Active Roof System

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Operation Manual

Document

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Chapter 1. Generator

To set up the generator the following items are needed: the generator, unleaded fuel and oil.

Verify that the generator is capable of provided more than enough power to the simulated sun, and then move the generator to an outdoor location and have the exhaust blowing away from any building intake. This is done to prevent any carbon monoxide inhalation. Once the generator is in its final location, fill gas reservoir with unleaded fuel until there an 1 ⅔in gap of air at the top, and check that the oil level is visible when the yellow oil cap is removed. If the oil is not visible then add more oil until it is. Next, turn choke to on position and pull starting cord until engine has started. One engine is on slowing lower choke level until no choke is needed to help maintain the engine RPM's. Allow engine to run for a few minutes until the engine has warmed up properly. Plug extension cords into the outlets on the generator, one for each breaker to not overload. After testing is complete it is necessary to drain fuel before storage. Turn off generator and turn off gas valve, done by the yellow tab, remove fuel hose from engine and place in a fuel container. Turn on valve and allow gas to flow into fuel container until the fuel reservoir on generator is empty. Place fuel hose back on engine nipple and store.

Chapter 2. Simulated Sun

The following items are needed to set up the simulated sun: the simulated sun frame, light board, 25 100W incandescent light bulbs, 2 breaker boxes, and 2 50ft extension cords.

First, move the simulated sun frame into the desired location. Do not stand nor sit on light stand; the simulated sun frame was not designated to withstand human weight capacity. Then, lift the 4ft by 4ft wooden board with the light sockets (light board) up into the lip on the simulated sun frame (see Figure 2.1 below).

Figure 2.1: Light Board Sitting on Simulated Sun Frame

Connect all 25 incandescent light bulbs to the existing sockets (see Figure 2.2 on the following page).

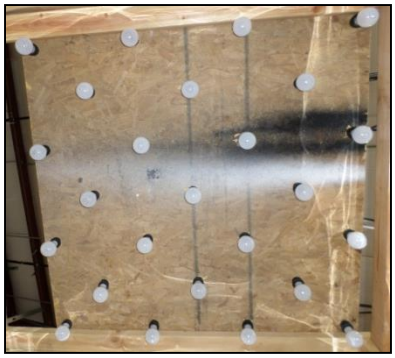

Figure 2.2: Light Bulbs Installed in Light Board

Plug the four power cords hanging from the light board into the breaker boxes (see Figure 2.3 below).

Figure 2.3: Breaker Boxes with Power Cords Plugged-In

The generator should be running at this point. Ensure that the breakers on the generators have been reset. Then, plug the two extension cords into the generator outlets. Never operate the generator with the extension cords already plugged into the generator outlets. Plug the breaker boxes to the other end of the extension cords. Flip the switch on both breaker boxes to the on position and verify that all of the lights are on.

If one or more lights do not turn on, immediate flip the switch of the breaker box off, and turn off the generator. In this case, check if the light sockets of the light bulbs which didn't turn on are in proper working order. If they are not, replace them. If they are, then check the wiring in the blue electrical boxes to ensure a proper electrical connection. These two issues are usually what is wrong when light bulbs on the simulated sun won't turn on.

Chapter 3. Scale Modeling Building

For this assembly, only the following is needed: a table of that is at least 4.5ft by 3ft and approximately 3ft tall, the scale model building, and some painter's tape.

Place the model building in the middle of the table. Then, clear a 94.5inches (7ft and 10.5in) by 5ft square of floor space. Place move the table into the middle of this cleared space. Finally, use

the painter's tape to make the placement of the table legs, so that before each test the table placement can be checked.

Chapter 4. A/C System

To set up the A/C system the following is needed: the water pump, two hoses that are at least 4ft long, the yellow hose that comes with the water pump, the modified cooler, a triple tap outlet power splitter, and the scaled building model.

Fill the modified cooler with ice and water, then place the water pump intake hose/ filter into the bottom of the cooler and connect the inlet hose to the inlet side of water pump (see Figure 4.1).

