

Infrared Thermographic Roof Moisture Analysis

PERFORMED FOR: Viking Construction
1387 Seaview Ave.
Bridgeport, CT 06607

LOCATION: Turn of River Middle School
Stamford, CT

CONDUCTED ON: May 22 & 24, 2019

REQUESTED BY: Jo Ann Michaels

PERFORMED BY: Tim Moughty, Certified Thermographer

IR Analyzers / Vector Mapping
65 Lyman Drive
Williston, VT 05495
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June 3, 2019

Jo Ann Michaels
Viking Construction
1387 Seaview Ave.
Bridgeport, CT 06607

Dear Jo Ann,

This report summarizes the findings of our Infrared Roof Moisture Analysis of the roofs at Turn of River Middle, Stamford, CT, performed on May 22 & 24, 2019.

Included in this report are 10 Thermograms and Control Photos taken during the inspection, and information about interpreting these images. Also included are four copies of an AutoCAD® map of the roofs. The suspected wet areas are marked directly on the roof surfaces with long-lasting spray paint. This report also includes descriptions of Infrared Thermography, as well as survey procedures and the weather conditions on the date of the infrared testing.

WEATHER CONDITIONS

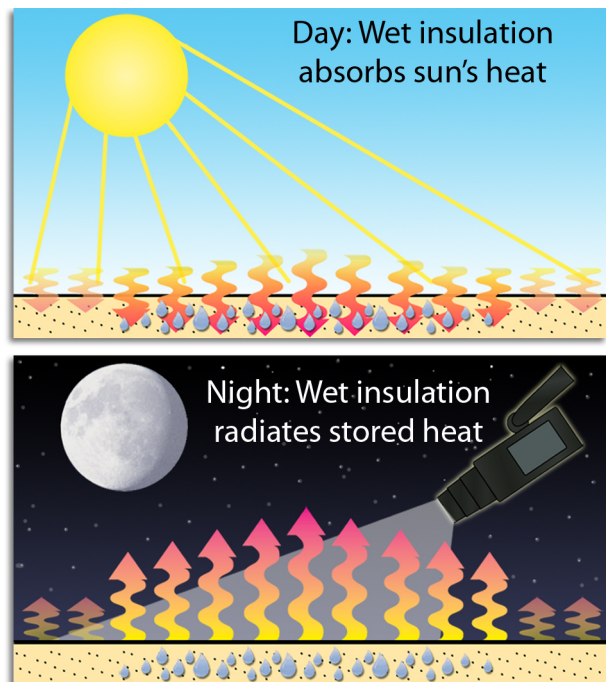
The Infrared Roof Moisture Survey was performed during the night of May 22, 2019. During the day the weather was sunny with a high temperature of approximately 73°F. At night the sky was clear with calm winds and an ambient nighttime temperature of approximately 55°F.

INFRARED THERMOGRAPHY

All objects emit heat (i.e. infrared radiation). This radiation is constantly being absorbed and re-emitted by ourselves and everything around us. “Infrared scanning” and “thermography” are the terms used to describe the process of making this thermal radiation visible and capable of interpretation.

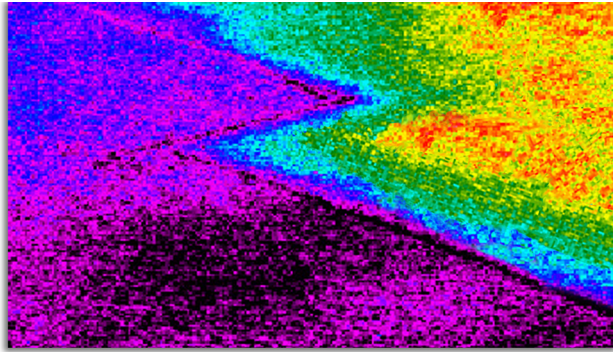
Infrared Roof Moisture Analysis locates areas of wet insulation within a flat roofing system. These areas of wet insulation can be pinpointed with the infrared scanner because wet and dry insulations have different abilities to conduct, absorb and retain heat. The thermal differences between wet and dry insulation are especially evident under two sets of circumstances.

