Heat treatment of Mills
&
Storage structures

IAOM Western District Meeting

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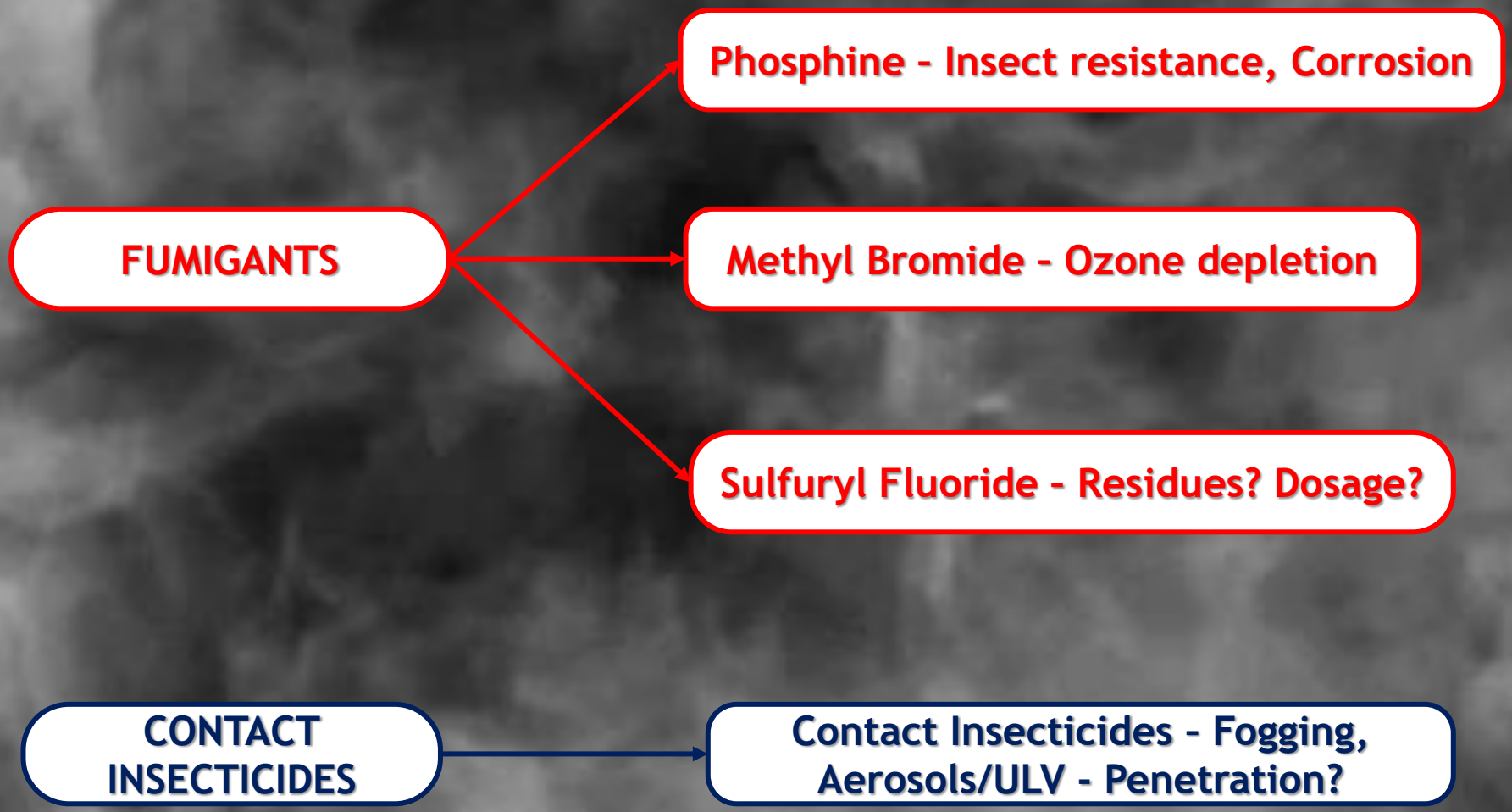
Structural Fumigation

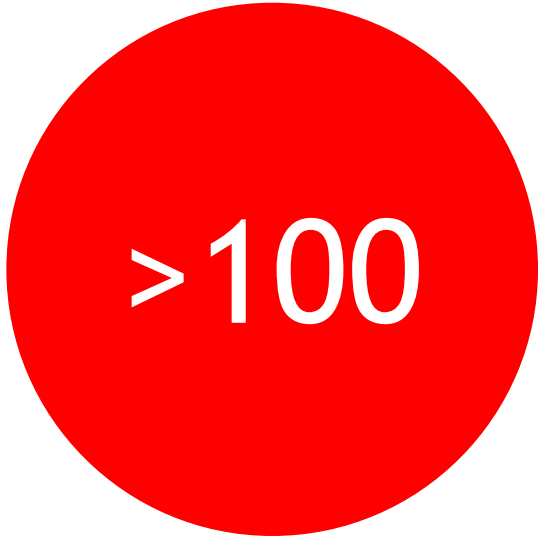


Back to Basics

First Use of Heat

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

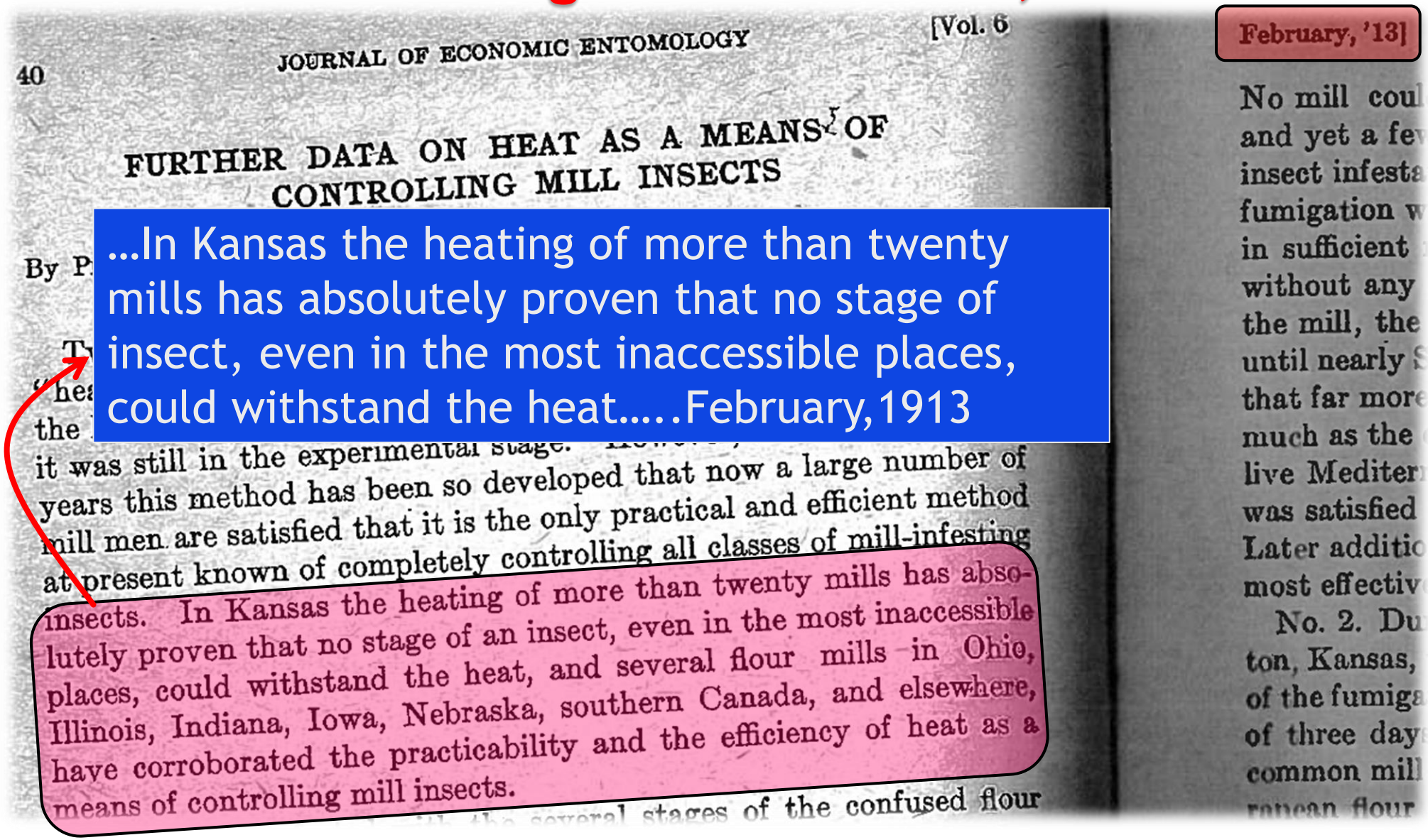
Heat treatment of Mills



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 P

…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

it was still in the experimental stage.

