abaa 2024 building enclosure conference

Re-Thinking Your Insulation Strategies

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AIA Continuing Education Provider

abaa EDUCATION

Re-Thinking Your Insulation Strategies

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Learning Objectives

Upon completing this program, the participant should understand

1.) Learn the prescriptive exterior wall insulation requirements in the current International Energy Code.

2.) Learn the performance exterior wall insulation requirements in the current International Energy Code.

3.) Learn that complying with the prescriptive requirements of the code can result in exterior wall assembly failures.

4.) Learn how to avoid exterior wall assembly failures while complying with the code.

The Four Barriers

- **HAMM is the 4 barriers needed to protect a building against the effects of weather. These barriers are:**

H **Heat Barrier**

A **Air Barrier**

M_L **Water Barrier (Liquid Moisture)**

M_V **Vapor Barrier (Gaseous Moisture)**

HAMM is the <u>WEATHER BARRIER SYSTEM</u>

THE HEAT BARRIER

- **Resists thermal transfer through the building enclosure system.**
  - **R-Value is the measure of resistance to thermal transfer.**
  - **The higher the R-Value, the greater the resistance.**
  - **The greater the resistance, the lower the heat gain / loss.**

- **The location of the heat barrier, in a properly designed and constructed building enclosure system, determines the location of the dew point.**

THE HEAT BARRIER

Functions

- **Prevents thermal loss, gain and bridging**
- **Wetting potential due to a dew point (location)**

THE HEAT BARRIER

Second Law Of Thermodynamics

“ The entropy of an isolated system which is not in equilibrium will tend to increase over time, approaching a maximum value at equilibrium. “

Translation anyone???

<u>Heat seeks cold!!!</u>

THERMAL PERFORMANCE

Factors affecting thermal performance of insulation

- **Air leakage through gaps in the insulation**
- **Wind wash effect on fibrous insulation**
- **Thermal Bridging**

THERMAL BRIDGING

What is the R-Value of a 6” LGMF wall with R-19 batts insulation, exterior gypsum sheathing and interior gypsum wallboard?

R 7.03

TABLE C402.1.4.2
EFFECTIVE *R*-VALUES FOR STEEL STUD WALL ASSEMBLIES

NOMINAL STUD DEPTH (inches)	SPACING OF FRAMING (inches)	CAVITY *R*-VALUE (insulation)	CORRECTION FACTOR (F_c)	EFFECTIVE *R*-VALUE (ER) (Cavity *R*-Value × F_c)
$3^1/_2$	16	13	0.46	5.98
		15	0.43	6.45
$3^1/_2$	24	13	0.55	7.15
		15	0.52	7.80
6	16	19	0.37	7.03
		21	0.35	7.35
6	24	19	0.45	8.55
		21	0.43	9.03
8	16	25	0.31	7.75
	24	25	0.38	9.50

For SI: 1 inch = 25.4 mm.

The Prescriptive Requirements

Table 401.1.3

TABLE C402.1.3
OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, *R*-VALUE METHOD[a]

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings[b]	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-25 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-25 + R-11 + R-11 LS	R-25 + R-11 + R-11 LS
Attic and other	R-38	R-38	R-38	R-38	R-38	R-38	R-49	R-49	R-49	R-49	R-49	R-49	R-60	R-60	R-60	R-60
Walls, above grade																
Mass[f]	R-5.7ci[c]	R-5.7ci[c]	R-5.7ci[c]	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci
Metal building	R-13 + R-6.5ci	R-13 + R-6.5ci	R13 + R-6.5ci	R-13 + R-13ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-17ci	R-13 + R-19.5ci	R-13 + R-19.5ci	R-13 + R-19.5ci
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-10ci	R-13 + R-10ci	R-13 + R-12.5ci	R-13 + R-12.5ci	R-13 + R-12.5ci	R-13 + R-15.6ci	R-13 + R-18.8ci	R-13 + R-18.8ci
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-7.5ci or R20 + R3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-18.8ci	R-13 + R-18.8ci
Walls, below grade																
Below-grade wall[d]	NR	NR	NR	NR	NR	NR	R-7.5ci	R-10ci	R-7.5ci	R-10ci	R-10ci	R-15ci	R-15ci	R-15ci	R-15ci	R-15ci
Floors																
Mass[e]	NR	NR	R-6.3ci	R-8.3ci	R-10ci	R-10ci	R-14.6ci	R-16.7ci	R-14.6ci	R-16.7ci	R-16.7ci	R-16.7ci	R-20.9ci	R-20.9ci	R-23ci	R-23ci
Joist/framing	R-13	R-13	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-38	R-38	R-38	R-38	R-38	R-38
Slab-on-grade floors																
Unheated slabs	NR	NR	NR	NR	NR	R-10 for 24″ below	R-15 for 24″ below	R-15 for 24″ below	R-15 for 24″ below	R-20 for 24″ below	R-20 for 24″ below	R-20 for 48″ below	R-20 for 24″ below	R-20 for 48″ below	R-20 for 48″ below	R-25 for 48″ below
Heated slabs[g]	R-7.5 for 12″ below+ R-5 full slab	R-7.5 for 12″ below+ R-5 full slab	R-7.5 for 12″ below+ R-5 full slab	R-7.5 for 12″ below+ R-5 full slab	R-10 for 24″ below+ R-5 full slab	R-10 for 24″ below+ R-5 full slab	R-15 for 24″ below+ R-5 full slab	R-15 for 24″ below+ R-5 full slab	R-15 for 36″ below+ R-5 full slab	R-15 for 36″ below+ R-5 full slab	R-15 for 36″ below+ R-5 full slab	R-20 for 48″ below+ R-5 full slab	R-20 for 48″ below+ R-5 full slab	R-20 for 48″ below+ R-5 full slab	R-20 for 48″ below+ R-5 full slab	R-20 for 48″ below+ R-5 full slab

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.

b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

e. "Mass floors" shall be in accordance with Section C402.2.3.

f. "Mass walls" shall be in accordance with Section C402.2.2.

g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

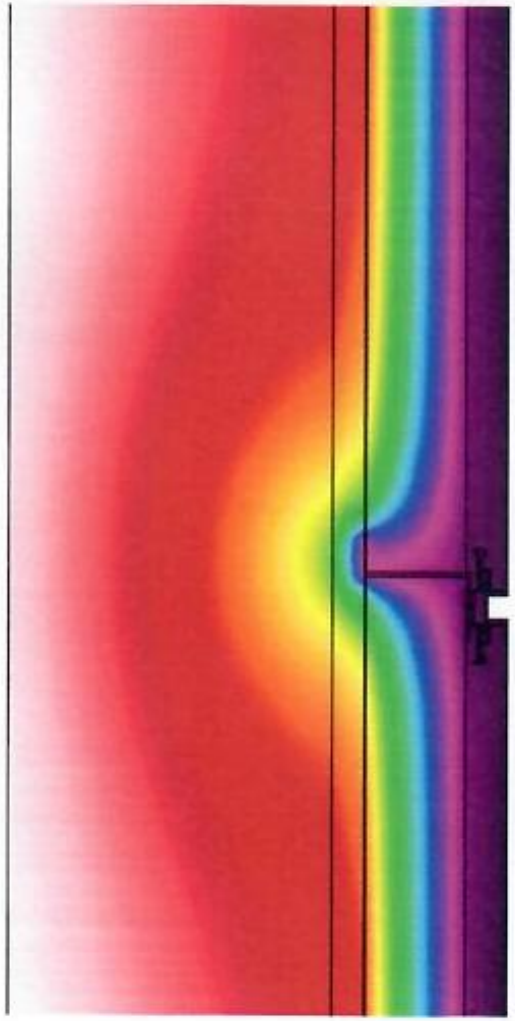
2018 IEC

C202 Definition of Continuous Insulation

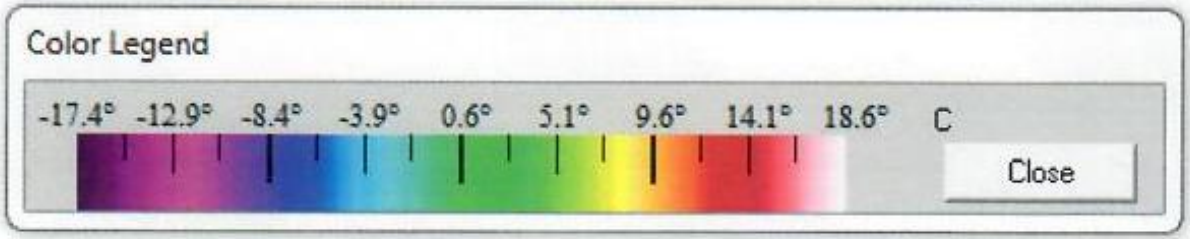
CONTINUOUS INSULATION (ci). Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope.

Is this continuous insulation?

Thermal Bridging Effect Of Continuous Z-Furring



43% reduction in effectiveness of the insulation layer.



The Performance Requirements

Table 401.1.4

TABLE C402.1.4
OPAQUE THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, *U*-FACTOR METHOD[a, b]

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039	U-0.039	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.028	U-0.028	U-0.028	U-0.028
Metal buildings	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.031	U-0.029	U-0.029	U-0.029	U-0.026	U-0.026
Attic and other	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.017	U-0.017	U-0.017	U-0.017
Walls, above grade																
Mass[f]	U-0.151	U-0.151	U-0.151	U-0.123	U-0.123	U-0.104	U-0.104	U-0.090	U-0.090	U-0.080	U-0.080	U-0.071	U-0.071	U-0.071	U-0.037	U-0.037
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	U-0.079	U-0.052	U-0.052	U-0.050	U-0.050	U-0.050	U-0.050	U-0.050	U-0.044	U-0.039	U-0.039	U-0.039
Metal framed	U-0.077	U-0.077	U-0.077	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.055	U-0.055	U-0.049	U-0.049	U-0.049	U-0.042	U-0.037	U-0.037
Wood framed and other[c]	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.032	U-0.032
Walls, below grade																
Below-grade wall[c]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-0.119	C-0.092	C-0.119	C-0.092	C-0.092	C-0.063	C-0.063	C-0.063	C-0.063	C-0.063
Floors																
Mass[d]	U-0.322[e]	U-0.322[e]	U-0.107	U-0.087	U-0.074	U-0.074	U-0.057	U-0.051	U-0.057	U-0.051	U-0.051	U-0.051	U-0.042	U-0.042	U-0.038	U-0.038
Joist/framing	U-0.066[e]	U-0.066[e]	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027
Slab-on-grade floors																
Unheated slabs	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.54	F-0.52	F-0.52	F-0.52	F-0.51	F-0.51	F-0.434	F-0.51	F-0.434	F-0.434	F-0.424
Heated slabs	F-0.69	F-0.69	F-0.69	F-0.69	F-0.66	F-0.66	F-0.62	F-0.62	F-0.62	F-0.62	F-0.62	F-0.602	F-0.602	F-0.602	F-0.602	F-0.602
Opaque doors																
Nonswinging door	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31
Swinging door[g]	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Garage door < 14% glazing[h]	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31

For SI: 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Where assembly *U*-factors, *C*-factors and *F*-factors are established in ANSI/ASHRAE/IESNA 90.1 Appendix A, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, and provided that the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/ISNEA 90.1 Appendix A.

b. Where *U*-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table. The *R*-value of continuous insulation shall be permitted to be added to or subtracted from the original tested design.

c. Where heated slabs are below grade, below-grade walls shall comply with the *U*-factor requirements for above-grade mass walls.

d. "Mass floors" shall be in accordance with Section C402.2.3.

e. These *C*-, *F*- and *U*-factors are based on assemblies that are not required to contain insulation.

f. "Mass walls" shall be in accordance with Section C402.2.2.

g. Swinging door *U*-factors shall be determined in accordance with NFRC-100.

h. Garage doors having a single row of fenestration shall have an assembly *U*-factor less than or equal to 0.44 in Climate Zones 0 through 6 and less than or equal to 0.36 in Climate Zones 7 and 8, provided that the fenestration area is not less than 14 percent and not more than 25 percent of the total door area.

U-Factor

The U-Factor is the overall heat transfer coefficient of an assembly.

U-Factor

U-Factor for metal framed exterior walls in climate zone 5

U-0.055

U-Factor is the inverse of R-Value

R-18.18

TABLE C402.1.4.2
EFFECTIVE *R*-VALUES FOR STEEL STUD WALL ASSEMBLIES

NOMINAL STUD DEPTH (inches)	SPACING OF FRAMING (inches)	CAVITY *R*-VALUE (insulation)	CORRECTION FACTOR (F_c)	EFFECTIVE *R*-VALUE (ER) (Cavity *R*-Value × F_c)
$3^1/_2$	16	13	0.46	5.98
		15	0.43	6.45
$3^1/_2$	24	13	0.55	7.15
		15	0.52	7.80
6	16	19	0.37	7.03
		21	0.35	7.35
6	24	19	0.45	8.55
		21	0.43	9.03
8	16	25	0.31	7.75
	24	25	0.38	9.50

For SI: 1 inch = 25.4 mm.

The Prescriptive Requirements

Table 402.1.4.1

R-13 insulation in LGMF = R-5.98

Table 402.1.3

Continuous insulation = R-10

Total Insulation R-value = 15.98

Need another R-2.2 from other elements in the assembly!!!

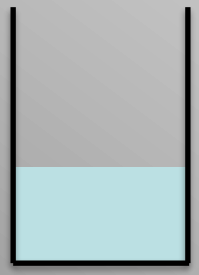
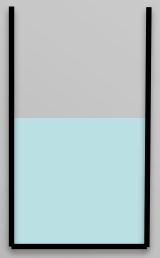
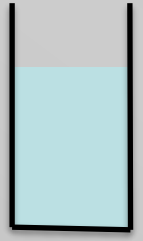
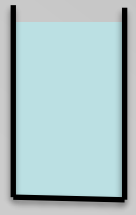
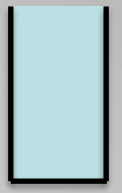
Envelope Backstops

An envelope backstop is a provision that limits the ability of a design team to trade better performing internal systems (HVAC, lighting, etc.) for envelope energy efficiency in the performance compliance paths.

The Dew Point

The dew point is the temperature at which air that contains a certain amount of vapor can no longer hold that vapor and must exhaust itself of excess vapor by depositing it on adjacent surfaces in the form of condensation (water).

The Dew Point

70 ˚ F 30% RH	60 ˚ F 50% RH	50 ˚ F 70% RH	40 ˚ F 90% RH	37 ˚ F 100% RH
				
				Dew Point

Where does the water on the outside of the glass come from?

