High Temperature Treatments in Food Processing Facilities

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and
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Presentation Outline

- Overview of TEMP-AIR
- Historical perspective
- Temperature effect on insects
- Heating Systems: Pros & Cons
- Process & Equipment
- Research on Efficacy – Basic & Applied
- Conclusion

THERMAL REMEDIATION FROM TEMPAIR

TEMP-AIR

- Largest provider of temporary heating & cooling equipment to US construction industry
- Custom manufactures HVAC for rental fleet
- Projects include:
  - Mall of America,
  - O'Hare and Denver Airports,
  - Pentagon Reconstruction
  - McCormick Place Expansion

Since 1965 & growing stronger. . .

THERMAL REMEDIATION FROM TEMPAIR

TEMP-AIR

- Burnsville, MN headquarters
- 11 regional offices serving northern US
- Founded 1965
  - 40 years of innovation
- 125 employees
- privately owned

THERMAL REMEDIATION
FROM TEMPAIR

Temp-Air Presence in Canada

- Partnership with companies in
  - Mississauga, ON
  - Montreal, QC
- Source Temp-Air heaters for treatment
  - Reduced shipping cost
  - Flexibility in logistical operations
- Pass on benefit to customers – reduced cost

THERMAL REMEDIATION FROM TEMPAIR

Construction Heating Equipment

- 6,000+ rental units
  - Up to 4,500,000 Btu/hr
  - Fleet rating 4 BCF/hr
- Natural gas- and propane-fueled heaters
- Steam, hot water, and electric available
- Primary market is commercial/industrial; residential growing

THERMAL REMEDIATION FROM TEMPAIR

History of Heat Treatments

- 1762, France: 69°C / 156 °F for 3 d, moth
- 1860, England: 57°C / 135 °F for grain
- 1910, USA: heat treatment of mills
- 1920, USA: 30 mills use heat in OH, PA
- 1932, France: MB as insecticide

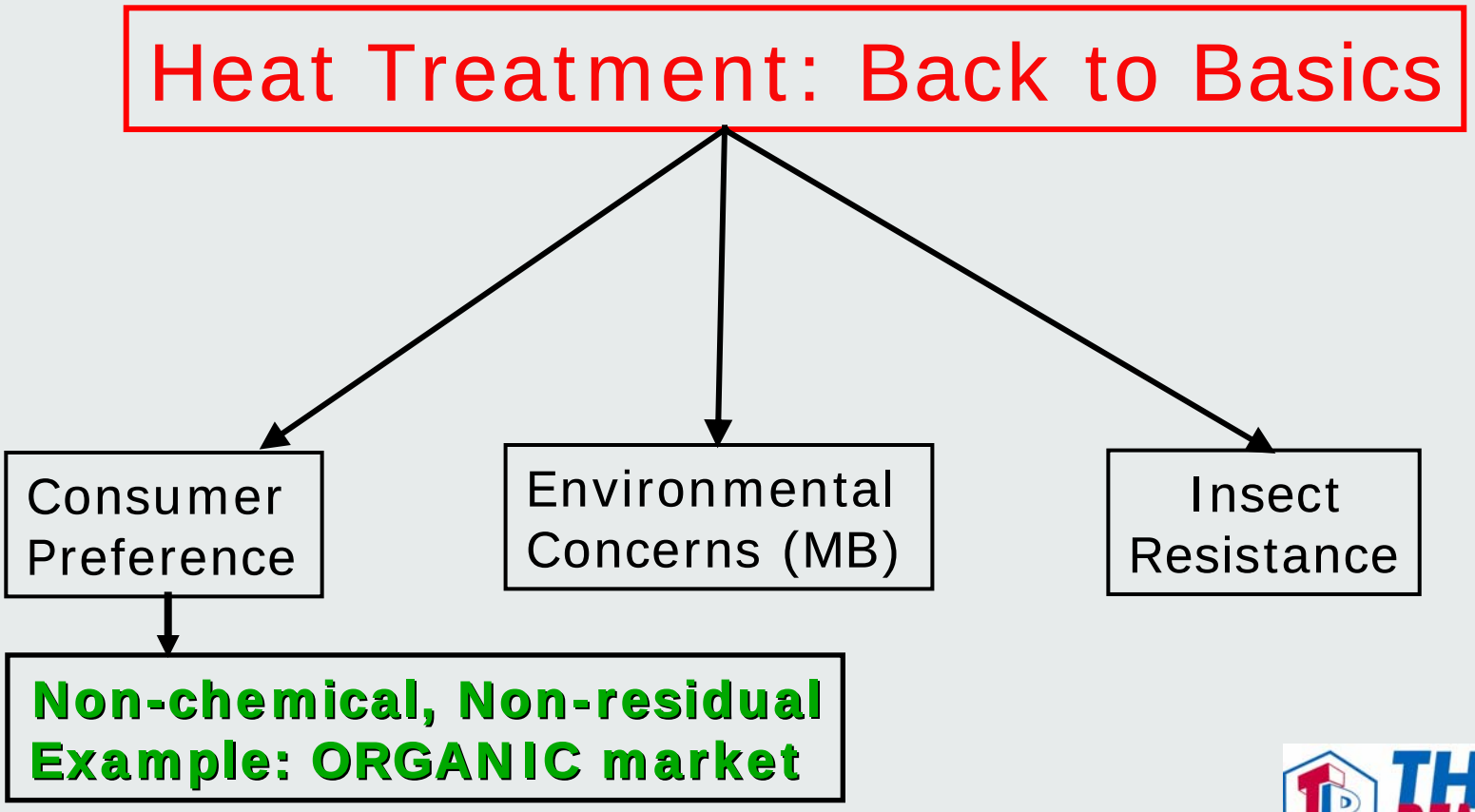
THERMAL REMEDIATION FROM TEMPAIR

History of Heat Treatments

- 1950's: Quaker Oats using heat
- 1983: EDB banned
- 1990's: increased interest in heat
- 1992: MB found ozone unfriendly
- 1994: Dursban in Cheerios
- 2005: MB to be phased out
- 2006: MB one-year extension US, Canada

THERMAL REMEDIATION FROM TEMPAIR

Why Heat Treatment?



