INFRARED PREDICTIVE SURVEYS INCORPORATED

Subject: IR/Nuclear/Capacitance Roof Analysis Report

SCOPE OF WORK:

- Nuclear backscatter scan of approximately 7,950 square feet of roof.
- Performance of two (2) core cuts to verify findings and determine roof construction.
- Infrared inspection of approximately 7,950 square feet of roof.
- Wet areas painted on roof for location/identification purposes.
- Performance of capacitance testing on suspected wet areas to confirm the infrared findings and in areas that could not be scanned thermally.
- Thermograms (photographs of infrared images) of roof areas are provided.
- Plot of wet areas per the nuclear scan provided.
- Drawing showing approximate locations of wet areas.

This survey was performed by a certified thermographer using a Mikron 7515 uncooled infrared imager. Lens for the Mikron was 29 degree FOV, 320 X 240 array with 7.5-13 spectral response. Temperature sensitivity is .1 degree C with accuracy of 2%.

Weather Conditions: On April 2, 2007 the sky was partly cloudy during the day with temperatures in the mid 70's. The evening sky was clear with wind at approx. 8-10 mph.

Environmental: Conditions were noted such as openness of the roof to receive solar loading and position of the sun to the roof areas. Roof areas directly under units were tested with capacitance.

Roof Type: Per the core sampling, there are two (2) roofs in place on this facility, both asphalt. The top roof appears to be a modified bitumen, while the bottom roof appears to be a straight asphalt built up roof (BUR). The

insulation is polyisocyanurate, measured at 2-1/2" thick. The insulation is below the bottom roof and there is no recovery/separator board between the two roofs. The insulation was mopped in hot asphalt to the deck, which appears to be a cementitious gypsum. The top roof looks like it was torched applied directly to the first roof.

Nuclear Backscatter Methodology:

A radioactive isotope consisting of Americium-241 with a beryllium target is utilized. The measurement method relies on the thermalization (slowing) of fast neutrons by the hydrogen atoms in water. Since other hydrogen bearing materials also thermalize neutrons, a measurement survey is necessary to establish a relative base level before an analysis can be performed.
The meter used, Troxler 3216, is a portable instrument with a periodic counter to measure the rate of thermalization of neutrons.

Infrared Testing Methodology:

Detecting entrapped moisture within insulated buildings is achieved through proper evaluation and application of thermographic imaging. To understand the methodology for infrared roof evaluations, it is important to first comprehend how thermal differences are detected and analyzed when applied to areas of wet and dry insulation.
During the day, the sun radiates energy onto the entire roof surface (solar loading). Later in the day, the wet insulation has the capability to retain more energy (heat capacity). Areas of the roof that are of higher mass (wet) retain heat longer than the lower mass (dry) areas and therefore radiate heat for a longer period of time, because it takes longer to cool.
The result of the infrared survey is a picture indicating areas of suspected moisture as white (hot) and dryer areas as black (cold). Additionally, surface heating pattern anomalies are colorized to delineate and make flaws within the roof more discernible. Visual photographs, capacitance testing, core samples and a roof drawing can provide correlating reference to significant IR findings

Additional Testing

Electric capacitance impedance testing was performed on the roof using a Tramex moisture meter (Leak Seeker). The meter sends an electric current into the roof without penetrating the membrane. The impedance is measured by creating a low frequency alternating field between the electrodes.
This test was performed at the same time as the thermography to verify the thermal images and expand/delineate the area of suspected moisture intrusion.

Discussion

Nuclear testing was first suggested due to the information that two roofs were in place at the facility. The nuclear testing can "read" down approximately 8" and

report the relative number of hydrogen atoms. If water were able to get into the top roof and travel below the insulation, it would be invisible to the infrared camera.
However, after the nuclear testing was completed and the core sampling performed, it became apparent that this roof would provide useful thermal information during the infrared scan.

NOTE: There was some ponded water in the SE corner.
This area could not be tested.

