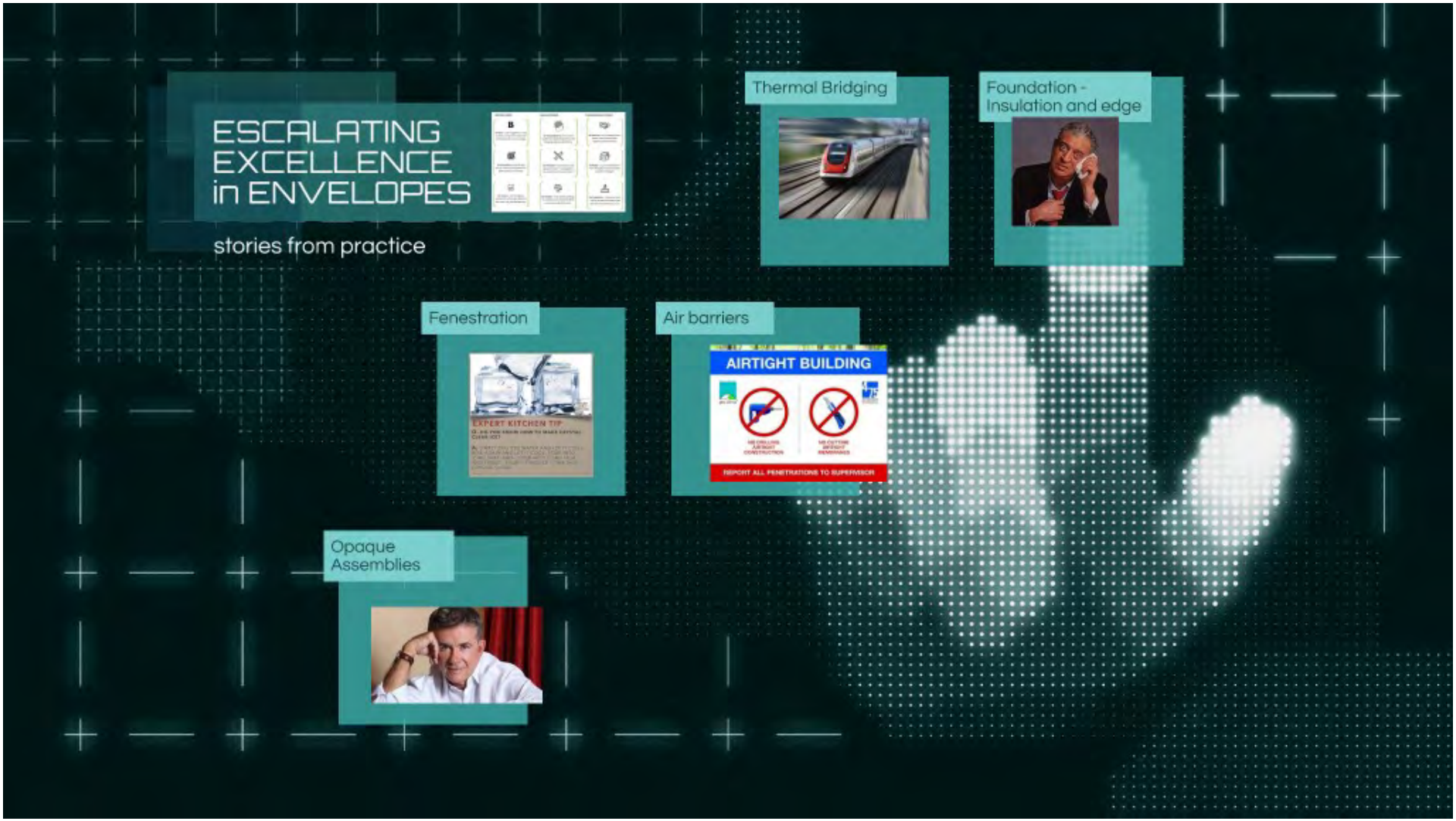
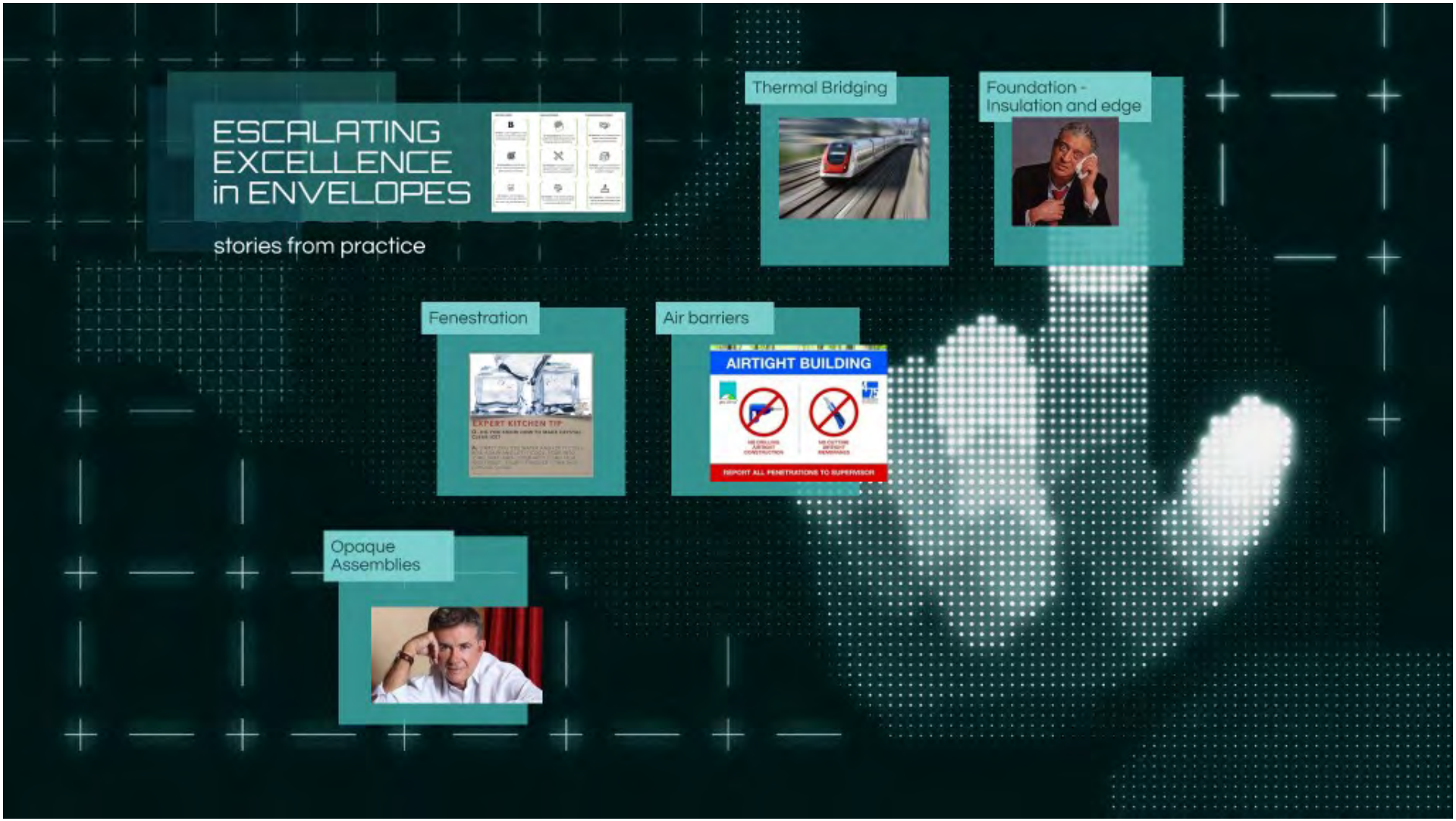

