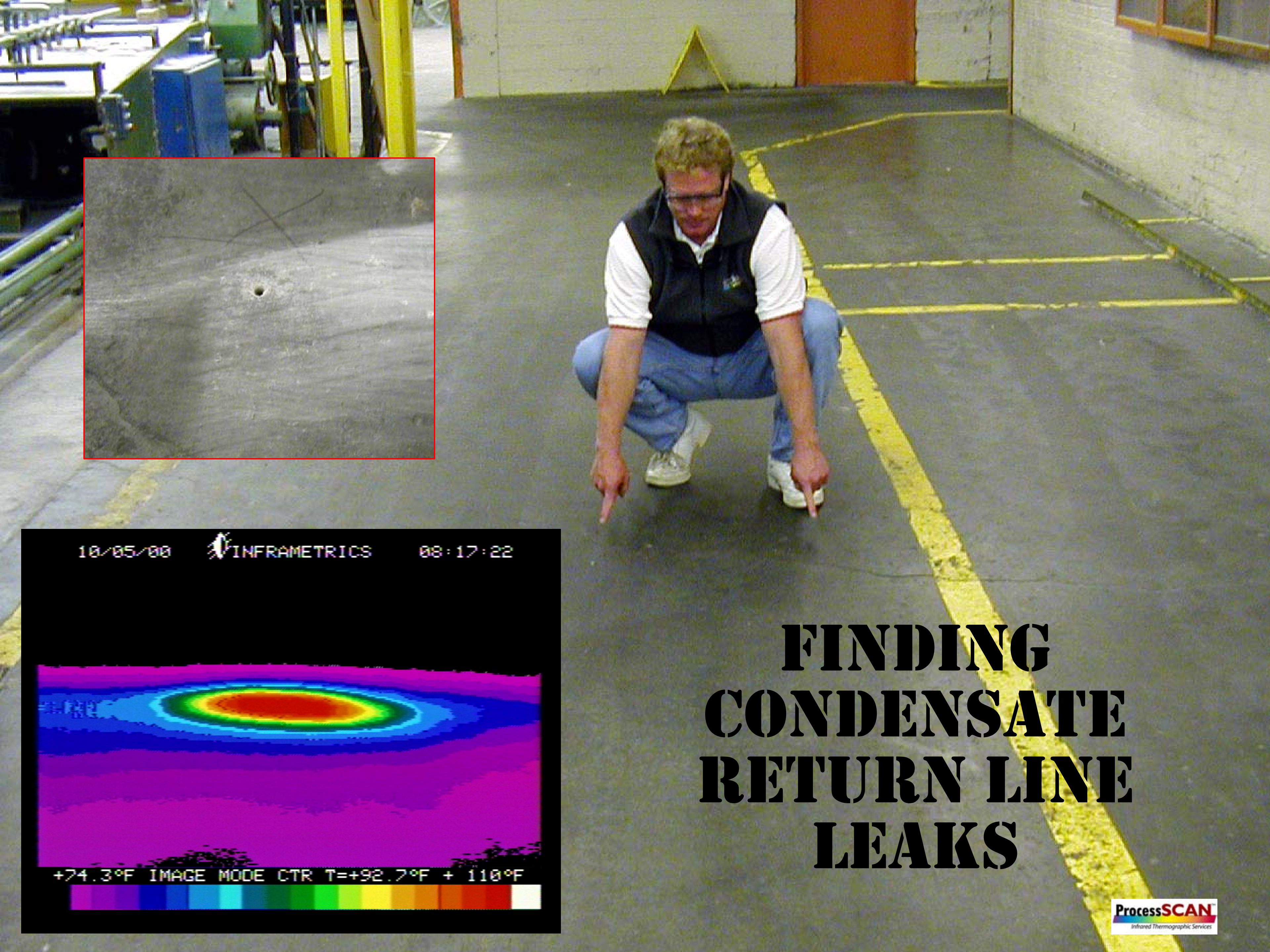




Motor Stator Testing

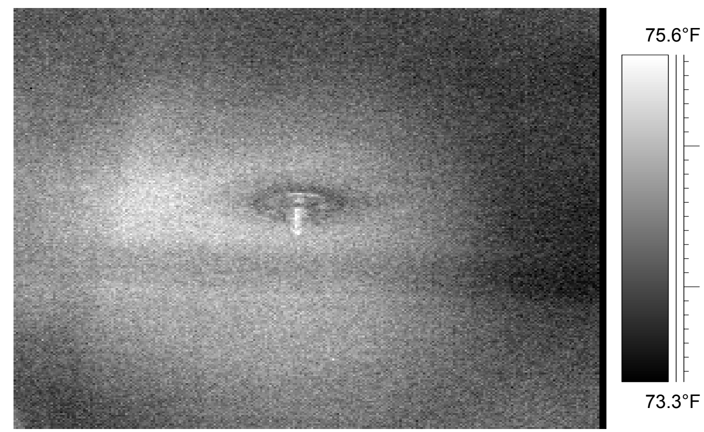


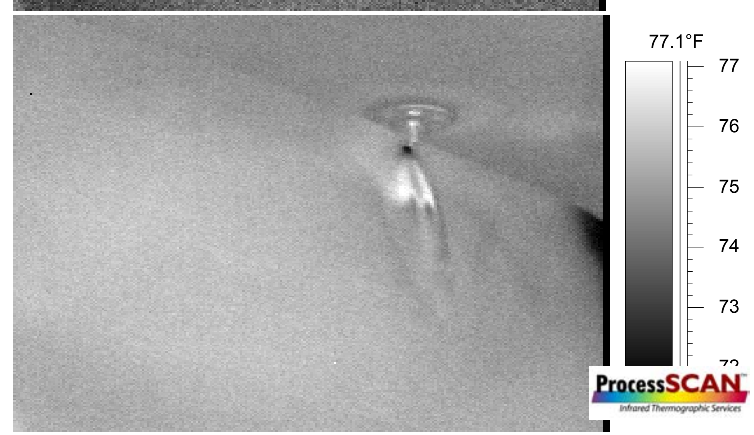
FINDING CONDENSATE RETURN LINE LEAKS

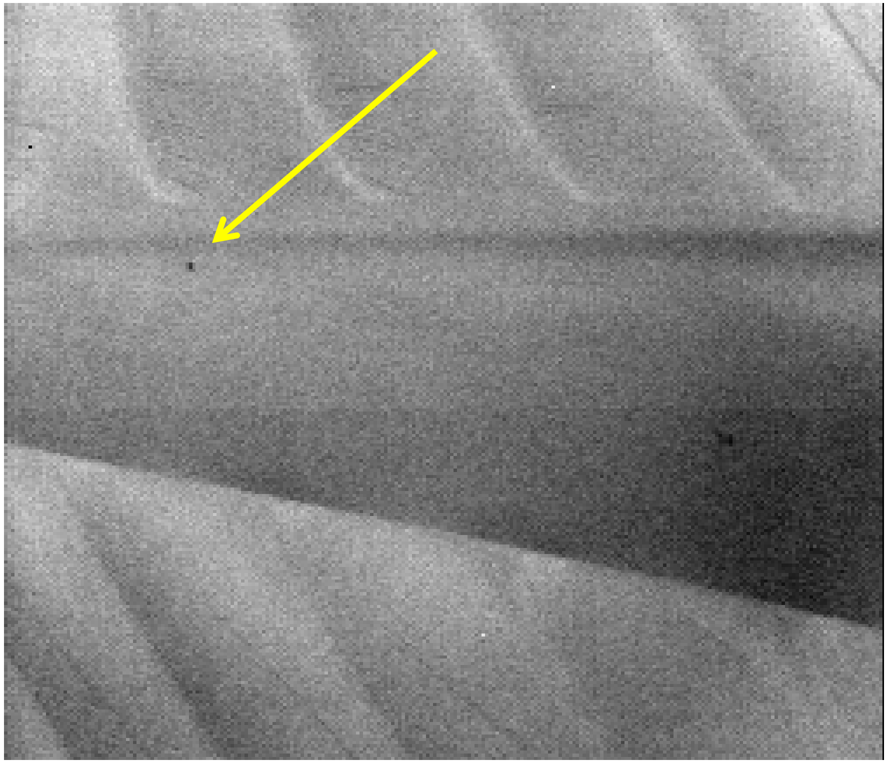


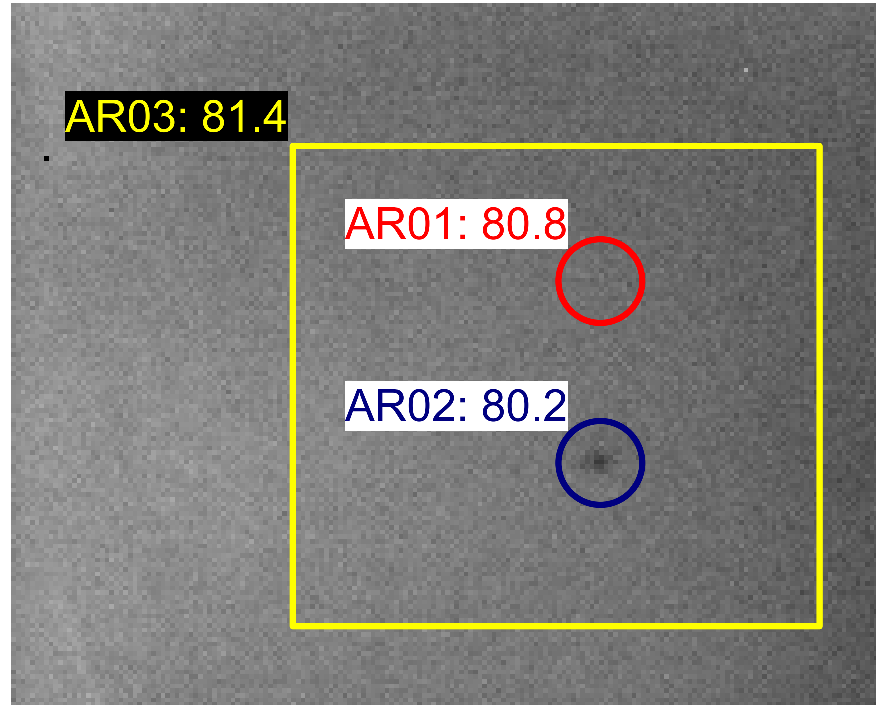
Aerostat Helium Leakage Detection using Infrared Thermography

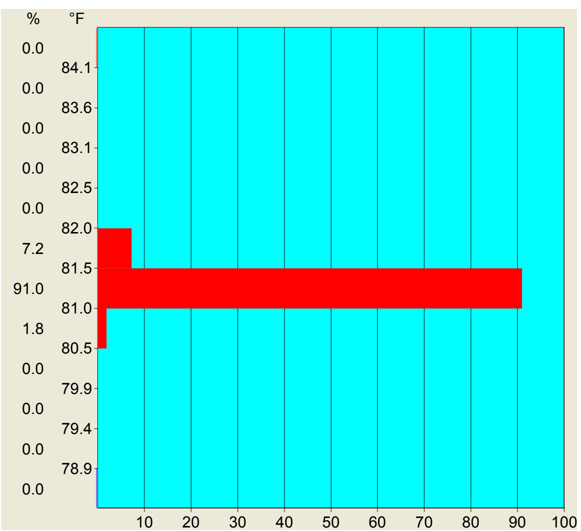
ProcessSCAN's technique relies on detecting very small temperature differences to see the escape of helium (or other gases). The gas itself is not visible, but the cooling effect of escaping gas impinging on the surface is detected. We methodically go down the surfaces quickly and close enough to see the small, cooler areas.