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.

several stages of the confused flour

February, '13]

No mill coul
and yet a fe
insect infesta
fumigation w
in sufficient
without any
the mill, the
until nearly
that far more
much as the
live Mediter
was satisfied
Later additio
most effectiv
No. 2. Du
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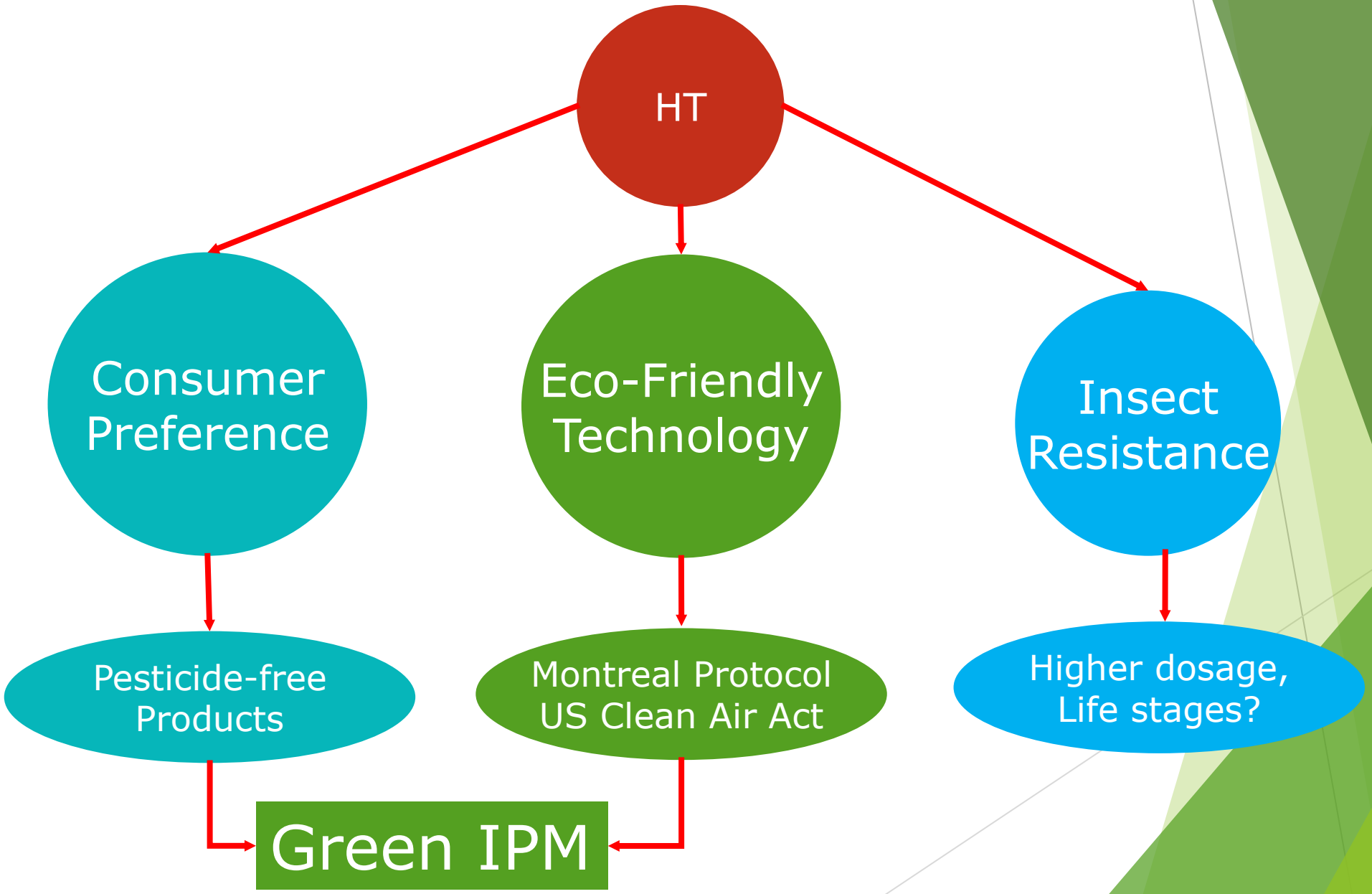
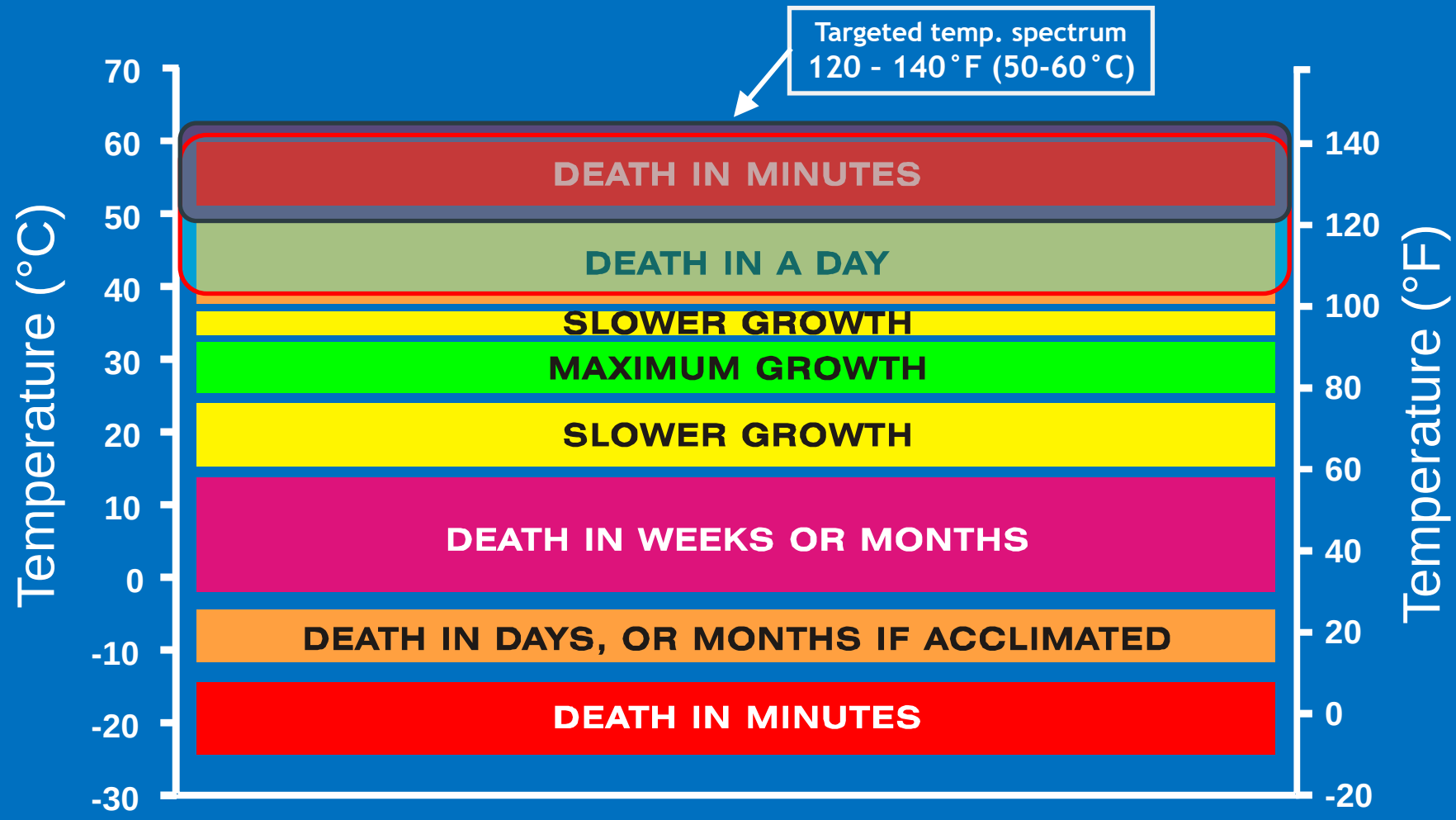
of three day
common mill
roman flour

Drivers - Heat Treatment (HT)?



Temperature Effects on Insects



WINTERPEG!!

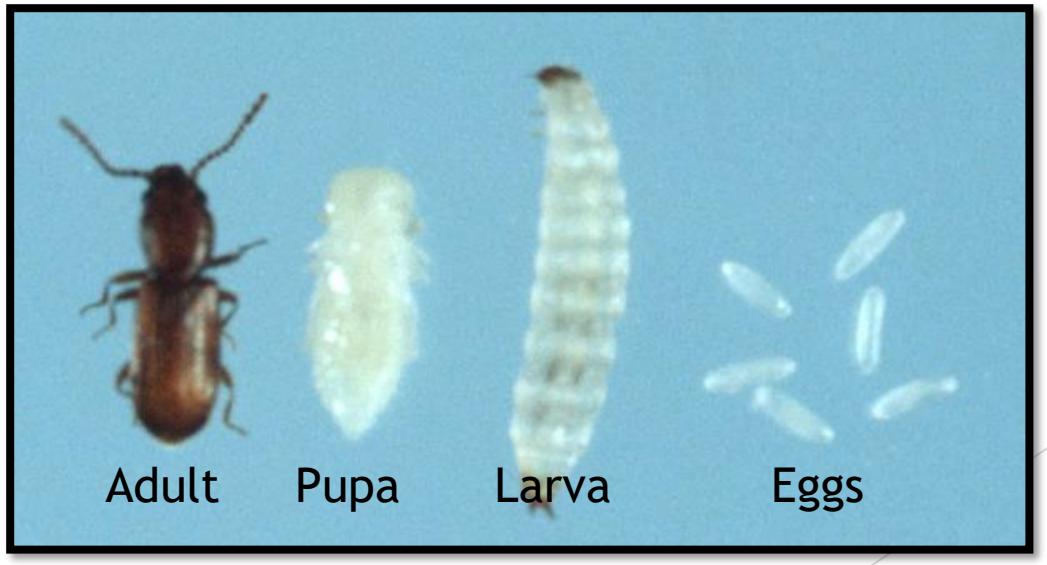
Source: P. Fields, AAFC, Canada

Heat treatment Concept

120°F
Minimum

140°F
Maximum

Kills ALL Stages of Insect Life Cycle



Heat - Advantages

- **afe**
- **ffective**
- **co-friendly**

- Non-Chemical
- People-Safe

- Kills all life stages

- No ozone depletion
- No Toxicity or
- Corrosion issues

Can go inside for inspections DURING the heat treatment

• No evacuation of People • No Sealing • Spot Treatments

Efficacy to Control Pests

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

. . . . .

Efficacy – function of temperature – Winter fumigation?

Heat treatments – Throughout the year!

Christmas Heat treatment - December Snowing!

