CORNERSTONE INNOVATIONS, INC.
CASE STUDY – PERMAFORM
HOLMES TESTING, INC.
170 SHEPARD AVENUE
WHEELING, ILLINOIS

December 6, 2013

HOLMES TESTING, INC.

• 170 Shepard Avenue • Wheeling, Illinois 60090 • 847-541-4040 • Fax 847-537-9098

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December 6, 2013

Attn: Mr. Kevin Westaby
Cornerstone Innovations, Inc.
1775 Balsam Avenue
Alexander, Iowa 50420

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CASE STUDY REPORT

HOLMES TESTING, INC.

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Attn: Mr. Kevin Westaby
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Re: Summary of Results for the Permaform Case Study, Holmes Testing Laboratories, Wheeling, Illinois

PURPOSE:
To determine if the use of the Permaform insulation and their various coatings around the concrete walls and footings reduces the heat lost from the inside of a structure.

PROCEDURE:
Holmes Testing, Inc. (Holmes) used an environmental chamber to simulate winter conditions. The door of the environmental chamber was removed and replaced with the concrete filled Permaform on the bottom half and fiberglass insulated standard drywall on the top half. The Permaform was filled in with concrete from Meyer Material Company with a mix designation of 9030L. No concrete was present on the fiberglass half of the wall. A sand bed was placed underneath the wall with a heating element to simulate the temperature of the soils underneath the footings. The sand was able to maintain room temperature without additional heating, therefore the heating element was turned off after a few hours of starting the test.


The construction of the concrete wall with the Permaform

Prior to the placement of the concrete, Nomad temperature readers were installed through out the wall to monitor the temperatures. A total of thirteen (13) Nomads were installed, eleven (11) of which were inside the actual wall and the remaining two (2) were used to keep track of the room and chamber temperatures, respectively. The Nomads within the wall were located at the front of the wall (closest to the room), the middle of the wall, and the back of the wall (closest to the chamber) in order to show the temperature profile throughout the wall.

Installation of the Nomad temperature readers

The table below shows the Nomad numbers and their locations inside the wall.

TABLE 1 – NOMAD DESIGNATIONS AND LOCATIONS

Nomad Number	Description of Location
#1	The back of the Perma board closest to the chamber with no coating
#2	Set in the center of the concrete wall not tied to wire mesh
#3	Tied to the wire mesh on the back of the Perma board closest to the chamber
#4	Tied to the wire mesh at the center of the concrete wall
#5	Tied to the wire mesh at the front of the Perma board closest to the room
#6	Tied to wire mesh at the top center portion of the wall
#7	Inside the wall stud with the Batt fiberglass insulation
#8	In the center of the Batt fiberglass insulation
#9	In the center of the Blowin fiberglass insulation
#10	Inside the wall stud with the Blowin fiberglass insulation
#11	Inside the sand bed underneath the wall
#12	Inside the Chamber
#13	Outside in the Room

In addition to the nomads being used to measure the temperature, an infrared heat camera was used to take pictures of the wall towards the end of the testing period. These pictures were able to capture the temperature profile of the entire wall from the room side.

The finished wall was sealed to insure that no transfer of heat could take place between the inside of the chamber and the outside room without going through the constructed wall. The finished Permaform wall was divided into three (3) sections; bare wall, Stucco coated, and rubber coated.

View from inside of the chamber, bare Permaform wall on the right, Stucco coating on top left, and rubber coating on the bottom left

The fiberglass insulated drywall used two different types of fiberglass insulations, the left half used the standard fiberglass insulation while the right half used the blowin fiberglass insulation.

The upper portion of the wall in this picture contains the fiberglass insulations

The concrete was placed on July 24th, 2013 and allowed to cure for five (5) days. The test began on July 29th, 2013 with the inside chamber temperature set at -10ºF and the outside room temperature was set at 70ºF. The test concluded on August 2nd, 2013. The Nomads were set to record temperatures at approximately 15 minute intervals. Additional intermittent readings of temperatures were taken daily using infrared laser thermometer. The Nomad data was downloaded, plotted, and analyzed once the test was completed.

DATA ANALYSIS:

Upon the review of the data we have concluded that several of the nomad graphs were inconclusive. The analysis of these graphs would not provide valid information and therefore will be omitted. The table below lists each nomad number, whether the data is valid or not, how it is invalid, and potential reasons for the invalid data.

TABLE 2 – DATA VALIDATION

Nomad Number	Valid or Invalid Data	How is the data Invalid?	Potential reasons for the data being invalid?
#1	Valid	--	--
#2	Valid	--	--
#3	Valid	--	--
#4	Valid	--	--
#5	Invalid	The temperature graph is erratic	Defective Nomad. Radiating hear from concrete curing Radiating heat from the sand bed
#6	Invalid	Redundancy	None
#7	Invalid	The temperature graph is erratic	Defective Nomad. Radiating hear from concrete curing Radiating heat from the sand bed
#8	Invalid	The temperature graph is erratic	Defective Nomad. Radiating hear from concrete curing Radiating heat from the sand bed
#9	Invalid	The temperature graph is erratic	Defective Nomad. Radiating hear from concrete curing Radiating heat from the sand bed
#10	Valid	--	--
#11	Valid	--	--
#12	Valid	--	--
#13	Valid	--	--

Based on the above table we have only analyzed Nomads #1 through #4 and #10 through #13. The following sections will summarize the data from each of the nomads and report the conclusions. Each analysis will include the minimum temperature, maximum temperature, average temperature, standard deviation, and the sample variance.

TABLE 3 – NOMAD #1 DATA ANALYSIS

Statistic	**Value**
Minimum	42.3°F
Maximum	85.8°F
Average	60.4°F
Standard Deviation	13.2°F
Sample Variance	173.1

The data analysis above and the graph indicate that the temperature began at approximately 85°F and decreased to approximately 42°F over the course of the testing period. We are unable to determine if the final temperature was at equilibrium. Based on the graph it is possible that the temperature would continue to drop and we would recommend that the test be performed for a longer duration until the temperature stabilizes.

TABLE 4 – NOMAD #2 DATA ANALYSIS

Statistic	Value
Minimum	45.3°F
Maximum	85.0°F
Average	62.2°F
Standard Deviation	11.7°F
Sample Variance	136.9

The data analysis above and the graph indicate that the temperature began at approximately 85°F and decreased to approximately 45°F over the course of the testing period. We are unable to determine if the final temperature was at equilibrium. Based on the graph it is possible that the temperature would continue to drop and we would recommend that the test be performed for a longer duration until the temperature stabilizes.

TABLE 5 – NOMAD #3 DATA ANALYSIS

Statistic	Value
Minimum	45.3°F
Maximum	82.3°F
Average	61.5°F
Standard Deviation	11.5°F
Sample Variance	131.7

The data analysis above and the graph indicate that the temperature began at approximately 82°F and decreased to approximately 45°F over the course of the testing period. We are unable to determine if the final temperature was at equilibrium. Based on the graph it is possible that the temperature would continue to drop and we would recommend that the test be performed for a longer duration until the temperature stabilizes.

TABLE 6 – NOMAD #4 DATA ANALYSIS

Statistic	Value
Minimum	40.4°F
Maximum	82.9°F
Average	56.9°F
Standard Deviation	11.3°F
Sample Variance	128.5

The data analysis above and the graph indicate that the temperature began at approximately 83°F and decreased to approximately 40.5°F over the course of the testing period. We are unable to determine if the final temperature was at equilibrium. Based on the graph it is possible that the temperature would continue to drop and we would recommend that the test be performed for a longer duration until the temperature stabilizes.

TABLE 7 – NOMAD #6 DATA ANALYSIS

Statistic	Value
Minimum	81.6°F
Maximum	176.6°F
Average	153.0°F
Standard Deviation	16.9°F
Sample Variance	286.2

The data analysis above and the graph indicate that the temperature began at approximately 82°F and increased to approximately 177°F and then slowly decreased to approximately 142°F over the course of the testing period. We are unable to determine if the final temperature was at equilibrium. Based on the graph it is possible that the temperature would continue to drop and we would recommend that the test be performed for a longer duration until the temperature stabilizes.

TABLE 8 – NOMAD #10 DATA ANALYSIS

Statistic	Value
Minimum	46.6°F
Maximum	78.3°F
Average	49.1°F
Standard Deviation	4.2°F
Sample Variance	17.3

The data analysis above and the graph indicate that the temperature began at approximately 78°F, drastically decreased to approximately 49°F, and kept steady for the remainder of the testing period. It would appear that the temperature reached equilibrium by the end of the testing period.

TABLE 9 – NOMAD #11 DATA ANALYSIS

Statistic	Value
Minimum	55.3°F
Maximum	122.3°F
Average	77.9°F
Standard Deviation	24.0°F
Sample Variance	576.8

The data analysis above and the graph indicate that the temperature began at approximately 82°F and drastically increased to approximately 121°F. It fluctuated for a short period of time and then drastically decreased to approximately 70°F. Once the temperature reached 70°F it gradually continued to decreased until it reached an ending temperature of approximately 55°F. We are unable to determine if the final temperature was at equilibrium. Based on the graph it is possible that the temperature would continue to drop and we would recommend that the test be performed for a longer duration until the temperature stabilizes.

TABLE 10 – NOMAD #12 DATA ANALYSIS

Statistic	Value
Minimum	-8.6°F
Maximum	80.0°F
Average	-4.3°F
Standard Deviation	16.5°F
Sample Variance	273.0

The data analysis above and the graph indicate that the temperature began at approximately 80°F and drastically decreased to approximately -7.5°F. The temperature held between -6.0°F and -7.0°F for the remainder of the test.

TABLE 11 – NOMAD #13 DATA ANALYSIS

Statistic	Value
Minimum	62.7°F
Maximum	83.1°F
Average	72.5°F
Standard Deviation	5.7°F
Sample Variance	32.3

The data analysis above and the graph indicate that the temperature began at approximately 72°F slowly increased to approximately 82°F and held for a short period of time. The temperature then dropped slowly and fluctuated 2-3 degrees around approximately 77°F for the remainder of the test.

INFRARED CAMERA RESULTS:

On August 1st, 2013 photographs of the wall were taken using an infrared heat camera to show the temperature profile across the wall. Based on these photographs it would seem that the temperatures on the side with the Stucco and rubber coatings were in the range of 65-70 degrees while the temperatures on the bare wall had temperature ranges between 60-65 degrees. See photographs attached in the appendix of this report.