Dew Point Calculator

Air Temp °F	% Relative Humidity																	
	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10
110	110	108	106	104	102	100	98	95	93	90	87	84	80	76	72	65	60	51	41
105	105	103	101	99	97	95	93	91	88	85	83	80	76	72	67	62	55	47	37
100	100	99	97	95	93	91	89	86	84	81	78	75	71	67	63	58	52	44	32
95	95	93	92	90	88	86	84	81	79	76	73	70	67	63	59	54	48	40	32
90	90	88	87	85	83	81	79	76	74	71	68	65	62	59	54	49	43	36	32
85	85	83	81	80	78	76	74	72	69	67	64	61	58	54	50	45	38	32	
80	80	78	77	75	73	71	69	67	65	62	59	56	53	50	45	40	35	32	
75	75	73	72	70	68	66	64	62	60	58	55	52	49	45	41	36	32		
70	70	68	67	65	63	61	59	57	55	53	50	47	44	40	37	32			
65	65	63	62	60	59	57	55	53	50	48	45	42	40	36	32				
60	60	58	57	55	53	52	50	48	45	43	41	38	35	32					
55	55	53	52	50	49	47	45	43	40	38	36	33	32						
50	50	48	46	45	44	42	40	38	36	34	32								
45	45	43	42	40	39	37	35	33	32										
40	40	39	37	35	34	32													
35	35	34	32																
32	32																		

The dew point is the temperature at which condensation forms on condensing surfaces. When air comes into contact with a surface that is at or below the dew point temperature of that air, condensation will form on it.

EXAMPLE 1: If the interior air temperature is 70˚ F and has an RH of 30%, the infiltration of air that is 37˚ F (the dew point temperature) can cool condensing surfaces to this temperature (37 ˚) causing dew to form on these surfaces.

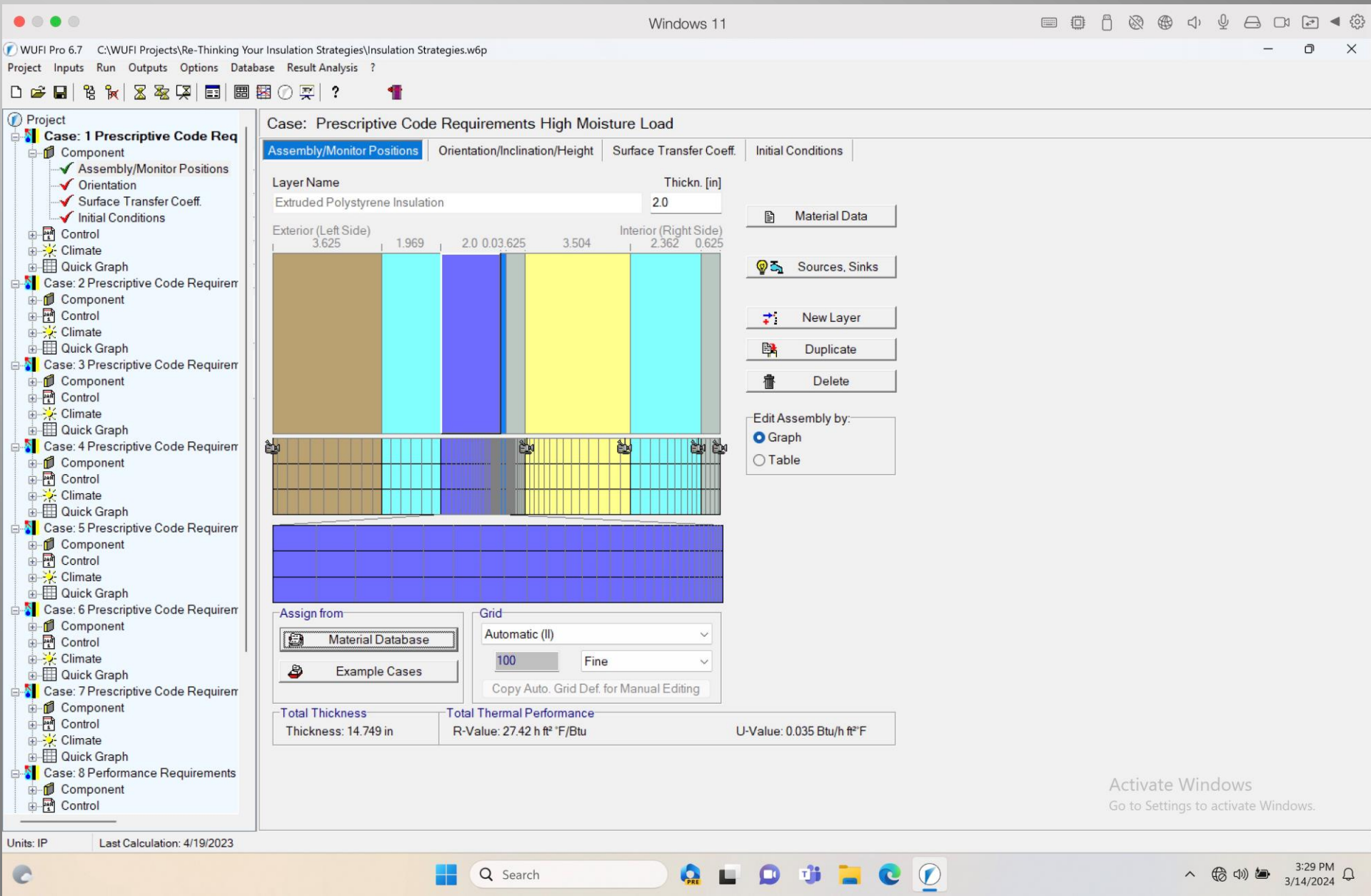
EXAMPLE 2: If exterior air with a temperature of 85˚ F and an RH of 70% infiltrates into the building envelope, dew will form on condensing surfaces in the system that have temperatures of 74˚ F or less.

NFPA 285

Burn test for exterior wall assemblies over two floors (40 feet) in height that includes plastic insulation outboard of the sheathing and / or a weather resistive barrier.

Adopted in the 2006 International Building Code (IBC).

Prescriptive Requirements High Moisture Load



Hygrothermal Analysis

The Failure Criteria

1.) 100% RH (condensation) within the assembly to the interior of the water barrier.

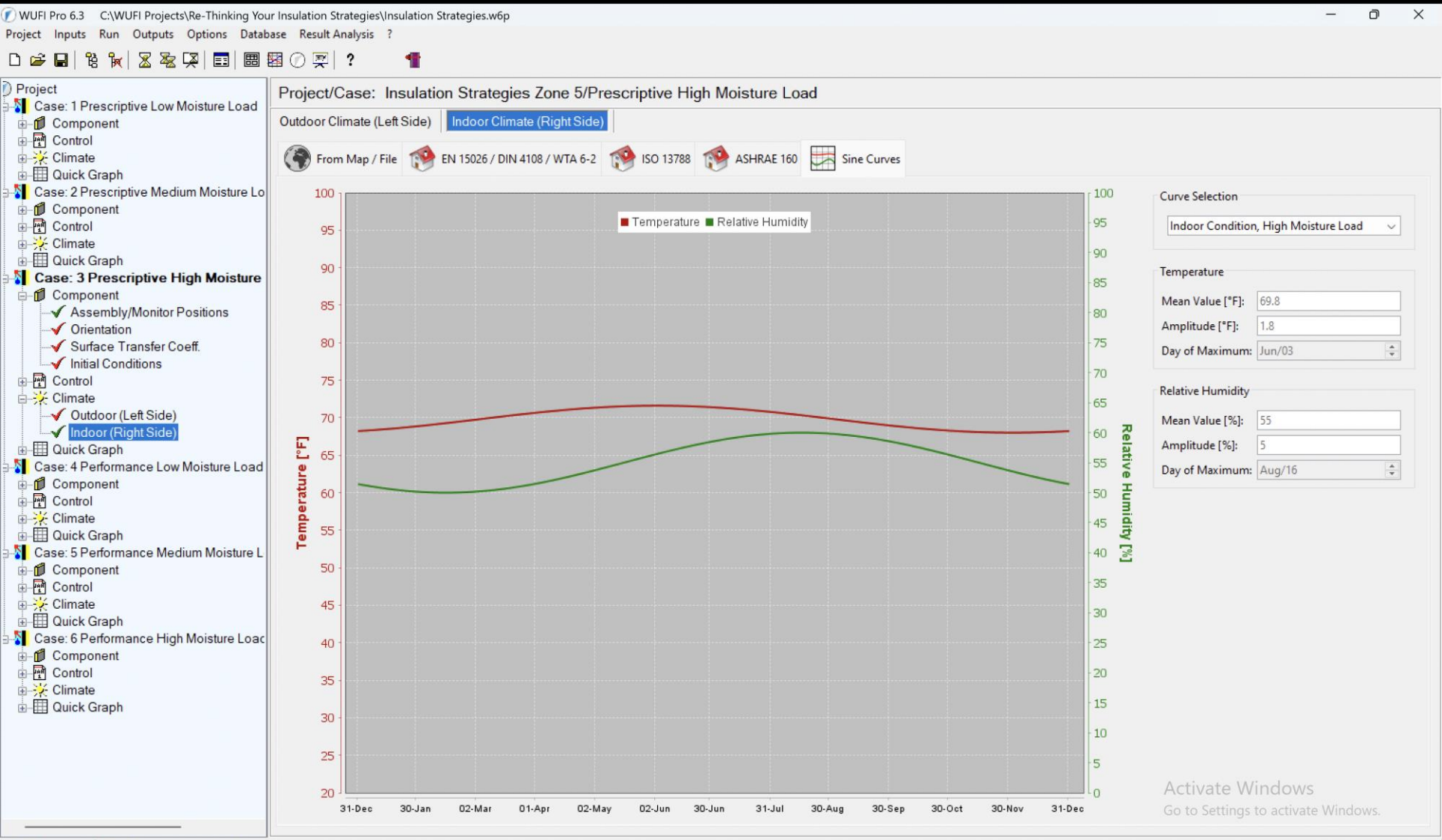
2.) RH levels above 80% for extended periods of time within the LGMF.

3.) Moisture content of moisture sensitive materials increasing from year to year.

4.) Moisture content of moisture sensitive materials above the content levels at an 80% RH environment.

5.) RH levels above 70% at paper faced gypsum board.

Prescriptive Requirements High Moisture Load



Prescriptive Requirements High Moisture Load

Windows 11

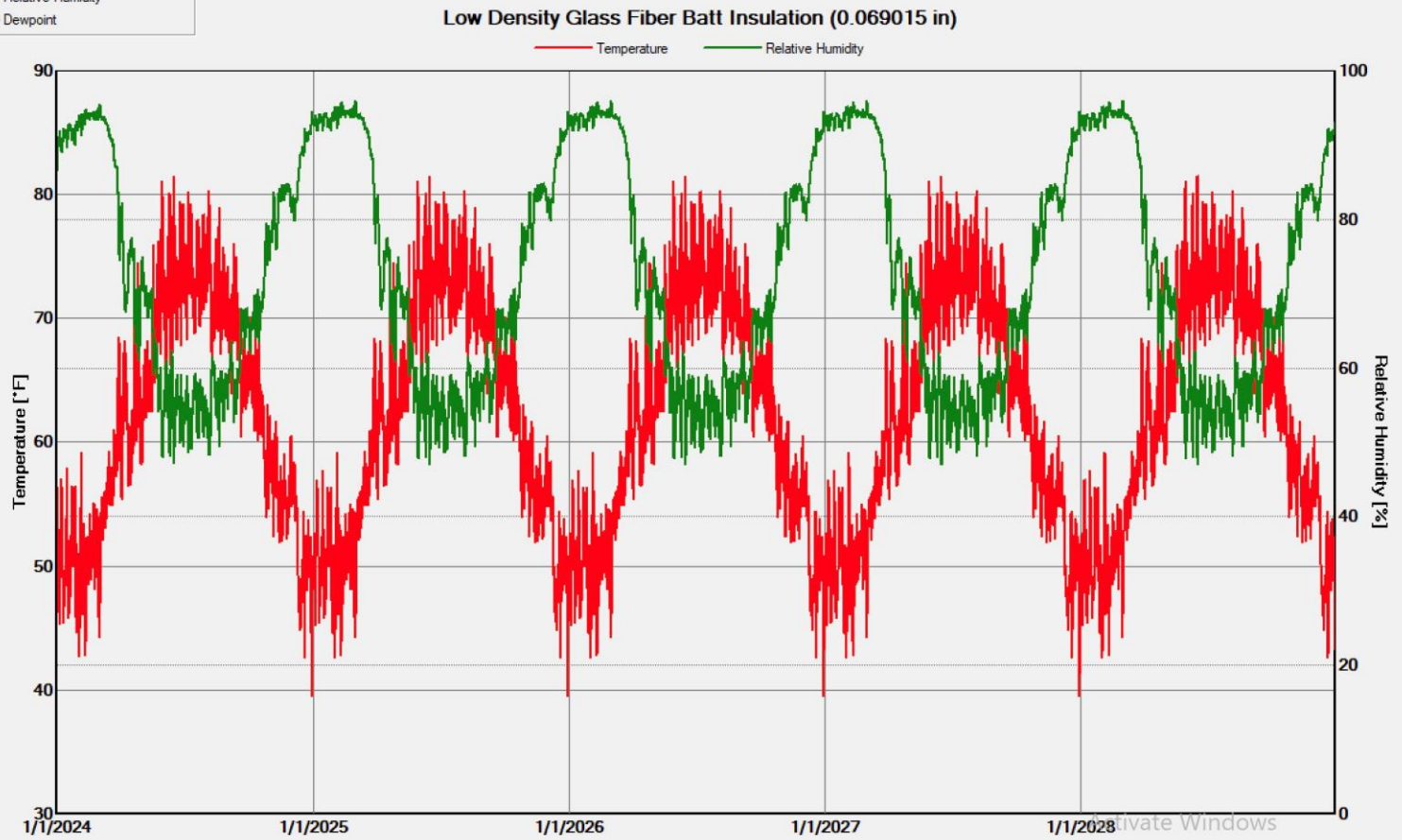
WUFI Pro 6.7 C:\WUFI Projects\Re-Thinking Your Insulation Strategies\Insulation Strategies.w6p

Project Inputs Run Outputs Options Database Result Analysis ?

- Project
  - Case: 1 Prescriptive Code Req
    - Component
    - Control
    - Climate
    - Quick Graph
      - Total Water Content
      - Water Content in Layer
      - Mon.Pos. Temp/Humidity
        - Exterior Surface
        - Low Density Glass Fiber B
        - Low Density Glass Fiber B
        - Air Layer 60 mm (2.292985
        - Interior Surface
      - Mon.Pos. Isopleths
  - Case: 2 Prescriptive Code Requirem
    - Component
      - Assembly/Monitor Positions
      - Orientation
      - Surface Transfer Coeff.
      - Initial Conditions
    - Control
    - Climate
    - Quick Graph
      - Total Water Content
      - Water Content in Layer
      - Mon.Pos. Temp/Humidity
        - Exterior Surface
        - Low Density Glass Fiber B
        - Low Density Glass Fiber B
        - Air Layer 60 mm (2.292985
        - Interior Surface
      - Mon.Pos. Isopleths
  - Case: 3 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - Case: 4 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph

Case: Prescriptive Code Requirements High Moisture Load

Humidity
- (•) Relative Humidity
- ( ) Dewpoint



Activate Windows
Go to Settings to activate Windows.

