air barrier abaa association of america

BUILDING ENCLOSURE CONFERENCE

RESTON VA

2022

MAY 10-11

To Scan or Not to Scan? Thermography is the Answer

Melissa I. Payne, BECxP, CxA+BE, CDT,

Level II Building Science Thermographer

Tremco CPG, Inc.

Enclosure System Solutions

abaa EDUCATION

Air Barrier Association of America (ABAA) is a Registered Provider with The American Institute of Architects Continuing Education Systems. Credit earned on completion of this program will be reported to CES Records for AIA members. Certificates of Completion for non-AIA members are available on request.

This program is registered with the AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

air barrier
abaa
association of
america

AIA
Continuing
Education
Provider

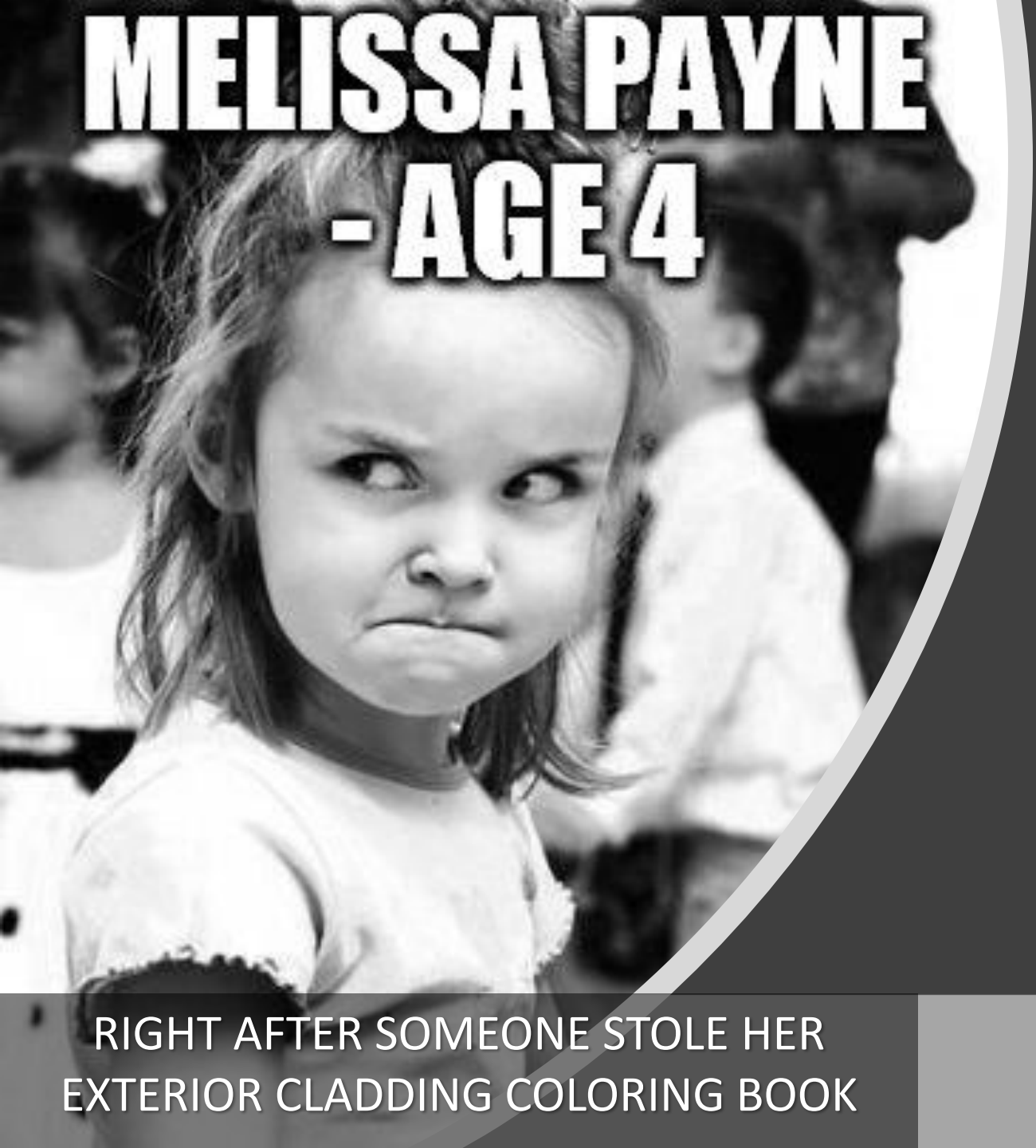
Learning Objectives

- Gain knowledge on how to avoid costly rework due to common construction issues which can easily be visualized with infrared technology
- Gauge the importance of infrared technology and determine when building enclosure diagnostics and performance thermography testing solutions should be used during construction and to accompany other performance testing methods
- Become acquainted with the science behind infrared technology and interpret the difference between bulk moisture and air penetration
- Identify what a thermogram represents and differentiate basic thermal anomalies as they represent heat, air and moisture

air barrier
abaa
association of
america

AIA Continuing Education Provider

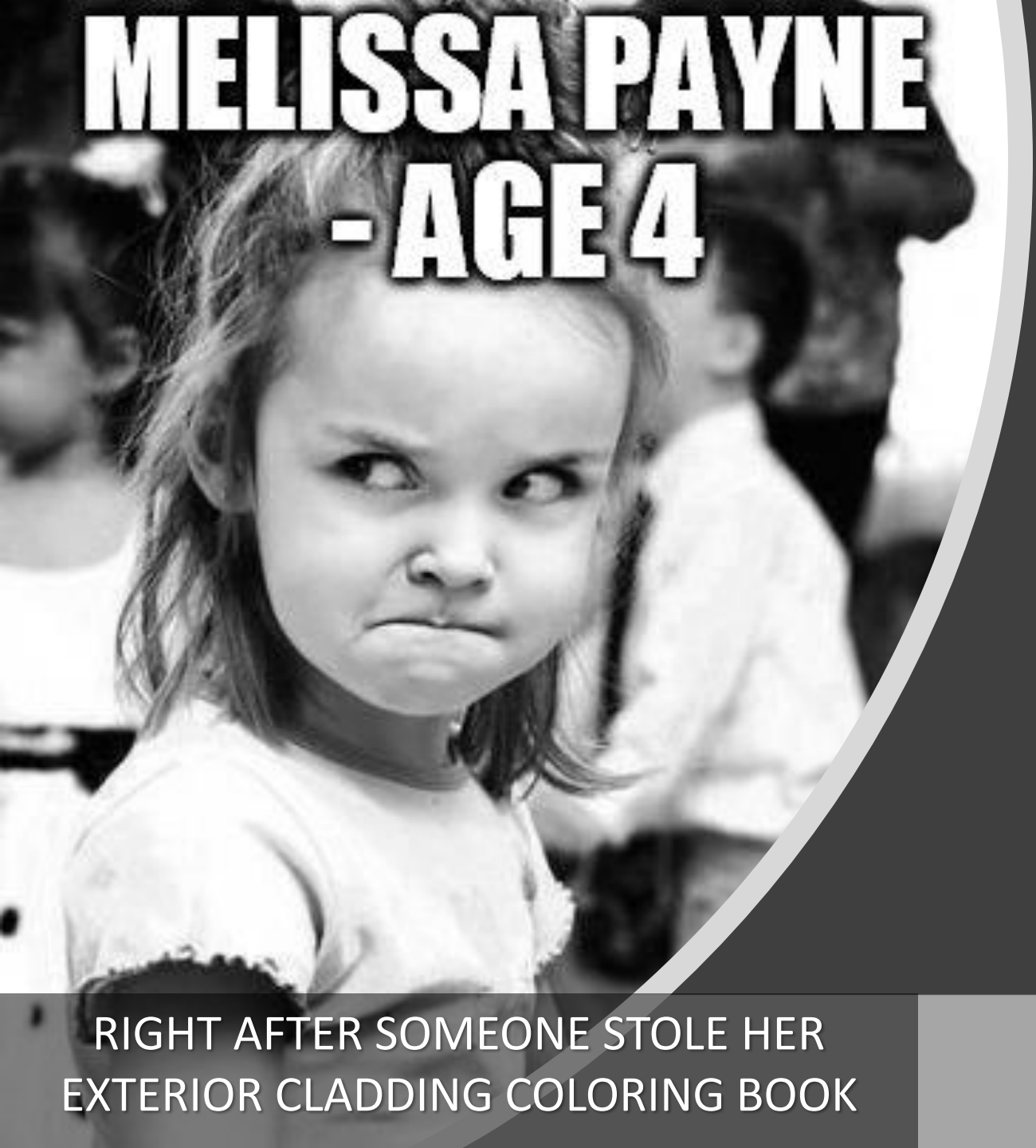
“Rework Costs — including labor, materials, equipment and subcontractors can run from 10% to 30% of a project's total contract amount.”



RIGHT AFTER SOMEONE STOLE HER EXTERIOR CLADDING COLORING BOOK

Why is this Happening?

- Incomplete Design and Construction Documents
- Time Crunch – Design and Construction
- Skilled Labor – The Dying Craft
- Lack of Training for Trades
- Lack of Inspections – Q/A & Q/C
- Lack of Coordination and Collaboration

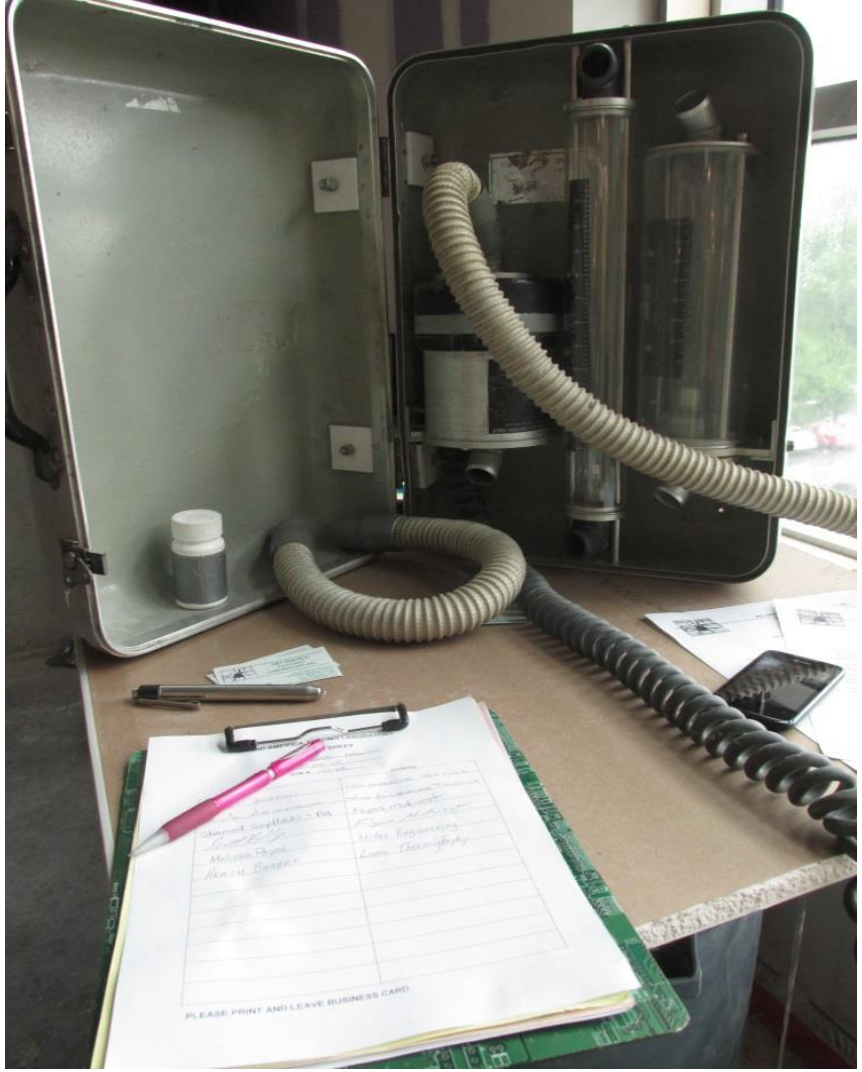


RIGHT AFTER SOMEONE STOLE HER EXTERIOR CLADDING COLORING BOOK

Why is this Happening?

- Incomplete Design and Construction Documents
- Time Crunch – Design and Construction
- Skilled Labor – The Dying Craft
- Lack of Training for Trades
- Lack of Inspections – Q/A & Q/C
- Lack of Coordination and Collaboration

SUCCESS vs. FAILURE



air barrier
abaa
association of
america

What Is A “Test”

“A procedure intended to establish the quality, performance, or reliability of something, especially before it is taken into widespread use.”

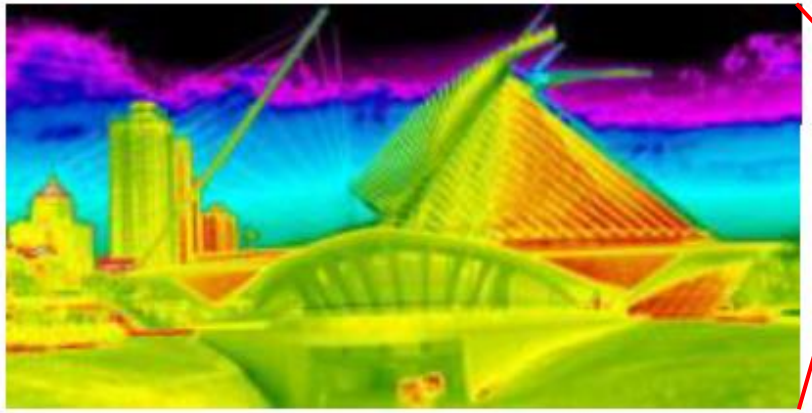
Oxford Dictionary

air barrier
abaa
association of
america


EXPECTATIONS
1
2
3
4
5
6
7
8

air barrier
abaa
association of
america

Thermal Imager Principle

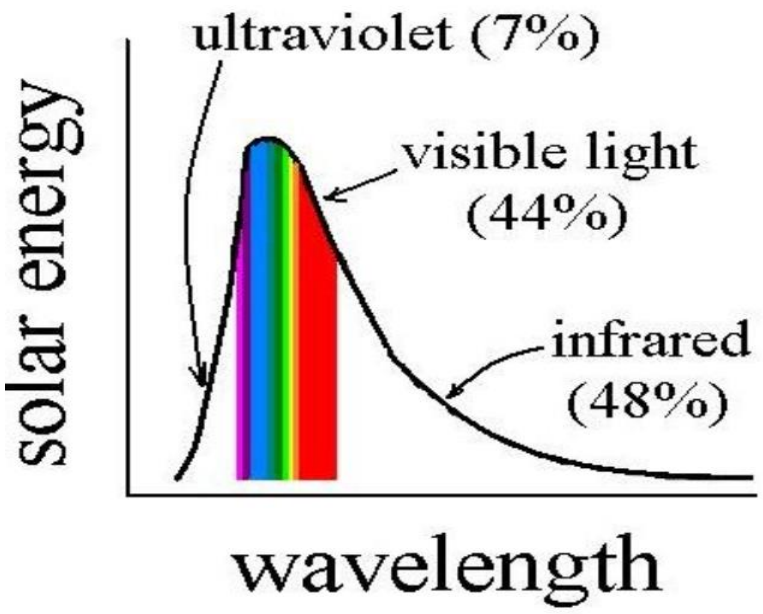


Thermal Imager converts invisible infrared radiation into a visible image which we call thermograms

air barrier
abaa
association of america

Electromagnetic Spectrum

- Defined by wavelengths
- Different wavelengths have different properties
- Our eyes see only visible light region
- Color is due to different wavelengths
- Infrared energy has no “color”



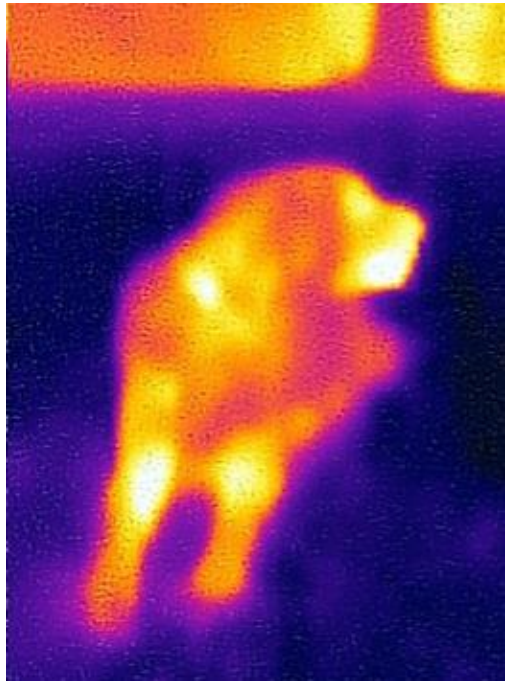
air barrier
abaa
association of
america

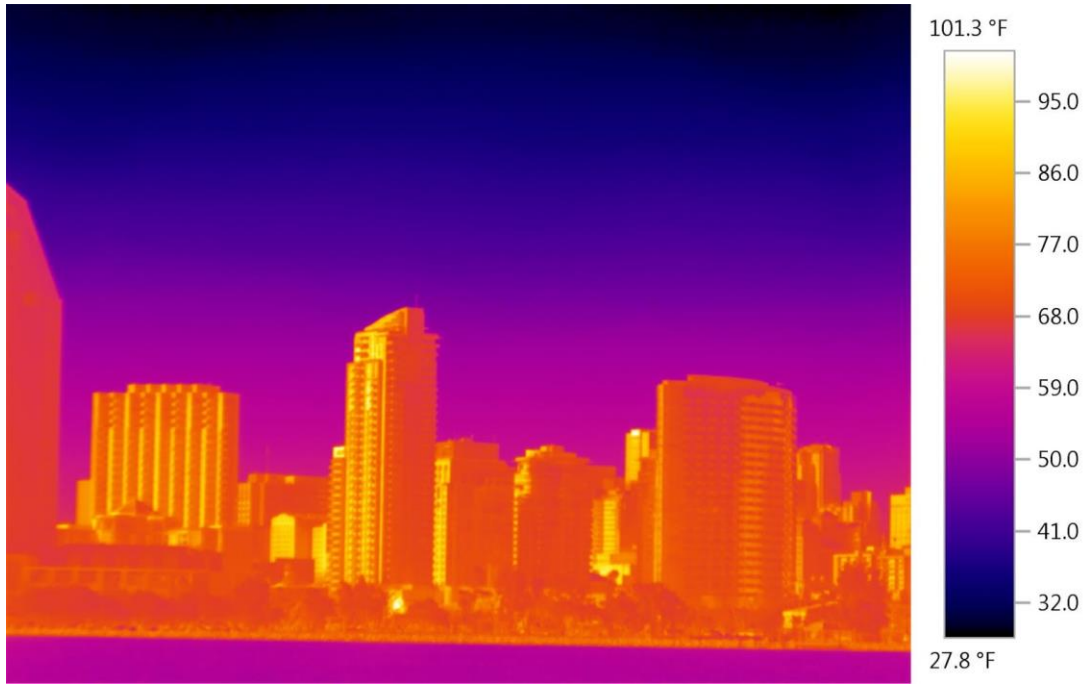
Infrared Imagers

air barrier
abaa
association of
america

Resolution

Poor - 40x30, 80x60, 100x100, 120x120, 160x160, 320x240, 640x480… - Good

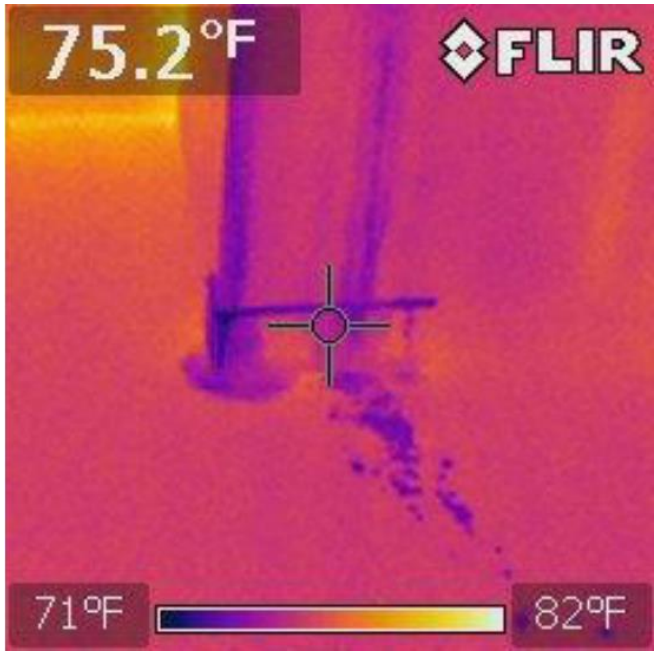




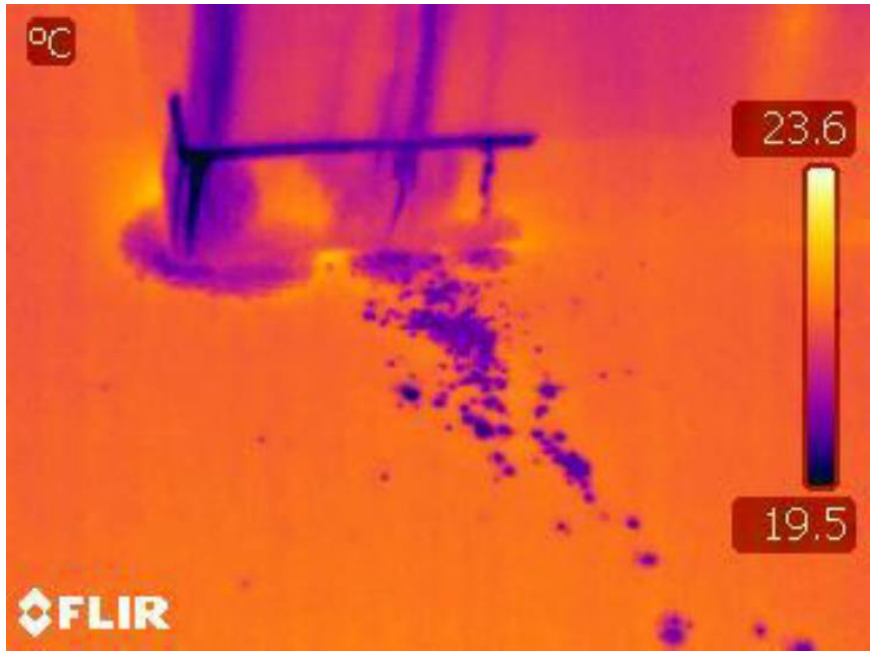
FLIR One:
80x60

Testo T890:
640x480

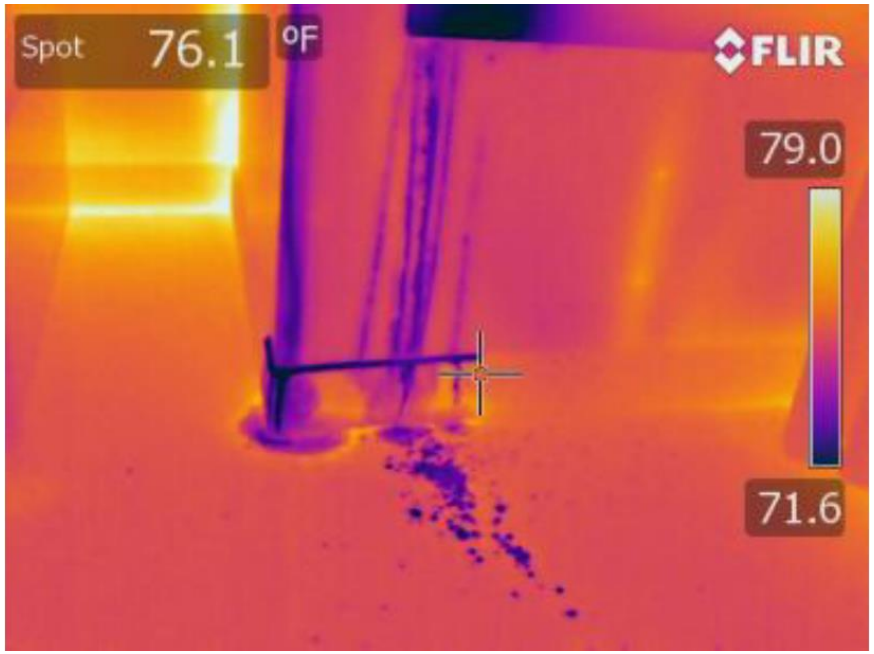
Resolution



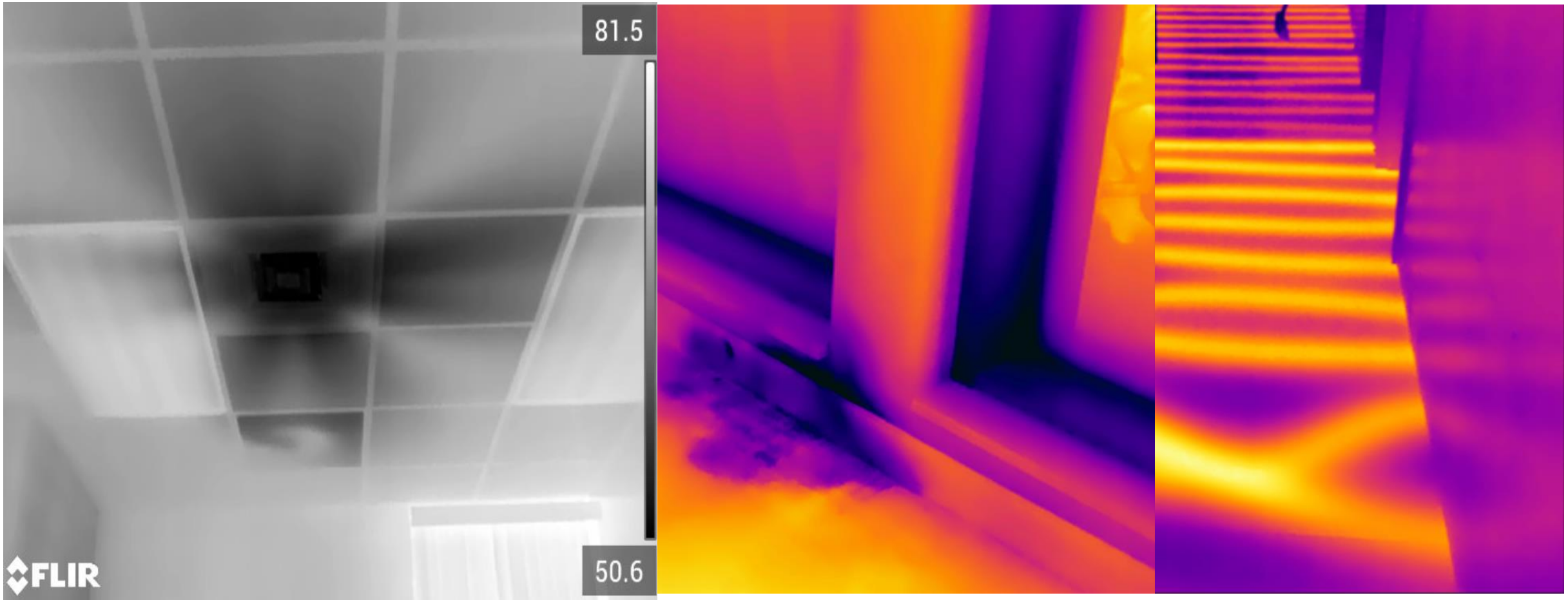
Low Resolution
140x140 pixel array
0.0196 MPixels