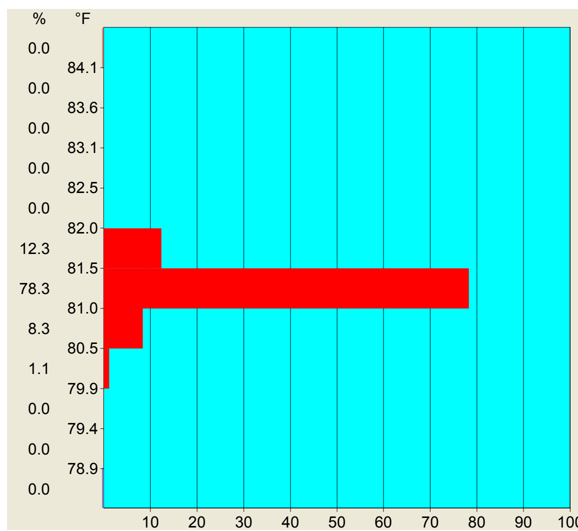




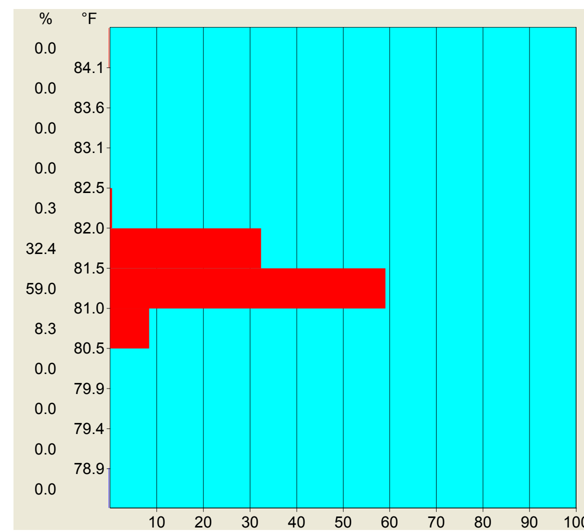




Histogram AR01



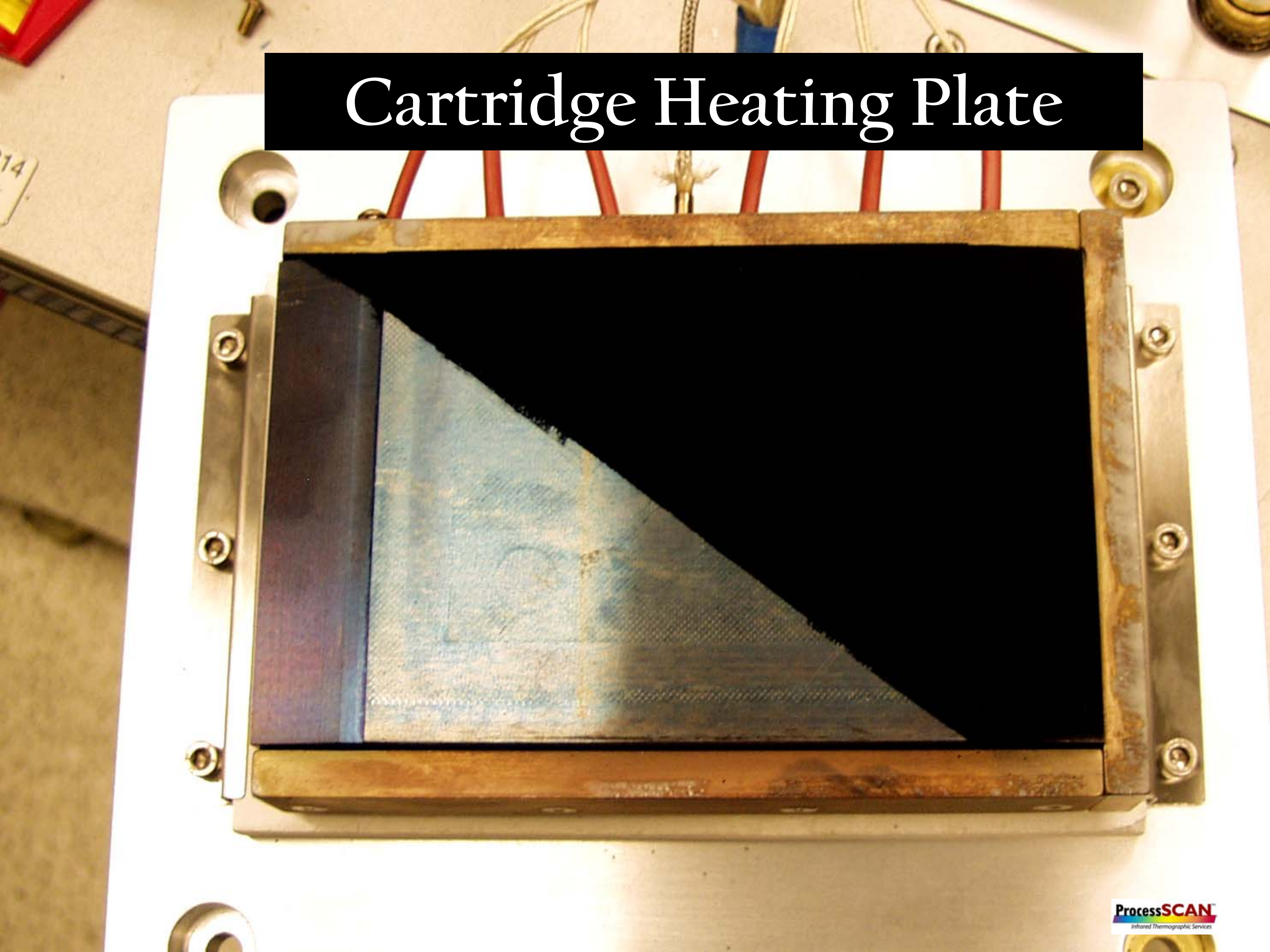
Histogram AR02



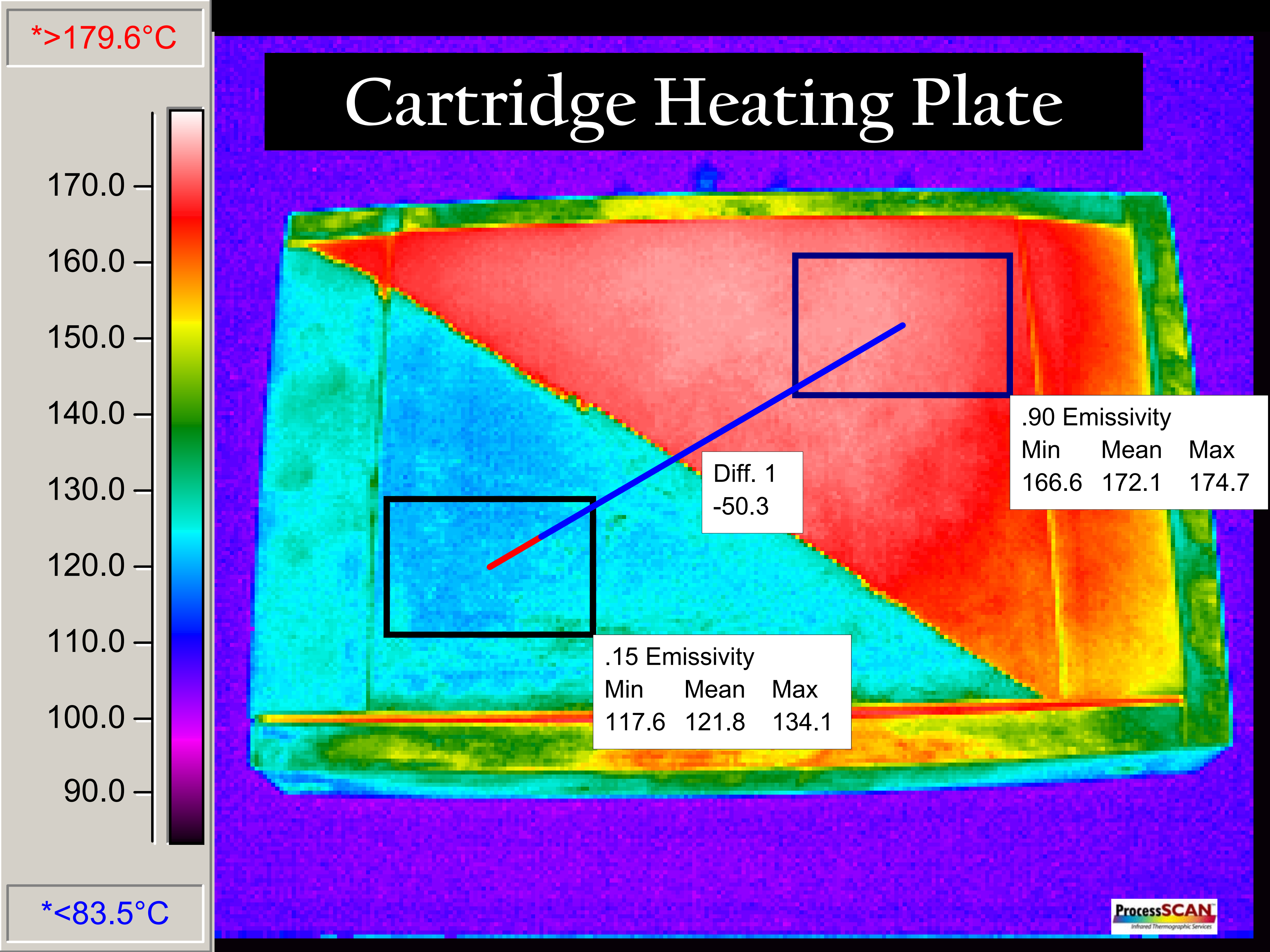
Histogram AR03

Cartridge Heating Plate

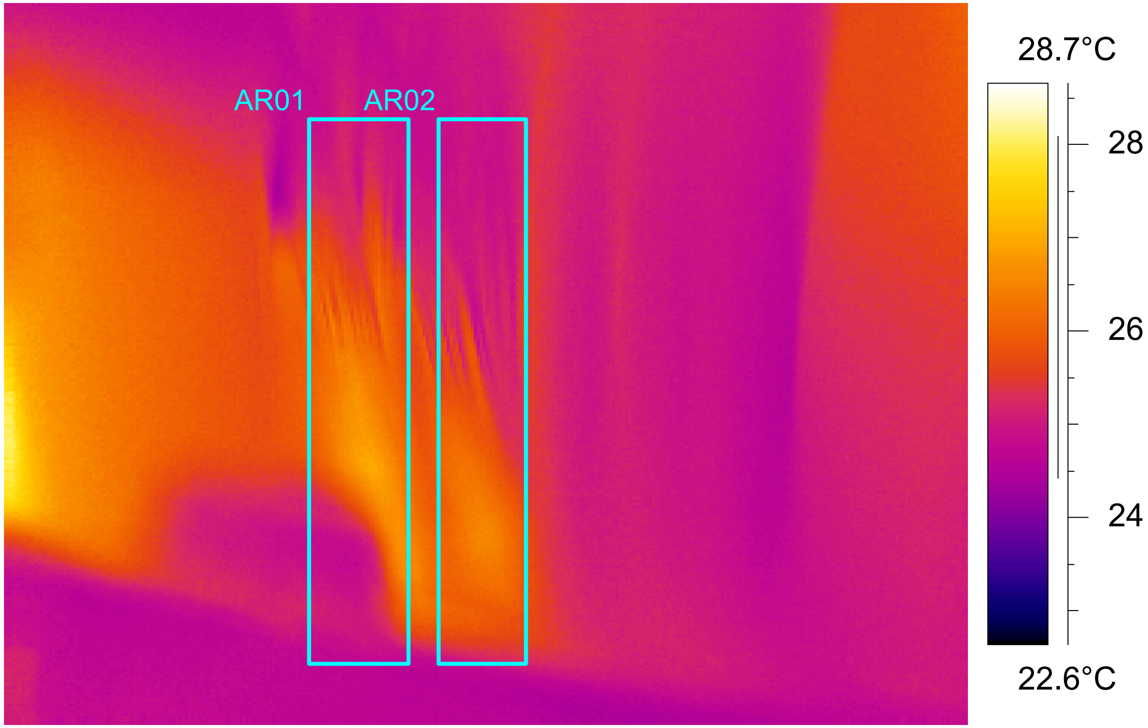
Cartridge Heating Plate

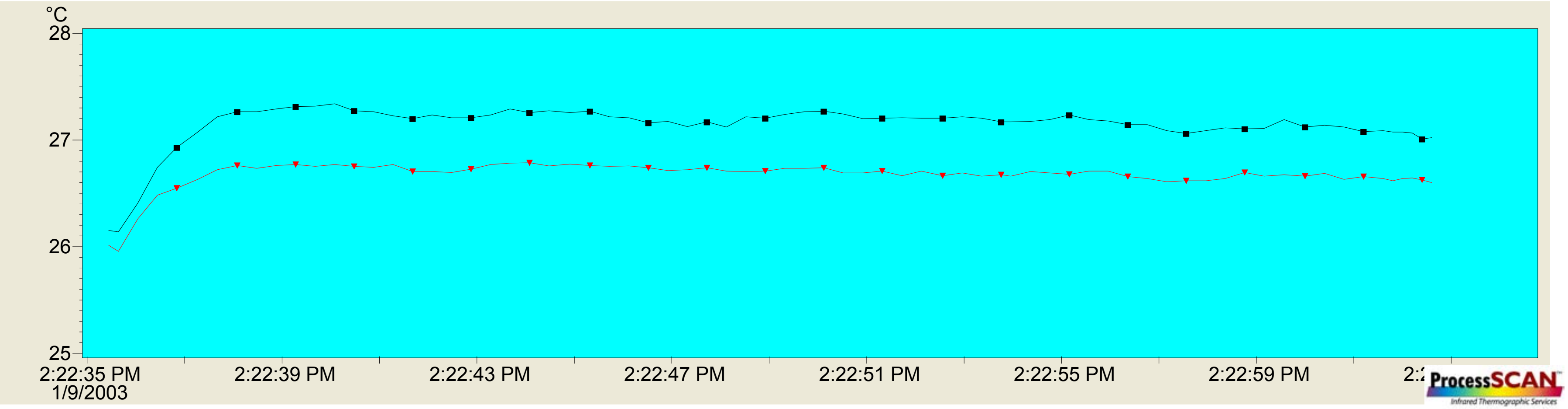


Cartridge Heating Plate

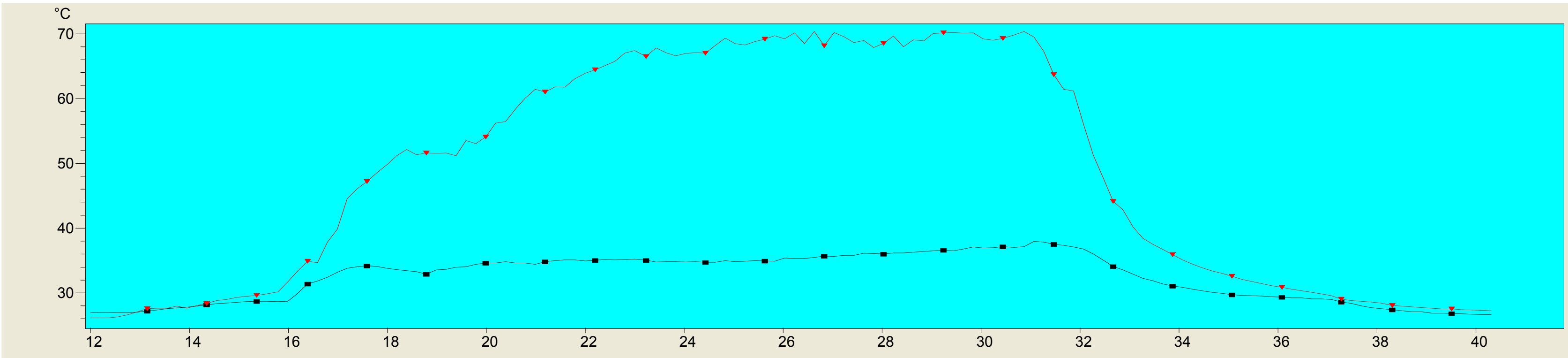