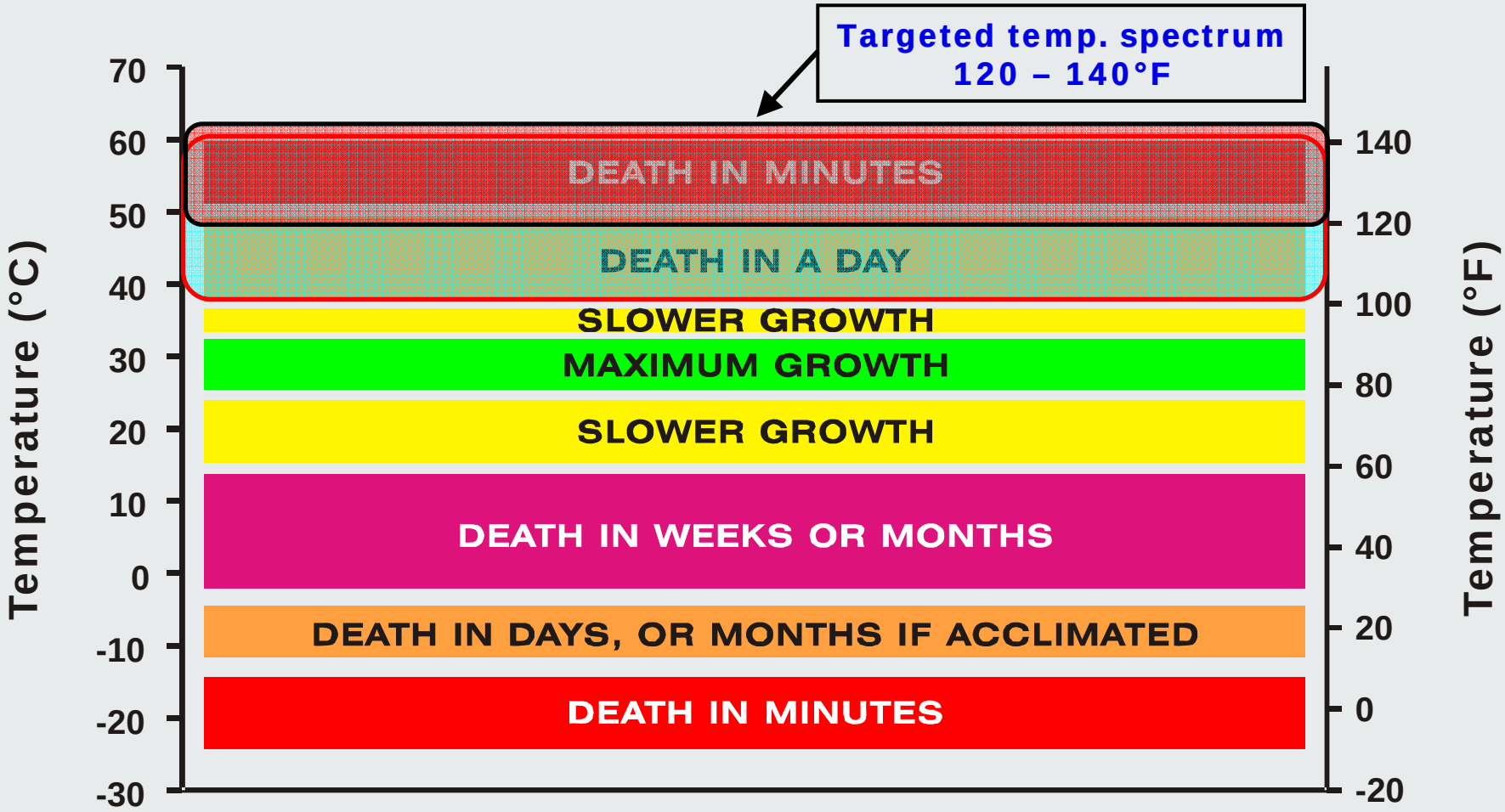
THERMAL REMEDIATION FROM TEMPAIR

Basics of Heat Death

- High temperature – spiracles remain open
  - Dehydration/desiccation (low humidity)
- Above 50 °C / 120 °F
  - Cell membranes “melt”
  - Damage to enzymes, protein breakdown
  - Change in salt balance