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

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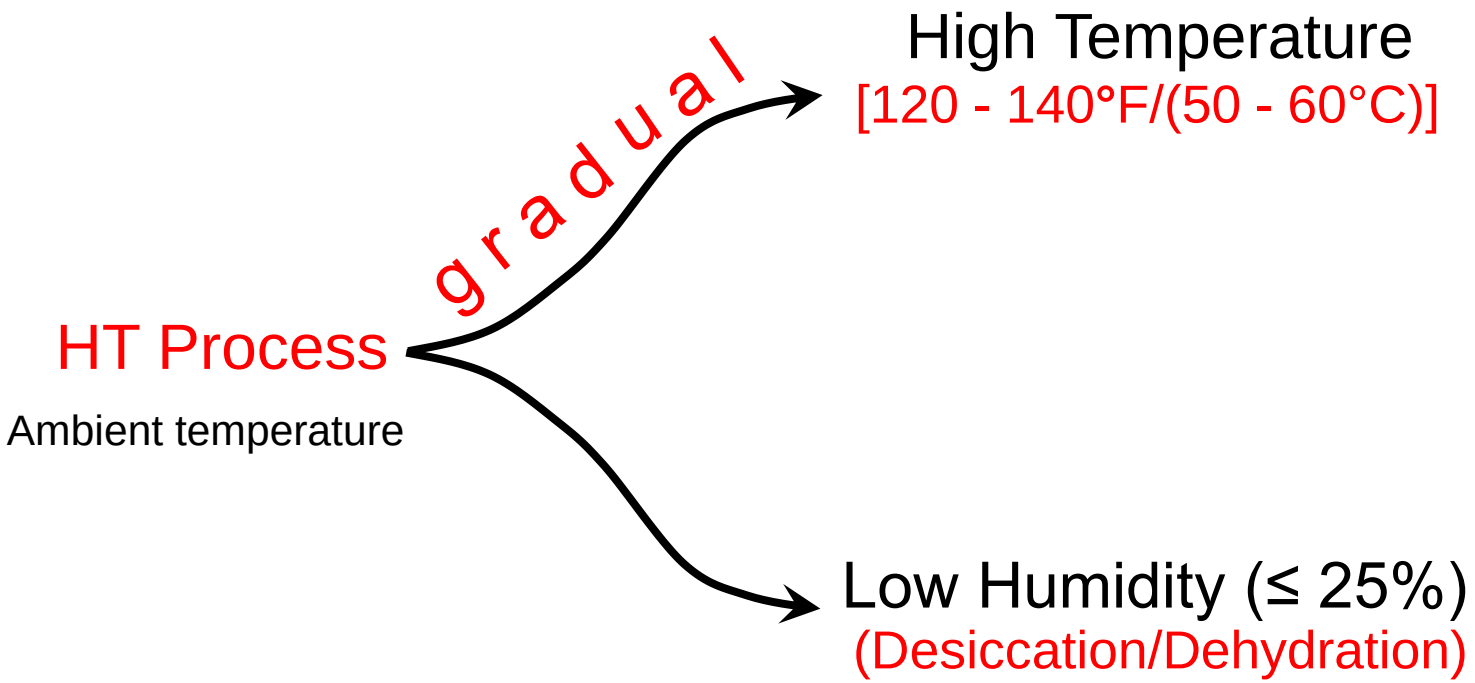
Heat Treatment



Insect Death by Dehydration (low RH)/desiccation

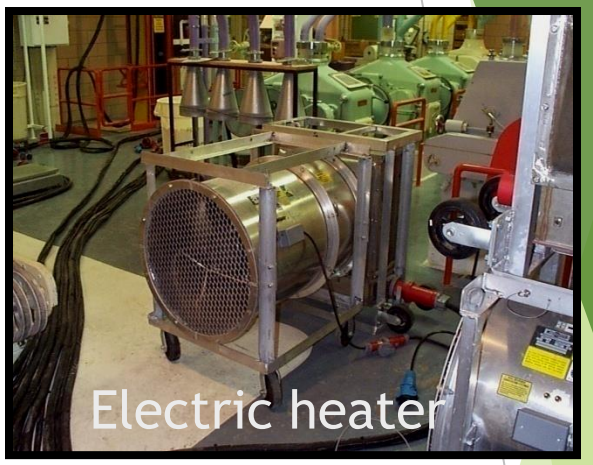
Heat & Insect Death

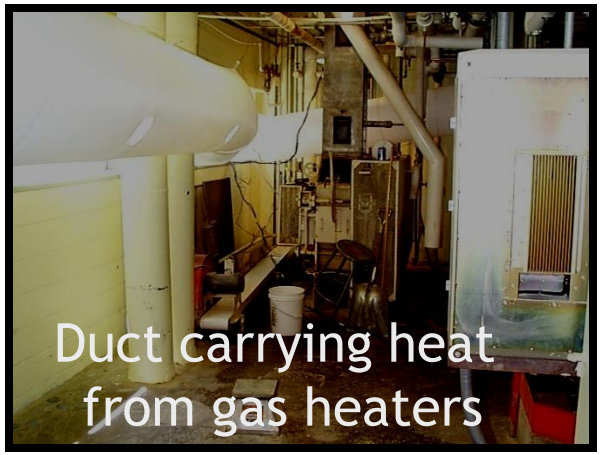
- High temperature –
  - Death by Dehydration (low RH)/desiccation
- Above 50 °C / 120 °F
  - Cell membranes “melt”
  - Enzyme destruction
  - Change in salt balance
  - Protein coagulation