Units: IP | Last Calculation: 3/14/2024

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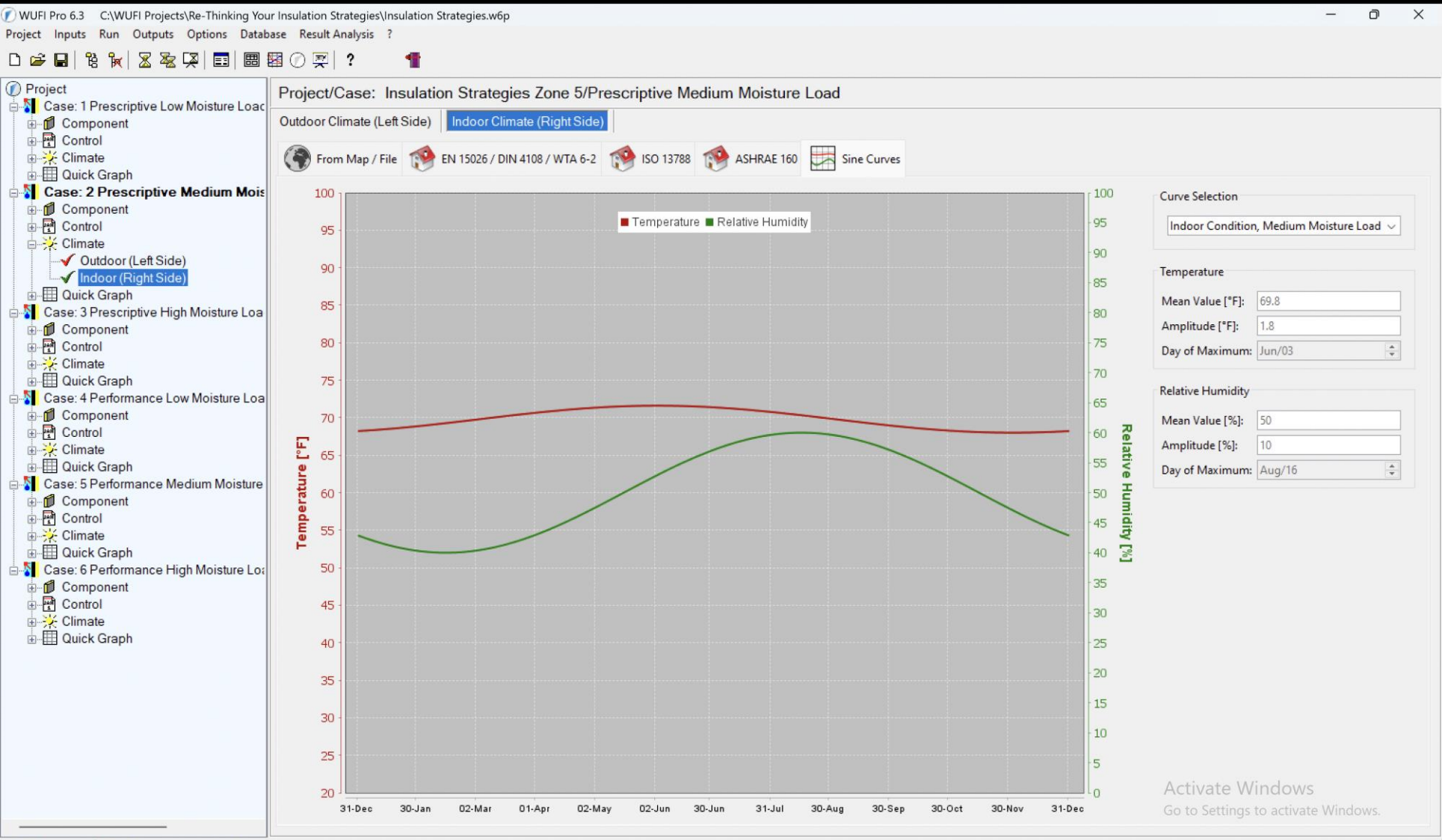
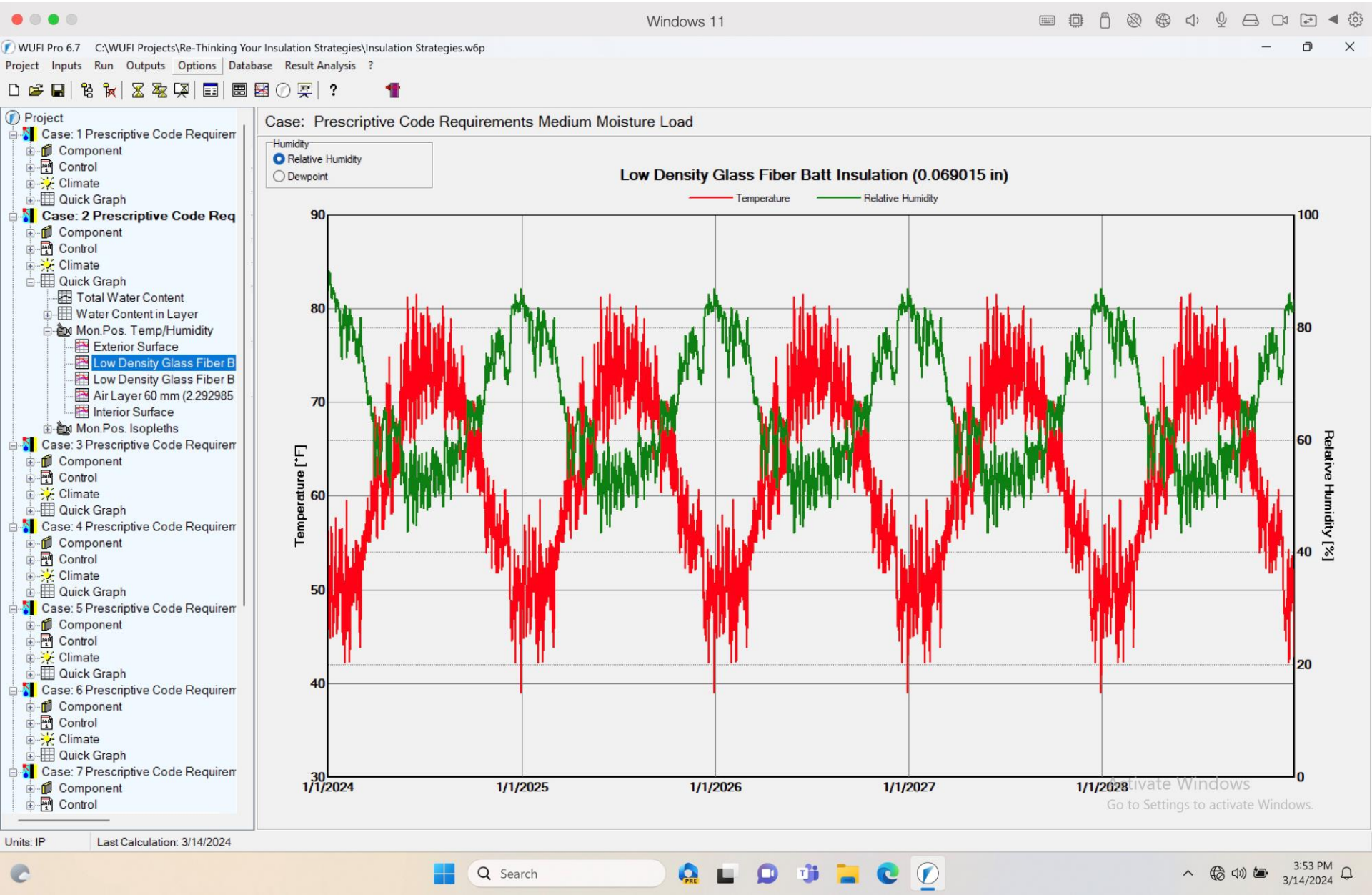
3/14/2024

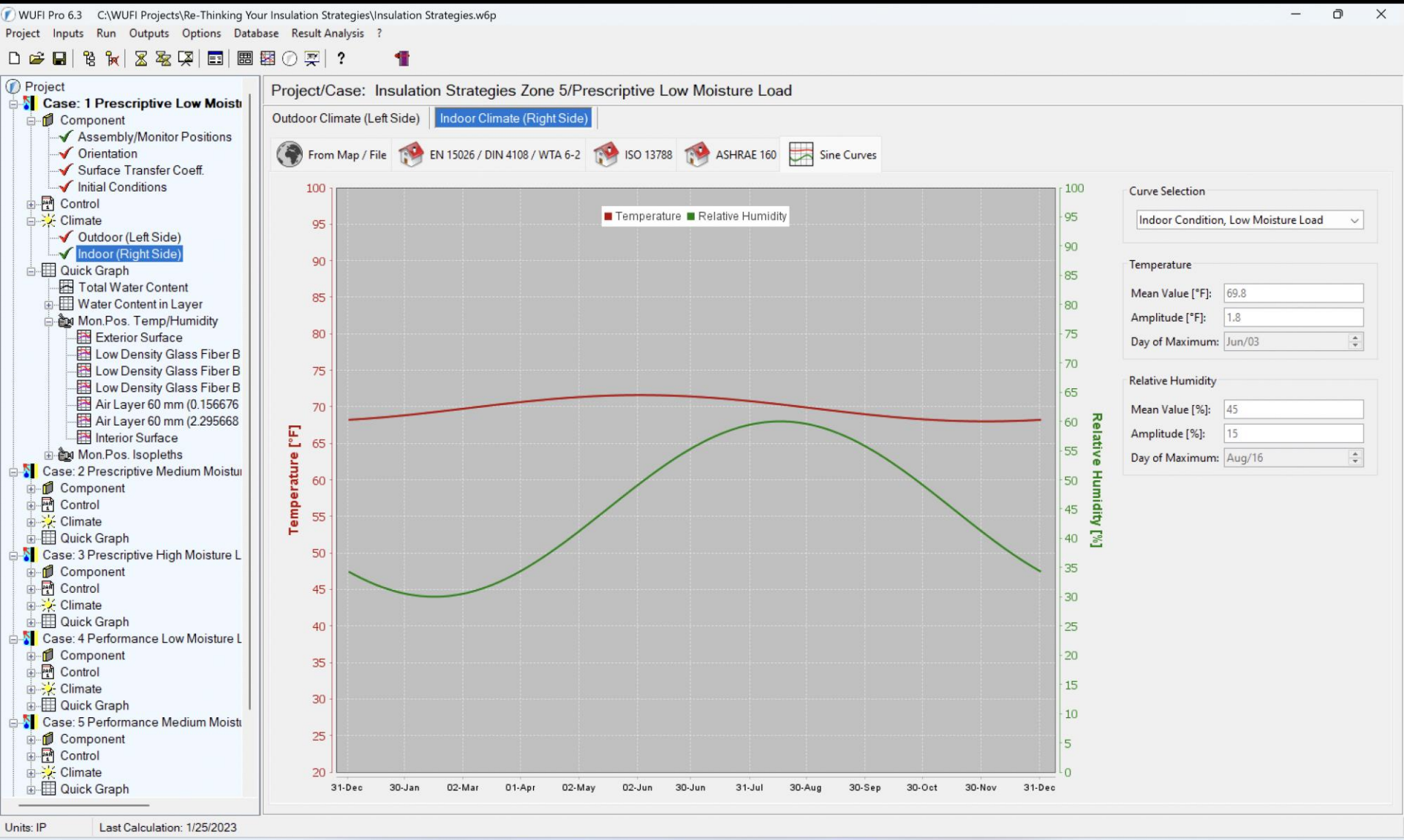
Prescriptive Requirements Medium Moisture Load



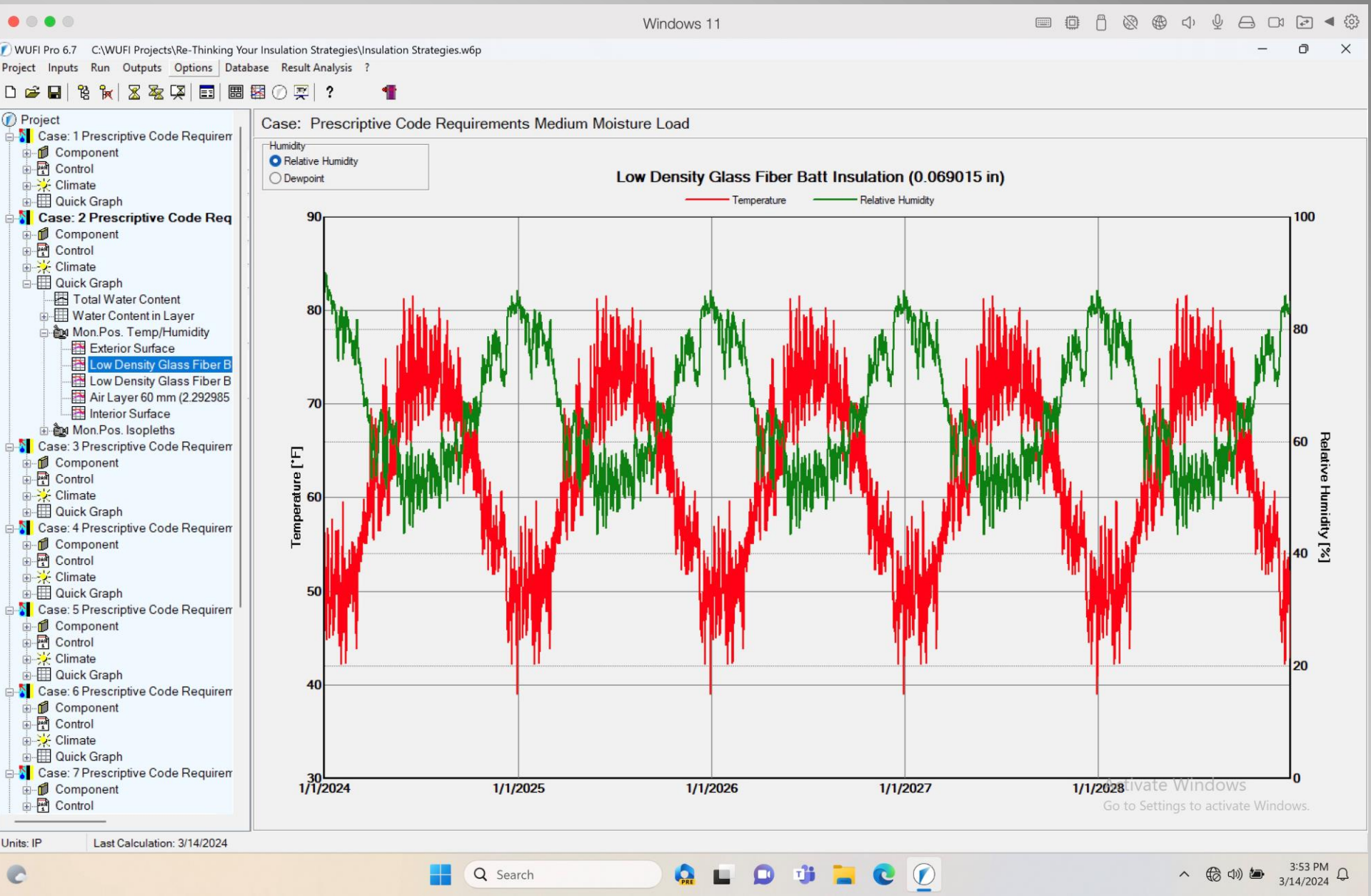
Prescriptive Requirements Medium Moisture Load