THERMAL REMEDIATION FROM TEMPAIR

Temperature Effects on Insects



Source: P. Fields, AAFC, Canada

Efficacy to Control Pests

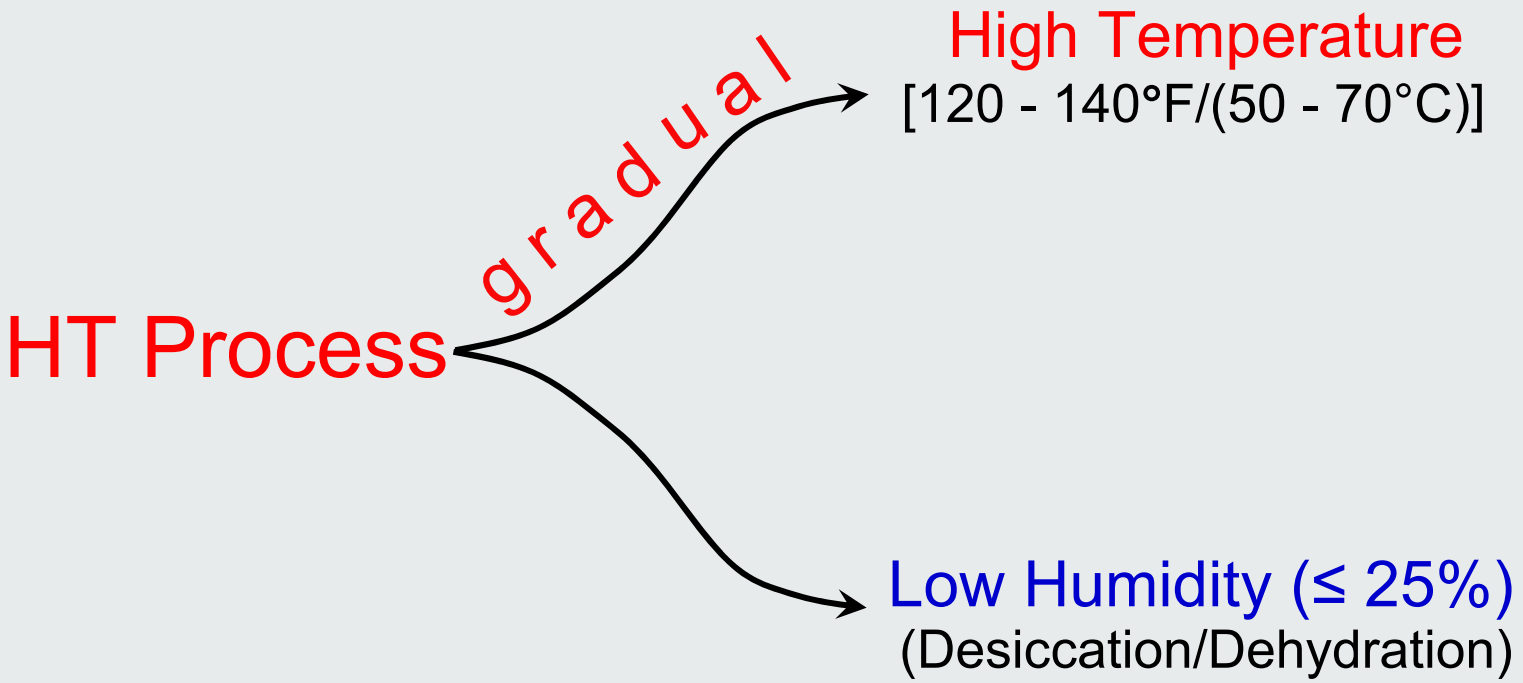
- MBr
- PH3
- SF (Profume)
- CO2
- O3
- . . . . .

Efficacy – function of temperature

THERMAL REMEDIATION FROM TEMPAIR

Heat Treatment

Insects – threshold temperatures



THERMAL REMEDIATION FROM TEMPAIR

Heat Advantages

- **Safety**
  - Non-chemical
  - Non-toxic to humans
  - No evacuation of plant
- **Efficacy**
  - Kills entire life cycle of pest insects, including eggs/larva
- **Environmentally-friendly**
  - No ozone depletion
  - FDA approved
- **Economical**
  - Spot treatments
  - production/non-production operations in untreated area

THERMAL REMEDIATION FROM TEMPAIR

Heat Vs MBr - Downtime Comparison

Methyl Bromide

- Sealing……..0
- Set up……..4-6
- Fumigation…….24
- Aeration……12-24
- TOTAL……40-54

Plant evacuation mandatory

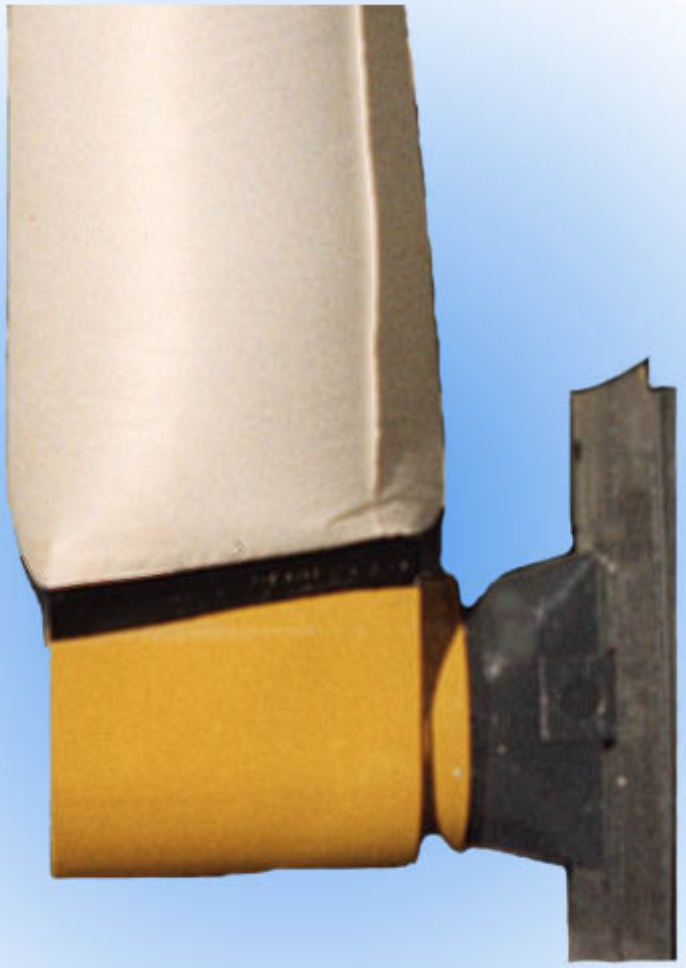
Thermal Remediation

- Set up……..0
- Heat up……6-8
- Kill Period…….24
- Cool down…….2-4
- Tear down…….1-2
- TOTAL…….33-40