Nuclear Test

A measured roof drawing was rendered and then a 10' x 10' grid pattern was established on the roof. Once completed, the measurement survey of 20 readings was performed to establish a relative base level before the actual analysis was performed.
Testing intervals were 7.5 seconds at each grid point location. The highest readings were located in the NE corner, over and adjacent to Unit 325.
A baseline core sample was taken on an area suspected to be either damp or dry. (The relative meter reading was "10"). The core sample was dry: felts, insulation and deck.
A second core sample was taken in the highest readings area, over unit 325. The insulation and the cementitious gypsum deck were very wet.

Infrared Scan

Prior to sunset the roof was viewed with the infrared camera. Thermal images were present in the shaded areas of the roof.
After the sun went below the horizon, the roof cooled quickly. Thermal patterns emerged suggesting wet insulation. The capacitance meter was employed to verify infrared findings. The wet areas were painted on the roof and numbered as follows:
#1, #1A, #2, #3, #4, #5 & #6.

Findings

There was excellent correspondence between the 4 modes of testing: the nuclear scan showed the wettest areas, which was seen with the infrared imager verified with capacitance and core sampling.

The infrared scan revealed six (6) main areas of subsurface moisture. The capacitance meter located the seventh wet area on top of the penthouse.

The area over and adjacent to unit 325 appears to be very wet, including the gypsum deck below. Water is in and below the roof system and it will *not* dry out.

There are other wet areas, but these are isolated areas and do not appear to have the same concentration of moisture as the NE corner and south elevation.

If you have any questions or if I may provide additional information, please contact me.

Sincerely,

Joseph Fitzpatrick
Thermographer

Additional information follows.

Moisture Map for Roof

Location:			
Date:	**2-Apr-07**		
Customer:	**Sample**		
Grid Spacing:	Each square represents 10' x 10'	0.00	M

Input Data

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t
1	8	7	7	6	9	6	8	8	8	9	9	7	8	8	8					
2	9	5	8	14	7	6	7	7	8	8	7	9	8	8	9					
3	8	7	7	7	7	6	8	7	7	12	9	9	9	13	13					
4	5	9	8	7	9	7	10	7	7	8	21	38	12	37						
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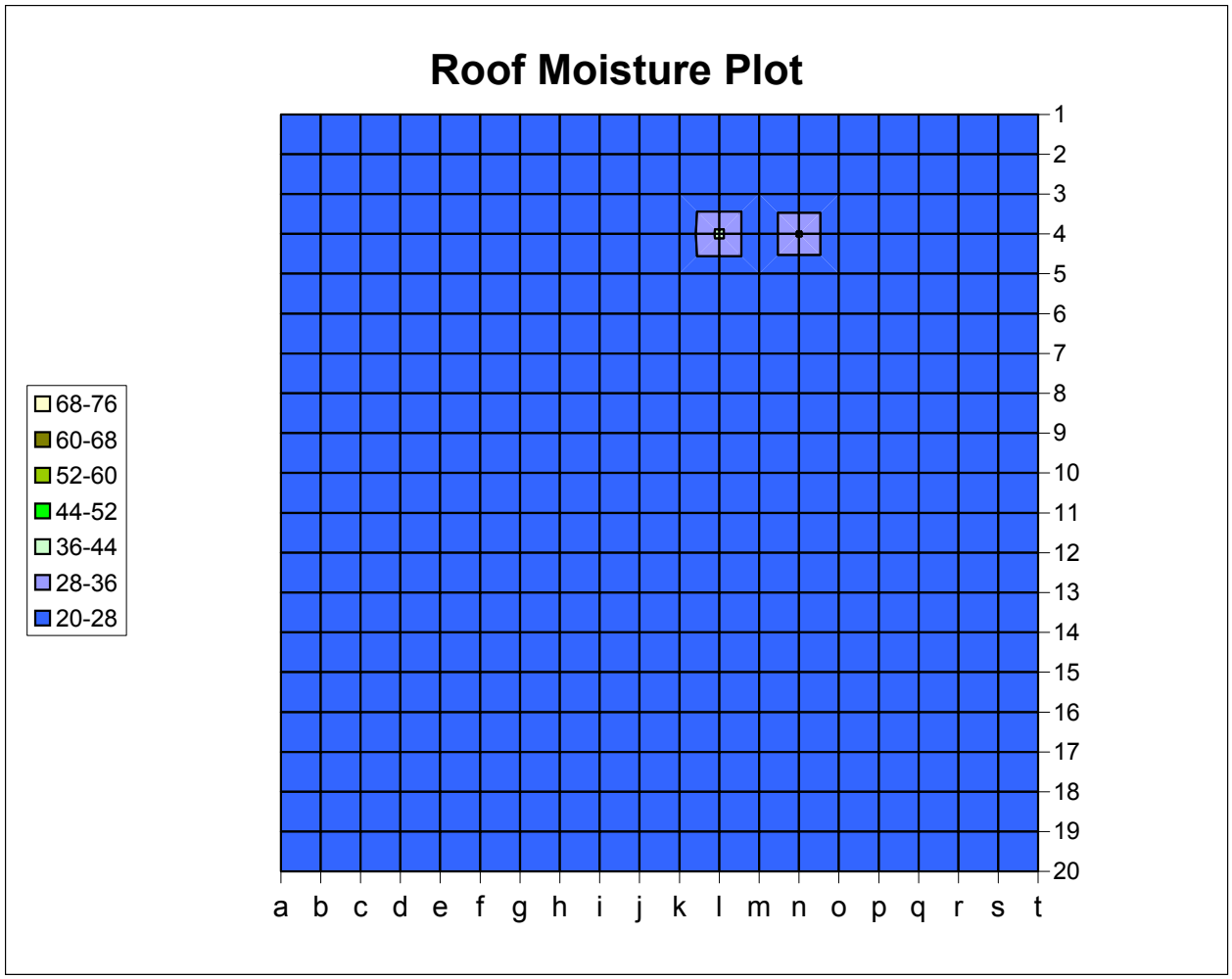