Prescriptive Requirements Low Moisture Load

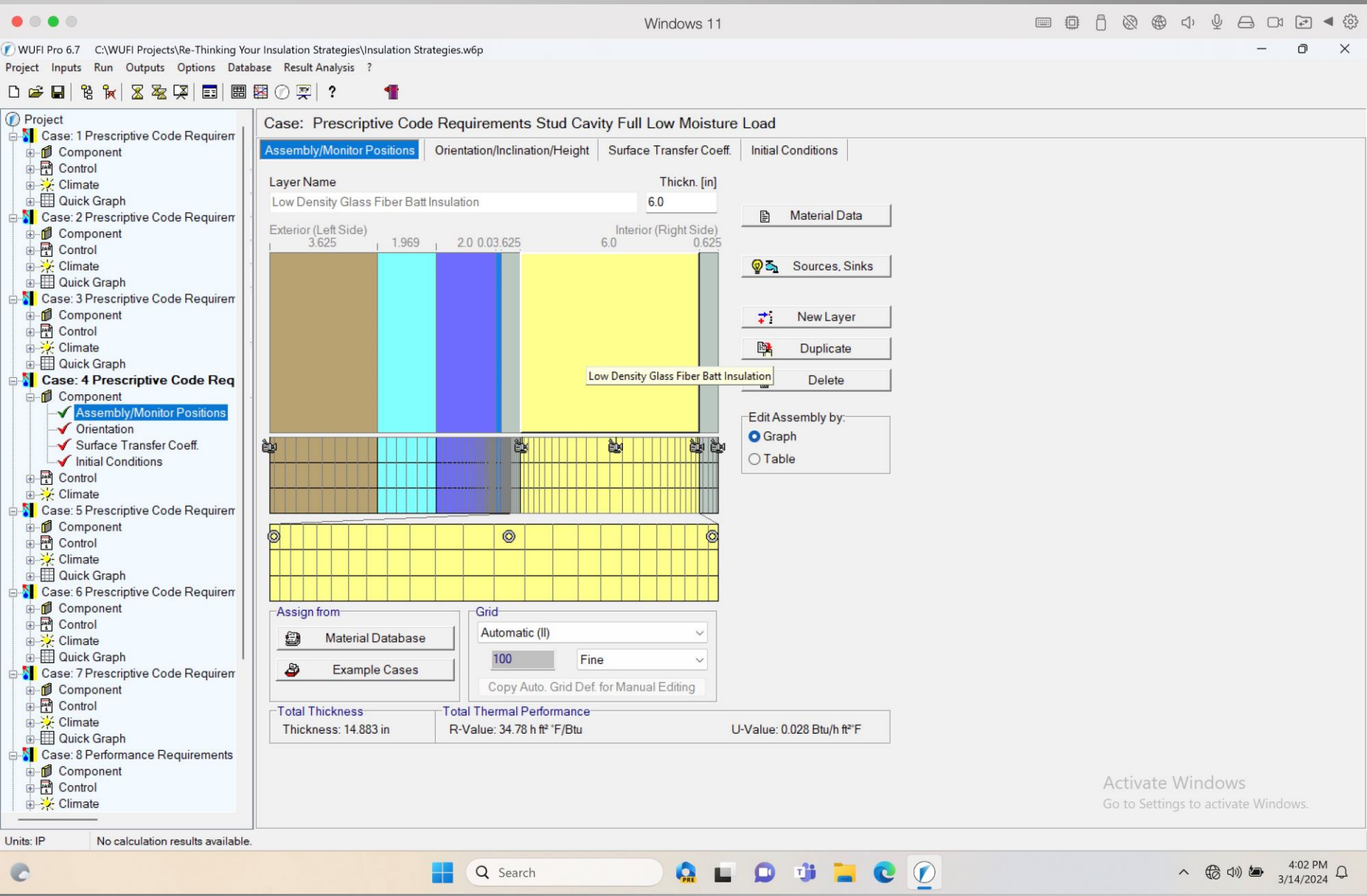


Prescriptive Requirements Low Moisture Load



More Is Not Always Better!!!

Fill The LGMF Cavity With Insulation



Fill The LGMF Cavity High Moisture Load

Windows 11

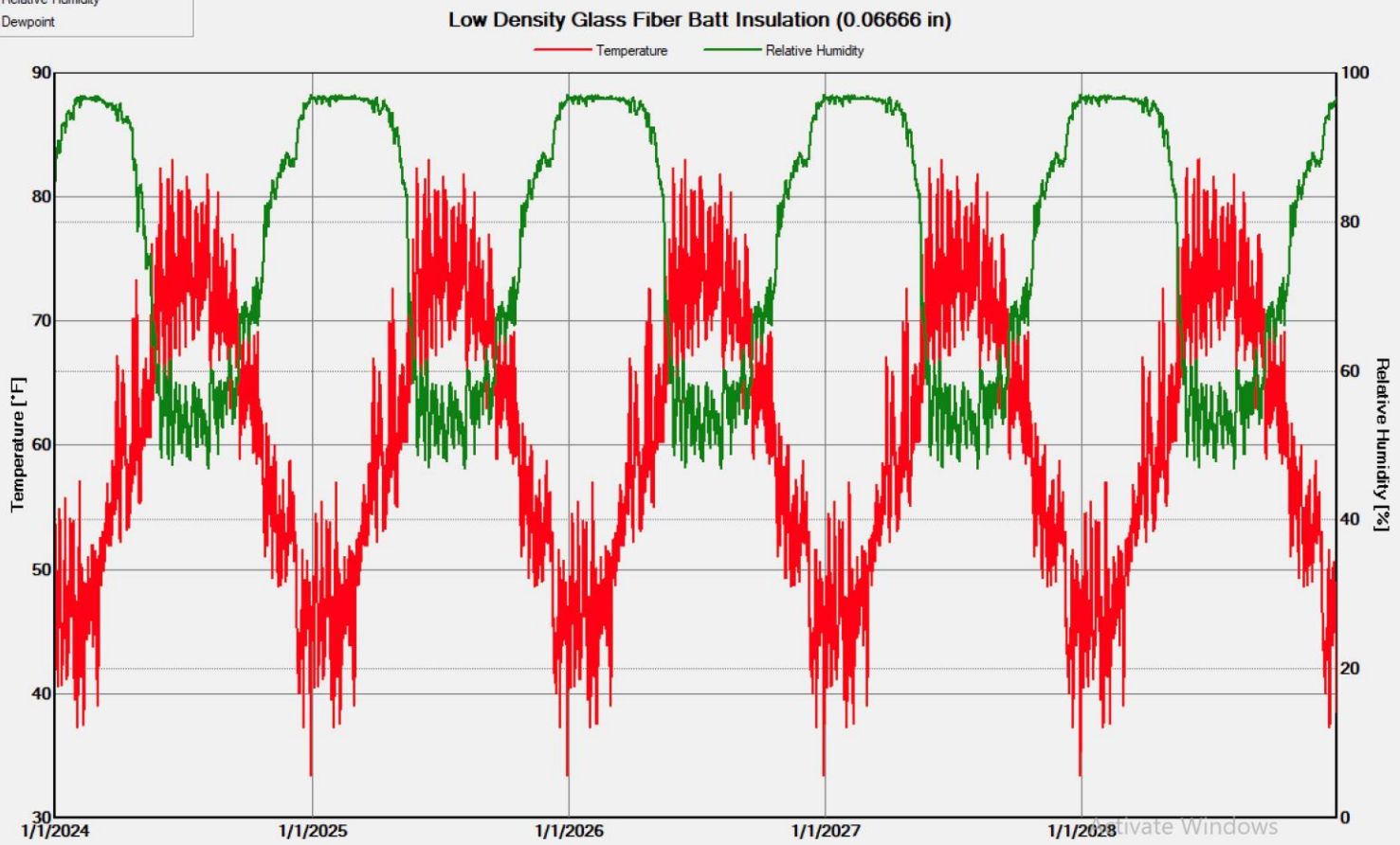
WUFI Pro 6.7 C:\WUFI Projects\Re-Thinking Your Insulation Strategies\Insulation Strategies.w6p

Project Inputs Run Outputs Options Database Result Analysis ?

- Project
  - Case: 1 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - Case: 2 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - Case: 3 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - Case: 4 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - Case: 5 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - **Case: 6 Prescriptive Code Req**
    - Component
      - Assembly/Monitor Positions
      - Orientation
      - Surface Transfer Coeff.
      - Initial Conditions
    - Control
    - Climate
    - Quick Graph
      - Total Water Content
      - Water Content in Layer
      - Mon.Pos. Temp/Humidity
        - Exterior Surface
        - Low Density Glass Fiber B
        - Low Density Glass Fiber B
        - Low Density Glass Fiber B
        - Interior Surface

Case: Prescriptive Code Requirements Stud Cavity Full High Moisture Load

Humidity
- (•) Relative Humidity
- ( ) Dewpoint



Units: IP | Last Calculation: 3/14/2024

Russell 2000 -1.96%

Search

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Fill The LGMF Cavity Medium Moisture Load

Windows 11

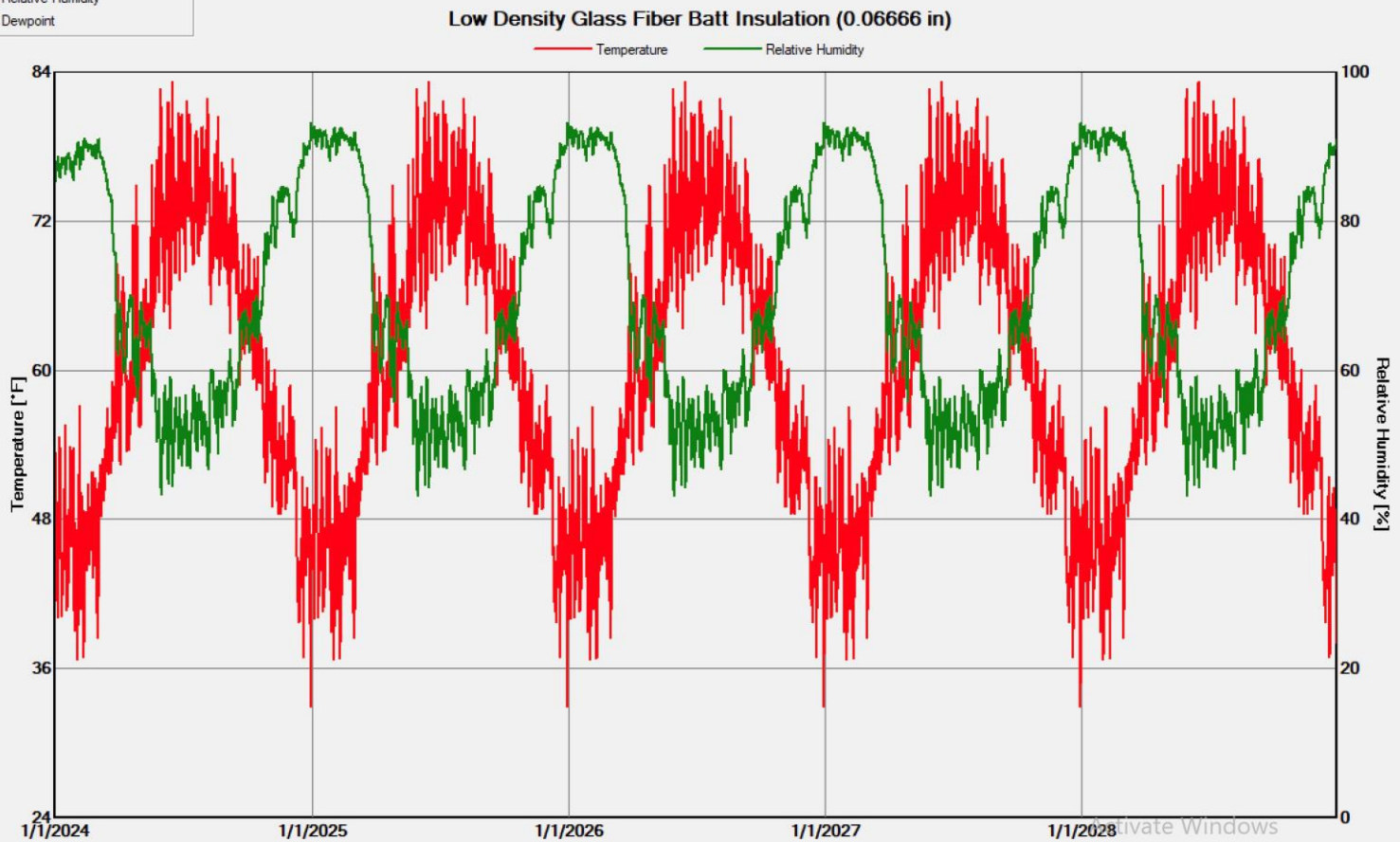
WUFI Pro 6.7 C:\WUFI Projects\Re-Thinking Your Insulation Strategies\Insulation Strategies.w6p

Project Inputs Run Outputs Options Database Result Analysis ?

- Project
  - Case: 1 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - Case: 2 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - Case: 3 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - Case: 4 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - **Case: 5 Prescriptive Code Req**
    - Component
    - Control
    - Climate
    - Quick Graph
      - Total Water Content
      - Water Content in Layer
      - Mon.Pos. Temp/Humidity
        - Exterior Surface
        - Low Density Glass Fiber B
        - Low Density Glass Fiber B
        - Low Density Glass Fiber B
        - Interior Surface
      - Mon.Pos. Isopleths
  - Case: 6 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - Case: 7 Prescriptive Code Requirem
    - Component
    - Control

Case: Prescriptive Code Requirements Stud Cavity Full Medium Moisture Load

Humidity
- (•) Relative Humidity
- ( ) Dewpoint



Activate Windows
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Fill The LGMF Cavity Low Moisture Load

Windows 11

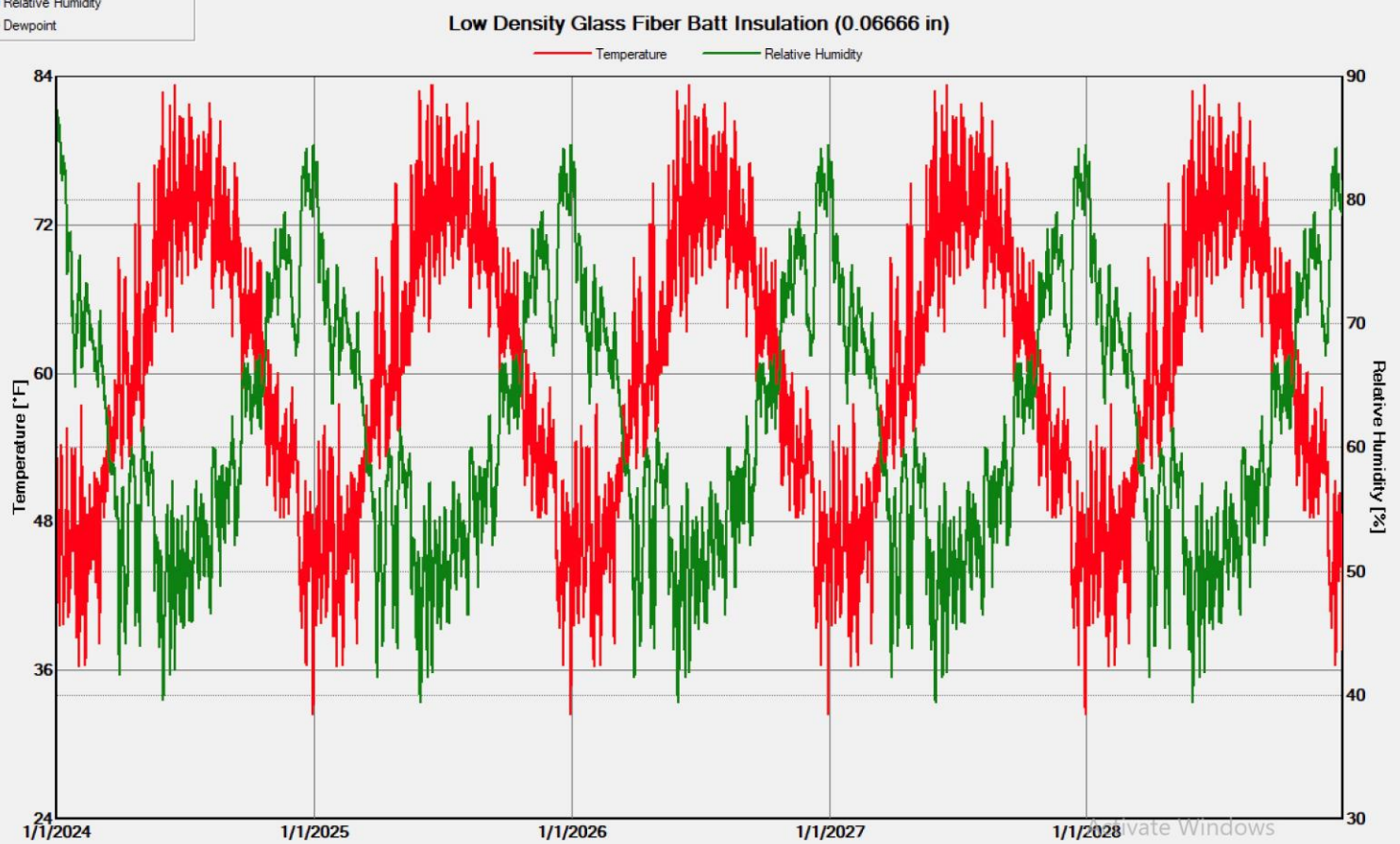
WUFI Pro 6.7 C:\WUFI Projects\Re-Thinking Your Insulation Strategies\Insulation Strategies.w6p

Project Inputs Run Outputs Options Database Result Analysis ?