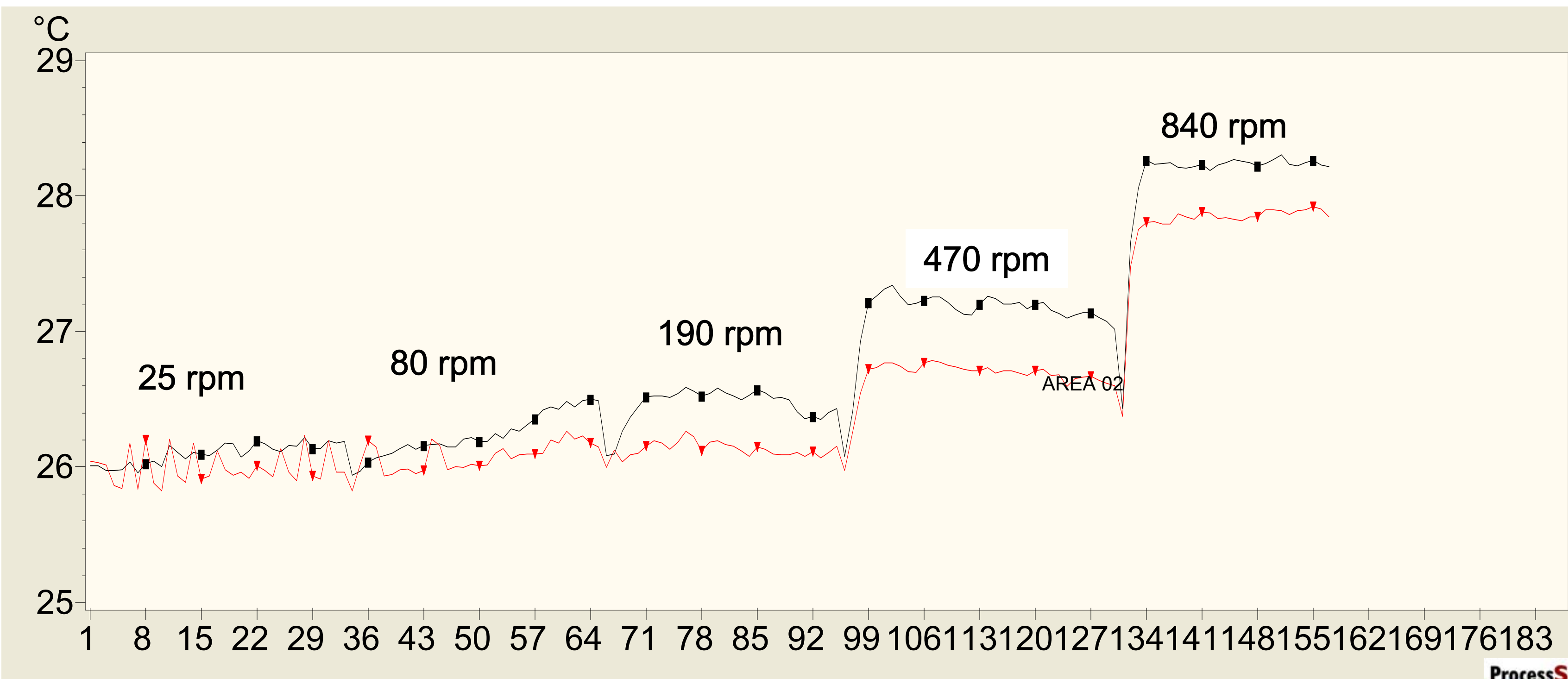
Machine Monitoring





Machine Monitoring

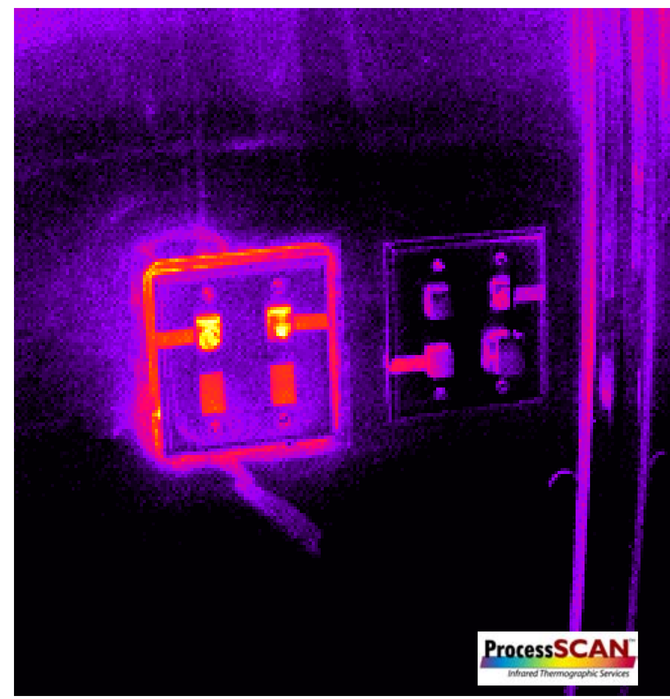




ProcessSCAN
Infrared Thermographic Services


Quantifying air leakage in
pressurization chambers


Air in-leakage at com outlet


ProcessSCAN

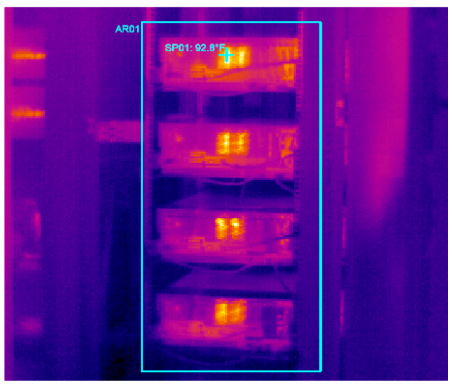
Computer Room Analysis

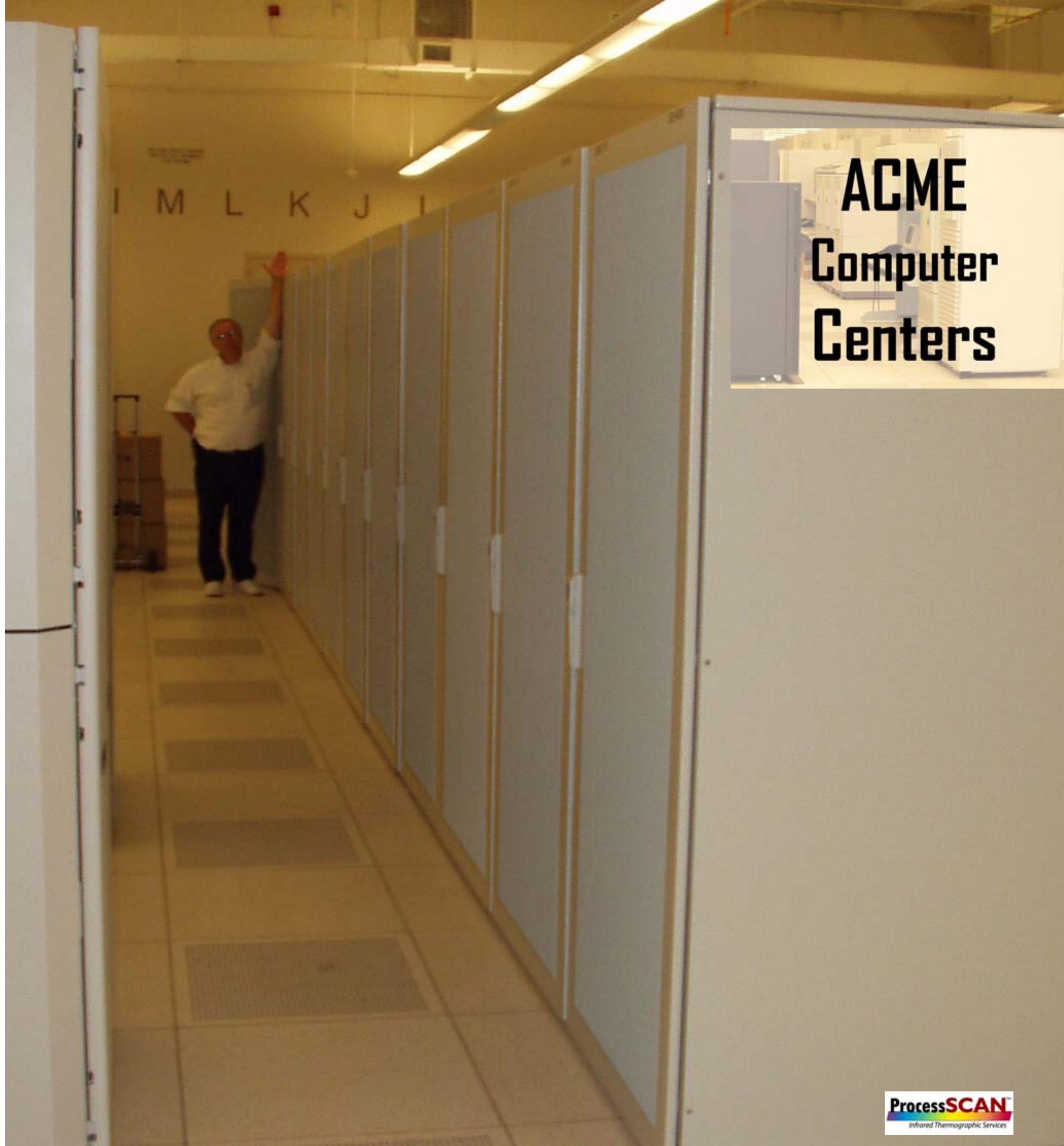
ProcessSCAN
Infrared Thermographic Services