ESCALATING
EXCELLENCE
in ENVELOPES
stories from practice
Thermal Bridging
Foundation -
Insulation and edge
Fenestration
EXPERT KITCHEN TIP
Air barriers
AIRTIGHT BUILDING
REPORT ALL PENETRATIONS TO SUPERVISOR
Opaque
Assemblies

| Attitude Habits | Expertise Habits | Interdependence Habits |
| --- | --- | --- |
| **B**<br>**Be Bold** – make suggestions, bring up ideas, and set fear aside when confronted with new knowledge. |  <br>**Be Knowledgeable** –this is about wisdom and applied experience and knowing what you don't know. |  <br>**Be Inclusive** –each design problem shows us that systems work together; people included. |
|  <br>**Be Committed** –keep the long view in mind and base decisions on getting closer, consistently. |  <br>**Be Innovative** –don't rest on what always has been – what applies to this moment and how do we do it? |  <br>**Be Ready** – you must be ready for many changes and also not berate yourself in hindsight. |
|  <br>**Be Curious** – a list of stagnant questions is not enough, delve into the whys, why-nots and the how. |  <br>**Be Realistic** – limits define creativity, so understand and accept the limits so you can excel within them. |  <br>**Be Celebratory** – thank your team, hold up success for others to see and love the moment you are in. |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Assemblies

# Opaque Assemblies

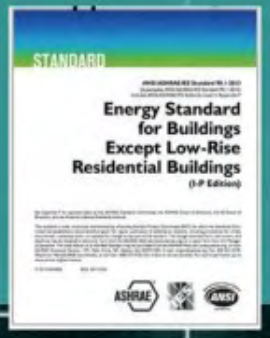
# Don't be Thick(e) about it...