- Project
  - Case: 1 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - Case: 2 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - Case: 3 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - **Case: 4 Prescriptive Code Req**
    - Component
      - Assembly/Monitor Positions
      - Orientation
      - Surface Transfer Coeff.
      - Initial Conditions
    - Control
    - Climate
    - Quick Graph
      - Total Water Content
      - Water Content in Layer
      - Mon.Pos. Temp/Humidity
        - Exterior Surface
        - Low Density Glass Fiber B
        - Low Density Glass Fiber B
        - Low Density Glass Fiber B
        - Interior Surface
      - Mon.Pos. Isopleths
  - Case: 5 Prescriptive Code Requirem
    - Component
    - Control
    - Climate
    - Quick Graph
  - Case: 6 Prescriptive Code Requirem
    - Component
    - Control
    - Climate

Case: Prescriptive Code Requirements Stud Cavity Full Low Moisture Load

Humidity
- (•) Relative Humidity
- ( ) Dewpoint



Activate Windows
Go to Settings to activate Windows.

Units: IP | Last Calculation: 3/14/2024

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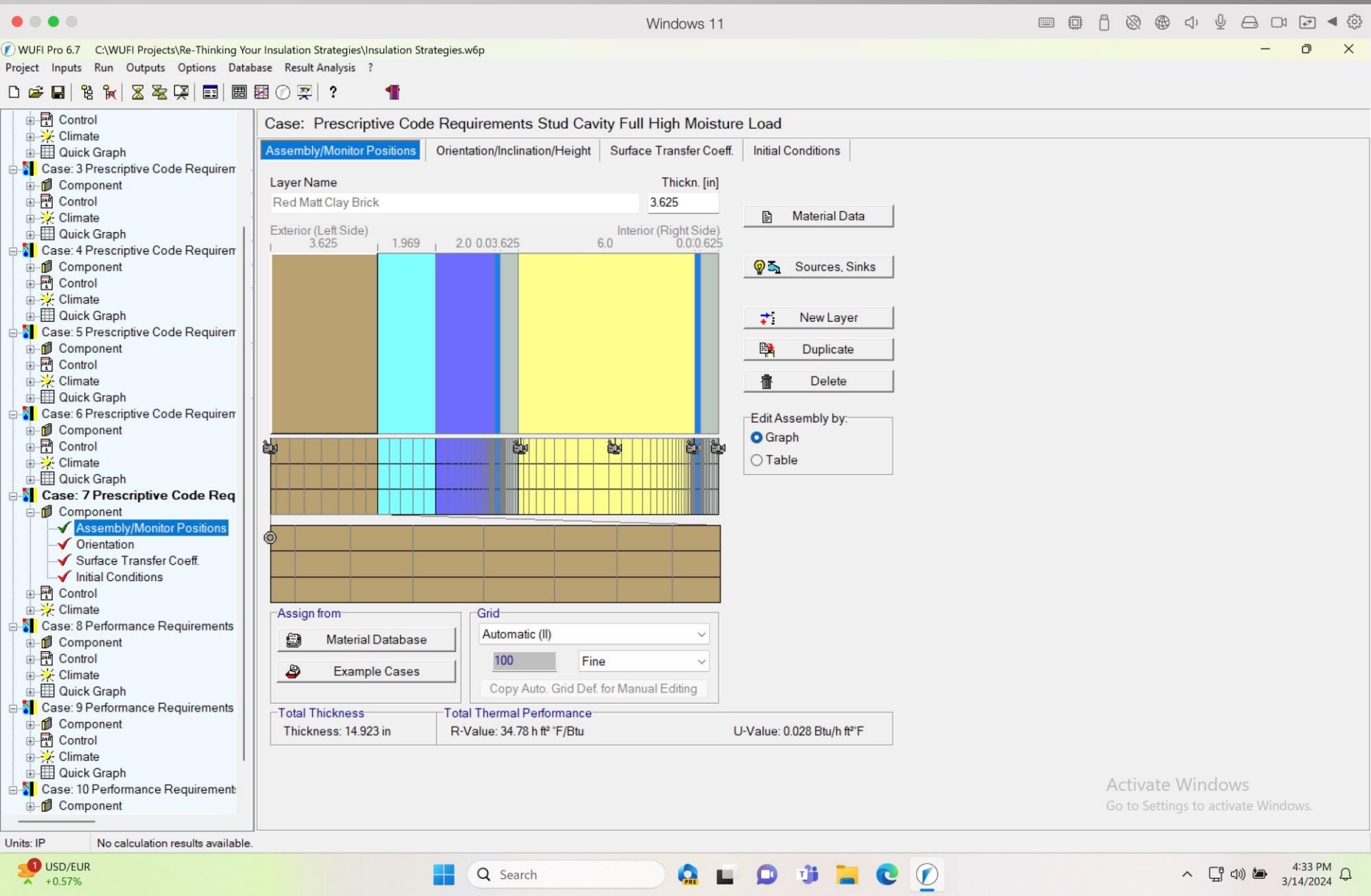
3/14/2024

Fill The LGMF Cavity Interior VB High Moisture Load



Fill The LGMF Cavity VB High Moisture Load

Windows 11

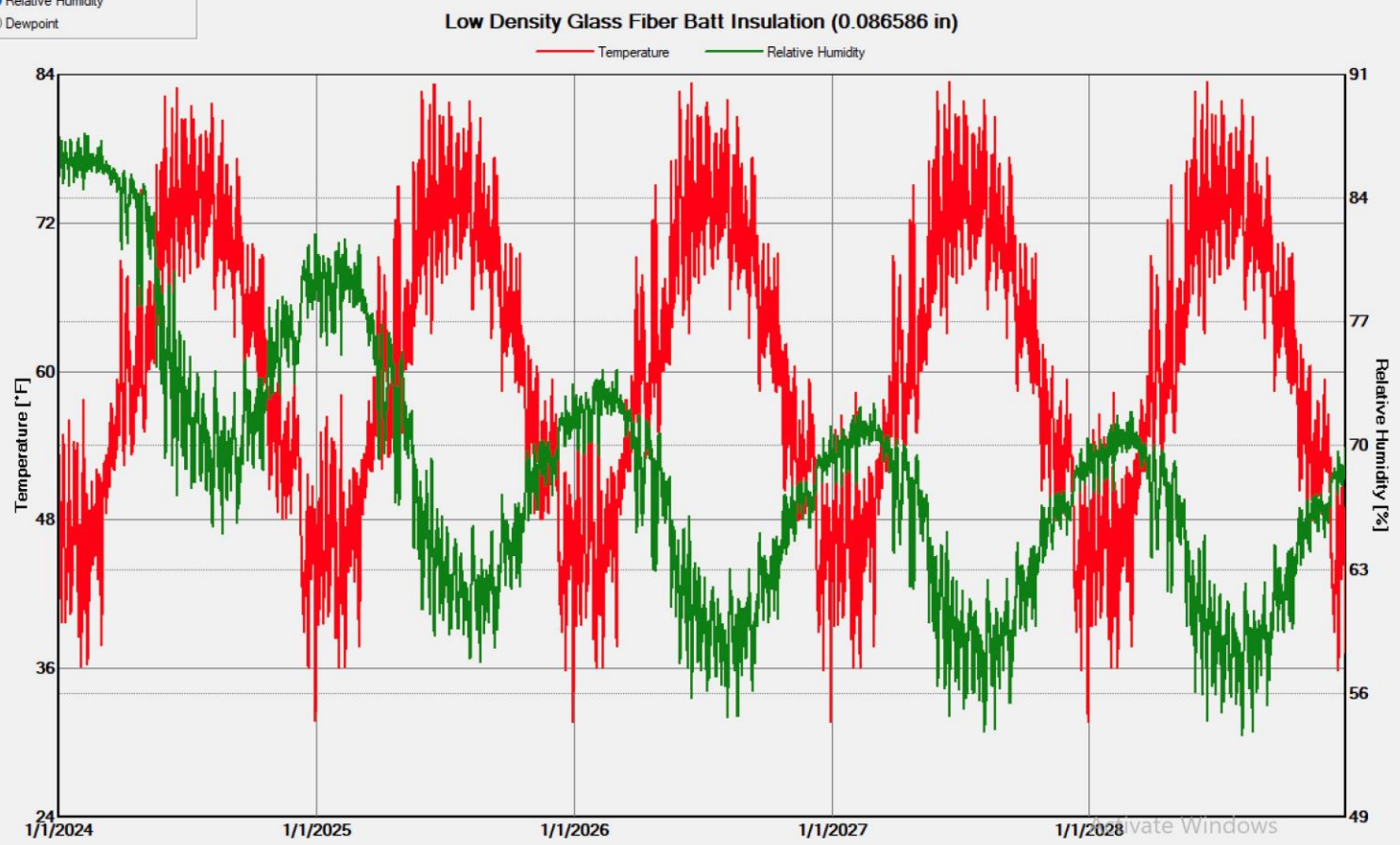
WUFI Pro 6.7 C:\WUFI Projects\Re-Thinking Your Insulation Strategies\Insulation Strategies.w6p

Project Inputs Run Outputs Options Database Result Analysis ?

- Control
- Climate
- Quick Graph
- Case: 3 Prescriptive Code Requirem
  - Component
  - Control
  - Climate
  - Quick Graph
- Case: 4 Prescriptive Code Requirem
  - Component
  - Control
  - Climate
  - Quick Graph
- Case: 5 Prescriptive Code Requirem
  - Component
  - Control
  - Climate
  - Quick Graph
- Case: 6 Prescriptive Code Requirem
  - Component
  - Control
  - Climate
  - Quick Graph
- **Case: 7 Prescriptive Code Req**
  - Component
  - Control
  - Climate
  - Quick Graph
    - Total Water Content
    - Water Content in Layer
    - Mon.Pos. Temp/Humidity
      - Exterior Surface
      - Low Density Glass Fiber B
      - Low Density Glass Fiber B
      - Low Density Glass Fiber B
      - Interior Surface
    - Mon.Pos. Isopleths
- Case: 8 Performance Requirements
  - Component
  - Control
  - Climate
  - Quick Graph
- Case: 9 Performance Requirements

Case: Prescriptive Code Requirements Stud Cavity Full High Moisture Load

Humidity
- (•) Relative Humidity
- ( ) Dewpoint



Units: IP Last Calculation: 3/14/2024

Breaking news Unfolding now

Search

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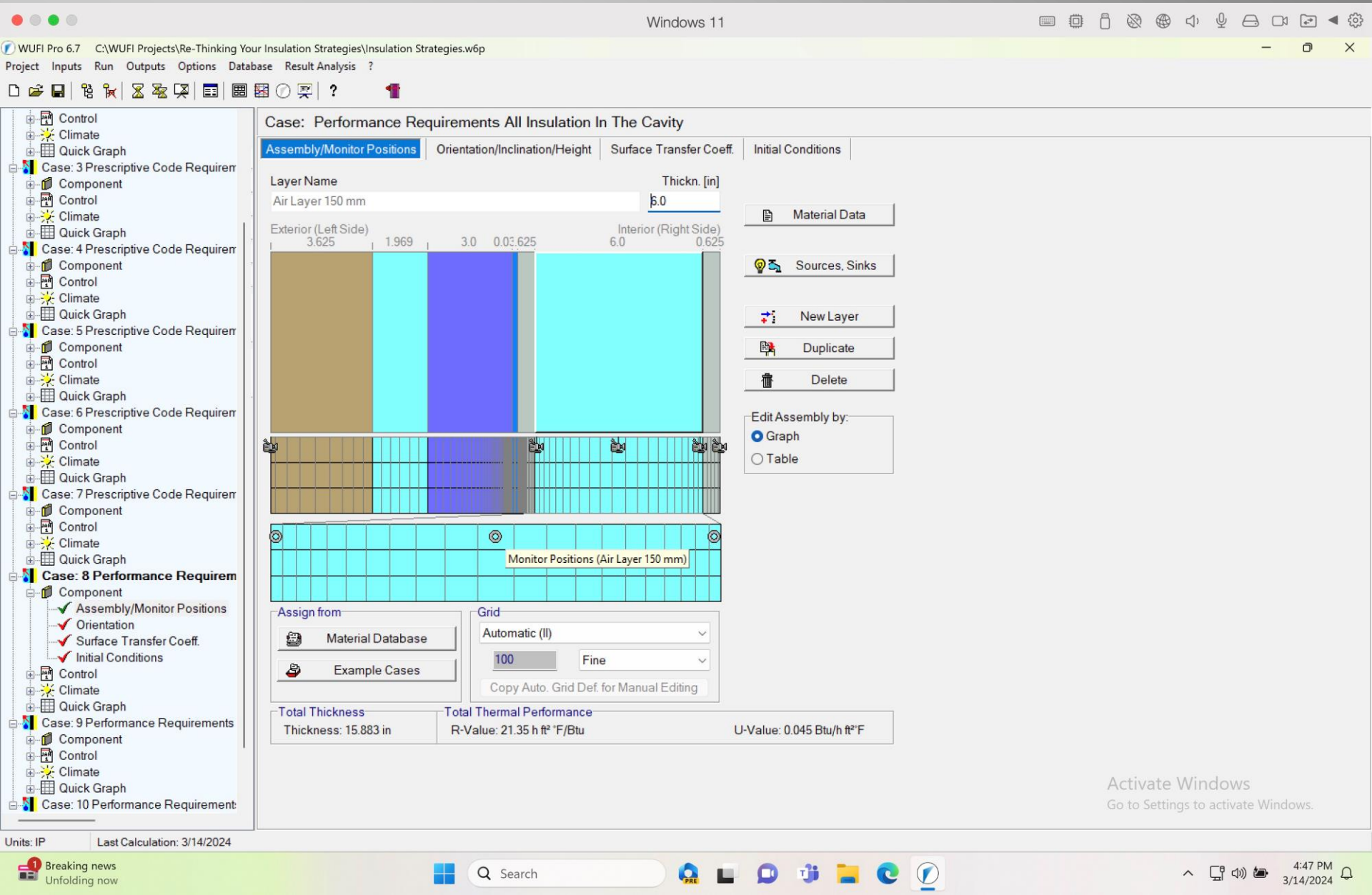
2021 IEC Requires R-18.18