ProcessSCAN™

Infrared Thermographic Services

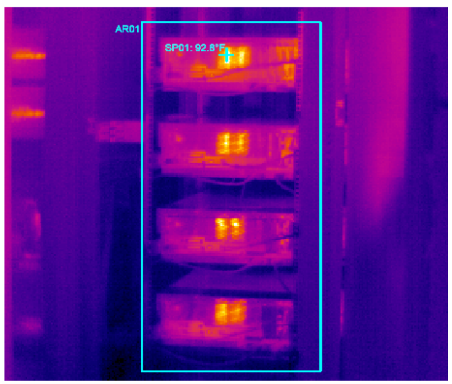
Computer Room Analysis

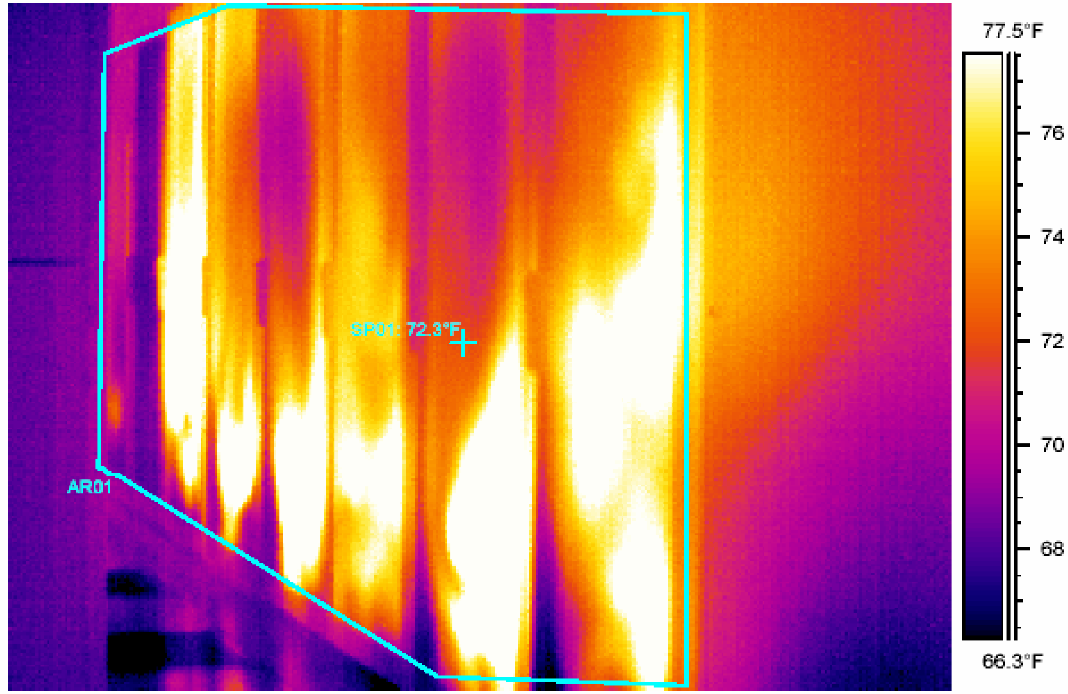




Computer Room Analysis

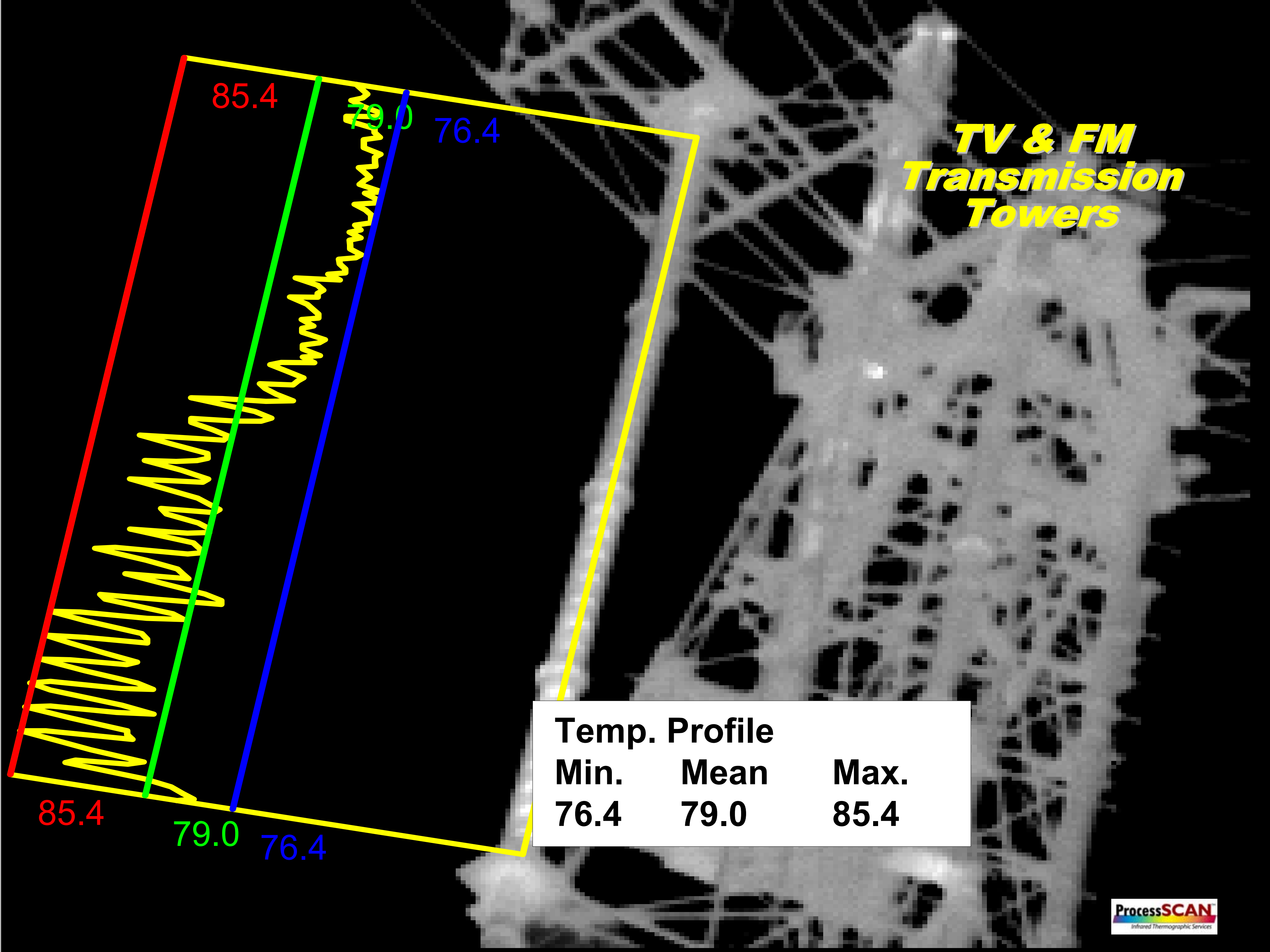
ProcessSCAN™ Infrared Thermographic Services





Object parameter	Value
Emissivity	0.94
Object distance	6.6 ft
Ambient temperature	68.0°F
Label	**Value**
IR : max	90.5°F
IR : min	64.9°F
SP01	72.3°F
AR01 : max	90.5°F
AR01 : min	66.0°F
AR01 : max-min	24.6°F
AR01 : avg	74.5°F

IR Text Comment	Value
Section	Room
Equipment	
Additional information	
Fault	
Recommendation	No action

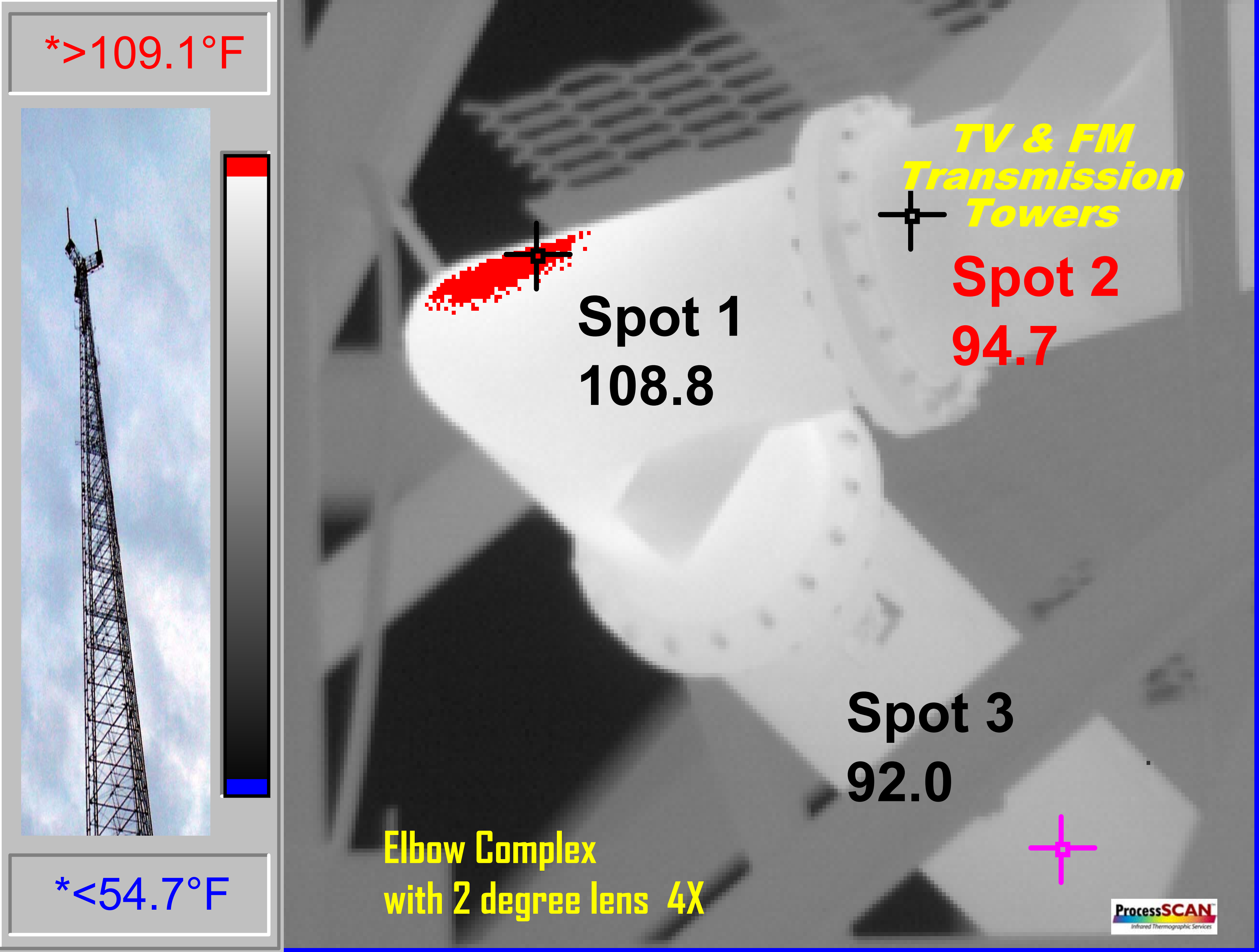


TV & FM
Transmission
Towers
85.4
79.0
76.4
85.4
79.0
76.4
Temp. Profile
Min. Mean Max.
76.4 79.0 85.4
ProcessSCAN
Infrared Thermographic Services