SUMMARY:

Preliminarily, it would seem that the data collected indicates that no heat or cold transfer exists through the Permaform walls. The Permaform walls that were coated with rubber and stucco seem to insulate the room from the cold temperature of the chamber better than the uncovered (non-coated) Permaform walls. All of the Permaform walls maintained a temperature inside the concrete wall as well as the wire mesh within the wall between 43°F and 45°F. The only fiberglass Nomad that produced valid data was the one inserted into the stud of the wall with the blowin fiberglass insulation. This graph showed that a temperature of approximately 48°F was maintained which is higher than the 43-45°F temperature maintained in the concrete wall surrounded by the Permaform. The infrared photographs showed that the coated walls maintained a temperature on the outside between 65-70 degrees while the bare walls had temperature between 60-65 degrees. All of the above temperatures are above the -7°F of the chamber which would indicate that the cold temperature from the chamber did not make it through to the outside room.

These conclusions are preliminary in nature since there were many uncontrolled variables in the test procedure. Below is a table listing the uncontrollable variables, other procedural concerns, and proposed solutions.

TABLE 12 – PROBLEMS AND SOLUTIONS

Uncontrollable variable/Procedural concern	**Proposed Solution**
Concrete not fully cured, potentially producing more heat	Allow the concrete to cure for at least 21 days prior to start of test
The temperature read by the nomads did not reach equilibrium when test was stopped	Allow the test to continue to run for at least 21 days
Not enough Nomads were installed to get a good profile of the temperature variations in the walls	Place more Nomad units at more critical points on the wall
No baseline wall was constructed and measured to be compared the Permaform results to. Without a baseline, it is impossible to determine whether the Permaform provides an insulation benefit over a standard concrete wall	The test should be set up with a bare concrete wall, a bare Permaform wall, a Stucco coated Permaform wall, and rubber coated Permaform wall and retested with a larger number of Nomad units placed at identical locations in each section
The sand bed was heated and then turned off shortly after the start of the test creating an additional heat source that potentially affected the results	Continue the use of the sand bed under the wall but do not heat it. Monitor the temperature of the bed to determine if any heat is transferred into it from the concrete wall
Concrete and Fiberglass walls were tested at the same time	Perform the test in two runs, first run would include the concrete walls and the second run would include the fiberglass wood framed walls

RECOMMENDATIONS:

We recommend that additional testing be performed to finalize the above findings. The new testing procedure should implement the proposed solutions listed in the table above or variations of said solutions that will eliminate the uncontrolled variables and other concerns. We recommend a meeting to discuss possible additional testing with our Engineer and Lab Manager.

We have welcomed the opportunity to be of service to you on this project. If there are any questions with regard to the information and recommendations presented, please do not hesitate to contact us.

Leigh Wojton
Laboratory Manager

Peter M. Sidorczuk, Chief Engineer
Registered Professional Engineer in Illinois

APPENDICIES

HOLMES TESTING, INC.

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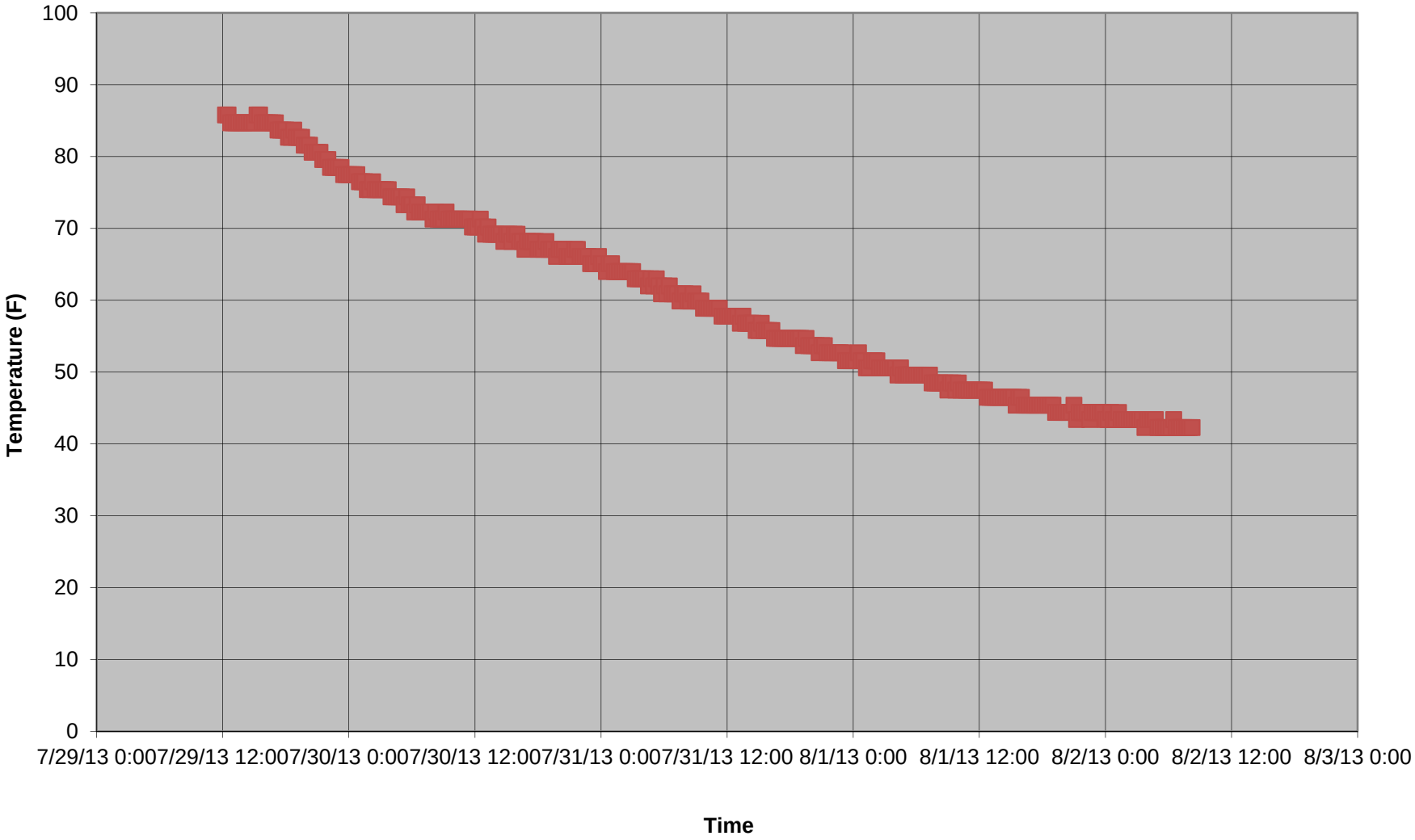
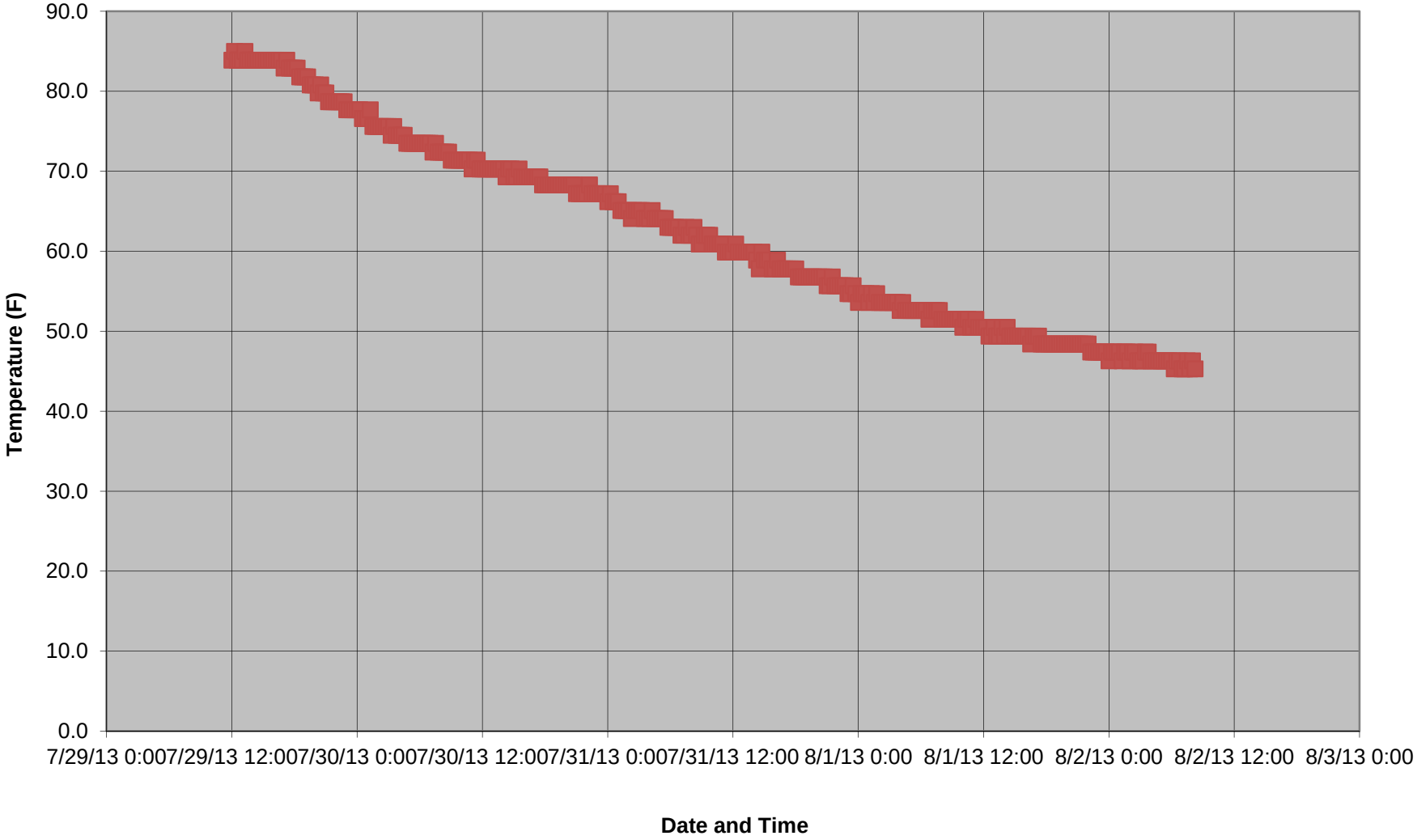
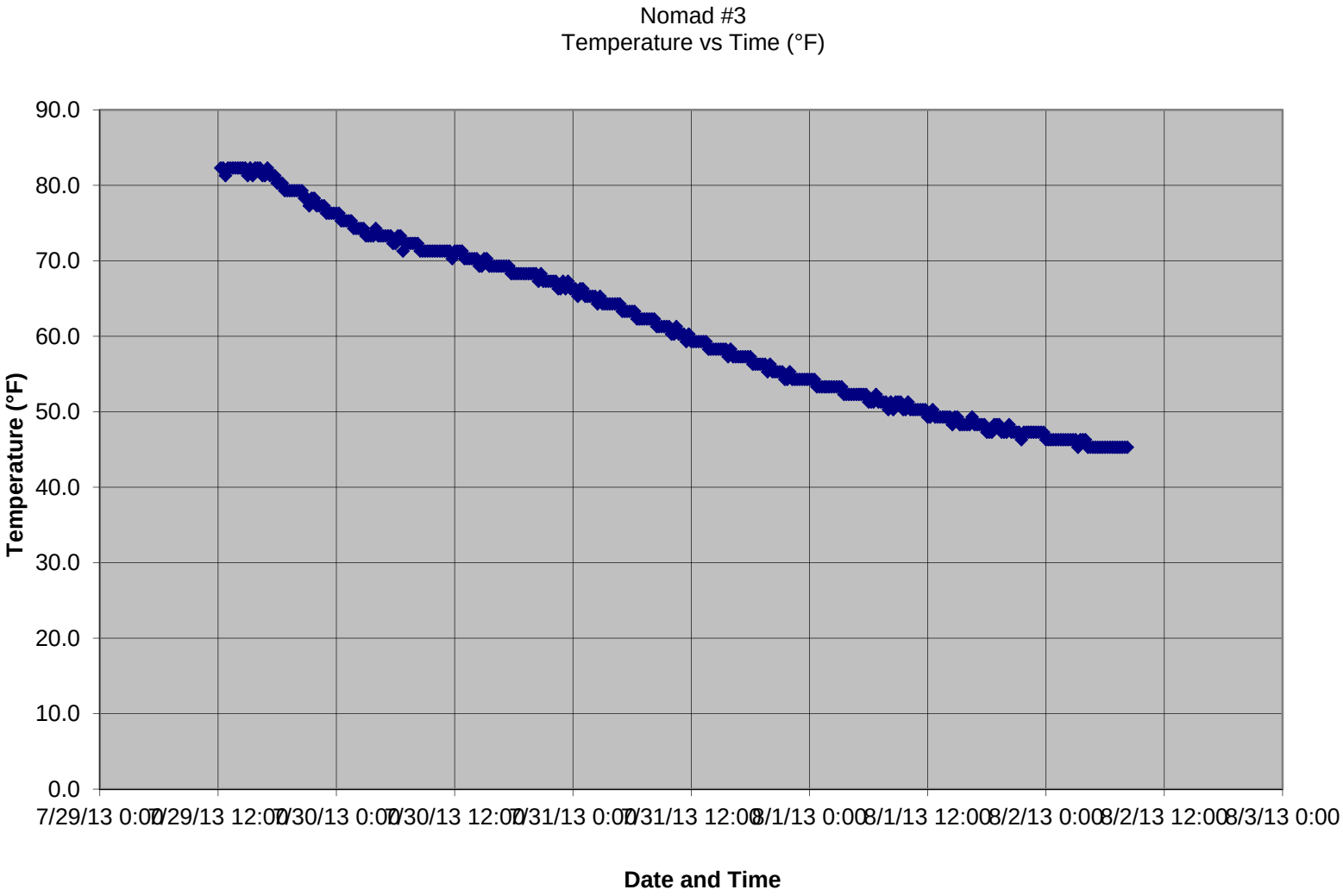
Nomad #1
Temperature vs Time