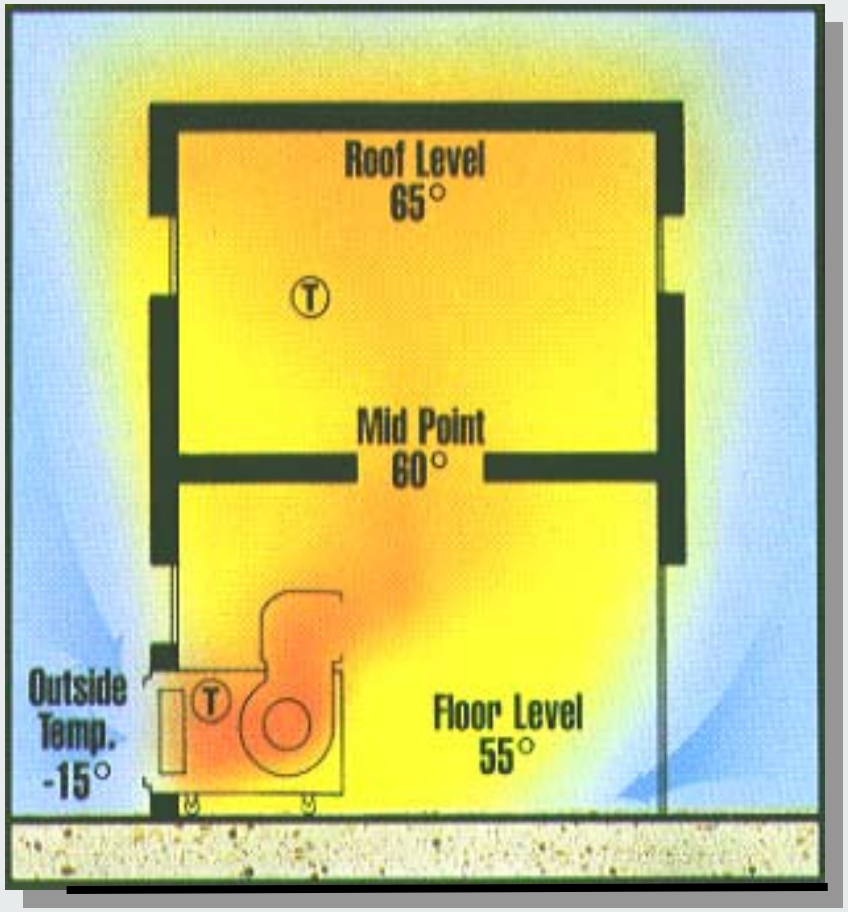
Non-treated areas remain operational

THERMAL REMEDIATION FROM TEMPAIR

Process



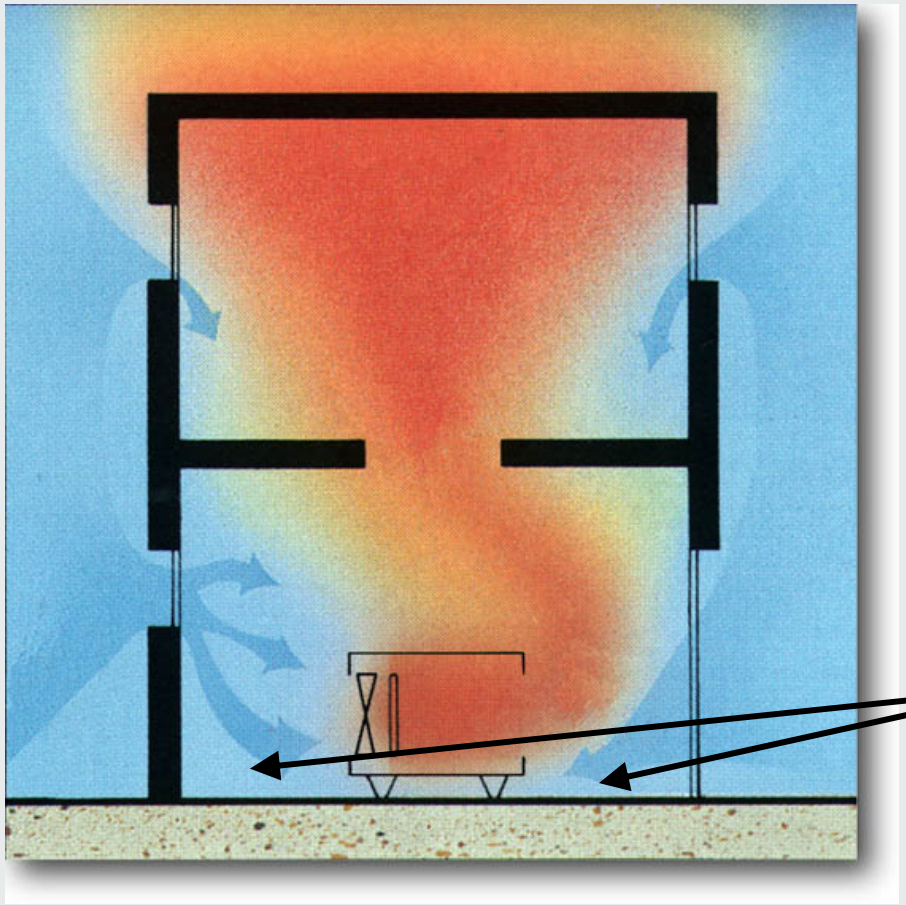
Provide Heated Outside Air
(Patented Process)



US & Canadian Patents

- **Positive pressure**
  - Good air distribution
  - Hot air is pushed to corners, cracks and crevices
- **Calculated and controlled infiltration (4-6 air changes per hour)**
- **Lower relative humidity**