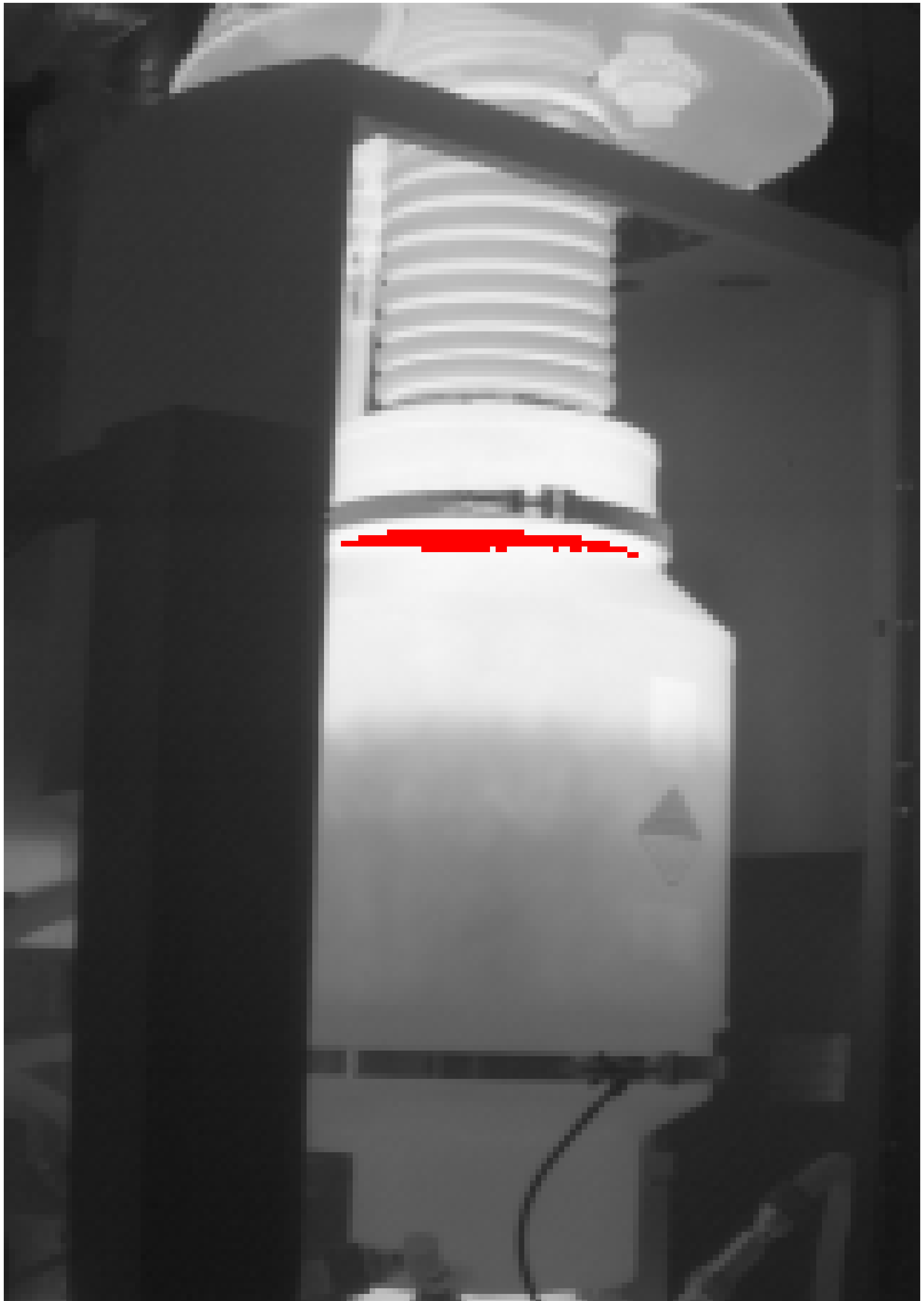
*>107.5°F

*<53.2°F

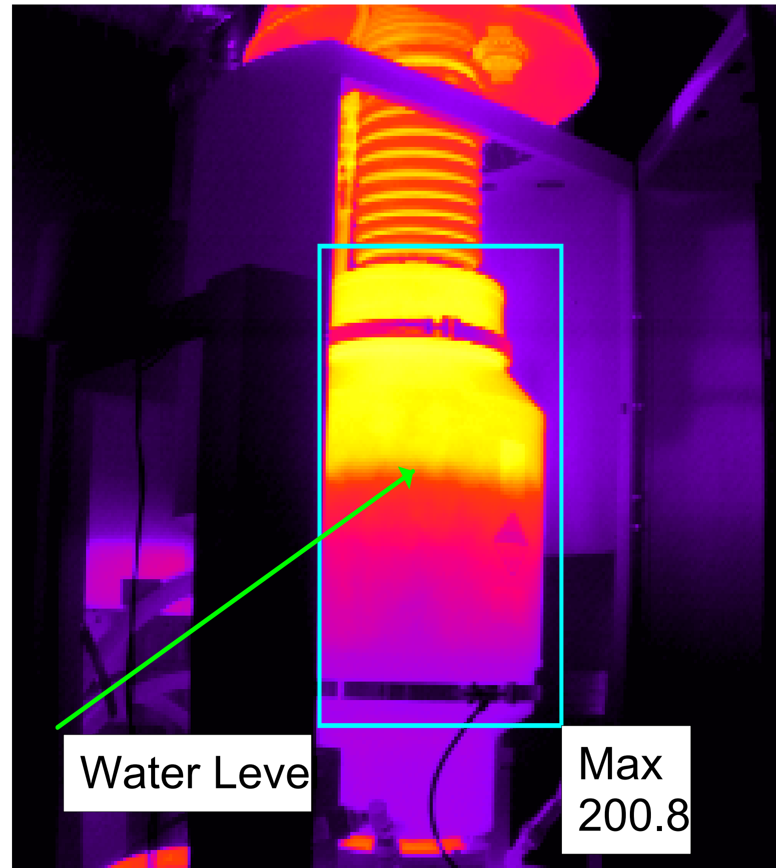

TV & FM
Transmission
Towers
Elbow Complex
with 8 degree lens 2X
ProcessSCAN


*>109.1°F
*<54.7°F
TV & FM Transmission Towers
Spot 1
108.8
Spot 2
94.7
Spot 3
92.0
Elbow Complex
with 2 degree lens 4X
ProcessSCAN
Infrared Thermographic Services


TV & FM
Transmission
Towers
Damage to
Elbow
Complex
found on
IR Survey
ProcessSCAN
Infrared Thermographic Services



TV & FM Transmission Towers



Klyston


ElectroCom Automation L.P. DBCS IV MODEL 996
Bar Code Sorters
ProcessSCAN
Infrared Thermographic Services

Bar Code Sorters

The mail is ~10F degrees cooler.
This has a cooling effect on the belts/bearings, etc.

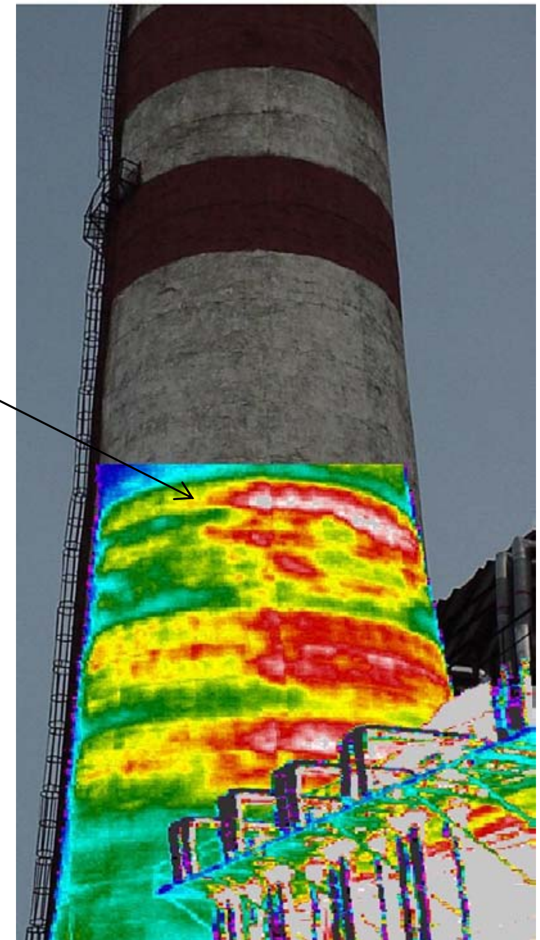
Smokestack Evaluation

A low quality repair of a through-crack

-3,7°C

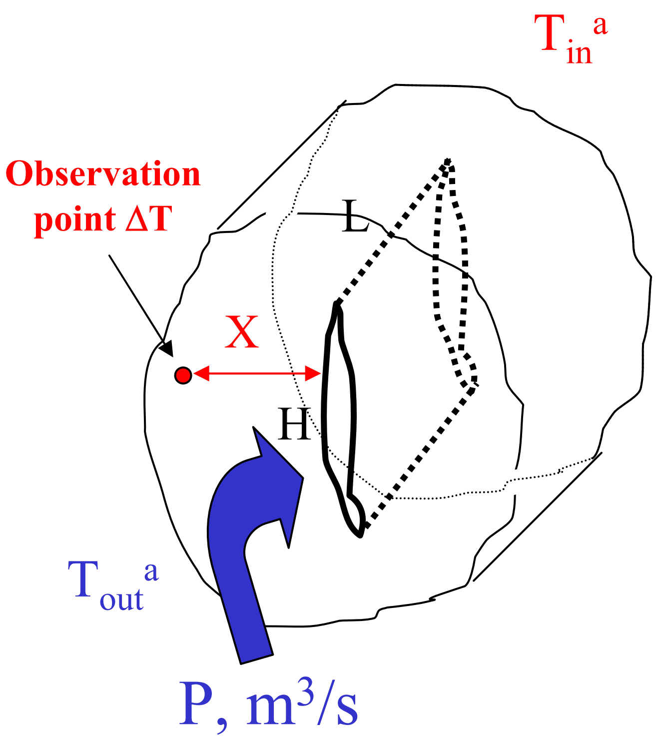
Degradation of thermal insulation

+3,5°C



Smokestack Evaluation

Air in-leak behaves as a heat sink

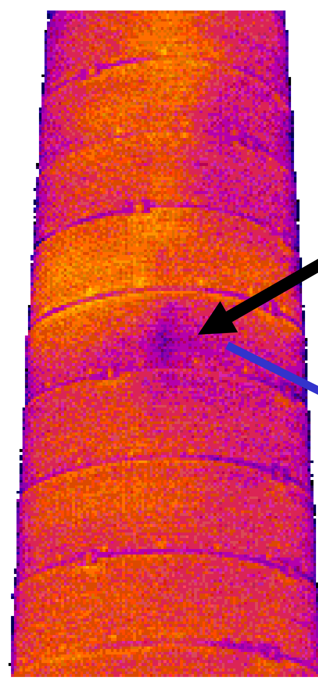


$$P = \frac{2\,H\,L\,K\,\Delta T}{C\,\rho\,X\,(T_{in}^{a} - T_{out}^{a})}$$

Wall average temperature 18.1°C

X=1.2 m

ΔT=1.8°C



P=43 litres/hr

Smokestack Evaluation

Assume that we measure the temperature gradients ΔT on a smokestack outer surface and determine the corresponding variations in thermal resistance ΔR_t

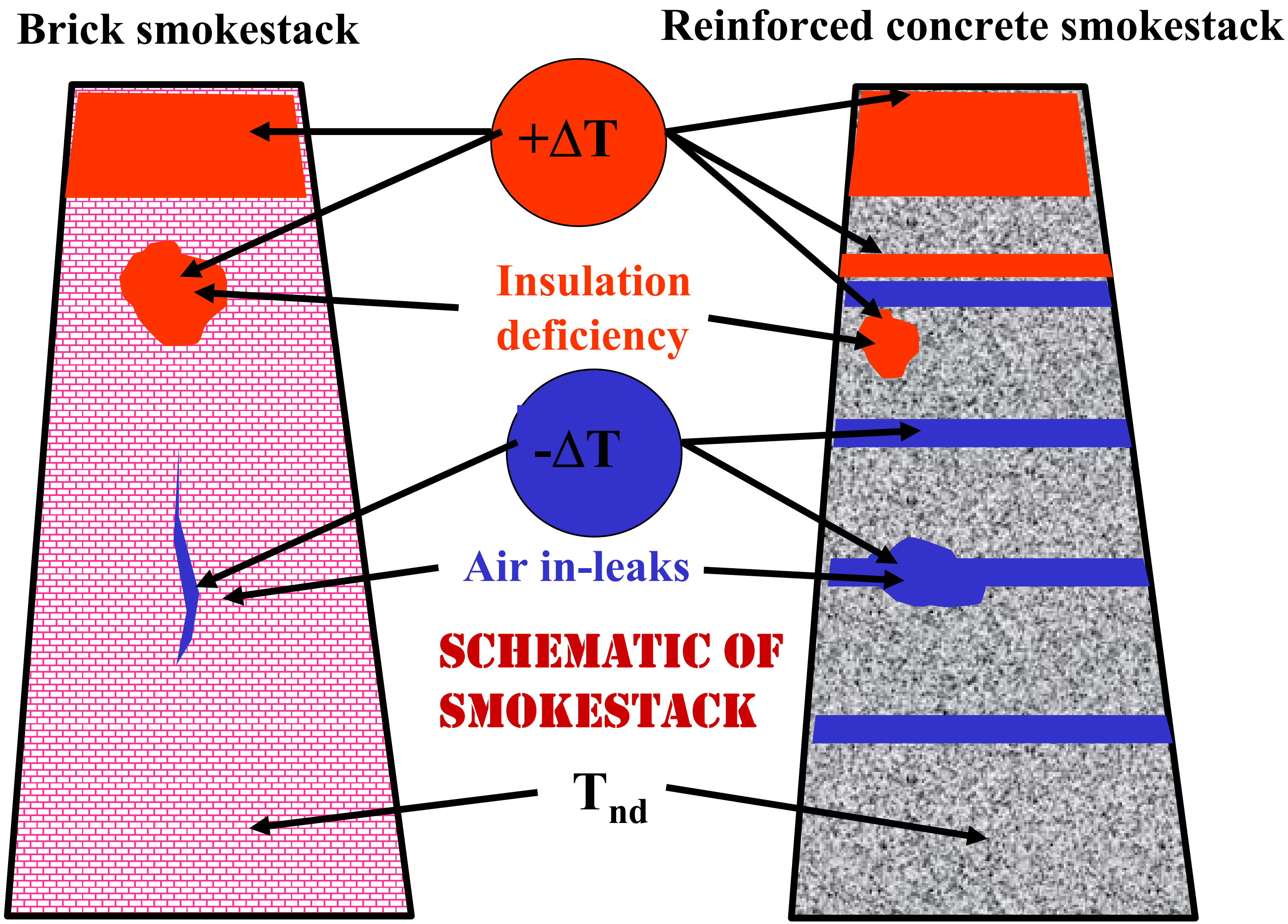
$$\Delta R_t = \frac{\left(1+\frac{h_{out}}{h_{in}}+h_{out}\,R_t\right)^2}{h_{out}\left(T^a_{out}-T^a_{in}\right)}\Delta T^w_{out}$$