NOMAD #2
Temperature vs. Time




Nomad #3
Temperature vs Time (°F)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Temperature (°F)
7/29/13 0:00
7/29/13 12:00
7/30/13 0:00
7/30/13 12:00
7/31/13 0:00
7/31/13 12:00
8/1/13 0:00
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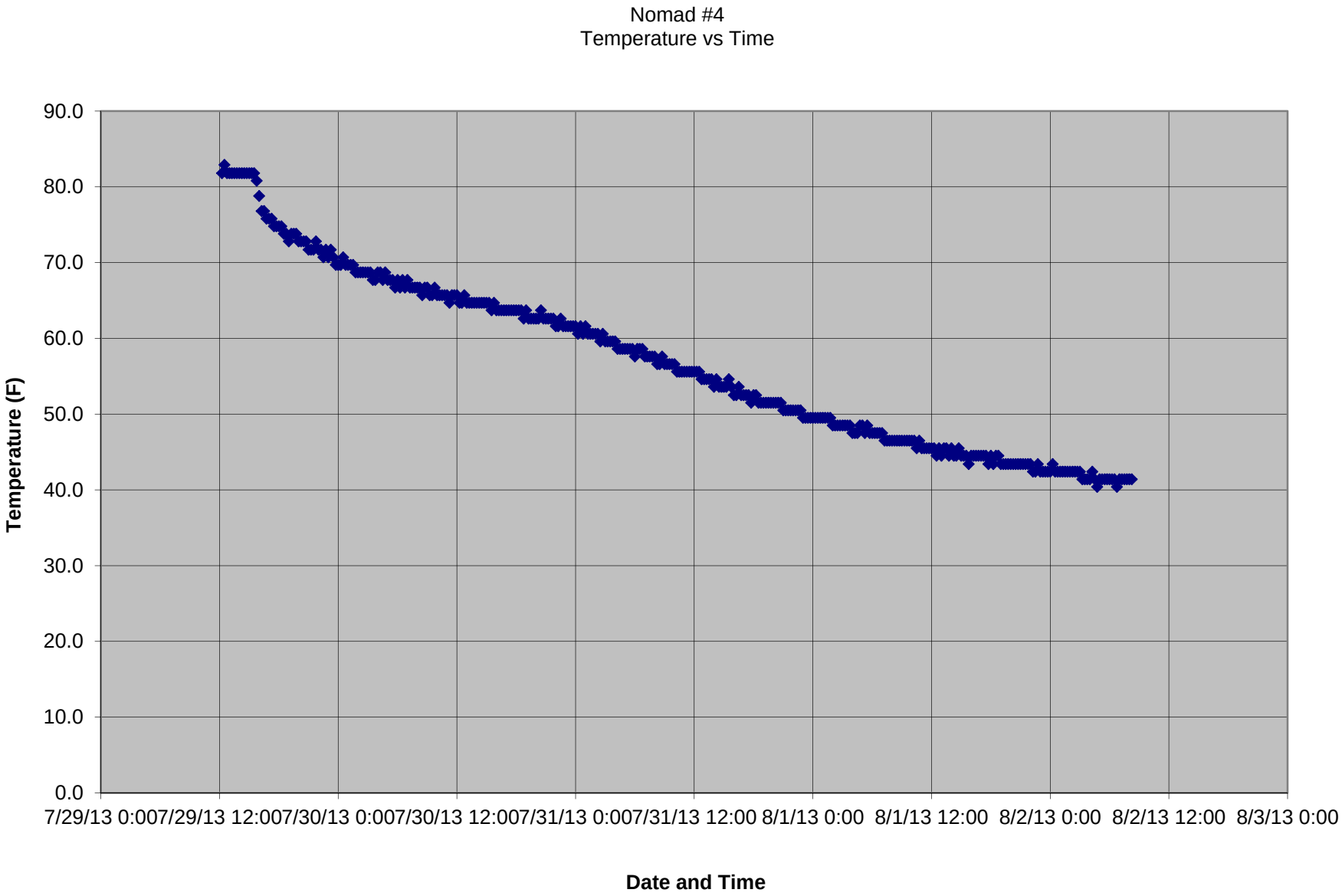
8/2/13 12:00
8/3/13 0:00
Date and Time


Nomad #4
Temperature vs Time
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Temperature (F)
7/29/13 0:00
7/29/13 12:00
7/30/13 0:00
7/30/13 12:00
7/31/13 0:00
7/31/13 12:00
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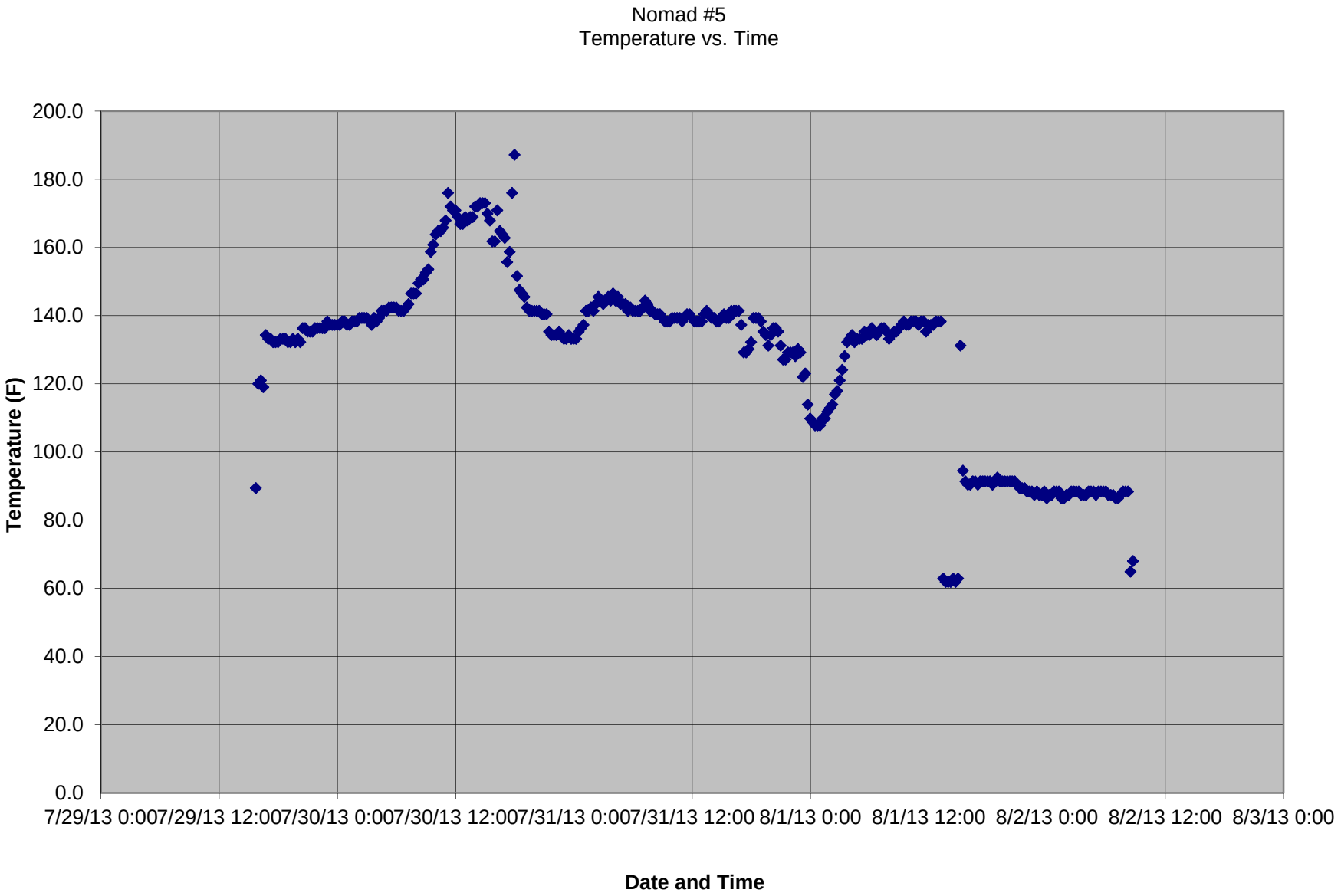
8/2/13 12:00
8/3/13 0:00
Date and Time