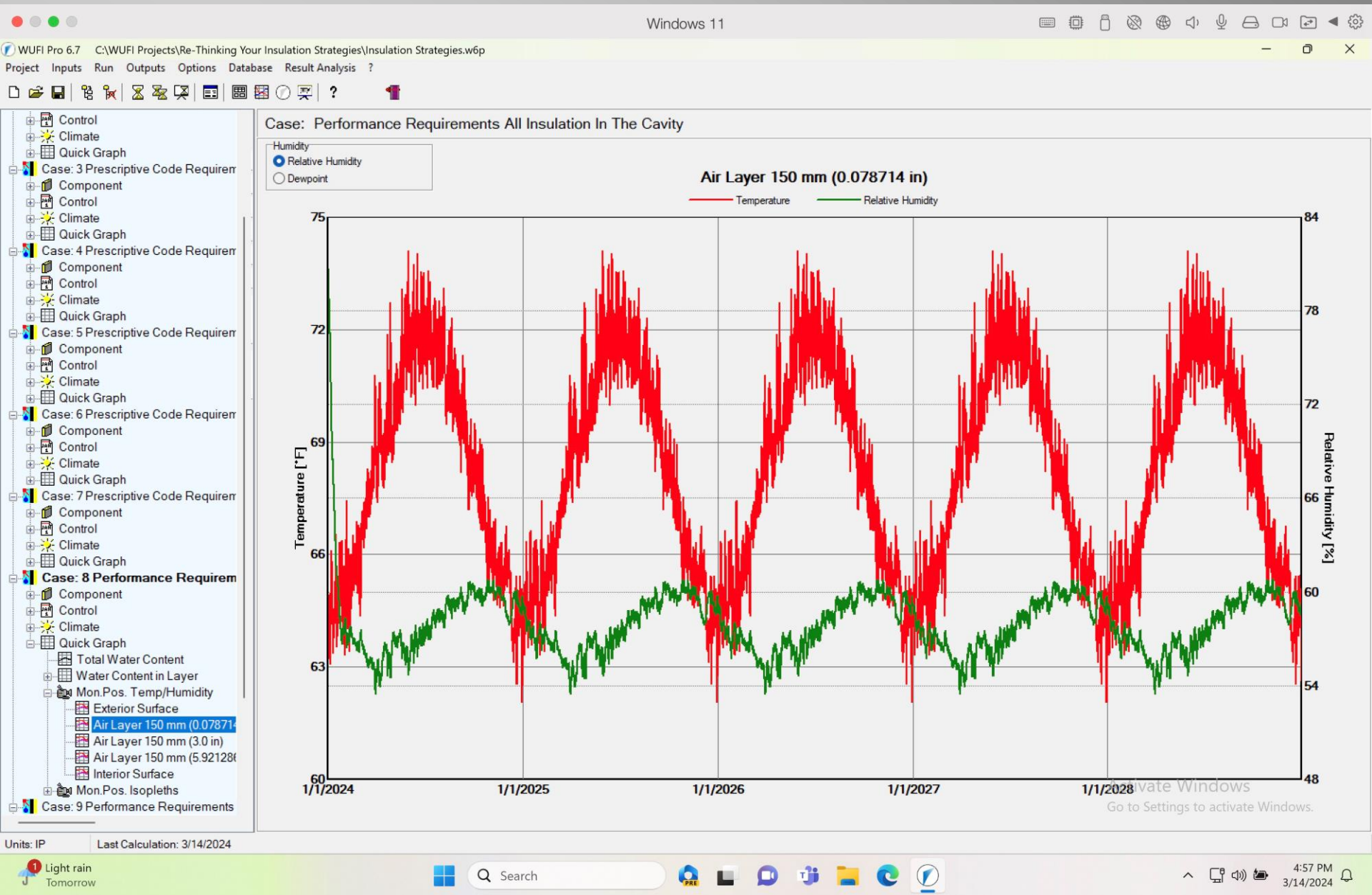
Exterior Air Film	**R-0.17**
Brick Veneer	**R-0.44**
Air Space	**R-1.0**
Insulation	**?????**
Air/Vapor Barrier	**0.00**
Sheathing	**0.56**
Metal Studs (air space)	**0.79**
Wallboard	**0.53**
Paint	**0.00**
Interior Air Film	**0.68**
Total Without Insulation	**4.17**

