



# COLD STORAGE SOLUTION

## 3CORE

James Cremeans ~ Christian Guynes ~ Stephen Kelley ~ Nicolas Meacham ~ Ben Severe

Advisor: Gregory Kallio, Ph.D.

### PROJECT OVERVIEW

The purpose of this project was to create a cold storage solution for small to medium sized agricultural farmers.

The constraints of the project included:

- Reach and maintain internal temperatures between 32-55 °F.
- Hold desired temperature within the unit to +/- 2.5 °F.
- Engineer floor to allow Forklift accessibility.
- Design to use 15% less energy compared to industry standard.
- Design for modularity.

The objectives of the project included:

- Reduce waste and cost associated with current cold storage methods.
- Provide a more efficient cooling solution.
- Ability to increase volume based on need.
- Ability to be transported to all desired location.

### HOW IT WORKS

**Prototype:** Utilizes a standard vapor-compression AC system. This system, normally used as a window AC, was modified using a CoolBot. The CoolBot utilizes multiple sensors and a micro-controller to override the AC compressor. This allows the AC system to reach our required temperatures, which are far below normal settings.

**Full-Scale:** Uses a 7,300 BTU/hr split vapor-compression refrigeration system. This V-C system is able to cool the required 1280 ft<sup>3</sup> space. This is approximately 8 times the volume of the prototype.

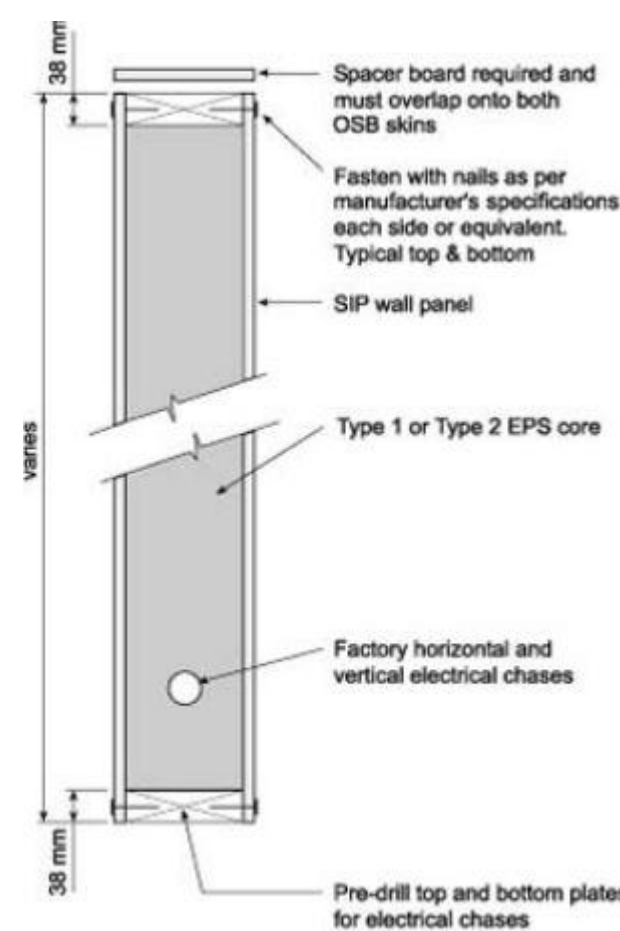


### FLOOR STRUCTURE

The floor is constructed with welded A500 rectangular steel tubing and fir planks in order to support a mid-size forklift. This was augmented with EPS foam to improve insulation.