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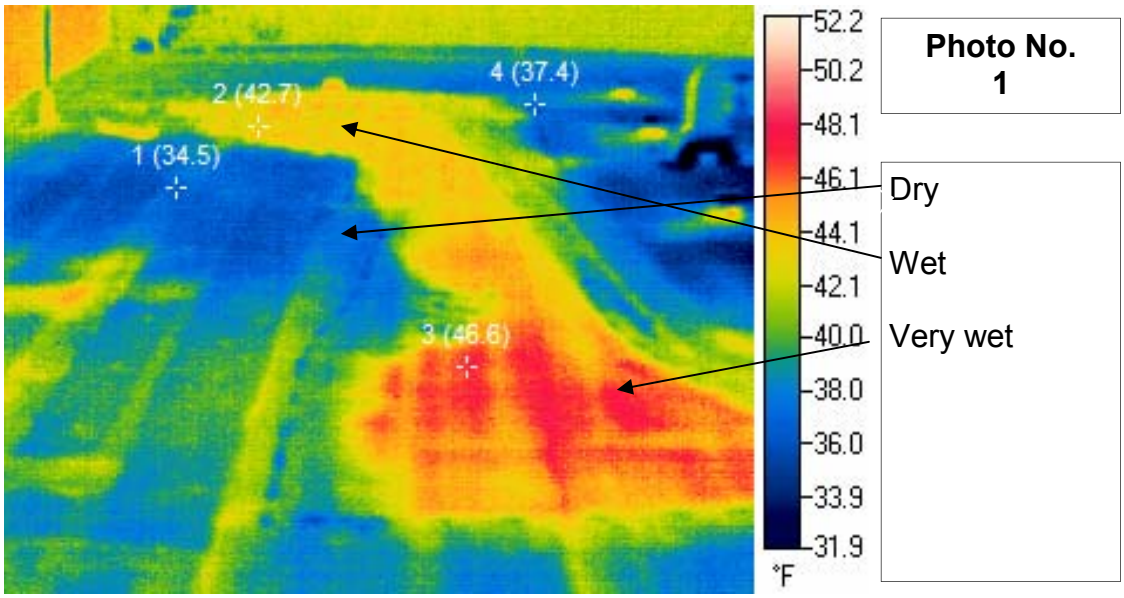
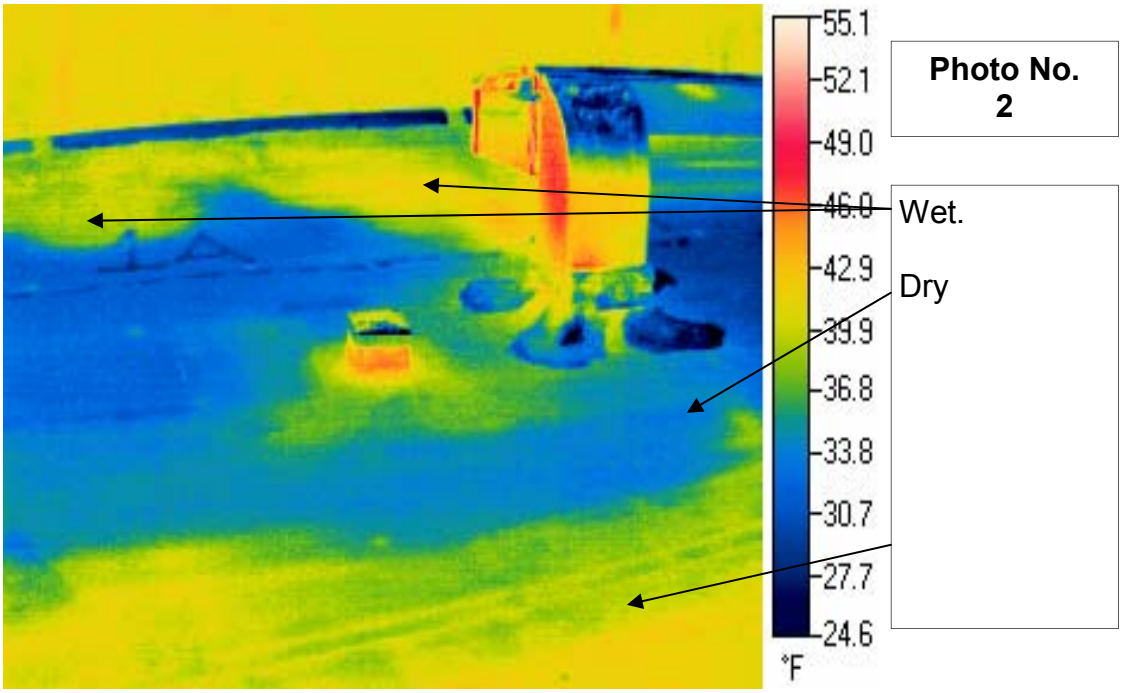
Infrared Roof Analysis