Insulation needs to be R-14.01 or better

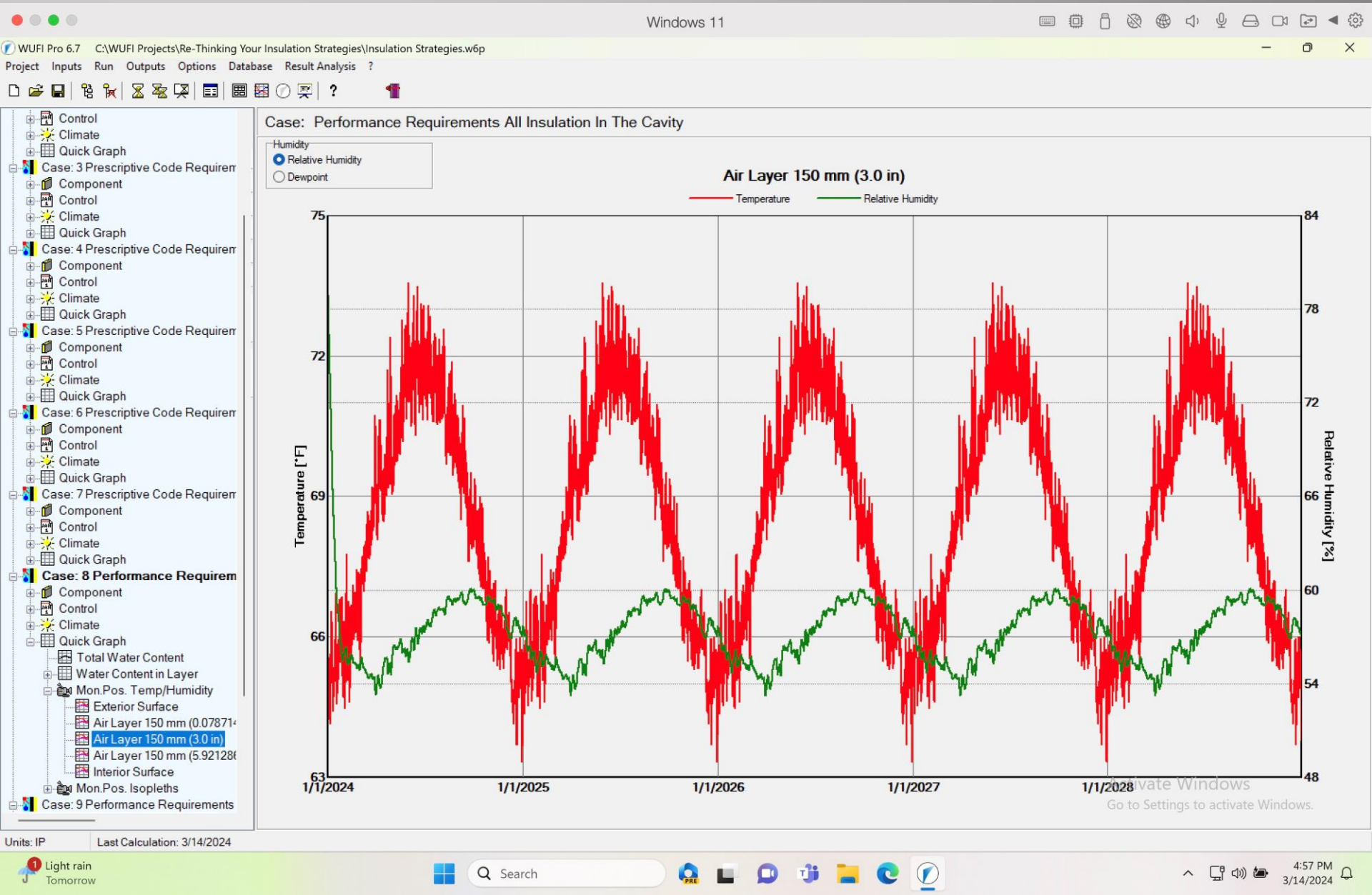
IEC Requires R-18.18



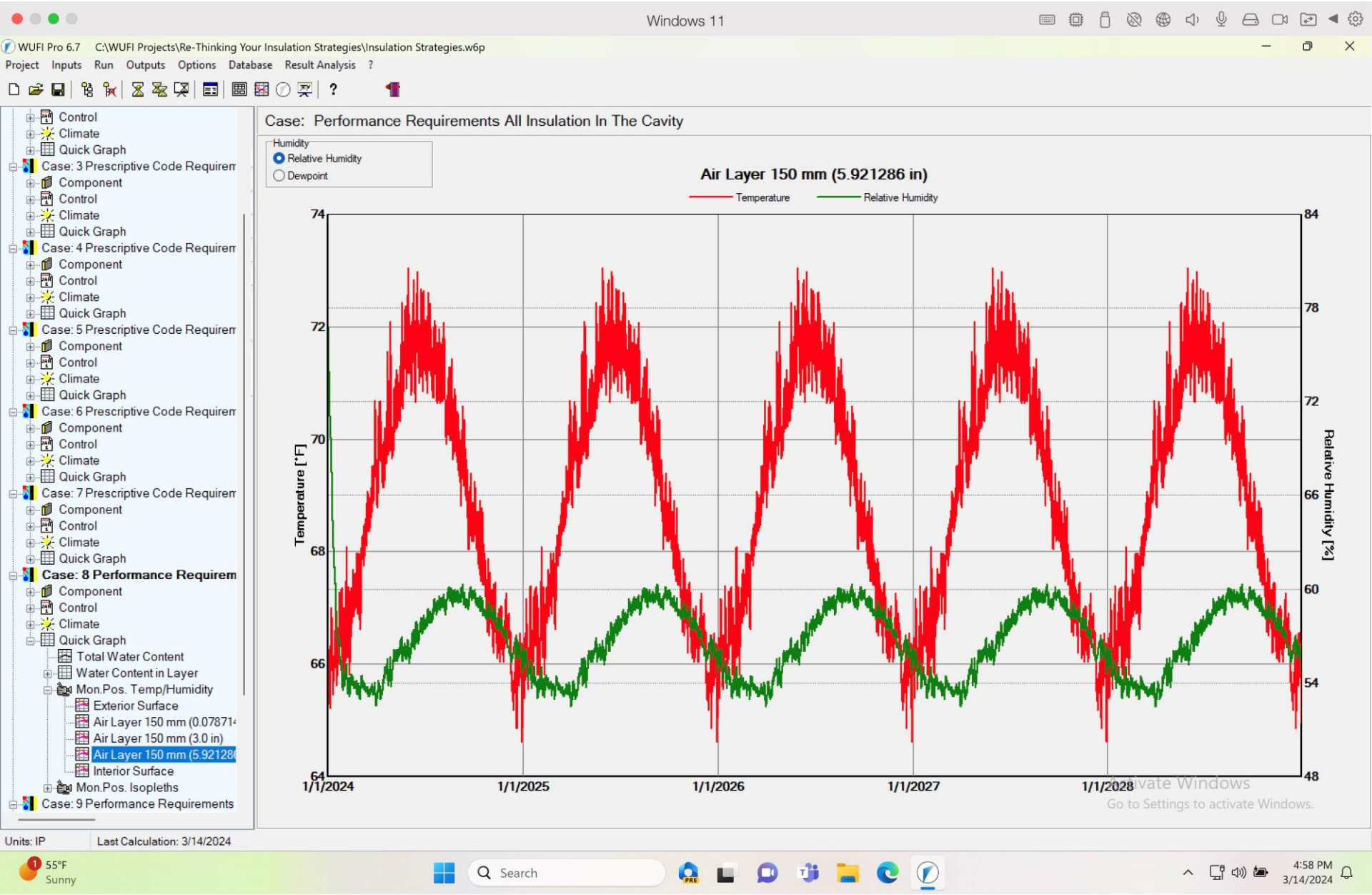
IEC Requires R-18.18



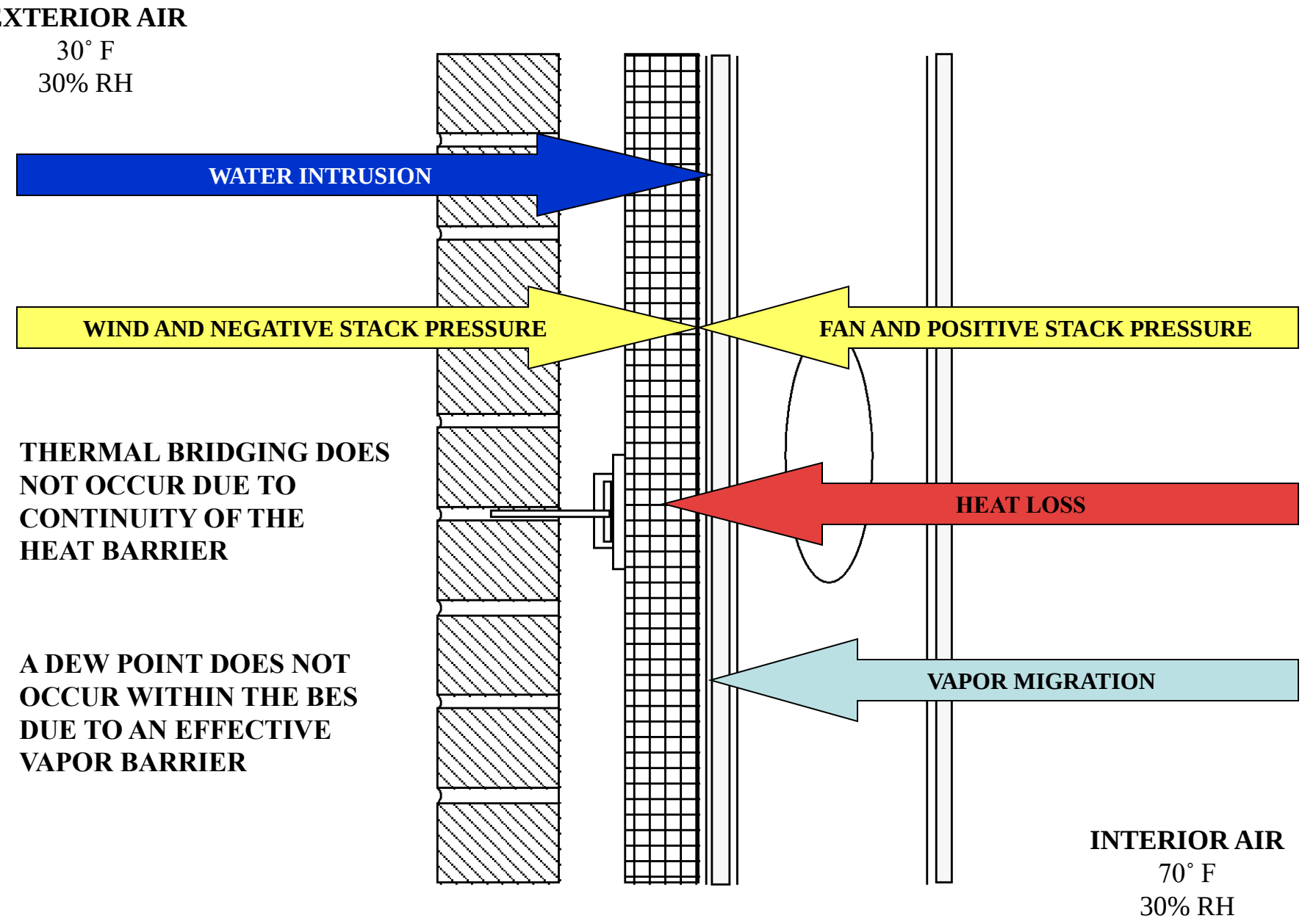
IECC Requires R-18.18



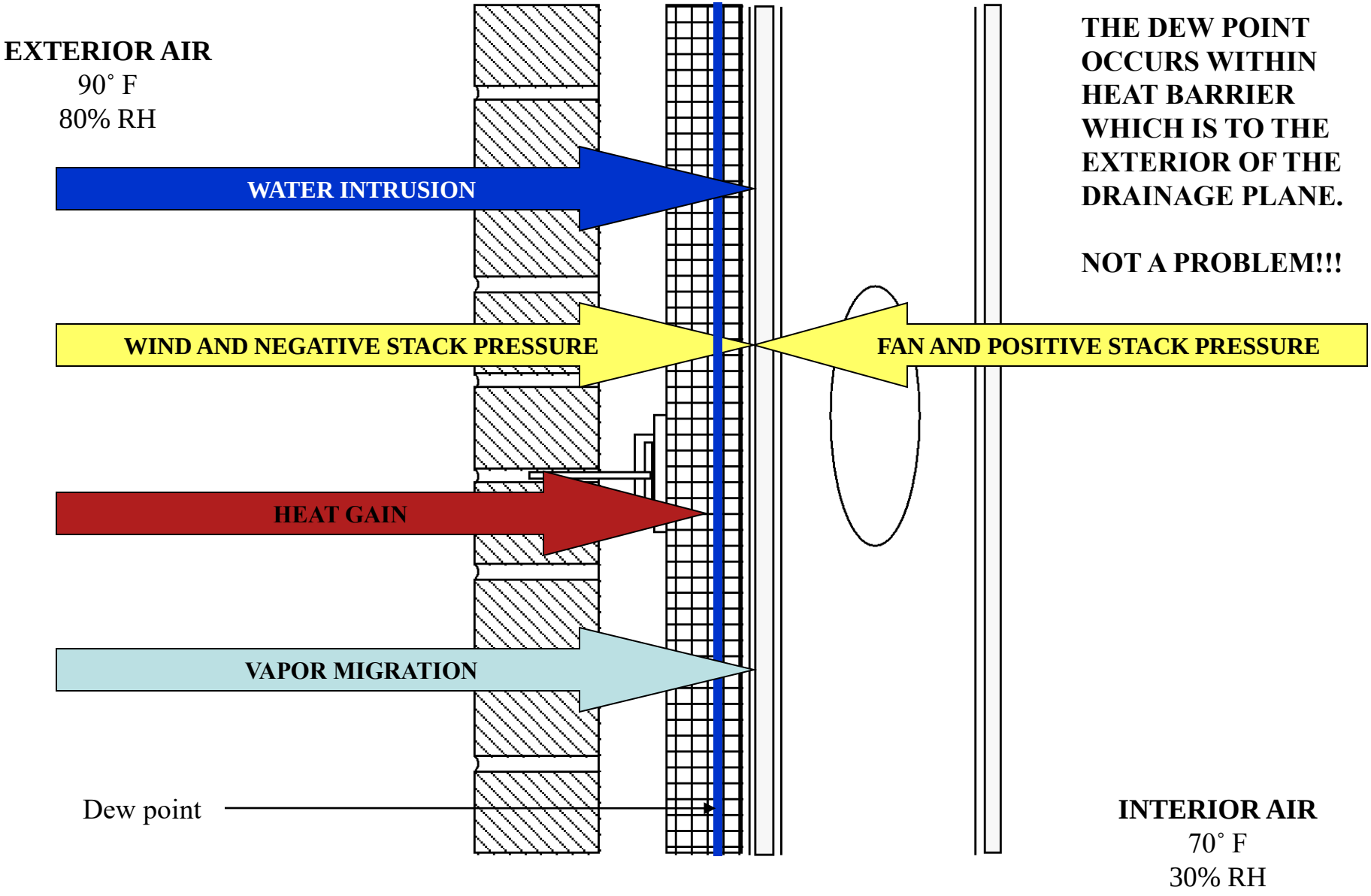
IEC Requires R-18.18



Cold Climate Air And Vapor Barrier System: Winter



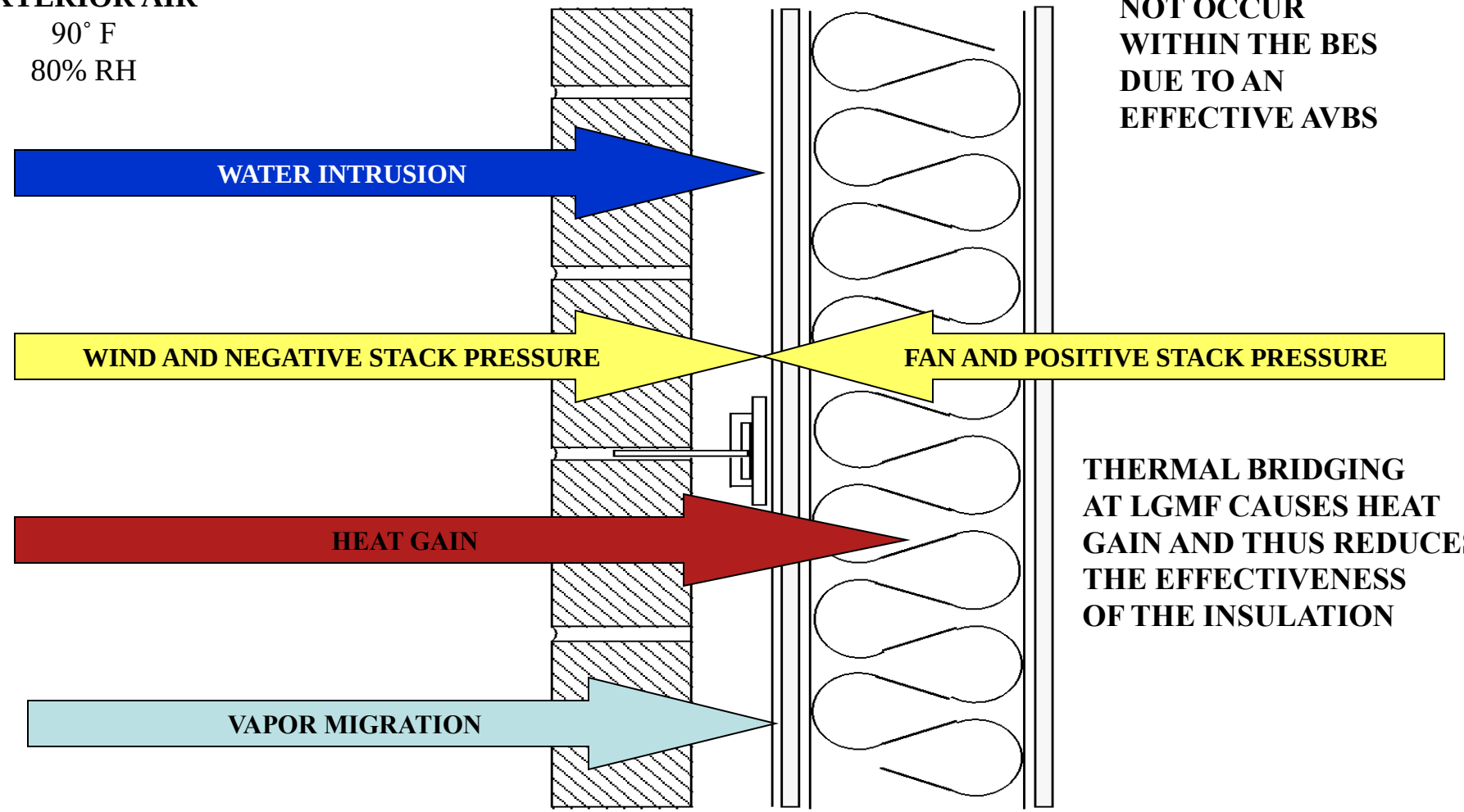
Cold Climate Air And Vapor Barrier System: Summer