Medium Resolution
320x240 pixel
array
0.0768 MPixels



Higher Resolution
640x480 pixel
array
0.3072 MPixels



air barrier
abaa
association of
america

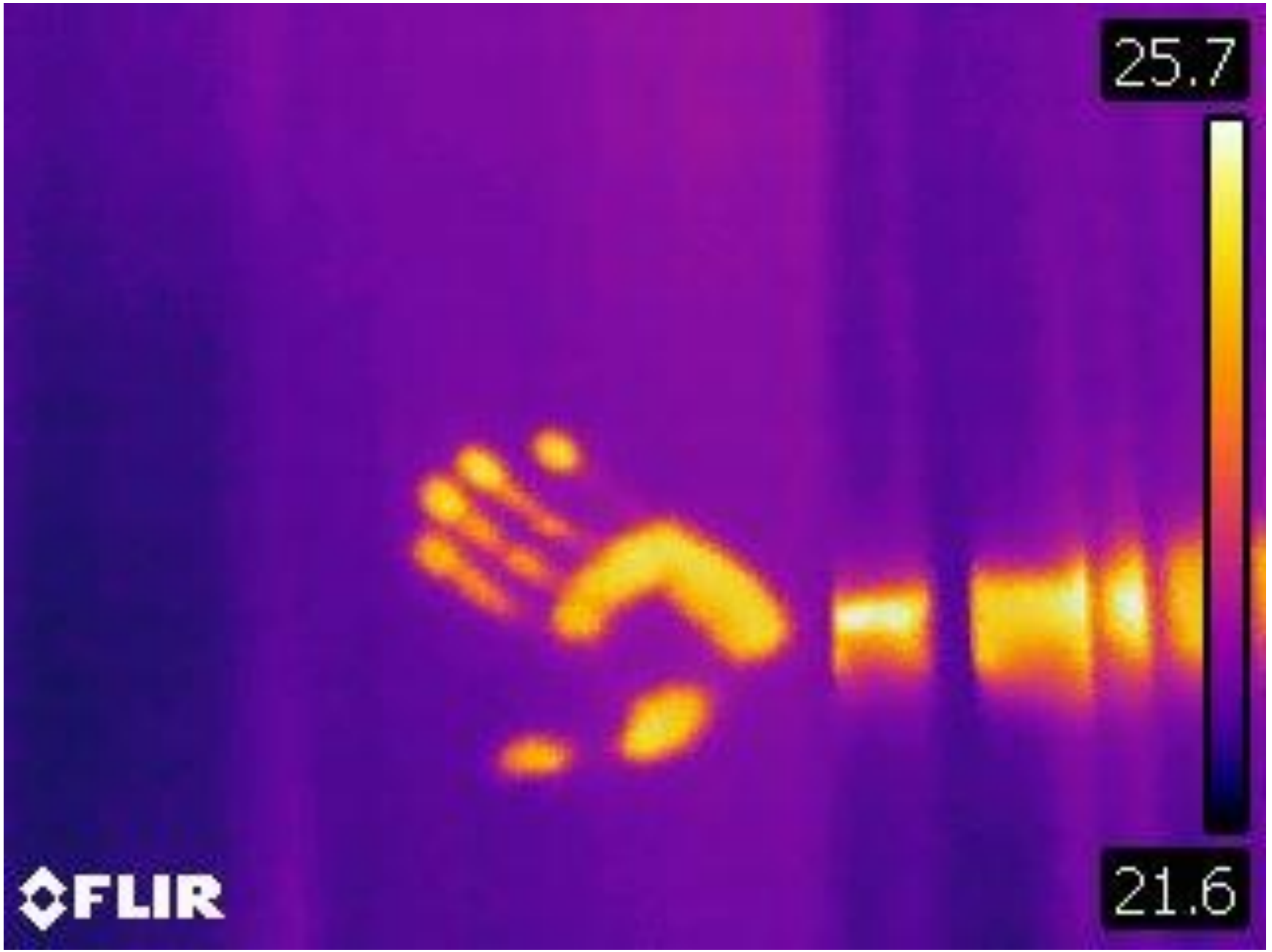
Heat Flow
Air Flow
Moisture Flow

The 2nd Law of Thermodynamics

#1	#2	#3	#4
Moisture	Air	Heat	Vapor
Liquid Water	High to Low	Hot to Cold	High to Low
Control and Disposal	Control Passage of air into and out of the building enclosure	Control Heat Transfer	Pressure Diffusion – Permeability Drying Capacity

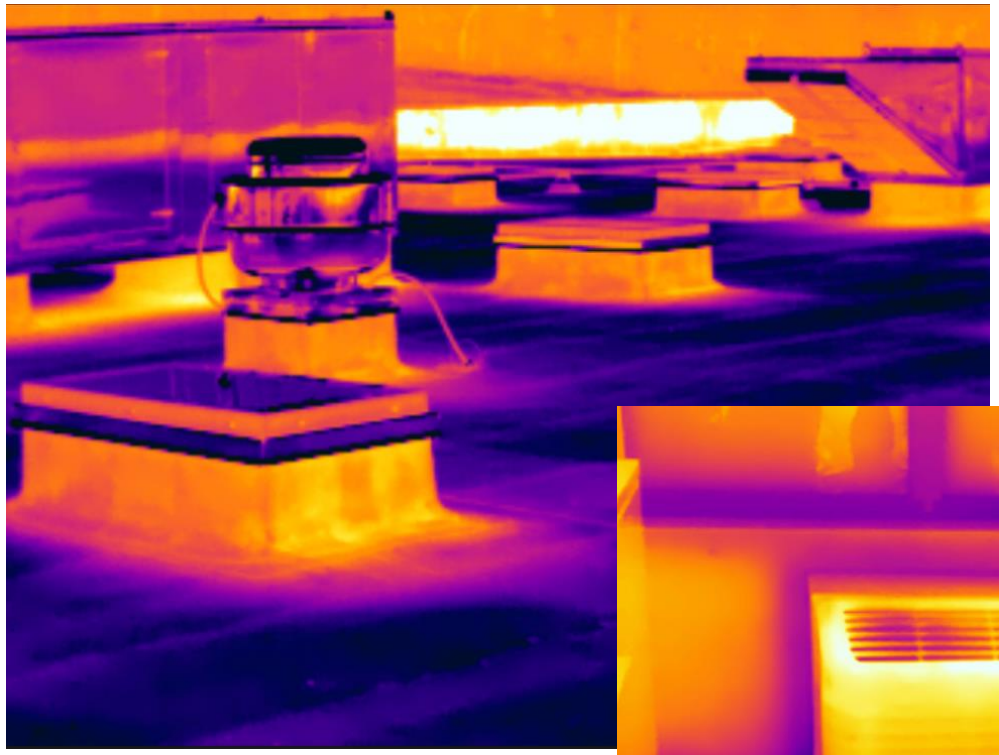
air barrier abaa association of america

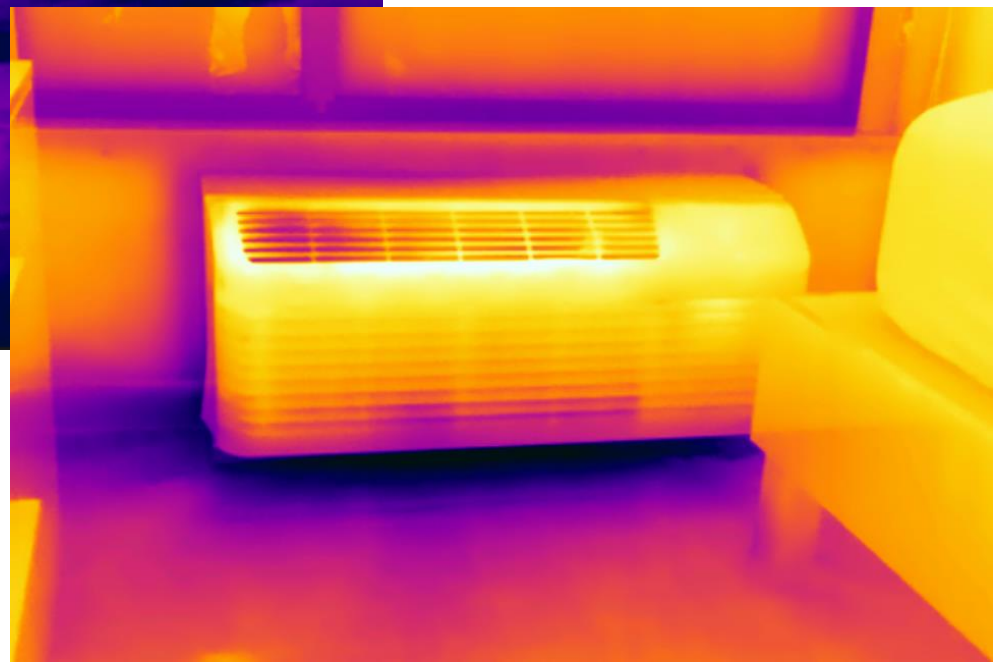
Gravity acts down

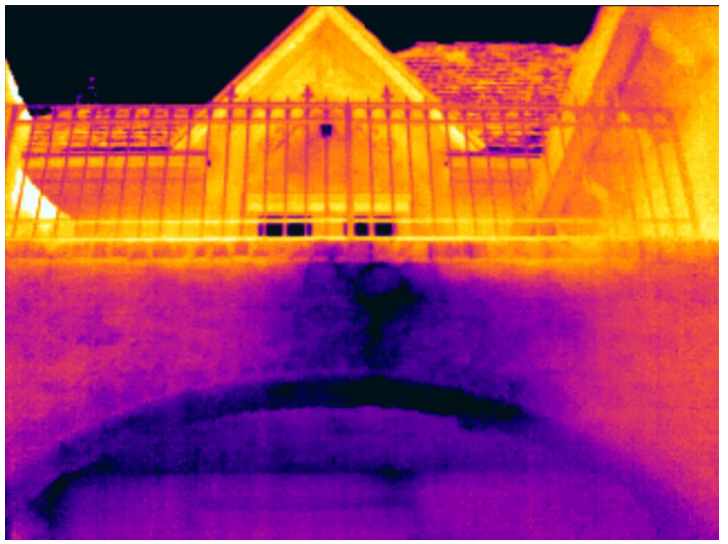


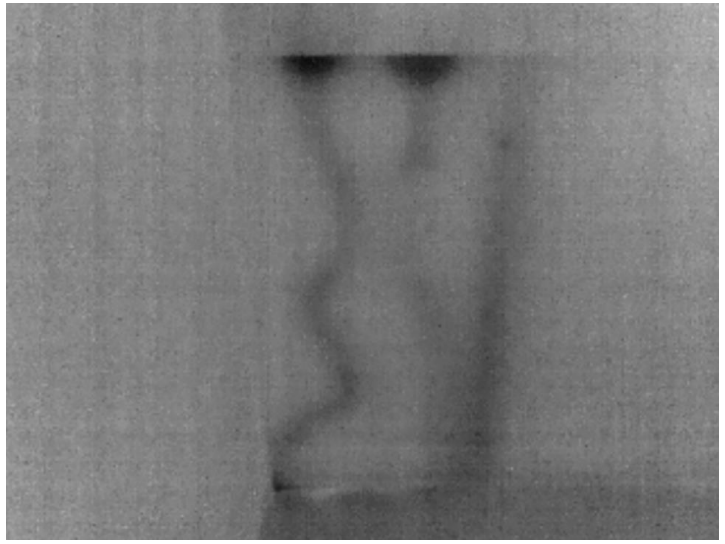
air barrier
abaa
association of
america

Non-traditional Means of Testing



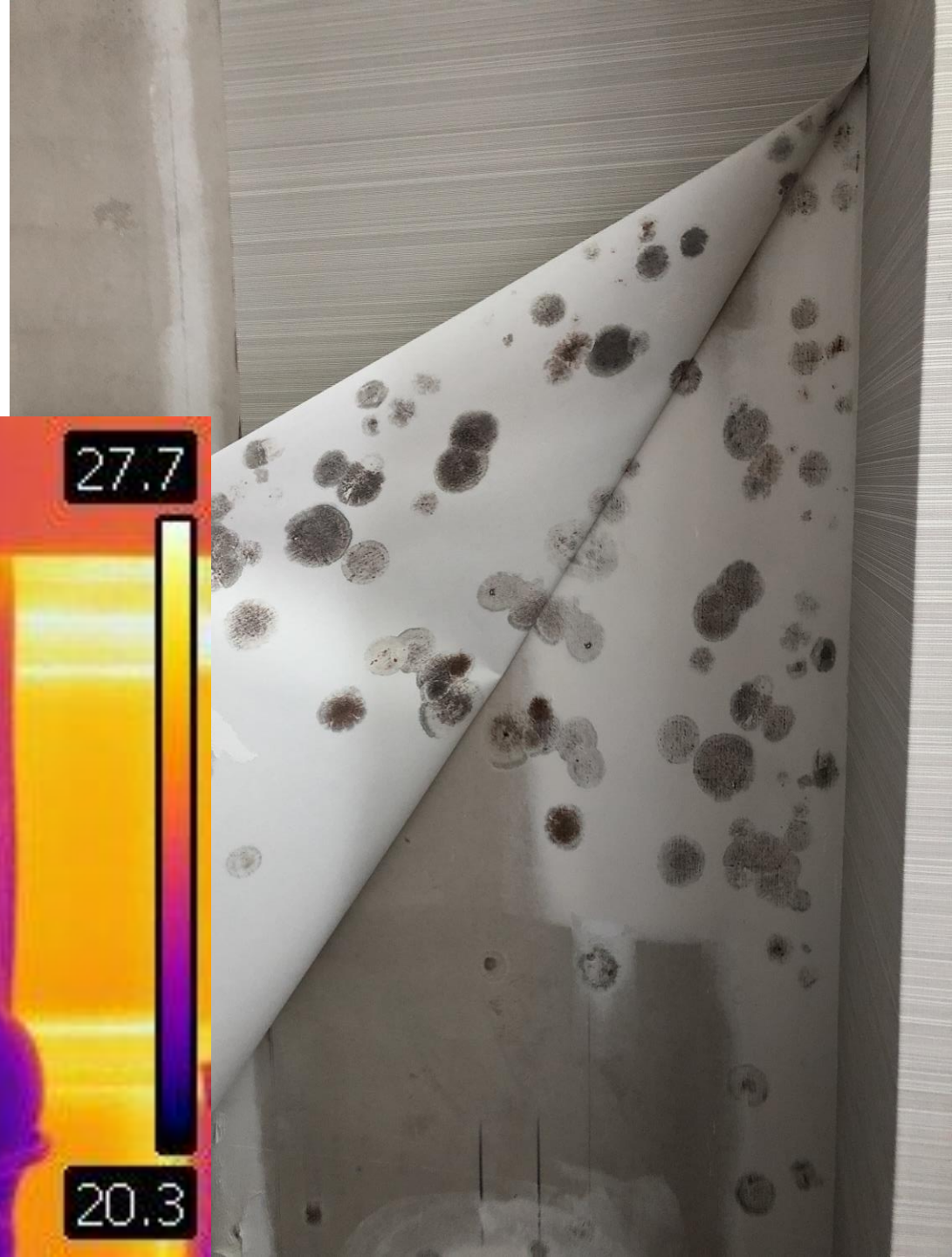






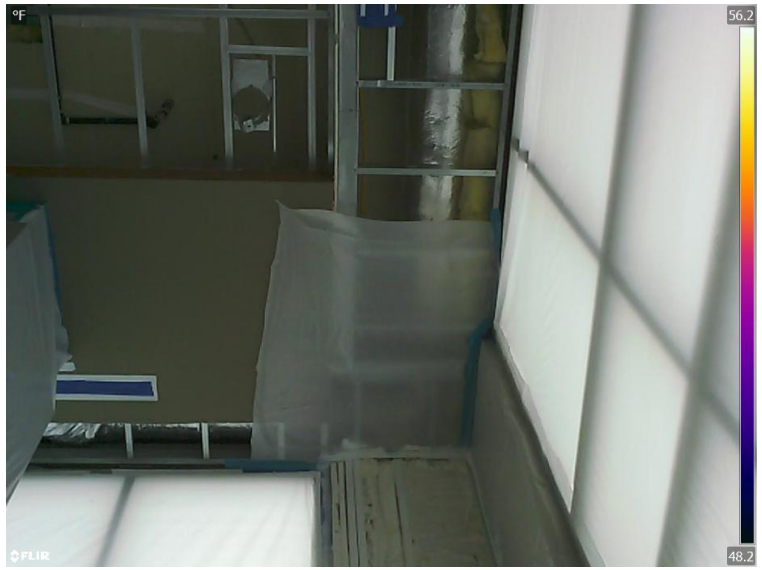
air barrier
abaa
association of
america

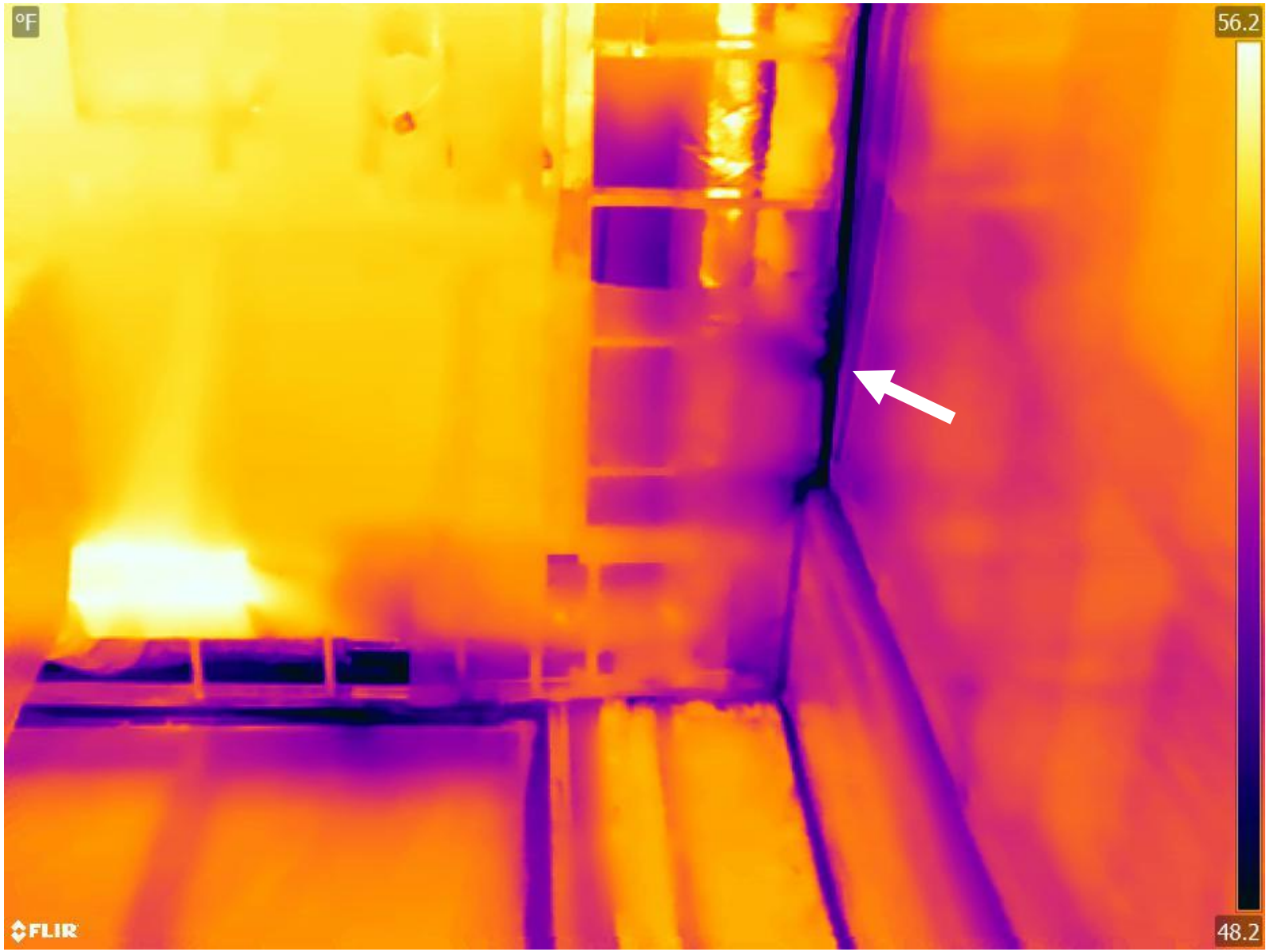
Mold? Can We See It?



