HEAT TREATMENTS

An Effective & Viable Alternative To Chemical Fumigation For Stored Product Insects

Flour Mills, Warehouses & Storage Structures

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Structural Fumigation

FUMIGANTS

- Phosphine – Insect resistance, Corrosion
- Methyl Bromide – Ozone depletion
- Sulfuryl Fluoride – Residues? Dosage?

CONTACT INSECTICIDES

- Contact Insecticides – Fogging, Aerosols/ULV – Penetration?

First Use of Heat

256 Years Ago . . .

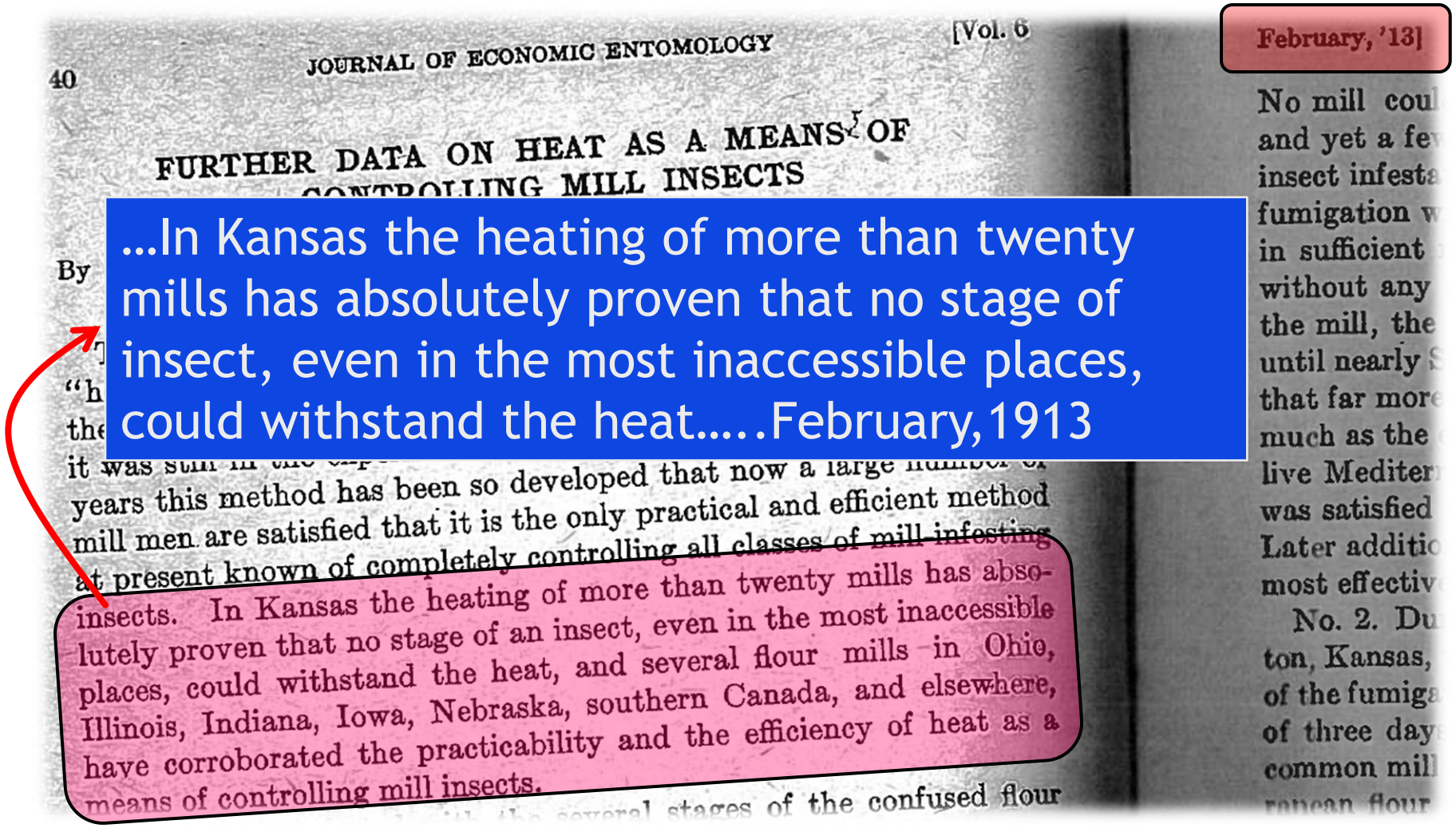
In 1762 – France: 69°C/ 156°F for 3 d, moth

Heat treatment of Mills

>100 Years Ago . . .

1913 - Kansas, Mid-West USA, Southern Canada

Heat in mills to control insects
100 Years ago…..Manhattan, Kansas



40 JOURNAL OF ECONOMIC ENTOMOLOGY [Vol. 6

FURTHER DATA ON HEAT AS A MEANS OF CONTROLLING MILL INSECTS

By

…In Kansas the heating of more than twenty mills has absolutely proven that no stage of insect, even in the most inaccessible places, could withstand the heat…..February,1913

years this method has been so developed that now a large number of mill men are satisfied that it is the only practical and efficient method at present known of completely controlling all classes of mill infesting insects. In Kansas the heating of more than twenty mills has absolutely proven that no stage of an insect, even in the most inaccessible places, could withstand the heat, and several flour mills in Ohio, Illinois, Indiana, Iowa, Nebraska, southern Canada, and elsewhere, have corroborated the practicability and the efficiency of heat as a means of controlling mill insects.

stages of the confused flour

February, '13]

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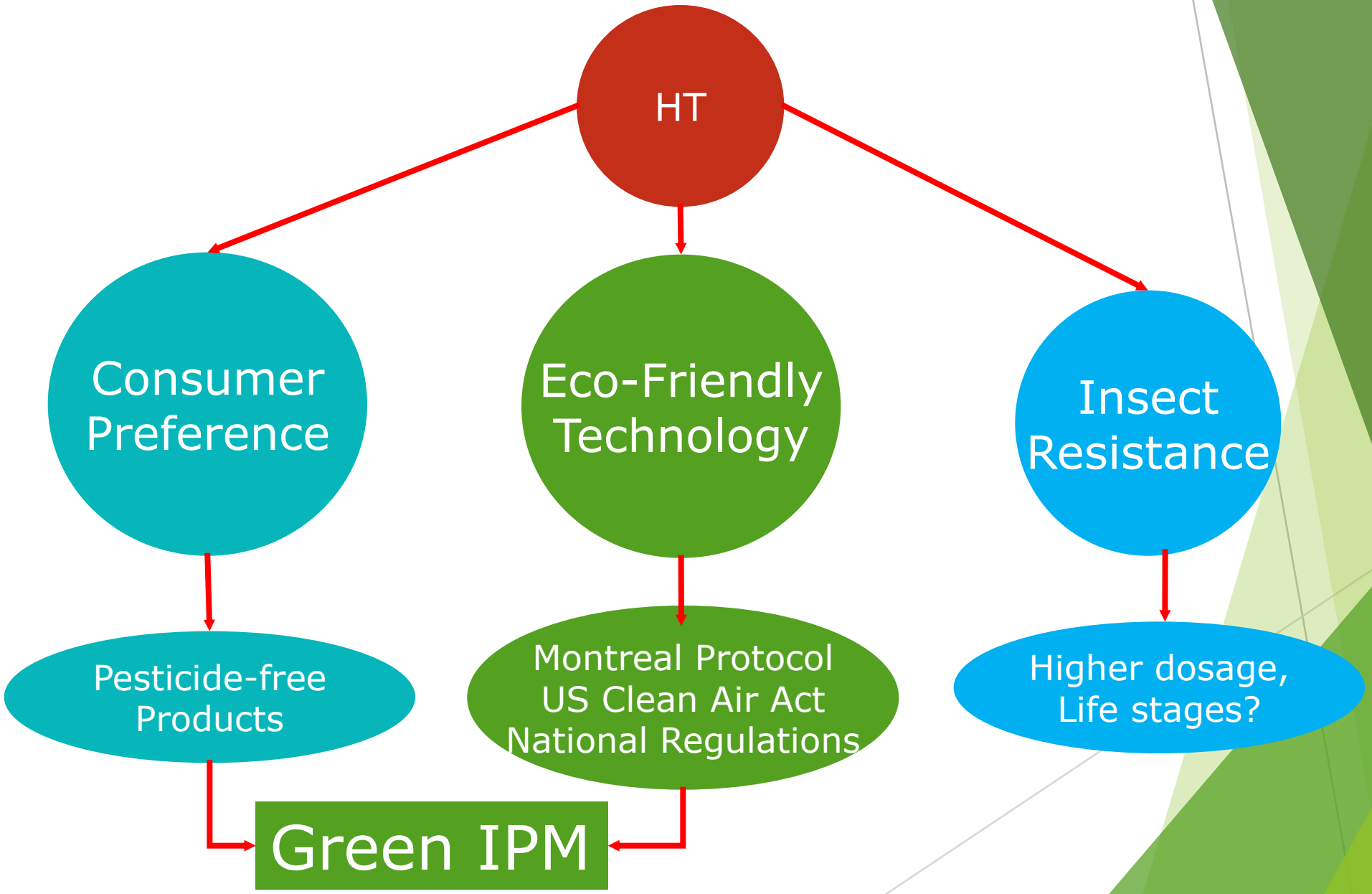
Drivers - Heat Treatment (HT)?