First, wet roof insulation absorbs much more heat than dry insulation. Moisture-damaged insulation also stores more heat over a longer period of time than intact, dry materials. During the day, the sun’s heat raises the temperature of wet insulation in the roofing system. As the roof cools off at night, the areas of wet insulation will stay warm longer than the dry areas. During the evening, this stored “solar gain” is released as radiant heat that is detectable with the infrared camera. As the evening progresses, areas of wet insulation will appear warmer to the camera than adjacent dry roofing.



Second, when there is a significant difference in ambient temperature between the interior and exterior of the building, heat losses from inside the building will be greater through the wet areas due to the reduced R-value of the wet insulation. This is especially true during the heating

season. In both instances, when viewed from the roof side, wet insulation will show up as warmer in the infrared image. Often these two phenomena work together, creating strong, long-lasting thermal images that clearly illustrate the differences between wet and dry insulation.



Thermographic image from infrared camera



Control image, wet sections marked for removal

Our Infrared cameras can also be used in a variety of other Nondestructive testing applications:

- Infrared Electrical/Mechanical Inspections pinpoint developing problems in power delivery systems. The infrared scanner can “see” hot spots where there are going to be failures, before they happen. This Predictive Maintenance approach provides for time to repair these problem areas before they cause equipment damage, unscheduled outages, and downtime. Problem areas are pinpointed, prioritized and fully documented.
- Infrared Steam System Inspections pinpoint failing steam traps, malfunctioning heat exchangers and boiler problems. These surveys can save thousands of dollars by reducing energy usage.
- Infrared Building Envelope Analysis locates and documents building heat loss problems, including sources of mold, drafts, and excess moisture. Infrared thermography is the only nondestructive and complete system for locating the causes of frozen pipes, ice dams, missing or wet insulation and high heating costs. Infrared Building Envelope Surveys provide valuable performance data for newly constructed buildings and energy retrofits.

INSTRUMENTATION

Your roofs were inspected with a FLIR T420, a professional long wave infrared camera. In combination with the powerful FLIR Tools+ software, the T420 system enables highly detailed image/data processing in the Windows® environment.

| FLIR® T-420 Specifications | |
|-----------------------------------|---------------------------------------|
| Detector | FPA uncooled microbolometer 320 x 240 |
| Spectral band | 7.5 to 13 µm |
| Sensitivity (NETD @ 30°C) | < 0.045°C |
| Temperature measurement range | -20 to 650° C |
| Focus range | 9" to infinity |
| FOV (standard lens) | 25° x 19° |
| Zoom | 4x continuous |
| Minimum Focus Distance | 0.4 meters |
| Video/Image Output Format | MPEG-4, USB, Wi-Fi |

SURVEY PROCEDURES

The IR Analyzers Certified Thermographers followed defined survey procedures when inspecting your roof.

GUIDELINES: Every square foot of roofing in the contract was scanned a minimum of two times. All suspected wet areas were marked directly on the roofs with long-lasting paint. ‘

VERIFICATION: These roofs were under a manufacturer’s warranty. Therefore, to avoid any possibility of jeopardizing this warranty, the Certified Thermographer did not take core samples or moisture probes of the roof to verify presence of water. The Infrared Cameras we use are extremely sensitive and accurate when locating areas of wet insulation. However, as with any non-destructive testing technique, there exists a slight possibility that false positives or false

negatives may occur. Due to the lack of absolute physical verification, the areas marked on your roof and on the maps should be considered to represent suspected or probable areas of wet insulation, rather than verified areas of wet insulation.

BOUNDARIES: Every effort is made to have the lines painted on the roof indicate accurately the boundaries of the wet insulation. However, the nondestructive nature of the testing can sometimes result in small inaccuracies. Therefore, the Thermographer will generally mark outside the wet area by about 6" to 12" to provide a reasonable margin of error. In other instances, it may be advisable to calculate a slightly larger area of insulation than what is actually painted on the roof. Additionally, the way water migrates through insulation may not be homogenous, and it may happen that there are a few square feet of dry insulation within the boundaries of the larger wet area. As a practical matter, these small dry spots are not significant, and the Thermographer will just define the overall boundaries of the wet area.