air barrier
abaa
association of
america

Air Infiltration at Head of Curtain Wall



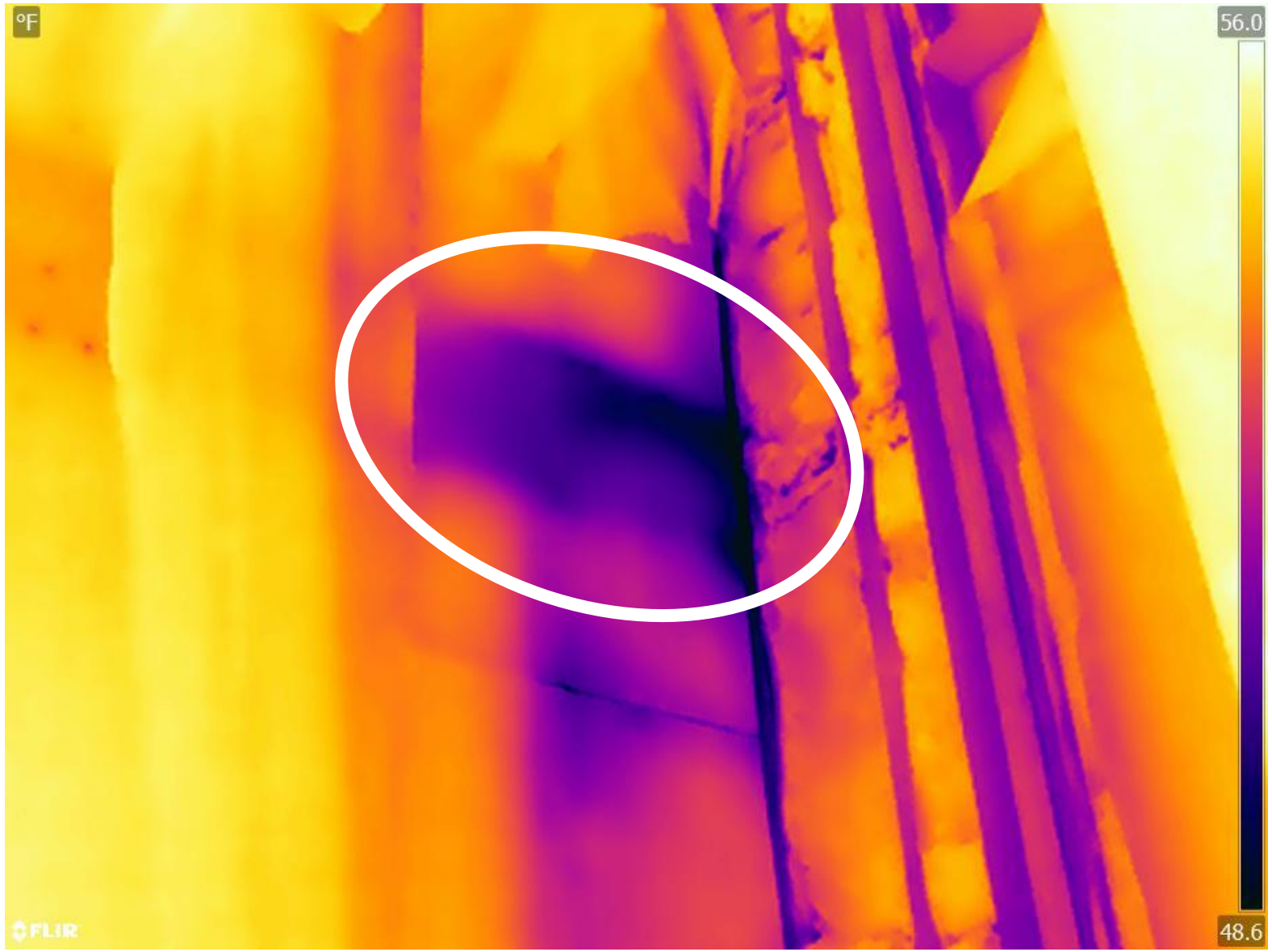


air barrier
abaa
association of
america

Air Infiltration on Exterior Wall in Return Air Plenum

air barrier
abaa
association of
america

Air Infiltration and Direct Transfer from Canopy

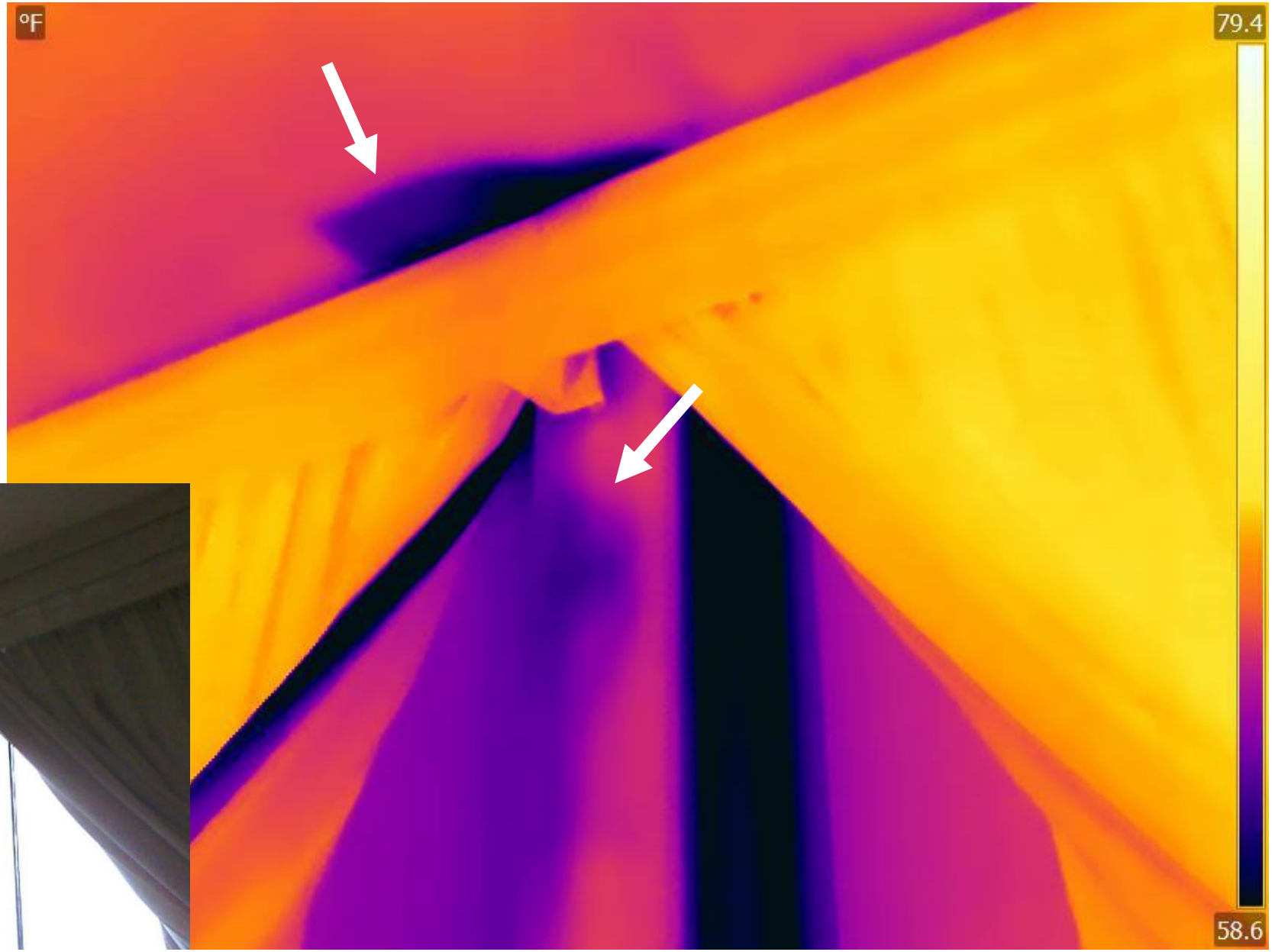


air barrier
abaa
association of
america

Air Infiltration and Direct Transfer from Canopy

air barrier
abaa
association of
america

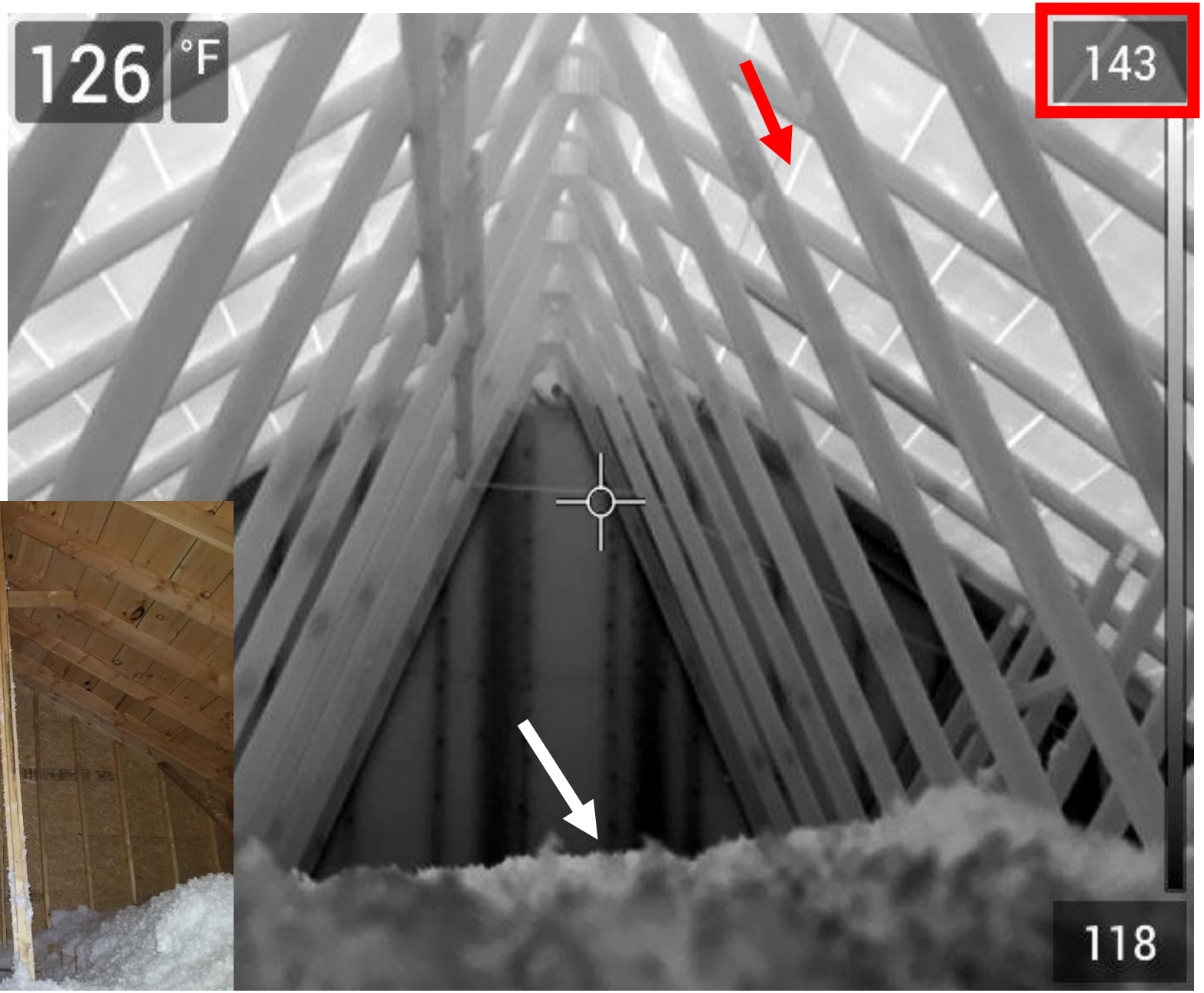
Water Infiltration from Signage Anchoring on Exterior Wall



air barrier
abaa
association of
america

Thermal Capacitance

Mechanical duct temperature drop of 10°F



air barrier
abaa
association of
america

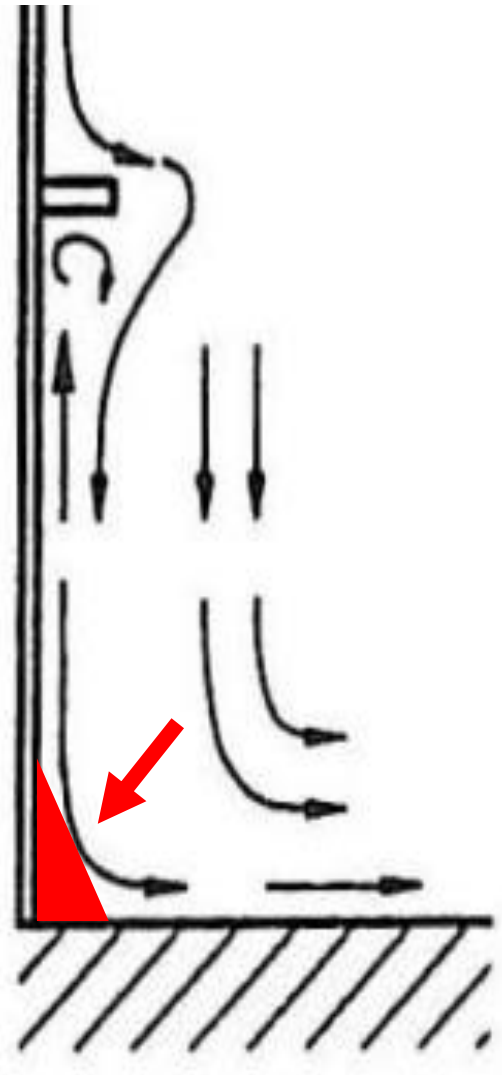
Thermal Capacitance

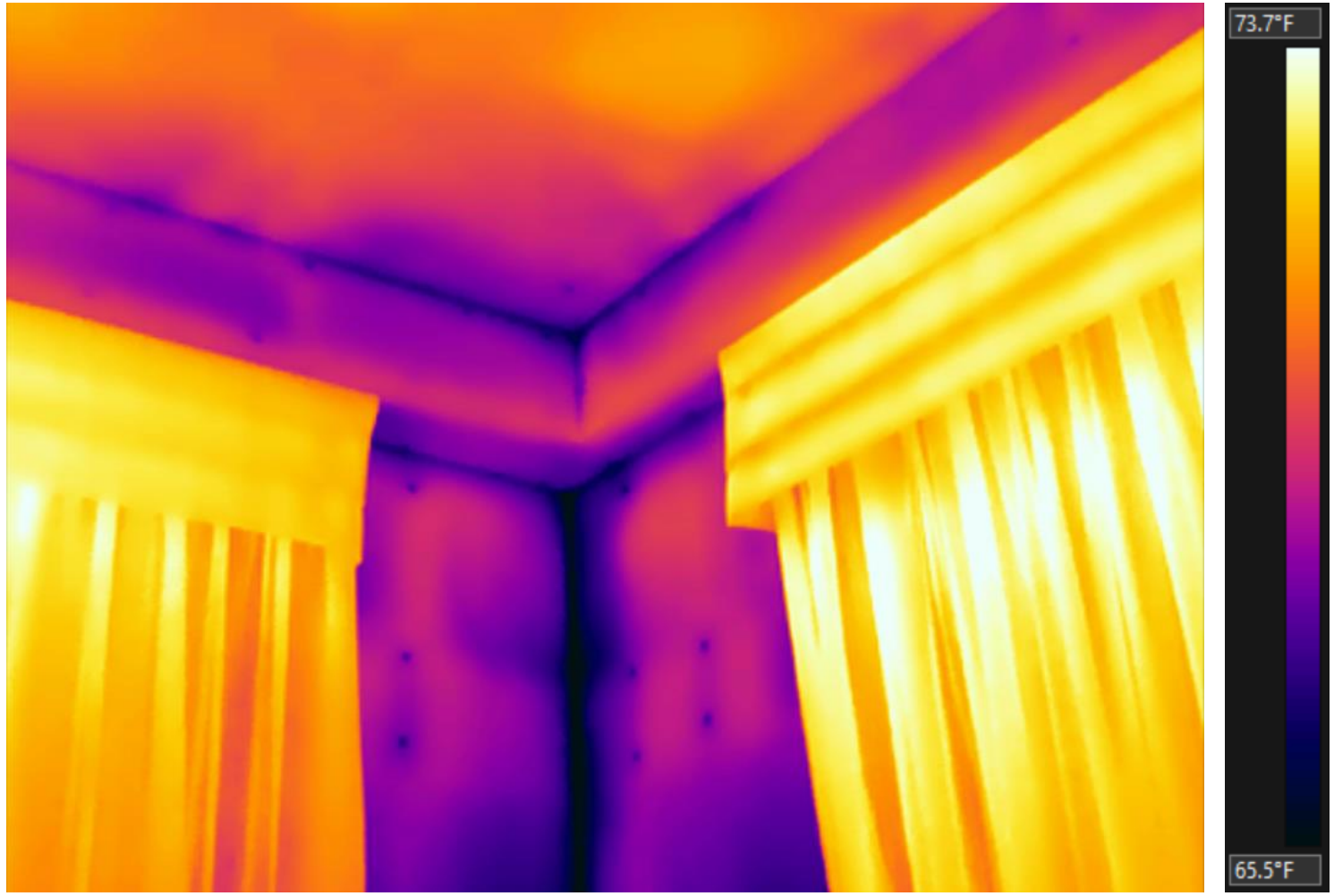
The Roof is Black!

No insulation, and no ventilation

air barrier
abaa
association of america

Don’t be Deceived

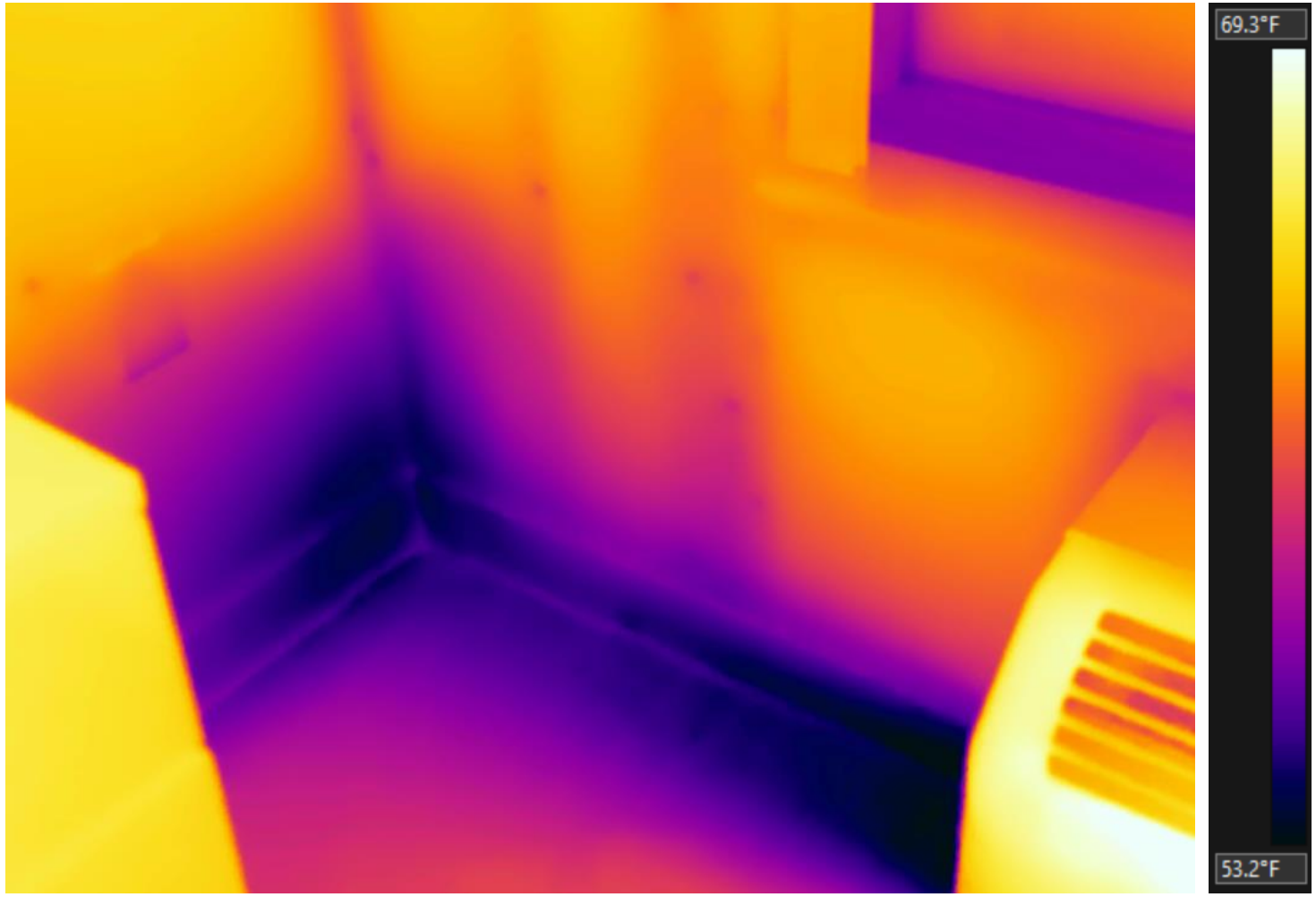




Cool Spots due to poor air circulation

air barrier association of america

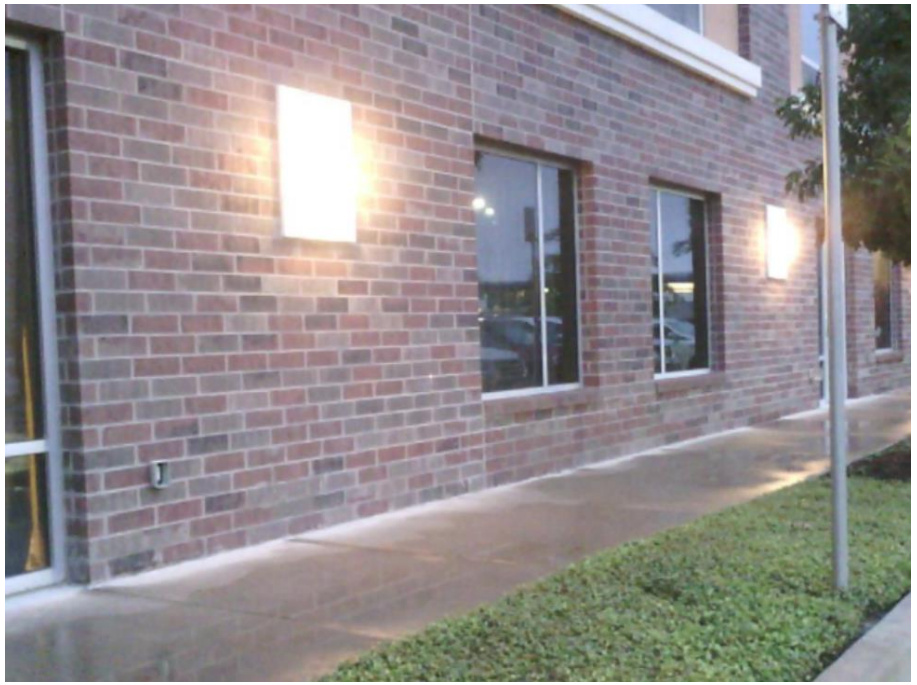
Don’t be Deceived – LEED Gold?

