Heat Treatment of Empty Steel Bins

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Outline

* Introduction & Motivation for Project
* Objective
* Equipment and Process Used
* Temperatures and Insect Mortality Results
* Conclusions
* Future Plans

Introduction & Motivation

* Residual chemicals currently recommended for pre-binning sanitation
* Heat treatments have been successfully applied in processing facilities to control insects
* Bins with full drying floor are particularly difficult for sanitation
* GMPRC Pilot Plant had a bin needing sanitation

Introduction & Motivation

Initial Treatment & Overview

*4,800 bu metal drying bin (perforated floor).

*Large variable speed drying fan (“choked” down).

*1 hp aeration fan for circulation in the bin.

*Perforated floor was covered with tarp.

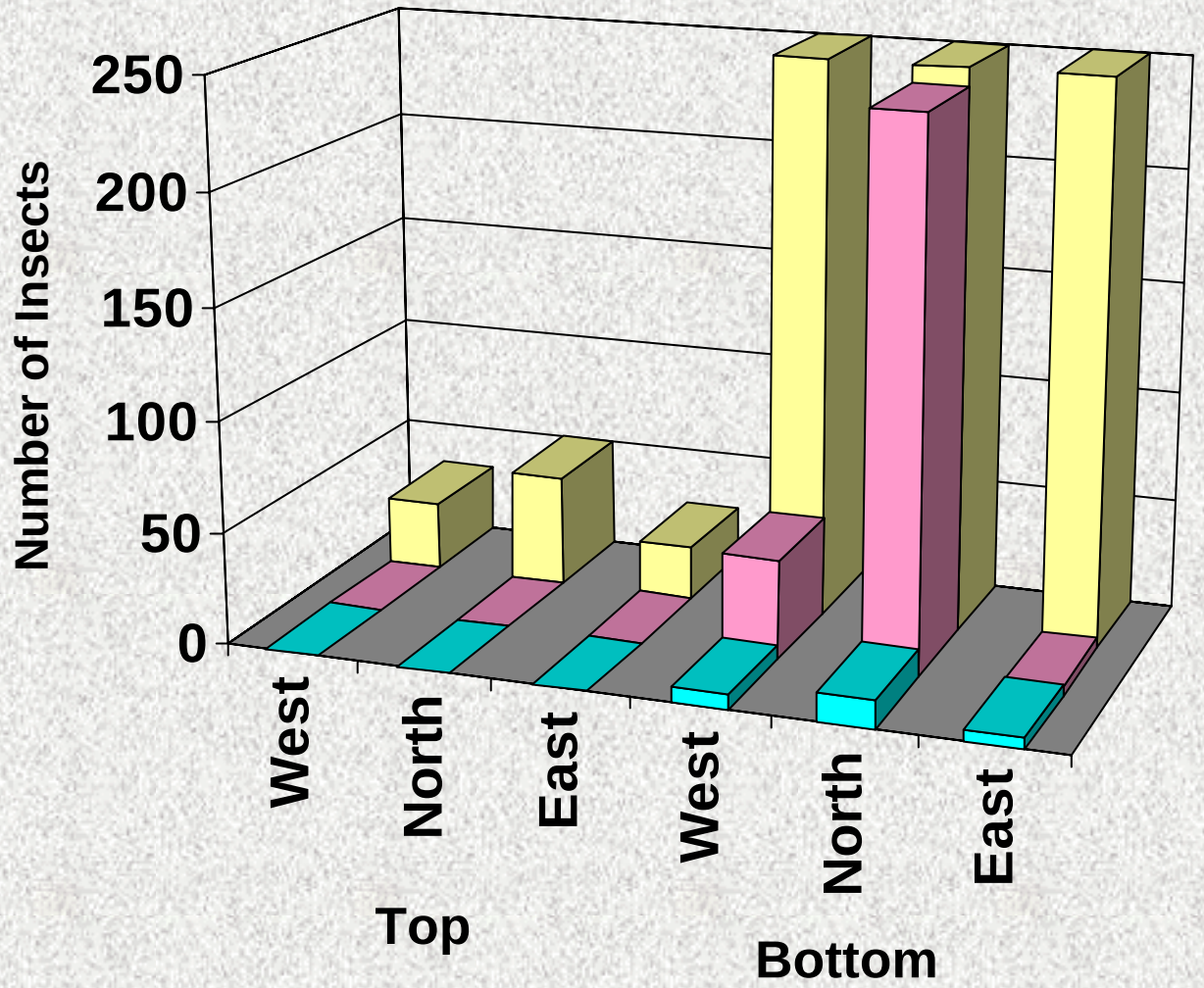
*Introduced live insects in arenas to check mortality.

Larvae Exiting Bin

18 kW Heating Element 40 Hour Treatment

Trap Counts

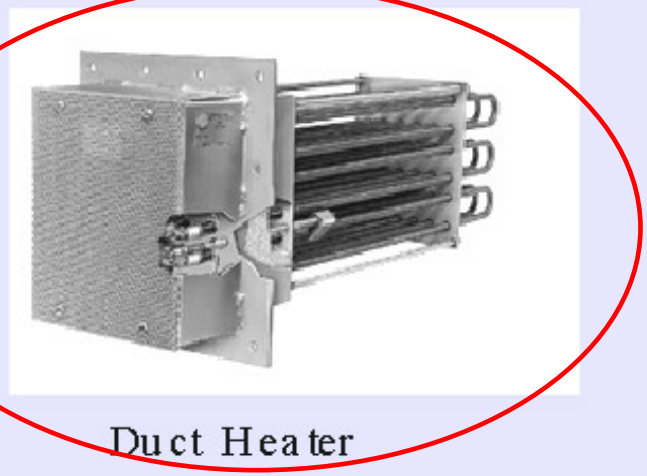
18 kW Heating Element 40 Hour Treatment



Project Objectives

* Develop a practical method to obtain a uniform heat distribution of 120°F within the bin.
* Evaluate insect mortality rates.
* Develop an economic model describing the most cost effective method of using heat to sanitize steel grain bins prior to filling.

Heating Equipment



Duct Heater

18 kW or 61,400 BTU

Forced Air Propane Heaters
65,000 - 85,000 - 100,000 BTU

Forced Air Electric Heaters

Three species added to arenas’

Rice weevil
(*Sitophilus oryzae*)

Red flour beetle
(*Tribolium castaneum*)

Lesser grain borer
(*Rhyzopertha dominica*)

Arena

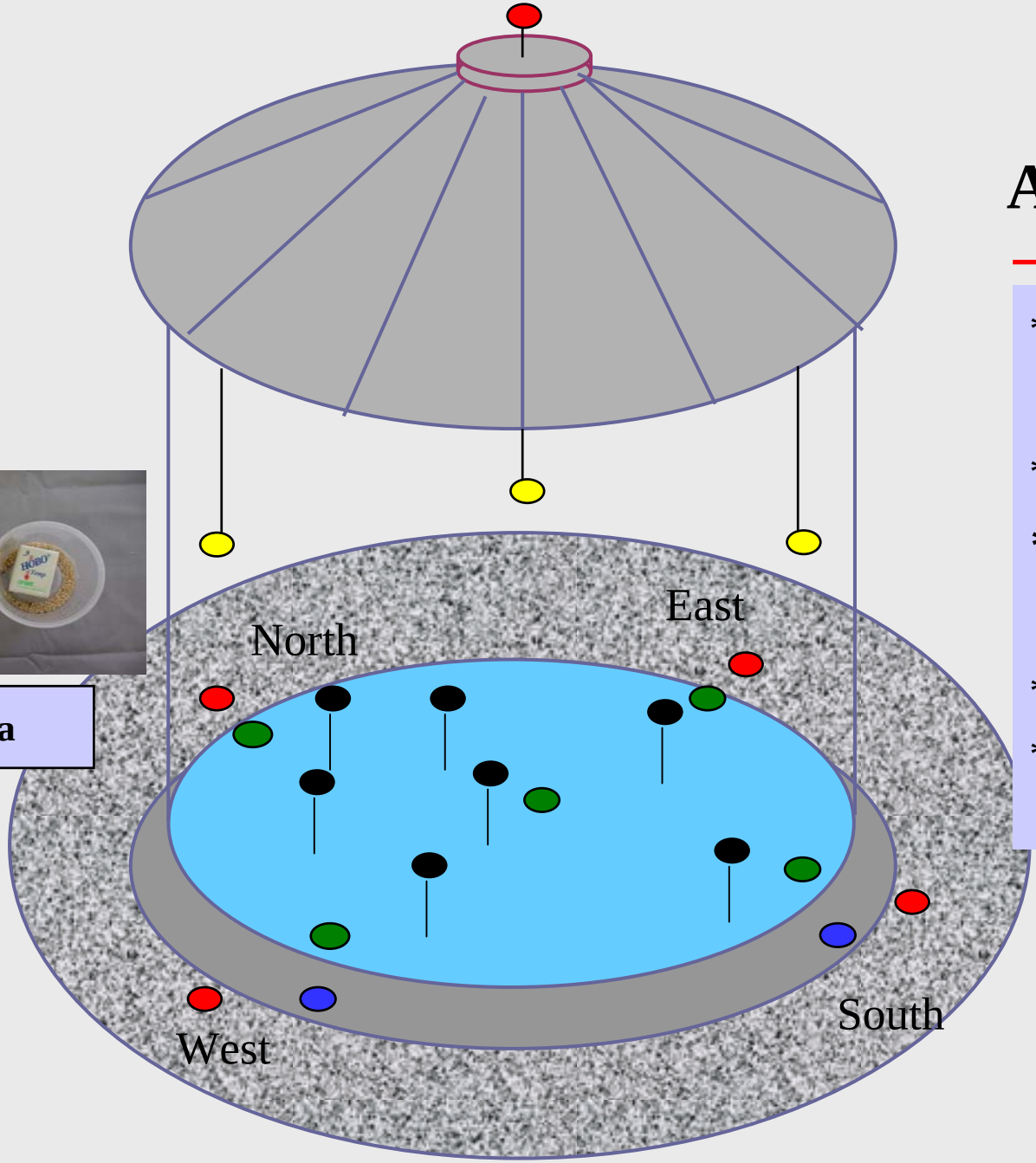
* 3 species of insects.