Heat - Advantages

afe • **ffective** • **co-friendly**

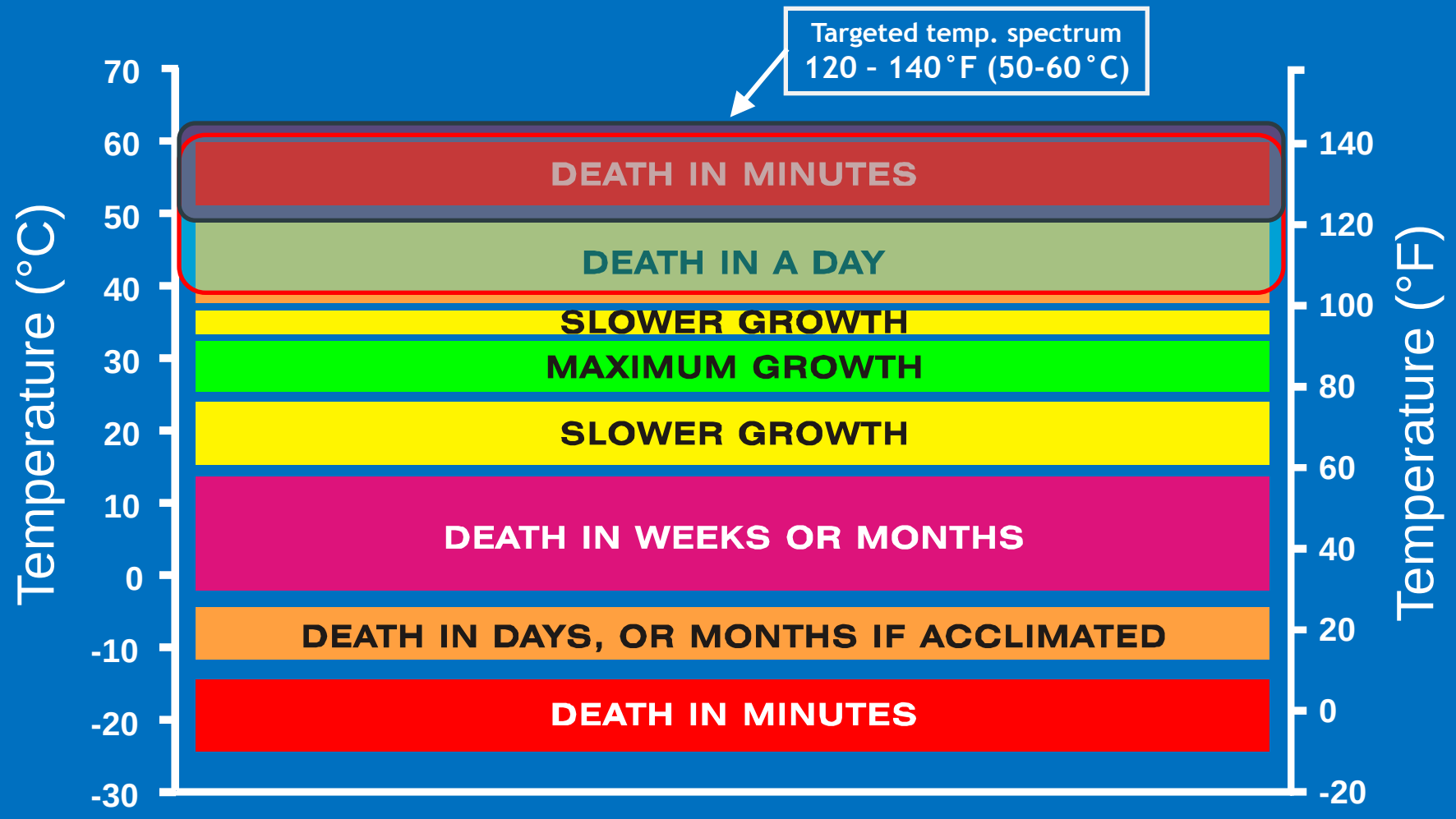
- Non Chemical
- People-Safe

- Kills all life stages

- No ozone depletion
- No Toxicity or
- Corrosion issues

• No evacuation of People • No Sealing • Spot Treatments

Temperature Effects on Insects



WINTERPEG!!

Source: P. Fields, AAFC, Canada

Efficacy to Control Pests

- MBr – Methyl bromide
- PH_3 - Phosphine
- SF (Profume)
- CO_2 – Carbon dioxide
- O_3 - Ozone

. . . . .

Efficacy – function of temperature

Heat & Insect Death

- High temperature –
  - Death by Dehydration (low RH)/desiccation
- Above 50 °C / 122 °F
  - Cell membranes “melt”
  - Enzyme destruction
  - Change in salt balance
  - Protein coagulation

Heat Treatment

Insects – lethal threshold temperatures

HT Process

Ambient temperature

gradual

High Temperature

[50 - 60°C /(120 -140°F)]

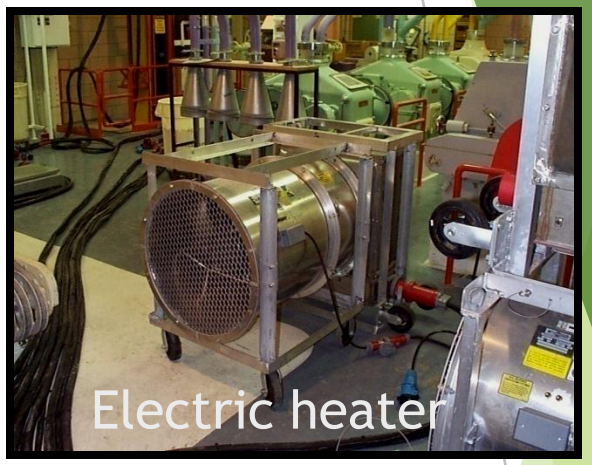
Low Humidity (≤ 25%)

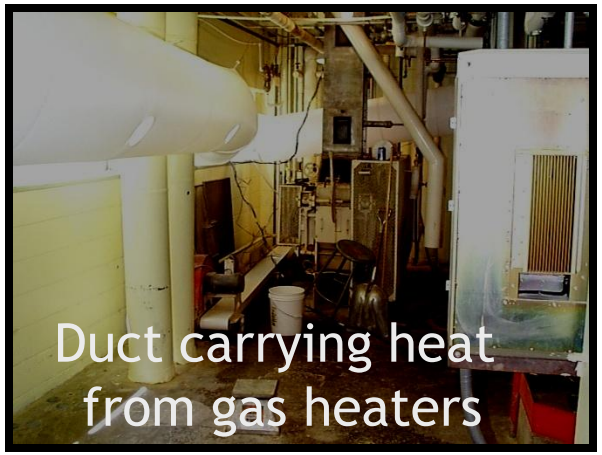
(Desiccation/Dehydration)

Heat treatment concept: Raising the ambient air temperature of the complete facility, or a part of it, to 122-140°F (50-60°C), and maintaining these temperatures for at least 24 hours or less depending on application