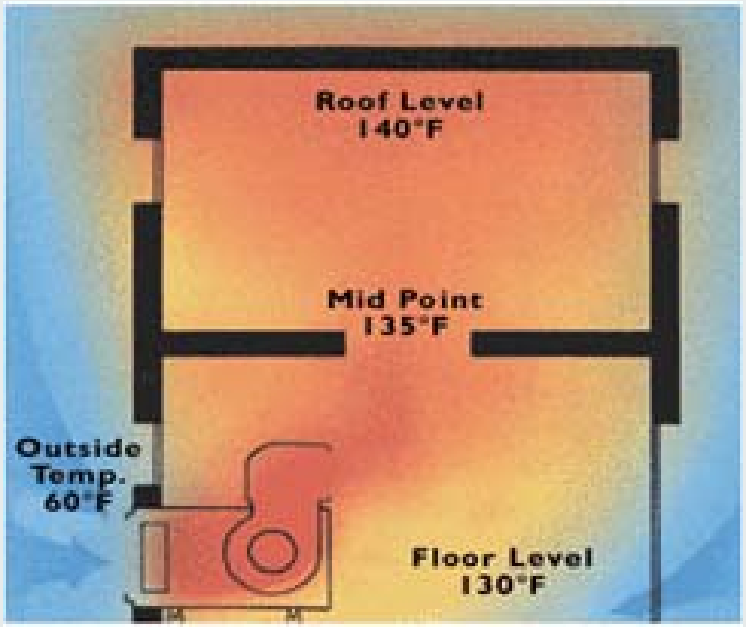
Re-circulating Inside Air



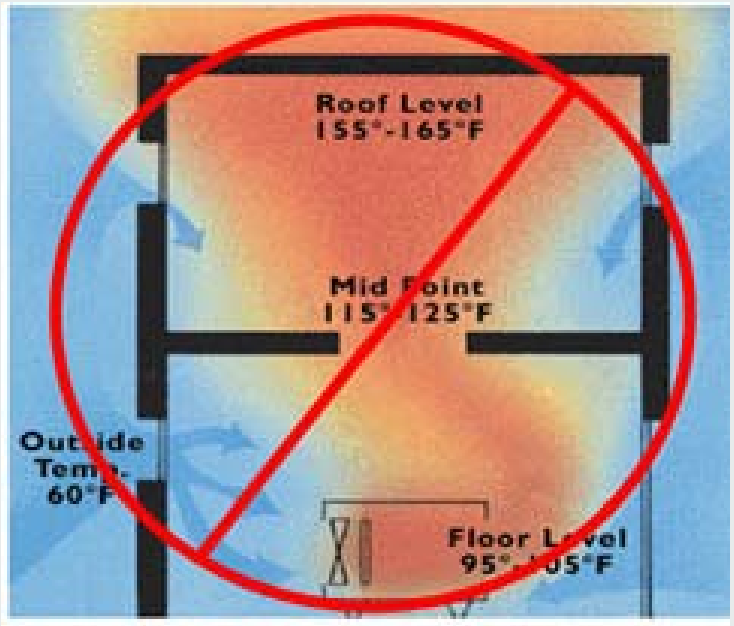
- **Negative pressure**
- **Poor air circulation**
- **Uncontrolled infiltration**
  - ✓ **No air changes**

Low temperature zones

Construction Heat Principles: Make-Up vs. Recirculation



100% OUTSIDE AIR



RECIRCULATING INSIDE AIR

- Recirculating heaters promote thermal stratification and infiltration
- Make-up air heaters provide uniform temperatures, pressurize the structure, and exhaust moisture and fumes

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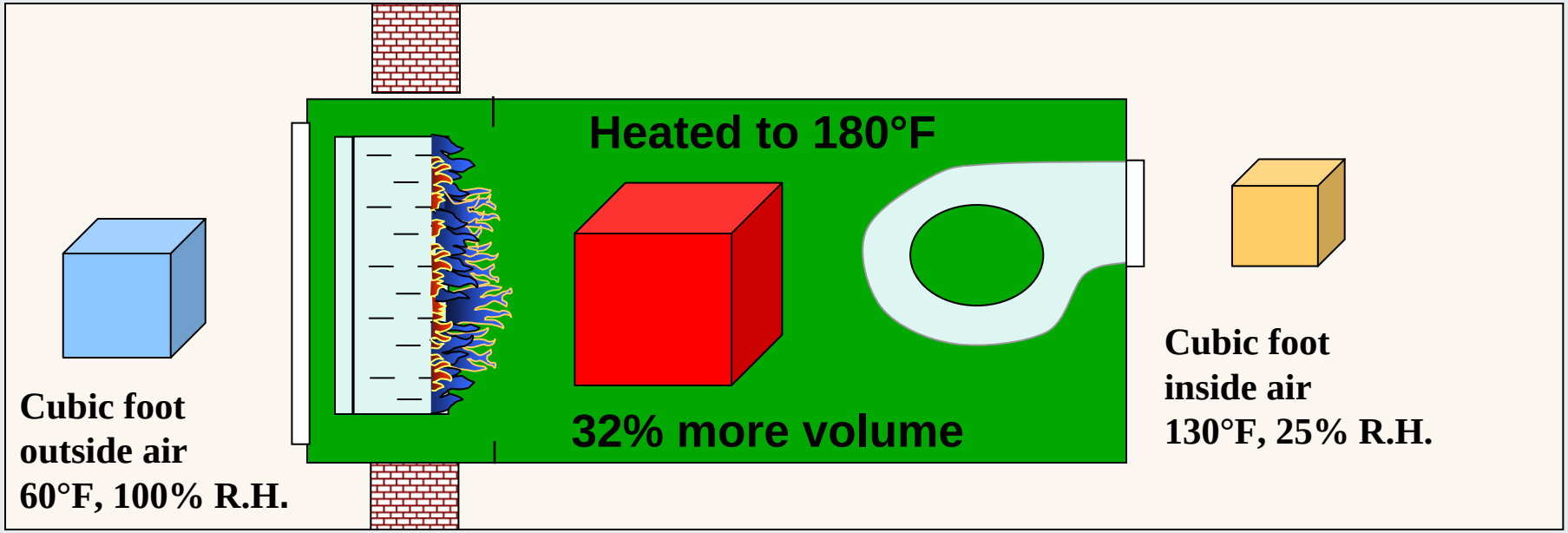
Humidity Control

- **Lower humidity = Quicker kill**
- **Cold air expands as it is heated and can absorb more moisture**



Heat Treatment Process

Inspection
- Sprinklers
- Equipment

Engineering
- Heat loss calculations
- Equipment selection
- Sizing and layout
- Ductwork
- Monitoring protocol
- Power and fuel

Mobilization
- Equipment shipment
- Install and set up

Heat Treatment
- Safety inspection
- Ramp up temperature
- Monitor temperatures
- Hold for 24 hours
- Inspect for activity
- Cool down/shut off
- Documentation

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Heat Treatment Process (cont.)