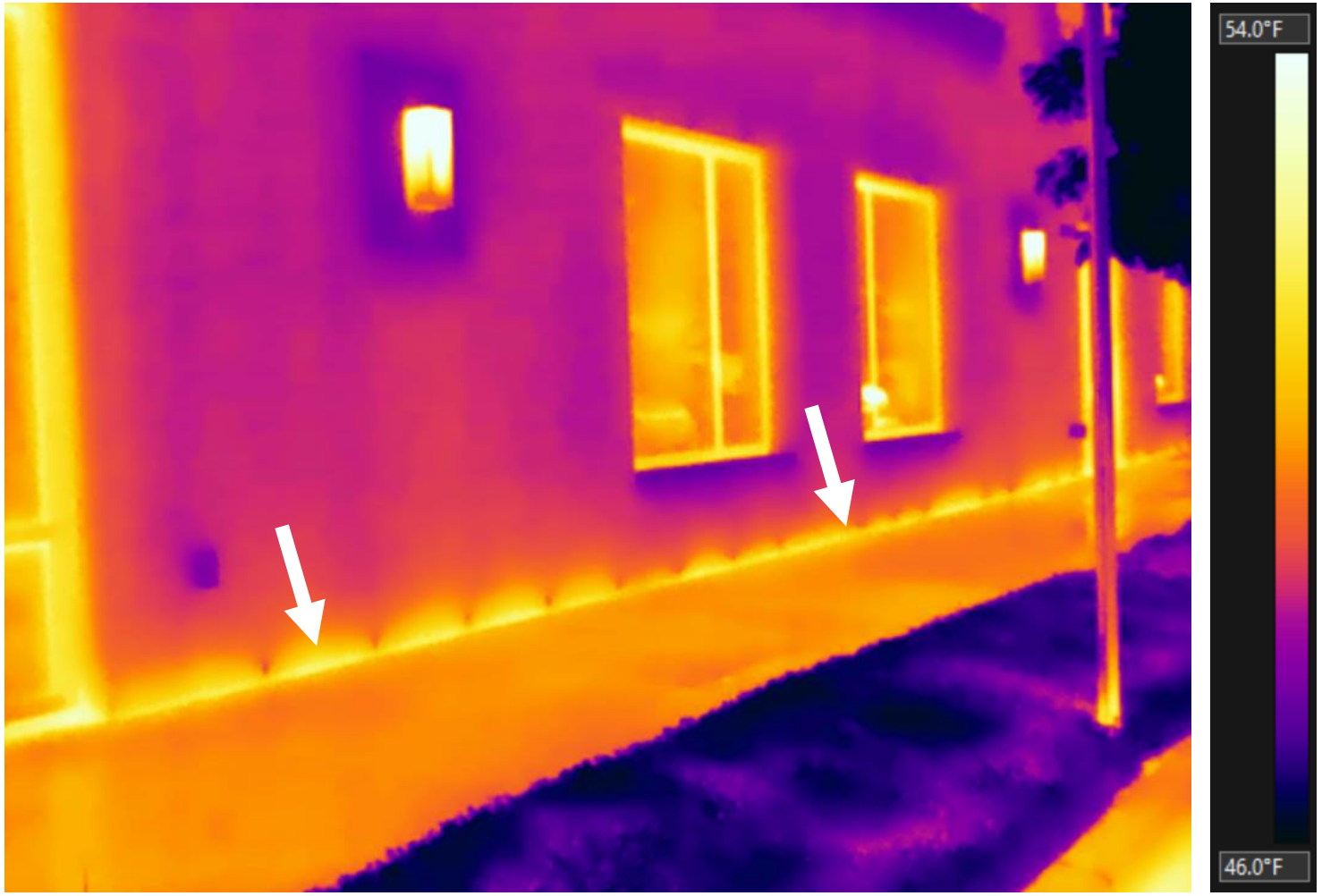


Air Infiltration from PTAC Unit

air barrier
abaa
association of
america

Don’t be Deceived – LEED Gold?

