Testing Procedures

F2 – SRP Solar Air Heater

Table 1: Engineering Requirements

Engineering Requirements	Target	Tolerance	Rationale
Size	4x8x2 ft.	±4 in.	To maximize the dimensions of the SolarThermiX STX 7000 solar air heater.
Cost	$2,500	N/A	The allowance given by SRP. The cost of design, prototyping, and testing should not exceed $2,500.
Weight (PCM)	50 lbs.	± 10 lbs.	To be able to safely lift the PCM off the SolarThermiX heater and bring inside the home.
Heat Absorption	73° to 80° Fahrenheit	± 3° Fahrenheit	PCM must be able to heat up the home within this temperature range.
Ease of Assembly/Installation	≤2 hours	N/A	Assembly of the solar air heater and placement of the PCM should not exceed 2 hours.
Lifespan	10 years	+ 1 year	The solar air heater and PCM must have a lifespan of 10 years as specified by SolarThermiX.
Heat Storage	8 hours	± 2 hours	PCM must be able to heat up the home for at least 8 hours.
Flow of Energy	7.9 MJ/hr.	N/A	The flow of energy specified by SolarThermiX STX 7000.
Maintenance	$300	N/A	The cost of repair of the solar air heater or replacement of the PCM should not exceed $300.

Size

The team specified that box would be 48x96x24 in. The actual dimensions of the box are 48x94.5x28 in.

Length: 94.5 inches

Figure 1: Length Measurement of the Box

Width: 48 inches

Figure 2: Width Measurement of the Box

Height: 28 inches

Figure 3: Height Measurement of the Box

Cost

The amount allocated to our project was $2,500. The amount spent was $2,473.16.

Table 2: Cost for Solar Air Heater System

Item	Cost	Quantity Needed	Size Of Materials	Function	Part Number/Company Producing
Solar Air Heater	$1,500	1	4 ft. x 8 ft.	Heating Air	STX7000/SolarThermix
PCM(Phase Change Material)	$24.00	9	4 in. x 2 ft. x 4 ft. x 8 lbs.	Controlling the temperature	Infinite R/InsolCorp.
Travel	$50	N/A	153 miles	Travelling to Competition	N/A
Battery	$150.00	1	12 volts./55Ah	Used for powering the coil	UB1250/Universal Battery
Coil	$11.72	2	3 x 7 x 3 inches	Heating PCM	5300622034/Garp
Arduino Uno	$19.22	1	9.8 x 6.6 x 2.4 inches	Controller for electrical use	A000073/Arduino
Fan	$19.99	2	120 by 120 by 38 mm	Moving air in from the coil area	PMD1212PMB1-A/Sunon
Thermasheath Rmax	$34.00	2	2 in. by 4 in. by 8 ft	Made into a wall for separation air flow	#416989/Thermasheath
Green Rhino Box	$300.00	1	4 ft. x 8 ft.	Durable for nature, contains air from escape	Green Rhino
Speedi-Collar Open/Close	$10.30	2	5 in.	Change air flow direction	#1000677624/Speedi-Collar
Insulated Flexible Duct	$26.75	1	5 in. x 25 ft.	Channels air flow	#1000683500/Master Flow
Master Flow Wye	$11.25	1	4 in. x 4in. x 4in. Wye	Channeling air flow	#232940/Master Flow
Solar Panel	$90.00	2	100W at 12 volt system	Used for recharging the battery	GS-Star-100W/GrapeSolar
Rebar	$4.20	2	3/8 in. x 20 ft.	Rack for PCM	REB/3/615G40/20
Total	$2,473.64	Not including tax			
Total Budget Left	$26.36				

Weight

Each sheet weighs 6.4 pounds. It met the weight requirements of being under 10 lbs.

Figure 4: Weight of PCM

Heat Absorption

Our box was able to heat the home up to about 73-74 degrees Fahrenheit. We had thermometers posted at 9 inches, 14 feet, and 23 feet from the box in the 566 sq. ft. apartment room. We do not have a video for the progression since the thermometers were measured from 1 PM to 6 AM.

The first thermometer was 9 inches from the duct transporting hot air into the house, it reached almost 100 degrees Fahrenheit.