MAPPING: After all the scanning and verification were completed, the roof was mapped. A draft copy of your drawing was made at the site, documenting all the information generated during the inspection. A final copy of the map was plotted in the office using an AutoCAD System. Please note that the measurements displayed in these maps should not be used as a substitute for as-built drawings.

FINDINGS

As per our survey procedures, the entire roof area in the contract was scanned a minimum of two times. A total of 14 areas of suspected wet insulation were detected in the top layer of roofing.

The total size of the roof that was inspected with the infrared camera is approximately 87,574 square feet. The total amount of suspected wet insulation equals approximately 1,347 square feet. The amount of suspected wet insulation is 1.5% of the total roof areas. These areas of suspected wet insulation are marked directly on the roof surfaces and on the maps provided. Please refer to these maps when reviewing the report.

THERMOGRAM INTERPRETATION AND DOCUMENTATION

Hard copy documentation of the survey findings is provided through the use of two different types of photographs. Color Thermograms (photographs of the infrared image) and Control Photos (conventional pictures of the same scene taken during the inspection) are provided of sample wet areas uncovered during the inspection. Dry areas of roofing are cooler, while wet areas are warmer. In the thermograms, temperatures are indicated in various colors. The following is a chart illustrating the hierarchy of colors that the FLIR T420 uses to represent the relative temperature differences of the wet areas and adjacent dry roofing:



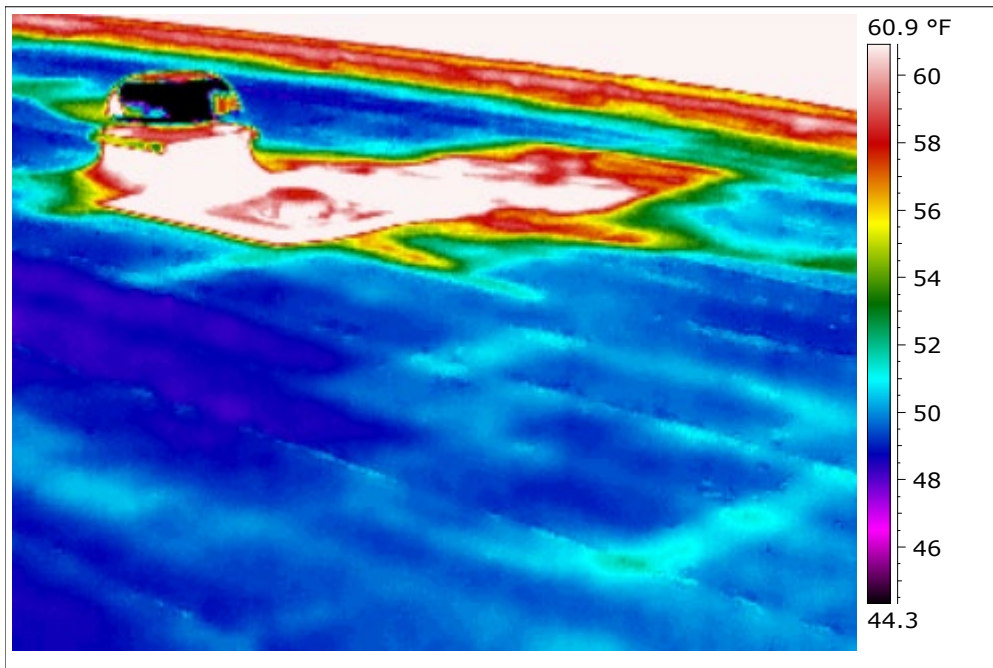
The next section of the report contains the 10 sets of thermograms and control photos that were generated during the inspection. The locations and directions from which these photos were taken are marked on the roof maps and directly on the roof surface with spray paint.