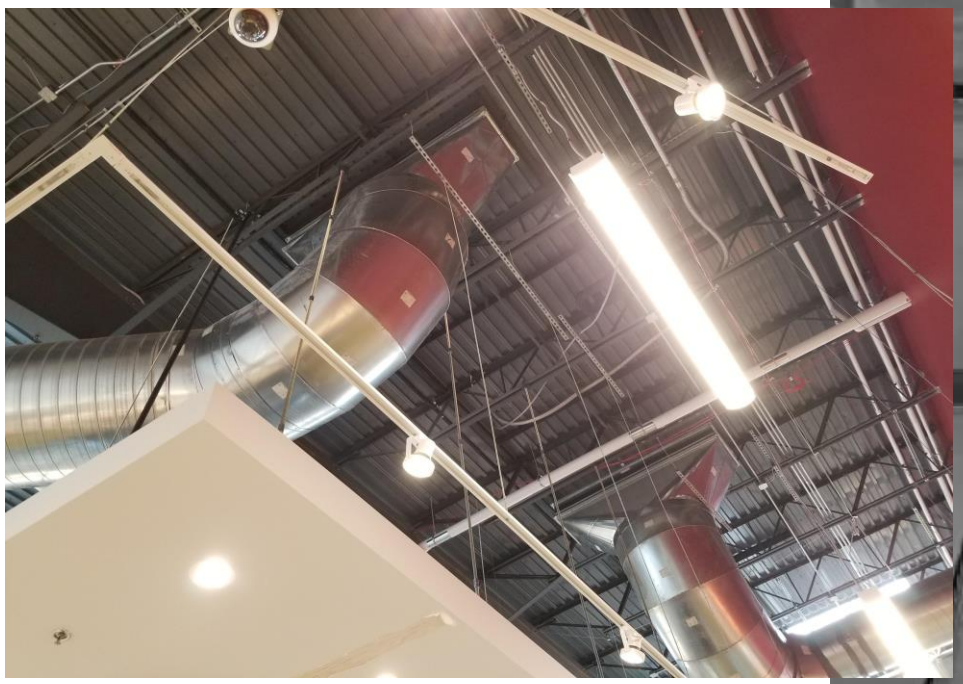


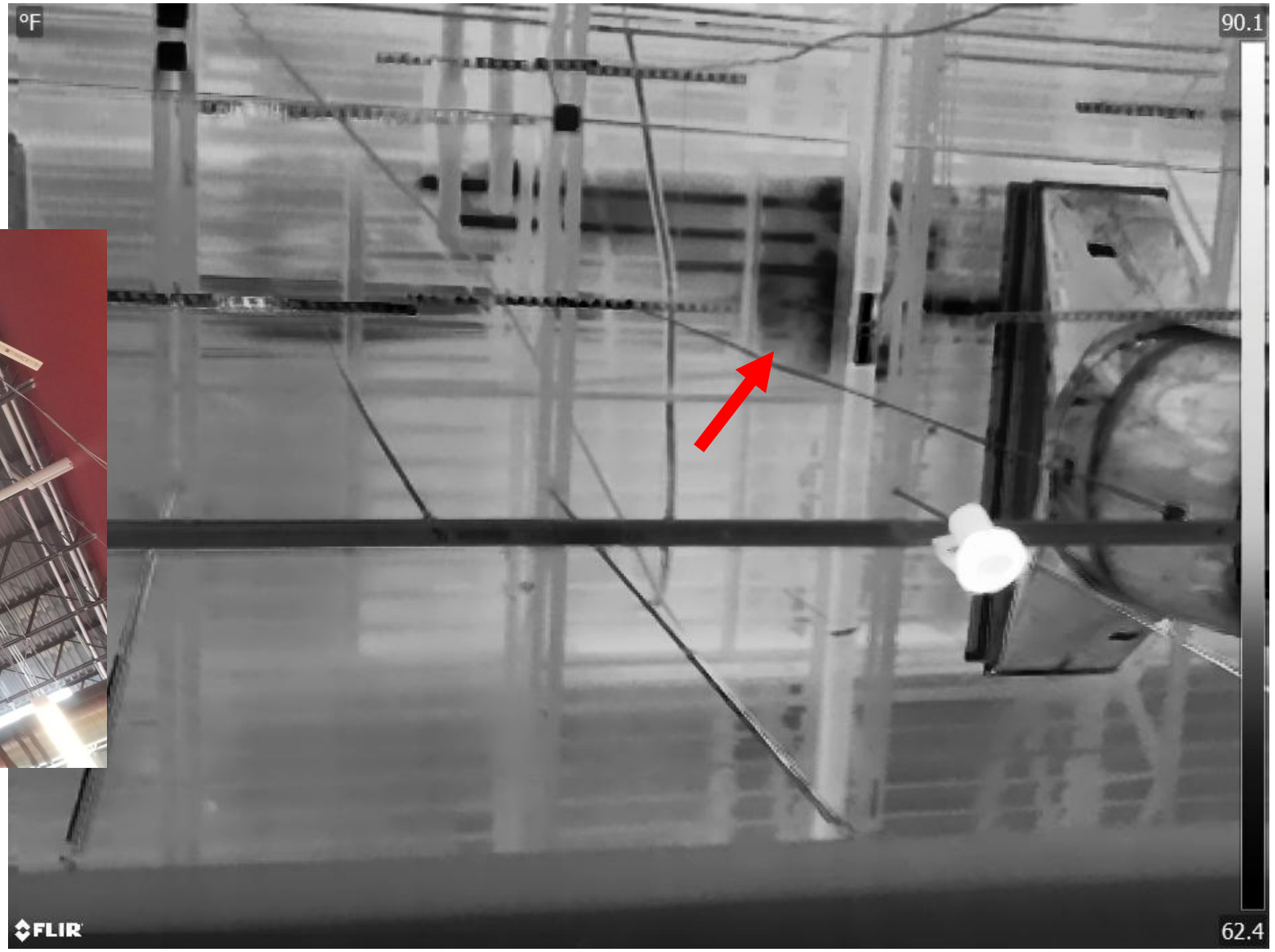


Direct Transfer – Energy Loss

air barrier
abaa
association of
america

Seeing past the Reflection



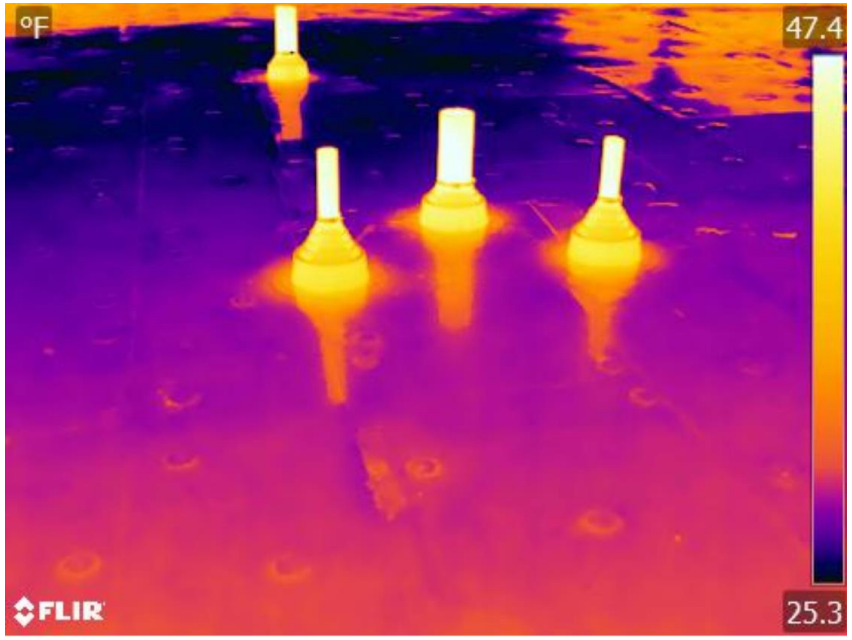


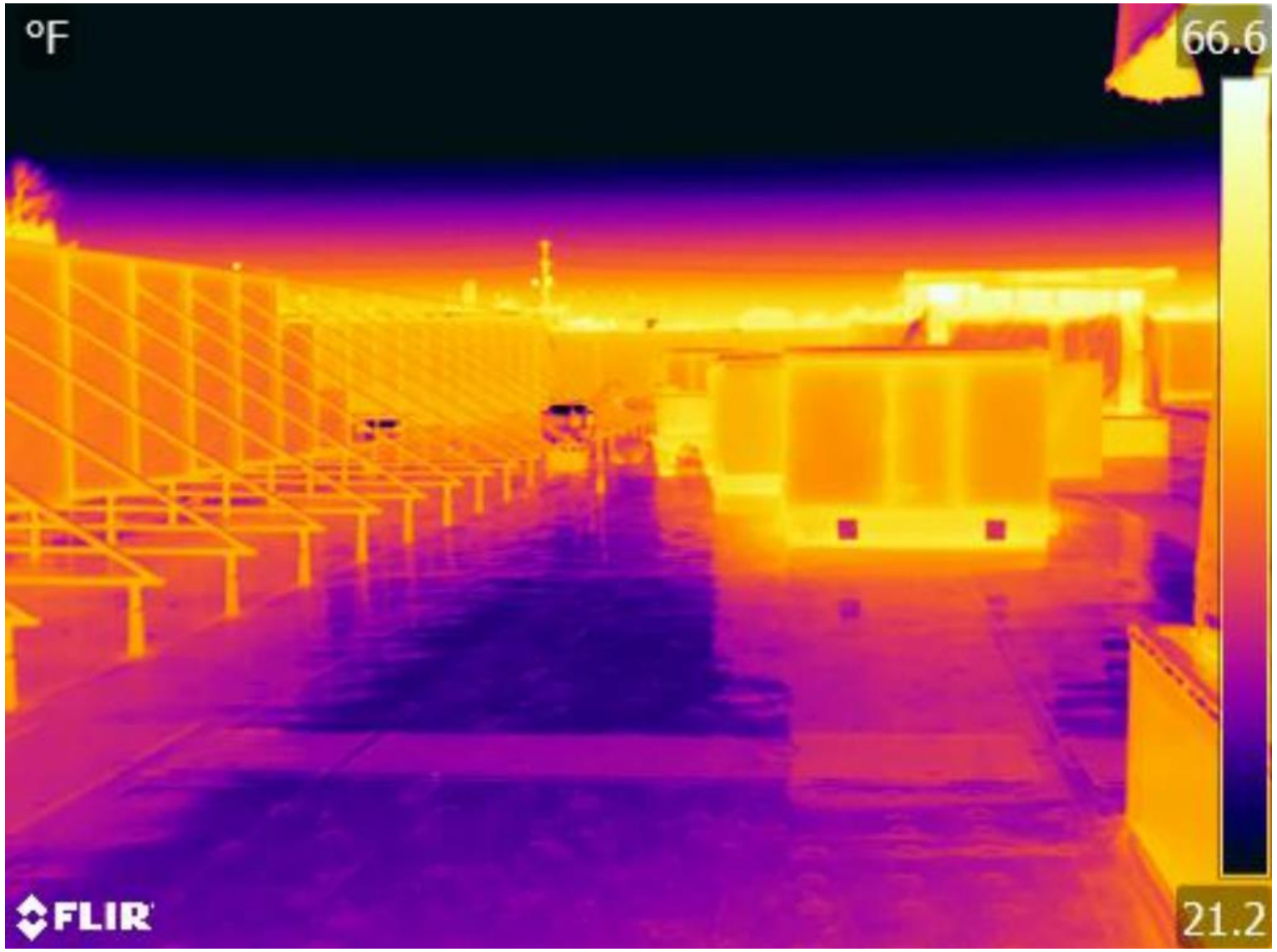
air barrier
abaa
association of
america

Non-standard Used to Narrow Down Point of Infiltration

air barrier
abaa
association of
america

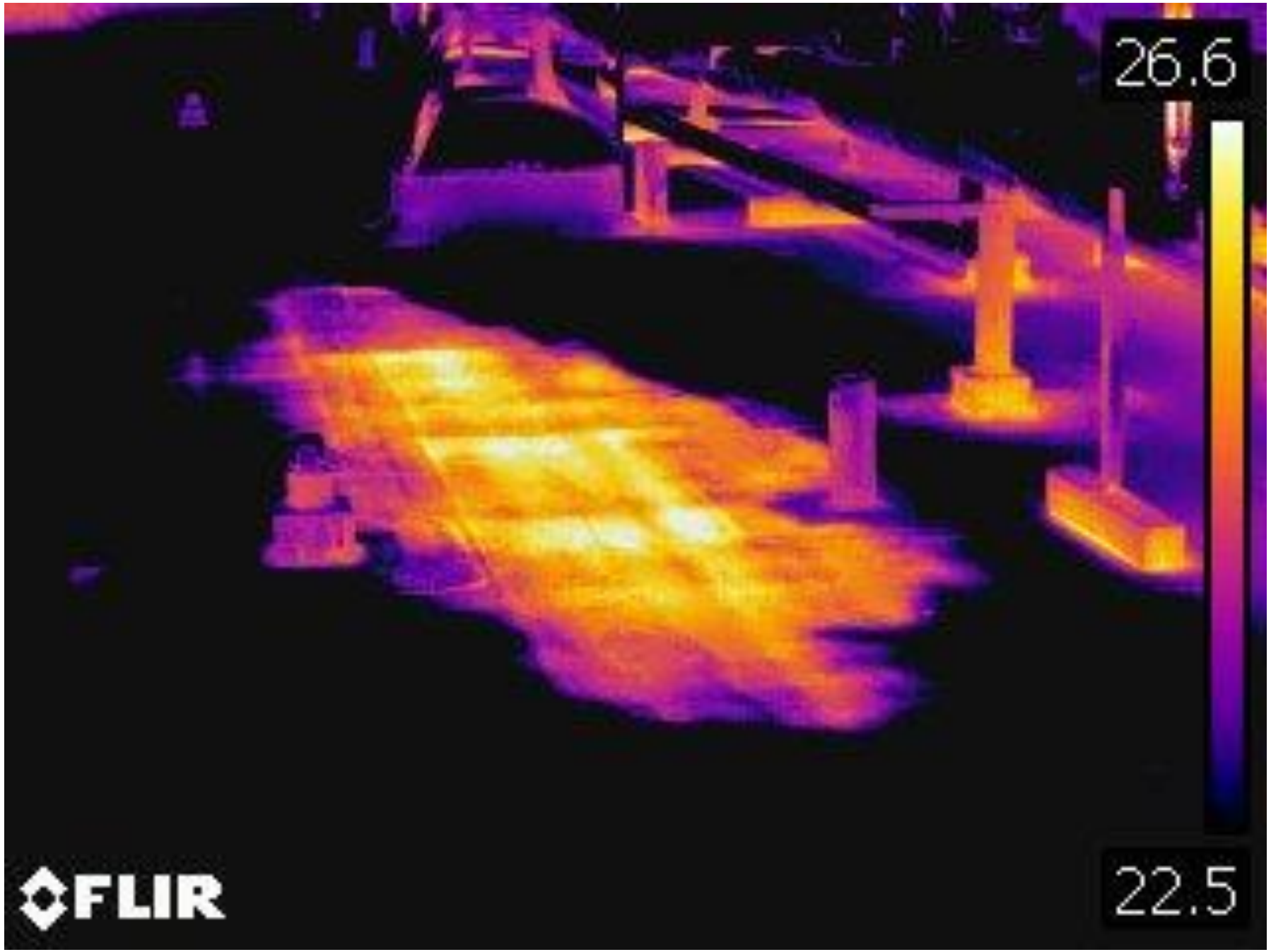
Limitations

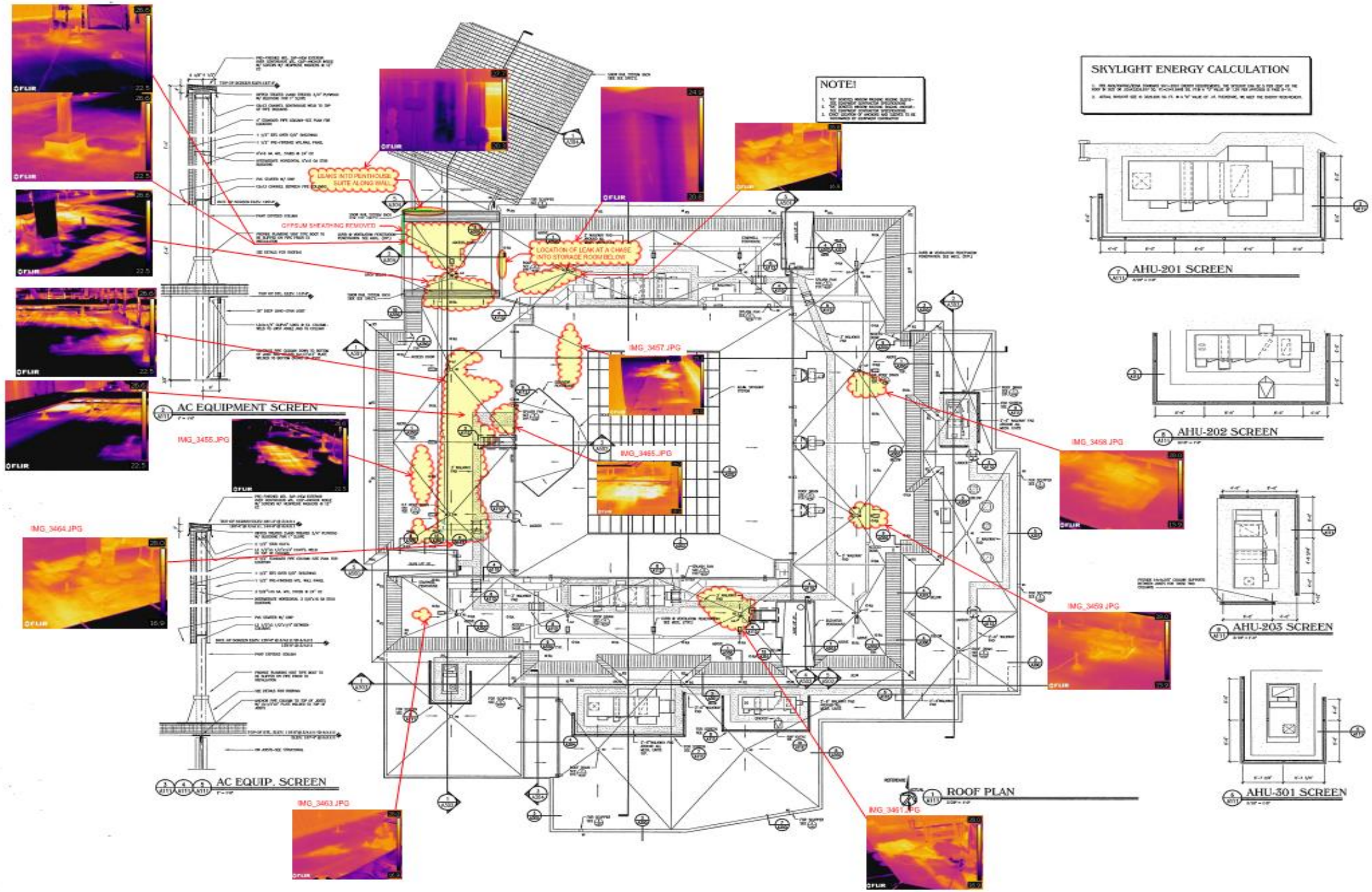




air barrier
abaa
association of
america

air barrier
abaa
association of
america





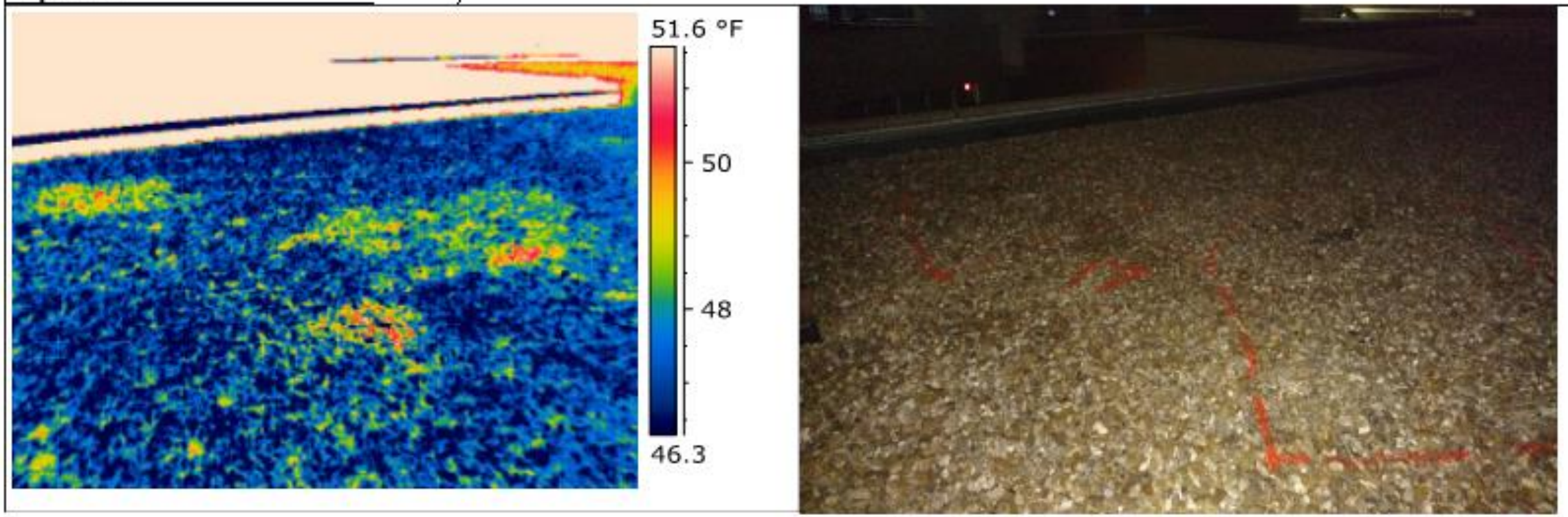
air barrier
abaa
association of
america

air barrier
abaa
association of
america

Roof: Cox Outpatient

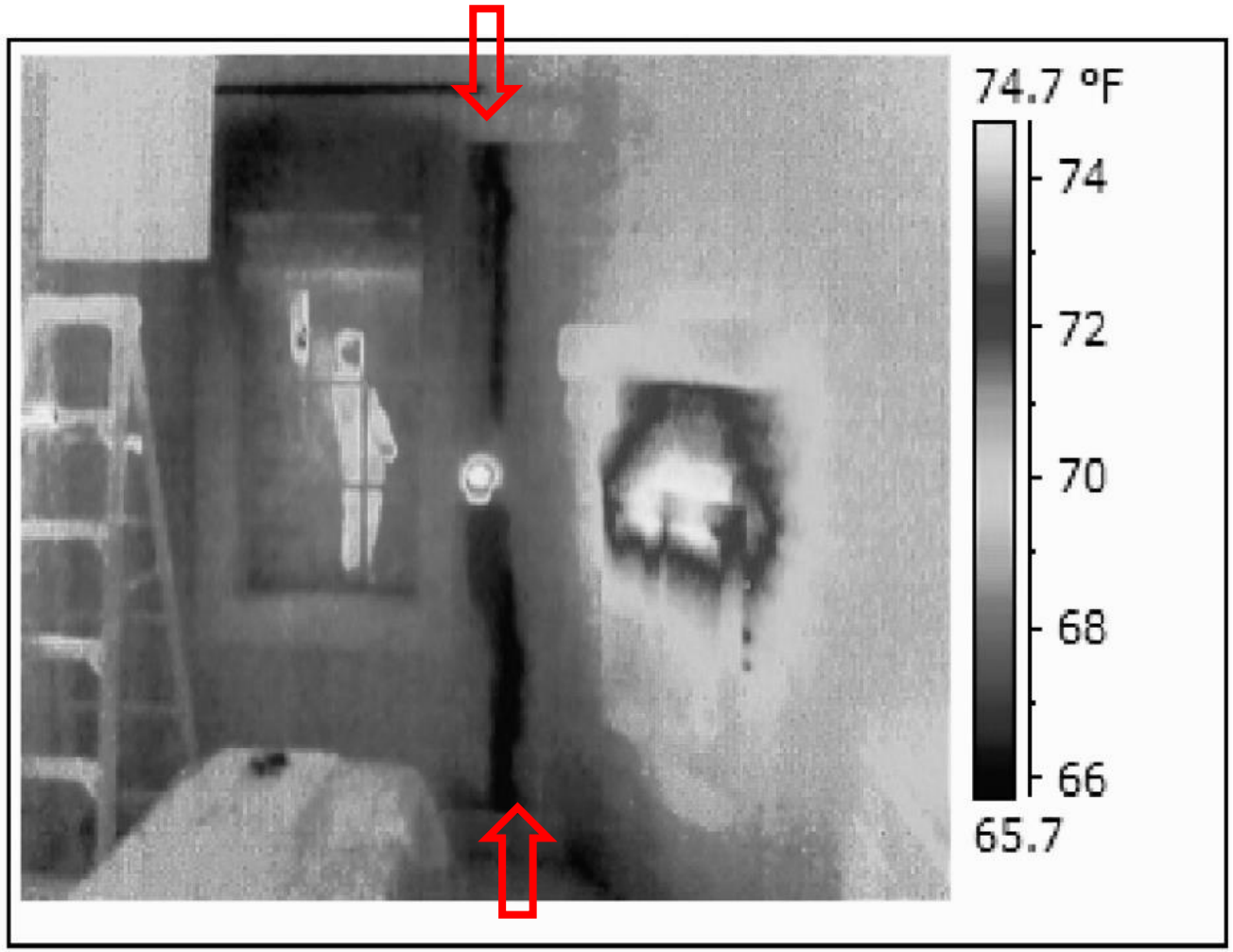
Spot: 17

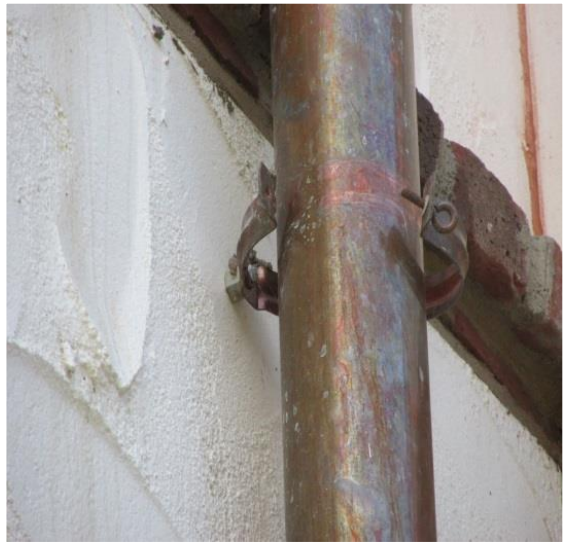
Comments: Thermal anomaly indicating possible moisture present.

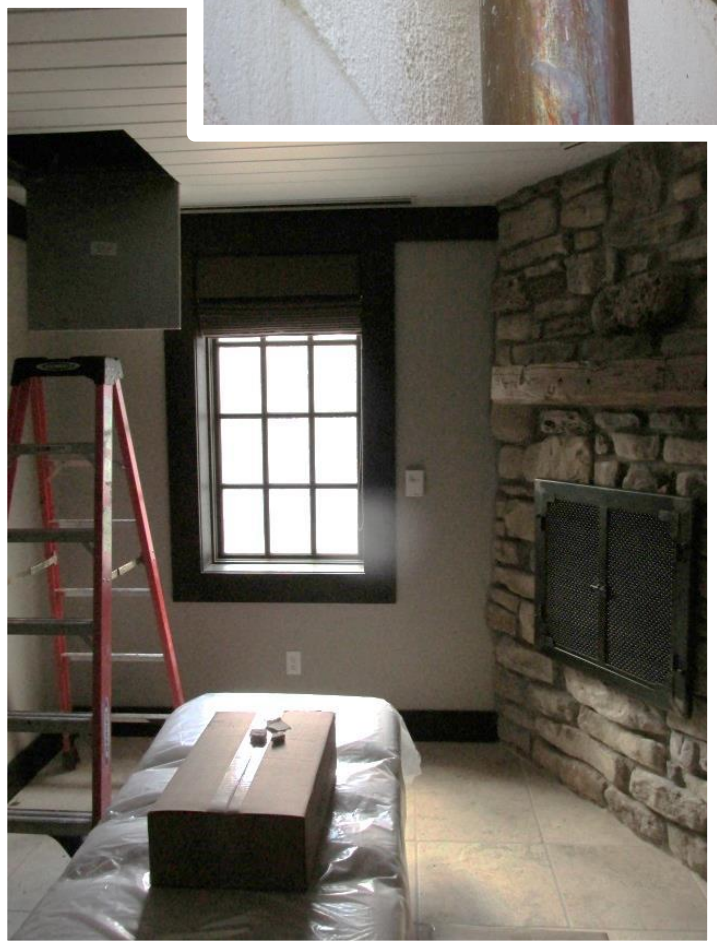


air barrier
abaa
association of
america

Commissioning Verification of Performance







air barrier
abaa
association of
america

air barrier
abaa
association of
america

Industry and Standards

ISO 6781-3:2015
Performance of buildings – Detection of heat, air and moisture irregularities in buildings by infrared methods

Part 3: Qualifications of equipment operators, data analysis and report writers.

(Results for residential and small buildings)

air barrier abaa association of america

ISO International Organization for Standardization

Industry and Standards

ASTM C1153 - 10(2015)

Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging

ASTM C1060-11a(2015)

Standard Practice For Thermographic Inspection Of Insulation Installations In Envelope Cavities Of Frame Buildings

air barrier abaa association of america

Case Study – Primatara Mansion

Case Study conducted by:
Miller Engineering, P.C.

Testing conducted for:
Killian Construction
& Robert Low

air barrier
abaa
association of
america

Case Study – Primatara Mansion

Every window and door on the project was to be tested and required to pass with no water infiltration criteria

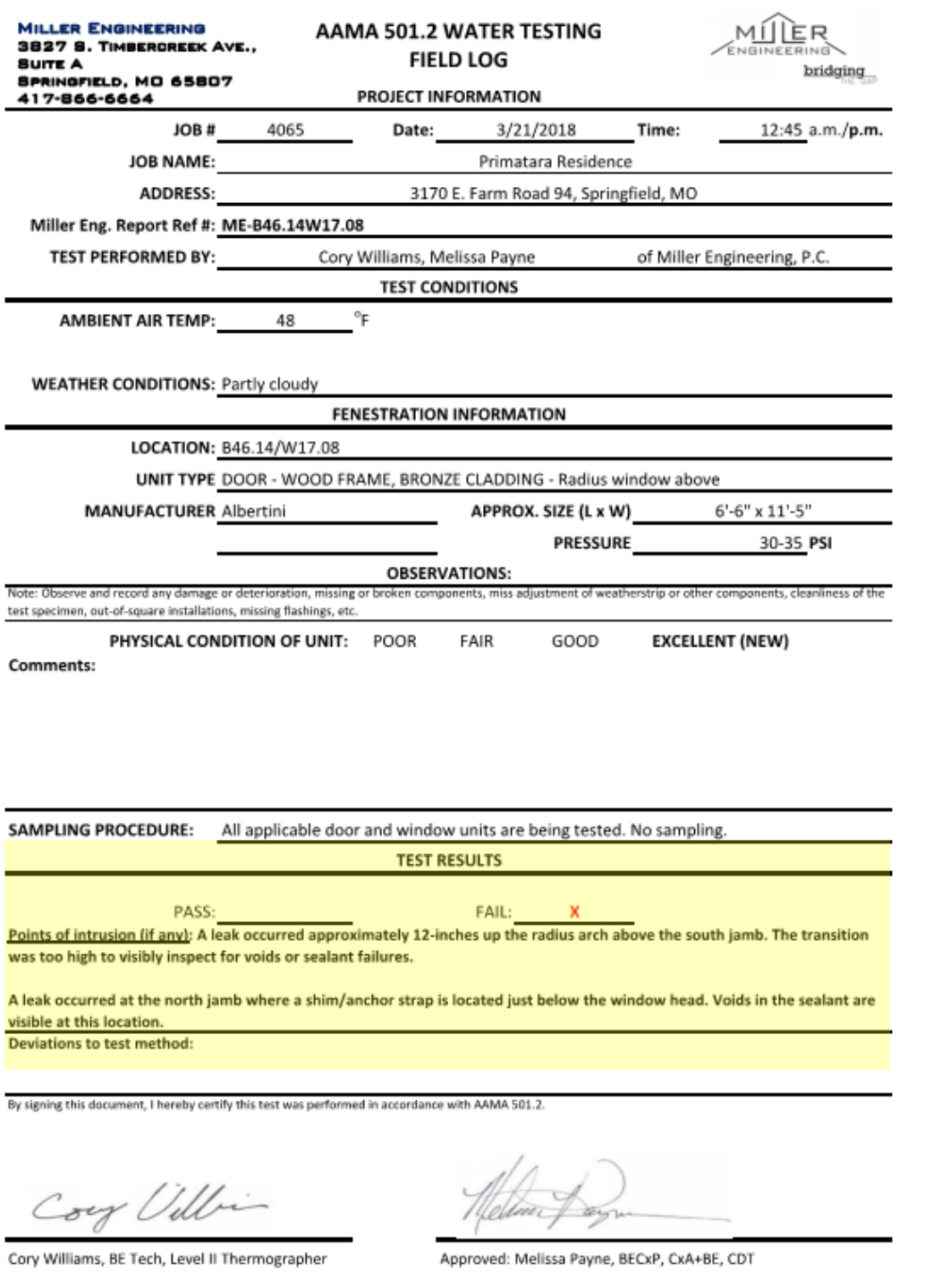
air barrier
abaa
association of
america

Case Study – Primatara Mansion

Modified AAMA 501.2 Water Testing with No-Water Penetration/Infiltration Criteria Conducted

A leak occurred at the north jamb where a shim/anchor strap is located just below the window head.

air barrier abaa association of america



MILLER ENGINEERING
3827 S. TIMBERCREEK AVE., SUITE A
SPRINGFIELD, MO 65807
417-866-6664

AAMA 501.2 WATER TESTING FIELD LOG

MILLER ENGINEERING bridging

PROJECT INFORMATION

JOB # 4065 Date: 3/21/2018 Time: 12:45 a.m./p.m.

JOB NAME: Primatara Residence

ADDRESS: 3170 E. Farm Road 94, Springfield, MO

Miller Eng. Report Ref #: ME-B46.14W17.08

TEST PERFORMED BY: Cory Williams, Melissa Payne of Miller Engineering, P.C.

TEST CONDITIONS

AMBIENT AIR TEMP: 48 °F

WEATHER CONDITIONS: Partly cloudy

FENESTRATION INFORMATION

LOCATION: B46.14/W17.08

UNIT TYPE DOOR - WOOD FRAME, BRONZE CLADDING - Radius window above

MANUFACTURER Albertini APPROX. SIZE (L x W) 6'-6" x 11'-5"

PRESSURE 30-35 PSI

OBSERVATIONS:

Note: Observe and record any damage or deterioration, missing or broken components, miss adjustment of weatherstrip or other components, cleanliness of the test specimen, out-of-square installations, missing flashings, etc.

PHYSICAL CONDITION OF UNIT: POOR FAIR GOOD EXCELLENT (NEW)

Comments:

SAMPLING PROCEDURE: All applicable door and window units are being tested. No sampling.

TEST RESULTS

PASS: FAIL: X

Points of intrusion (if any): A leak occurred approximately 12-inches up the radius arch above the south jamb. The transition was too high to visibly inspect for voids or sealant failures.

A leak occurred at the north jamb where a shim/anchor strap is located just below the window head. Voids in the sealant are visible at this location.

Deviations to test method:

By signing this document, I hereby certify this test was performed in accordance with AAMA 501.2.

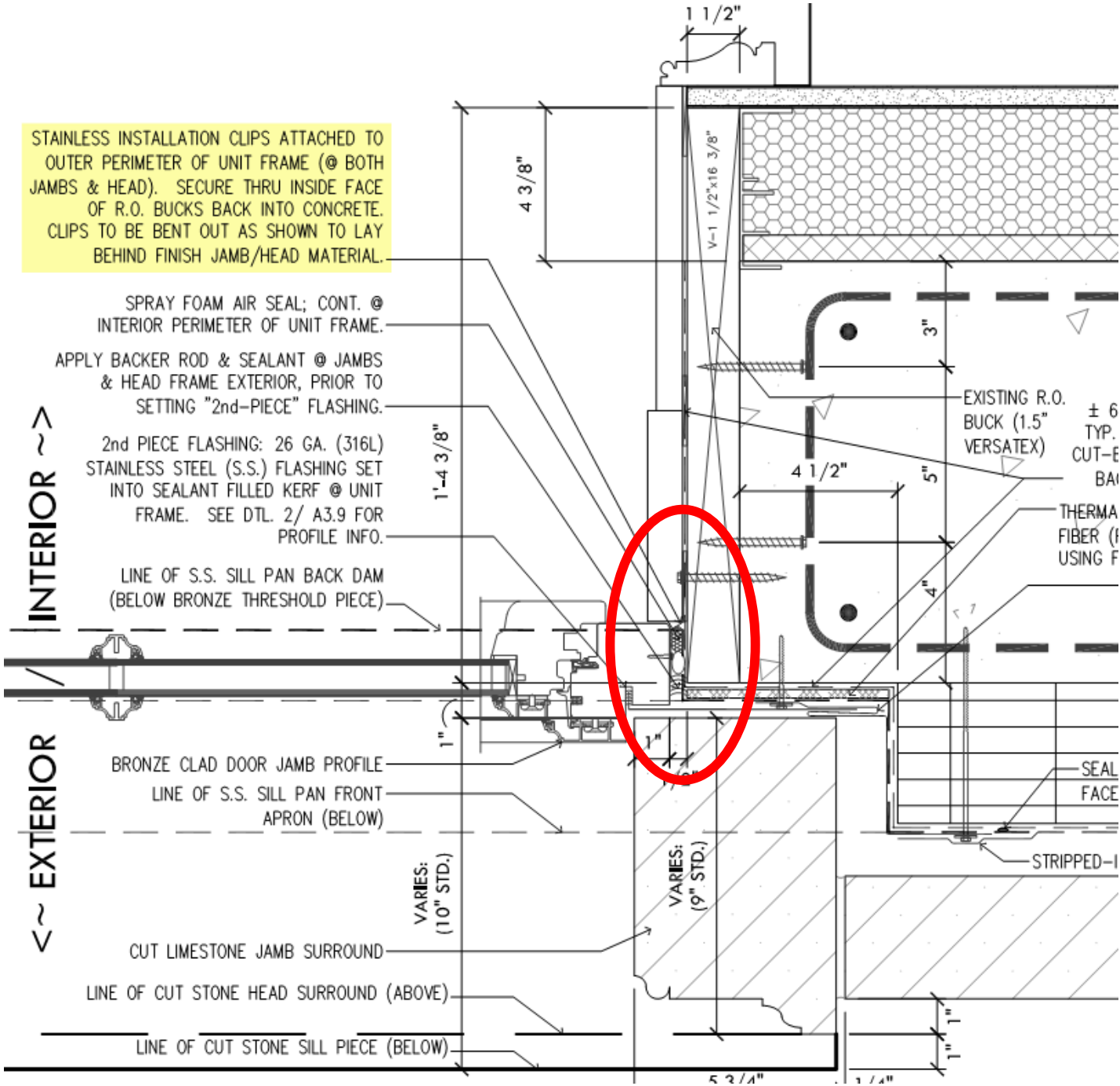
Cory Williams, BE Tech, Level II Thermographer

Approved: Melissa Payne, BECxP, CxA+BE, CDT

Case Study – Primatara Mansion

Leak Point at every window identified at the stainless clips at both the head and jambs.

air barrier
abaa
association of
america

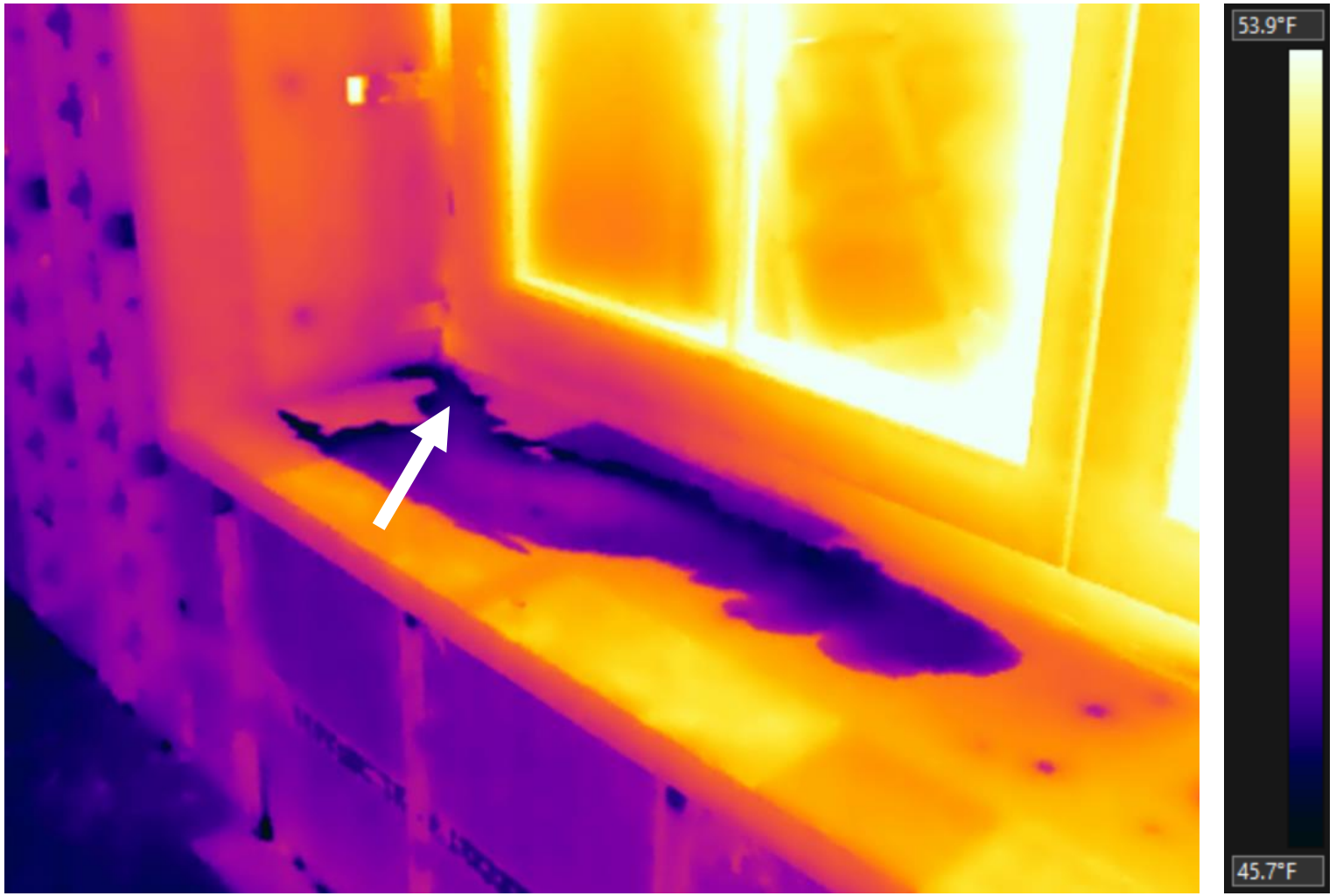


Case Study – Primatara Mansion

air barrier
abaa
association of
america

Case Study – Primatara Mansion

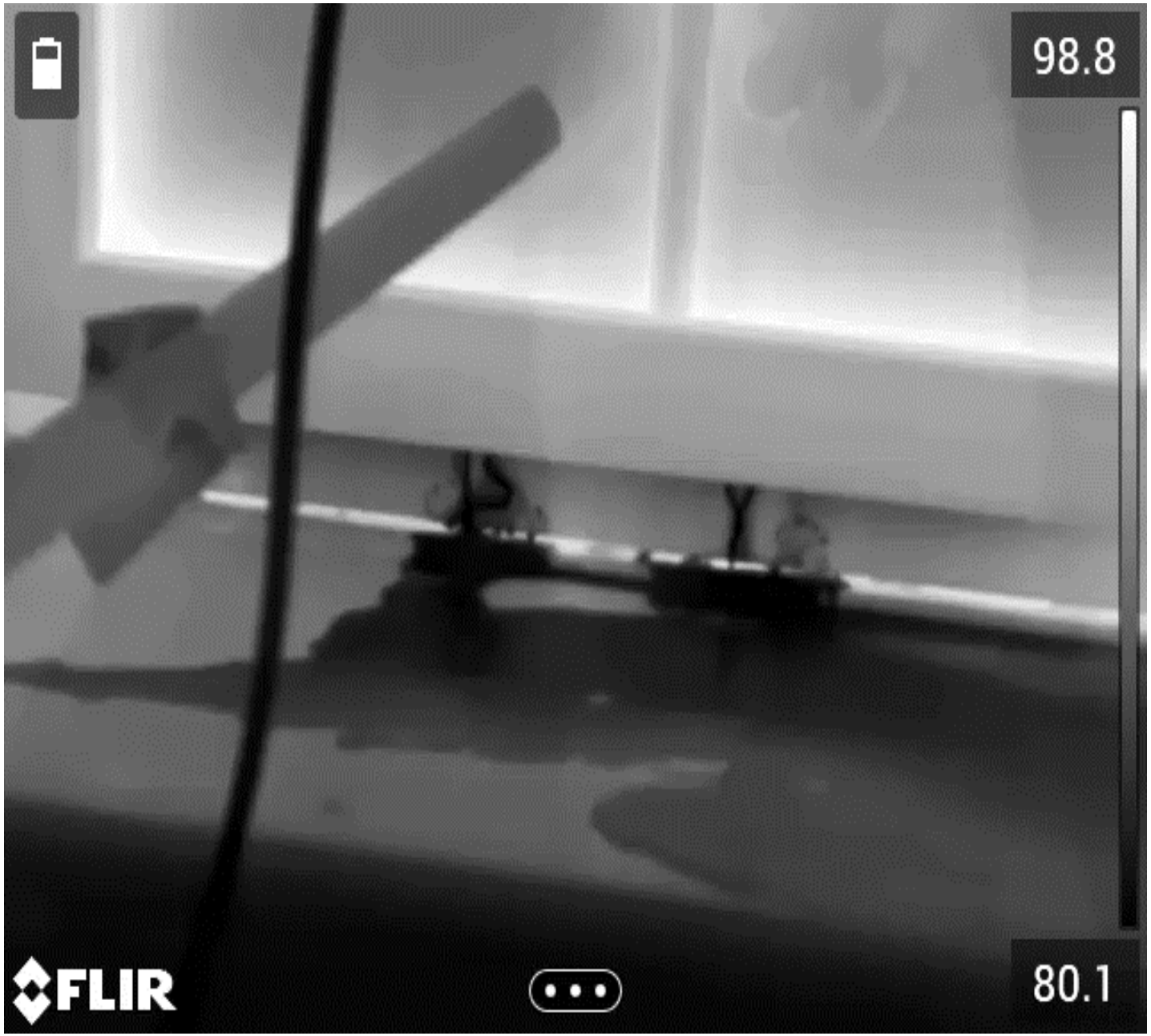
Leak Point confirmed with thermography where it could not be confirmed visually.



air barrier
abaa
association of
america

Case Study – Primatara Mansion

Unit failure at seals of operable windows.