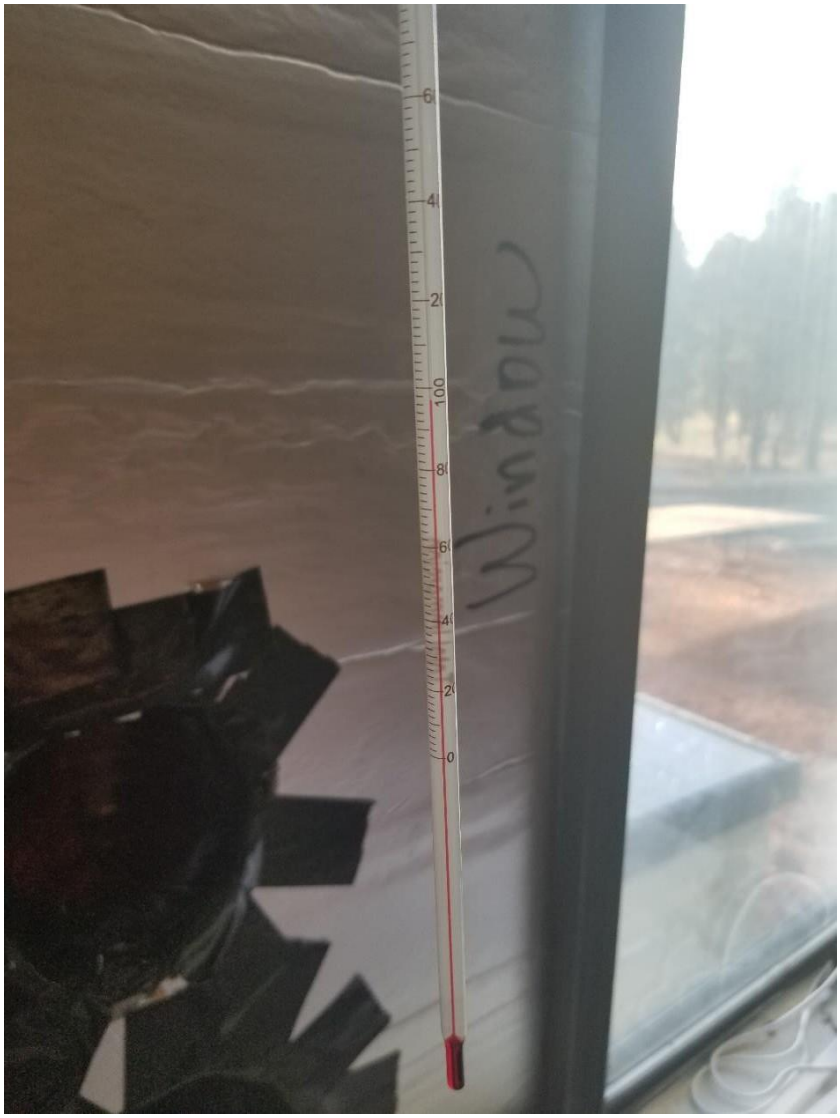

Figure 5: Temperature Reading from 9 Inches Away From Heat Source

The second thermometer was placed 14 feet from the duct into the house and reached about 74 degrees Fahrenheit.

Figure 6: Temperature Reading from 14 Feet Away from Heat Source

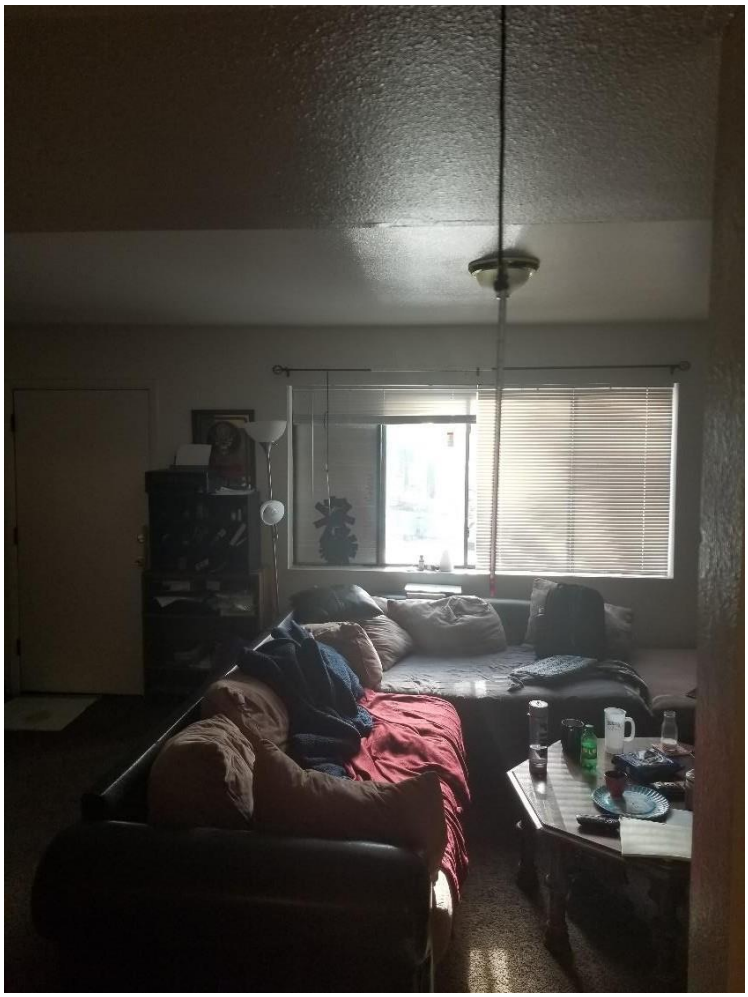

Figure 7: Distance from 14 Feet to the Duct

Picture on the left is the second thermometer reading and the right is showing the distance to the duct

The third thermometer reached about 74 degrees Fahrenheit and was located 23 feet from the duct into the house.

Figure 8: Temperature Reading from 23 Feet Away From Heat Source


Figure 9: Distance from 23 Feet to the Duct

The picture on the left shows the measurement reading, and the picture on the right shows the distance to the duct.