Conclusion. The typical IR camera temperature resolution of 0.1°C is equivalent to ΔR_t=0.032 m^2KW^{-1} (to compare to the total value R_t=1.37 m^2KW^{-1}) that is much better than in the case of absolute measurement.

Example. A smokestack is made of two brick layers separated with an air gap (R_t=1.37 m^2KW^{-1}). The ΔT=1.8°C surface temperature signal is equivalent to ΔR_t=0.33 m^2KW^{-1} that can be explained by the destruction of the internal brick layer and the gas infiltration into the air gap.

ProcessSCAN
Infrared Thermographic Services

Smokestack Evaluation

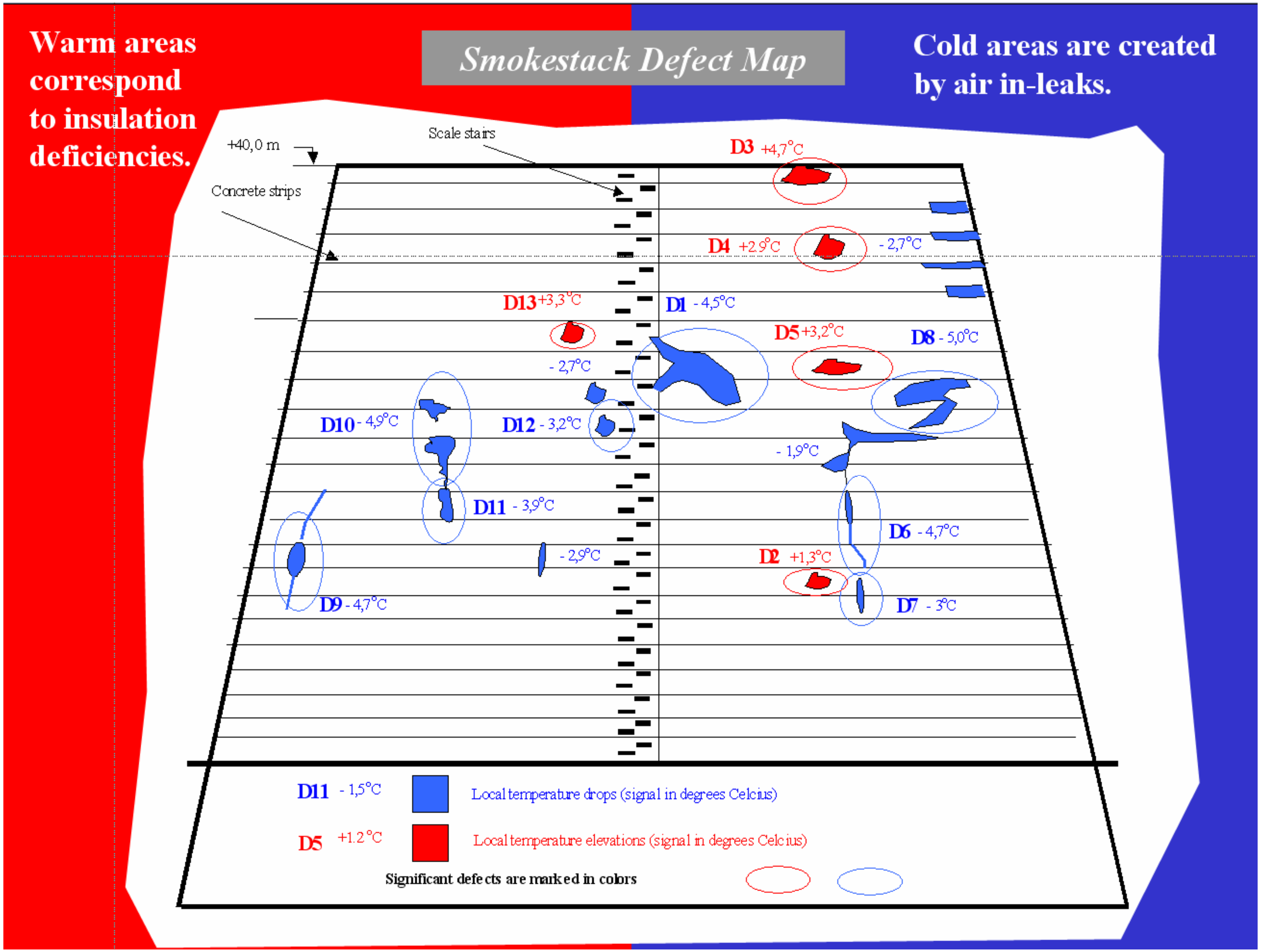


ProcessSCAN
Infrared Thermographic Services

Smokestack Evaluation

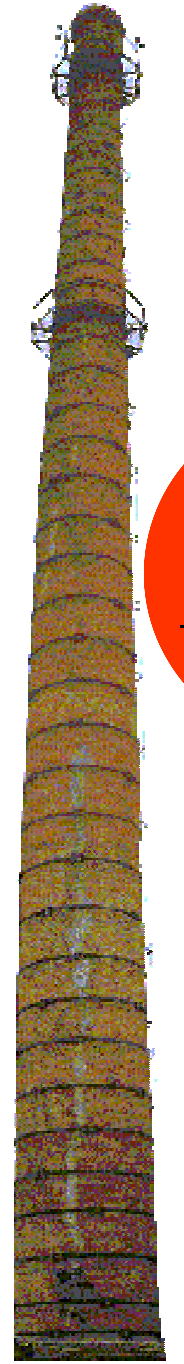
Warm areas correspond to insulation deficiencies.

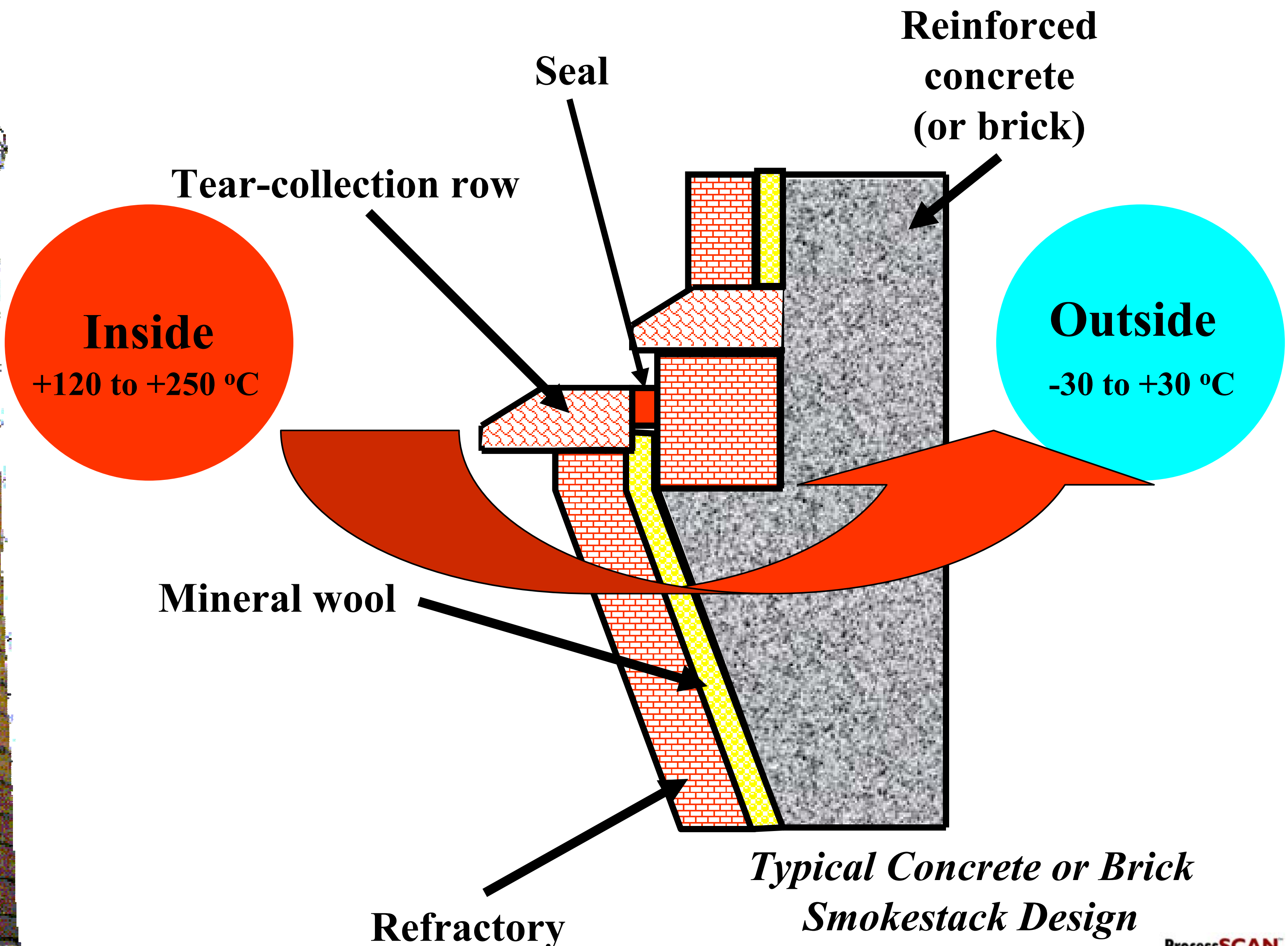
Cold areas are created by air in-leaks.