* HOBO Temperature Instrument.

* 1 tsp of cracked wheat

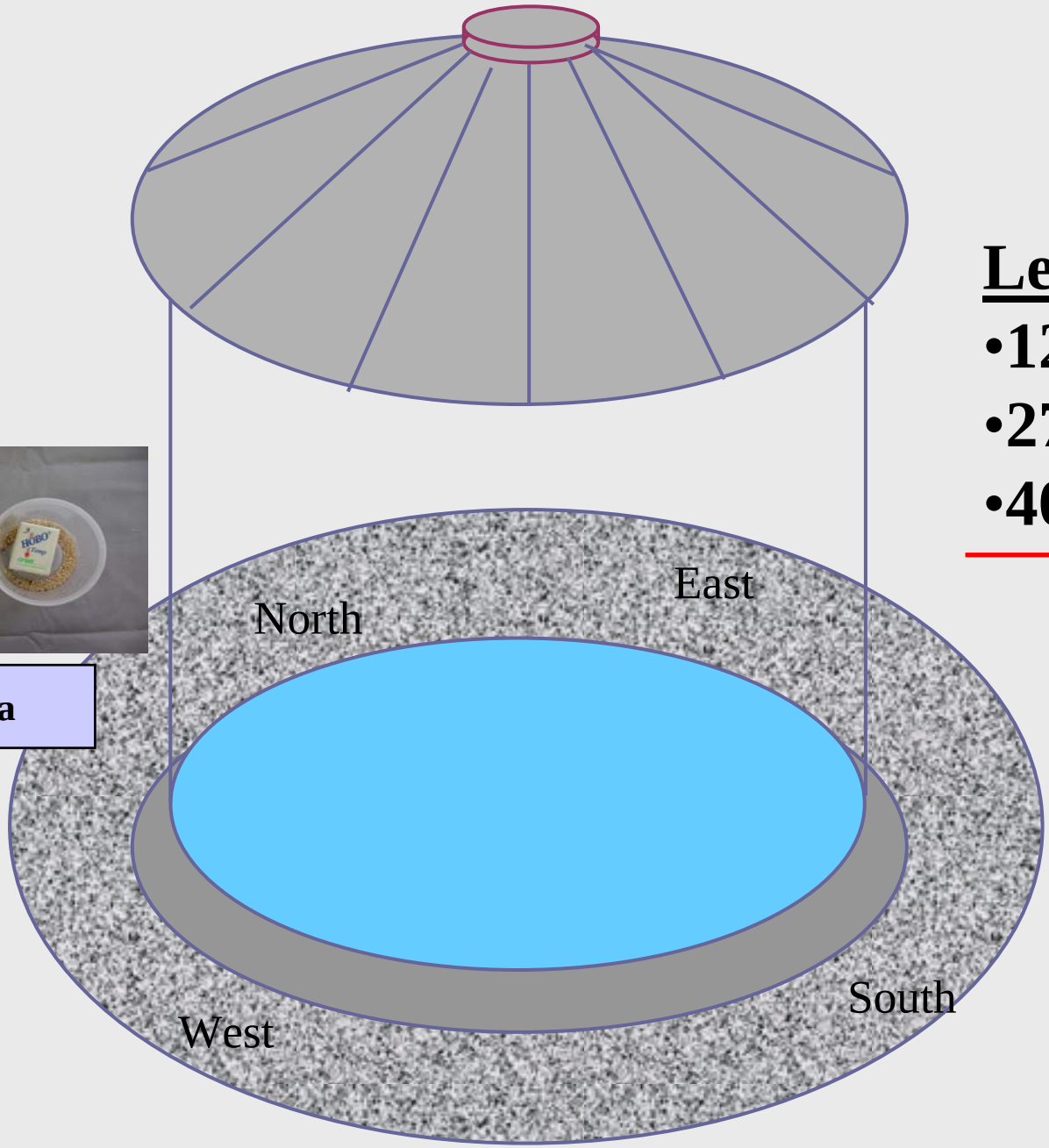
Arena Locations

Arena



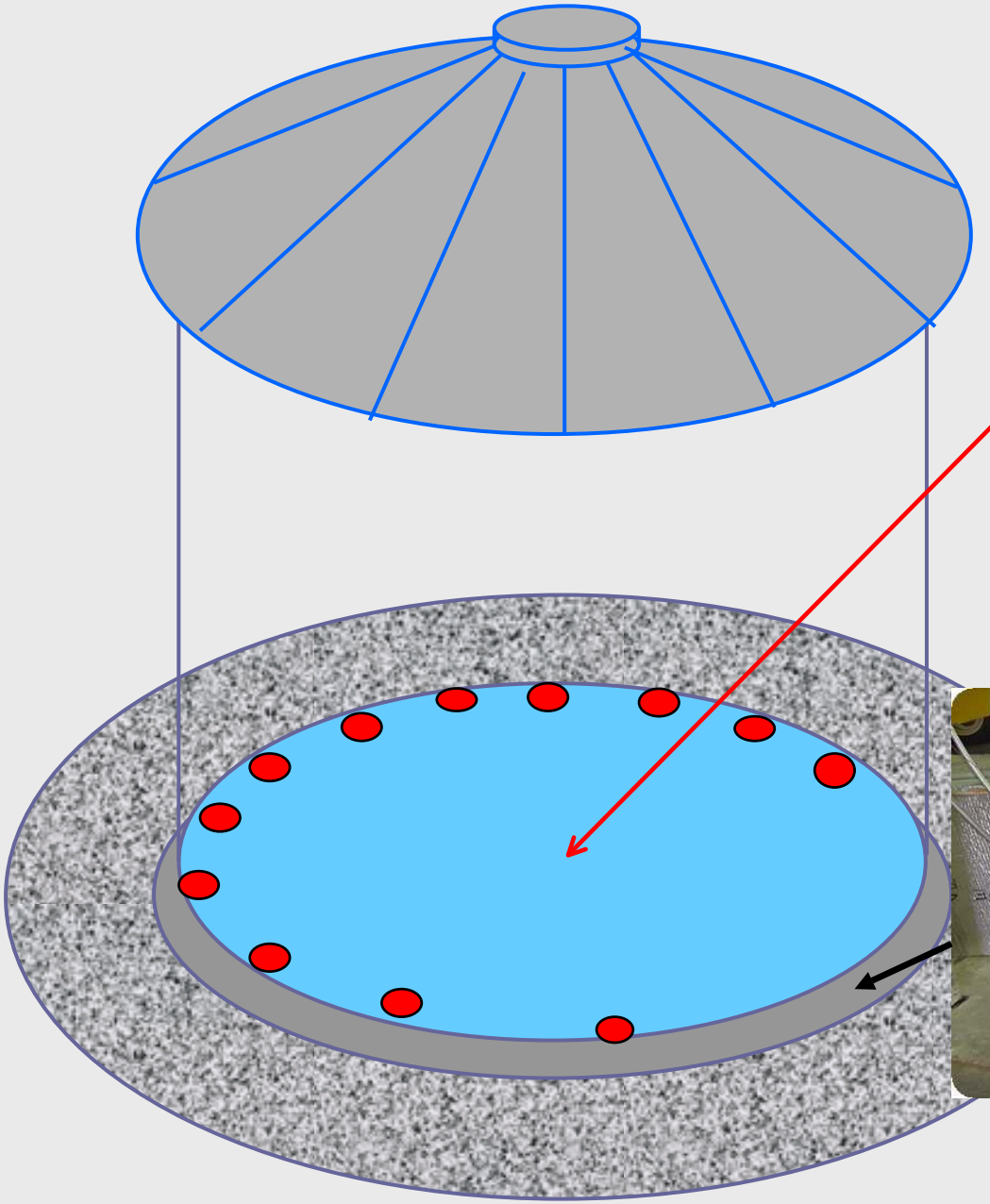
* 5 Control located outside of bin..
* 5 Below aeration
* 5 Above Aeration floor
* 7 One foot above
* 3 Upper Portions of bin

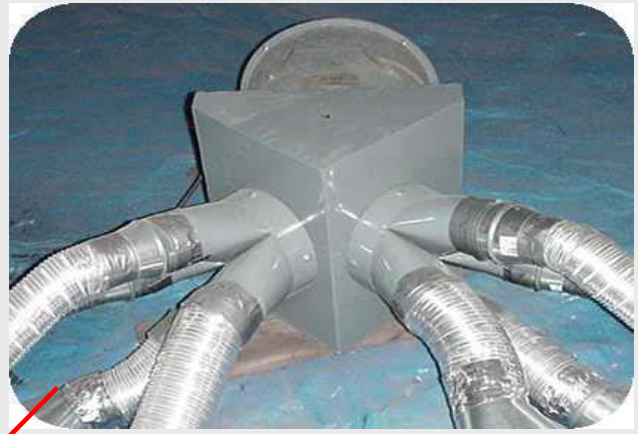
Arena



Length of tests:

- 12 hr
- 27 hr
- 40 hr

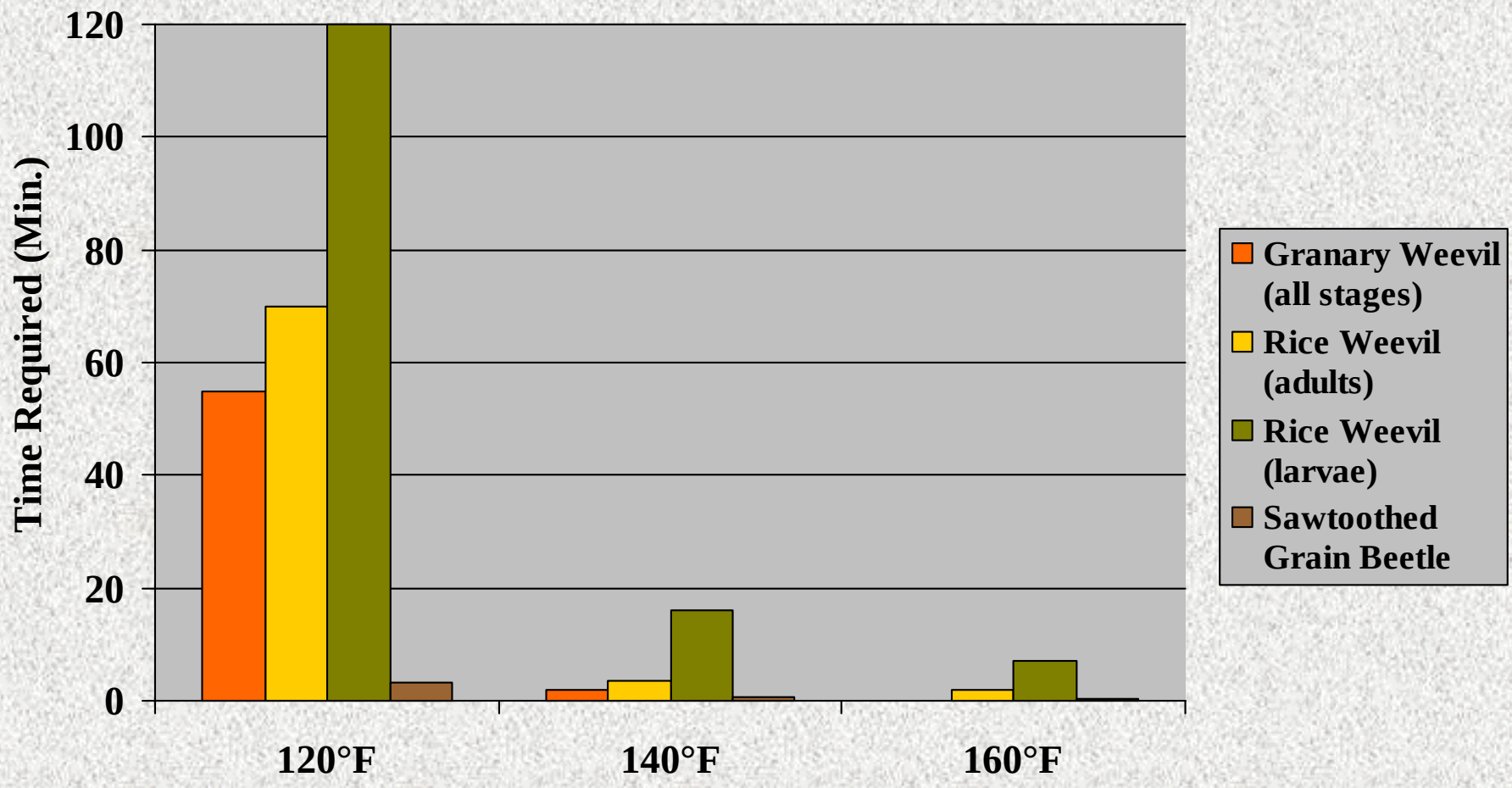




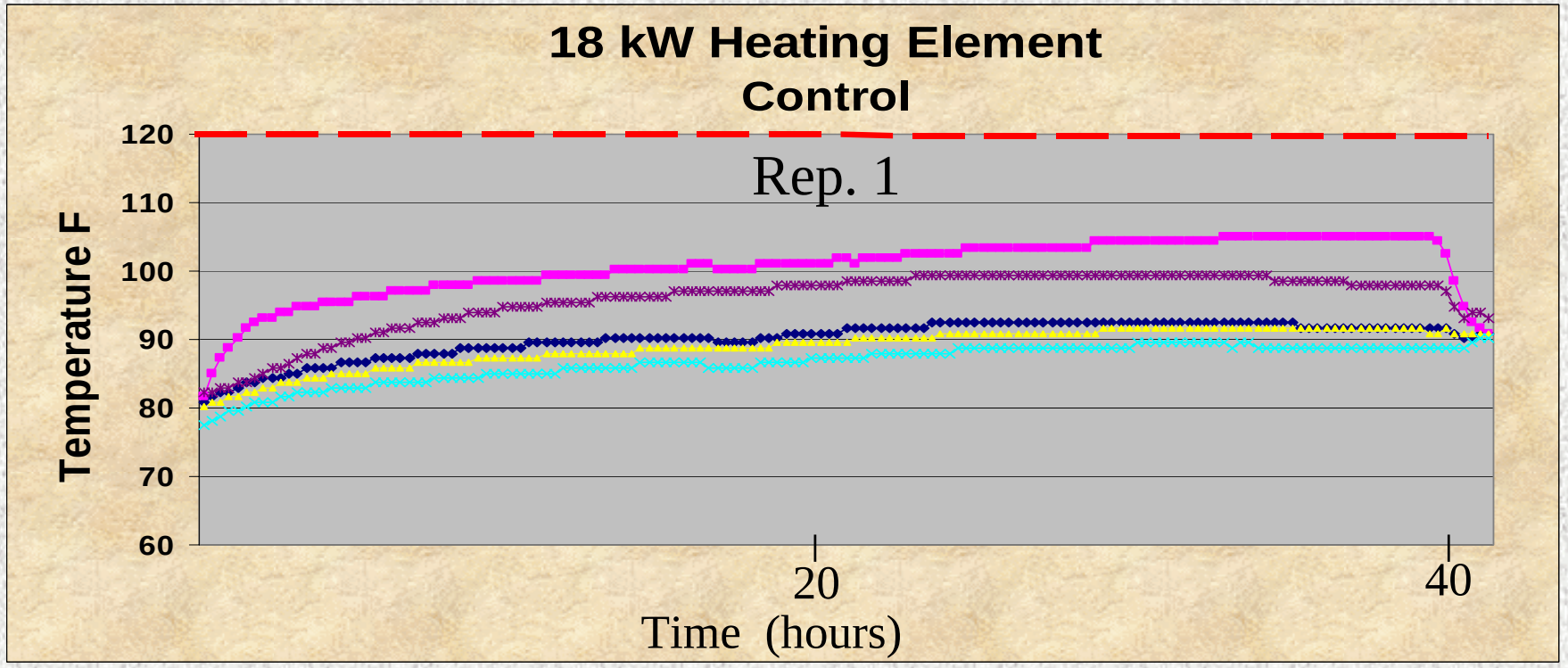
Manifold and Aeration Fan

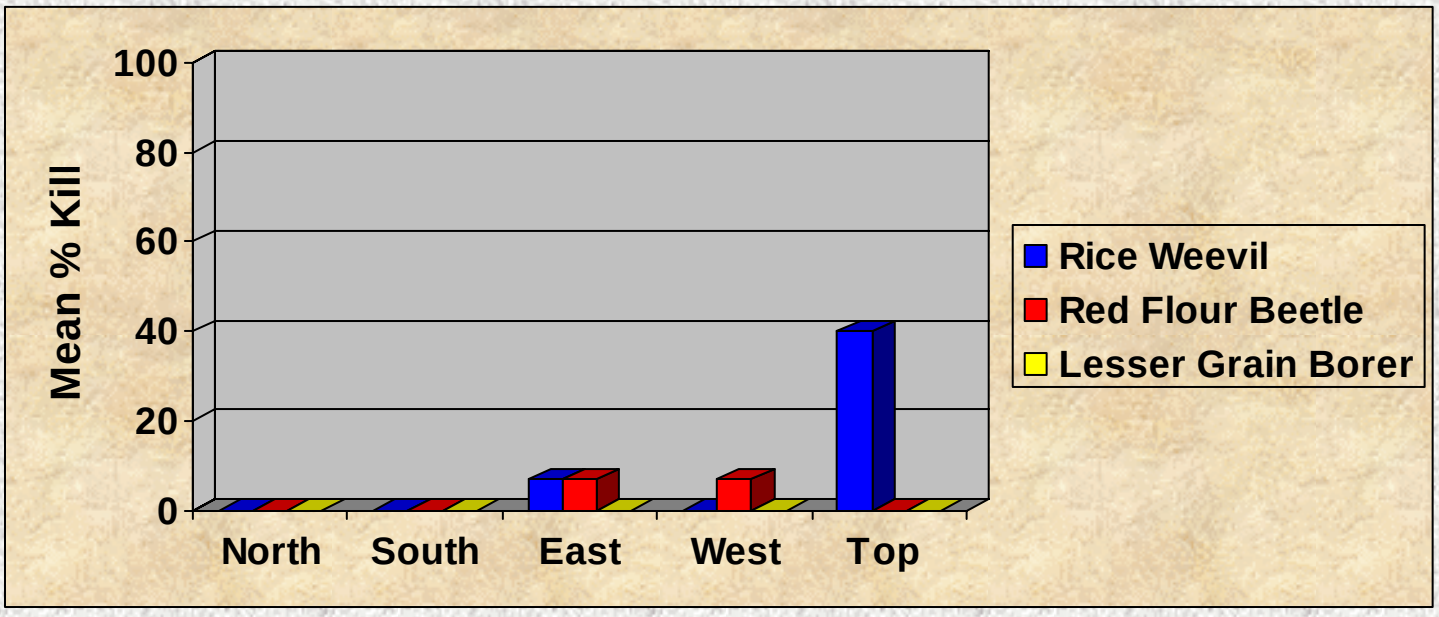
Inlet of 18 kW Heater

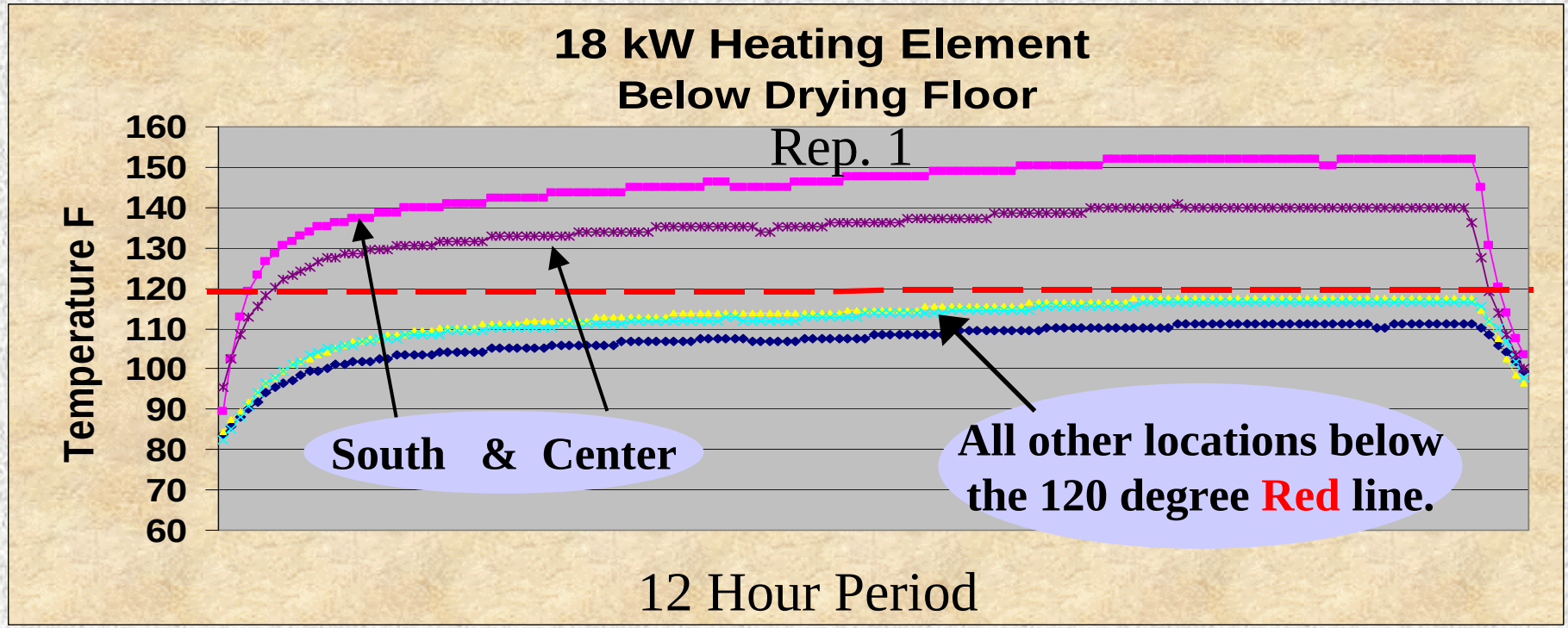
Temperature and Time Required to Kill