Gas heaters

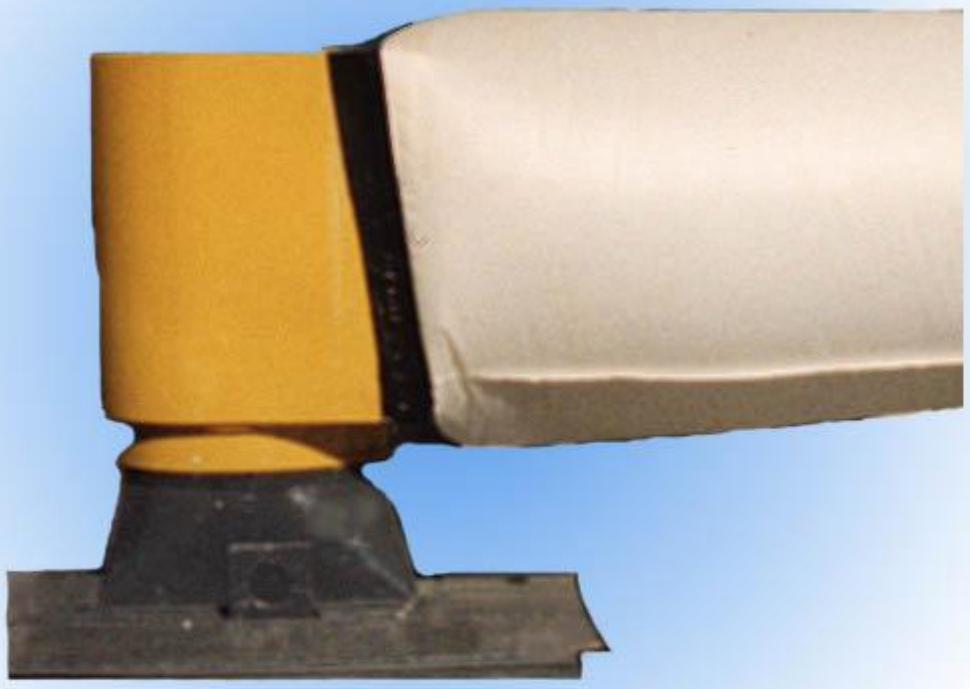

Steam heater


Electric heater

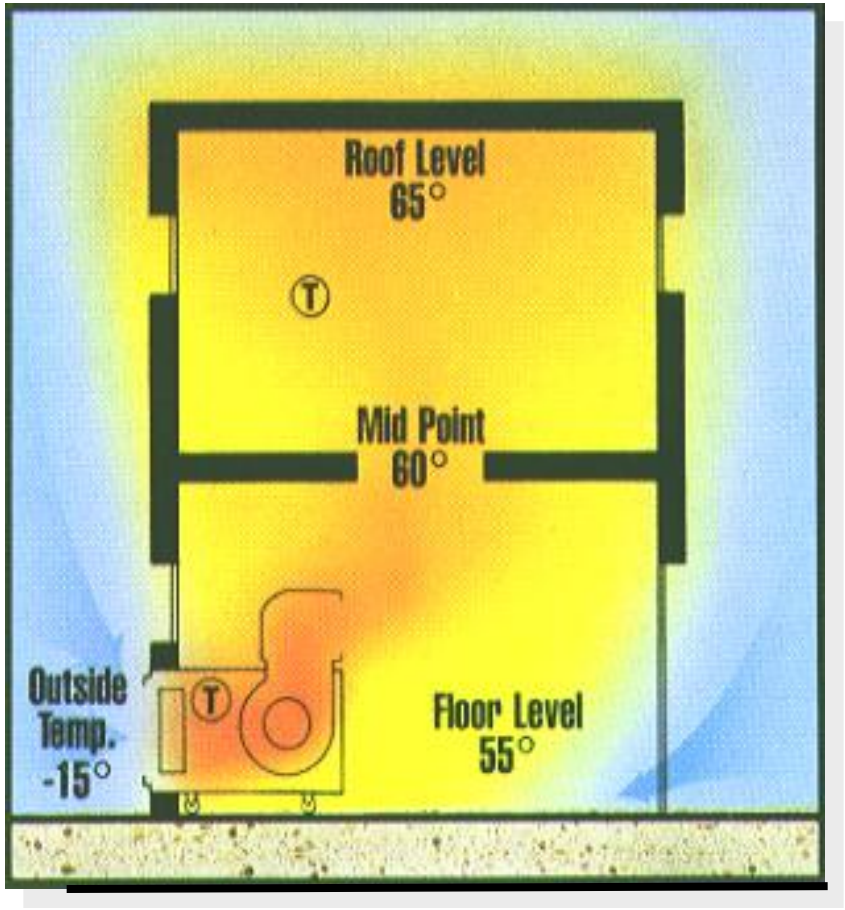

Duct carrying heat from gas heaters


Fan

Process



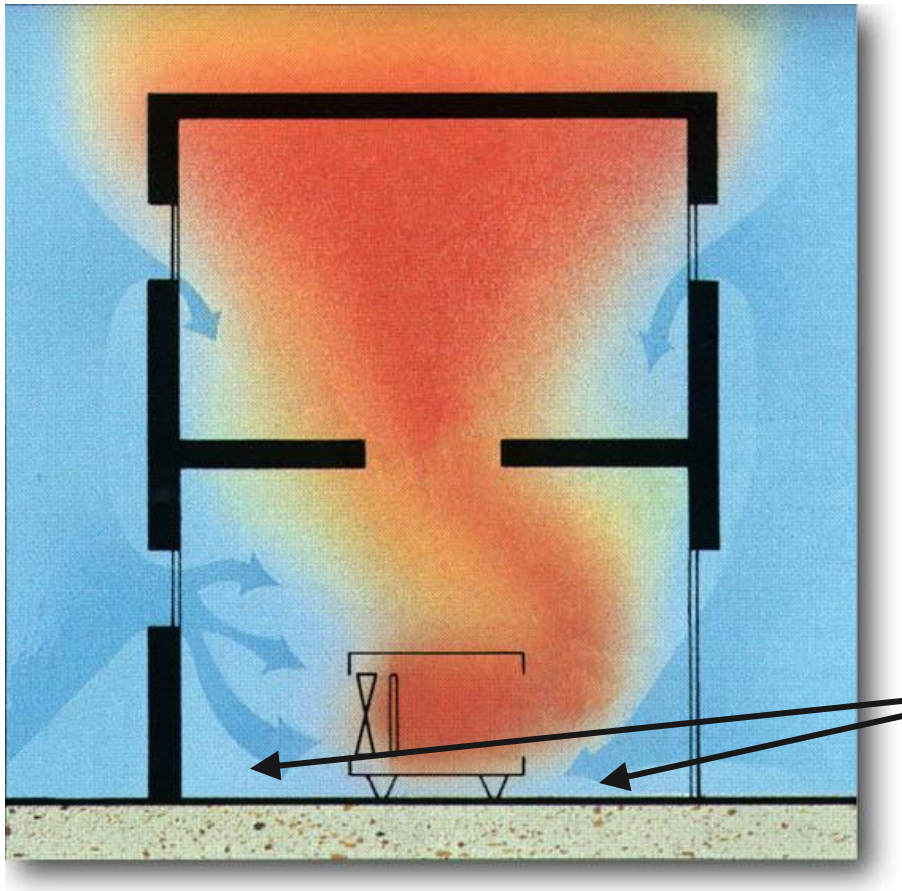
Positive Pressurization – Forced ambient air (Patented Process)



US & Canadian Patents

- Positive pressure
  - Good air distribution
  - Hot air is pushed into corners, cracks and crevices
- Calculated and controlled infiltration – air changes
- Lower relative humidity

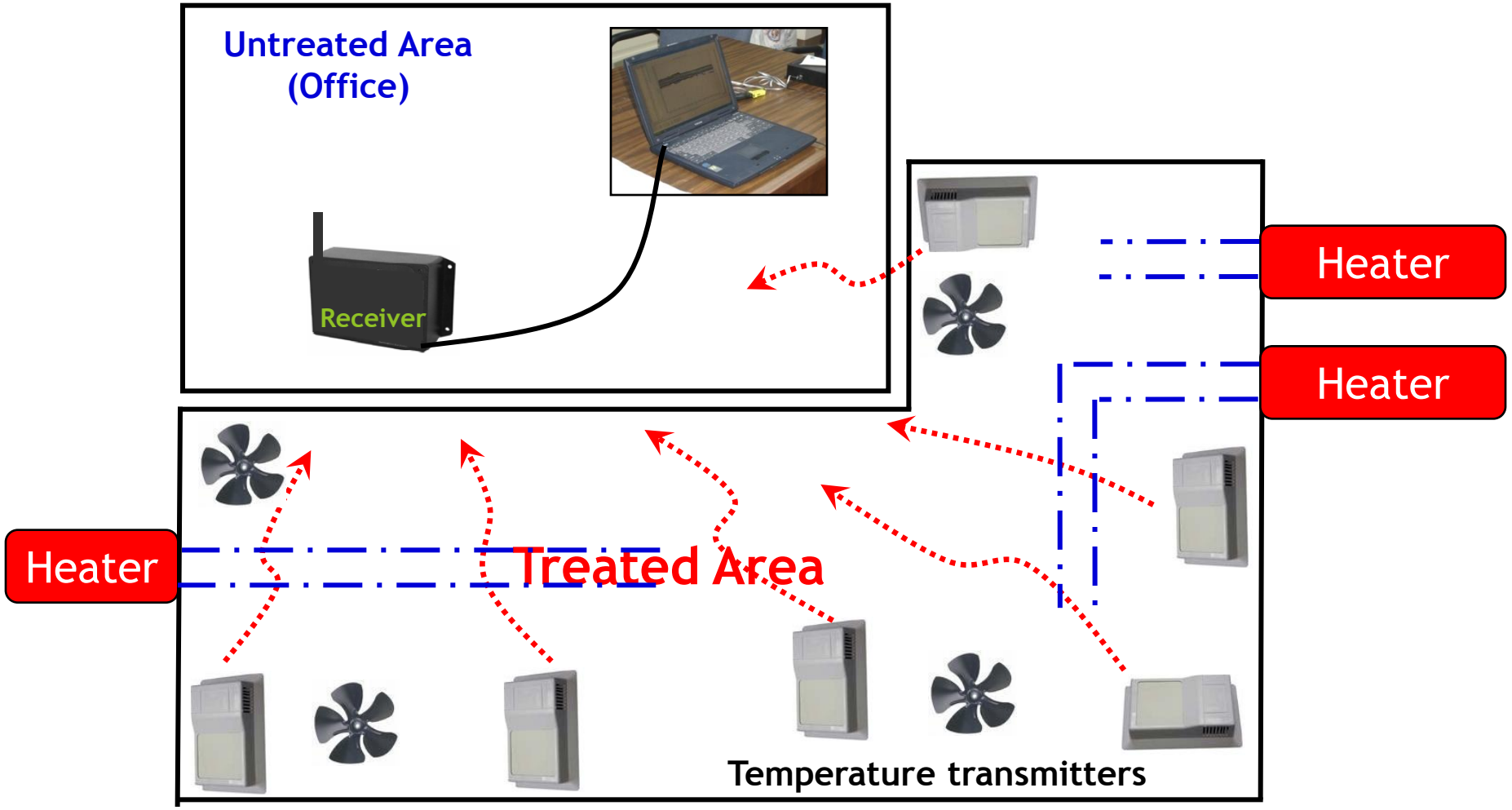
Re-circulating Inside Air



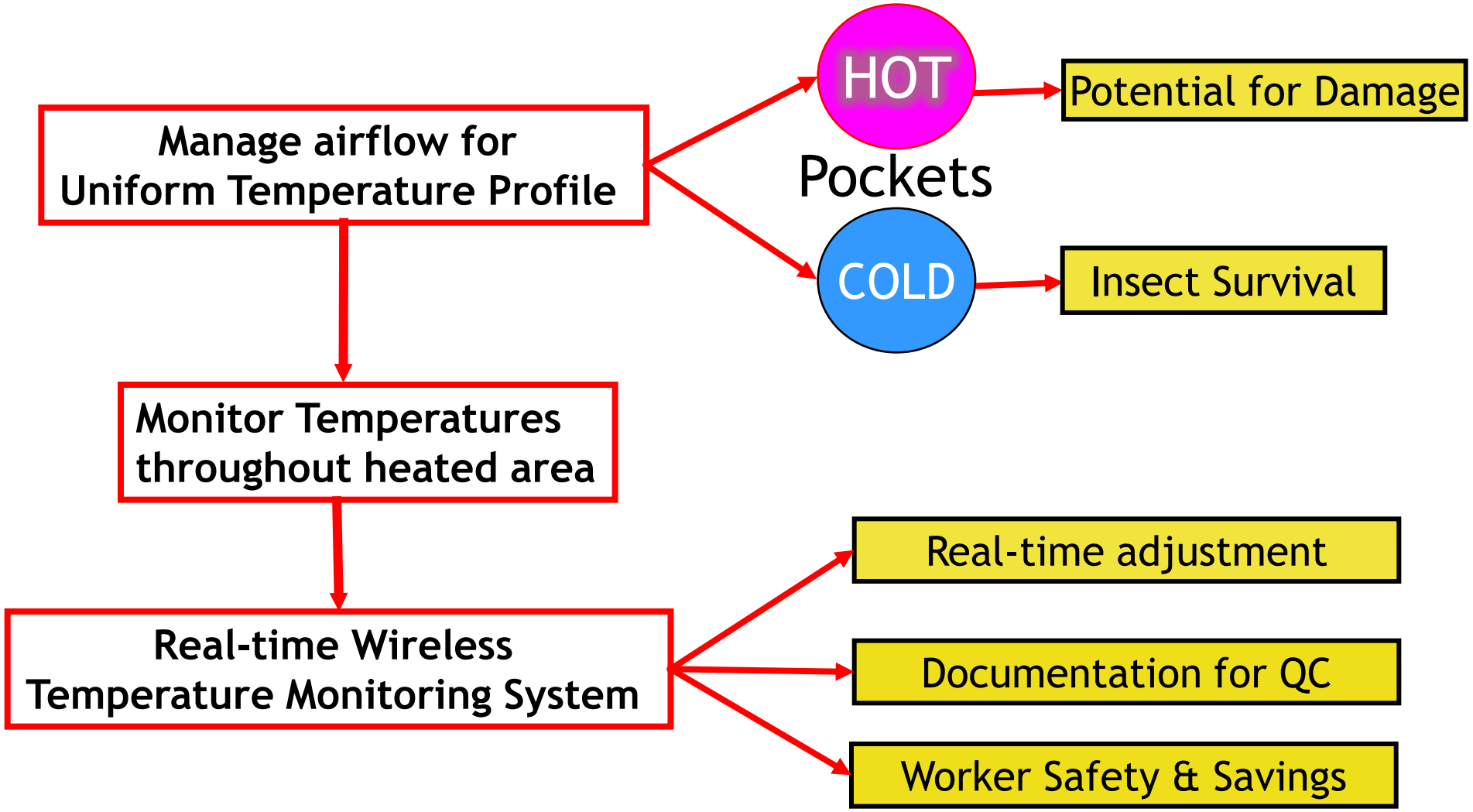
- Negative pressure
- Poor air circulation
- Uncontrolled infiltration
  - No air changes