- Heating Estimator
  - Design conditions – Regional temp/RH data
  - Outside and inside temperatures
  - Building type: open area/high rise etc.
  - Enclosure integrity (1 to 8)
  - Building information: roof, exterior walls, glass etc
  - Cubic ft, air changes, heater selection etc.

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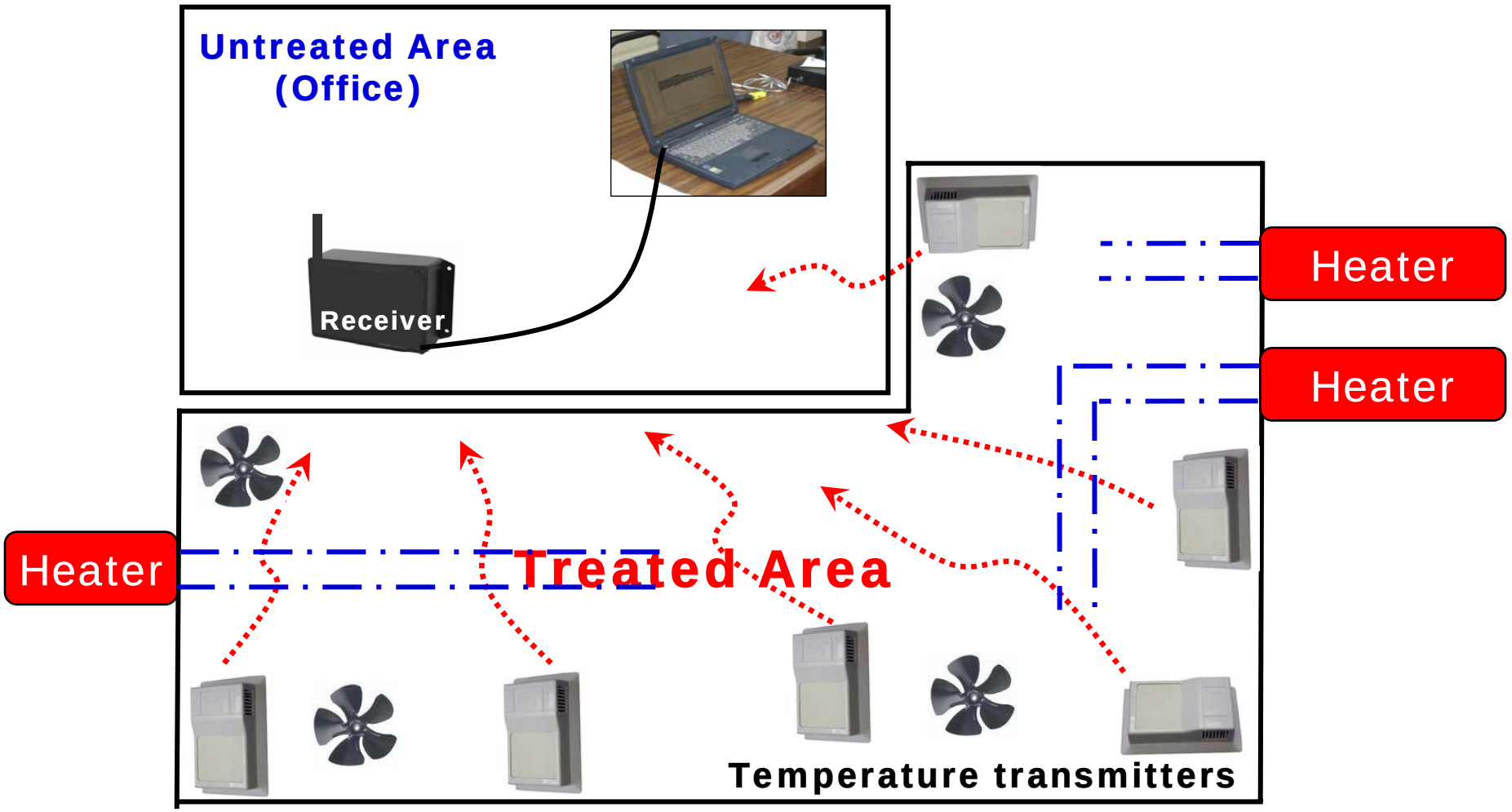
Real-time Wireless Temperature Monitoring



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FROM TEMPAIR

Wireless Temperature Monitoring System

- Real Time Monitoring to Permit Adjustment
- Documentation for Quality Control
- Worker Safety & Labor Savings