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


Gas heaters

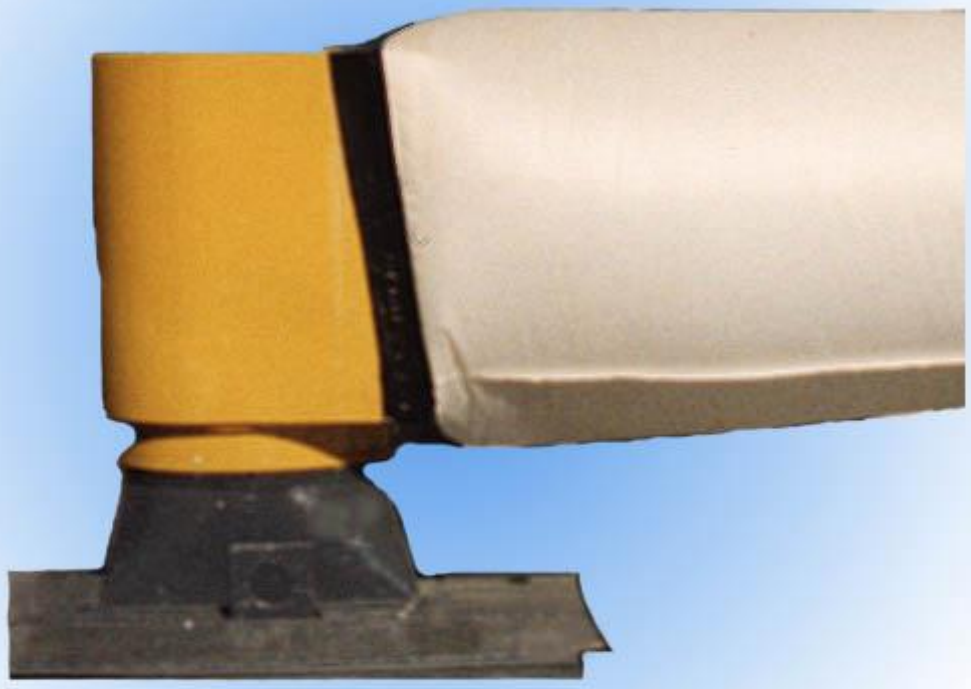

Steam heater


Electric heater

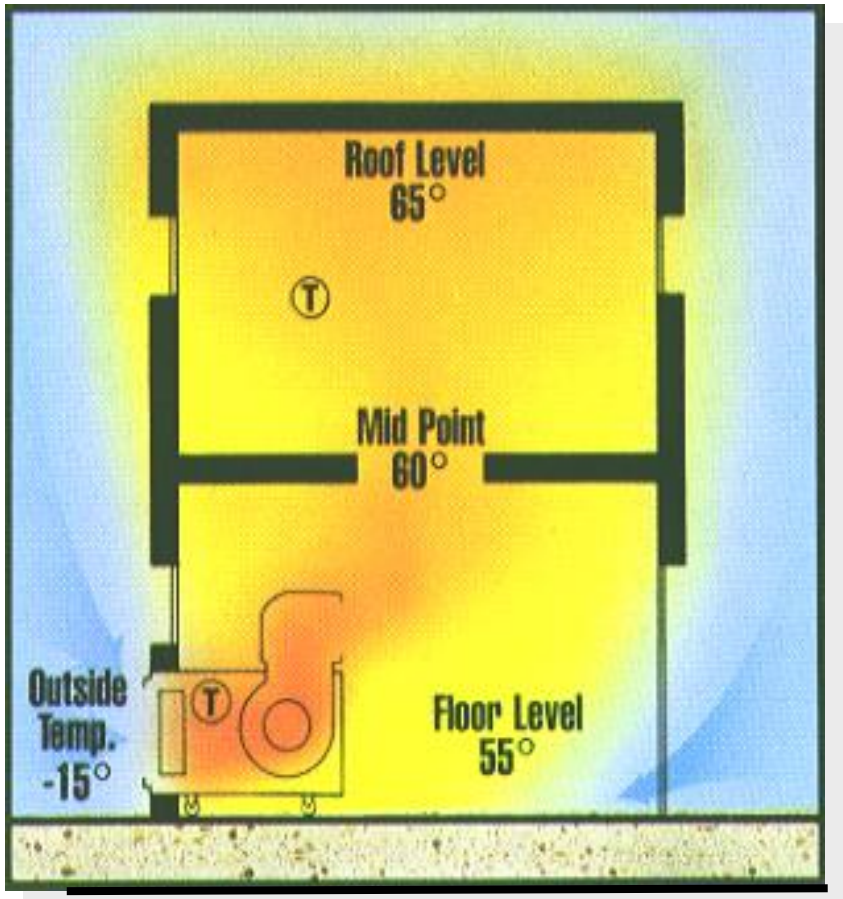

Duct carrying heat from gas heaters


Fan

Process



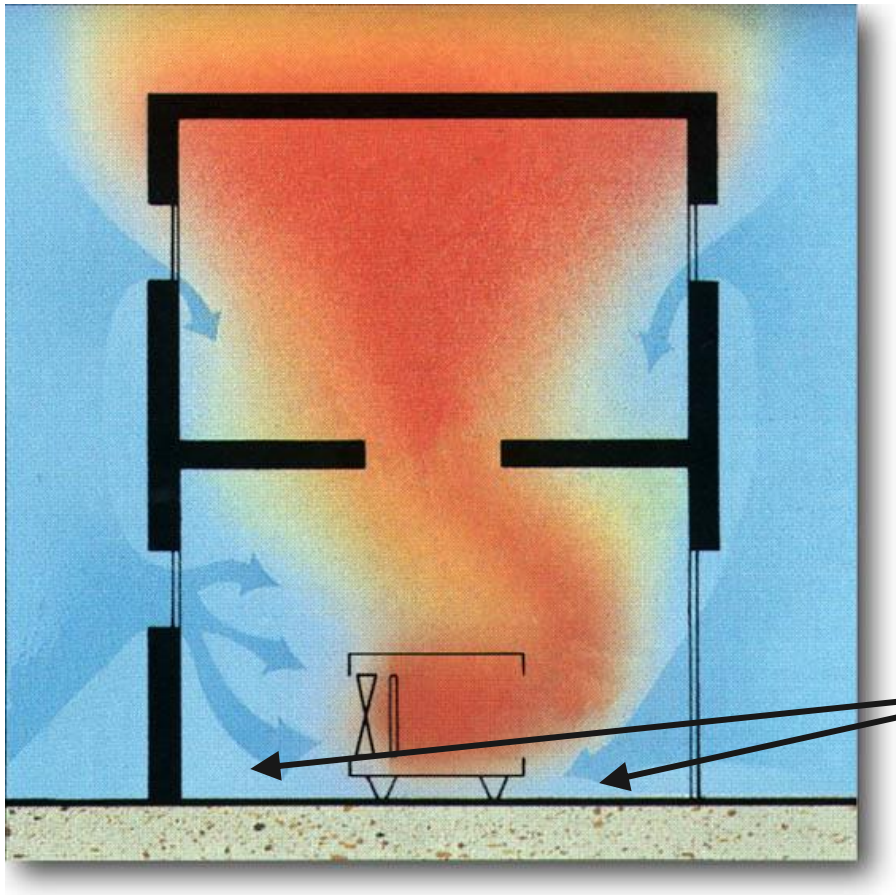
Positive Pressurization – Forced ambient air (Patented Process)



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

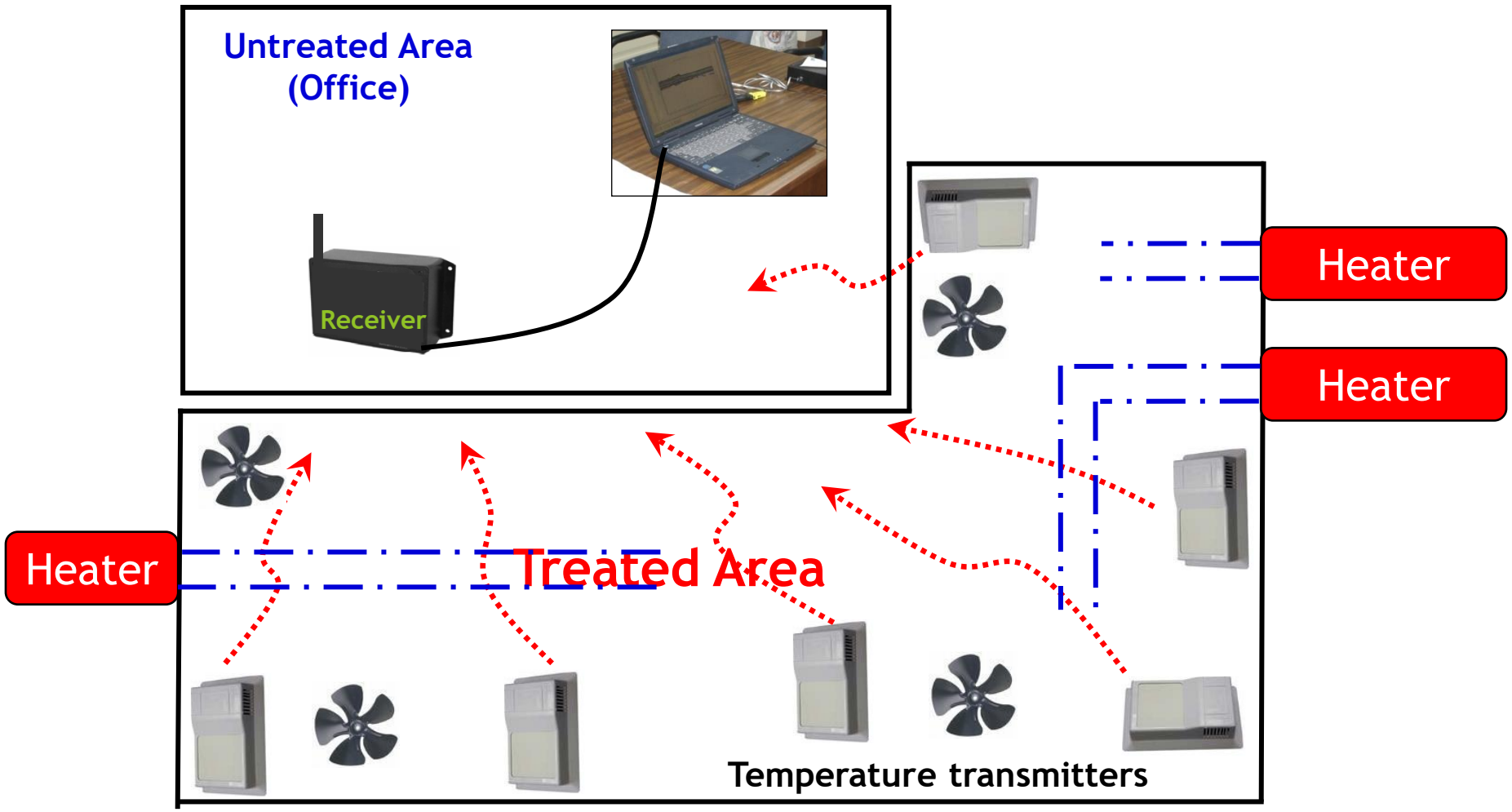
Re-circulating Inside Air



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

Low temperature zones (cold spots)