Area 1. Over Unit 325. NE corner.



Area 1A. Over unit 325 and adjacent unit. At east elevation, near NE corner.

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Infrared Roof Analysis

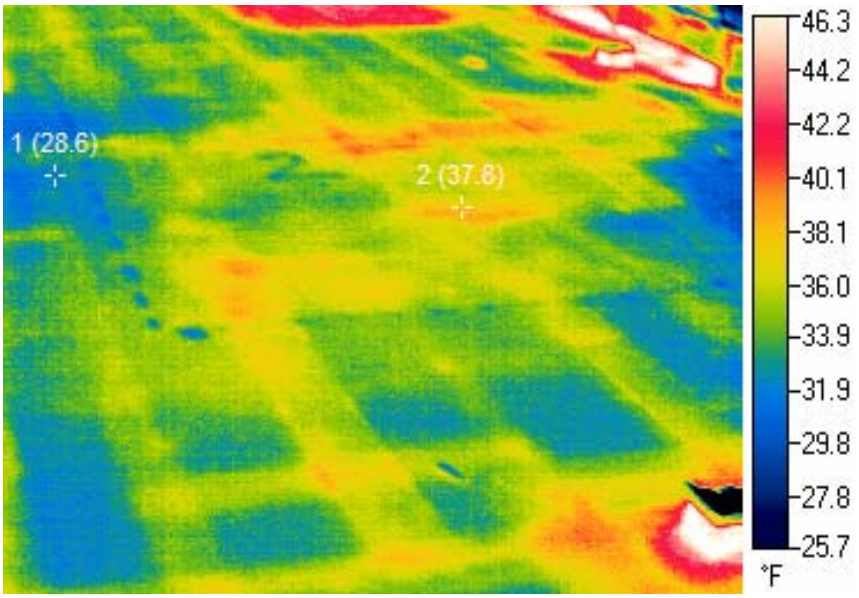

Photo No. 3

Wet areas may extend beyond paint lines.

"Hatch" patterns appear to be just more thermal mass due to strip patches.

Area 2. This is along east elevation, south of Area 1.

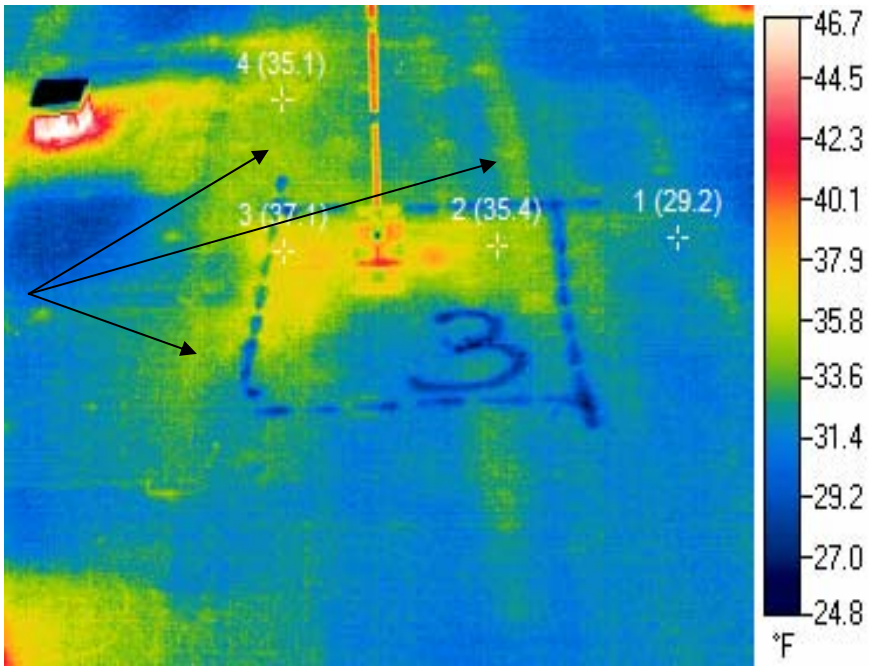

Photo No. 4

It appears the wet area extends beyond the painted line.