ProcessSCAN Infrared Thermographic Services

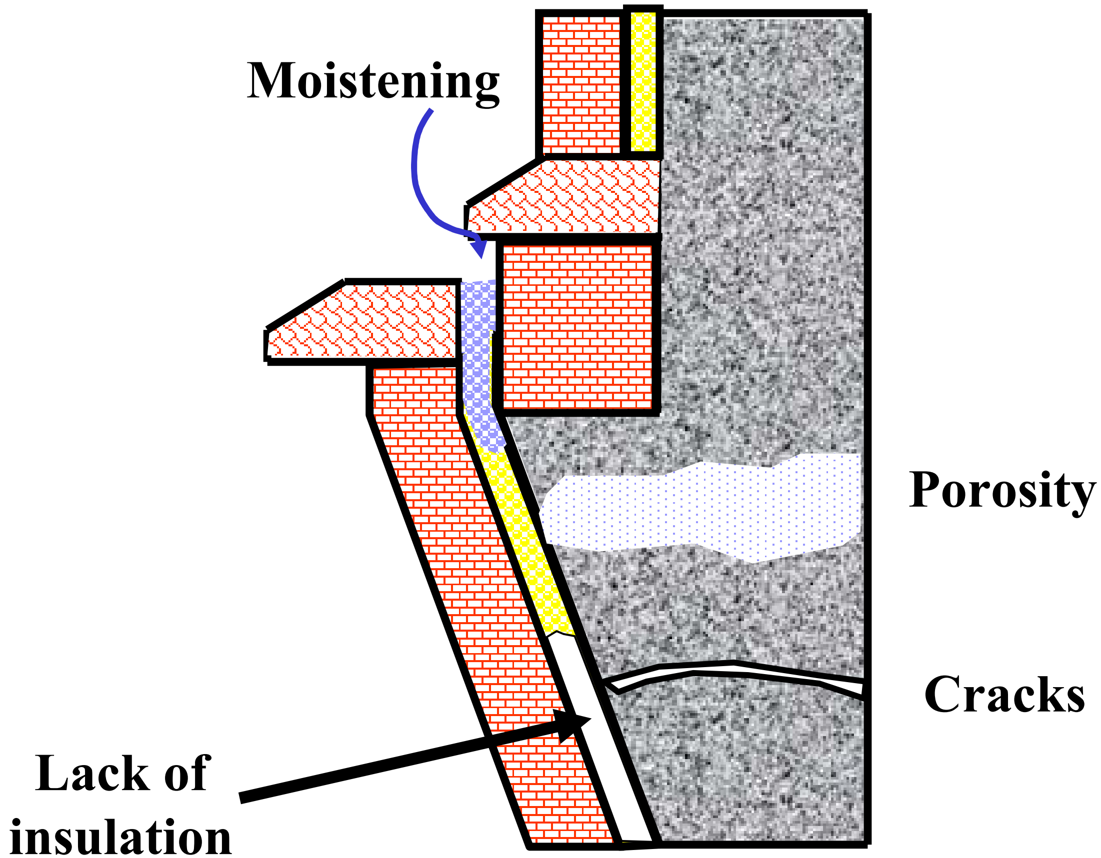
Smokestack Evaluation





Typical Concrete or Brick Smokestack Design

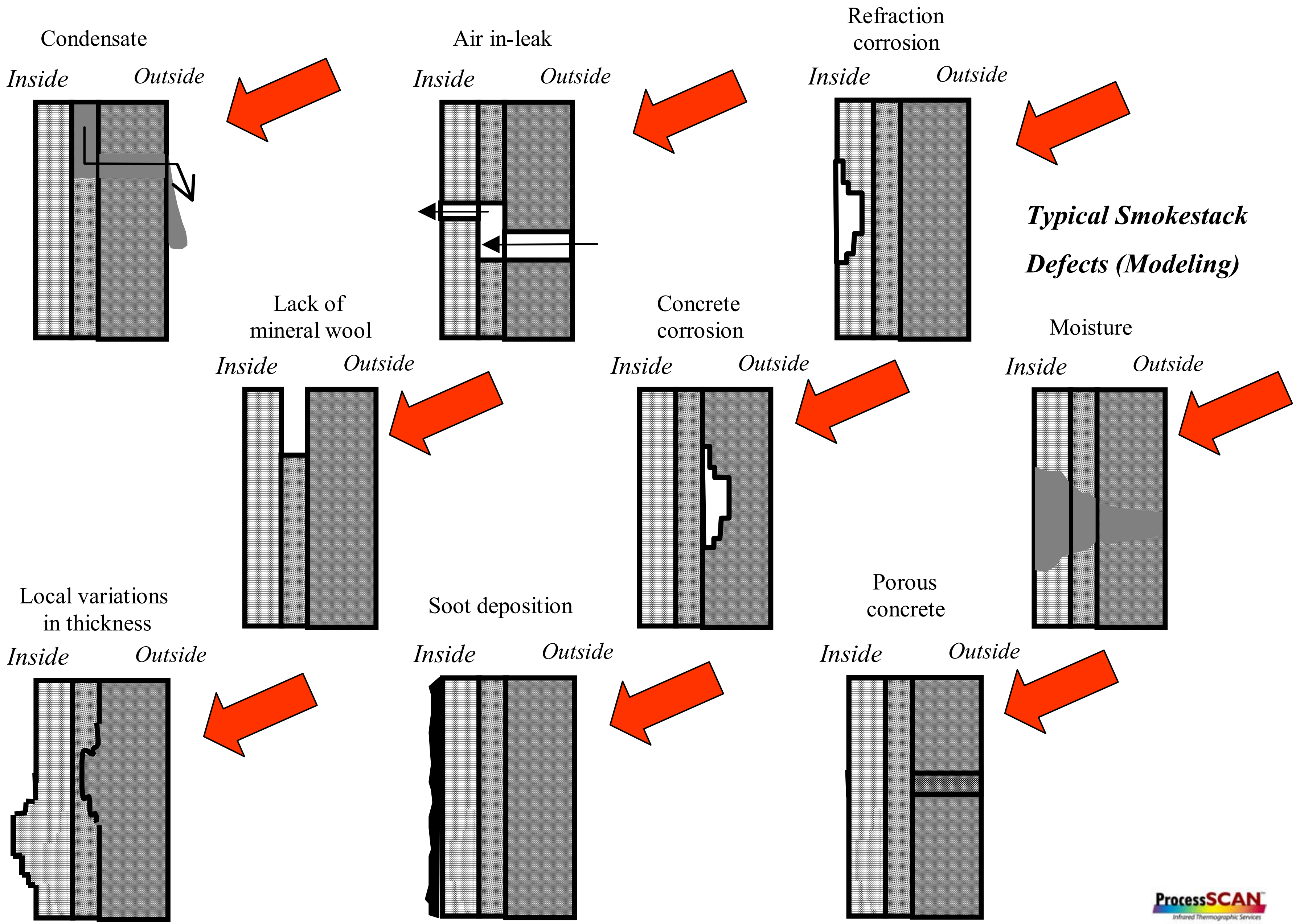
SMOKESTACK EVALUATION



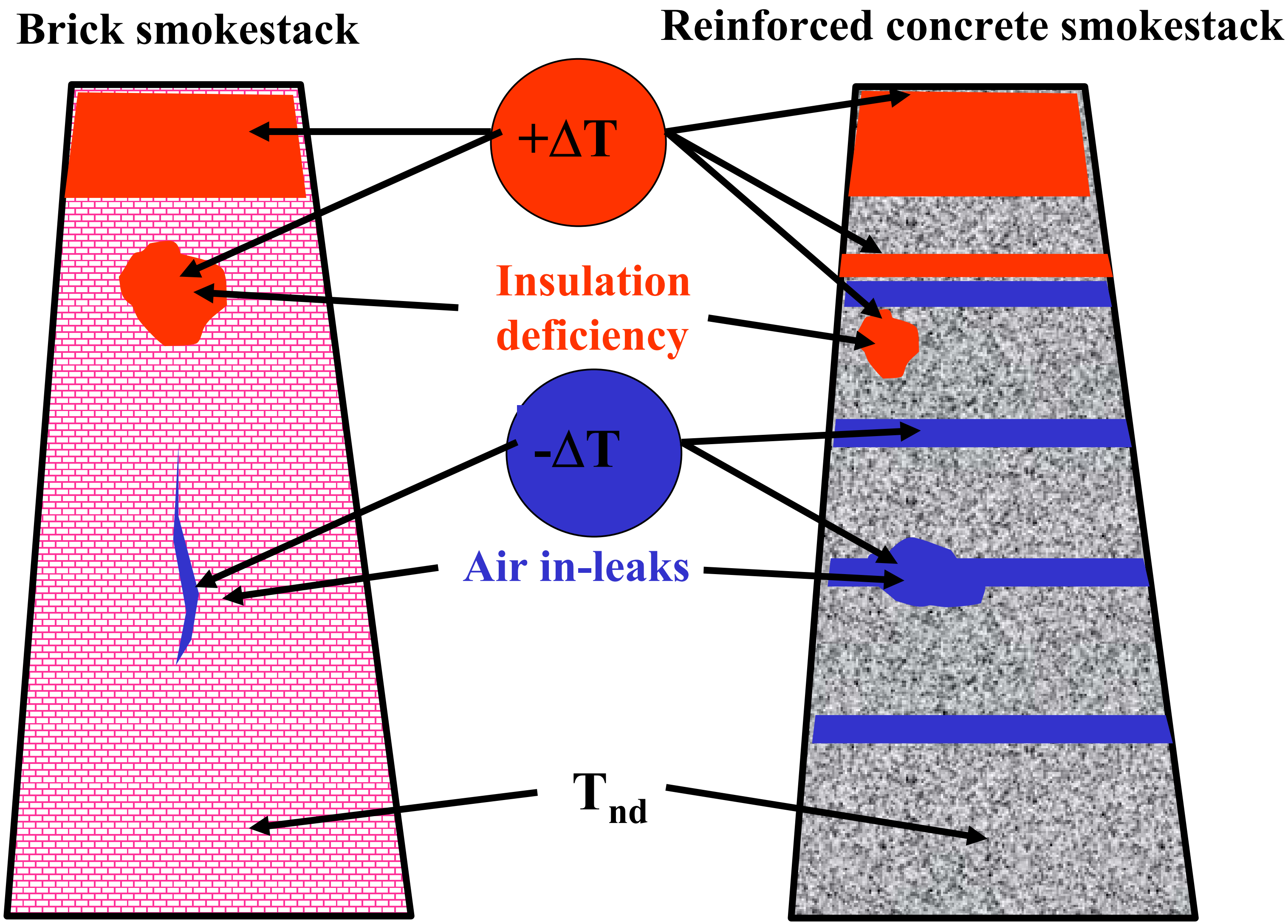
The severity of defects depends on the smokestack design and its use.

Typical Smokestack Defects (Outline)

Smokestack Evaluation

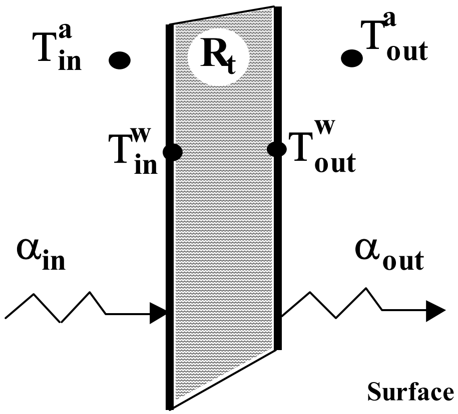


SMOKESTACK EVALUATION



SCHEMATIC PRESENTATION OF SMOKESTACKS

Smokestack Evaluation



Evaluating absolute magnitudes of wall thermal resistance

$$T^w_{out} = \frac{T^a_{in} + \alpha_{out}\, T^a_{out}\,(\frac{1}{\alpha_{in}} + R_t)}{1 + \frac{\alpha_{out}}{\alpha_{in}} + \alpha_{out}\, R_t} \qquad R_t = \frac{T^a_{in} - \frac{\alpha_{out}}{\alpha_{in}}(T^w_{out} - T^a_{out}) - T^w_{out}}{\alpha_{out}\,(T^w_{out} - T^a_{out})}$$

1

Surface smokestack temperature variations vs. variations in experimental parameters

(central part of a typical smokestack involving brick refractory, mineral wool layer and reinforced concrete, smokestack wall thermal resistance $R_t = 1.37\ m^2\ K\,W^{-1}$, gas temperature inside is 125°C, ambient temperature is +18 °C, heat exchange coefficients: $h_{in} = 23\ W\,m^{-2}\ K^{-1}$, $h_{out} = 16\ W\,m^{-2}\ K^{-1}$, smokestack outer surface temperature $T^w_{out} = 22.53\ ^oC$)

Parameter variation	**Surface temperature variation,** ΔT^w_{out} , ^oC
$\Delta T^a_{in} = +1\ ^oC$	0.042
$\Delta T^a_{out} = +1\ ^oC$	0.96
$\Delta h_{in} = \pm 1\ W\,m^{-2}\ K^{-1}$	0.0058
$\Delta h_{out} = \pm 1\ W\,m^{-2}\ K^{-1}$	-0.27

This is equivalent to the total destruction of refractory

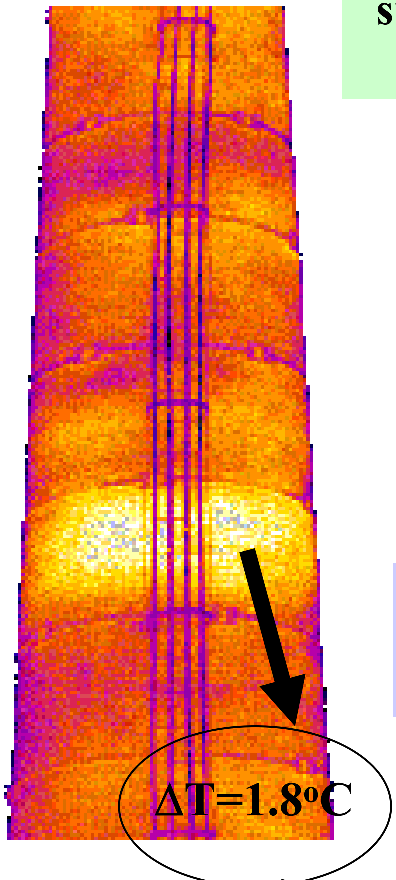
Conclusion. The error in measuring an absolute value of smokestack surface temperature is about ΔT_{out}^{w}=1°C that is equivalent to ΔR_t=0.26 m^2KW^{-1} (to compare to the total value R_t=1.37 m^2KW^{-1})

Smokestack Evaluation

Assume that we measure the temperature gradients ΔT on a smokestack outer surface and determine the corresponding variations in thermal resistance ΔR_t

Evaluating variations in wall thermal resistance

$$\Delta R_t = \frac{\left(1 + \dfrac{h_{out}}{h_{in}} + h_{out}\, R_t\right)^2}{h_{out}\left(T_{out}^{a} - T_{in}^{a}\right)} \Delta T_{out}^{w}$$



Conclusion. The typical IR camera temperature resolution of 0.1°C is equivalent to ΔR_t=0.032 m^2KW^{-1} (to compare to the total value R_t=1.37 m^2KW^{-1}) that is much better than in the case of absolute measurement.