Real-time Wireless Temperature Monitoring



Start of the Heat Treatment

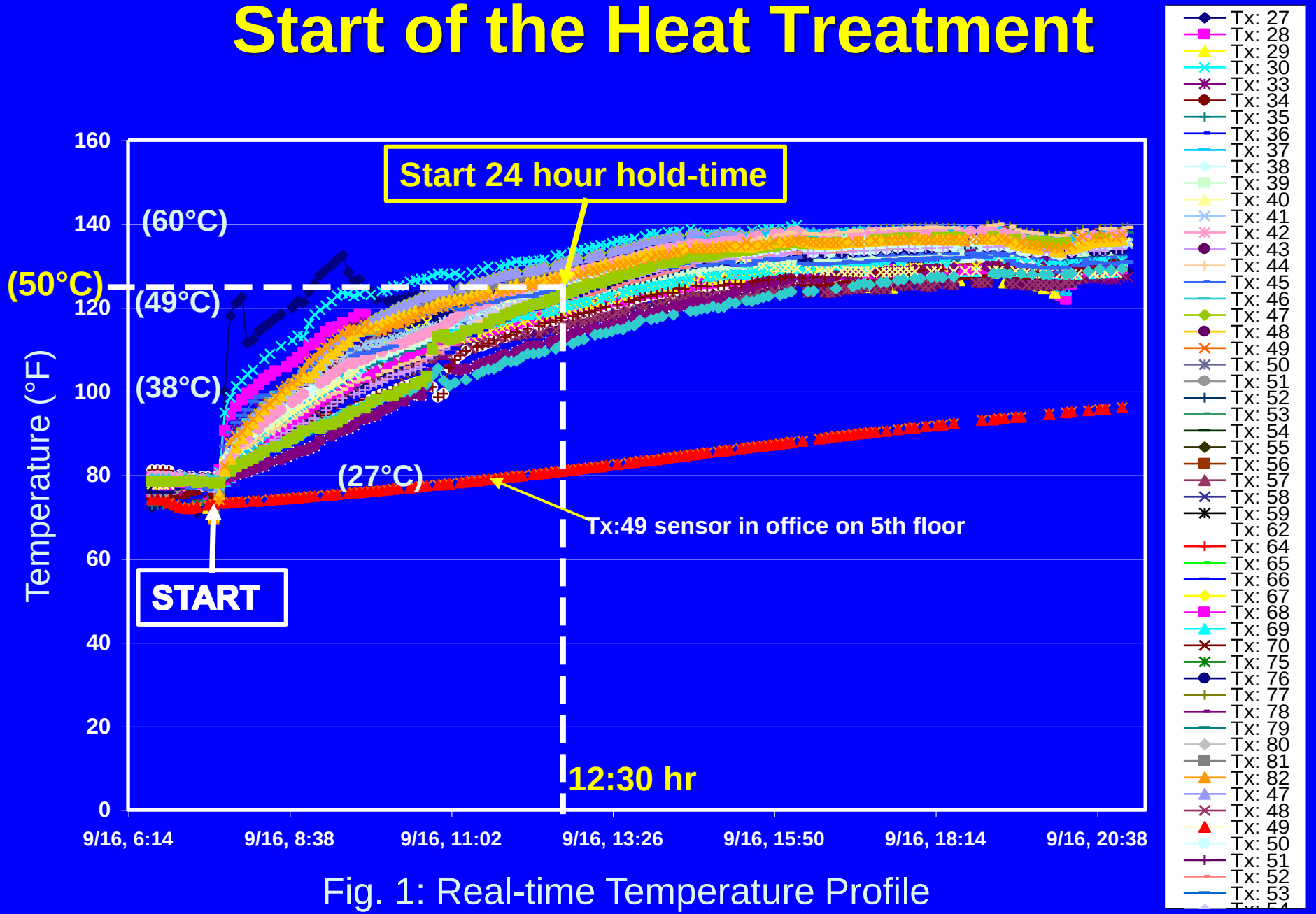


Fig. 1: Real-time Temperature Profile

End of the Heat Treatment

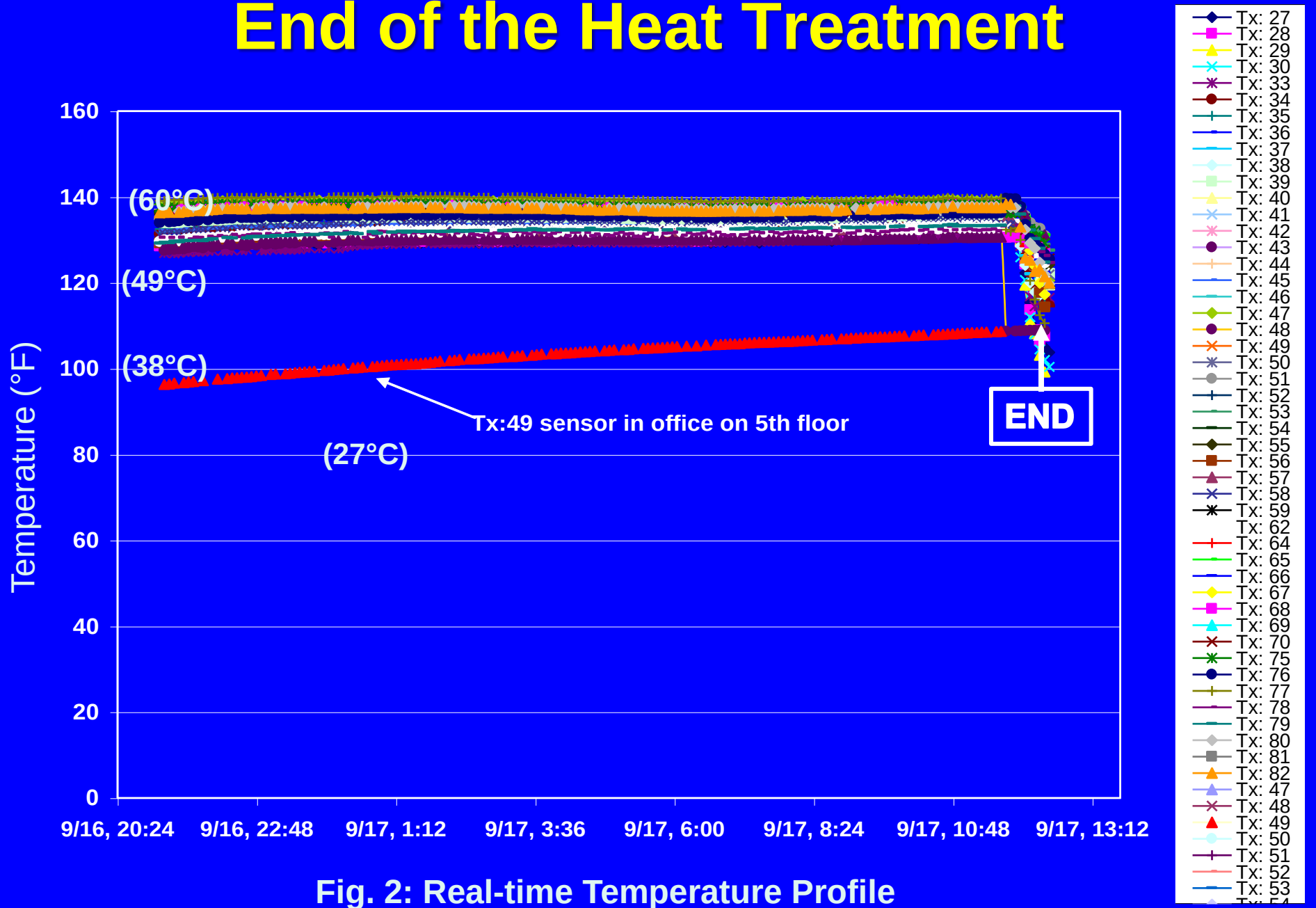
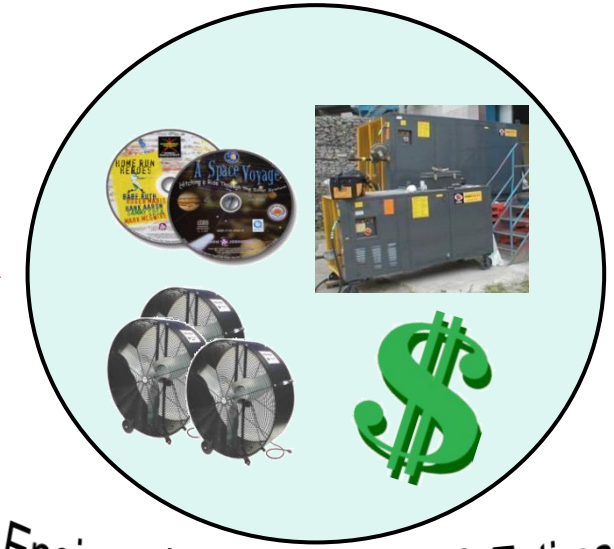


Fig. 2: Real-time Temperature Profile

Steps in Heat Treatment

Visit & Feasibility



Engineering, Equipment & Estimate

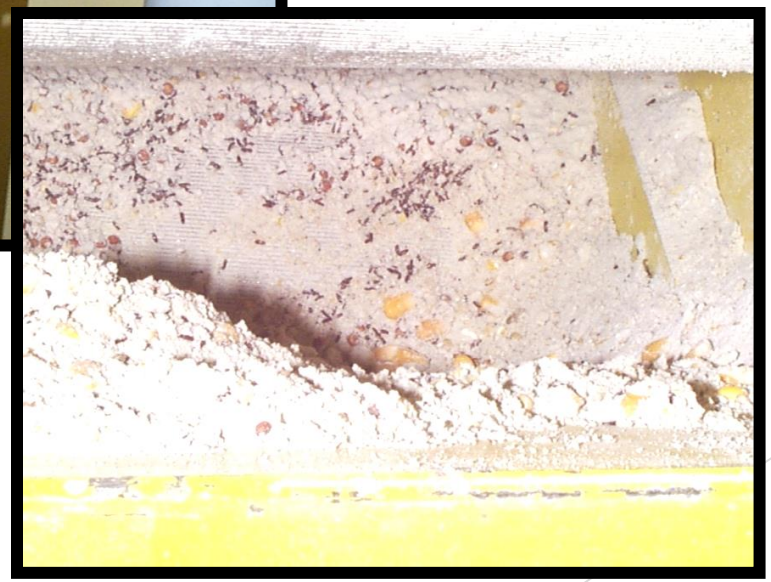
Equipment mobilization

Setup, HT, Document & Review

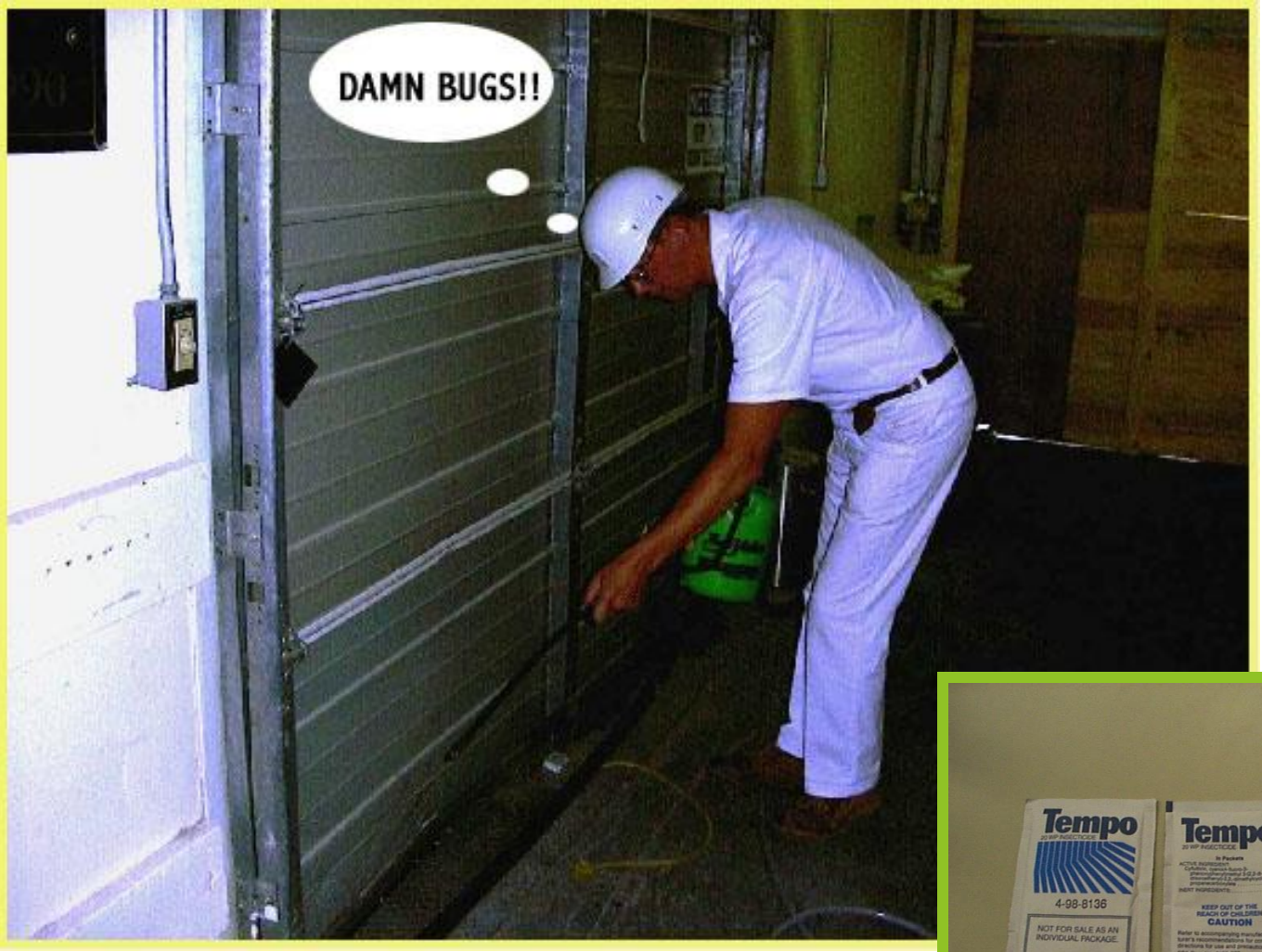
Important Pre-heat Treatment Checklist

- Remove tension from drive belts to avoid stretching
- Perform sanitation and remove all food products
- Sprinkler heads should withstand 127^{o}C
- Protect heat sensitive equipment

Sanitation is the key



Important as heat does not penetrate products well.