Start of the Heat Treatment

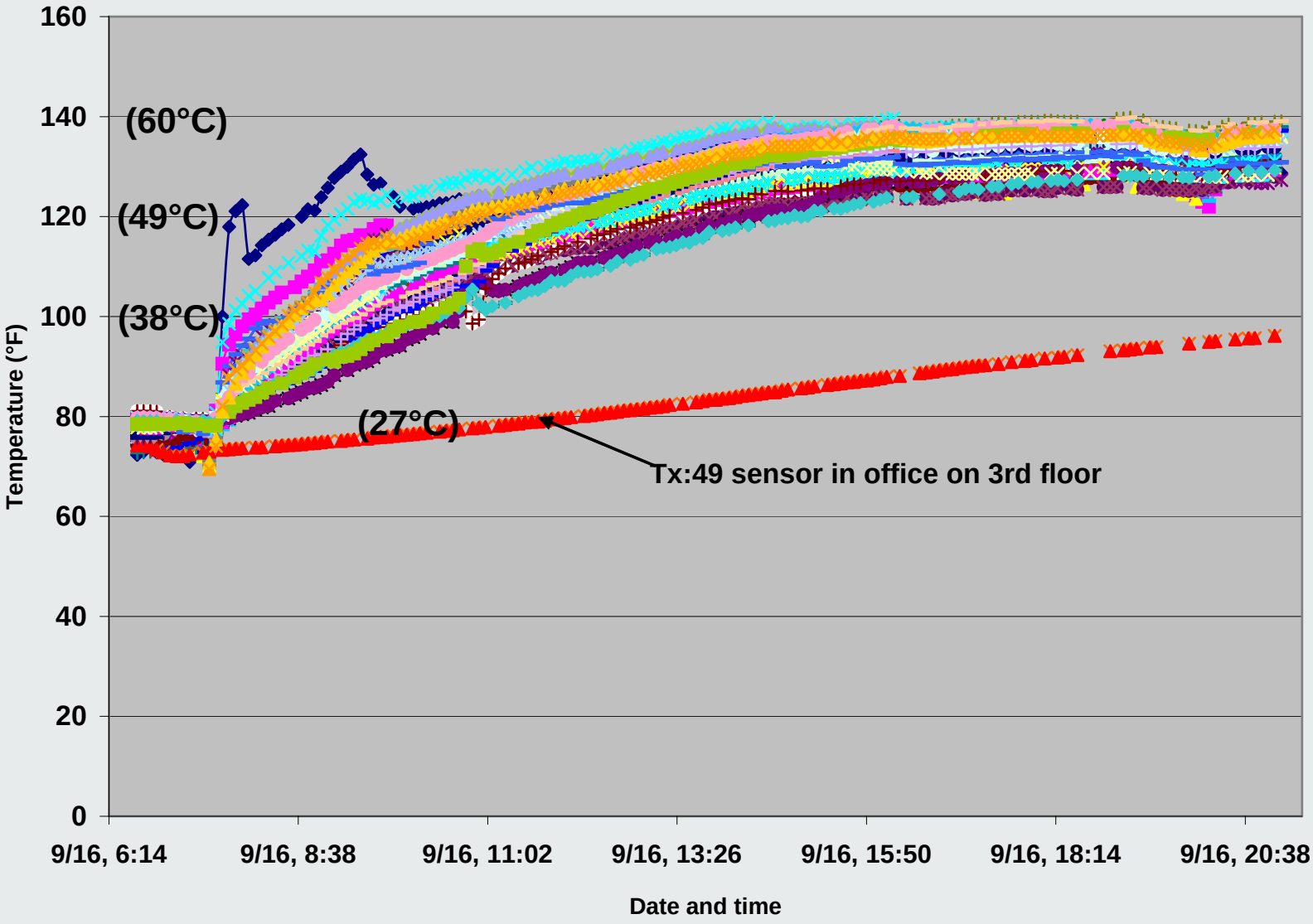

Fig. 1: Realtime Temperature Profile from Sep 16, 2006, 06:35 AM to 09:05 PM

End of the Heat Treatment

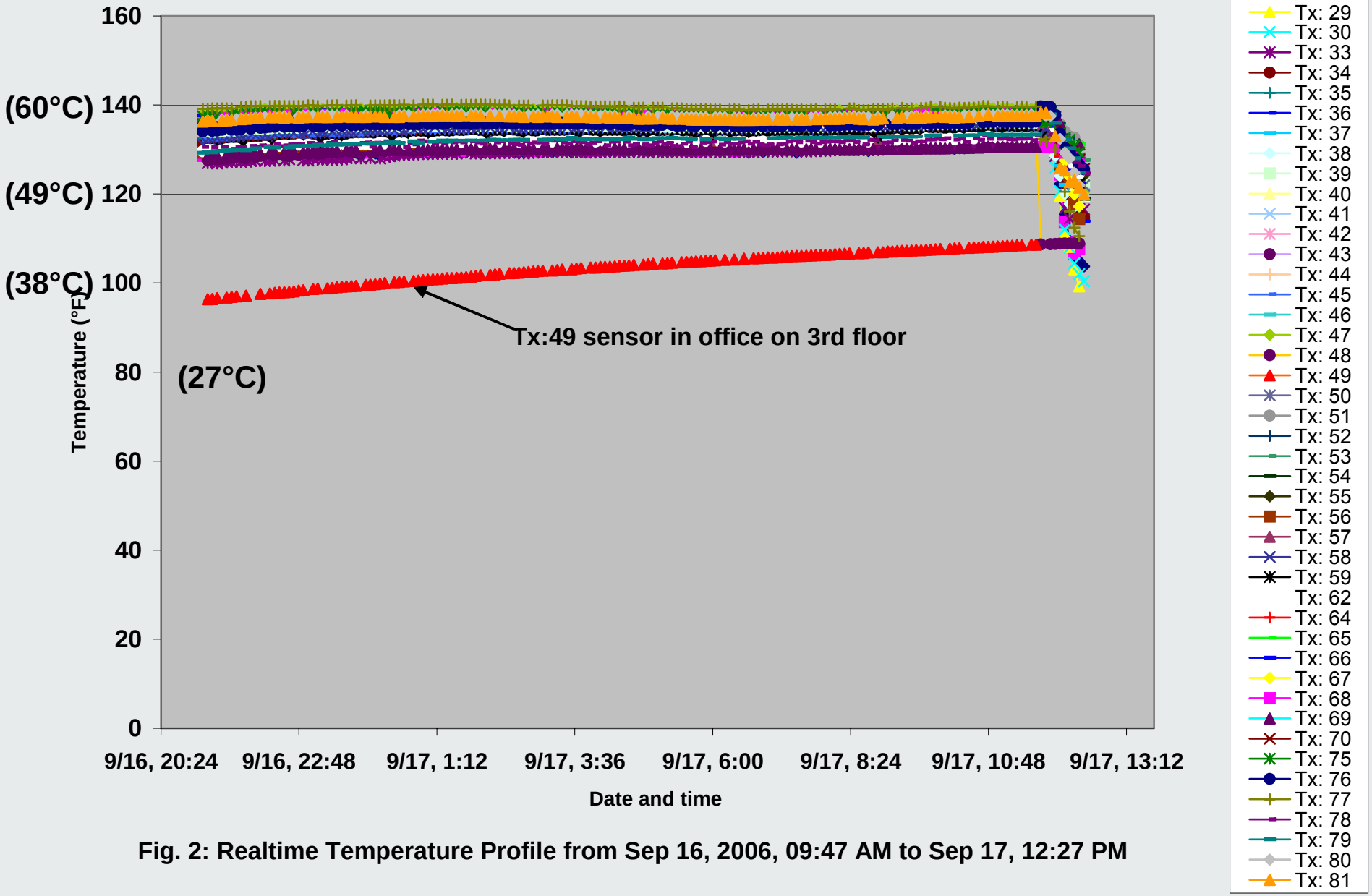

Fig. 2: Realtime Temperature Profile from Sep 16, 2006, 09:47 AM to Sep 17, 12:27 PM