The Code says...
Choose, identify your choice, and comply with:

The Code Book:
ASHRAE or IECC (or State Code as Applicable)

Compliance Path:

- Prescriptive R-Value
- Prescriptive U, C and F factor
- Component Trade-off (COMcheck or REScheck)
- Performance (modeling)





Issues

Examples

Skills/Tips

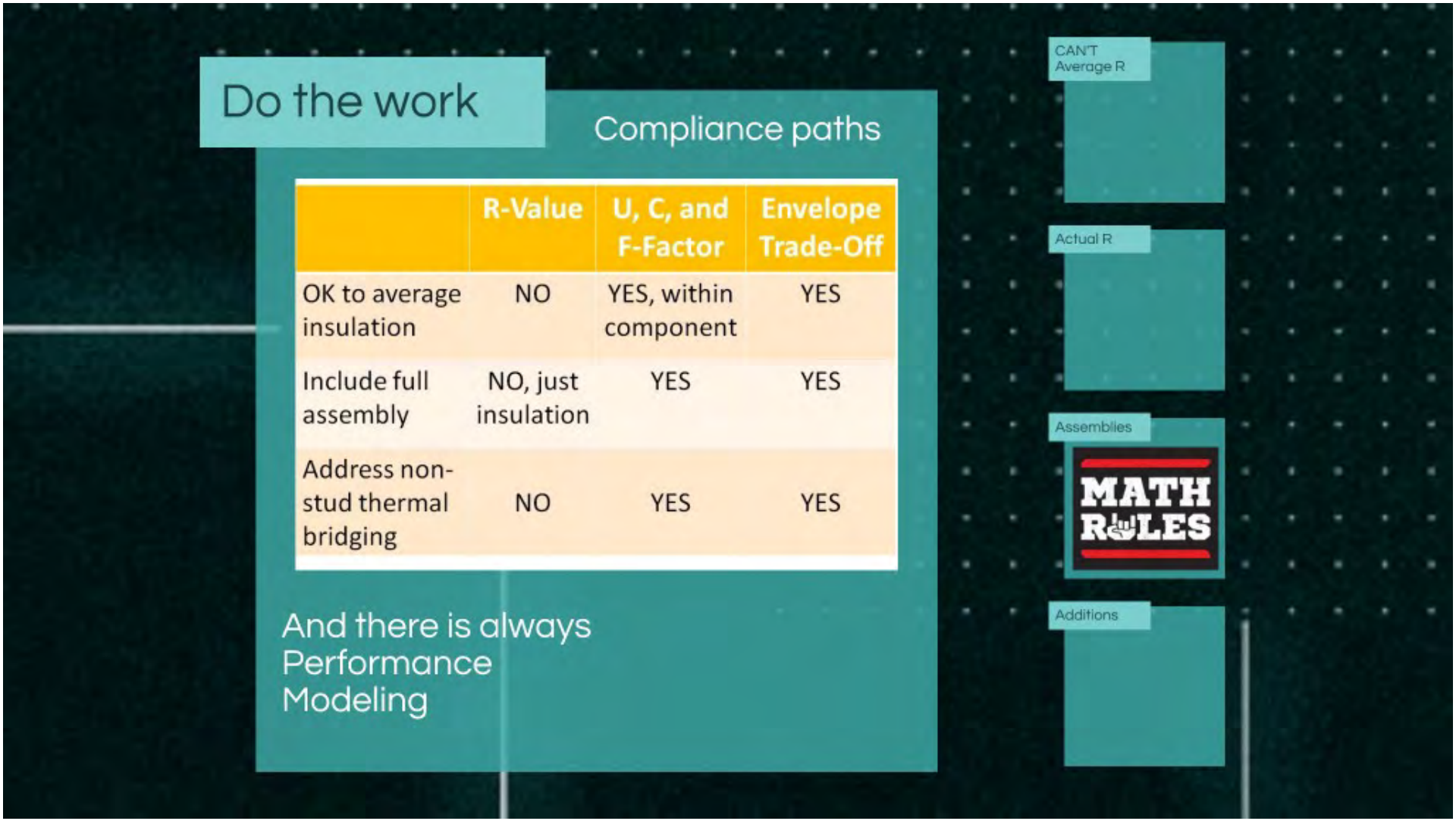
# Challenges

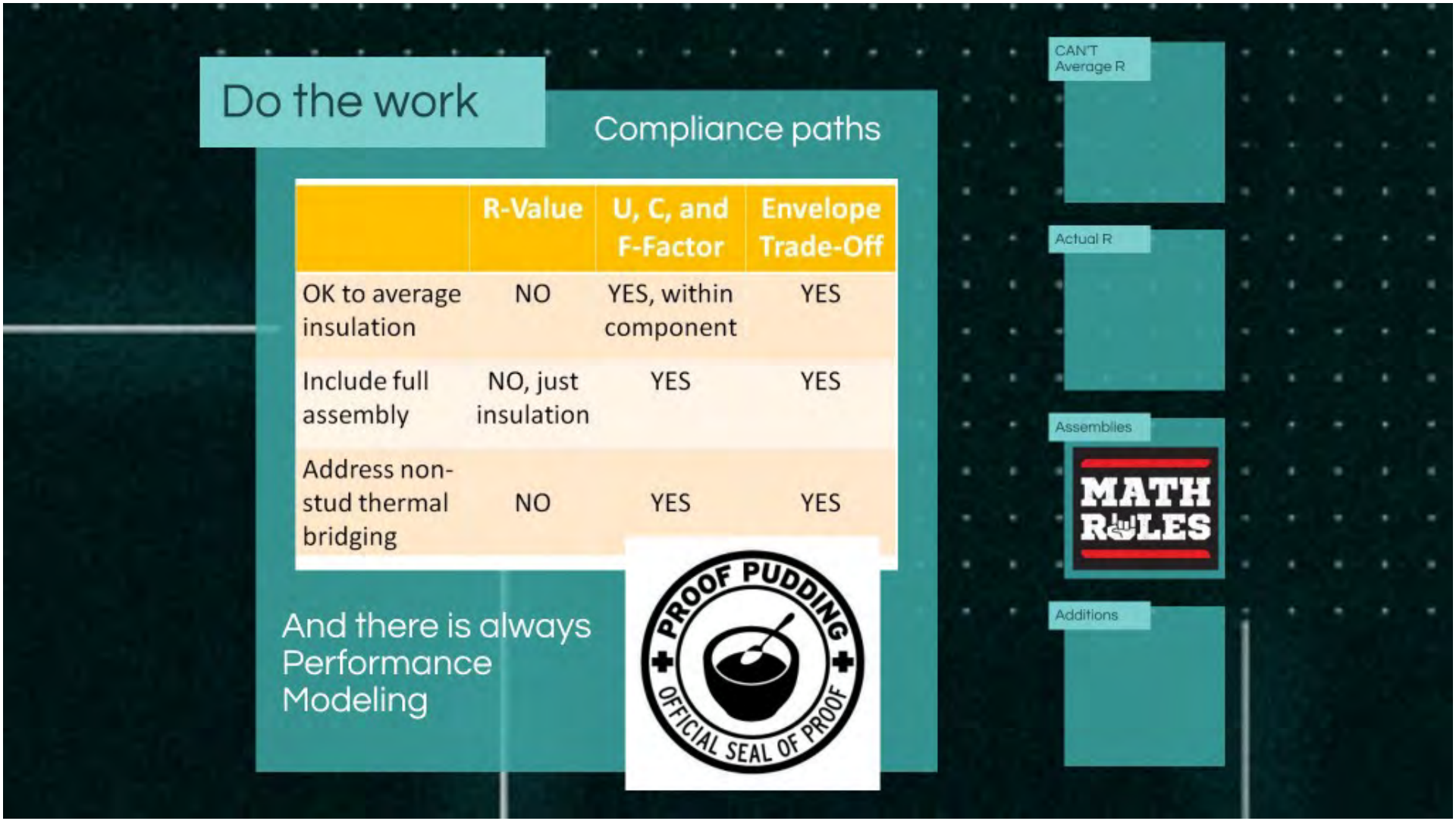
The team moving together and in the same direction.

Transitions, transitions, transitions, oh my.

"The way we've always done it."

"You can only meet two: money, time, quality."