The next hose connection is the hose that connects the pump to the copper piping system. Connect the female end of the hose to the outlet side of the water pump and connect the hose to the female end of the copper piping. The third and final hose is connected to the male end of the copper piping and runs back into the cooler to recycle the water. These hose connections to the A/C piping coming out of the model building are shown in Figure 4.1 below:

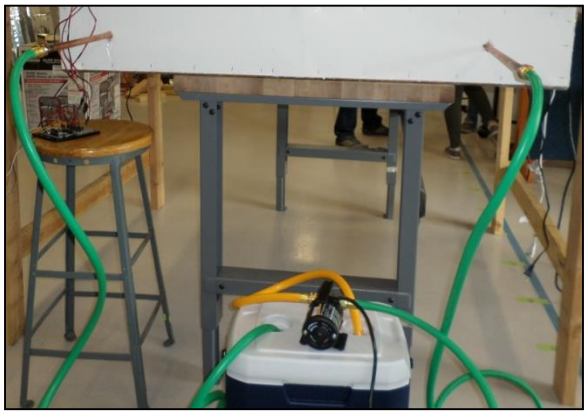

Figure 4.1: A/C Setup

The last step is connecting the pump to the temperature monitoring system by plugging fans and the water pump into the triple tap outlet power splitter, and then connecting that to the power switch with will be connect to the Arduino. This will allow the temperature monitoring system to turn the entire A/C system on and off.

Chapter 5. Temperature Monitoring System

The following is needed to assemble the temperature monitoring system: four thermistors that are at least 5ft long, electrical tape, Arduino board, pre-written code for Arduino board, 3ft high stool, power switch that can be controlled by the Arduino board, and a laptop with UNO software.

First, make sure all four thermistors are placed and attached to their proper locations inside of the model building: One in the far corner and three in the middle of the prototype arrange as shown in Figure 5.1 below:

Figure 5.1: Placement of Thermistor Locations Inside the Model Building

Check that the Arduino wires are all connected and fixed to avoid error reading (see Figure 5.2 below).

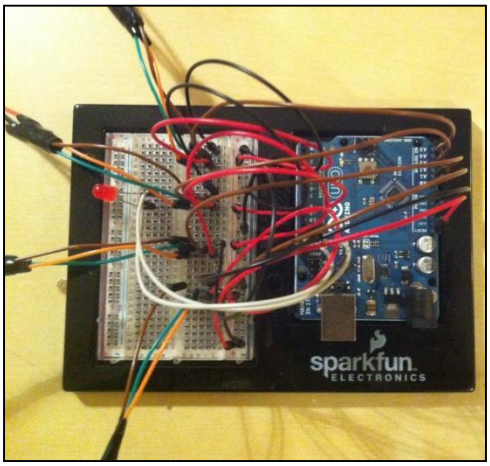

Figure 5.2: Wires Plugged into Arduino Board

Connect the power switch to the Arduino and make sure the "+" in wire is connected to the power pin on the Arduino; the ground wire is connected to the ground pin on the Arduino and the - in wire is connected to Analog A5. Connect the USB cable to the Arduino and laptop. Open UNO software and upload the code to Arduino. Open PLX-DAQ software and make sure that the USB port number is the one linked to Arduino. Check the Download Data box and click connect to start logging data.

Chapter 6. Simulated Sun Movements

Brightly colored painters tape should be used for marking the floor. First, measure out 7ft and 10.5in on the floor. Your starting position should be closest to the generator while still being

indoors. Place one end of the painters tape at your starting position and stretch the tape across the floor to the measured 7ft and 10.5in. Place the end of the tape strip at this measurement mark, making sure the tape line is as straight as possible.

At the starting position, place a strip of tape perpendicular to the long strip. Stretch the tape across the floor so it is as wide as the simulated sun (4.5ft). The top of this strip is the "zero" starting point. Repeat this process so the top of each perpendicular strip is 10.5 inches away from the top of the last strip. There should be a total of nine perpendicular strips stretching across the width of the simulated sun. Beginning at the starting point, label each perpendicular strip one through nine to represent each move. These nine moves are used to simulate an expedited day.