Area 3

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Infrared Roof Analysis

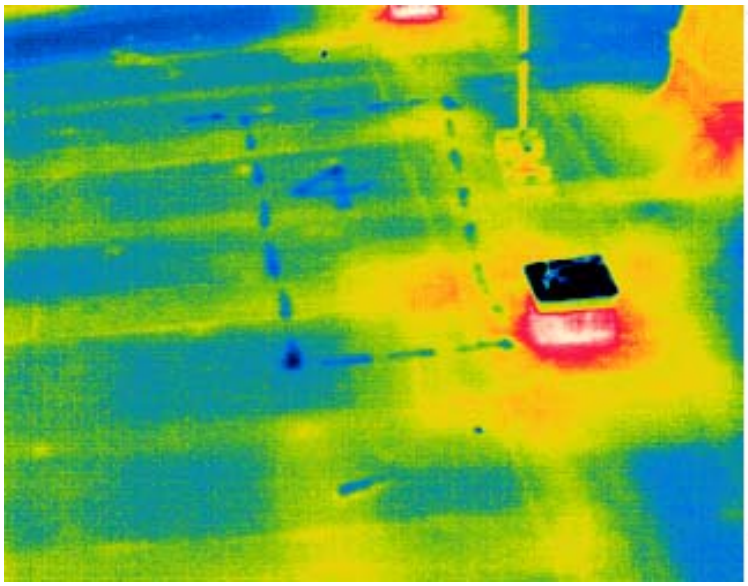


Photo No. 5

Moisture patterns extend past the paint lines.