Nomad #5
Temperature vs. Time
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Temperature (F)
7/29/13 0:00
7/29/13 12:00
7/30/13 0:00
7/30/13 12:00
7/31/13 0:00
7/31/13 12:00
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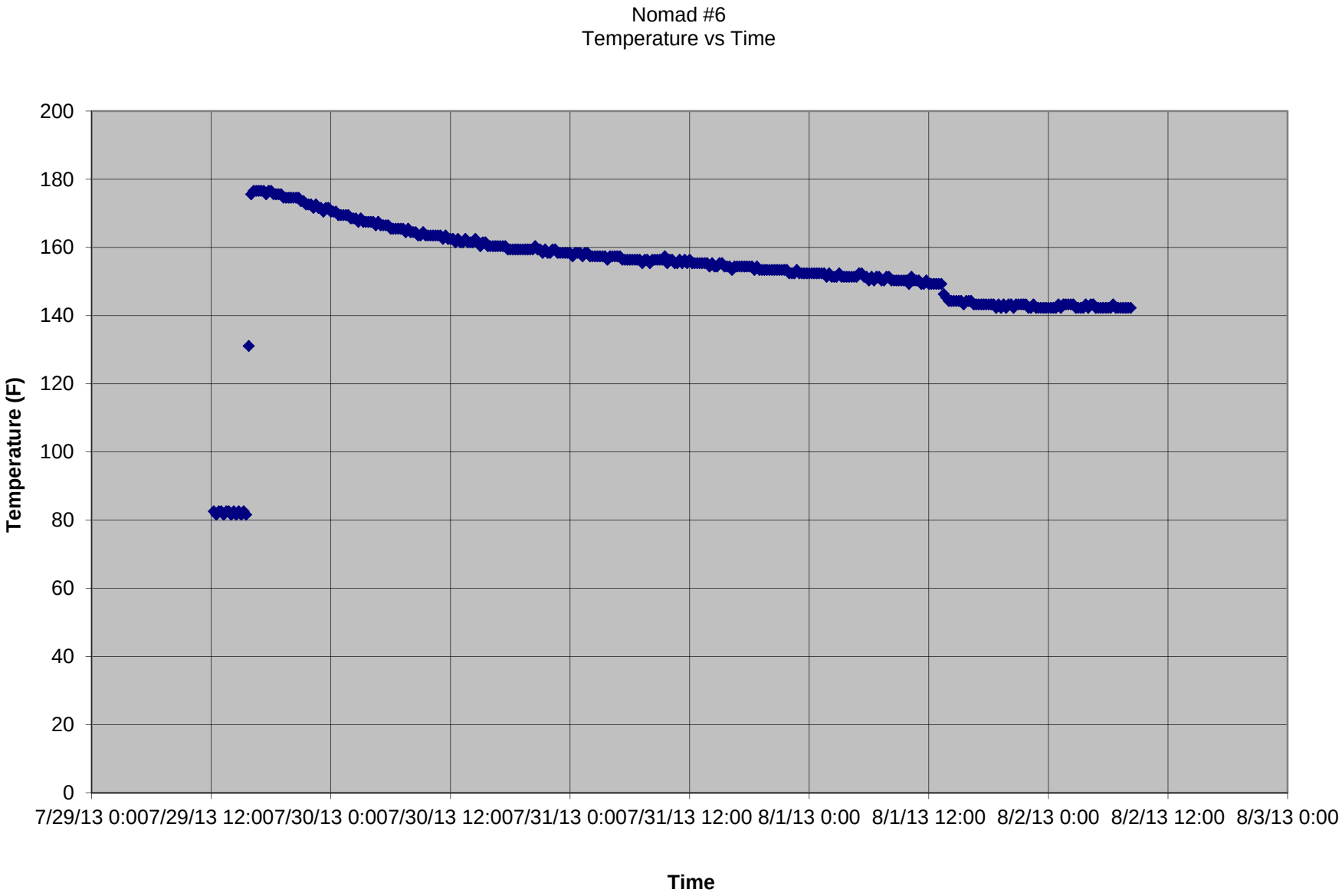
8/2/13 12:00
8/3/13 0:00
Date and Time


Nomad #6
Temperature vs Time
Temperature (F)
200
180
160
140
120
100
80
60
40
20
0
7/29/13 0:00
7/29/13 12:00
7/30/13 0:00
7/30/13 12:00
7/31/13 0:00
7/31/13 12:00
8/1/13 0:00
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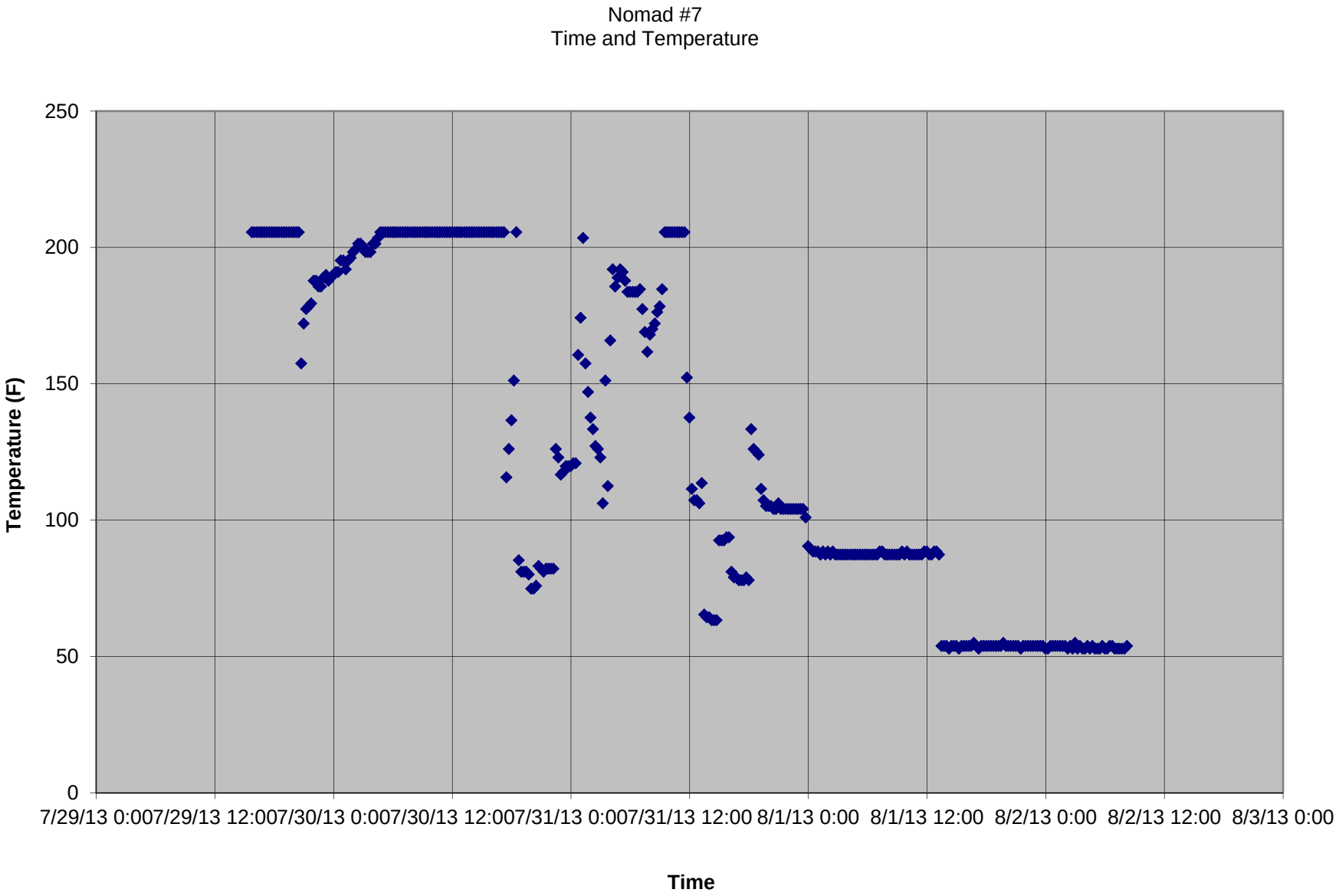
8/2/13 12:00
8/3/13 0:00
Time