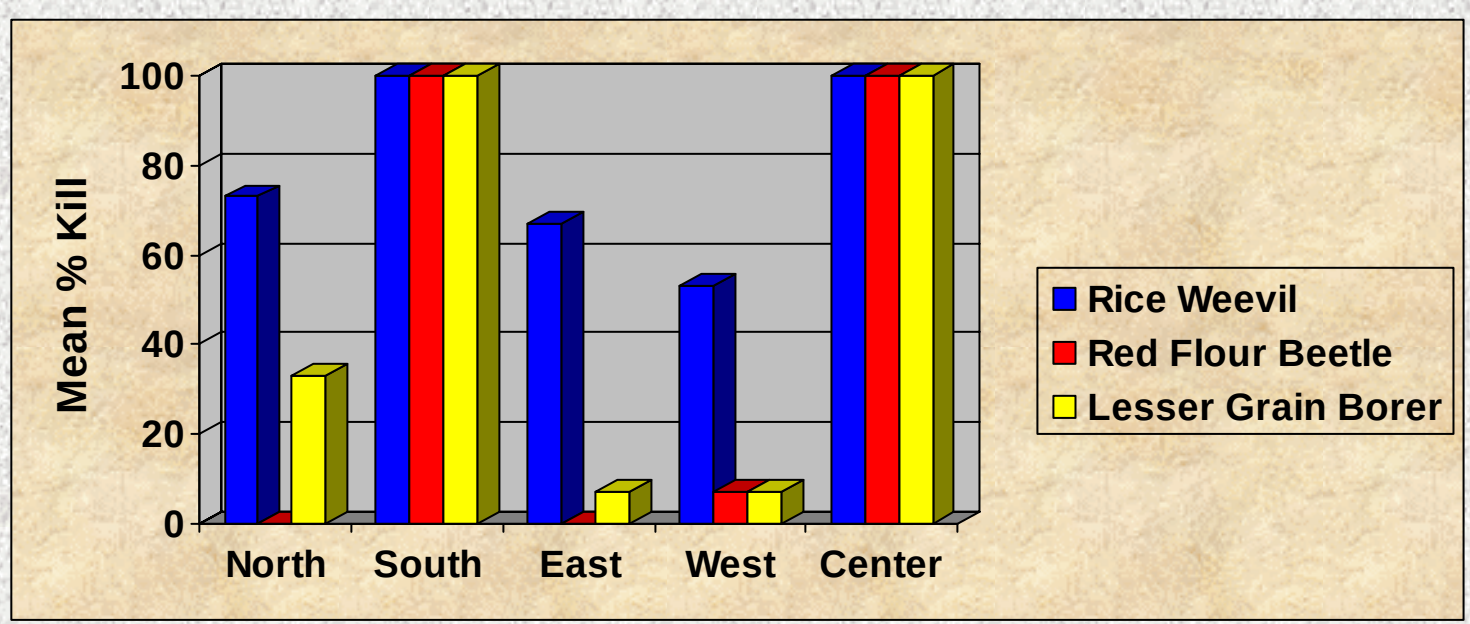


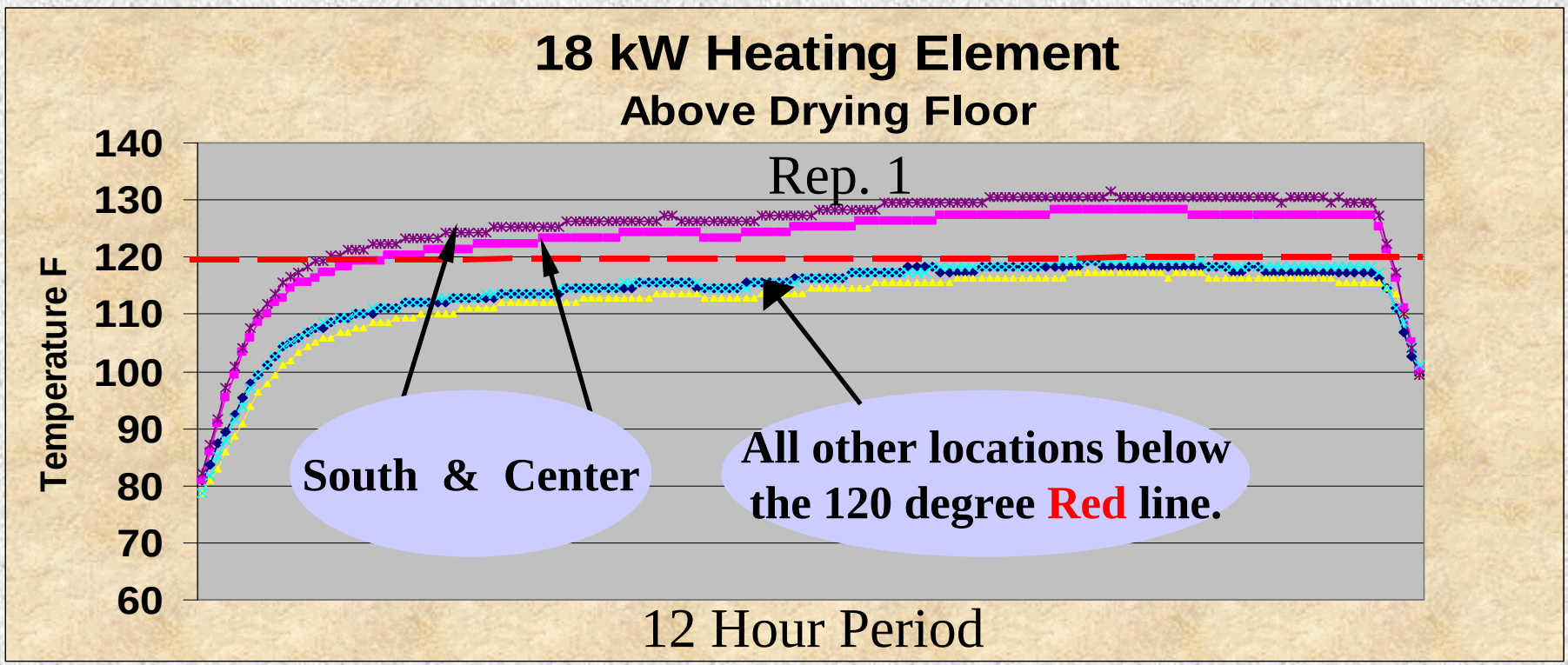
* Evans, D. E. 1981. The influence of some biological and physical factors on the heat tolerance relationships for *R. dominica* and *S. oryzae*. J. Stored Prod. Res. 17:656-72.