The reason for an odd amount of moves is due to the center move, which is move five, is to have a time period during testing which represents 12pm to 2pm. This is generally the hottest part of the day, and therefore it needs to be represented by the simulated sun being directly over the roof prototypes.

During testing, the simulated sun needs to be moved every six minutes and forty seconds to a new marked position.

At the simulated sun's starting position (position 1), the Mylar on the front side should be removed so that the radiation can come in at an angle resembling the sun rising (see Figure 6.1). Then, once the simulated sun is directly over the model building at position 5, the Mylar on the front side needs to be added back on so that all the radiation can be directed towards the roof prototype. Finally, remove the Mylar sheet on the back side of the simulated sun so that the radiation angles can resemble the sun setting.

This movement of the simulated sun during each test is illustrated in Figure 6.1 below:

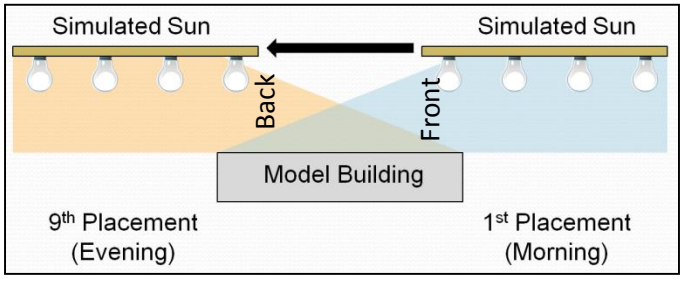

Figure 6.1: Simulated Sun Movement During Testing

Chapter 7. Active Roof System Movements

The active roof panels should be rotated at the same rate as the simulated sun movement. Therefore, there should be a total of nine new angular positions for the reflective panels of the active roof, and at position five the panels should be completely horizontal to shield the roof from the radiation of the simulated sun.

The active roof panels should be rotated at the same rate as the simulated sun movement. This can be done by moving the rod attaching all the reflective panels together to its proper angular position by placing the screw attach to the rod into the correct hole on the peg-board (see Figure 7.1 below).

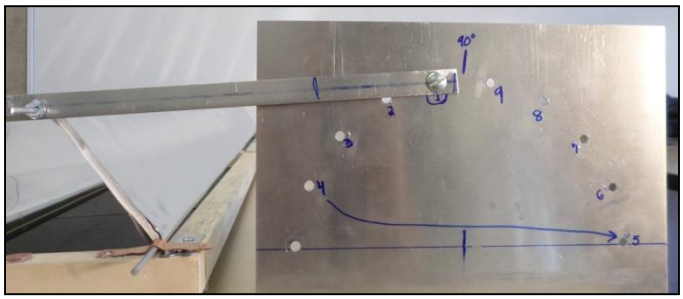

Figure 7.1: Peg-Board used to Control the Active Roof System Prototype

In Figure 7.1, the panels are shown at position 1, which represents the morning where the sun is just starting to rise.

Chapter 8. Testing Procedures

The testing apparatus includes the three different systems previously assembled: the simulated sun, temperature monitoring and A/C system. How all of these systems fit together is shown in Figure 8.1 on the following page.

All testing of the three prototype roofs should be done in the same controlled environment, such as a large, indoors, temperature controlled room. Doing this will reduce variable factors such as wind, rain or other weather events which could cause errors between the test trials. Each prototype roof should be tested twice using one hour long testing sessions.

During each of these one hour long tests, the simulated sun should be moved as described in Chapter 6.

At the end of each test:

- The light bulbs of the simulated sun need to be turned off by flipping the off switch on the power boxes.

- The temperature readings and recorded times when the A/C system was on needs to be saved under an identifiable name, so that it will be available for any future analysis.
- The prototype type roof needs to be removed and the poster paper and cork roll which makes up the ceiling of the scale model building needs to carefully be rolled back so that the inside of the model building can return to approximately 70°F before the next test starts.