Perimeter Spray/Dust

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

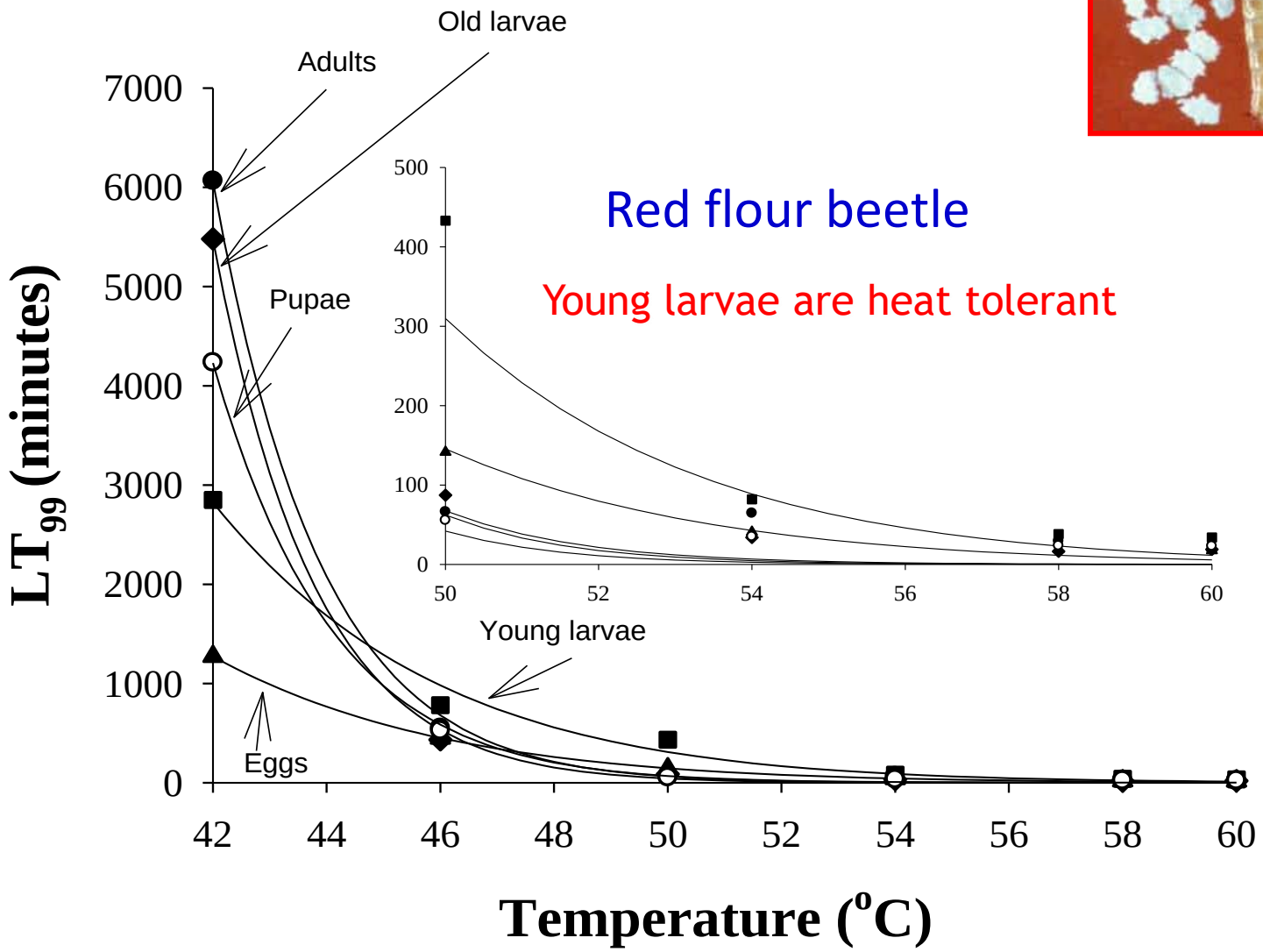
Comparison of Heat Tolerant Stages of Four Species (LT_{99} in minutes (95% CL))

Species	Stage	46°C/115°F	50°C/122°F	54°C/129°F
Cigarette beetle	Eggs	598.1 (571.21-633.10)	165.45 (152.62-182.84)	37.87 (35.14-41.56)
Red flour beetle	Young larvae	430.7 (364.3-573.6)	432.8 (365.3-572.6)	81.9 (60.4-207.7)
Confused flour beetle	Mature larvae	299.46 (281.81-324.88)	90.05 (81.80-102.26)	55.71 (48.75-67.25)
Indianmeal moth	Mature larvae	69 (62-80)	34 (29-43)	Not tested