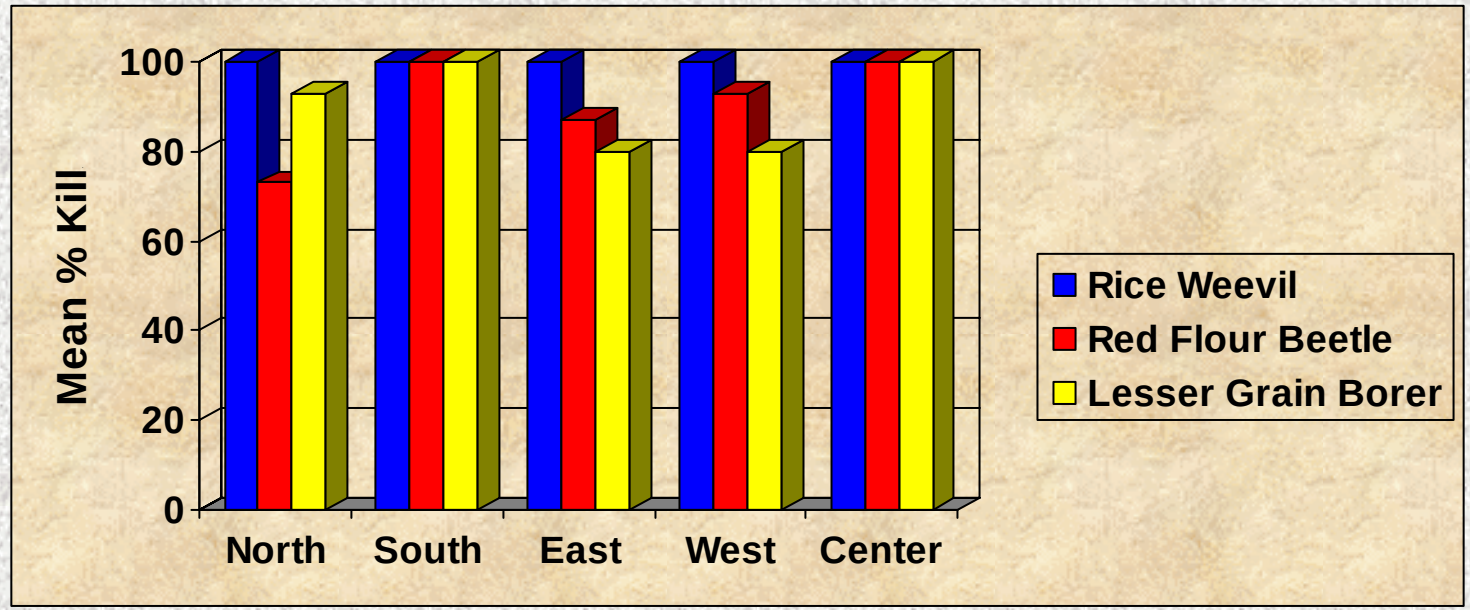

18 kW Heating Element
Control
Rep. 1
Temperature F
120
110
100
90
80
70
60
20
40
Time (hours)

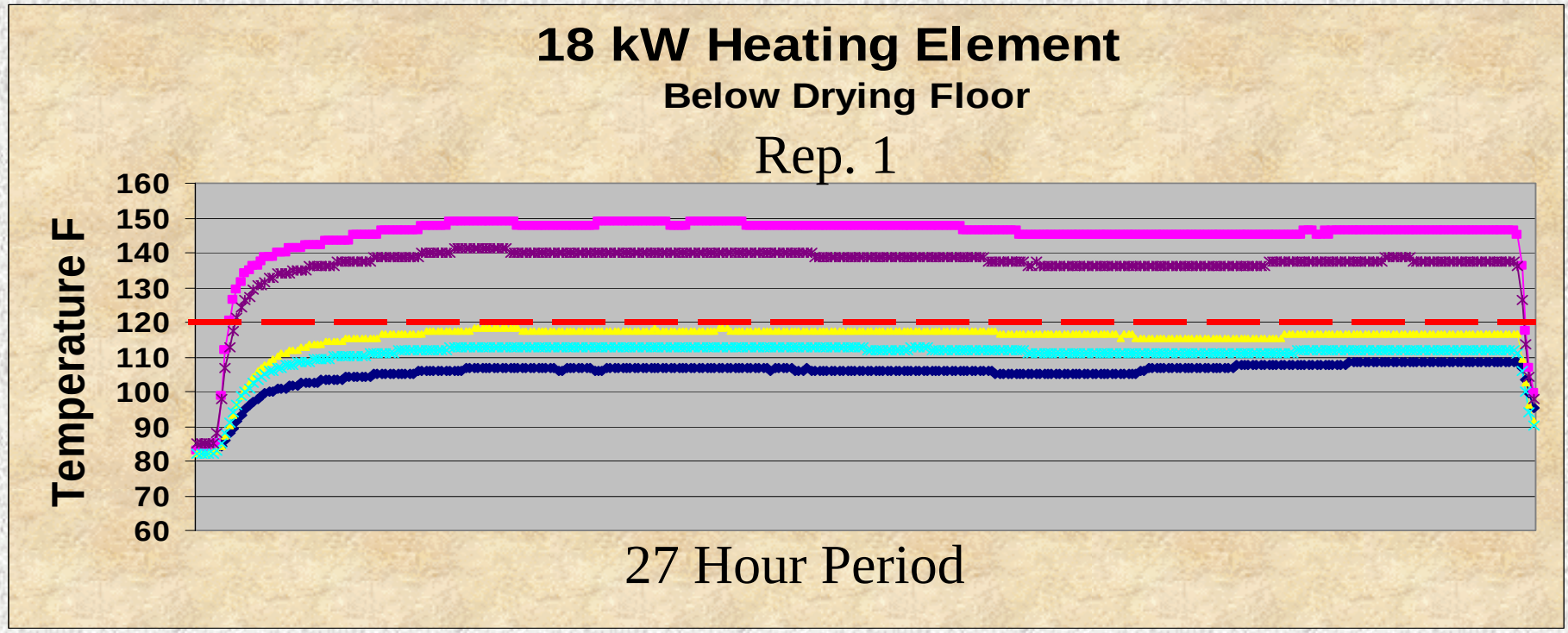

Mean % Kill
100
80
60
40
20
0
North
South
East
West
Top
Rice Weevil
Red Flour Beetle
Lesser Grain Borer

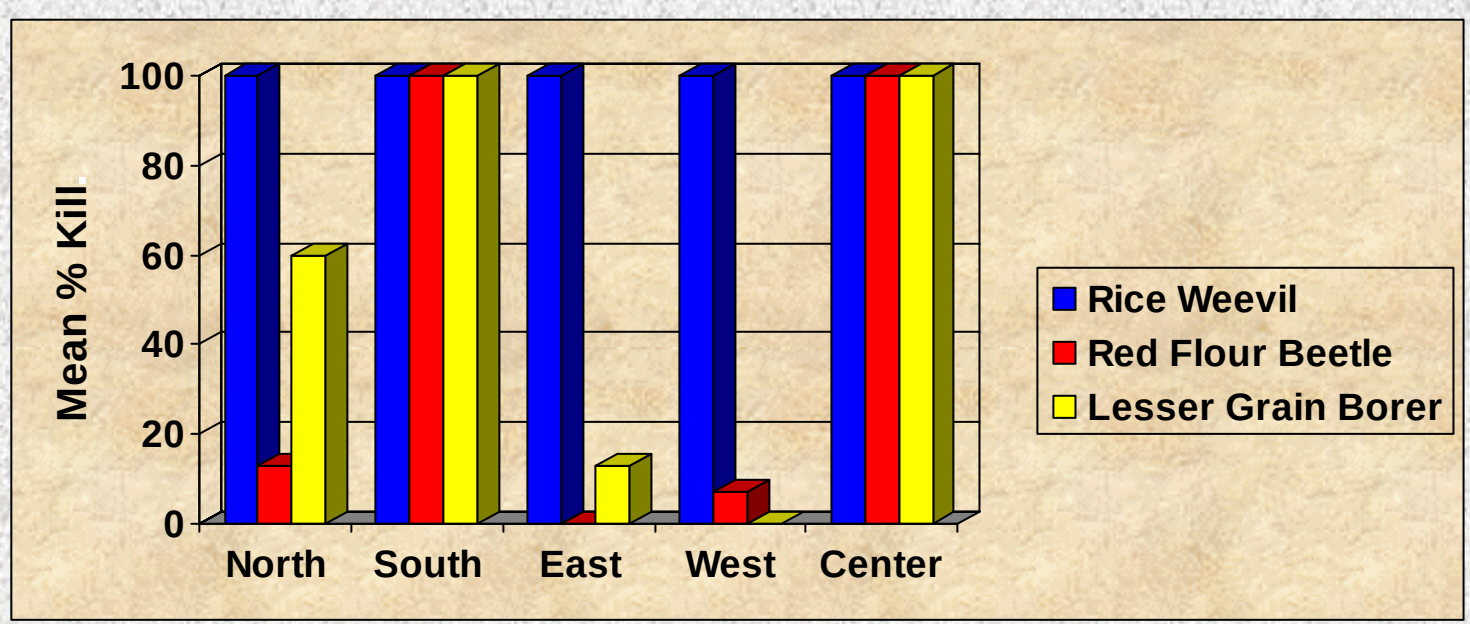

18 kW Heating Element
Below Drying Floor
Rep. 1
Temperature F
160
150
140
130
120
110
100
90
80
70
60
South & Center
All other locations below the 120 degree Red line.
12 Hour Period