Control Photo:
Visible Light
Image



Wet Area #7

Thermogram:
Infrared
Image



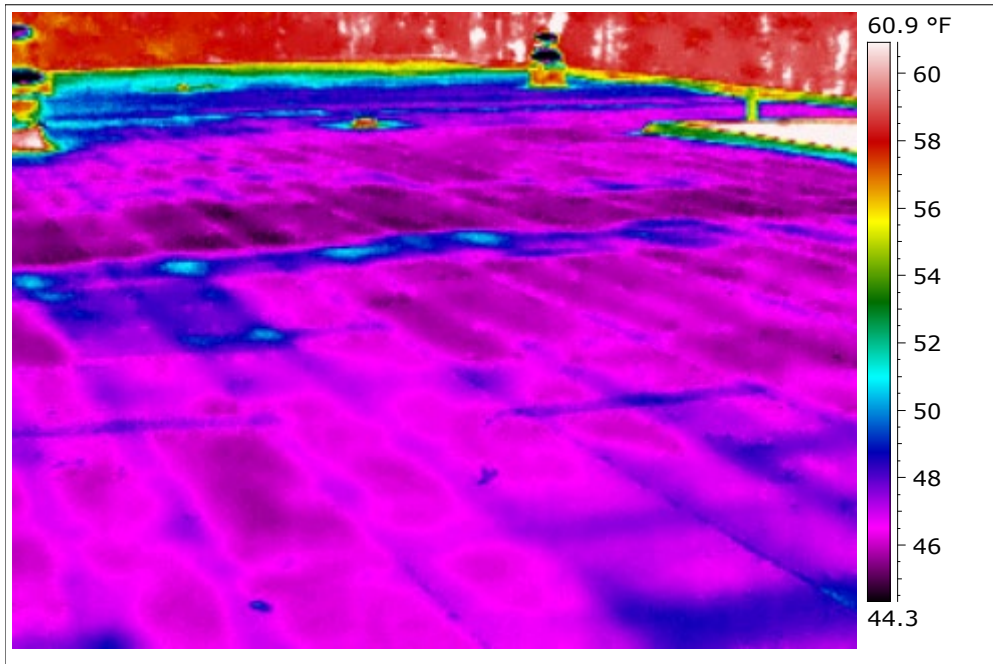
Thermogram # 1

Control Photo:
Visible Light
Image



Dry area of roofing

Thermogram:
Infrared
Image



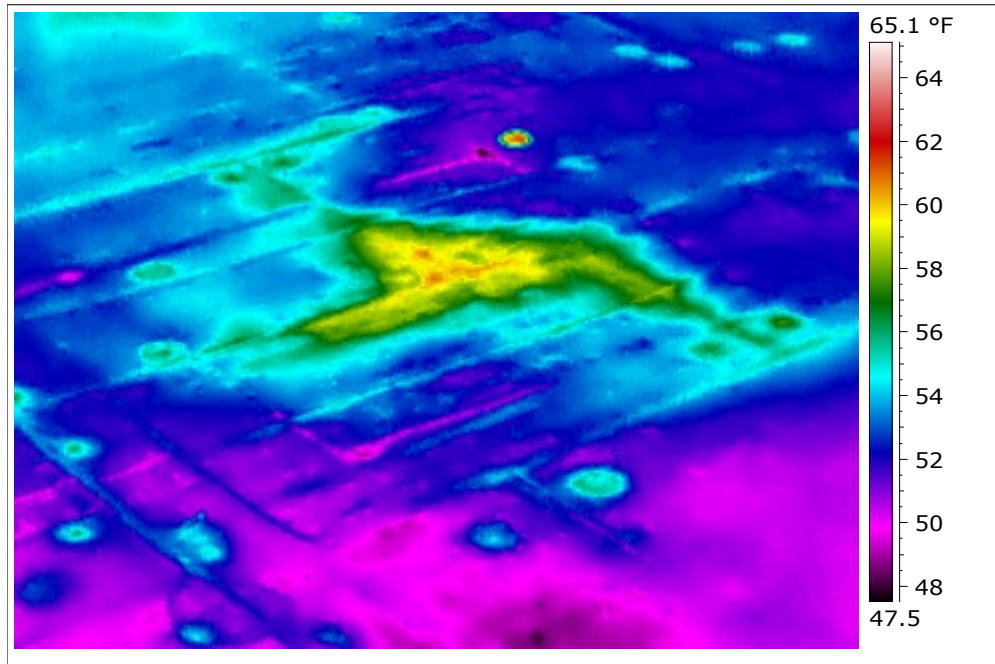
Thermogram # 2

Control Photo:
Visible Light
Image



Wet Area #12

Thermogram:
Infrared
Image



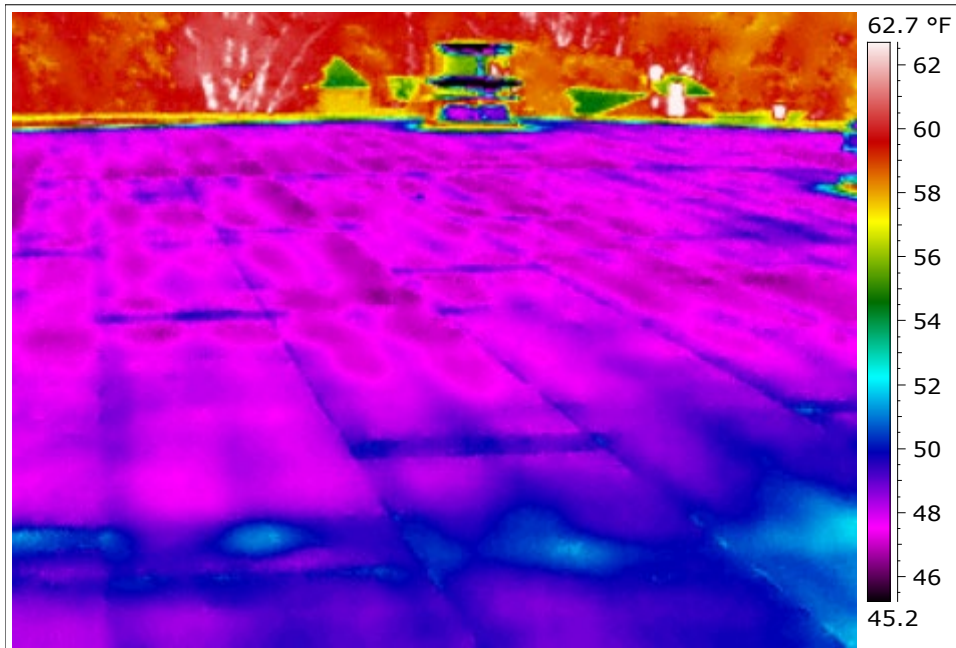
Thermogram # 3

Control Photo:
Visible Light
Image



Dry area of roofing