Low temperature zones (cold spots)

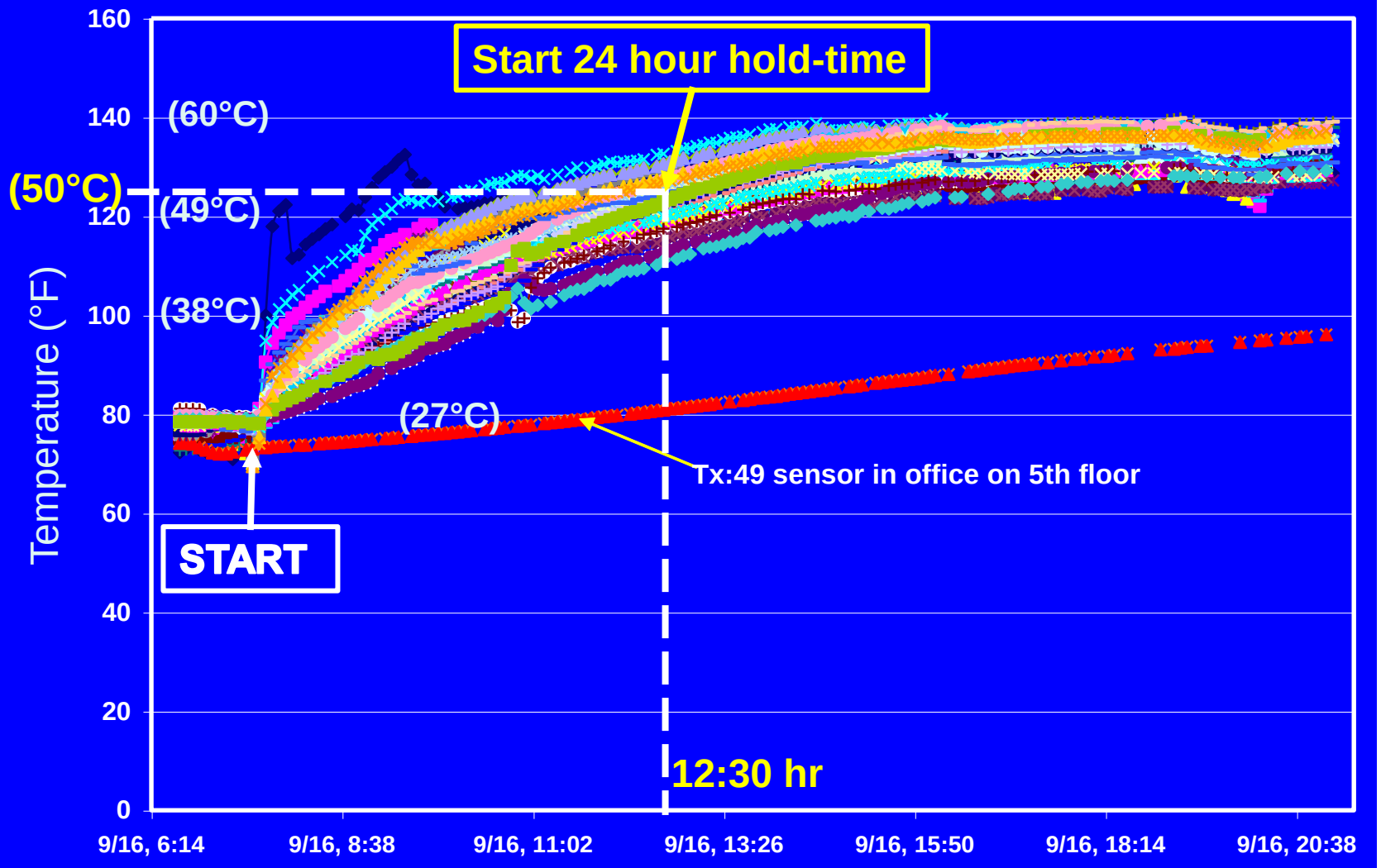
Real-time Wireless Temperature Monitoring