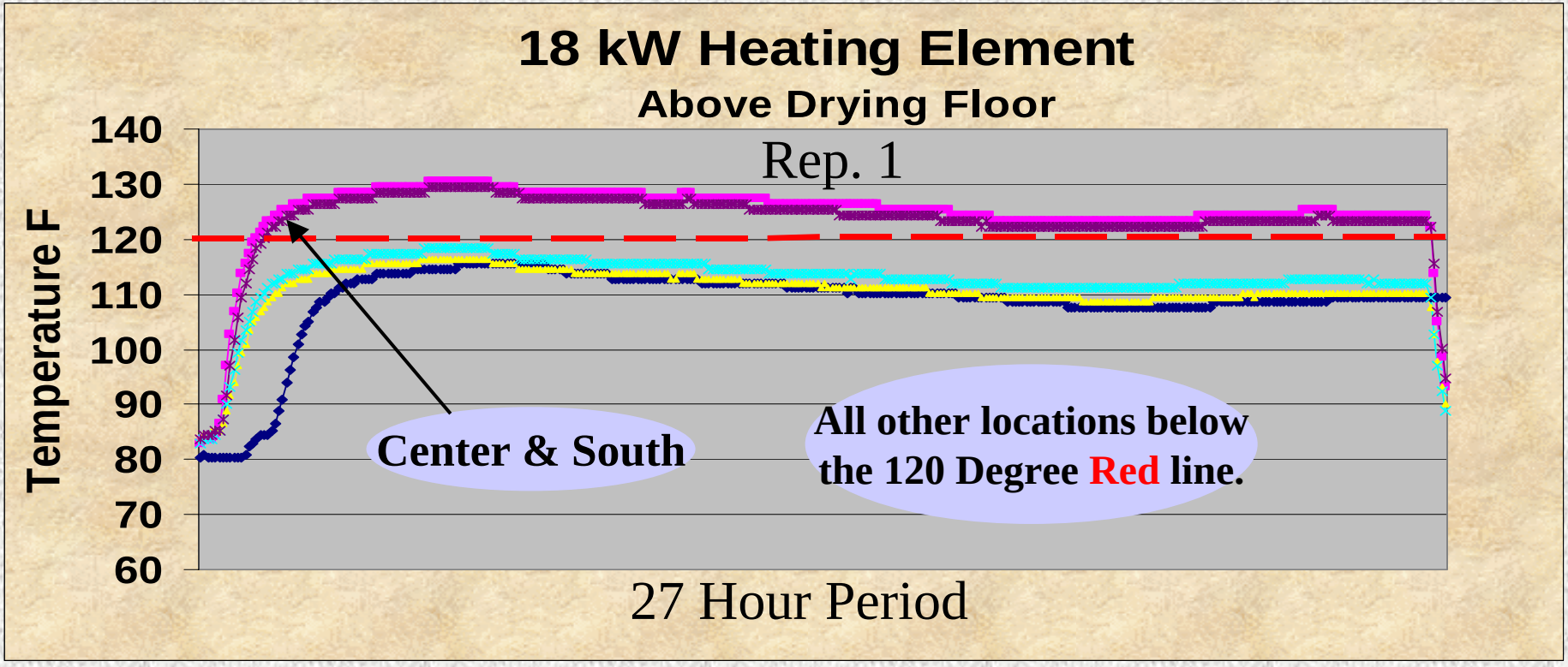

Mean % Kill
100
80
60
40
20
0
North
South
East
West
Center
Rice Weevil
Red Flour Beetle
Lesser Grain Borer

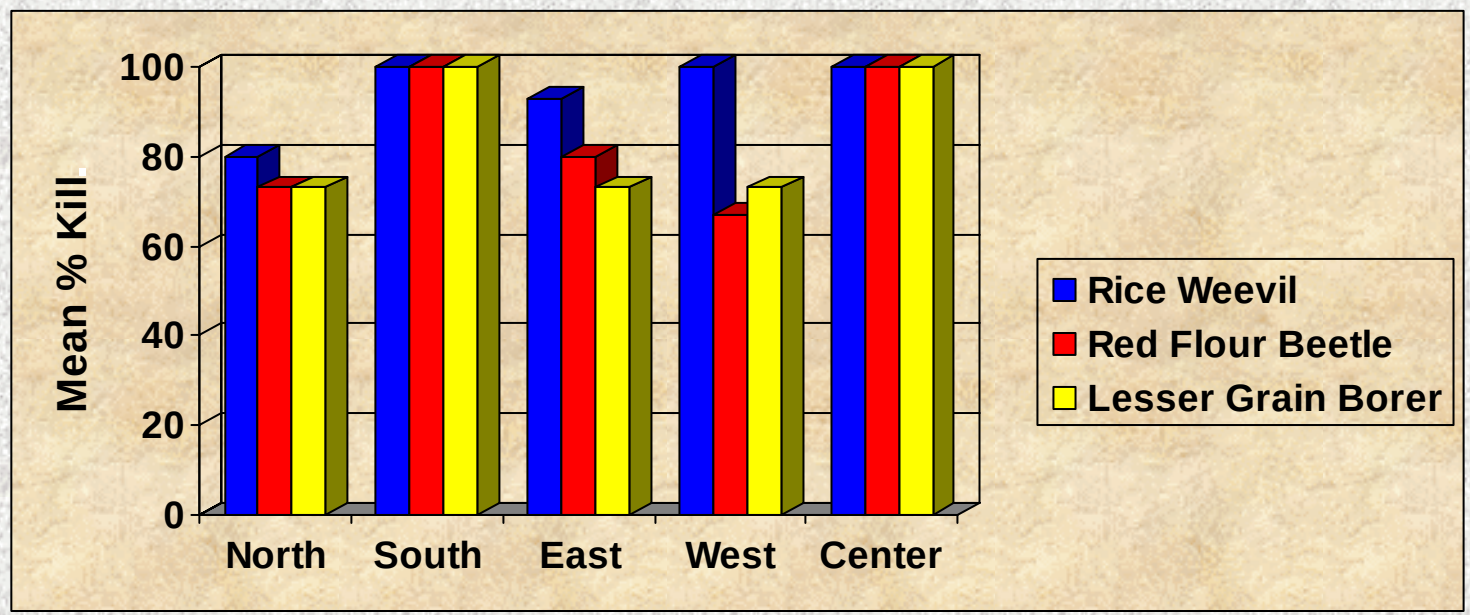

18 kW Heating Element
Above Drying Floor
Rep. 1
Temperature F
140
130
120
110
100
90
80
70
60
South & Center
All other locations below the 120 degree Red line.
12 Hour Period


Mean % Kill
100
80
60
40
20
0
North
South
East
West
Center
Rice Weevil
Red Flour Beetle
Lesser Grain Borer


18 kW Heating Element
Below Drying Floor
Rep. 1
Temperature F
160
150
140
130
120
110
100
90
80
70
60
27 Hour Period