Nomad #7
Time and Temperature
250
200
150
100
50
0
Temperature (F)
7/29/13 0:00
7/29/13 12:00
7/30/13 0:00
7/30/13 12:00
7/31/13 0:00
7/31/13 12:00
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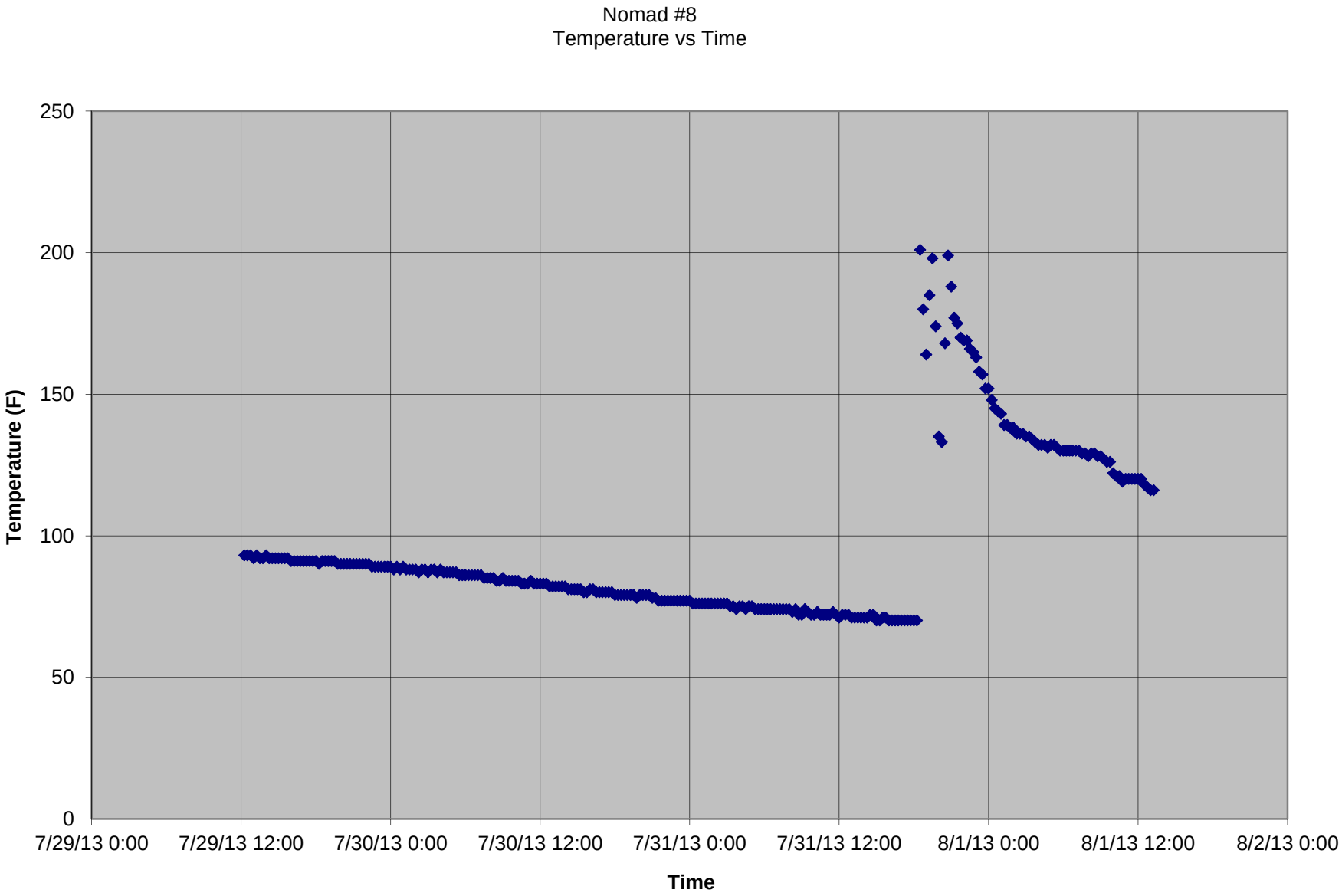
8/2/13 12:00
8/3/13 0:00
Time


Nomad #8
Temperature vs Time
250
200
150
100
50
0
Temperature (F)
7/29/13 0:00
7/29/13 12:00
7/30/13 0:00
7/30/13 12:00
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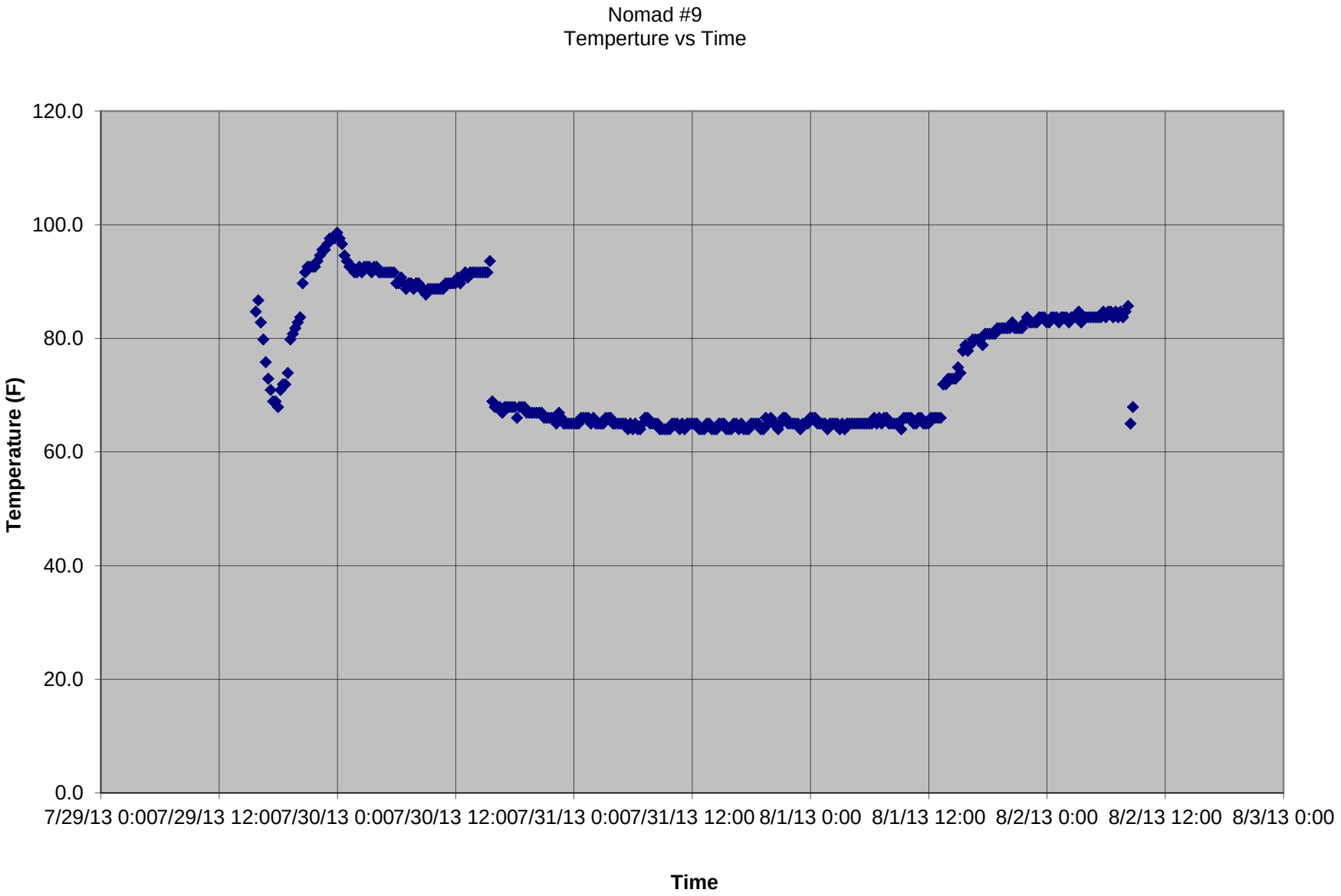
8/1/13 12:00
8/2/13 0:00
Time


Nomad #9
Temperture vs Time
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Temperature (F)
7/29/13 0:00
7/29/13 12:00
7/30/13 0:00
7/30/13 12:00
7/31/13 0:00
7/31/13 12:00
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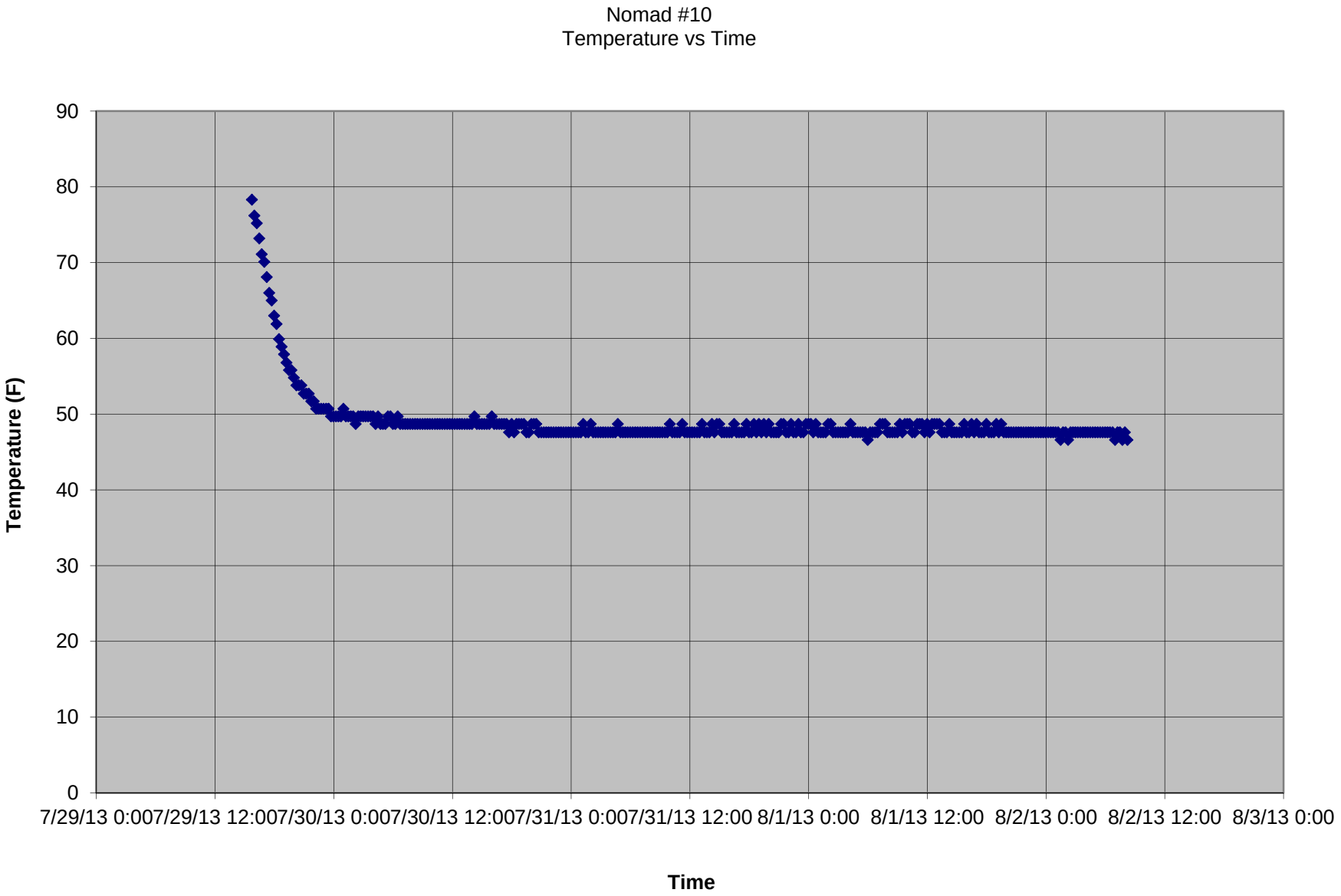
8/2/13 12:00
8/3/13 0:00
Time