Do the work
Compliance paths
R-Value
U, C, and F-Factor
Envelope Trade-Off
OK to average insulation
NO
YES, within component
YES
Include full assembly
NO, just insulation
YES
YES
Address non-stud thermal bridging
NO
YES
YES
And there is always Performance Modeling
CAN'T Average R
Actual R
Assemblies
MATH RULES
Additions

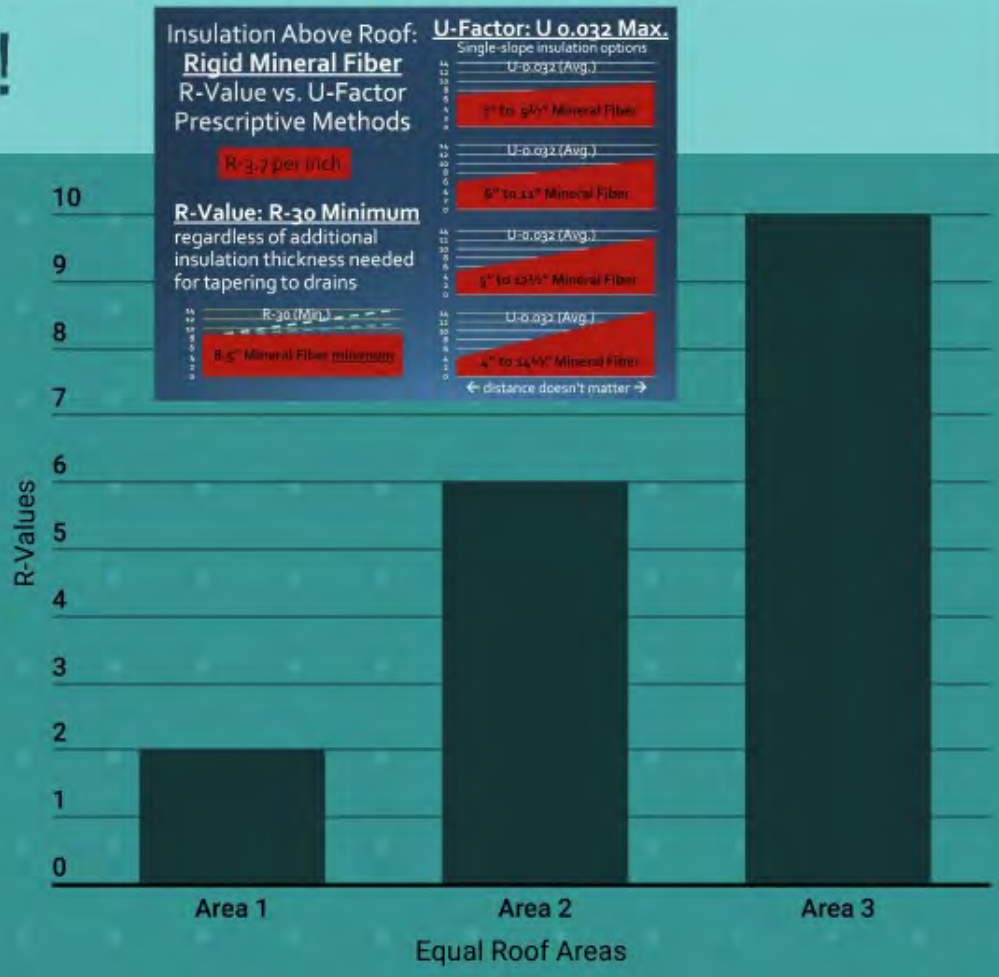

Do the work
Compliance paths
R-Value
U, C, and F-Factor
Envelope Trade-Off
OK to average insulation
NO
YES, within component
YES
Include full assembly
NO, just insulation
YES
YES
Address non-stud thermal bridging
NO
YES
YES
And there is always Performance Modeling
PROOF PUDDING
OFFICIAL SEAL OF PROOF
CAN'T Average R
Actual R
Assemblies
MATH RULES
Additions