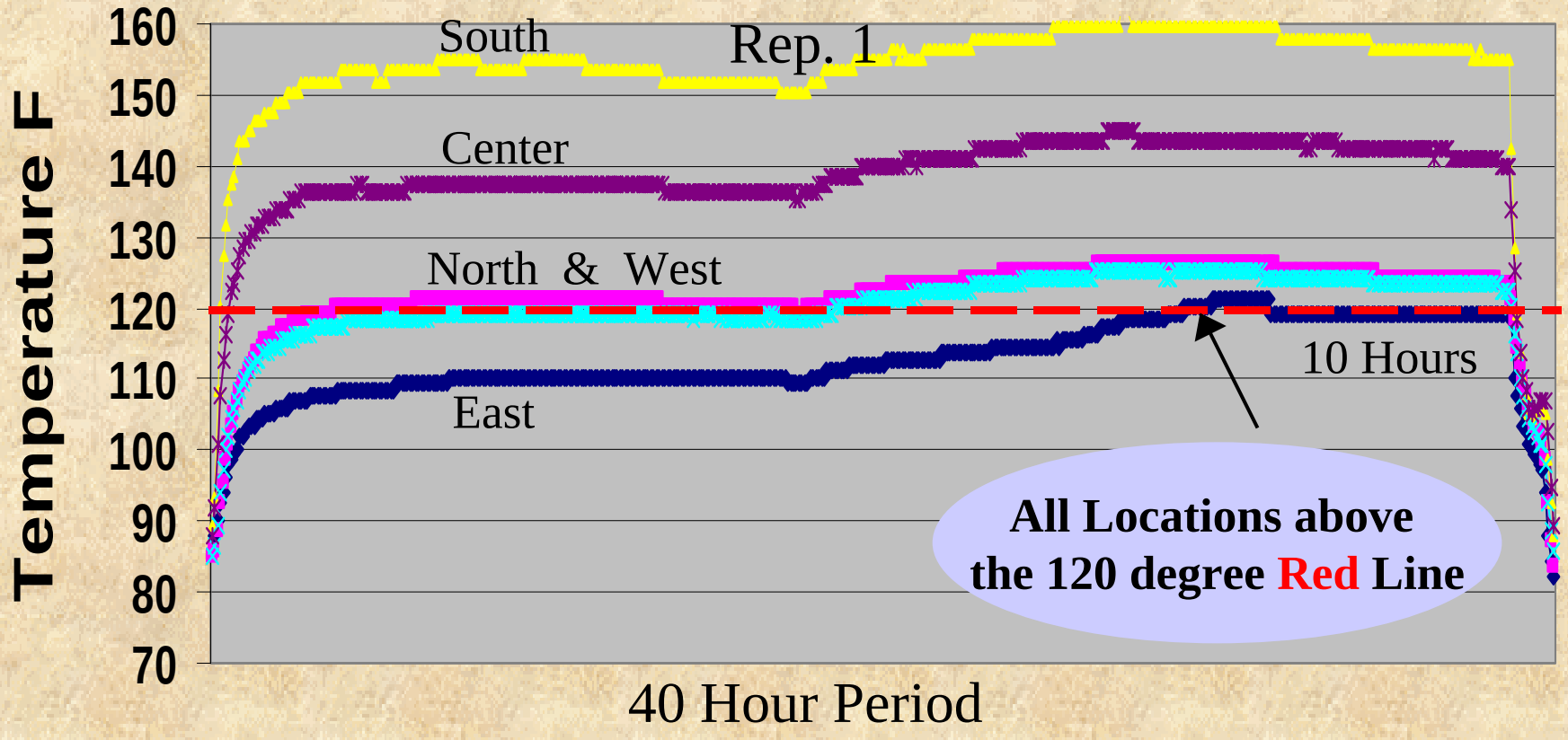

Mean % Kill
100
80
60
40
20
0
North
South
East
West
Center
Rice Weevil
Red Flour Beetle
Lesser Grain Borer


18 kW Heating Element
Above Drying Floor
Rep. 1
Temperature F
140
130
120
110
100
90
80
70
60
Center & South
All other locations below the 120 Degree Red line.
27 Hour Period

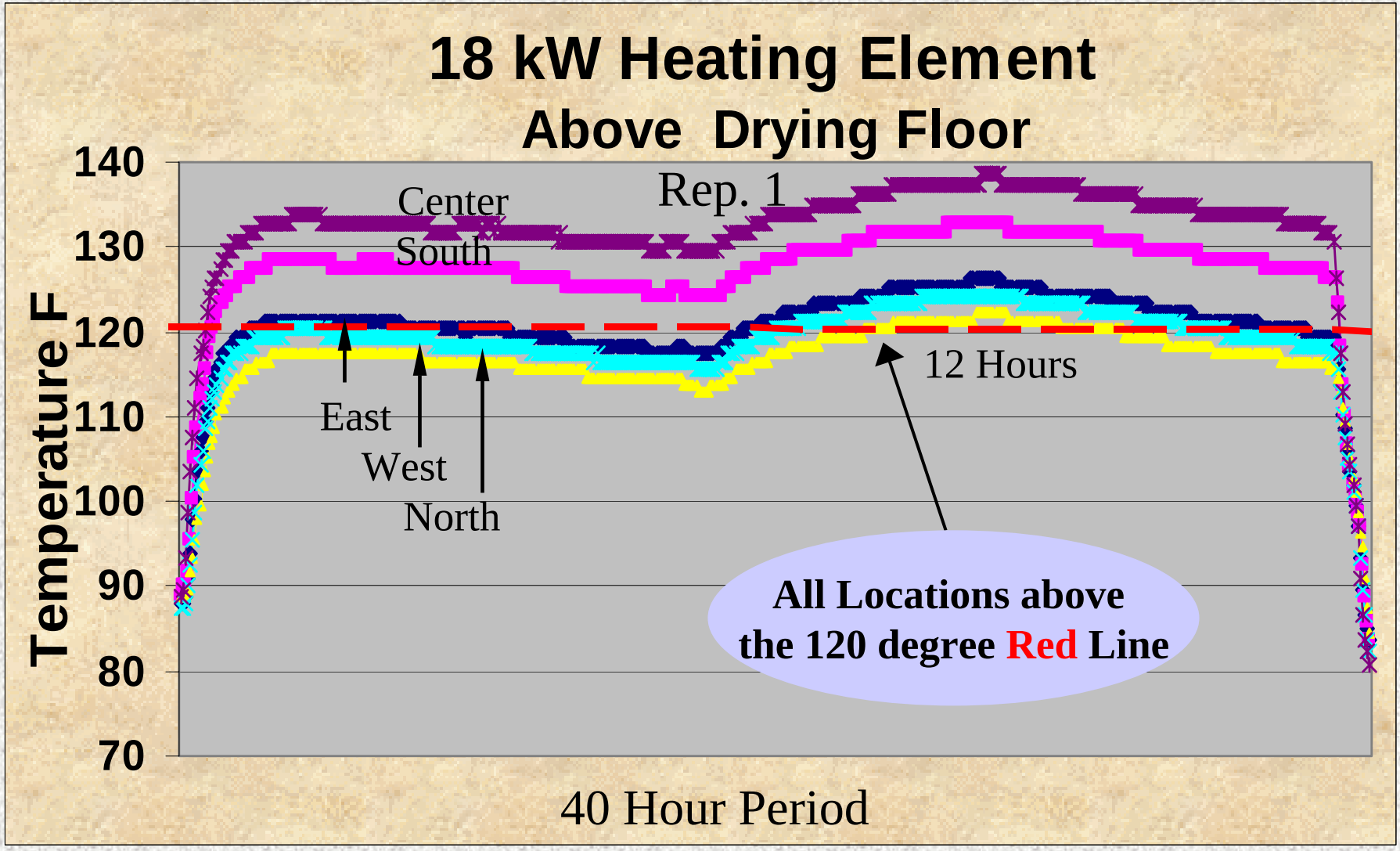

Mean % Kill
100
80
60
40
20
0
North
South
East
West
Center
Rice Weevil
Red Flour Beetle
Lesser Grain Borer

18 kW Heating Element

Below Drying Floor



100 % Kill

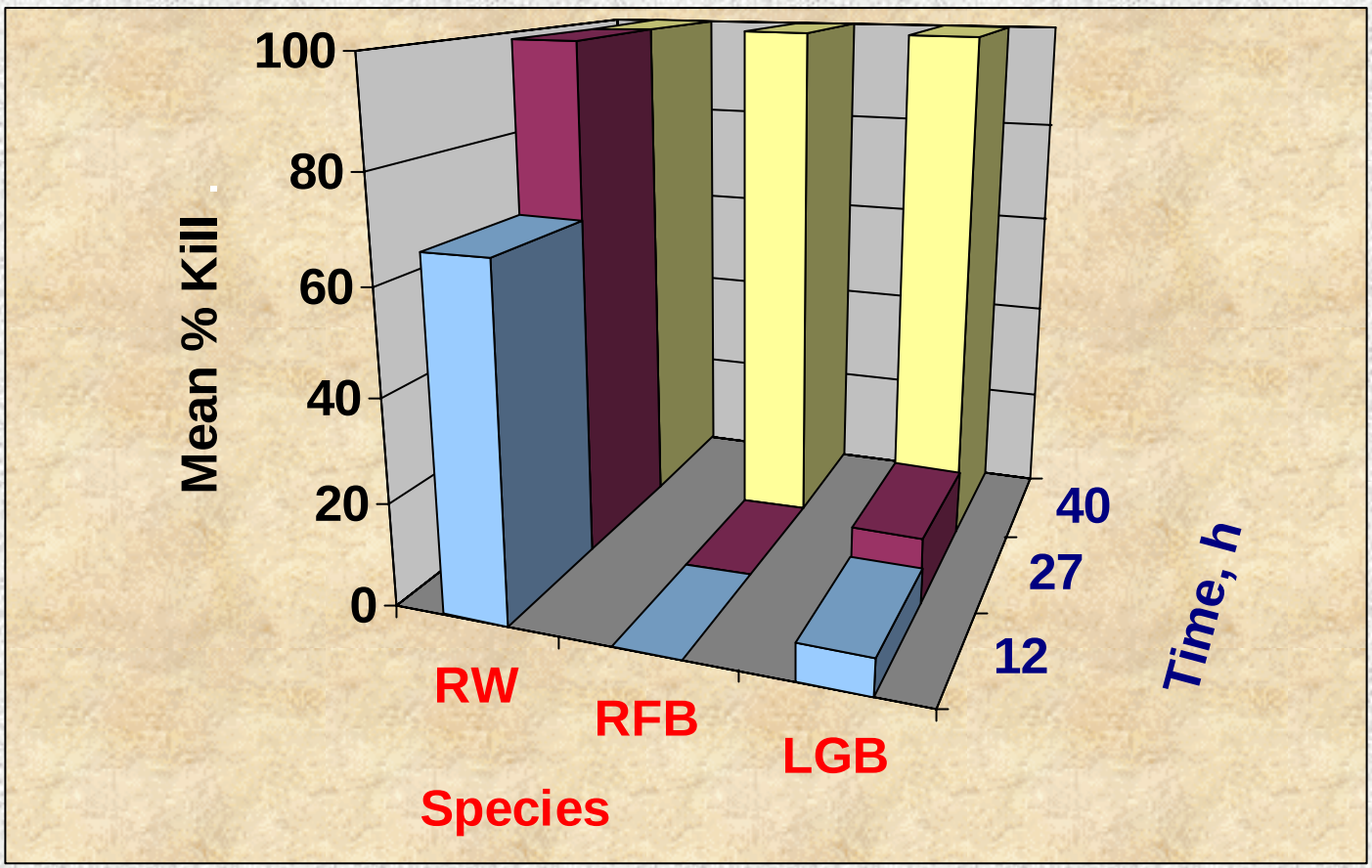

18 kW Heating Element
Above Drying Floor
Rep. 1
Center
South
East
West
North
12 Hours
All Locations above
the 120 degree Red Line
Temperature F
140
130
120
110
100
90
80
70
40 Hour Period