Warm Climate Air And Vapor Barrier System

EXTERIOR AIR
90˚ F
80% RH

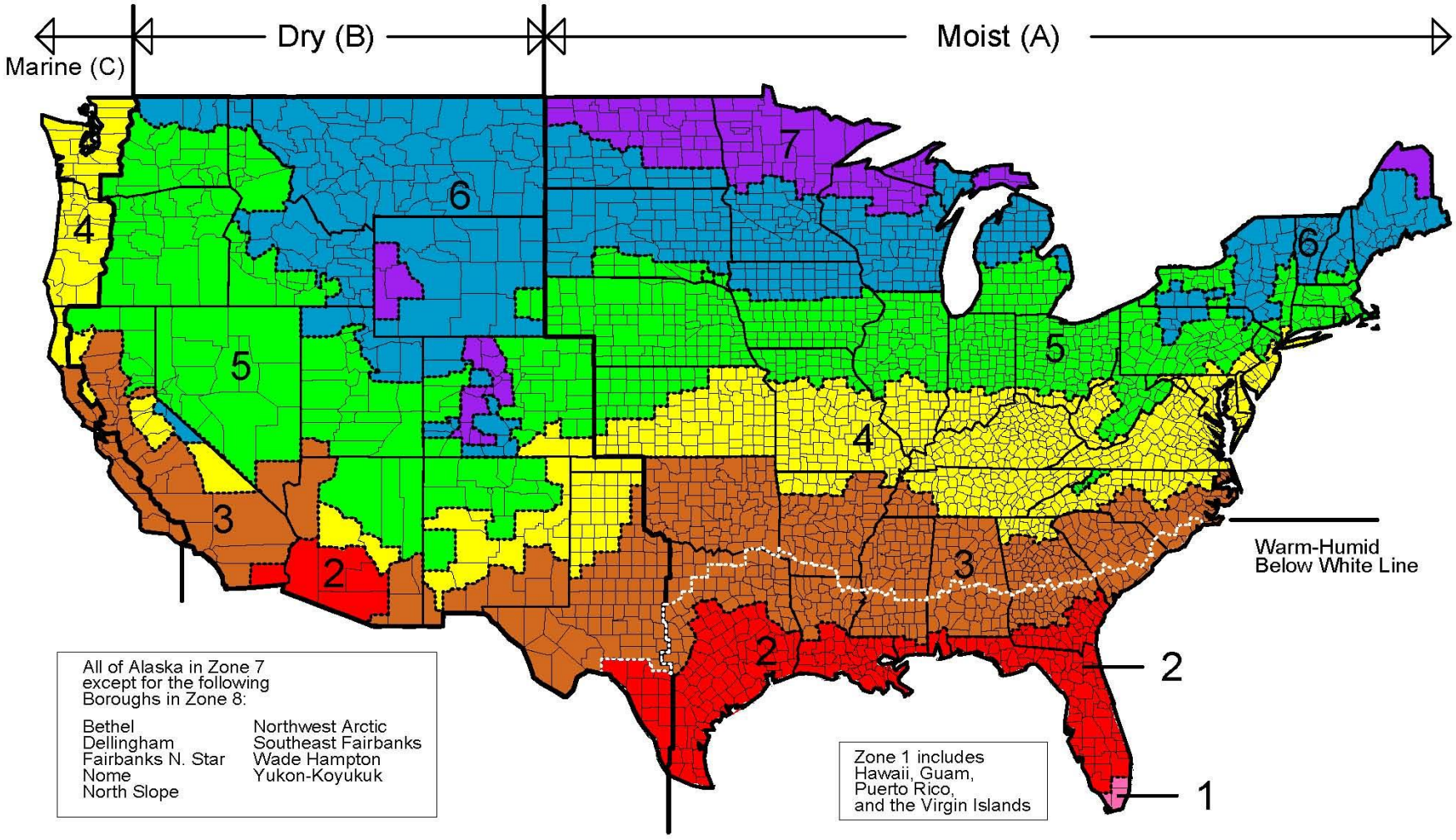
A DEW POINT DOES NOT OCCUR WITHIN THE BES DUE TO AN EFFECTIVE AVBS



THERMAL BRIDGING AT LGMF CAUSES HEAT GAIN AND THUS REDUCES THE EFFECTIVENESS OF THE INSULATION

INTERIOR AIR
70˚ F
30% RH

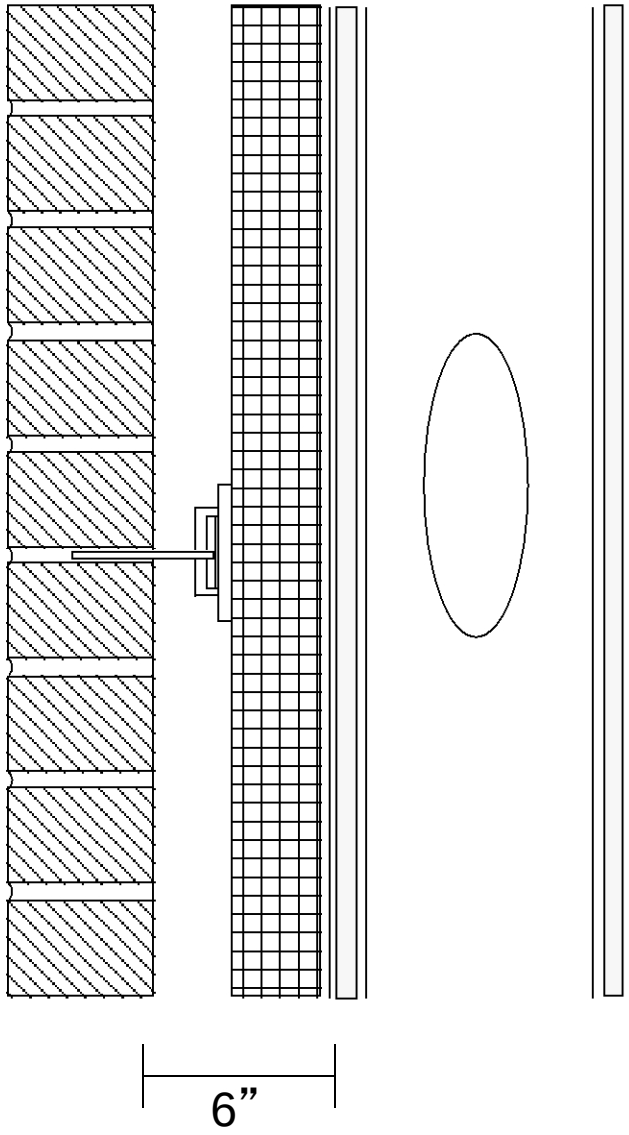
Map of DOE's Proposed Climate Zones



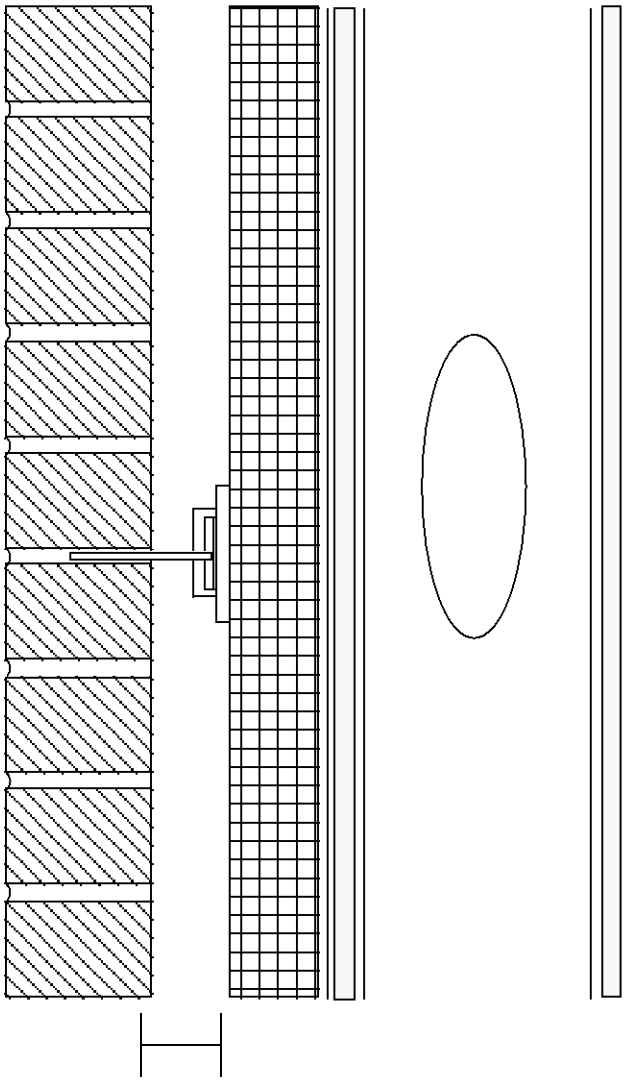
March 24, 2003

What We Can Do?

ACI 530



BIA Tech Notes



1” Minimum……..2” Recommended

SPF In Cavity

5” of 2 lb Density Closed-Cell SPF (R-7.1 / inch thickness)

= R-35.5 insulation layer

Leaves 1” cavity

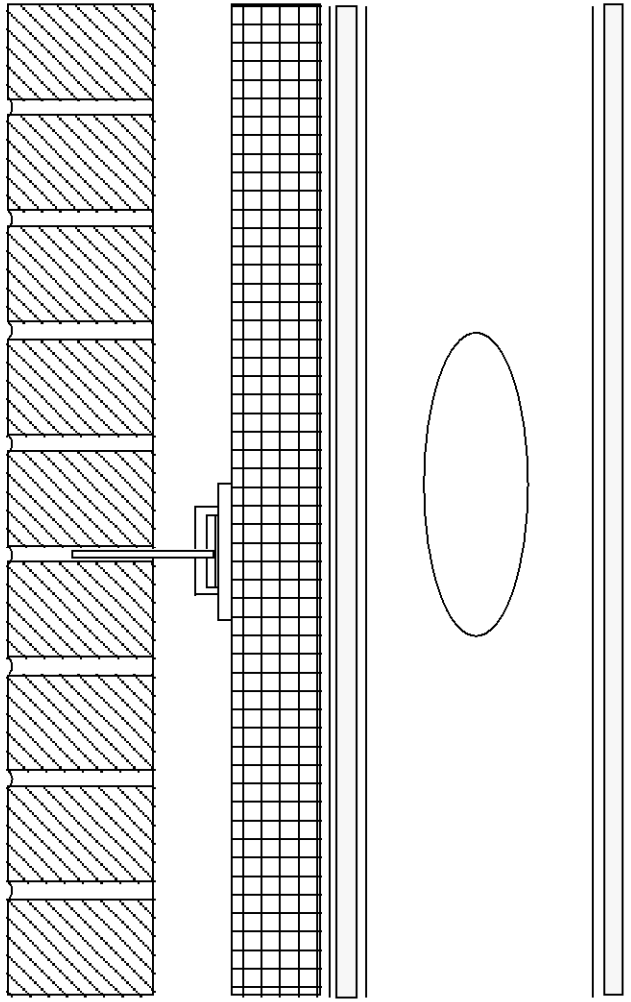
Assembly: R-39.67

<u>Code Requirements:</u>

2021 IEC: R-18.18

90.1 2019: R-18.18

MA Stretch Code: R-24



Good applicators can control the thickness

Polyisocyanurate In Cavity

5” polyiso in cavity
(R-6.5 / inch thickness)

= R-32.5 insulation layer

Leaves 1” cavity

Multiple layer installation
(2” + 3“)

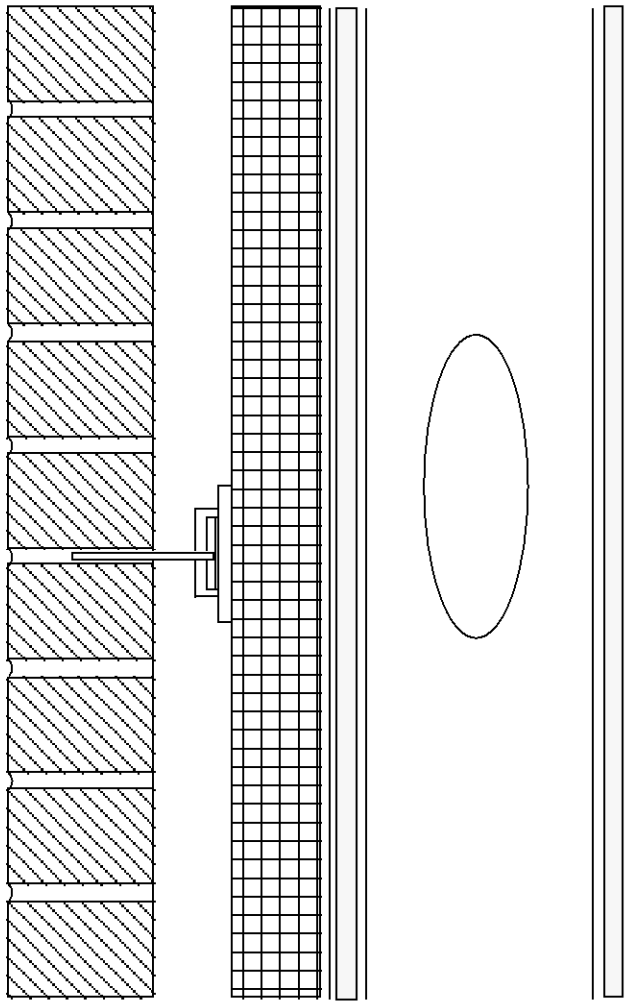
Assembly: R-36.67

<u>Code Requirements:</u>

2021 IEC: R-18.18

90.1 2019: R-18.18

MA Stretch Code: R-24



XPS In Cavity

5” XPS in cavity
(R-5 / inch thickness)

= R-25 insulation layer

Leaves 1” cavity

Multiple layer installation
(2” + 3“)

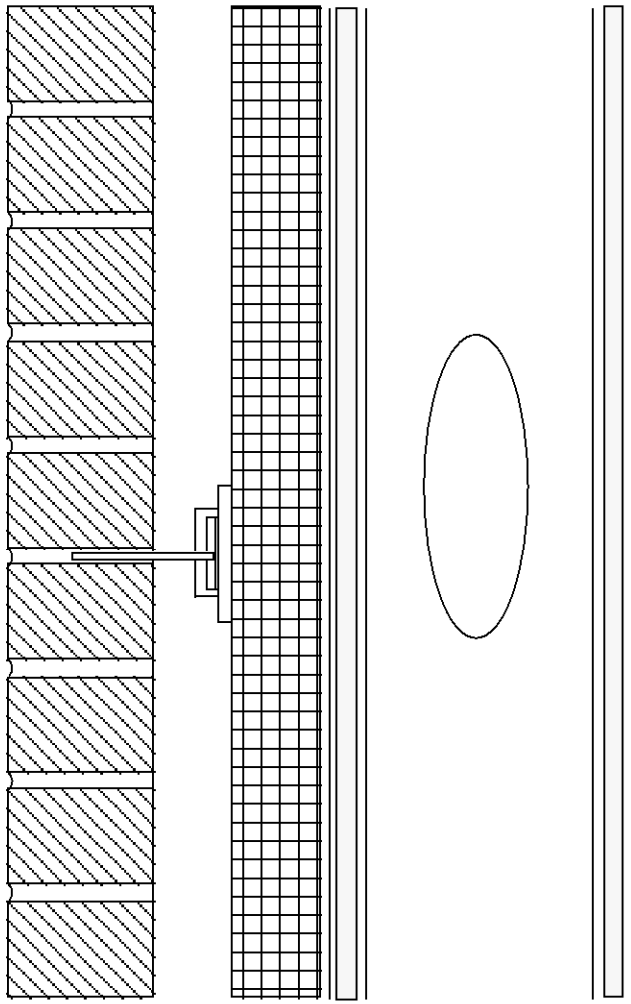
Assembly: R-29.17

<u>Code Requirements:</u>

2021 IEC: R-18.18

90.1 2019: R-18.18

MA Stretch Code: R-24



Rock or Mineral Wool In Cavity

5” mineral wool in cavity
(R-4.2 / inch thickness)

= R-21 insulation layer

Leaves 1” cavity

Multiple layer installation

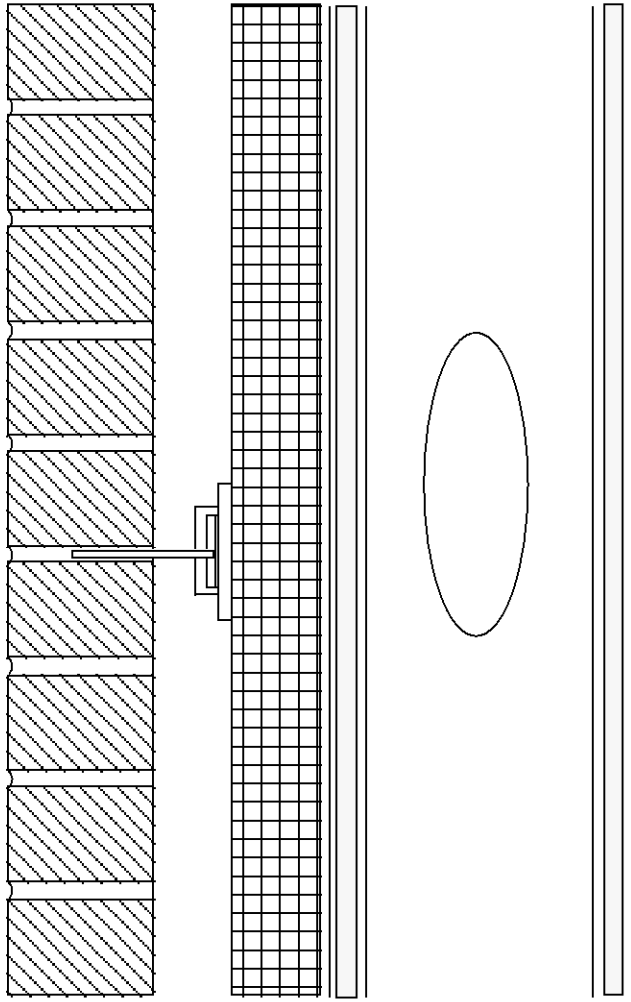
Assembly: R-25.17

<u>Code Requirements:</u>

2021 IEC: R-18.18

90.1 2019: R-18.18

MA Stretch Code: R-24



EPS In Cavity

5” EPS in cavity
(R-4 / inch thickness)

= R-20 insulation layer

Leaves 1” cavity

Multiple layer installation
(2” + 3”)

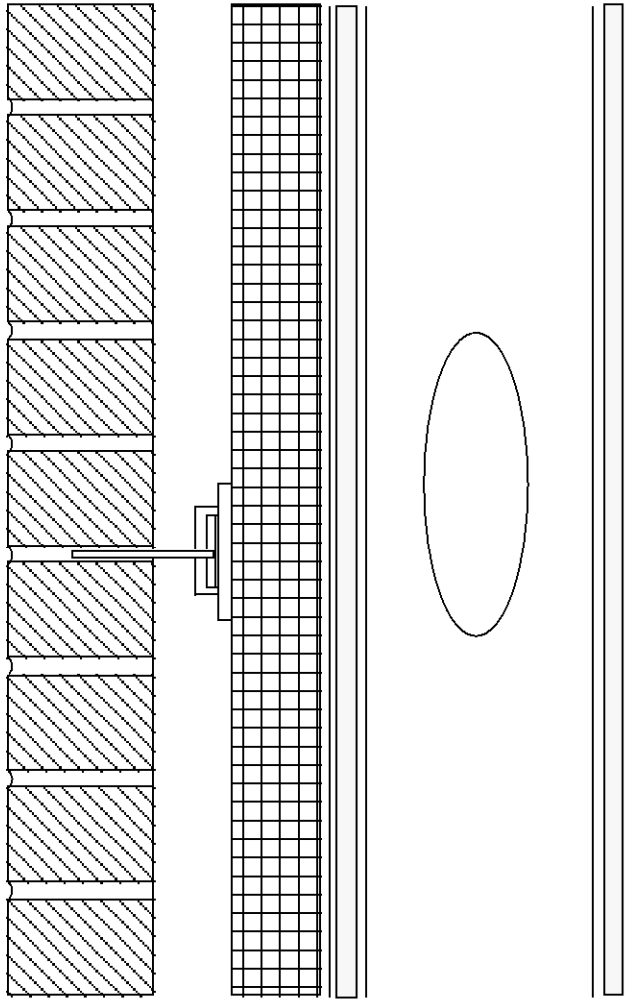
Assembly: R-24.17

<u>Code Requirements:</u>

2021 IEC: R-18.18

90.1 2019: R-18.18

MA Stretch Code: R-24



Precast Concrete Panel Veneer

https://exo-tec.biz/insulating-precast-walls/

Existing Multi-Wythe Masonry Walls

https://buildingscience.com/documents/bareports/ba-1105-internal-insulation-masonry-walls-final-measure-guideline/view


questions?

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