Effective Heat Treatment



Start of the Heat Treatment



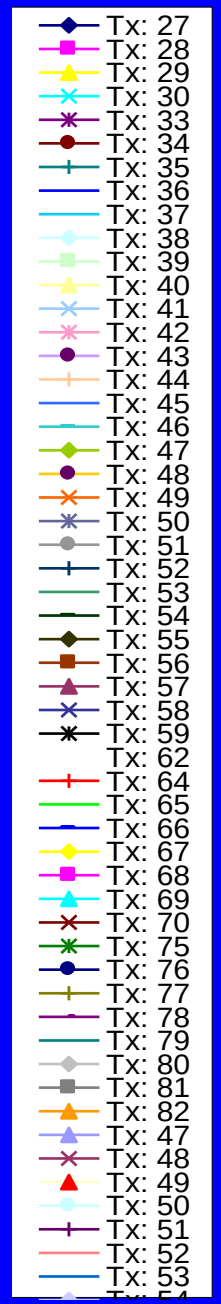


Fig. 1: Real-time Temperature Profile

End of the Heat Treatment

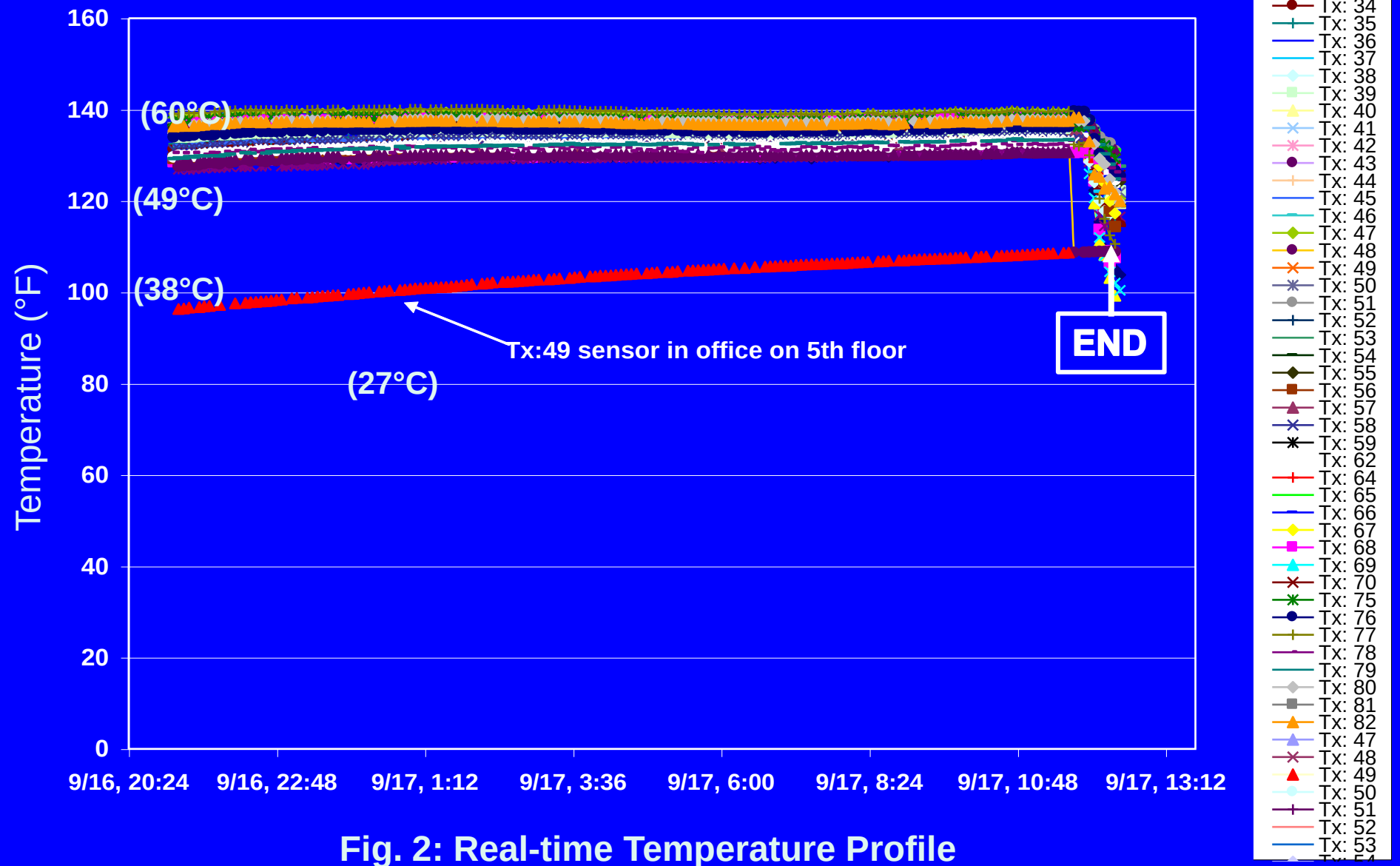


Fig. 2: Real-time Temperature Profile

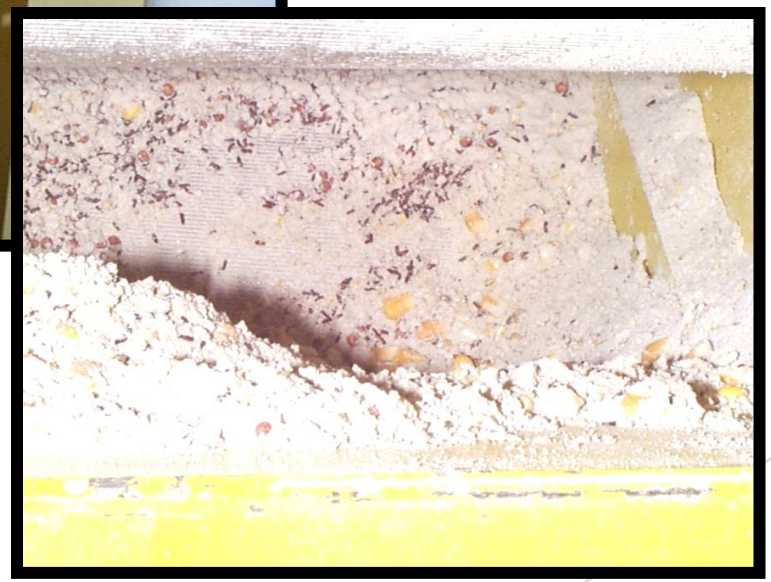
Heat Treatment Checklist

- **Before** : cleaning, drive belts, product removal, sprinkler heads, sensitive eqpmt etc.
- **During**: Intrusive, temperature points/frequency, fans and/or duct movement for airflow and heat distribution
- **After**: cool down, insect bioassays, inspection etc.