100 % Kill

18 kW Heating Element

Summary of Kill Results:

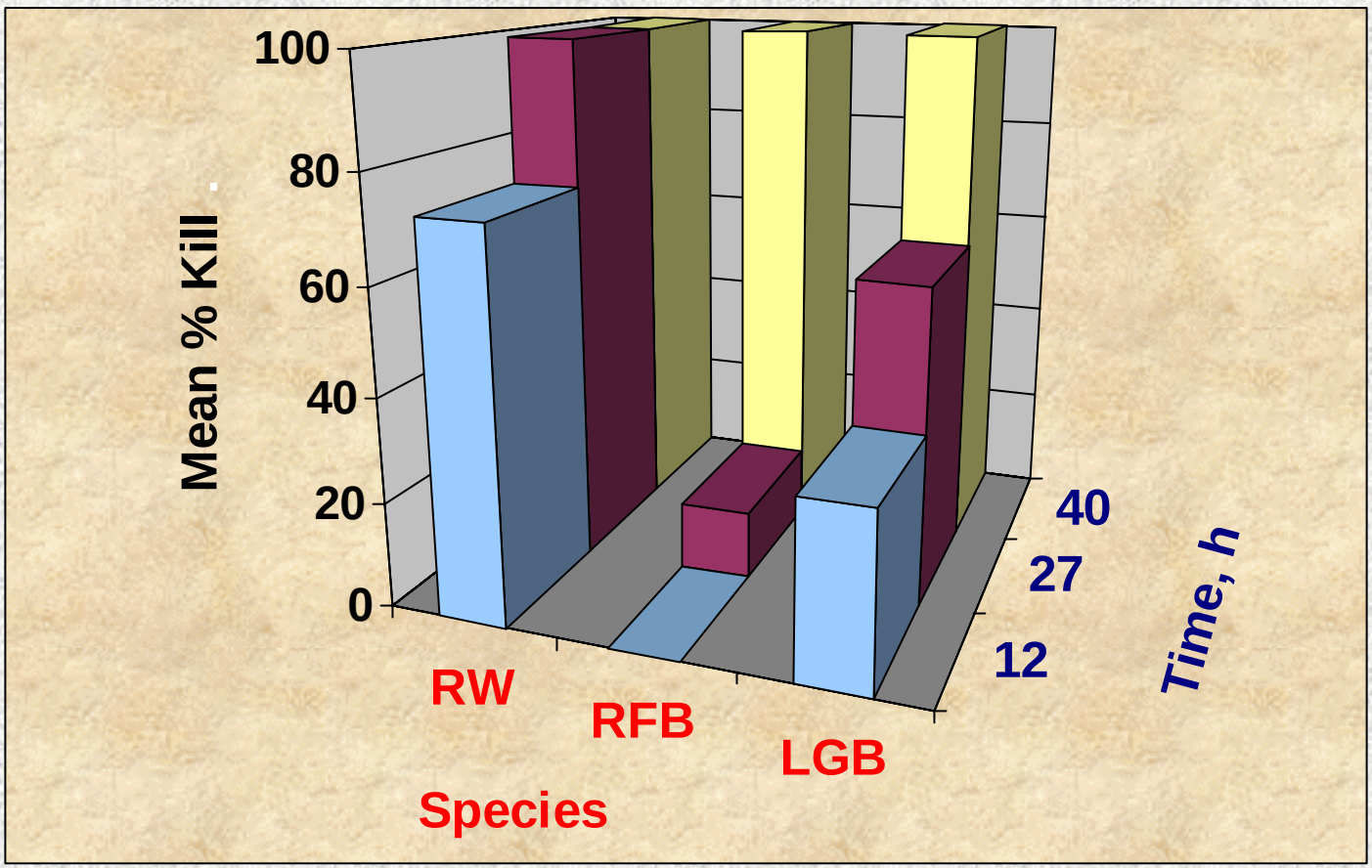
Below Drying Floor on the East Side



18 kW Heating Element

Summary of Kill Results:

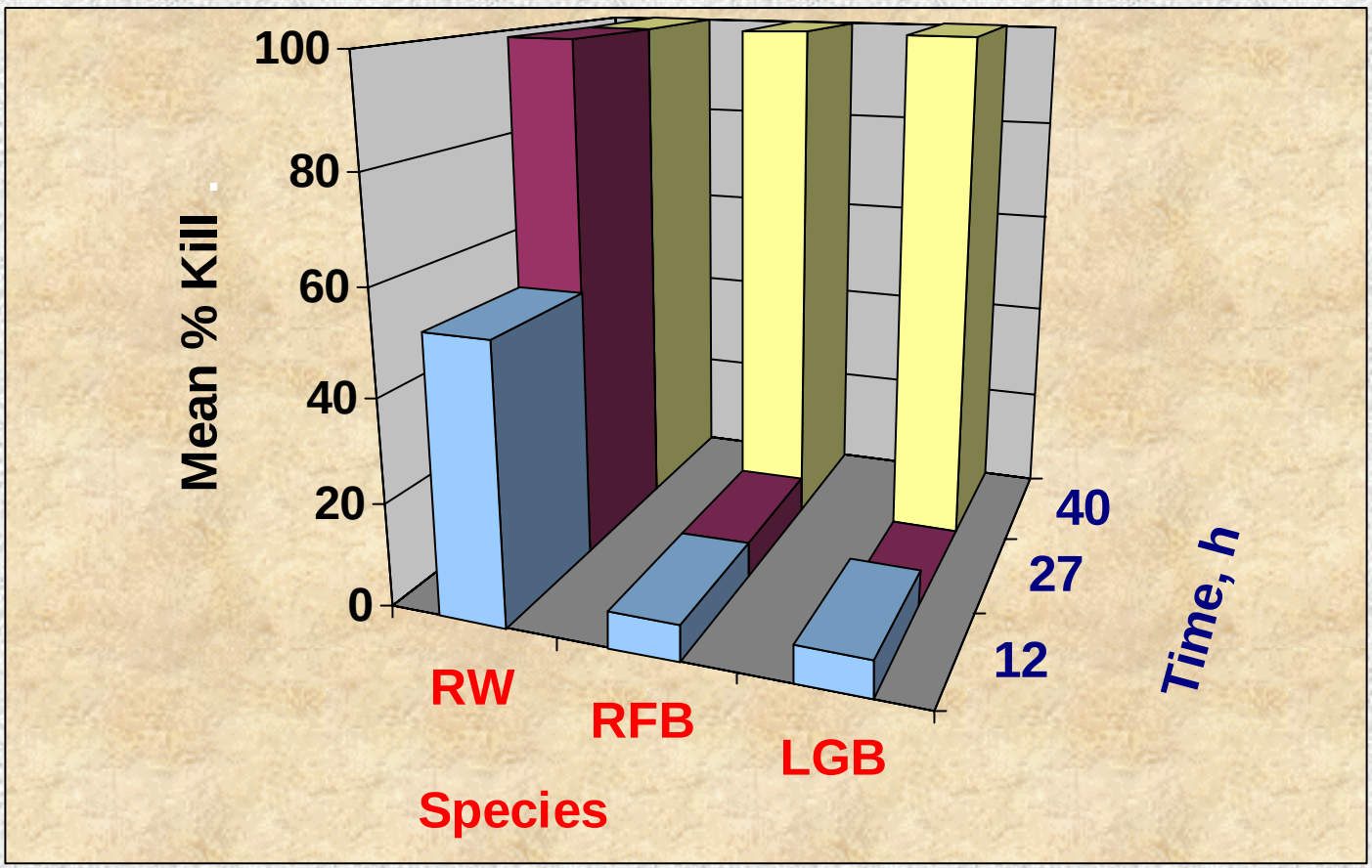
Below Drying Floor on the North Side



18 kW Heating Element

Summary of Kill Results:

Below Drying Floor on the West Side



Conclusions

* Sanitizing a steel grain bin using heat is a viable option.

* Heat can penetrate trash under drying floor.

* Distributing heat uniformly to all parts of the concrete floor can be difficult with small heaters.

Future Plans

* Repeat treatments with propane heater and forced air electric heat in the bin.
* Heat treatment of other bins on small concrete slab.
* Controlled time motion study of sanitizing a bin by removing flooring and manually cleaning.
* Development of economic model.