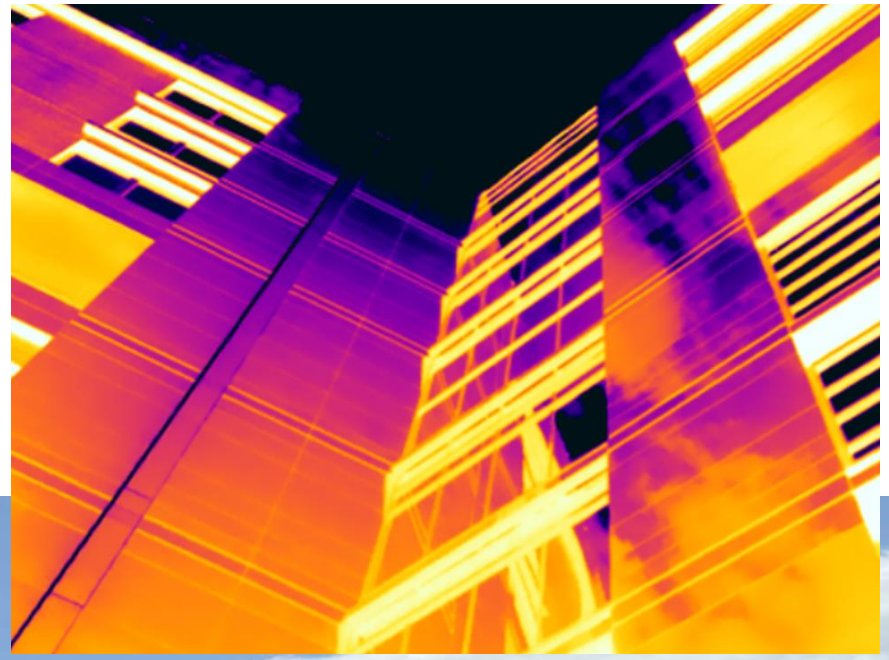
air barrier
abaa
association of
america

Case Study – Primatara Mansion

Installation failure jamb/sill flashing of windows.

air barrier
abaa
association of america

Case Study – CoxHealth Patient Tower Addition



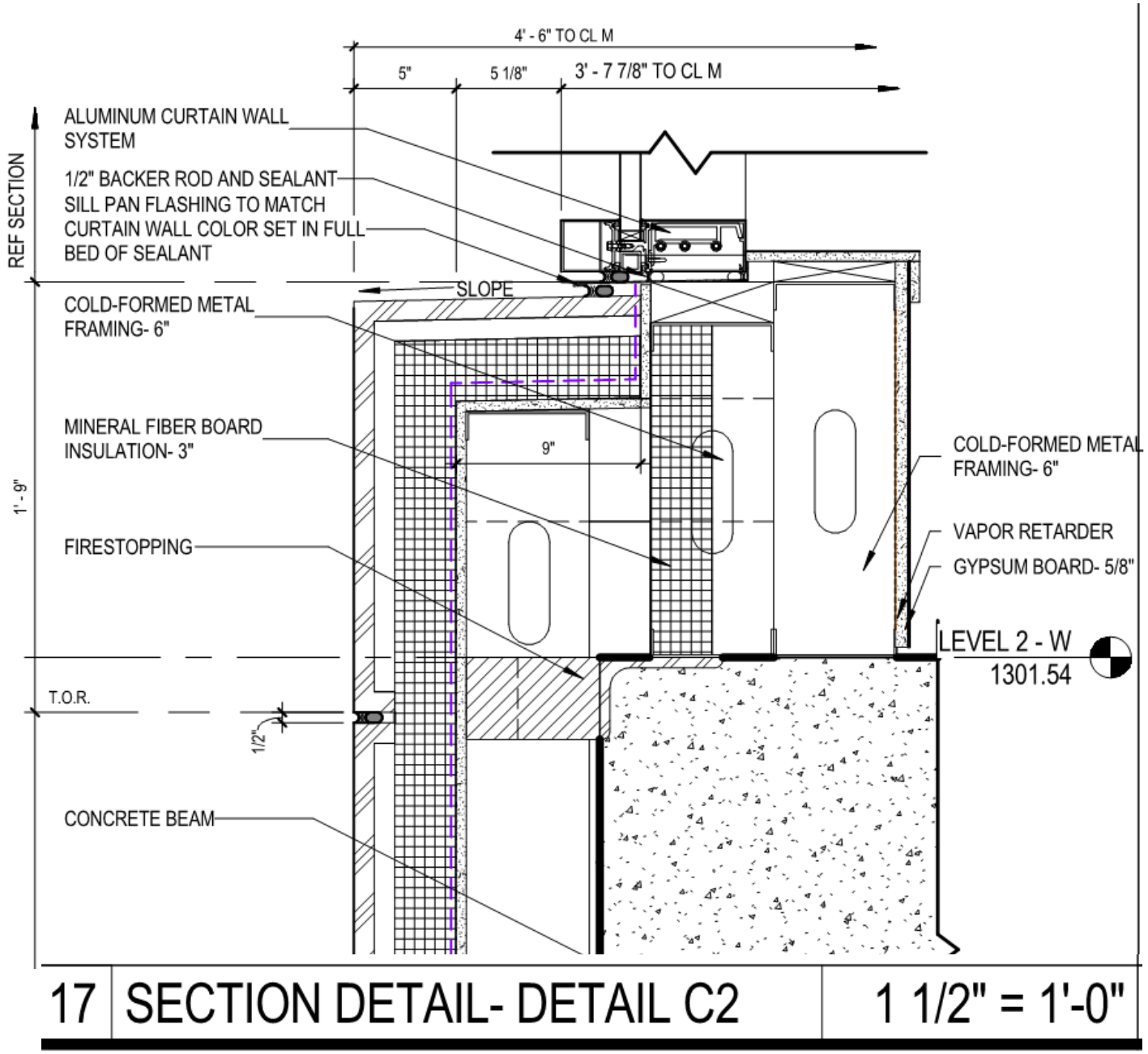
Case Study conducted by:
Miller Engineering, P.C.

Case Study conducted for:
Killian Construction
& CoxHealth

air barrier
abaa
association of
america

Case Study – CoxHealth Patient Tower Addition

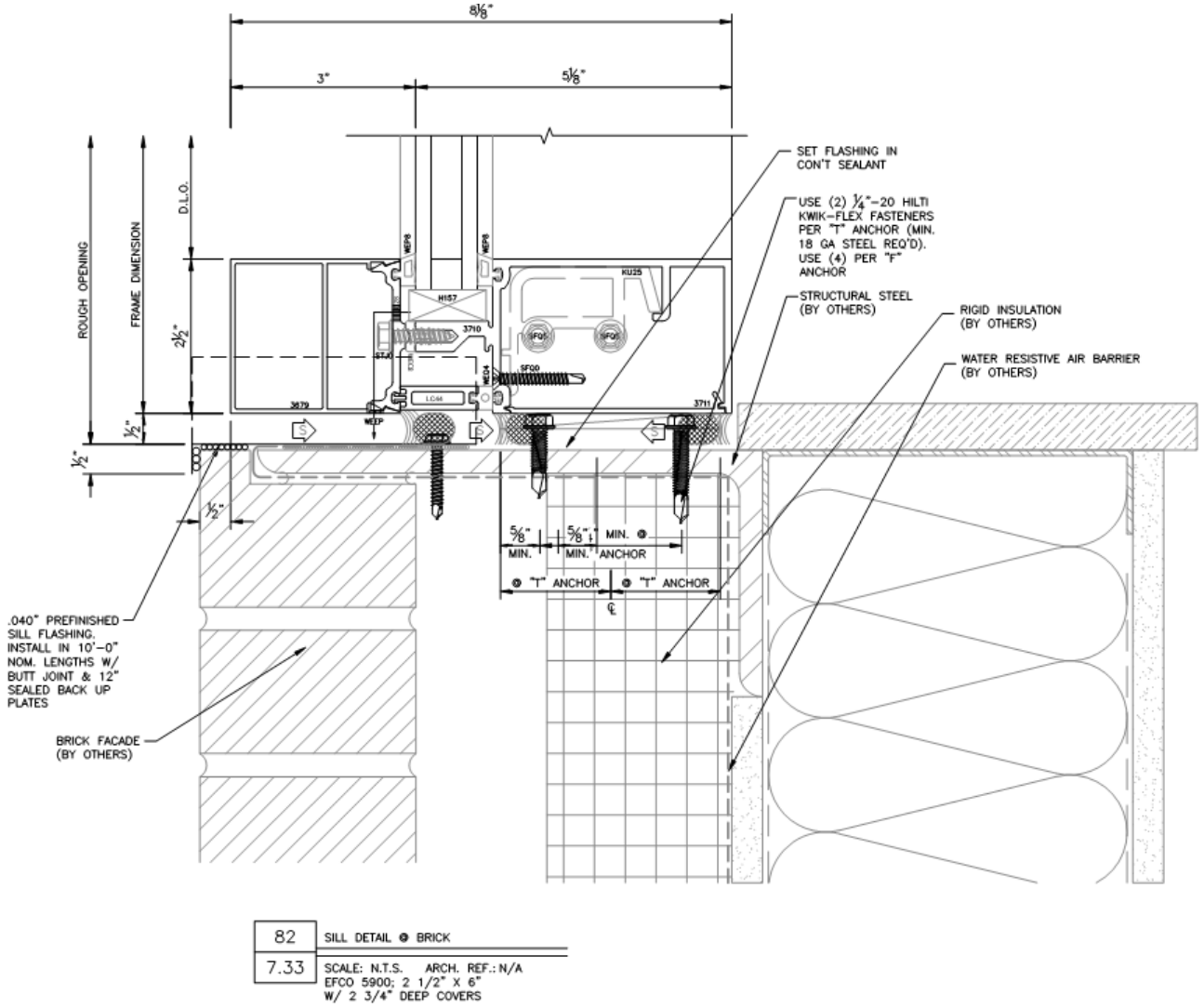
Thermal Performance of Curtain Wall System was studied and reviewed.



air barrier abaa association of america

Case Study –
CoxHealth Patient Tower Addition

Shop Drawing Details

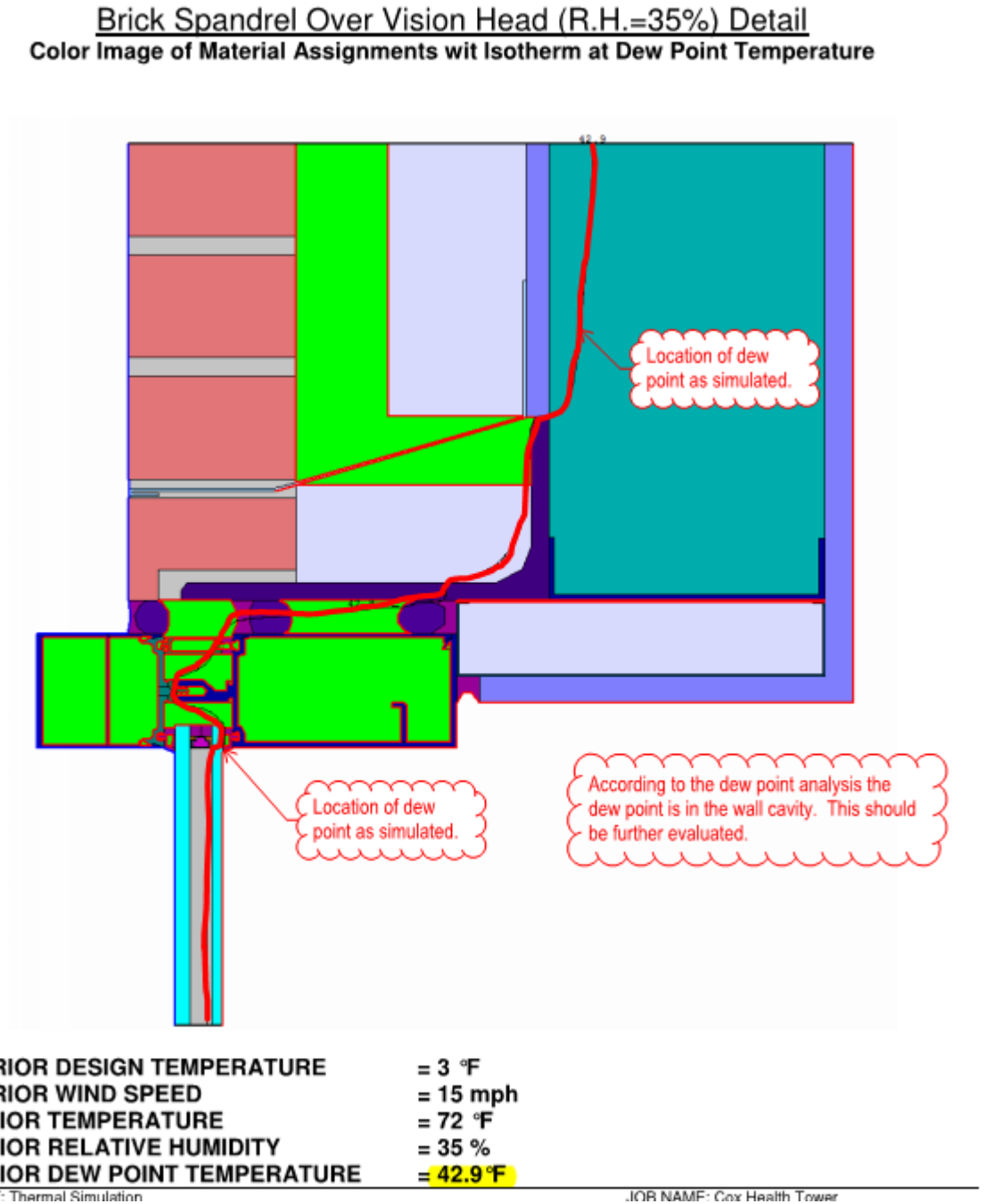


air barrier
abaa
association of
america

Case Study – CoxHealth Patient Tower Addition

Predicting surface temperature and condensation of the building enclosure assembly is critical in understanding how components will maintain inside surface temps when thermal bridging in present.

air barrier
abaa
association of
america



Case Study – CoxHealth Patient Tower Addition

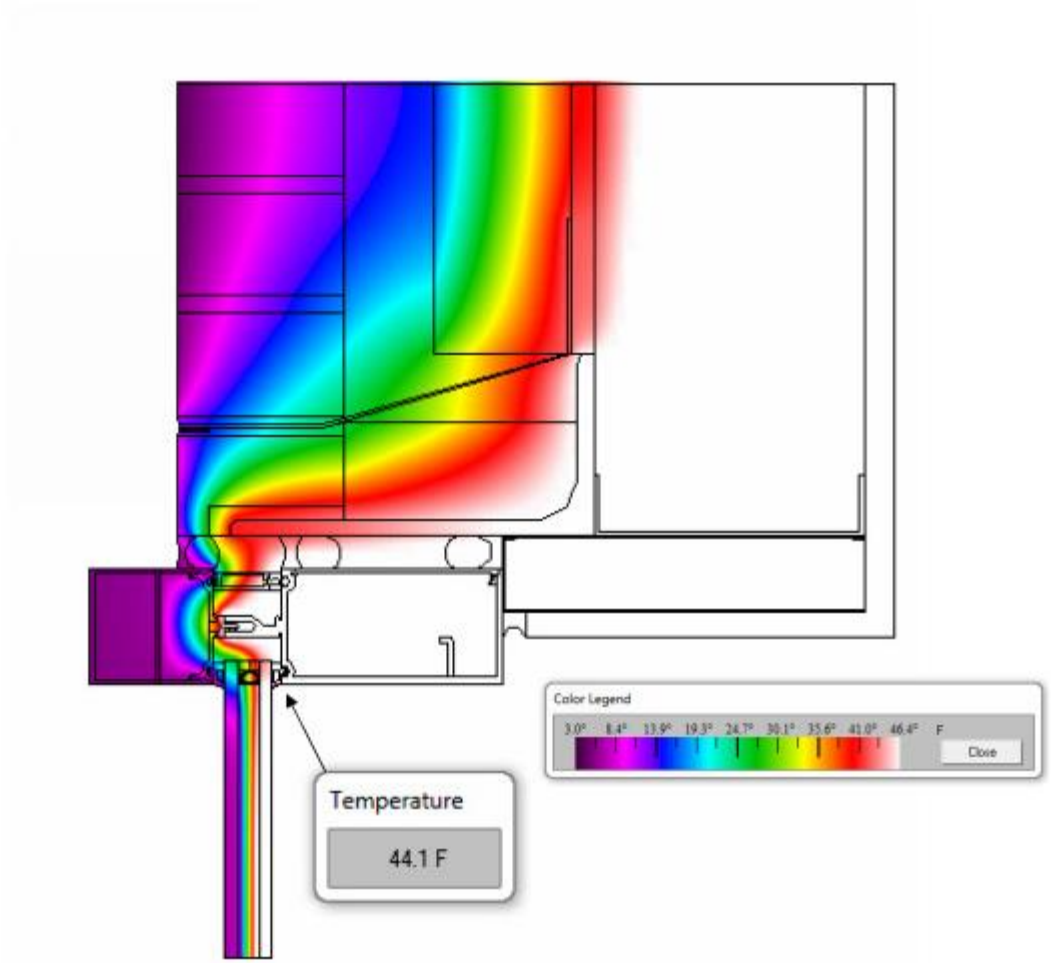
What is the anticipated surface temperature with heating design temperature of 3°F with a 15mph wind?

What about night sky radiation?

air barrier
abaa
association of
america

Brick Spandrel Over Vision Head (R.H.=35%) Detail

Color Infrared Image with Temperatures at or Below the Dew Point and Lowest Interior Surface Temperature



EXTERIOR DESIGN TEMPERATURE	= 3 °F
EXTERIOR WIND SPEED	= 15 mph
INTERIOR TEMPERATURE	= 72 °F
INTERIOR RELATIVE HUMIDITY	= 35 %
INTERIOR DEW POINT TEMPERATURE	= 42.9 °F

SUBJECT: Thermal Simulation JOB NAME: Cox Health Tower

Case Study –
CoxHealth Patient Tower Addition

According to Weather Underground (wunderground.com), weather conditions prior to and at the time of limited assessment were as follows:

CONDITIONS AT THE TIME OF INSPECTION

Outside ambient temperature	11°F – 25°F	Interior relative humidity	Varies
Interior ambient temperature	Varies	Sky conditions	Clear
Average wind velocity	4.6 mph	Wind chill temperature	2.9°F – 19°F

CONDITIONS 24-HOURS PRIOR & RECENT PRECIPITATION

Outside ambient temp. (min.)	11°F	Outside ambient temp. (max.)	40°F
Average wind velocity (wind chill)	7 mph	Average rainfall	0.00 in.

air barrier
abaa
association of
america

Case Study –
CoxHealth Patient Tower Addition

NICU Room 14 - Average Surface Temperatures on February 2, 2018 at 9:15am

Location	Average Surface Temperature Outside	Average Surface Temperature Inside	ΔT Int/Ext Temperature
Top of sill member - approximately 1/2" from glass	22.5°F	47.6°F	25.1°F
Gasket - surface temperature of gasket material	22.6°F	44.8°F	22.2°F
Glass surface - approximately 1" from sill member	22.7°F	49.9°F	27.2°F

Note: Exterior ambient temperatures were documented at around 18°F at 8:52am and 22°F at 9:52am.

air barrier
abaa
association of
america

Case Study – CoxHealth Patient Tower Addition

NICU Room 14 - Estimated Surface Temperatures on February 2, 2018 at 7:00am

Location	Wind Chill at 11°F and 7mph	Ambient Temperature Outside	ΔT Int/Ext Temperature	Projected Surface Temp Inside	Projected Interior Surface Temp with Applied Wind Speed
Top of sill member - approximately 1/2" from glass	±0.2°F	±11°F	25.1°F	36.1°F	25.3°F
Gasket - surface temperature of gasket material	±0.2°F	±11°F	22.2°F	33.2°F	22.4°F
Glass surface - approximately 1" from sill member	±0.2°F	±11°F	27.2°F	38.2°F	27.4°F

Note: According to the design criteria used of: 3°F exterior temp, 72°F interior temp, wind velocity of 15 mph, relative humidity at 35% and dew point temperature of 42.9°F the projected surface temperatures of the frames above would result in surface condensation.

air barrier abaa association of america

Condensation Resistance Factor (CRF) was reviewed

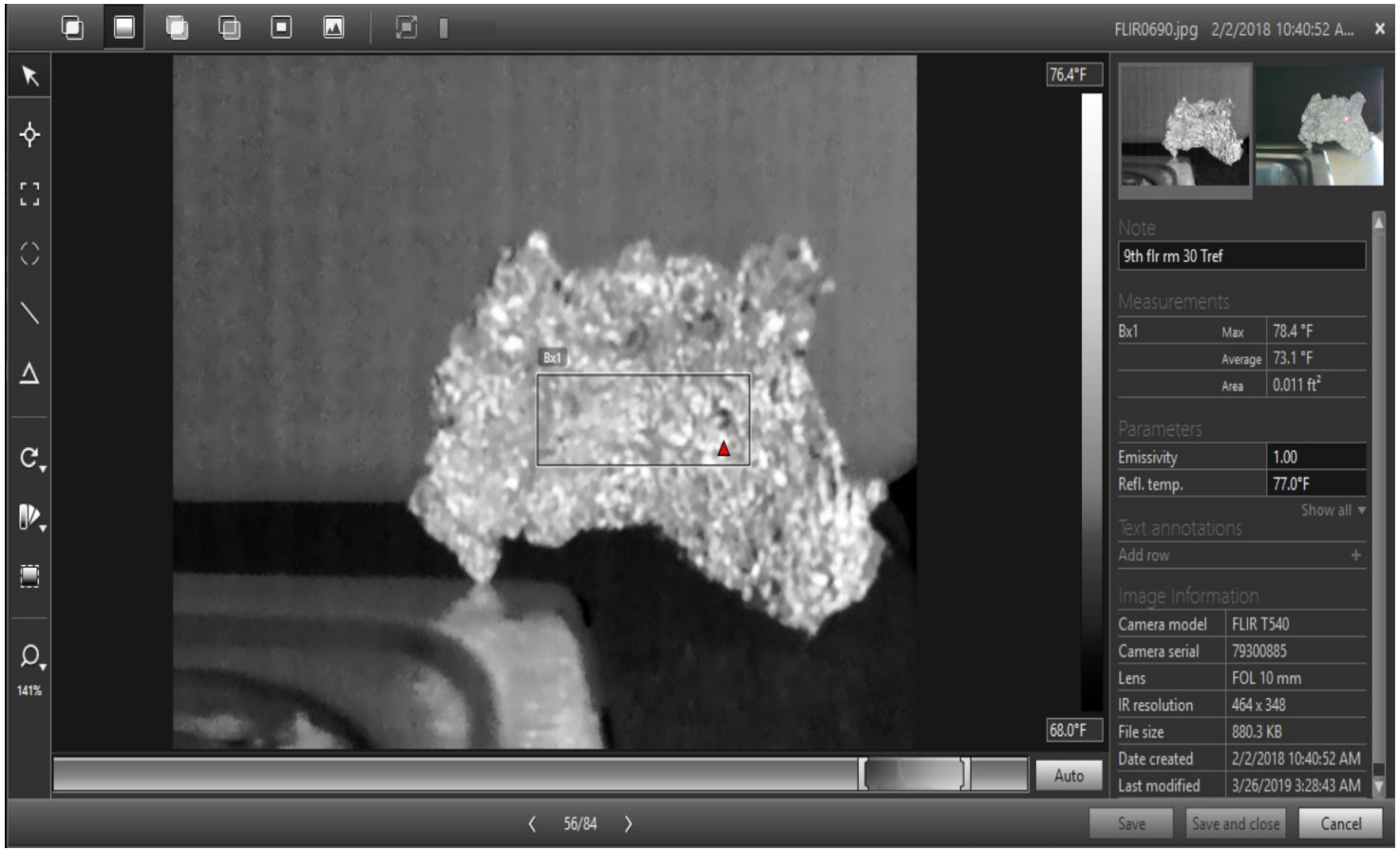
AAMA 1503-98 – specifies a warm side temperature of 70°F and a cold side temperature of 0°F with a 15mph exterior wind