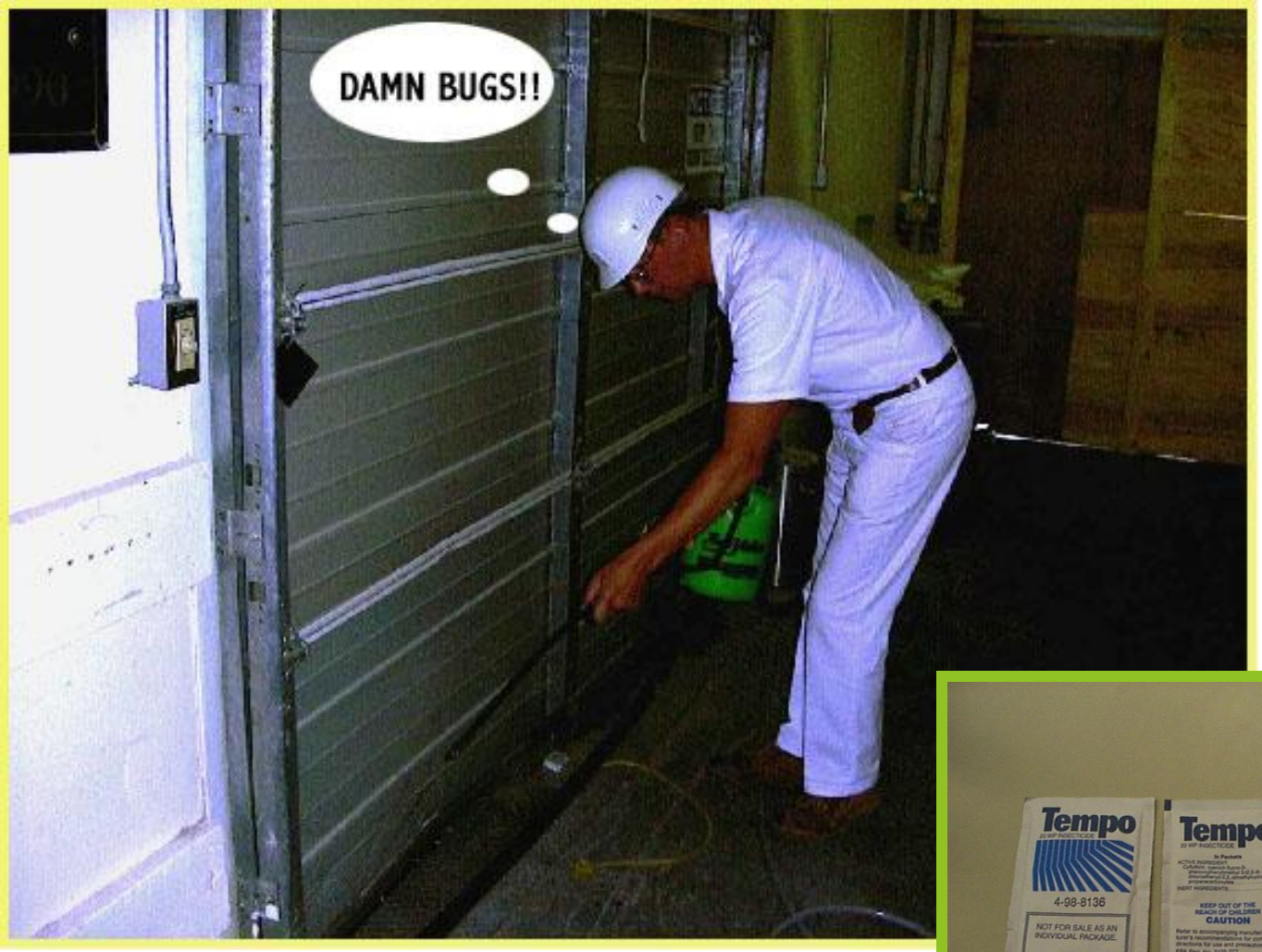
Heat Damage

Make a list of heat susceptible equipment

Sanitation is the key

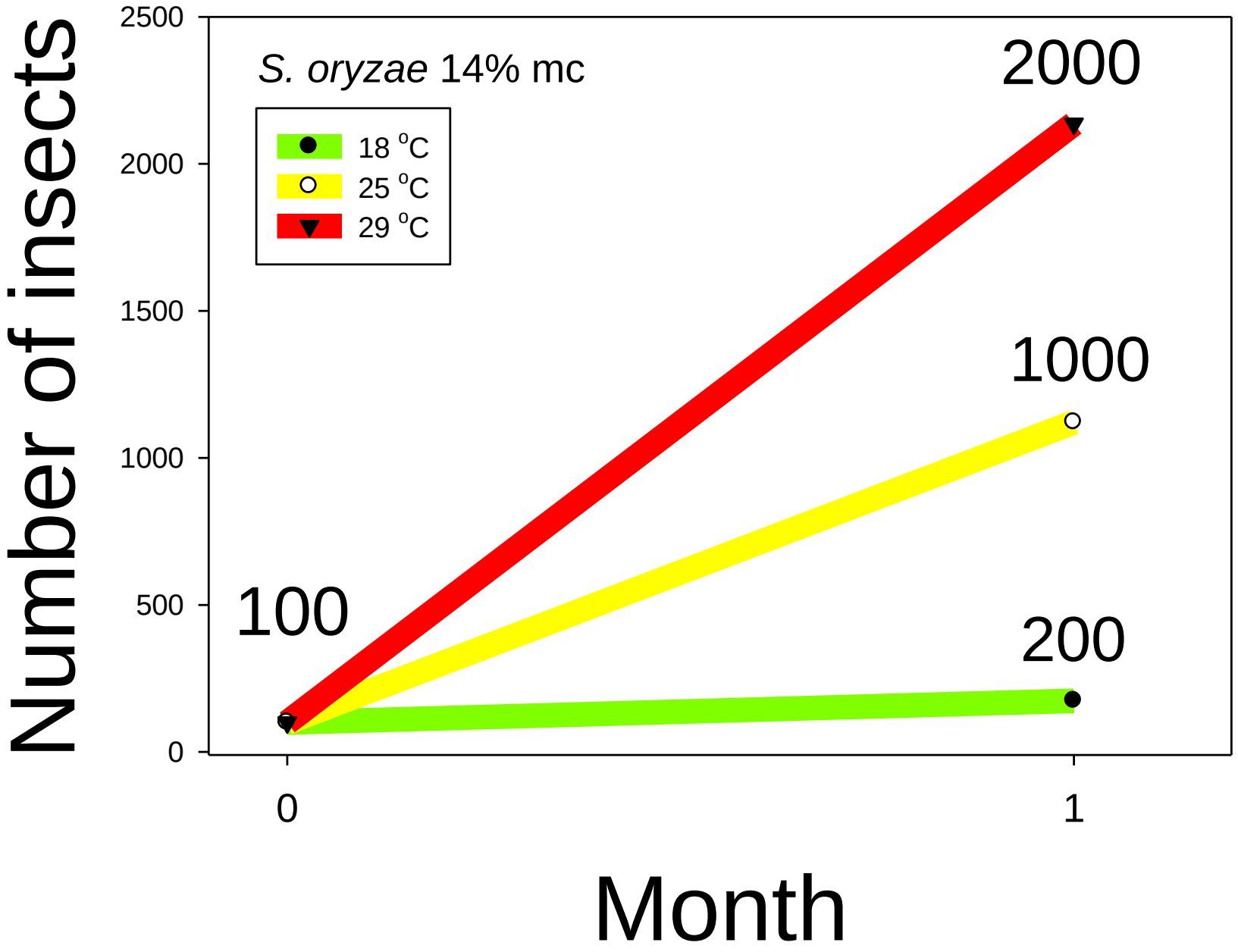


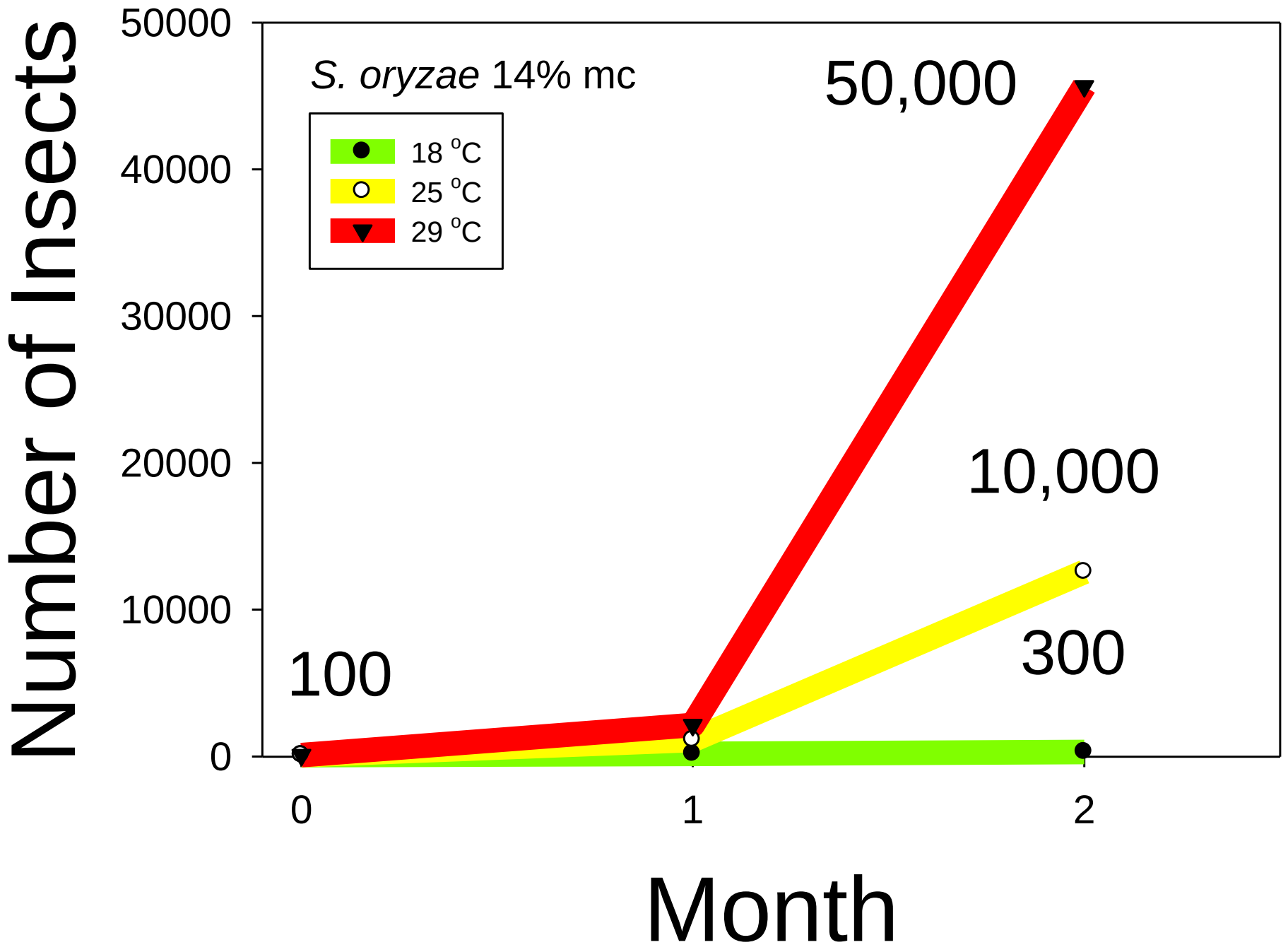
Important as heat does not penetrate products well.



Apply a residual pesticide such as cyfluthrin (Tempo) or diatomaceous earth

Exponential Growth of Insect Populations


S. oryzae 14% mc
18 °C
25 °C
29 °C
2500
2000
1500
1000
500
0
0
1
100
2000
1000
200
Number of insects
Month


S. oryzae 14% mc
18 °C
25 °C
29 °C
50,000
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Number of Insects
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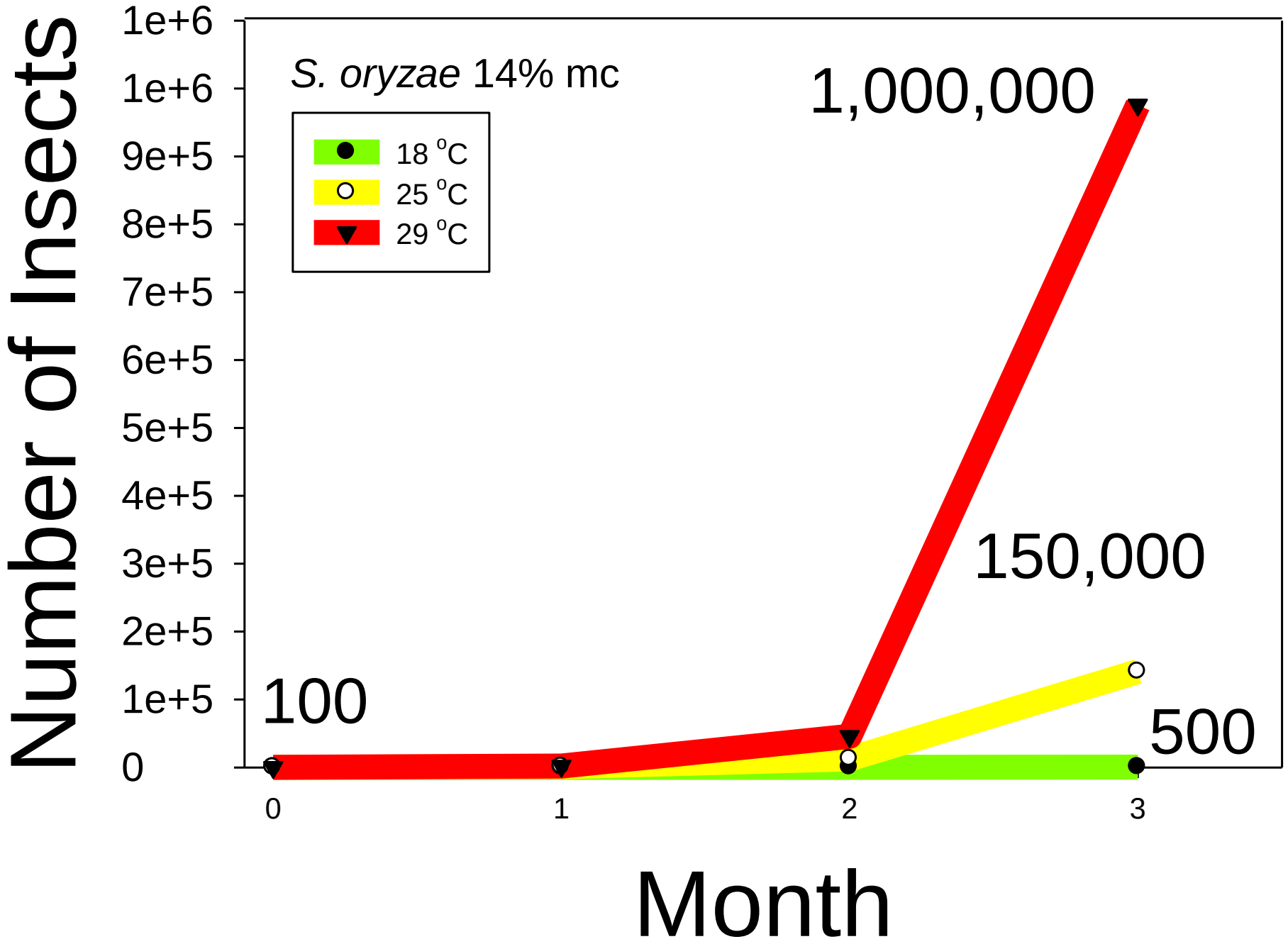
S. oryzae 14% mc
18 °C
25 °C
29 °C
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Number of Insects
1e+6
1e+6
9e+5
8e+5
7e+5
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5e+5
4e+5
3e+5
2e+5
1e+5
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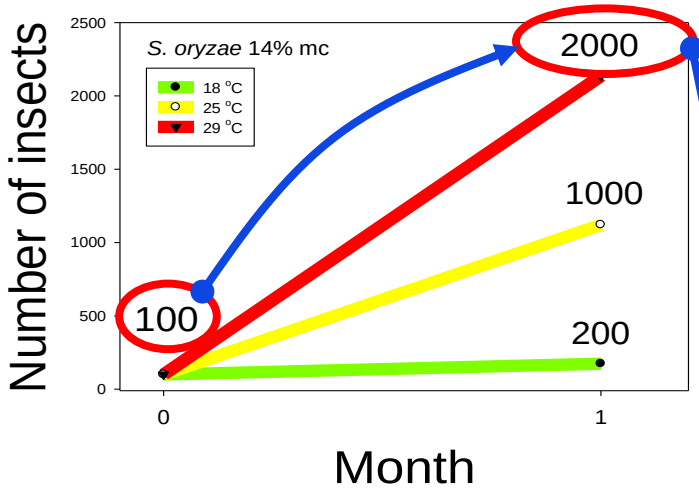
1
2
3
Month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18 °C
25 °C
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Number of insects
Month
2500
2000
1500
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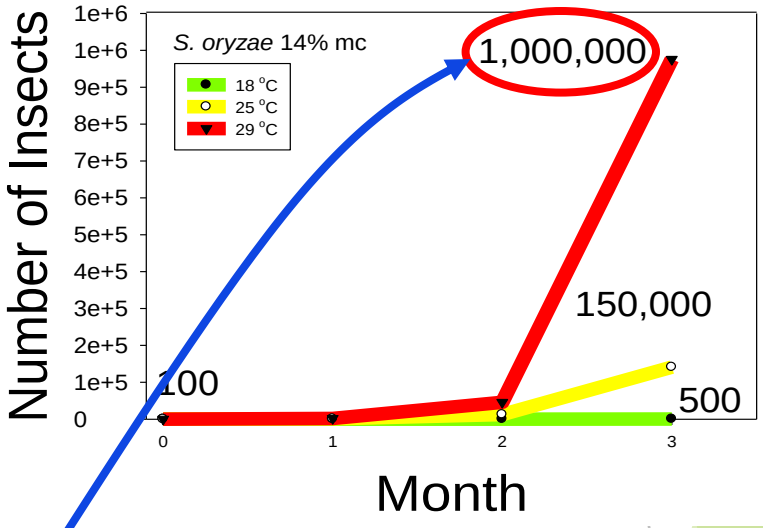
S. oryzae 14% mc
18 °C
25 °C
29 °C
Number of Insects
Month
1e+6
1e+6
9e+5
8e+5
7e+5
6e+5
5e+5
4e+5
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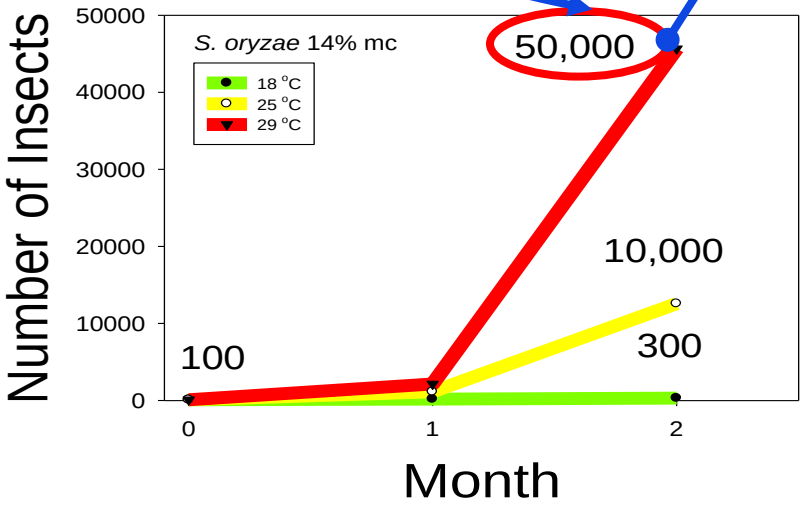