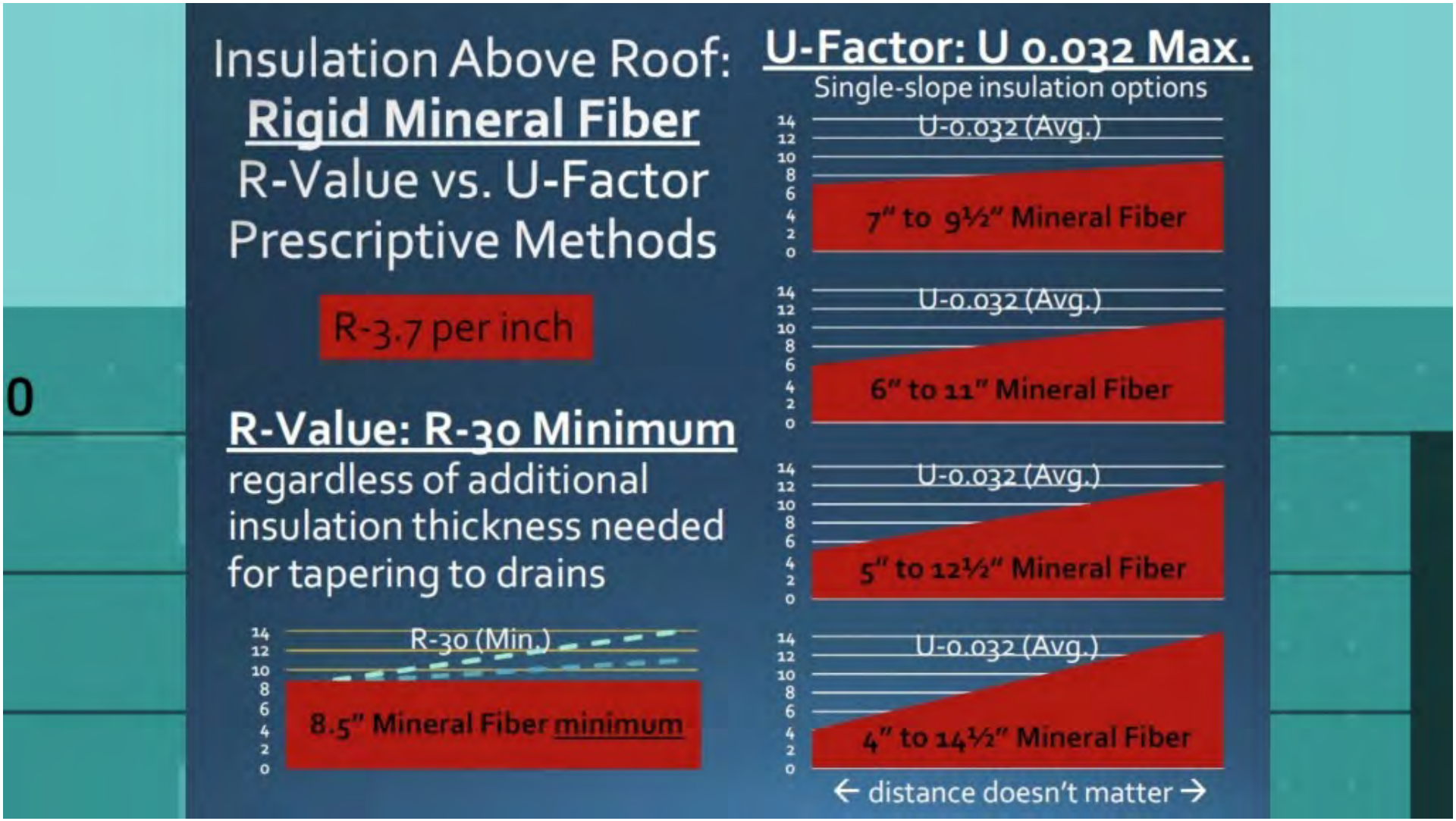
# You average the U!

If you average the R values (NO-NO) then -
(2 + 6 + 10) /3 = R of 6
(again BIG NO)

Average the U-Factors (YES!!)
- (.5 + .17 + .10) /3 = U of 0.26

This is an R of 3.9 (Correct)




Insulation Above Roof:
Rigid Mineral Fiber
R-Value vs. U-Factor
Prescriptive Methods
R-3.7 per inch
R-Value: R-30 Minimum
regardless of additional
insulation thickness needed
for tapering to drains
R-30 (Min.)
8.5" Mineral Fiber minimum
U-Factor: U 0.032 Max.
Single-slope insulation options
U-0.032 (Avg.)
7" to 9½" Mineral Fiber
U-0.032 (Avg.)
6" to 11" Mineral Fiber
U-0.032 (Avg.)
5" to 12½" Mineral Fiber
U-0.032 (Avg.)
4" to 14½" Mineral Fiber
← distance doesn't matter →

# NYS DOS rules!

"… C402 Building Envelope requirements allow for EITHER; C402.1.3 Insulation component R-value-based method, OR, C402.1.4 Assembly U-factor, C-factor or F-factor-based method.

One could choose to provide a compliance path per Section C402.1.4 thereby averaging the roof insulation by U factor (rather than "R" value) of the entire roof assembly, and therefore not be concerned with limiting insulation thickness variation by "R" value, as is required by Section C402.1.3."