Thermogram:
Infrared
Image



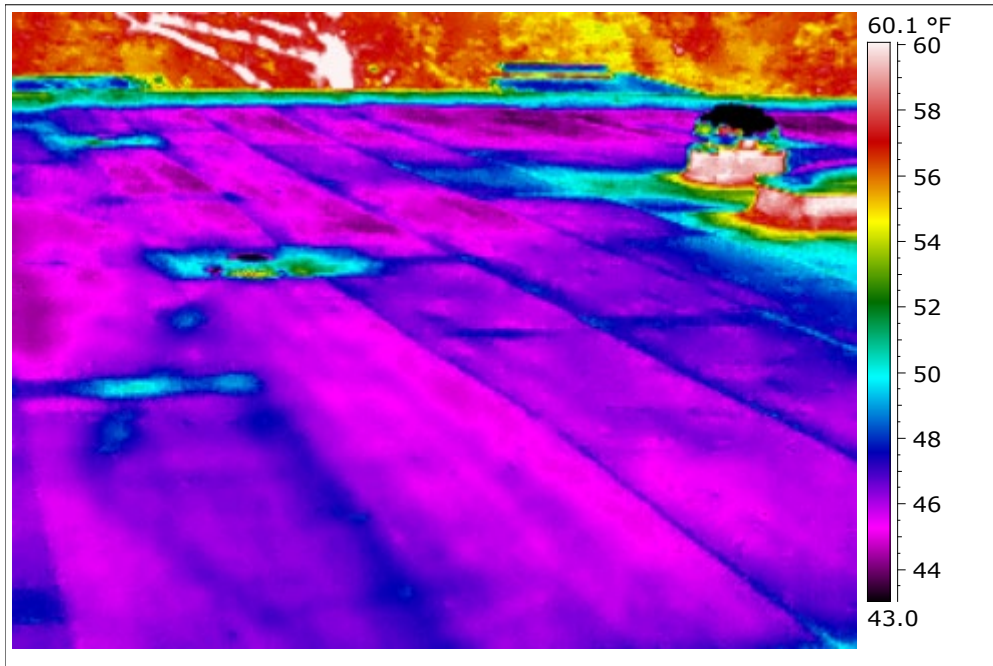
Thermogram # 4

Control Photo:
Visible Light
Image



Dry area of roofing

Thermogram:
Infrared
Image



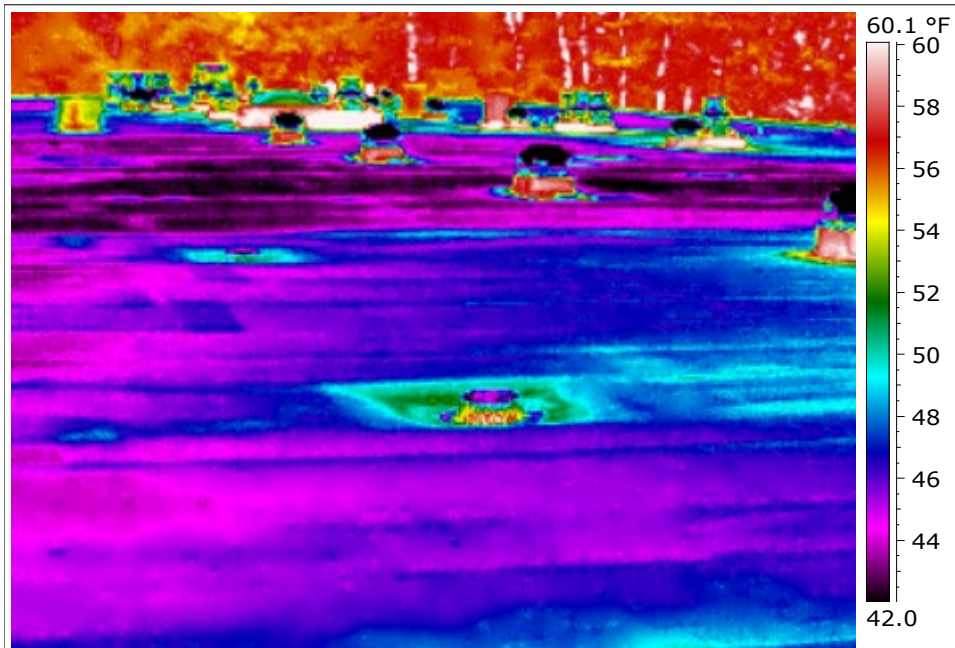
Thermogram # 5

Control Photo:
Visible Light
Image



Dry area of roofing

Thermogram:
Infrared
Image



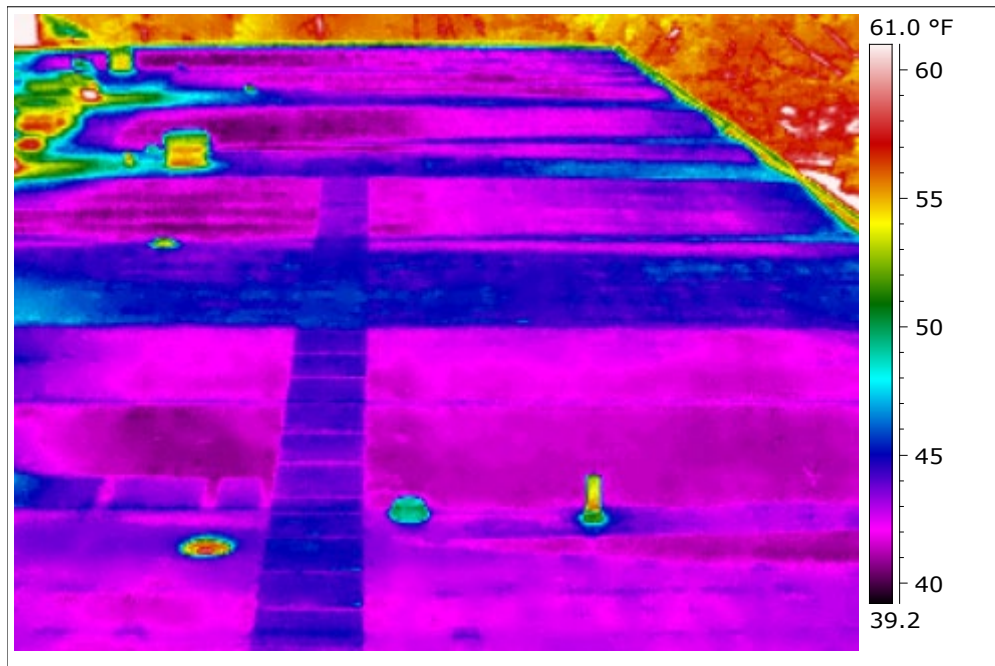
Thermogram # 6

Control Photo:
Visible Light
Image



Dry area of roofing

Thermogram:
Infrared
Image