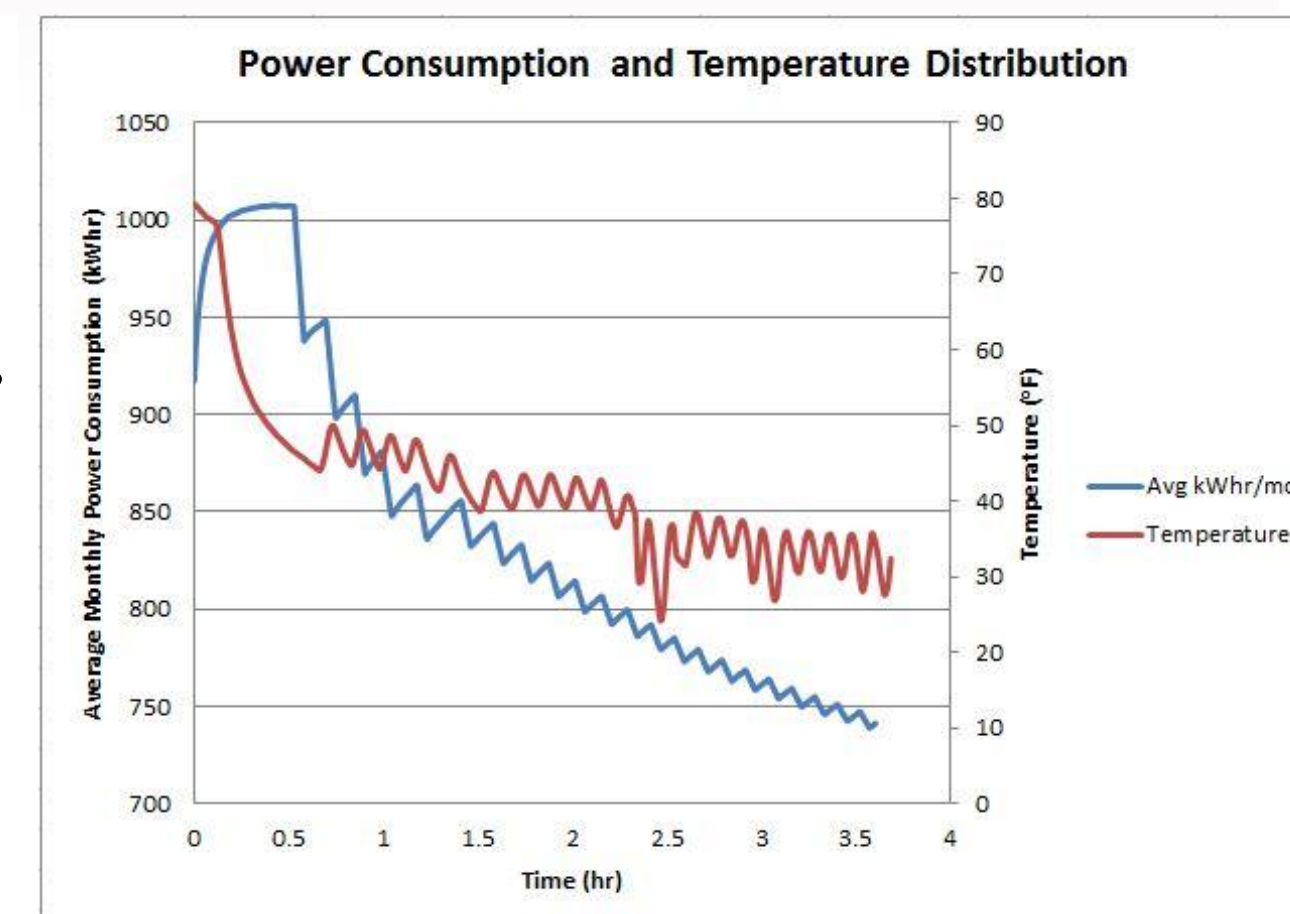
### WALL AND ROOF CONSTRUCTION

The walls and roof use structurally insulated panels (SIPs). These panels are made with expanded polystyrene placed between two sheets of oriented strand board (OSB). SIPs have many benefits for these cold storage units including ease of construction (lowering labor costs), superior R-value compared to normal stick frame construction, and increased strength. The exterior is covered with a gel coated fiberglass panel used in many different applications including RVs and houseboats. Fiber reinforced plastic (FRP) is used on the interior walls. These FRP panels are often used in food storage applications for the food service industry.



### THERMAL ANALYSIS

A thermal analysis was conducted using EES to determine the total heat rate of the unit at worst case conditions of 108 °F, clear, windy and sunny day. This analysis was used to optimize the floor design and help determine the required SIP thickness. The sizing of the refrigeration unit was then determined by using the obtained heat rate and SolidWorks flow simulation.



### TEST RESULTS

**Power:** The power test showed approximately a 50% duty cycle on the AC and dropped to just below an average of 750 kWh per month.

**Temperature:** The spatial distribution was within 2°F and the temporal distribution was within 6 °F due to the A/C duty cycle.

**Floor:** Zero plastic deformation was detected in the steel tubing.

### PROJECT OUTLOOK

This solution will provide local agricultural farmers with on-site cold storage. It will reduce their food waste and cost associated with the transportation and renting of current cold storage facilities. This solution will also increase the exchange of local produce to local businesses.