Area 4. Center of roof.

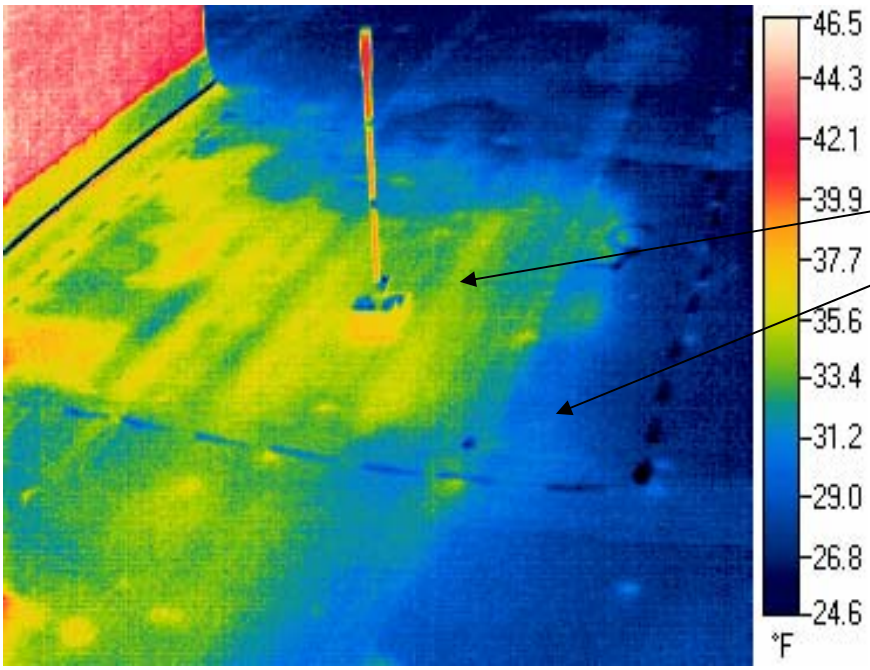
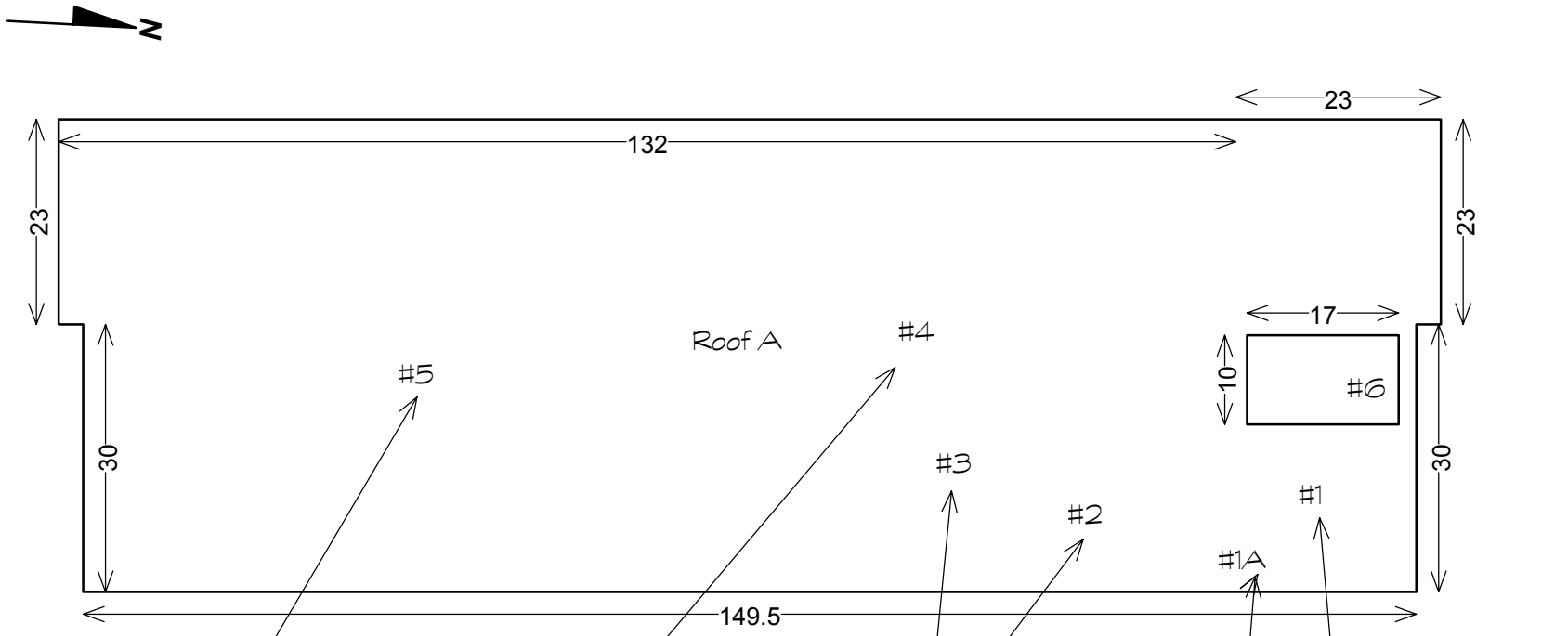
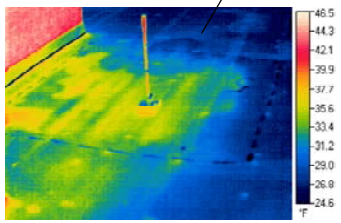
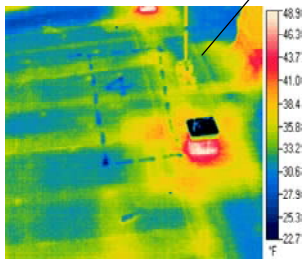