Case Study –
CoxHealth Patient Tower Addition

NICU Room #14: Image on left was taken upon arrival at 7:15am on 2/2/18. Image on the right was taken to document the reoccurrence of condensation within 30 minutes of drying glass and tube.

air barrier
abaa
association of
america

Case Study –
CoxHealth Patient Tower Addition



air barrier
abaa
association of
america

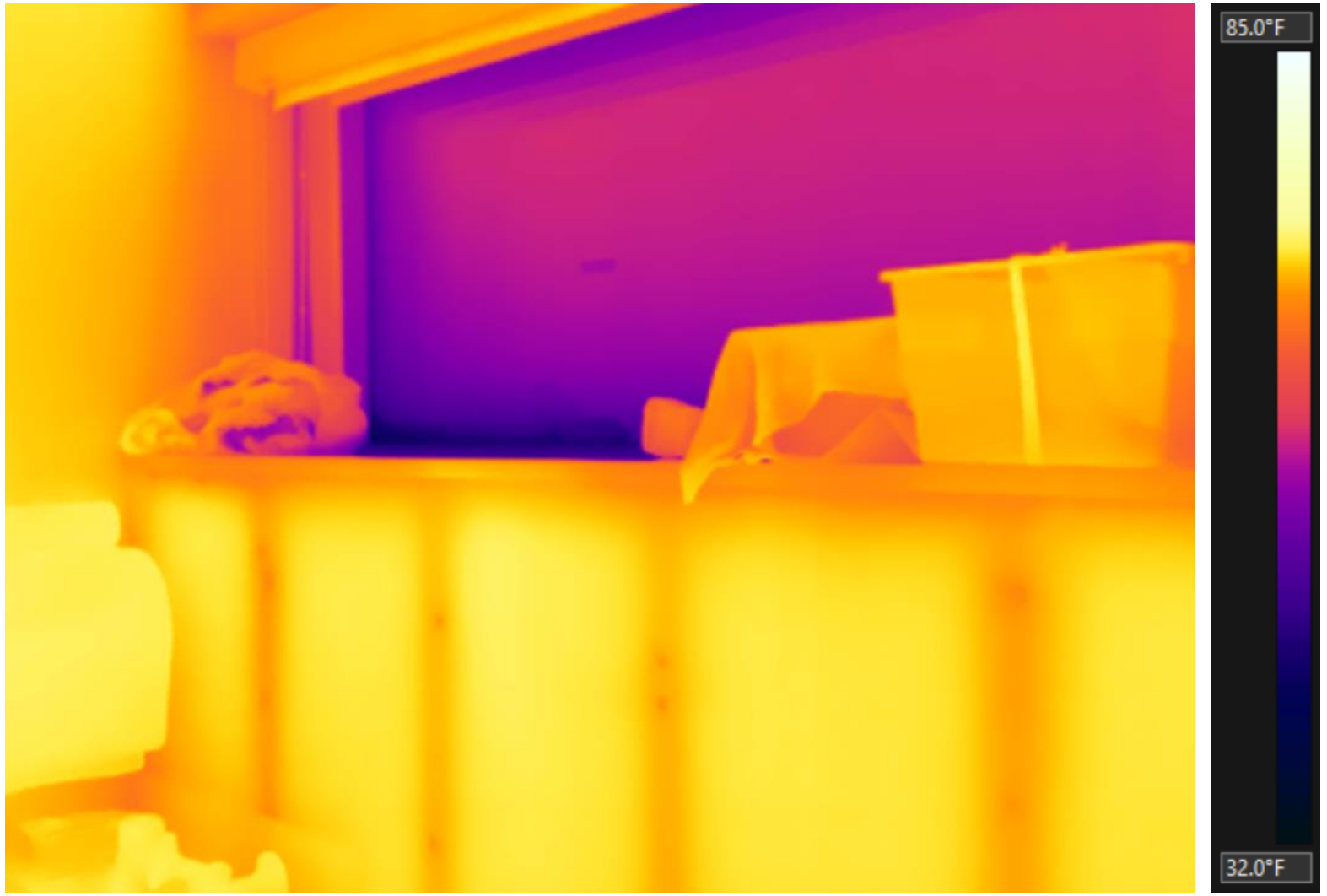
Case Study 1 – CoxHealth Patient Tower Addition

NICU Room 14 – North Elevation

air barrier
abaa
association of
america

Case Study – CoxHealth Patient Tower Addition

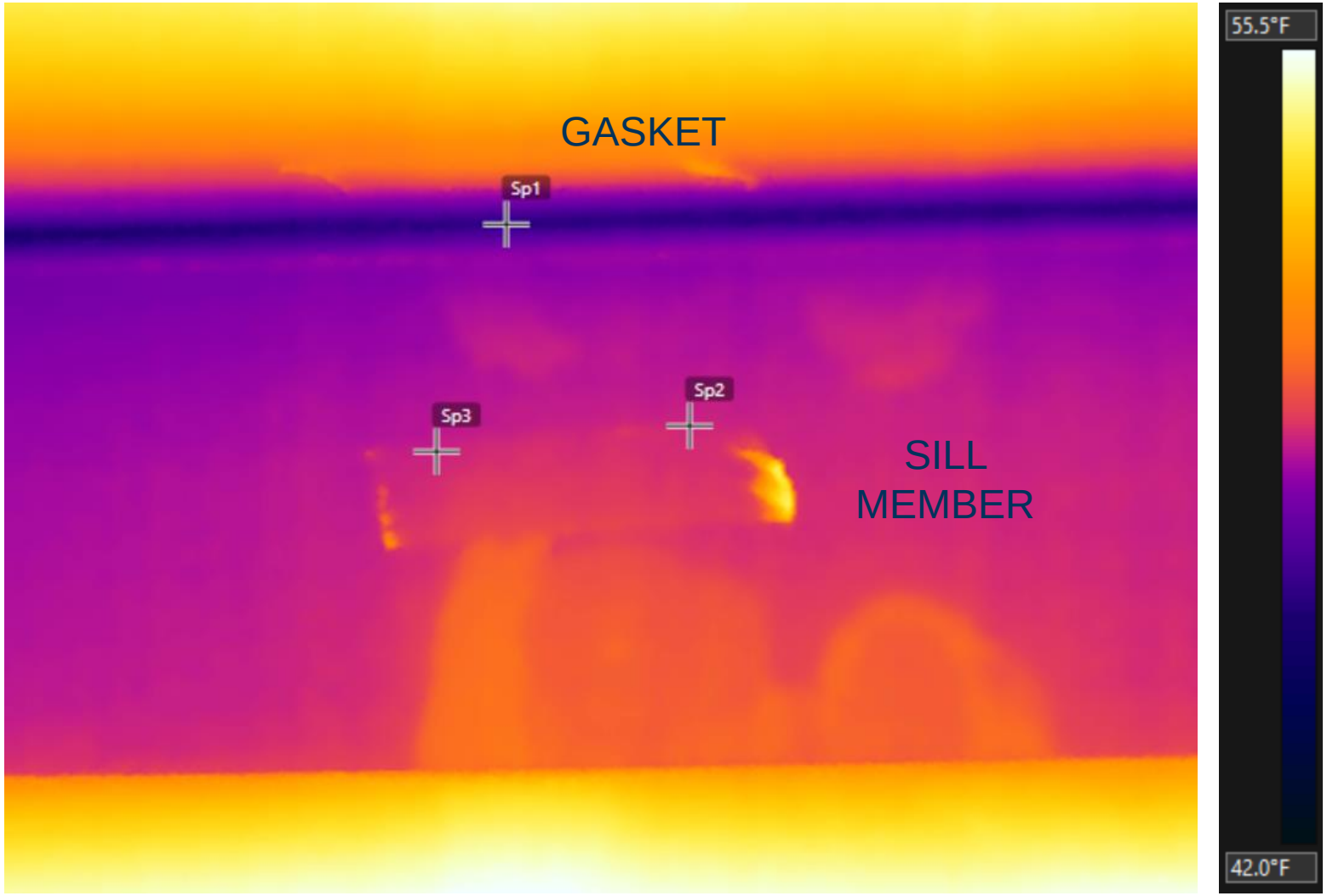
air barrier
abaa
association of
america



NICU Room 14 – Baseline Reference

Case Study – CoxHealth Patient Tower Addition

Note	
West light @ sill tube	
Measurements	
Sp1	46.4 °F
Sp2	49.0 °F
Sp3	49.0 °F



NICU Room 14 – Interior at Sill Tube

air barrier abaa association of america

Case Study – CoxHealth Patient Tower Addition

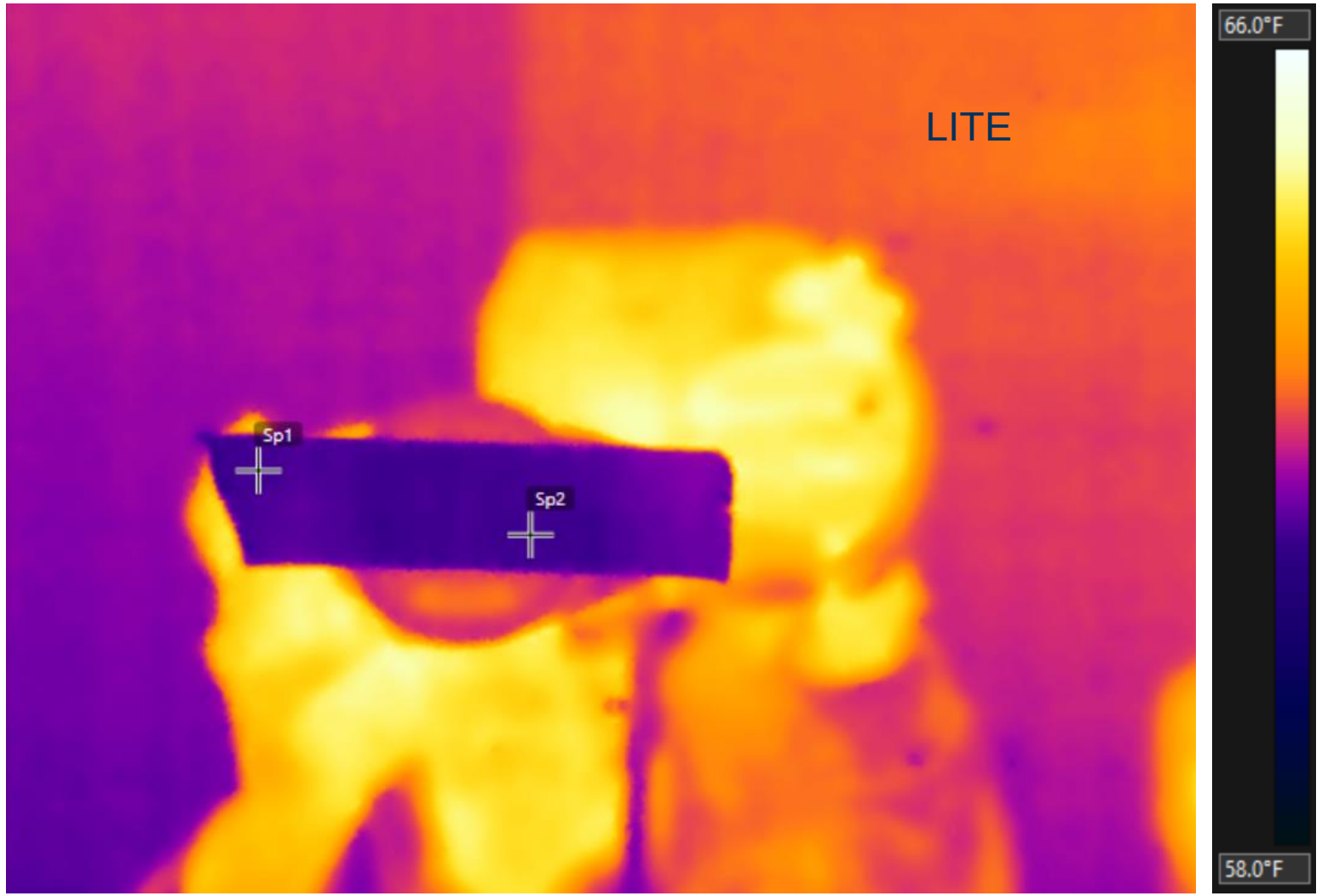
Note	
West side mid lite	
Measurements	
Sp1	50.8 °F
Sp2	46.7 °F
Sp3	46.6 °F

NICU Room 14 – Interior at Middle Tube

air barrier abaa association of america

Case Study – CoxHealth Patient Tower Addition

Note	
West side mid lite	
Measurements	
Sp1	61.1 °F
Sp2	61.1 °F



NICU Room 14 – Interior at Middle Lite

air barrier abaa association of america

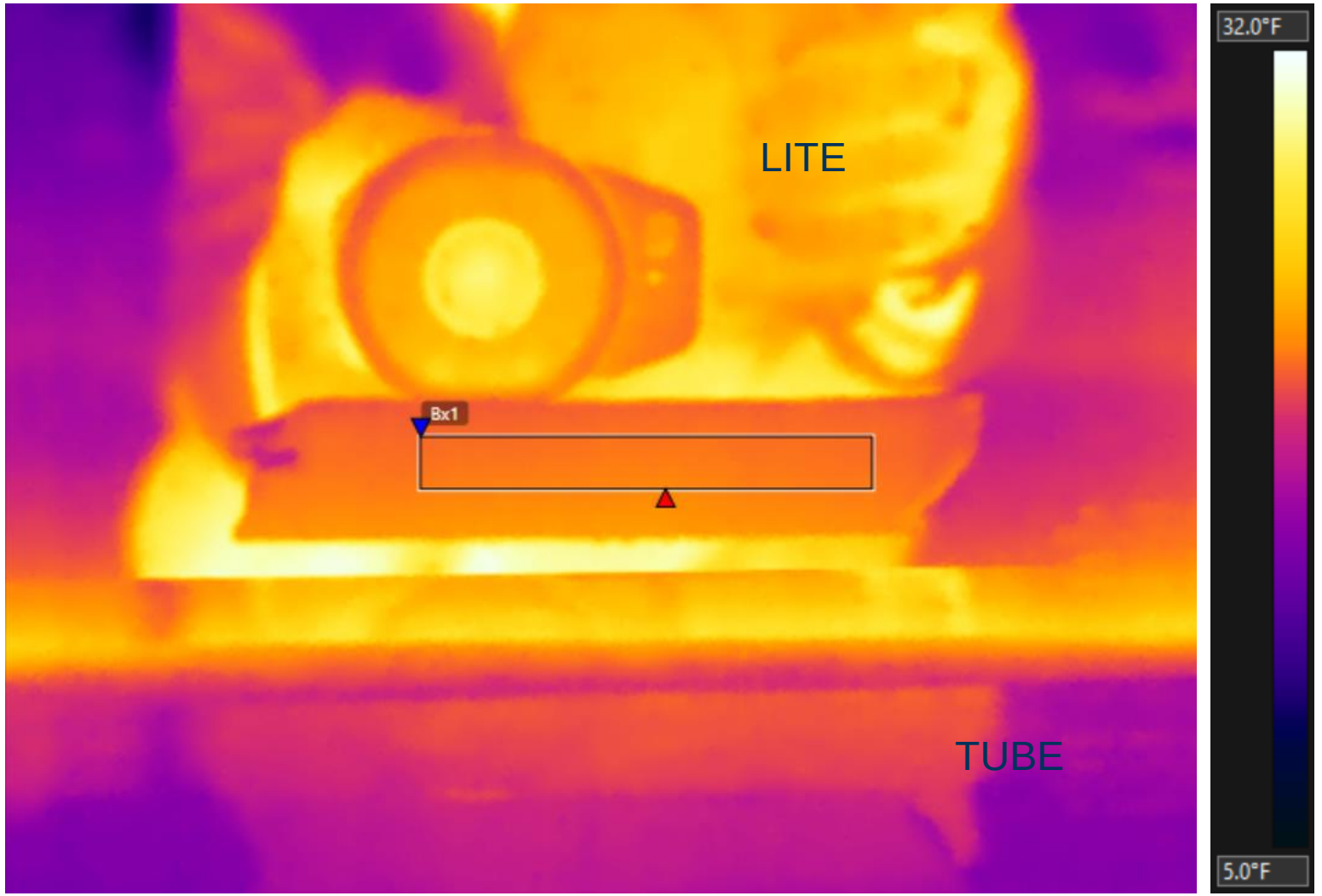
Case Study – CoxHealth Patient Tower Addition

Note

West outside of NICU14

Measurements

Bx1	Max	23.9 °F
	Min	22.3 °F
	Average	23.2 °F

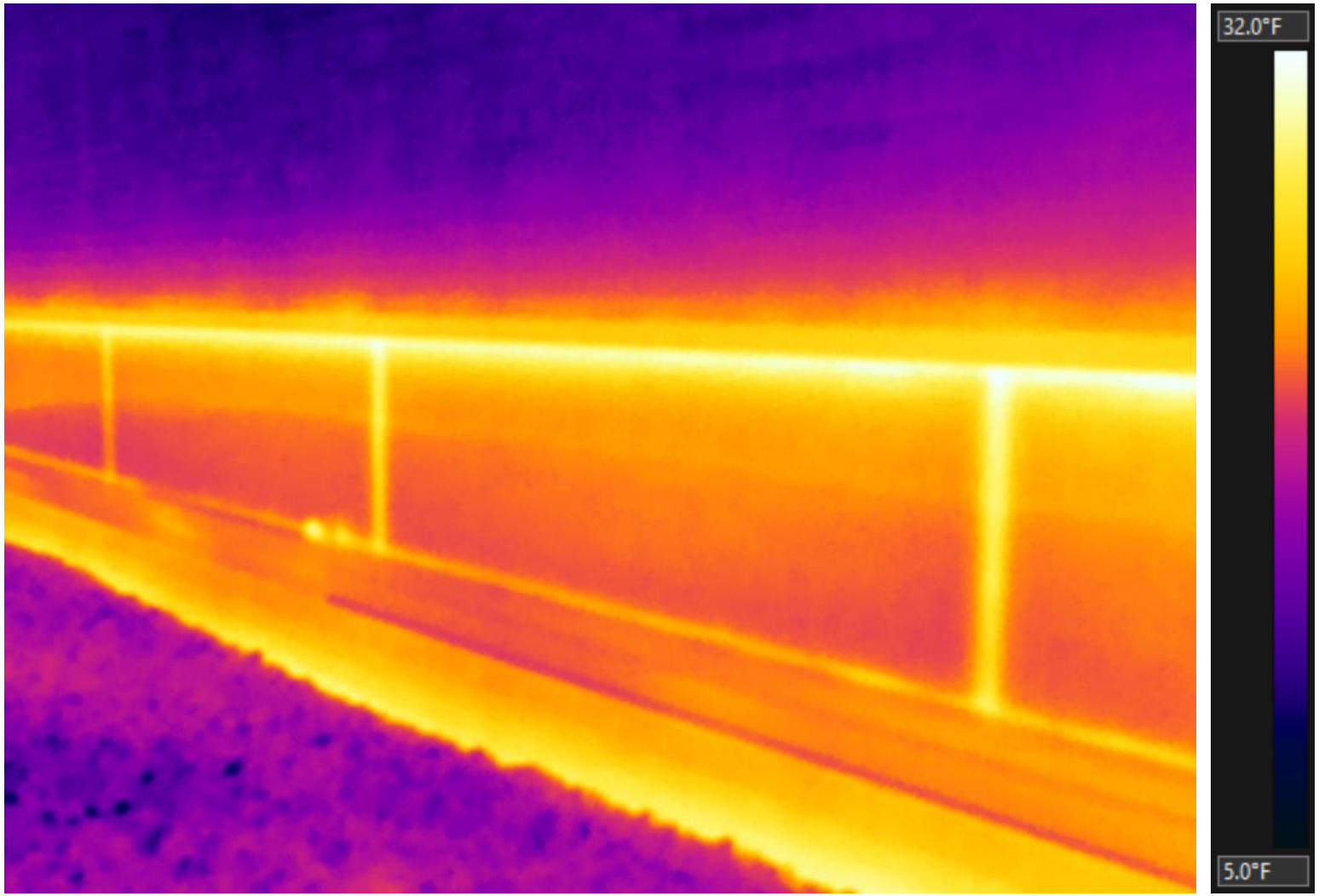


NICU Room 14 – Exterior at Sill Tube

air barrier abaa association of america

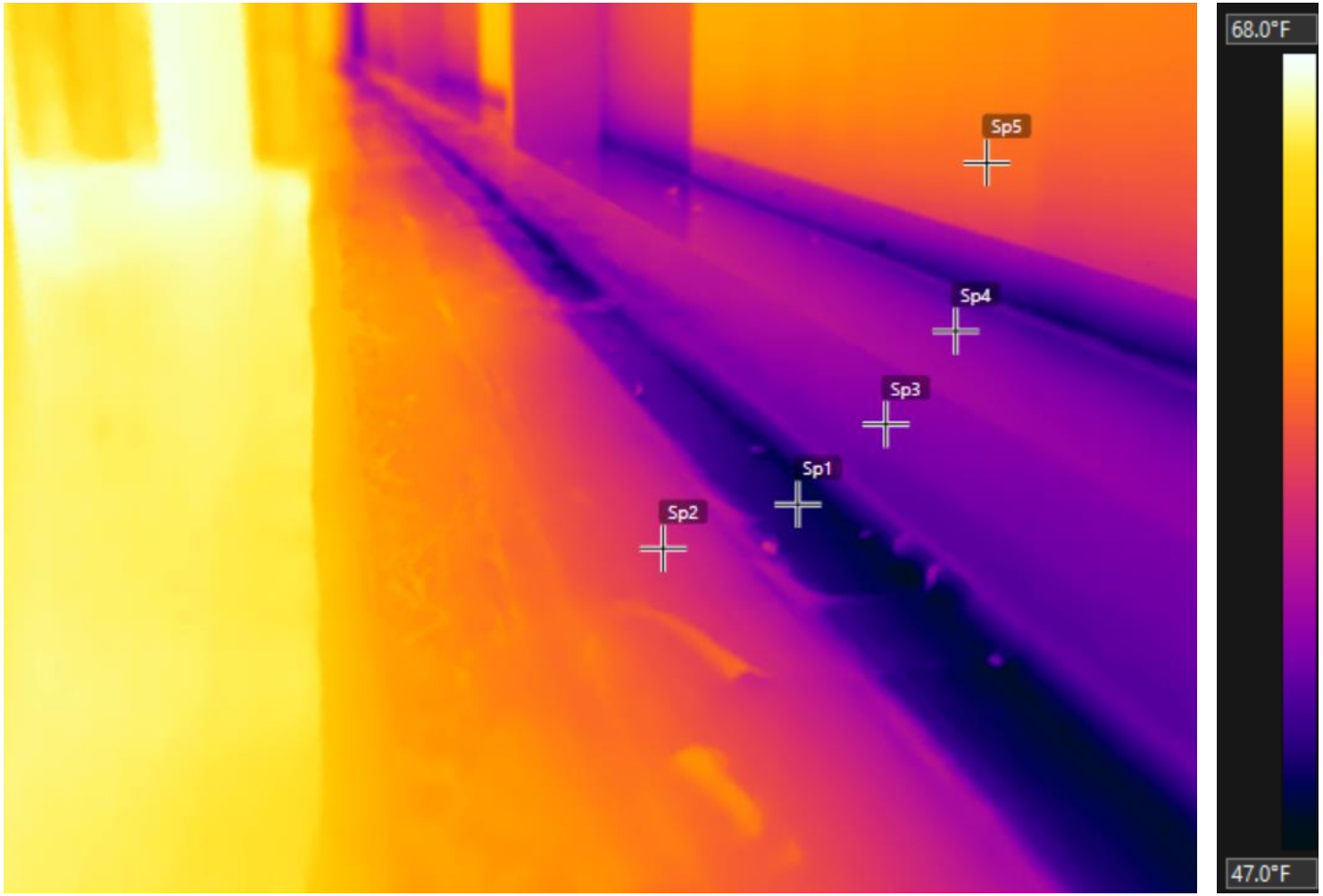
Case Study – CoxHealth Patient Tower Addition