Joseph Hill, RA
Assistant Director for Code Administration
NYS Division of Building Standards and Codes
31 Aug 2017

# NYS D

"… C402 Build
component R
F-factor-bas

One could ch
averaging th
assembly, ar
variation by '

Joseph Hill, P
Assistant Dir
NYS Division
31 Aug 2017

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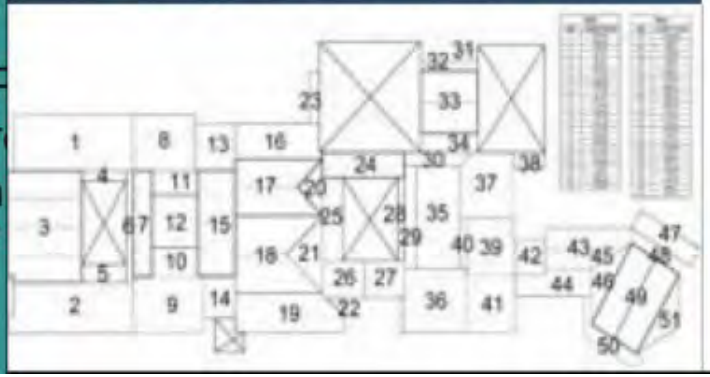
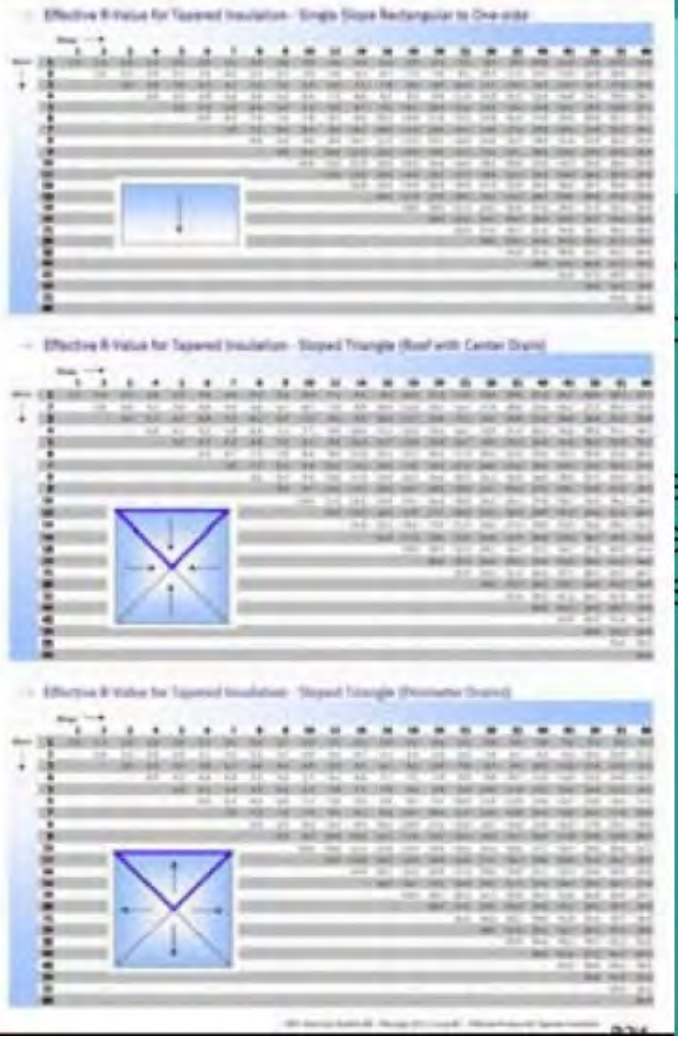
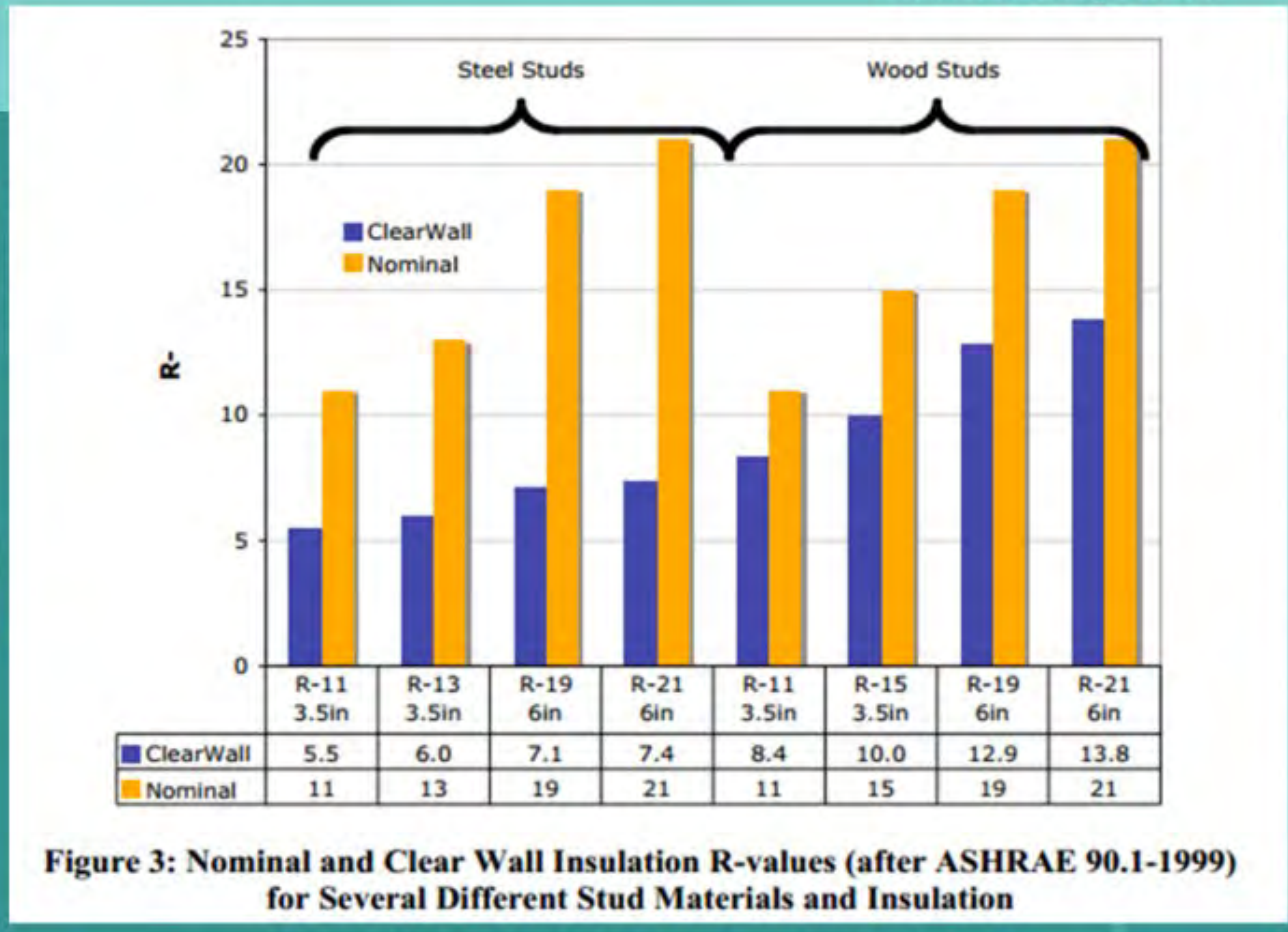
## Averaging Insulation