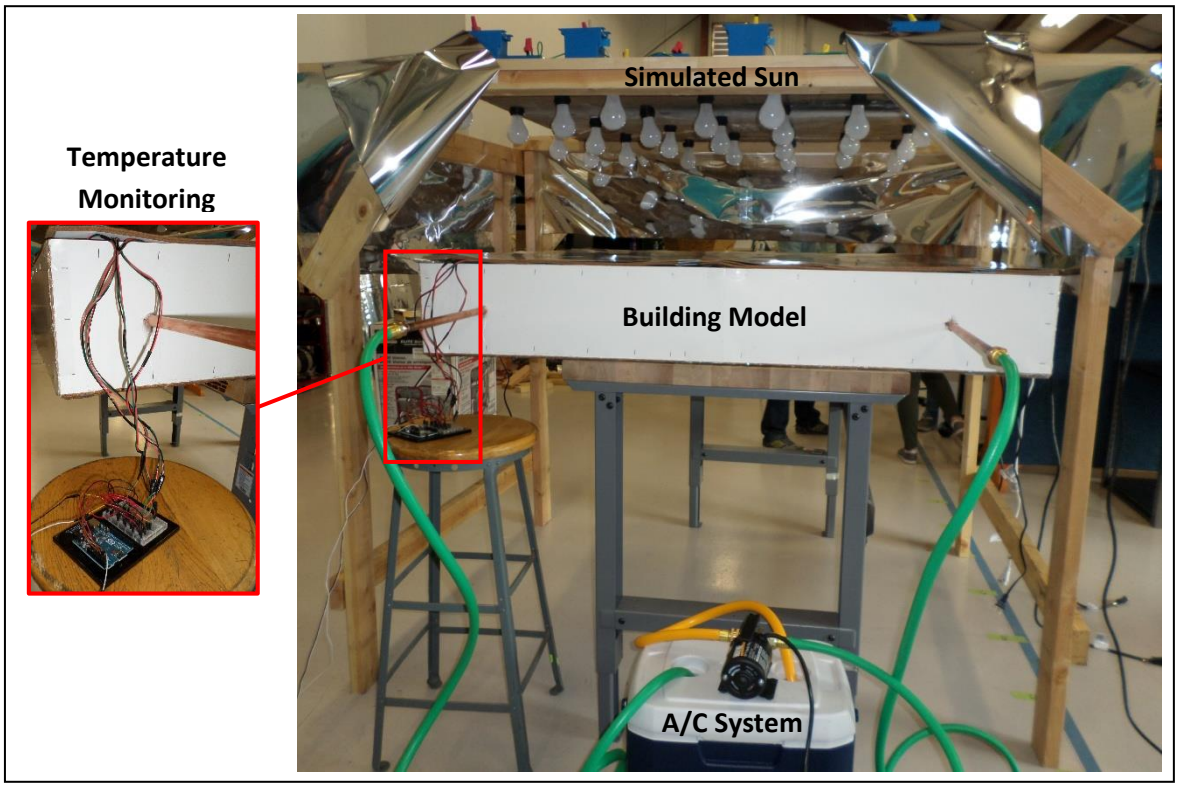

Figure 8.1: Front View of the Testing Apparatus

The temperature on the inside of the model building during this cool down may be monitored by the temperature measuring system. Once the interior of the modeling building has returned to 70°F, then the ceiling can be closed and the prototype roof being tested next may be placed on top.

Now the next test may be started. However, every two or three tests the oil and gas level of the generator should be checked, and to do such the generator needs to not be running.

Chapter 9. Safety Concerns

Due to the heavy amount of wiring that was used to construct the simulated sun, that system has some specific safety precautions.

The first safety precaution is that no wiring, light bulbs or extension cords should ever be touched while the simulated sun is plugged in to the generator. Tampering or adjusting the wiring or light bulbs while the simulated sun is plugged in can lead to physical harm to both the system and the operator. So in order to turn off the light bulbs of the simulated sun, the switch on the power boxes must be used.

Another safety concern has to do with the placement of the generator. The generator must be placed far enough away from the testing room to prevent the exhaust fumes from entering. Also, the window or doorway which the 50ft extension cords run through needs to be propped open only big enough to allow the wiring to pass through, and this will also help the exhaust fumes to not enter the room.

Finally, before beginning testing please located the nearest fire extinguisher and defibrillator just in case of an emergency.