S. oryzae 14% mc
18 °C
25 °C
29 °C
Number of Insects
Month
50000
40000
30000
20000
10000
0
0
1
2
50,000
10,000
100
300

For successful Heat Treatment

- Engineering Design for structure – building parameters to determine heat energy (BTUs) – Site Visit
- Airflow Management – Cold & Hot Spots
- Physical Exclusion & Sanitation
- Pre & Post Heat treatment Insect counts for population rebounds
- Learning Curve

Heat versus Fumigants

Insect stage	Sanitation level	Treatment	% Mean (SE) mortality[a]	*F*	*P*
Adults	2 cm	MB	100a	69.90	<0.0001
		SF	100a		
		Heat	90.1 (1.2)b		
	dusting	SF	100	1.00	0.4219
		MB	100		
		Heat	98.7 (1.3)		
Pupae	2 cm	MB	100	2.56	0.1568
		SF	100		
		Heat	95.4 (2.9)		
	dusting	MB	100	0.60	0.5787
		SF	98.7 (1.3)		
		Heat	97.3 (2.7)		
Large larvae	2 cm	MB	99.8 (0.1)a	8.62	0.0172
		SF	100 (0.0)a		
		Heat	96.1 (1.3)b		
	dusting	MB	99.9 (0.1)	1.73	0.2552
		SF	100		
		Heat	98.2 (1.3)		
Small larvae	2 cm	MB	100a	5.39	0.0457
		SF	100a		
		Heat	93.5 (2.8)b		
	dusting	MB	100	3.69	0.0901
		SF	100		
		Heat	99.4 (0.3)		
Eggs	2 cm	MB	99.9 (0.1)	1.02	0.4145
		SF	92.3 (7.3)		
		Heat	99.3 (0.3)		
	dusting	MB	99.9 (0.1)	1.25	0.3523
		SF	88.7 (10.0)		
		Heat	99.8 (0.1)		

K-State Study (2009-2010)

n = 3/trt

Trt time=24 h for all

THERMAL REMEDIATION
Industrial Applications

- Food Processing
- Rice Mills
- Flour Mills
- Pet Food
- Corn Mills
- Cereal Processing
- Bakeries
- Warehouses
- Baby Food Plants
- Wood Packaging
- Tobacco Companies

Organic processing plants/storages

Entire structure or spot treatment

Heat Treatment of Bins & Silos

Proactive - Preventative

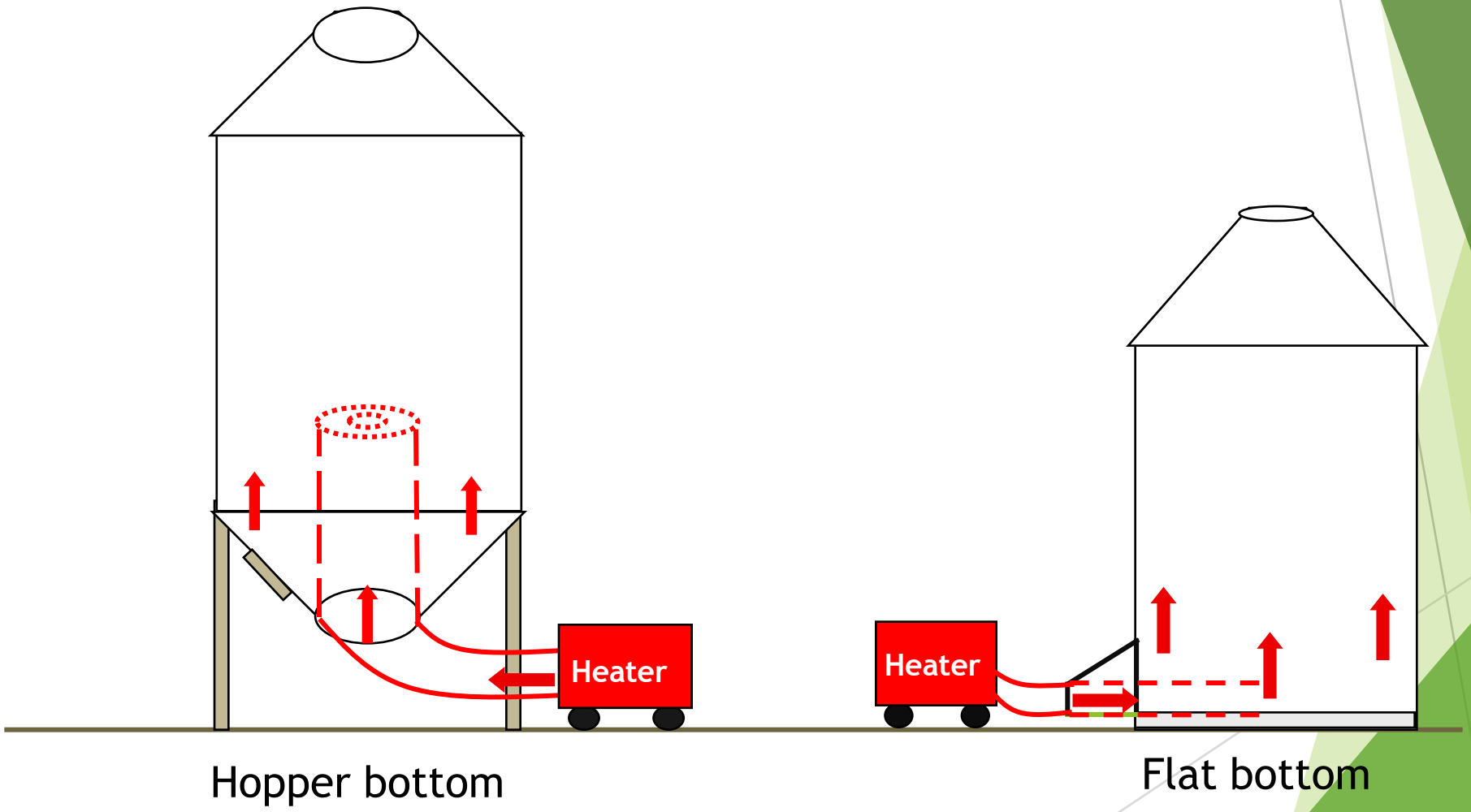
&

Reactive - Response

Bins & Silos

- Pre-loading or Pre-harvest HT
  - On-farm bins
  - Elevators storages
  - Processing facilities
  - Organic processing plants
- Bin/Silo types
  - Concrete
  - Metal
    - GI bins
    - Tanks

HT of bins and silos



Advantages of HT of Bins/Silos

- Shorter treatment times (4 to 12 hours)
- Bins/Silos in facilities
  - Treated in rotation without shut-down
- No retrofitting – existing transition, bin-entry
- On farm or warehouses – no extensive sealing or evacuation

Conclusions

- Heat kills all life stages of insects
- Good method to locate insect problems in industrial plants
- Repeat customers = efficacy of heat
- Viable alternative to methyl bromide
- Economies of scale - will make it more affordable

On Site Images

Heater Placement on multiple floors

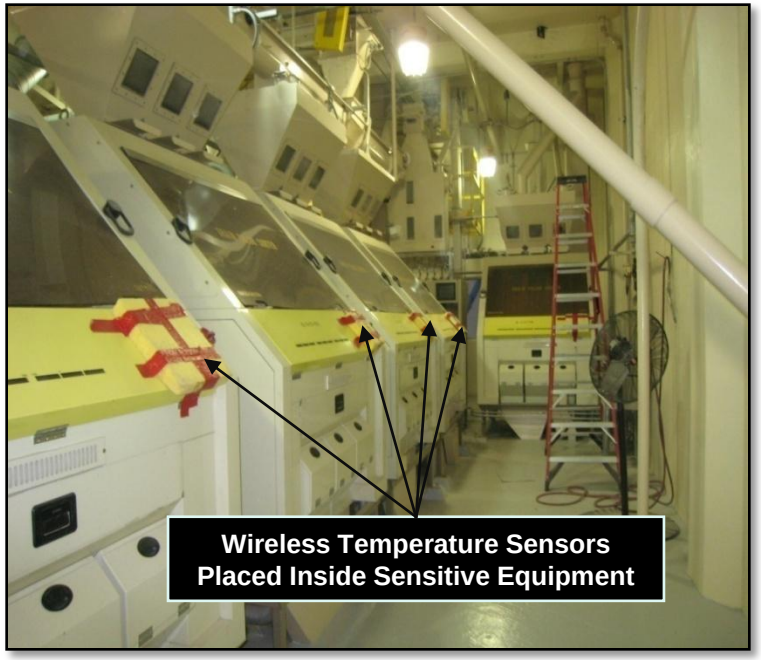
Heater Placement under rolling shutter

Heater Placement & Layout

Heater Partially inside Packaging Plant

Duct & Fan Layout - Packaging

Basement, Sensitive Equipment



Detecting hidden infestations

Overhead electrical junction box

10,000s of adults, larvae, pupae!!