air barrier
abaa
association of
america



NICU Room 14 – Exterior Baseline

Case Study – CoxHealth Patient Tower Addition

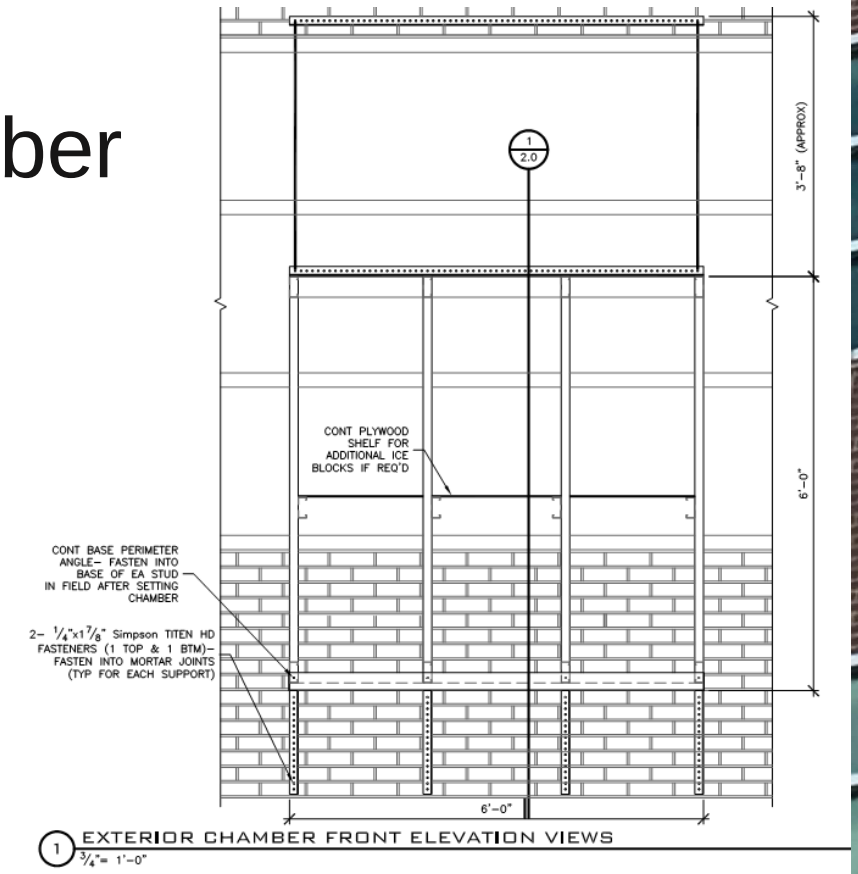


air barrier abaa association of america

North wall 5th floor looking north, structural steel temperatures are lower than frame temperatures. This image was taken at 10:00 am when exterior ambient temperatures were approximately 22°F. This image shows the frame sitting on the cold side of the exterior wall, directly onto the steel member. The spot surface temperatures are as follows: Spot1 - 46.7°F, Spot2 - 60.0°F, Spot3 – 51.0°F, Spot4 – 51.0 °F, Spot5 – 51.8°F, Spot6 – 59.8°F.

Case Study – CoxHealth Patient Tower Addition

Exterior Chamber designed and installed



air barrier abaa association of america

Case Study – CoxHealth Patient Tower Addition

Exterior Chamber filled with dry ice

air barrier
abaa
association of
america

Case Study – CoxHealth Patient Tower Addition

200 pounds of dry ice used in 21 hours

air barrier
abaa
association of
america

Case Study – CoxHealth Patient Tower Addition

Interior Chamber climate controlled to mechanical system design.

air barrier
abaa
association of
america

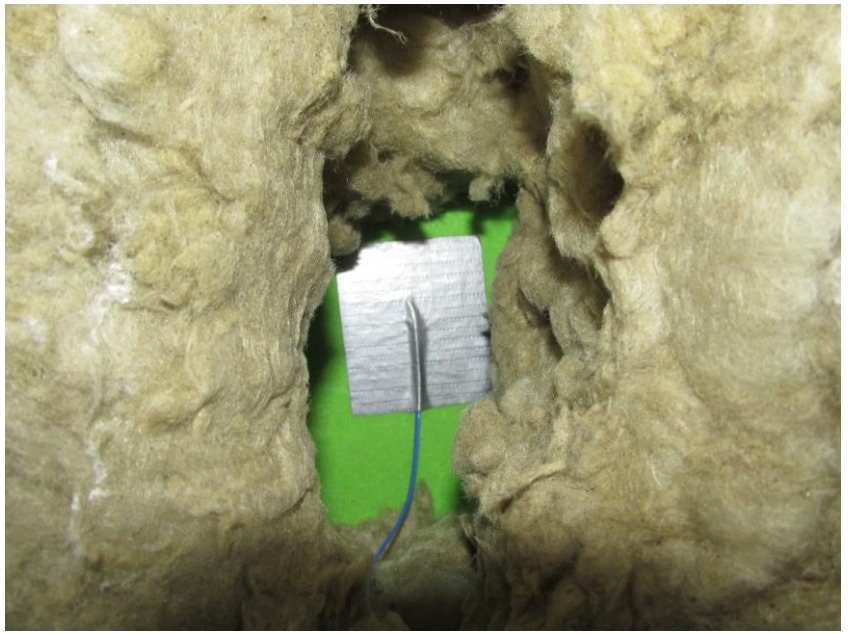
Case Study – CoxHealth Patient Tower Addition

Interior Chamber climate controlled to mechanical system design.

air barrier
abaa
association of
america

Case Study – CoxHealth Patient Tower Addition

Thermocouples installed on interior and exterior at sill, lite, and wall on interior and exterior



air barrier
abaa
association of
america

Case Study – CoxHealth Patient Tower Addition

Thermocouples installed on interior and exterior at sill, lite, and wall on interior and exterior

air barrier
abaa
association of
america

Case Study – CoxHealth Patient Tower Addition

Thermocouples installed on interior and exterior at sill, lite, and wall on interior and exterior

air barrier
abaa
association of america

Case Study –
CoxHealth Patient Tower Addition

Place	Date	Time	Value	Unit	Value	Unit	Value	Unit	Value	Unit
1	5/30/2018	14:00:02	80	T1 KTemp	9999	T2 KTemp	9999	T3 KTemp	9999	T4 KTemp F
2	5/30/2018	14:00:04	80	T1 KTemp	9999	T2 KTemp	9999	T3 KTemp	9999	T4 KTemp F
3	5/30/2018	14:00:05	80	T1 KTemp	9999	T2 KTemp	9999	T3 KTemp	9999	T4 KTemp F
4	5/30/2018	14:00:06	79.9	T1 KTemp	9999	T2 KTemp	9999	T3 KTemp	9999	T4 KTemp F
5	5/30/2018	14:00:07	79.9	T1 KTemp	9999	T2 KTemp	9999	T3 KTemp	9999	T4 KTemp F
1573	6/1/2018	11:05:18	37.5	T1 KTemp	37.2	T2 KTemp	28.6	T3 KTemp	36	T4 KTemp F
1574	6/1/2018	11:06:18	37.7	T1 KTemp	37.2	T2 KTemp	28.7	T3 KTemp	36.1	T4 KTemp F
1575	6/1/2018	11:07:18	37.9	T1 KTemp	37.4	T2 KTemp	28.6	T3 KTemp	36.1	T4 KTemp F
1576	6/1/2018	11:08:18	37.9	T1 KTemp	37.5	T2 KTemp	28.4	T3 KTemp	36.3	T4 KTemp F
1577	6/1/2018	11:09:18	38.1	T1 KTemp	37.7	T2 KTemp	31	T3 KTemp	36.6	T4 KTemp F

air barrier
abaa
association of
america

Exterior Thermocouple Readings –
21 hour acclimation

Case Study –
CoxHealth Patient Tower Addition

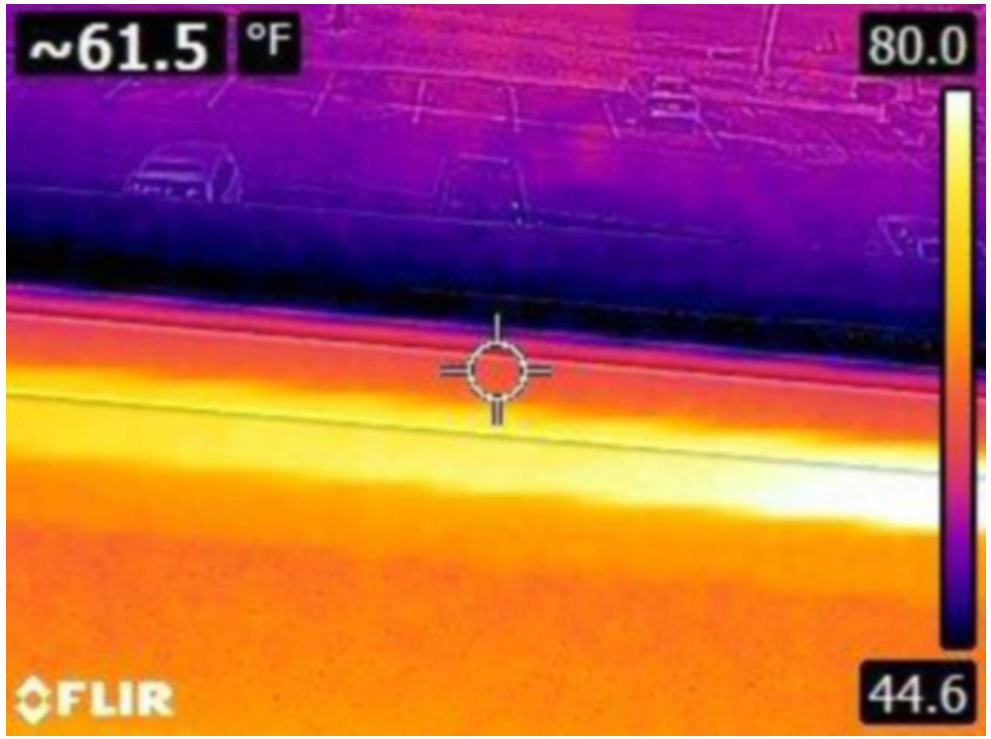
Place	Date	Time	Value	Unit	Value	Unit	Value	Unit	Value	Unit
1	5/31/2018	9:58:58	71.7	T1 KTemp	71.1	T2 KTemp	72.5	T3 KTemp	75.5	T4 KTemp F
2	5/31/2018	9:59:58	71.7	T1 KTemp	71.2	T2 KTemp	72.3	T3 KTemp	75.3	T4 KTemp F
3	5/31/2018	10:00:58	71.7	T1 KTemp	71.2	T2 KTemp	72.3	T3 KTemp	75.2	T4 KTemp F
4	5/31/2018	10:01:58	71.7	T1 KTemp	71.2	T2 KTemp	72.3	T3 KTemp	75.2	T4 KTemp F
5	5/31/2018	10:02:58	71.7	T1 KTemp	71.4	T2 KTemp	72.3	T3 KTemp	75	T4 KTemp F
1523	6/1/2018	11:20:58	59.9	T1 KTemp	59.1	T2 KTemp	65.8	T3 KTemp	62.2	T4 KTemp F
1524	6/1/2018	11:21:58	60	T1 KTemp	59.4	T2 KTemp	65.8	T3 KTemp	62.1	T4 KTemp F
1525	6/1/2018	11:22:58	60.2	T1 KTemp	59.7	T2 KTemp	66	T3 KTemp	62.2	T4 KTemp F
1526	6/1/2018	11:23:58	60.4	T1 KTemp	59.7	T2 KTemp	66.3	T3 KTemp	62.2	T4 KTemp F
1527	6/1/2018	11:24:58	60.6	T1 KTemp	59.5	T2 KTemp	66.2	T3 KTemp	62	T4 KTemp F

air barrier
abaa
association of
america

Interior Thermocouple Readings –
21 hour acclimation


FAILURE
SUCCESS

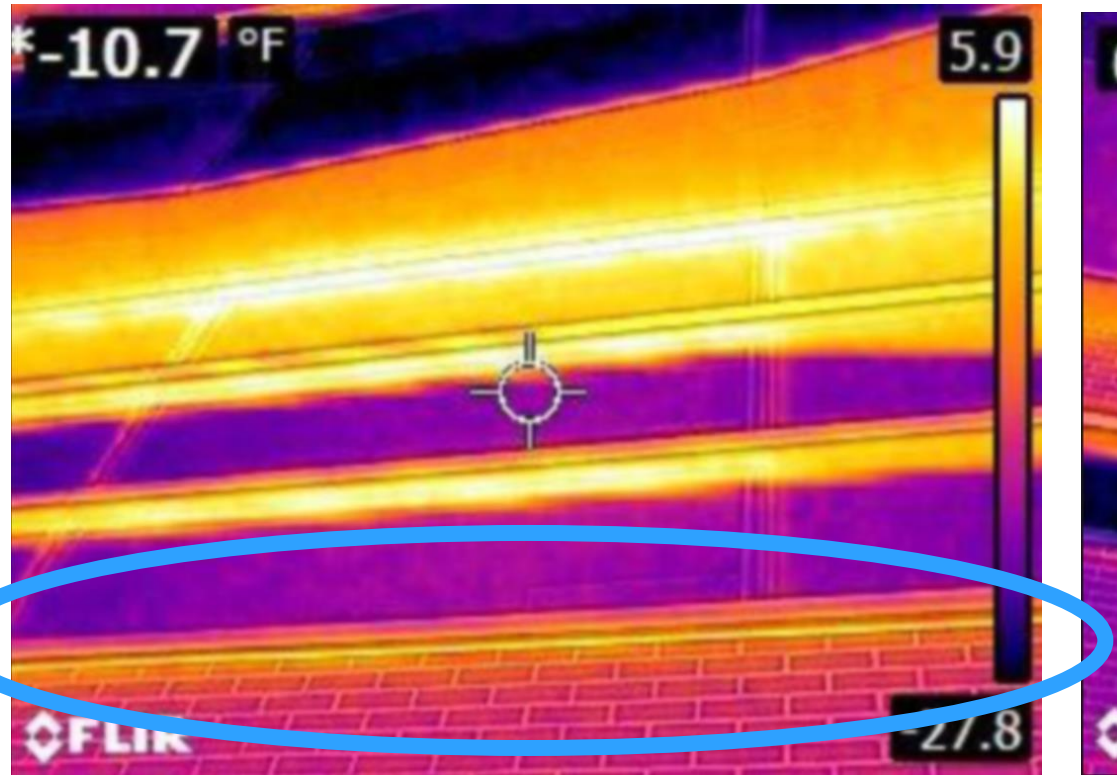
Case Study –
CoxHealth Patient Tower Addition

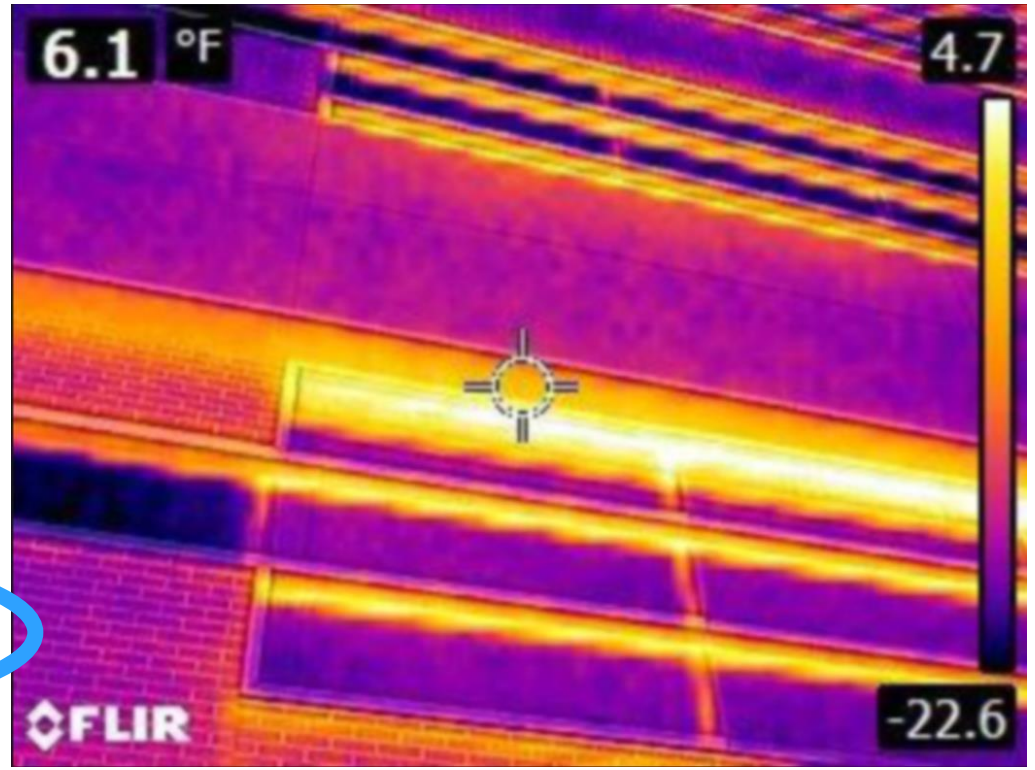


air barrier
abaa
association of
america

Introduction of Electric Heat strips were added to “warm” the window frame

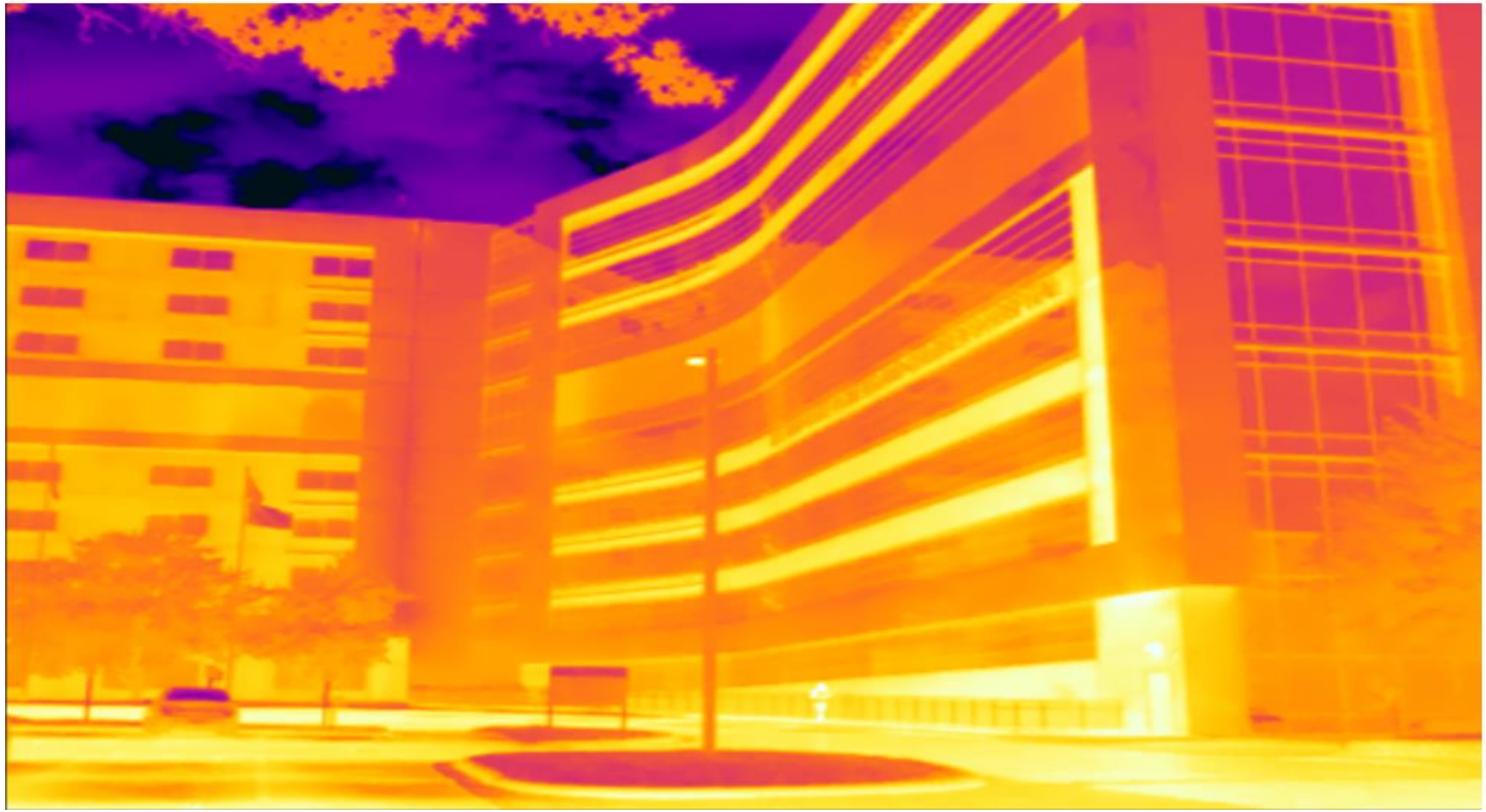
Case Study –
CoxHealth Patient Tower Addition





air barrier
abaa
association of
america

Case Study – CoxHealth Patient Tower Addition



air barrier
abaa
association of
america

Special Thanks to:

MILLER ENGINEERING

structural ▪ forensic ▪ building enclosure

For Case Study Thermograms

Level I Building Science Thermography

SWA Consulting

Certified Infrared Thermographer

For the Knowledge

air barrier abaa association of america

Melissa I. Payne

BECxP, CxA+BE, CDT,

Level II Building Science Thermographer

Manager Enclosure Solutions,

Tremco CPG, Inc.

M. 417.343.0094

mpayne@tremcoinc.com

TREMCO

Construction Products Group

air barrier abaa association of america

BUILDING ENCLOSURE CONFERENCE

2022 RESTON VA

ThankYou Sponsors!

DÖRKEN

DELTA®

HIGH PERFORMANCE AIR & MOISTURE BARRIERS

TMI®

AIR BARRIER TESTING

NCFI

POLYURETHANES

We finish strong.

Master Wall Inc.

Building a Culture of Excellence

Henry®

A CARLISLE COMPANY

HB

HOHMANN & BARNARD, INC

CARLISLE

COATINGS & WATERPROOFING

PROSOCO

BE BUILDING ENCLOSURE

air barrier

abaa

association of america

XCELUS

Telligent

Masonry Construction

Architect's Newspaper