Source: Dr. Subi, KSU, KS

Red flour beetle

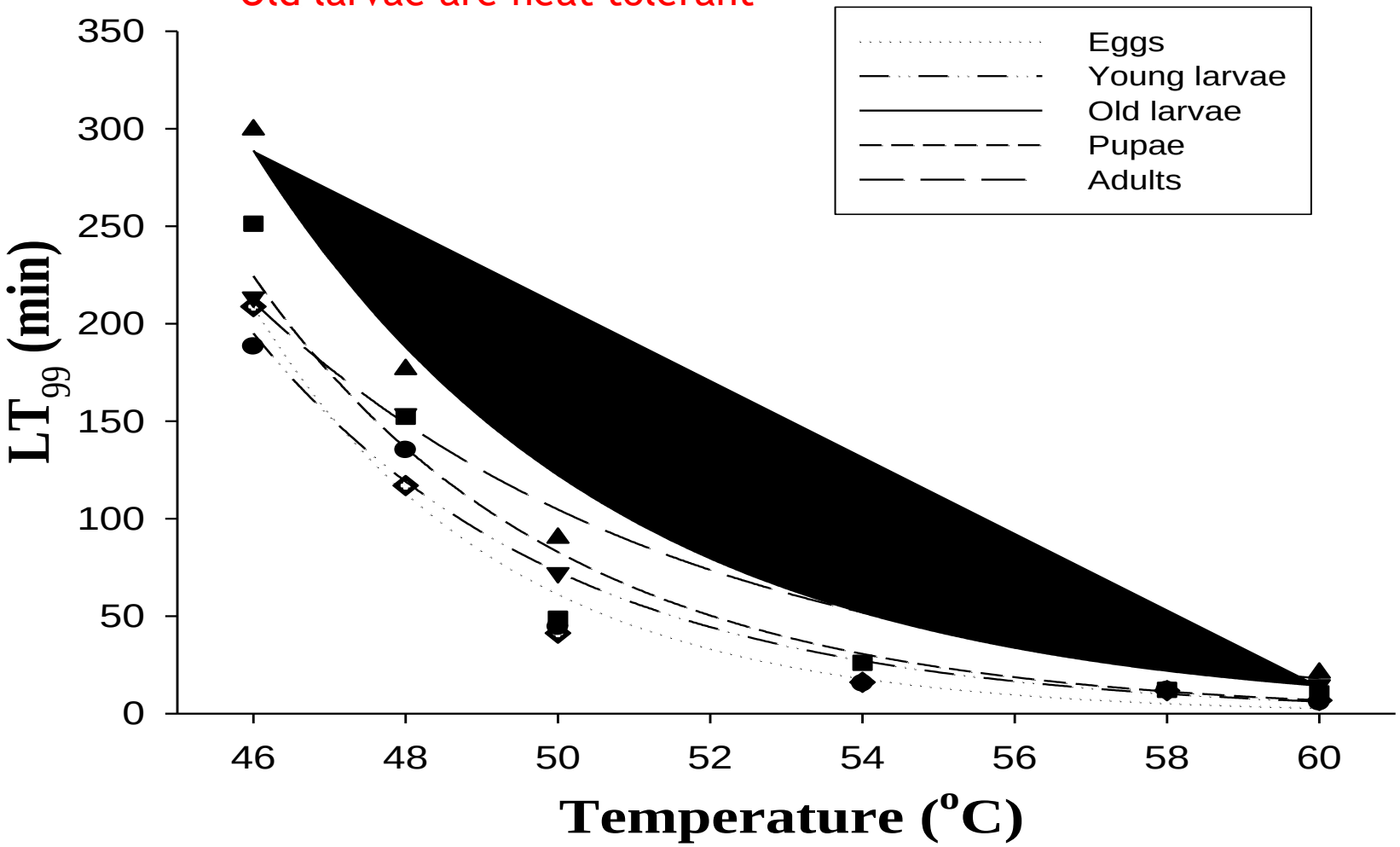
Young larvae are heat tolerant



Source: Dr. Subi, KSU, KS

Confused flour beetle

Old larvae are heat tolerant



Source: Dr. Subi, KSU, KS

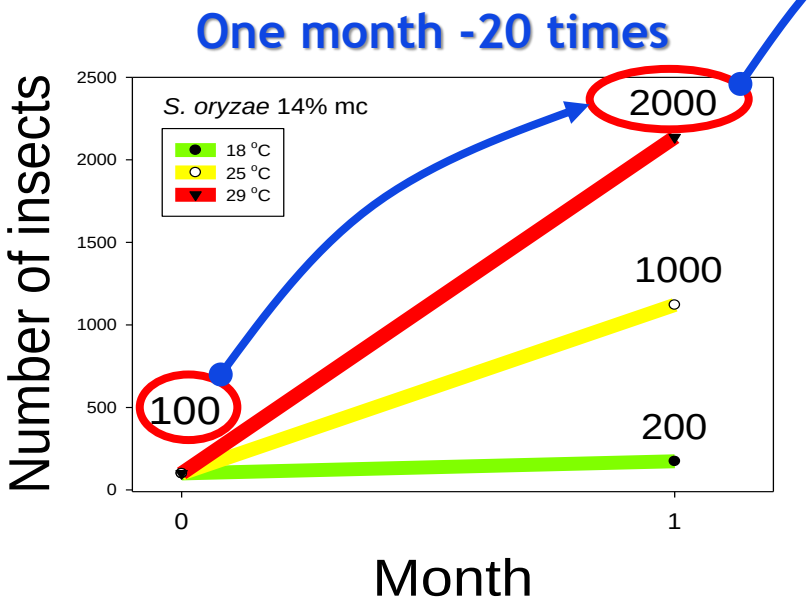
Insect stage	Sanitation level	Treatment	% Mean (SE) mortality[a]	*F*	*P*
Adults	2 cm	MB	100a	69.90	<0.0001
		SF	100a		
		Heat	90.1 (1.2)b		
	dusting	SF	100	1.00	0.4219
		MB	100		
		Heat	98.7 (1.3)		
Pupae	2 cm	MB	100	2.56	0.1568
		SF	100		
		Heat	95.4 (2.9)		
	dusting	MB	100	0.60	0.5787
		SF	98.7 (1.3)		
		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)		

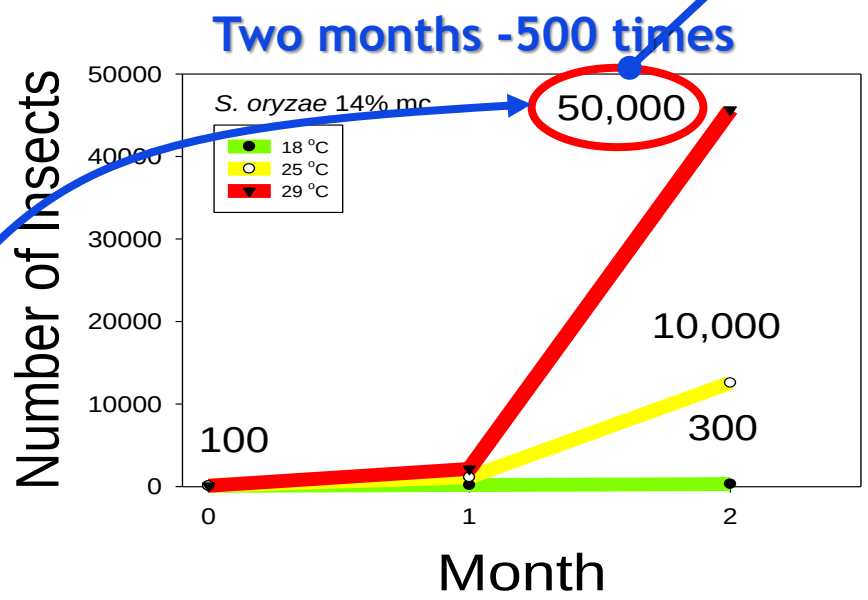
K-State Study (2009-2010)