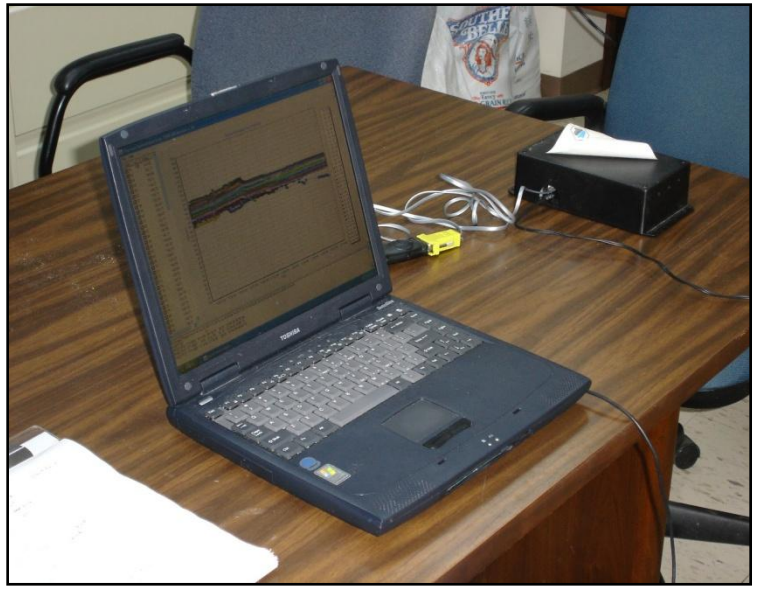
Partial/Spot heat treatment of Mill extension in a warehouse Philippines – March 2018

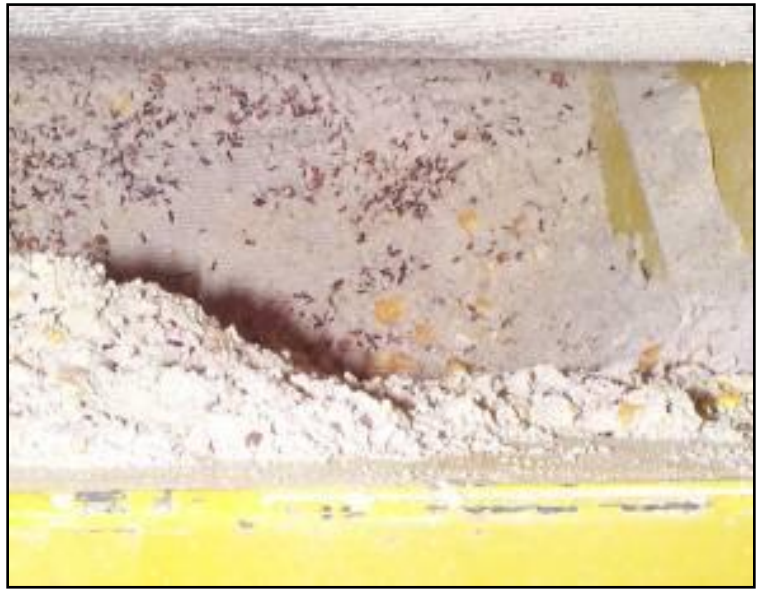
A temporary Plastic Sheet OR Fumigation cover – No Sealing

Partial/Spot heat treatment of Packaging Area in a warehouse (Canada)

Sprinkler heads and opening the machines

Temperature Profile, Beetles, & Rats!!!!





Concrete Bins, Basement and Head house

Christmas Heat treatment
December – Snowing!

Outside temperature: 26-30°F/ -1 to -3°C

Flour Mill, Celaya, Mexico

High temperature duct through the ‘well’ of Stairwell to six floors of the mill

Flour Mill, Philippines

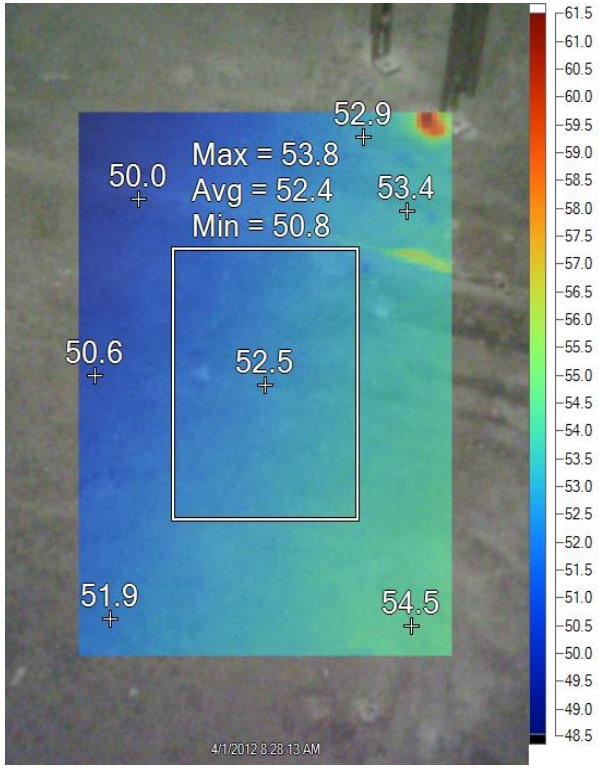
Dead beetles, cockroaches

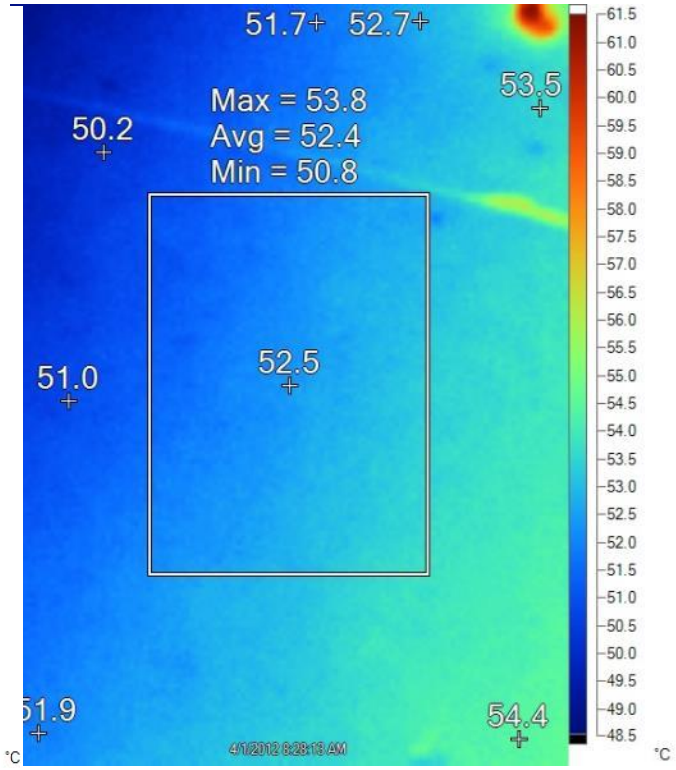
Pasta Mill, Monterrey, Mexico

Flour Mill, Philippines

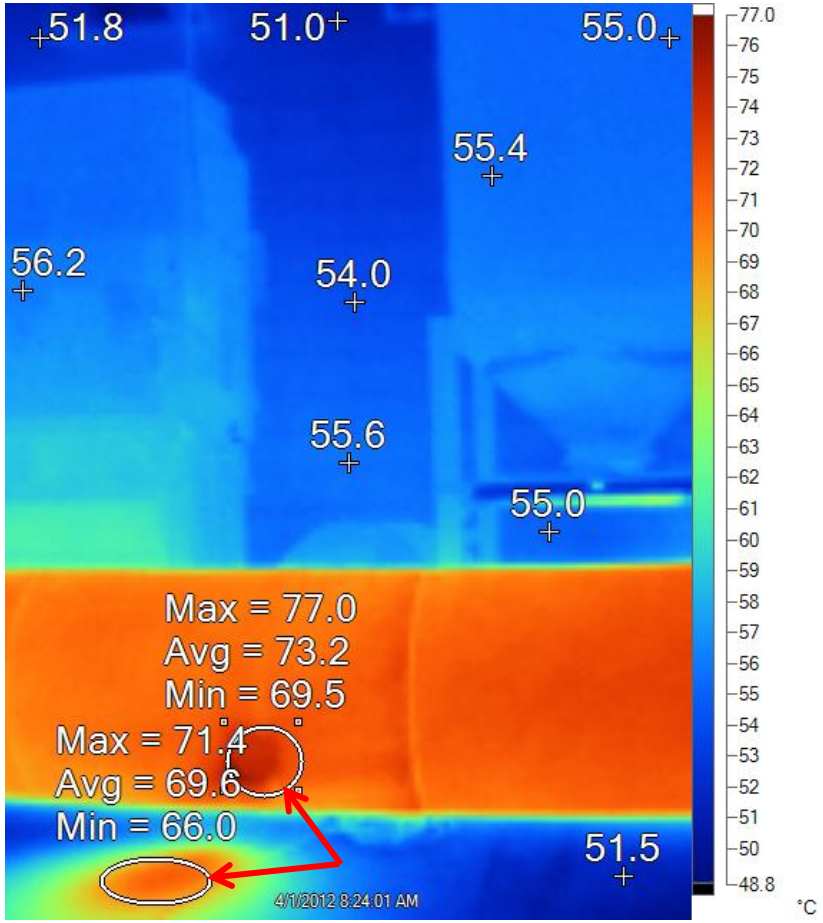
Heat Treatment – Durum Mill, Canada (Sept 22-23, 2018)

Concrete floor





Concrete floor & wall



Heat Treatment: Patented Scientific Process

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

www.thermalremediation.com

rhulasare@temp-air.com
Ph: 1-800-836-7432 - Raj