Nomad #10
Temperature vs Time
Temperature (F)
90
80
70
60
50
40
30
20
10
0
7/29/13 0:00
7/29/13 12:00
7/30/13 0:00
7/30/13 12:00
7/31/13 0:00
7/31/13 12:00
8/1/13 0:00
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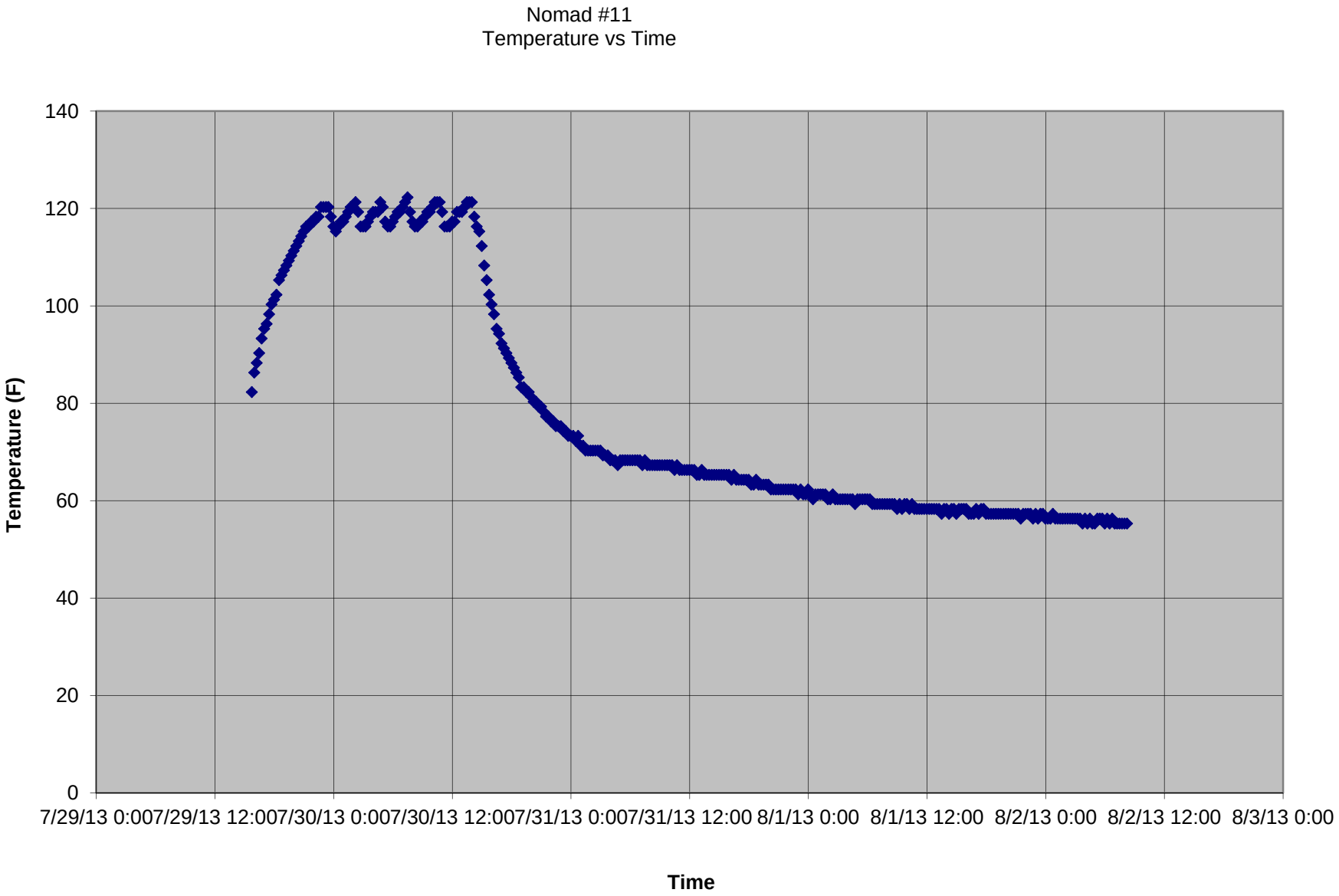
8/2/13 12:00
8/3/13 0:00
Time


Nomad #11
Temperature vs Time
140
120
100
80
60
40
20
0
Temperature (F)
7/29/13 0:00
7/29/13 12:00
7/30/13 0:00
7/30/13 12:00
7/31/13 0:00
7/31/13 12:00
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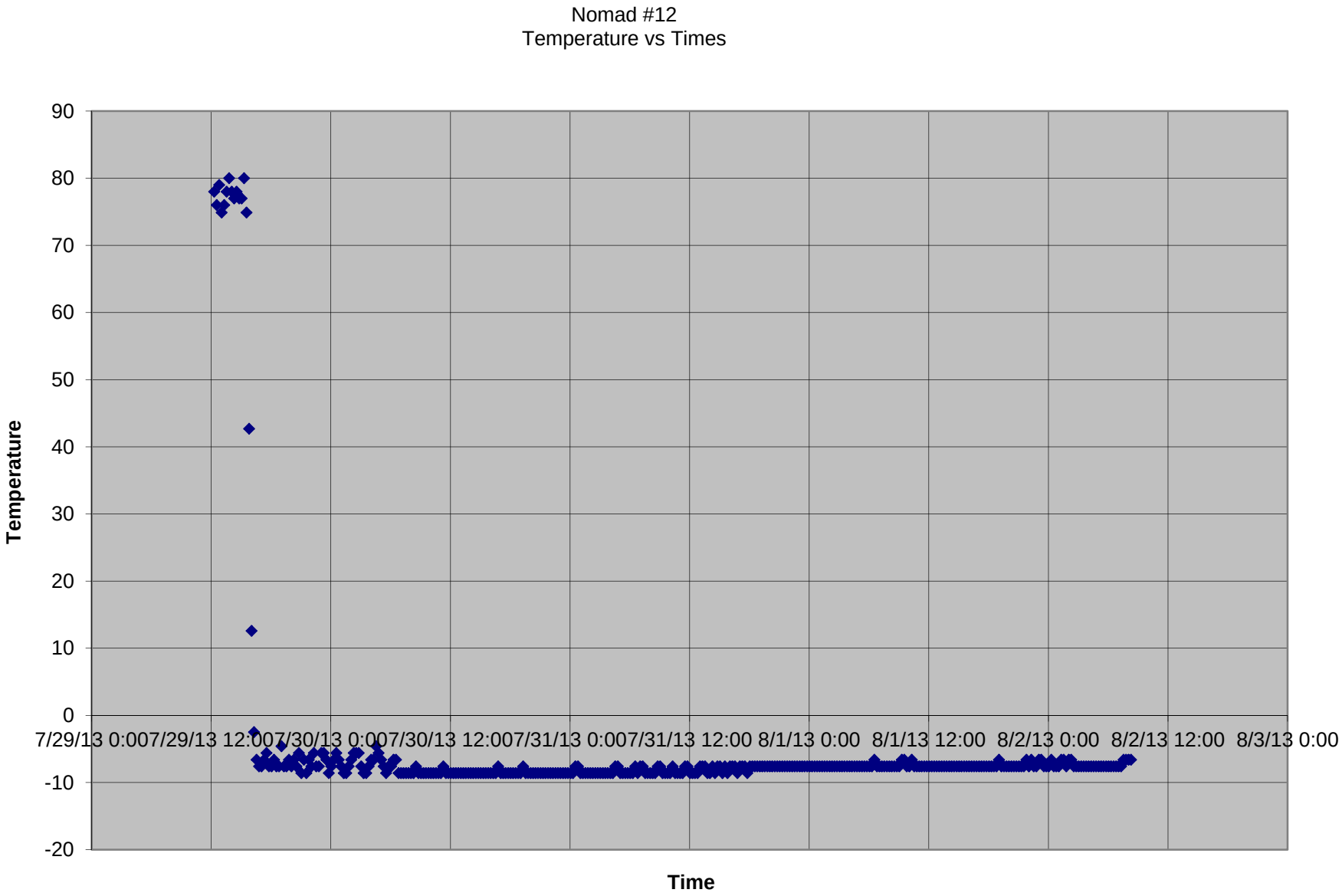
8/2/13 12:00
8/3/13 0:00
Time