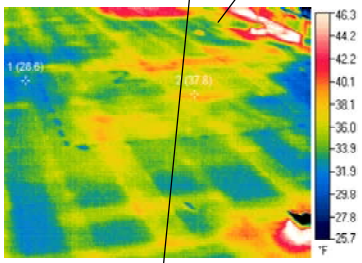
Photo No. 6

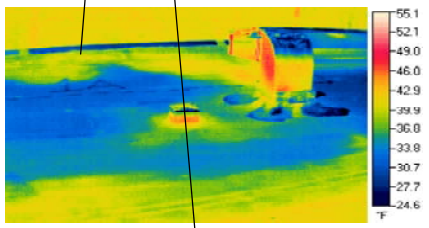
Area 5. This is on the east side of the small roof towards the south elevation.

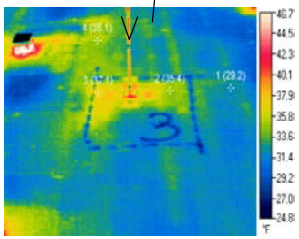


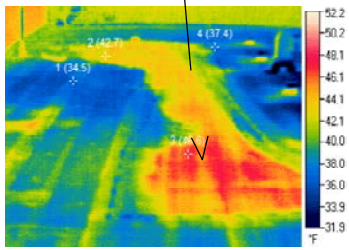












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