Ease of Assembly

The only parts that should need assembly are the connecting of the ducting from the solar air box to the house. The box should come fully assembled. The attaching of the ducts can be connected through a window with insulation put over it, or 2 small 6 in. and 4 in. holes can be cut into the home to attach the box, overall it should not take more than 2 hours. To install on the window for testing took about 40 minutes.

Lifespan

The box that was made is made of Styrofoam and a concrete stucko mixture. We visited a home in Phoenix, AZ that was made from the material and has been standing for over 15 years with little wear to the home. The solar air heater by SolarthermiX is made of metal and very sturdy. The ROTC building on the NAU campus has several air heaters attached to it and have no signs of wearing to them. We do not have an accurate estimate for how long they will last. Further information can be found on their website: http://www.solarthermix.net/heat.

Figure 10: SolarThermiX Solar Air Heater on RTC Building

Heat Storage

During the day the solar air box can keep the house above 70 degrees Fahrenheit. The PCM was able to last by itself from 6 PM when the solar air heater on top was shut off till about 12:40 AM and kept the apartment about 66 degrees Fahrenheit until then. It lasted about 6 hours to keep it at 66 degrees Fahrenheit. Even though it was not able to hold the temperature above 73 degrees Fahrenheit during that time the solar air box has plenty of room to add more PCM to fit the users need. Videos of our box can be found in the gallery section of our website.

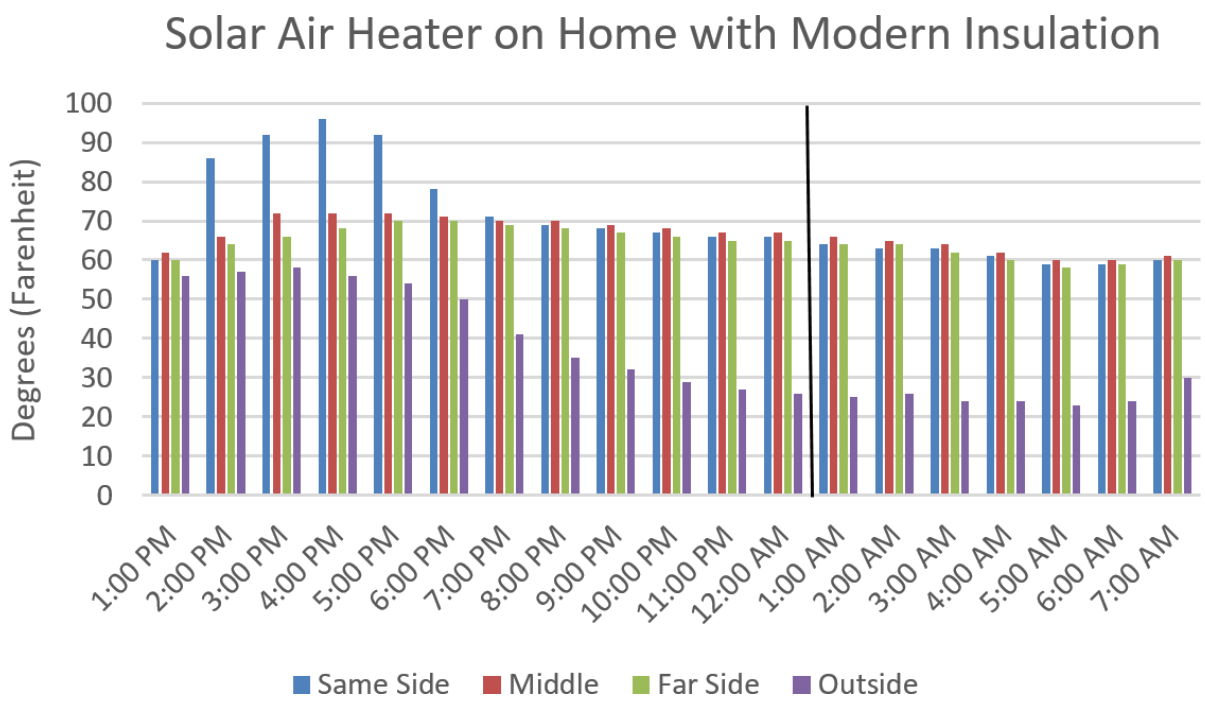

Figure 11: Results from Temperature Readings of Thermometers 9 inches, 14 Feet, and 23 Feet Away from Duct

Flow of Energy

This was for the SolarthermiX solar air heater that we used for our box. It is a preexisting system and that was the specifications given to us by the team from SolarthermiX. More information about the air heater can be found on their site: http://www.solarthermix.net/heat.

Maintenance

The maintenance needed on the box would be to buy concrete mixture and patch any weathering that may occur. The fans my need to be replaced after several years but are inexpensive and are approximately 11 dollars each. The PCM may wear down if moved into the home constantly without care and cost 24 dollars per sheet, but the box is designed to be able to hold the PCM with no need to remove it from the box. The battery may need replacing after several years and has a price of 150 dollars. The user should not have to spend more than 300 dollars in the 10 years to maintain the box.