Nomad #12
Temperature vs Times
Temperature
90
80
70
60
50
40
30
20
10
0
-10
-20
7/29/13 0:00
7/29/13 12:00
7/30/13 0:00
7/30/13 12:00
7/31/13 0:00
7/31/13 12:00
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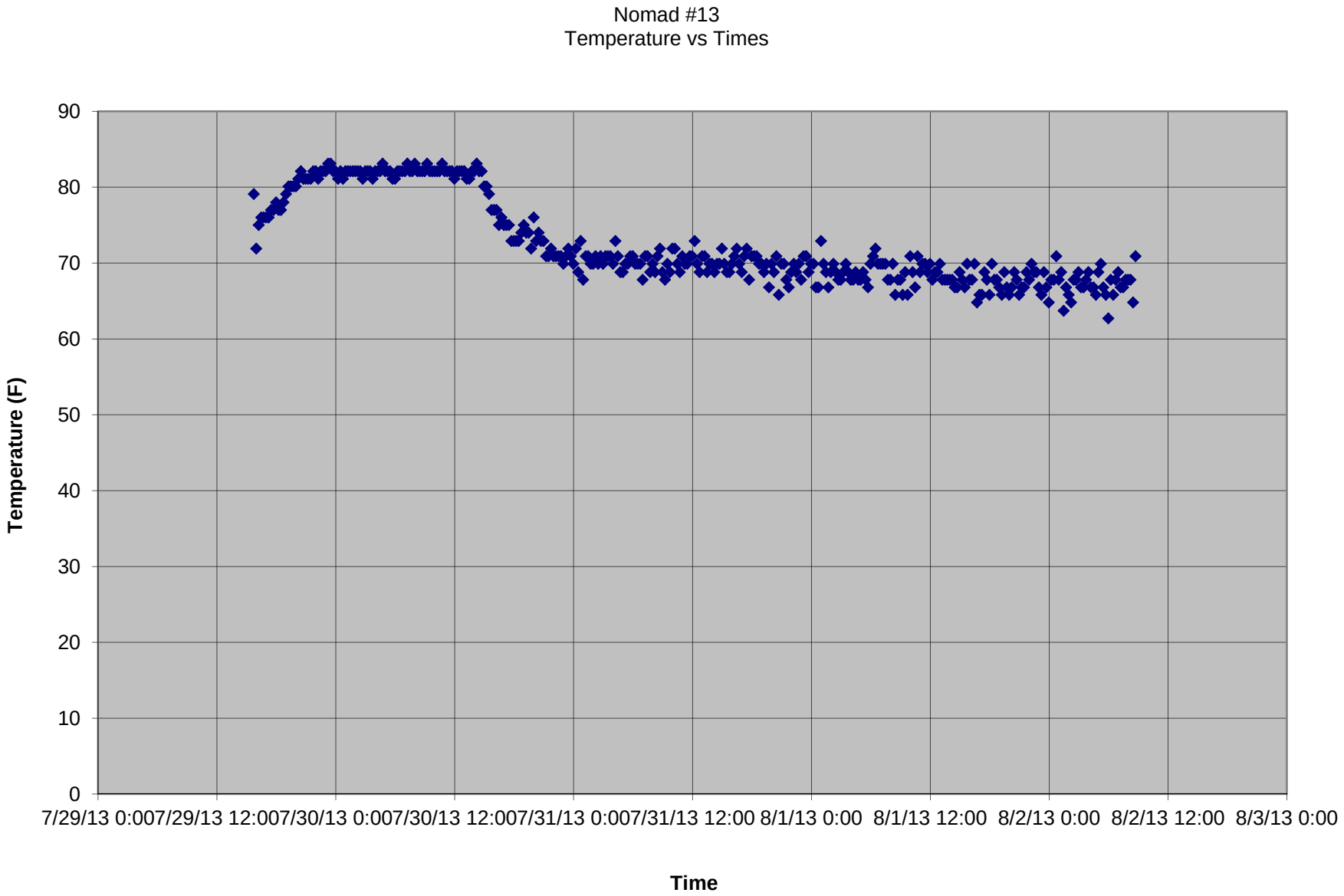
8/2/13 0:00
8/2/13 12:00
8/3/13 0:00
Time


Nomad #13
Temperature vs Times
Temperature (F)
90
80
70
60
50
40
30
20
10
0
7/29/13 0:00
7/29/13 12:00
7/30/13 0:00
7/30/13 12:00
7/31/13 0:00
7/31/13 12:00
8/1/13 0:00
8/1/13 12:00
8/2/13 0:00
8/2/13 12:00
8/3/13 0:00
Time

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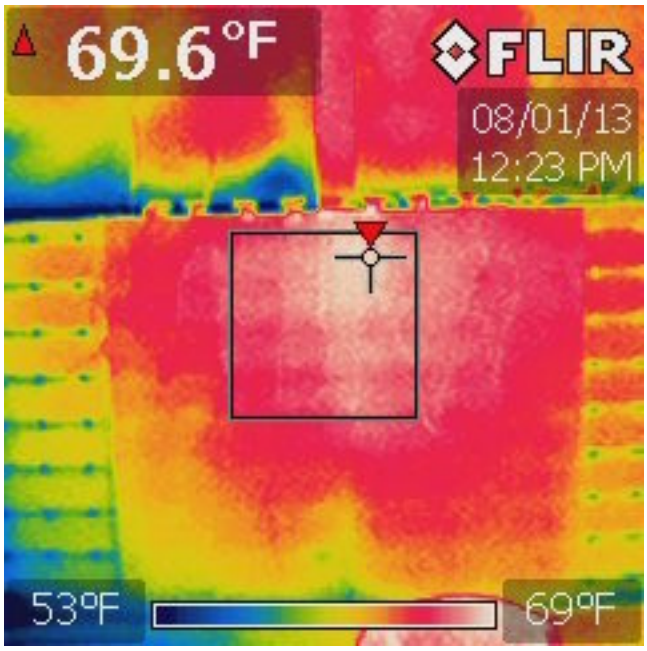
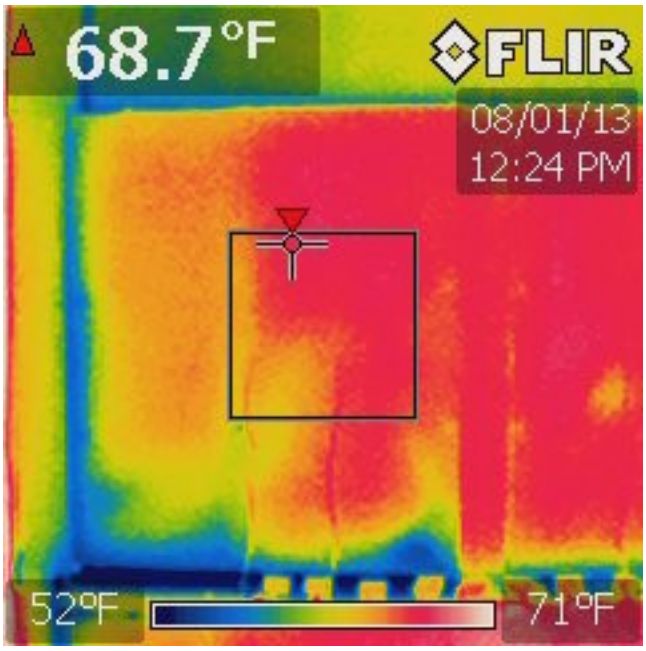
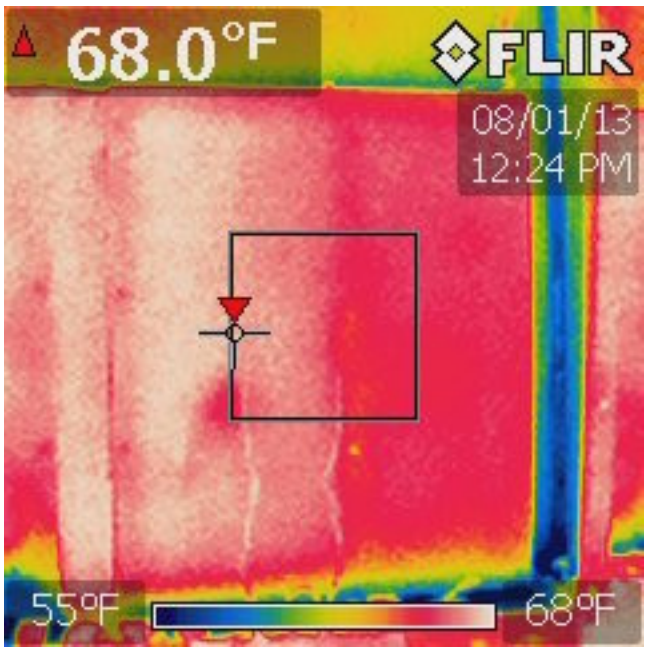
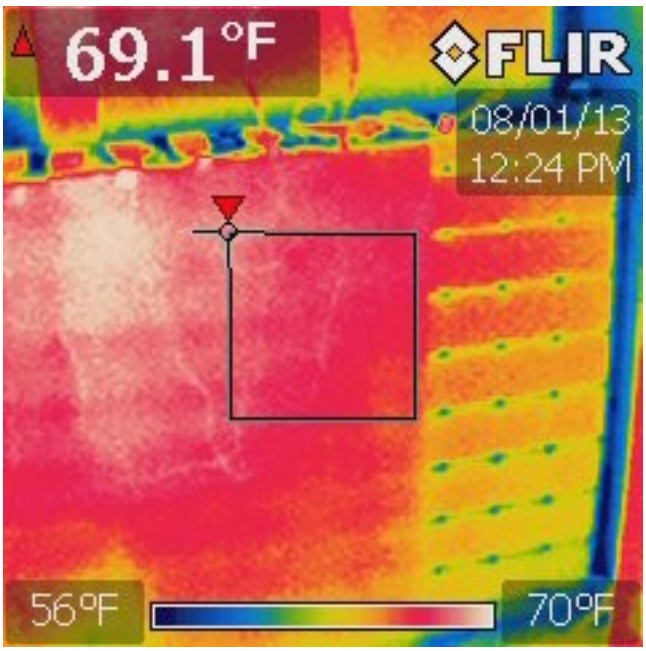
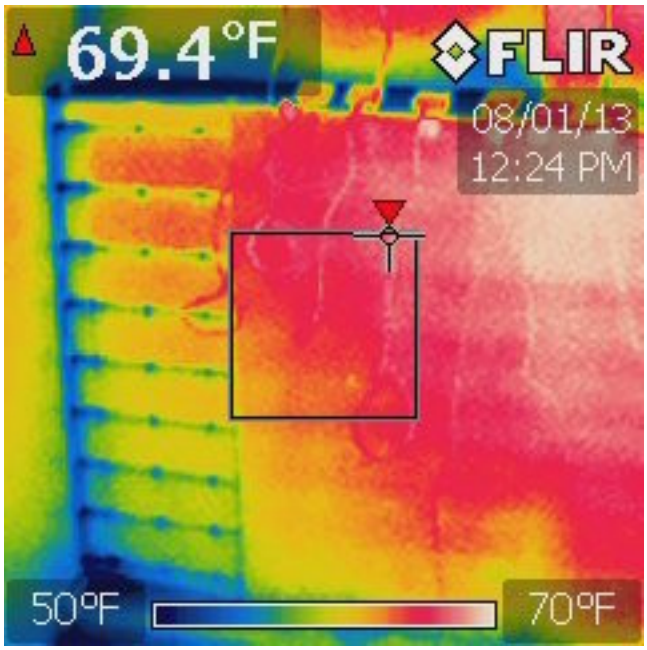
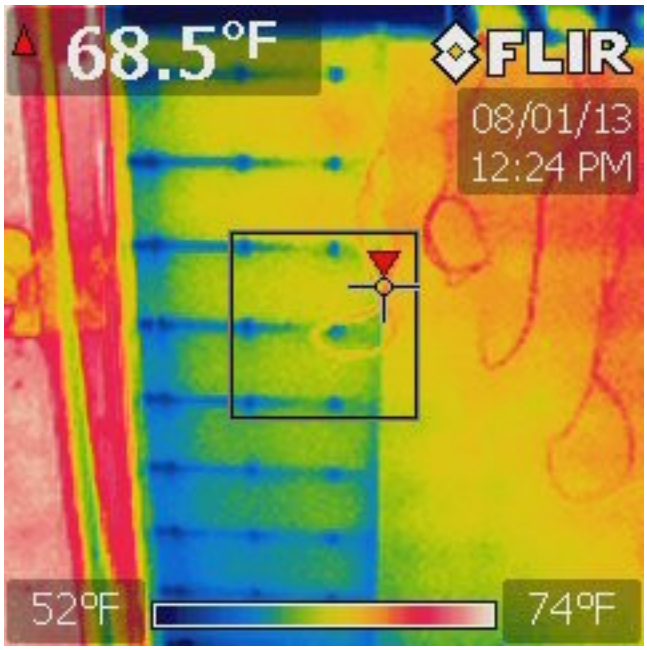