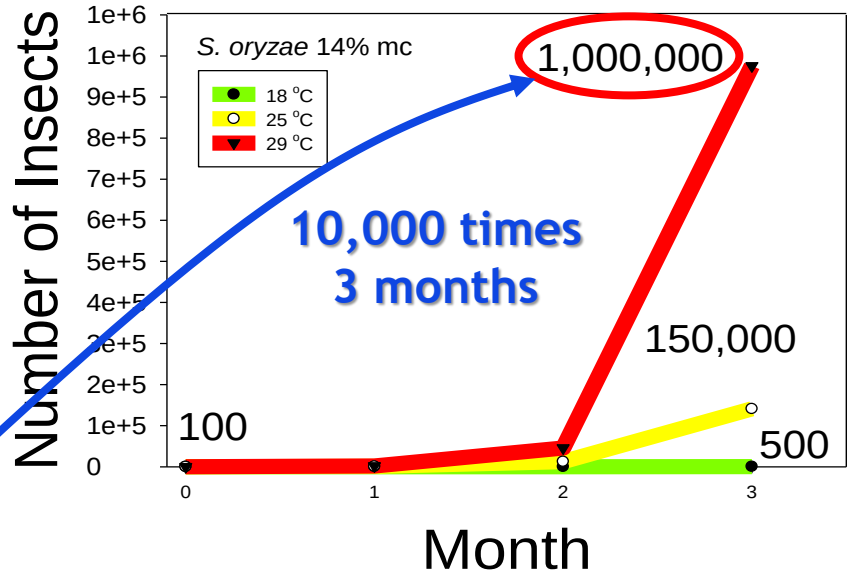
n = 3/trt

Trt time=24 h for all

Exponential Growth of Insect Populations







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

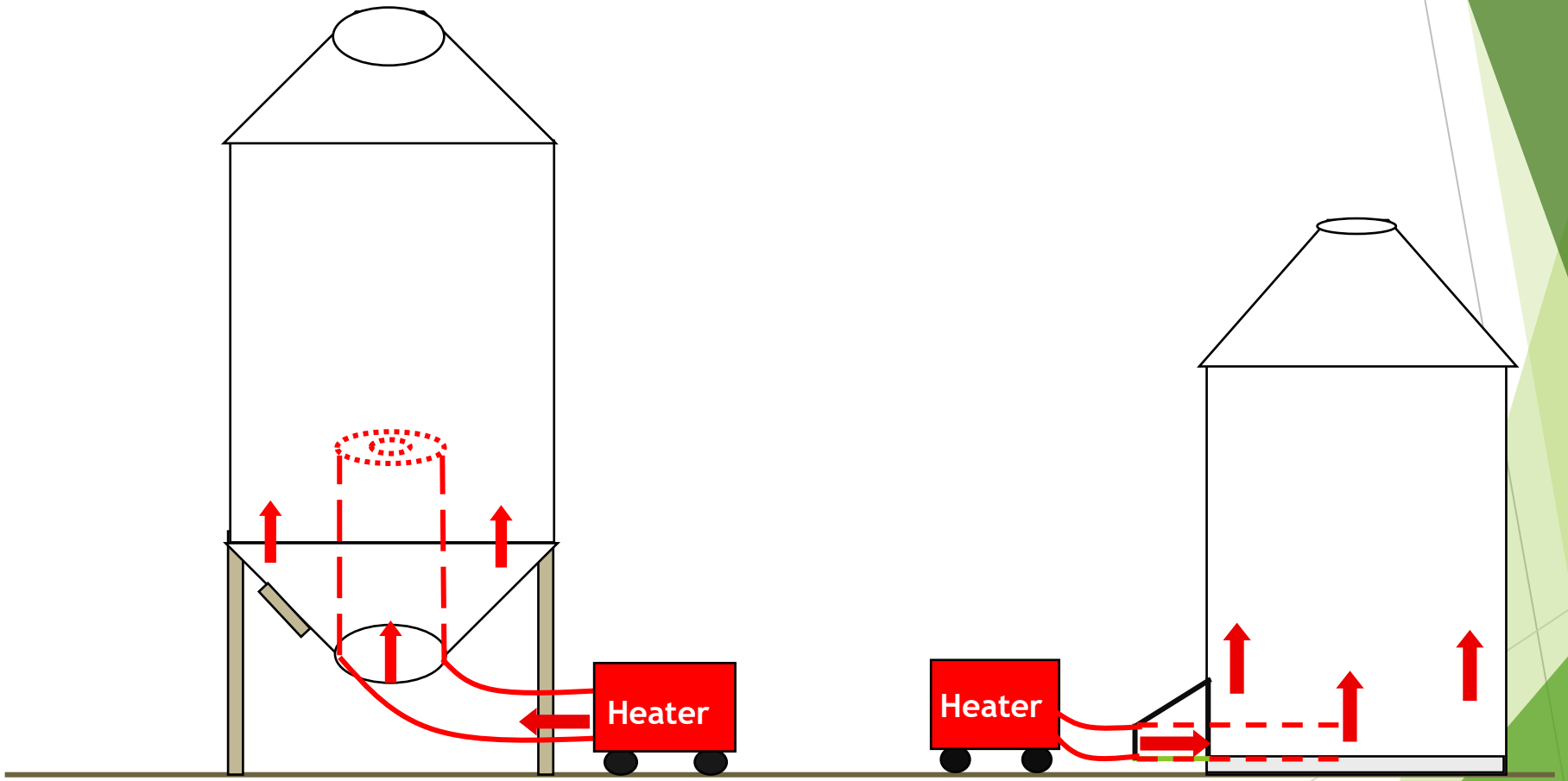
Entire structure or spot treatment

Heat Treatment of Bins & Silos

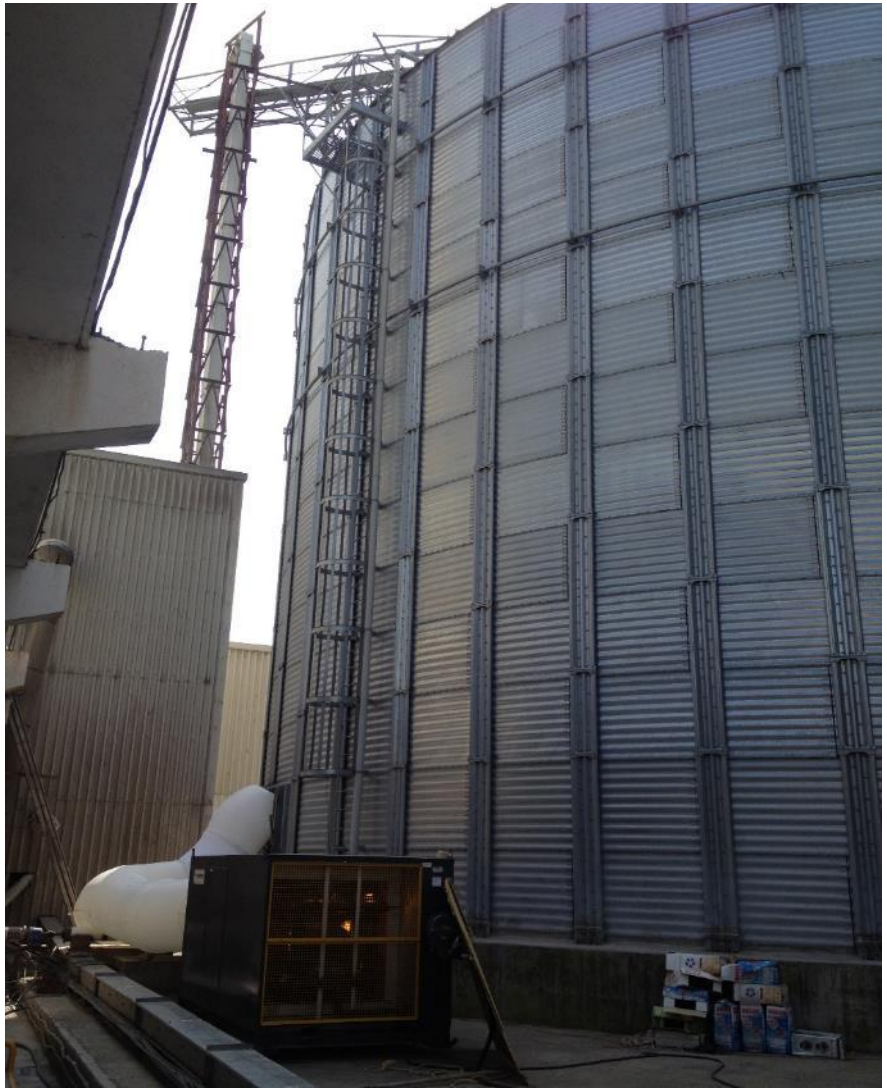
Bins & Silos

- 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



Bin/Silo Heat treatment



Empty Metal Silo - India

Advantages of HT of Bins/Silos

- S E E
- 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

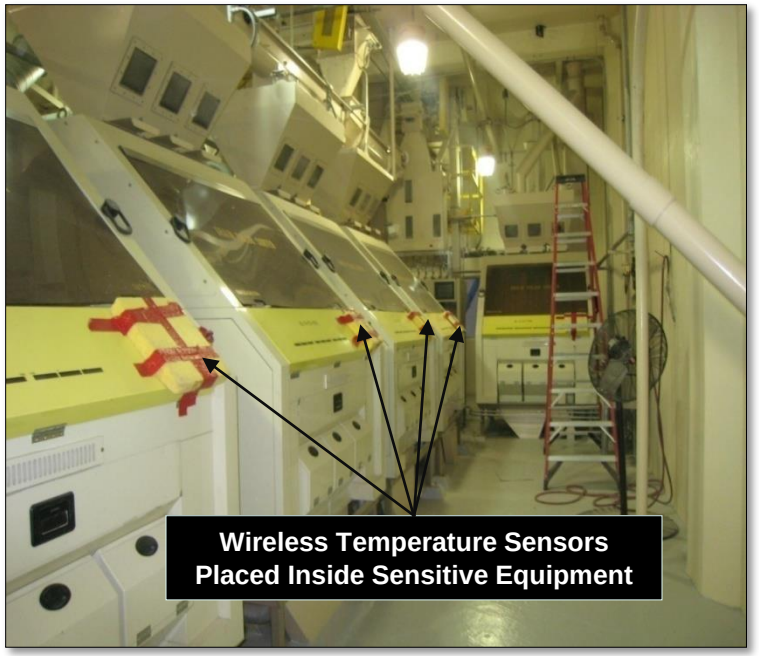
Heater Placement under rolling shutter

Heater Placement & Layout

Heater Partially inside Packaging Plant

Duct & Fan Layout - Packaging

Basement, Sensitive Equipment



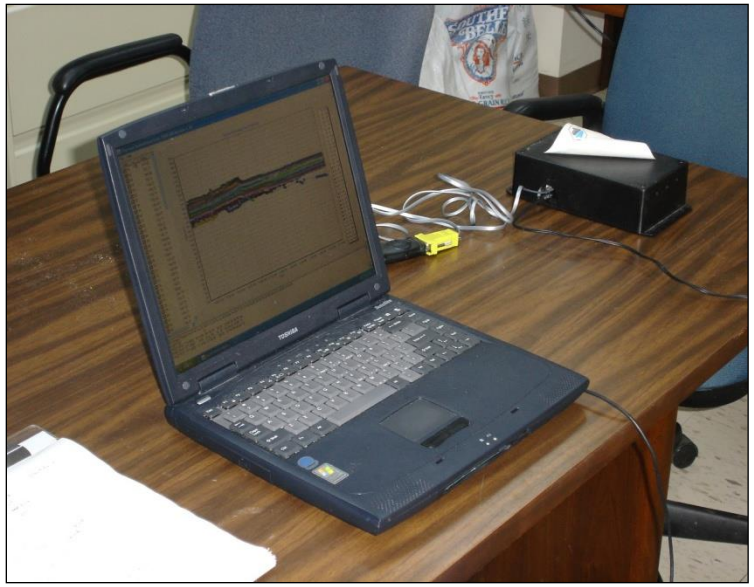
Partial/Spot heat treatment in a Warehouse/Plant

Packaging Area in warehouse

Spot Treatment in Cookie Packaging Plant

Sprinkler heads and opening the machines

Temperature Profile, Beetles, & Rats!!!!



Concrete Bins, Basement and Head house

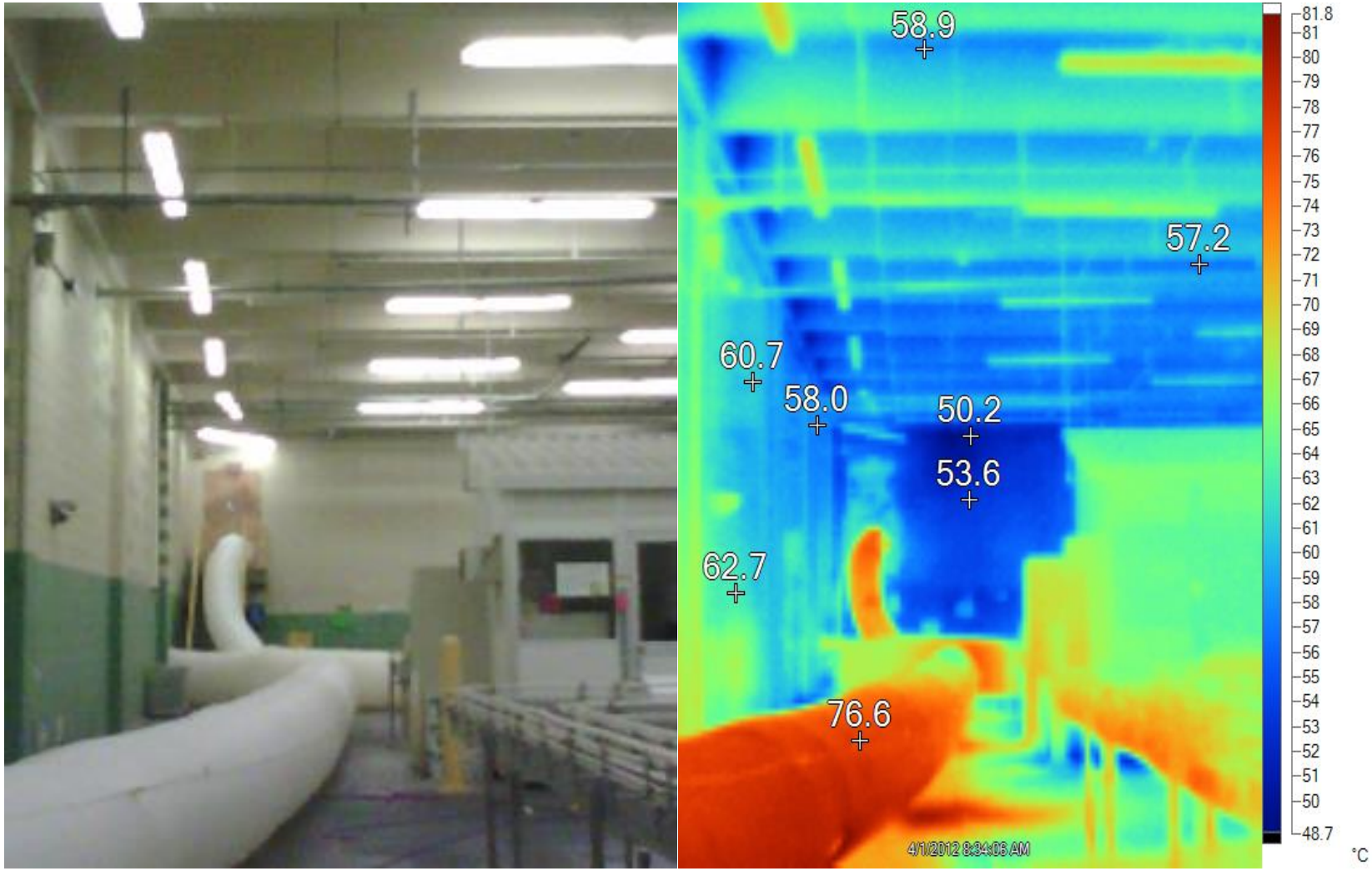
Pasta Mill, Monterrey, Mexico

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

Philippines

Flour Mill, Philippines

Packaging Hall



Heat Treatment: Scientific Process

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

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