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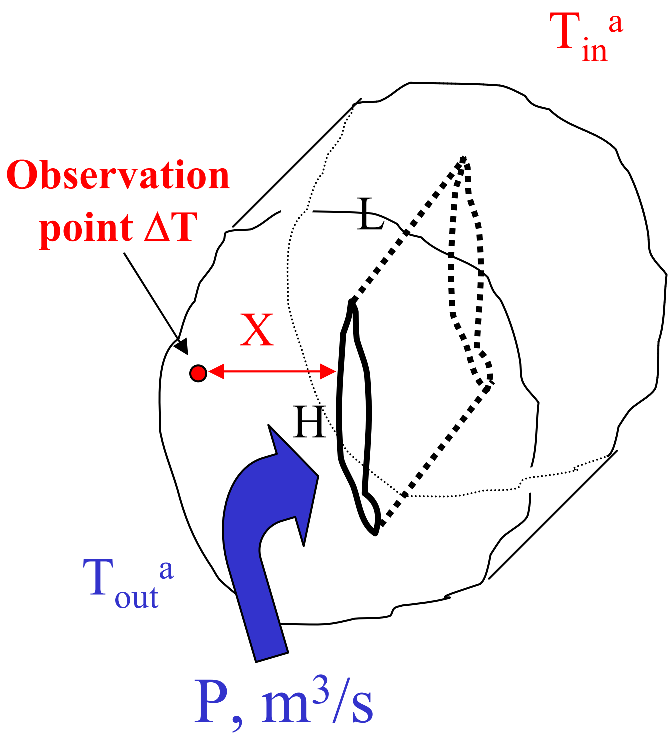
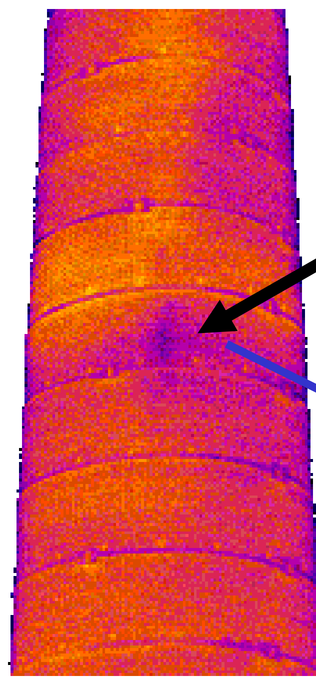
Smokestack Evaluation



Quantifying Air Leaks

Air in-leak behaves as a heat sink

$$P = \frac{2\,H\,L\,K\,\Delta T}{C\,\rho\,X\,(T_{in}^{a} - T_{out}^{a})}$$



Wall average temperature 18.1°C

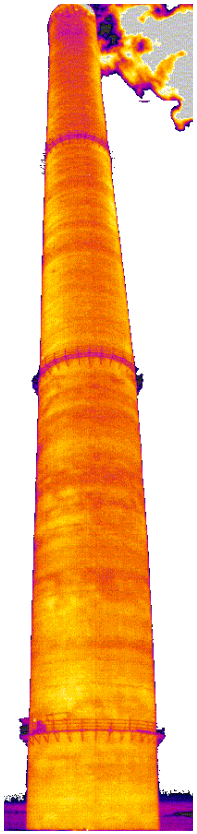
X=1.2 m

ΔT=1.8°C

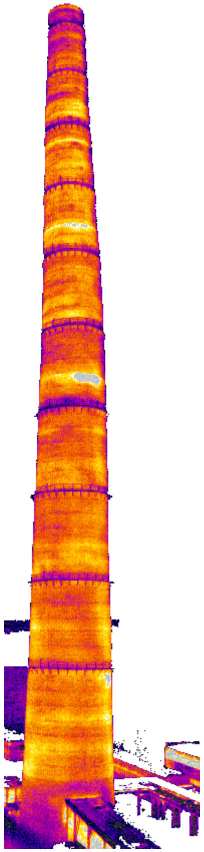
P=43 litres/hr

SMOKESTACK EVALUATION

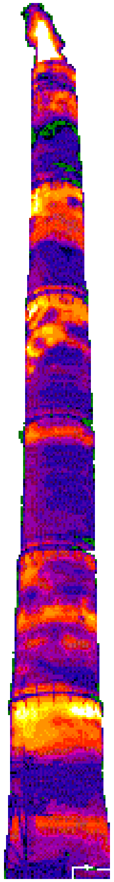
'Good'



'Medium'



'Bad'



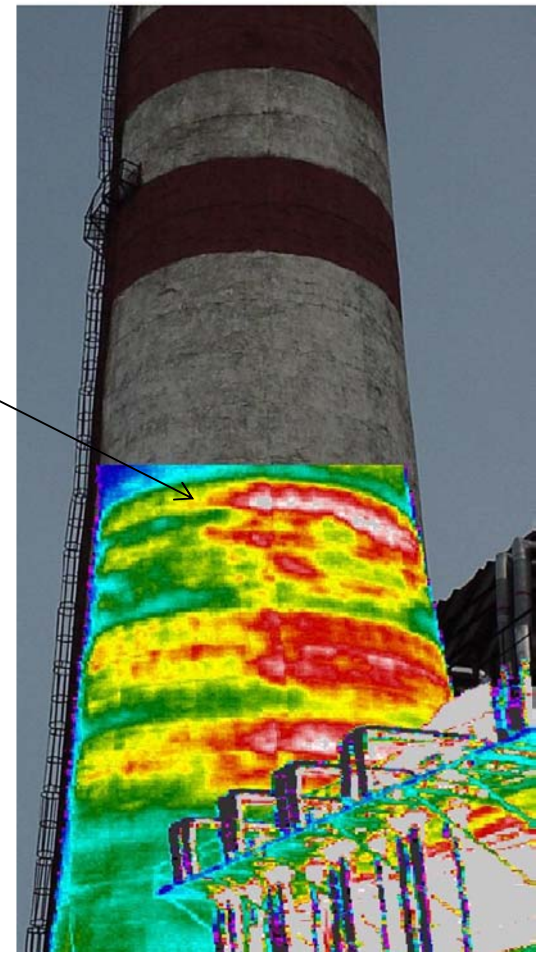
Typical Smokestack Thermograms

Typically, a smokestack is surveyed from 6-7 ground observation points by collecting 40-60 thermograms in total.

Smokestack Evaluation

A low quality of a through-crack repair

Degradation of thermal insulation

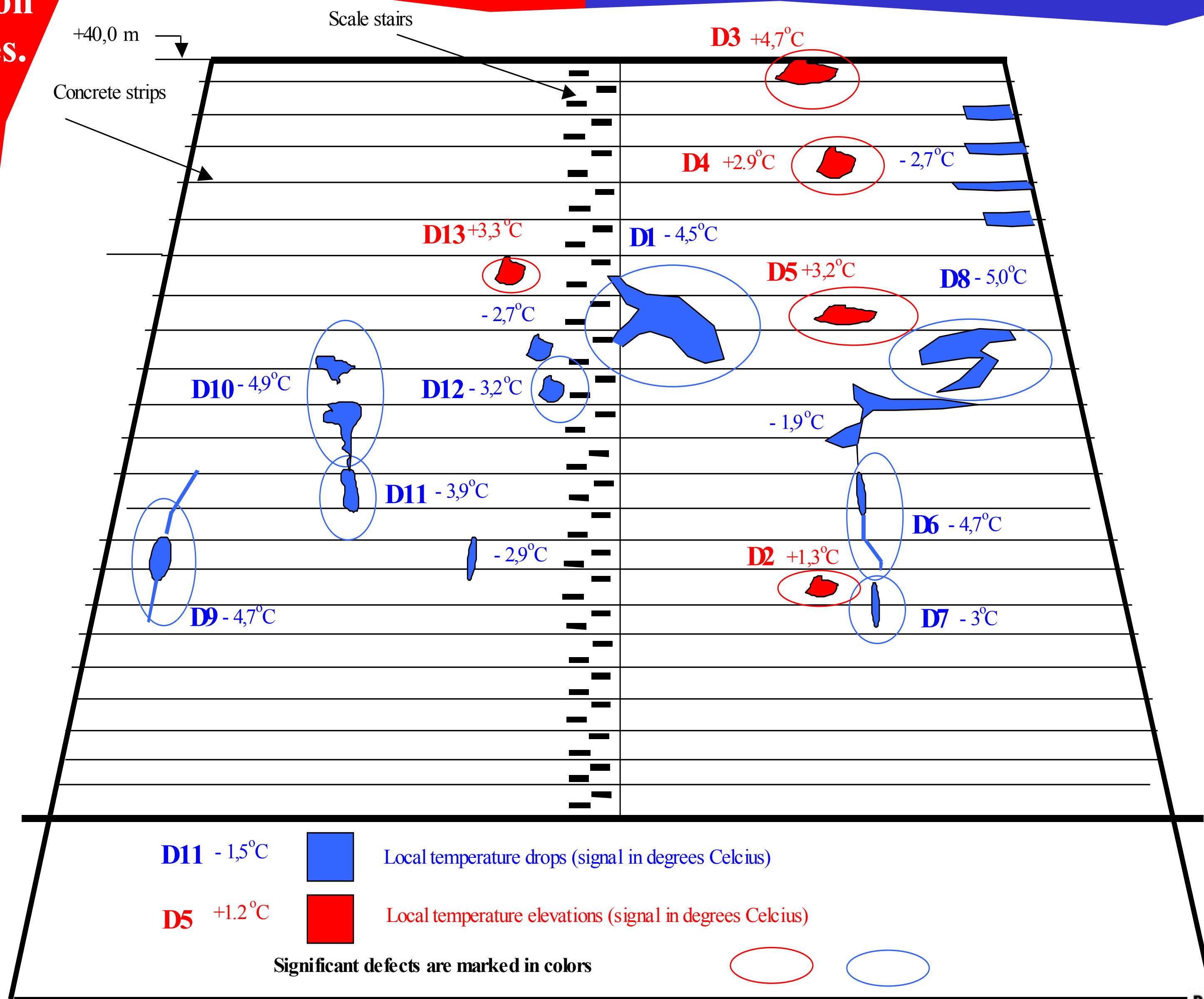


Typical Smokestack Thermograms

Smokestack Defect Map

Warm areas correspond to insulation deficiencies.

Cold areas are created by air in-leaks.



Smokestack Evaluation

Conclusions

Warm areas observed on the smokestack surface, typically correspond to insulation deficiencies. The gravity of the defect can be reliably evaluated by solving the corresponding heat conduction problem. Surface temperature gradients can be used to estimate thermal resistance variations.

Cold areas of a particular pattern usually correspond to air in-leaks. A simple quantitative estimate allows to determine an air in-leak rate.

Aging smokestacks require the use of reliable diagnostic techniques. Infrared thermography is a fast and accurate method of condition monitoring.

Smokestack owners can use this form of condition monitoring to get accurate qualitative data to make decisions about repair activities.

From the practical point of view, any smokestack inspection should determine how long the smokestack can be used safely. To make that conclusion, an infrared survey should be complemented with a visual evaluation performed by an expert industrial chimney inspector.