69.4°F
FLIR
08/01/13
12:24 PM
50°F
70°F


68.5°F
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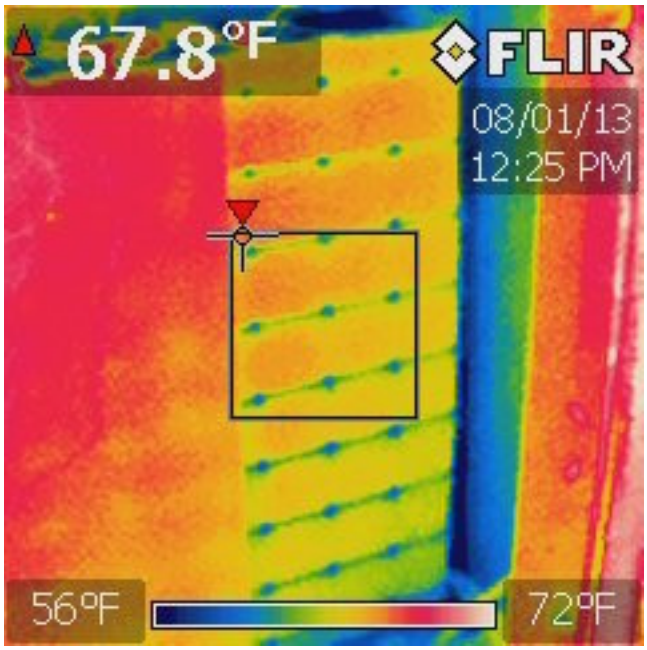
08/01/13
12:24 PM
52°F
74°F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08/01/13
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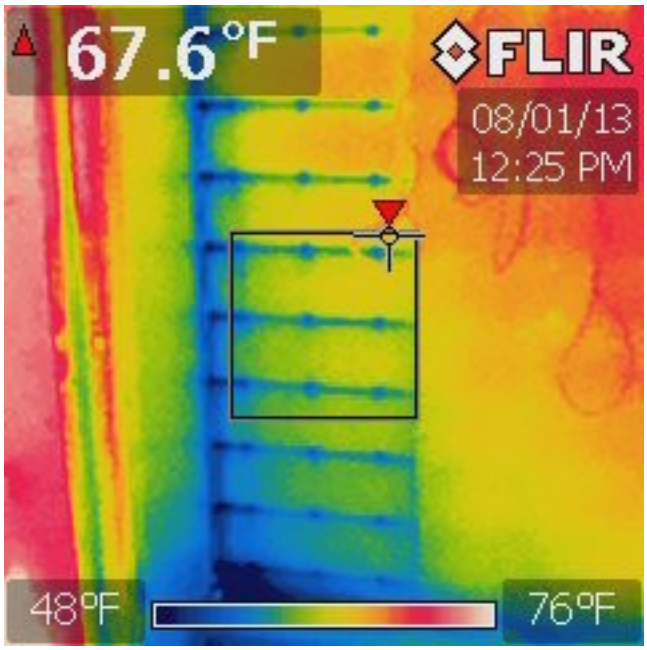
56°F
72°F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08/01/13
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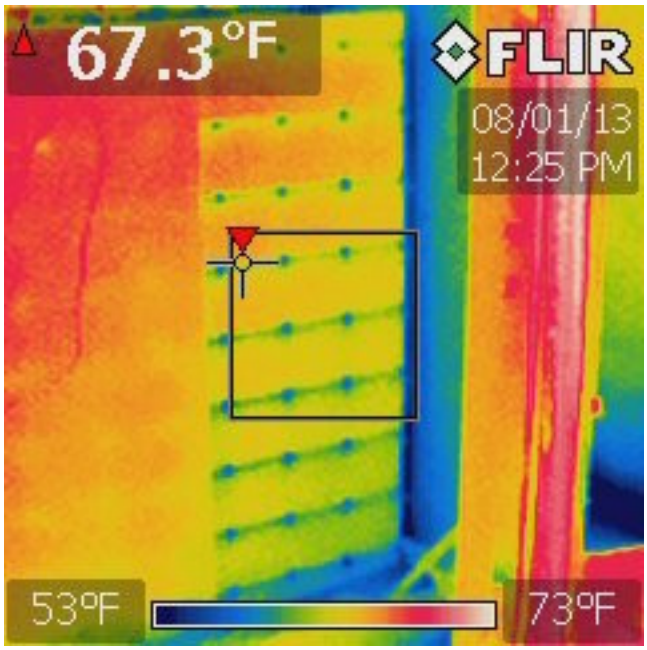
48°F
76°F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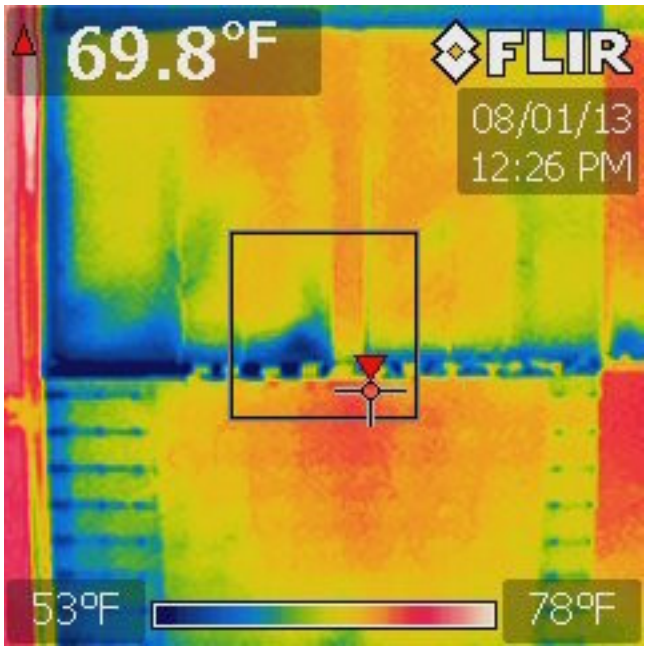
08/01/13
12:25 PM
53°F
73°F


69.8°F
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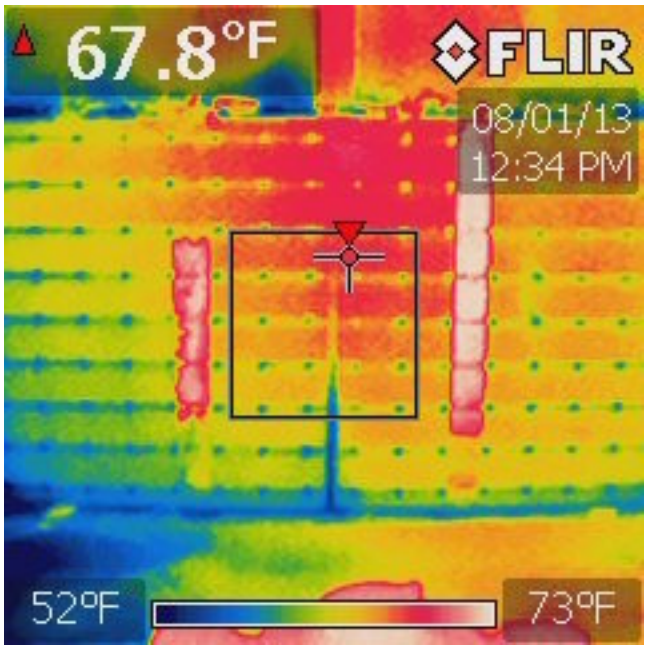
08/01/13
12:26 PM
53°F
78°F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08/01/13
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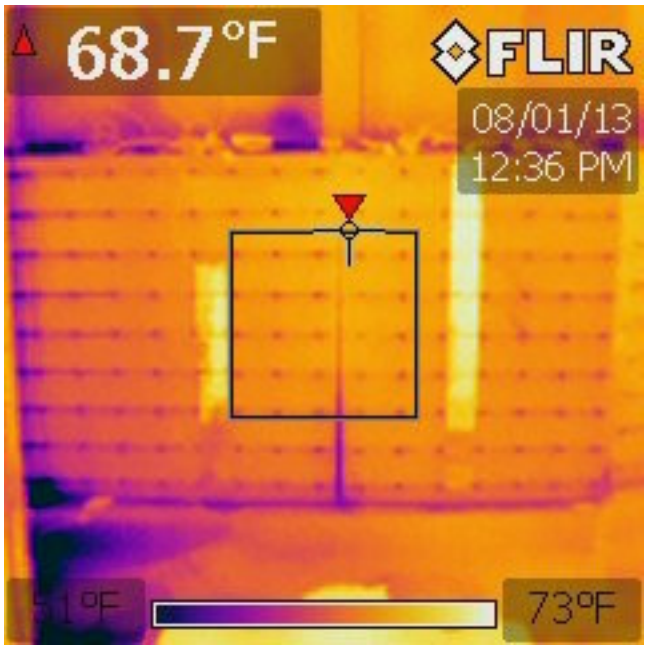
52°F
73°F


68.7°F
FLIR
08/01/13
12:36 PM
73°F