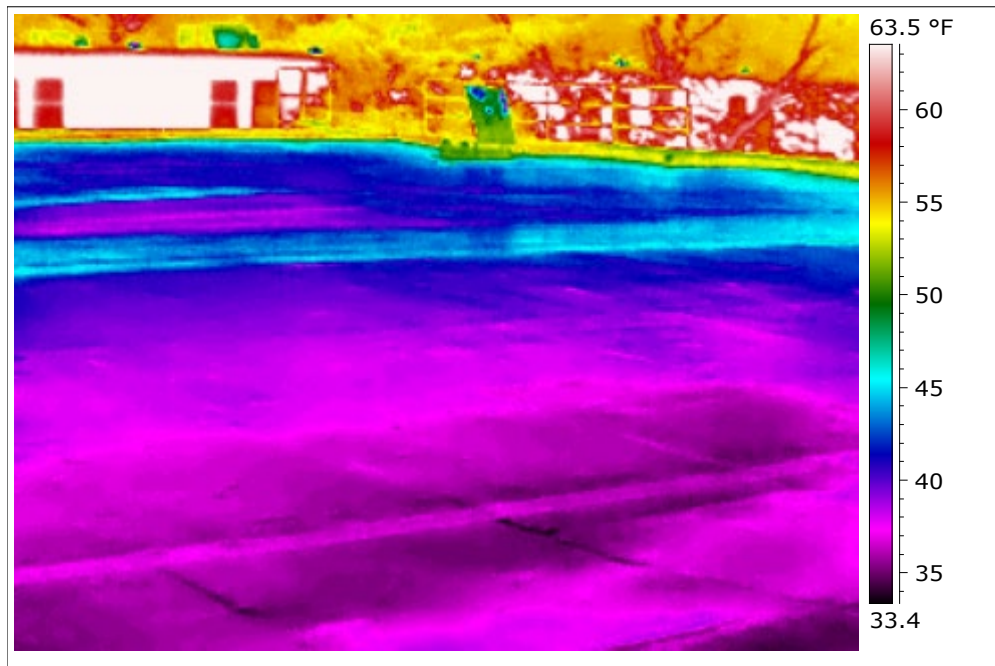
Thermogram # 7

Control Photo:
Visible Light
Image



Dry area of roofing

Thermogram:
Infrared
Image



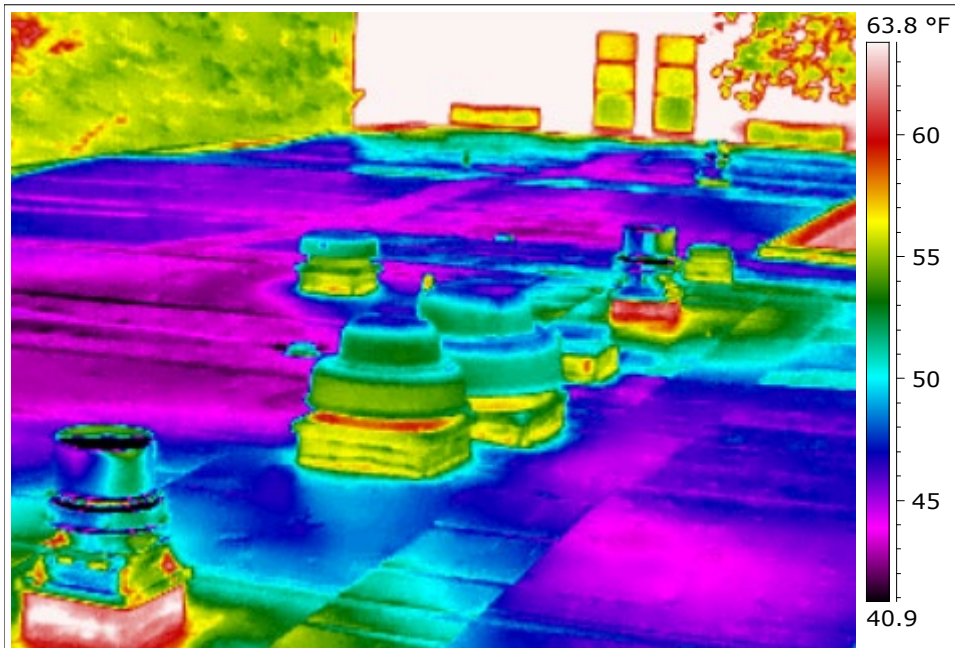
Thermogram # 8

Control Photo:
Visible Light
Image



Dry area of roofing

Thermogram:
Infrared
Image

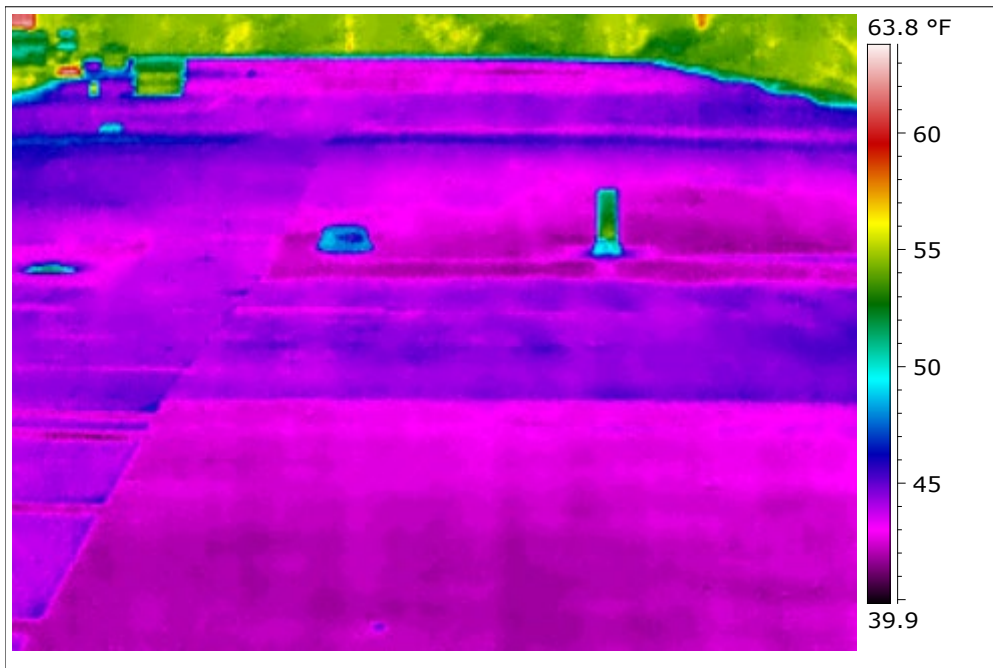


Thermogram # 9



Control Photo:
Visible Light
Image

Dry area of roofing



Thermogram:
Infrared
Image

Thermogram # 10

ROOF MAPS

The last part of the bound hard-copy version of this report contains four copies each of a map of the roofs. These scaled drawings were plotted on an AutoCAD system and complete the documentation of the findings of the survey.

This report documents the locations and extent of suspected wet insulation at the time of the inspection. No information regarding the integrity of the roofing system or building is provided or implied in this report. Many factors, including sunlight, precipitation, wind, foot traffic, and building movement and the like can affect a roof over a short period of time. Regular inspections ensure early detection of problems and can extend the life of a roof membrane.

Prepared for: Viking Construction

Survey Location: Turn of River

Jo Ann, thank you for using our Infrared Services. Please call me if you have any questions regarding this report, or if I can help in any way.

Sincerely,

J.P. Phillips
Director of Operations