Preliminary Results of Canadian National Millers Association's CARD Project on Methyl Bromide Alternatives

Thermal Remediation (100% outside air)

***CARD** – **The** Canadian Adaptation and Rural Development Fund*

THERMAL REMEDIATION FROM TEMPAIR

Canadian CARD & ACAAF Projects Overview

- CARD Project: 2003
  - Comparative Evaluation of Heat Treatment Technologies as Alternatives to Methyl Bromide Fumigation for Control of Stored Product Pests In Canadian Grain Milling Facilities.
  - $169,000 industry, $165,000 AAFC

- ACAAF Project: 2005-2006
  - Further Evaluation of Alternatives to Methyl Bromide Use in Structural Fumigation of Grain Milling Facilities.
  - $220,000 industry, $269,000 AAFC

Canadian CARD & ACAAF Projects Overview

- 9 mills
- 6 provinces
- 6 milling companies
- Over 9 service providers

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Insect Bioassay: Red Flour Beetle; eggs, larvae and adults

Insects pulled every
1 to 2 hours, one location

Insects pulled at end of
treatment, many locations

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Canadian Flour Mill Results 2003

- Thermal Remediation killed 23 out of 23 bio-assays (100%)

- Steam heat killed 19 out of 23 bio-assays (83%)

THERMAL REMEDIATION FROM TEMPAIR

Canadian Flour Mills Results 2006

Mortality after 24 h heat treatment in Red flour beetle bioassays at 25 locations throughout the mill :

Mill Number	Adults Mortality (%)	Off springs after 1 ½ months		
		Adults	Larvae	Pupae
1 (Aug 4-5)	100	0	0	0
7 (Sep 16-17)	100	0	0	0

***100% mortality at the end of 6 h in both mills on reaching 120°F.**

**** 2% adult mortality in controls and emergence of progeny in 1 ½ months.**

Canadian Flour Mill Results 2006 (contd)

Pre and Post-treatment comparison MB Vs Heat :

Forced-air heat treatmt

Date	% Pretreatment
Aug 29/06	140
5-Sep-06	84
12-Sep-06	77
19-Sep-06	0
3-Oct-06	14
10-Oct-06	14
17-Oct-06	21
24-Oct-06	7
30-Oct-06	28

Methyl bromide treatmt

Date	% Pretreatment
May 18/06	67
May 25/06	82
June 1/06	151
June 8/06	0
June 15/06	0
June 22/06	0
June 29/06	0
July 5/06	9
July 11/06	13
July 18/06	6
July 25/06	0
Aug 8/06	43

Date	% Pretreatment
Aug 15/06	48
Aug 22/06	9
Aug 29/06	30
5-Sep-06	22
12-Sep-06	35
19-Sep-06	17
3-Oct-06	9
10-Oct-06	24
17-Oct-06	24
24-Oct-06	9
30-Oct-06	30

HT Process: not a rocket science

It’s more of an Art – HOW you apply it

THERMAL REMEDIATION
FROM TEMPAIR

Conclusions

- Heat kills all life stages of insects
- Good method to locate insect problems in mill
- Mills satisfied with heat treatments and have become repeat customers
- **Viable alternative** to methyl bromide
- Economies of scale - will make it more affordable

THERMAL REMEDIATION FROM TEMPAIR

Virtual Tour

THERMAL REMEDIATION FROM TEMPAIR

Virtual Tour

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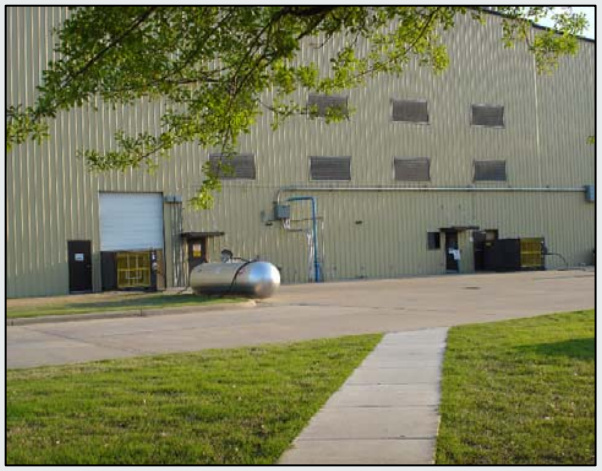
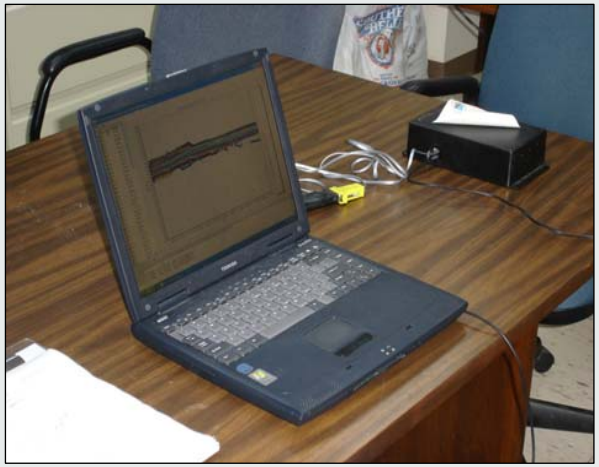
Virtual Tour



THERMAL REMEDIATION
FROM TEMPAIR

Virtual Tour



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THERMAL REMEDIATION FROM TEMPAIR

www.thermal-remediation.com

Questions?

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