1. Identify and tally areas with different insulation patterns.
2. Calculate average R-value for each area, using tables or other methods (do NOT average depth).
3. Invert (U = 1/R) for each area.
4. Tally total (UxA) for all areas.
5. Divide by total area to get average U-factor for total area.





J. Straube, 2007

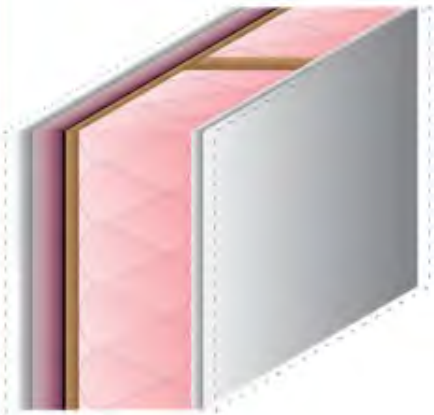



| | R-11 3.5in | R-13 3.5in | R-19 6in | R-21 6in | R-11 3.5in | R-15 3.5in | R-19 6in | R-21 6in |
|---|---|---|---|---|---|---|---|---|
| ClearWall | 5.5 | 6.0 | 7.1 | 7.4 | 8.4 | 10.0 | 12.9 | 13.8 |
| Nominal | 11 | 13 | 19 | 21 | 11 | 15 | 19 | 21 |

**Figure 3: Nominal and Clear Wall Insulation R-values (after ASHRAE 90.1-1999) for Several Different Stud Materials and Insulation**

# Assembly U, C, & F, and More!

... But C402.1.4 takes into account the insulating value of entire assembly:



+ Air films
+ Gypsum board
+ Cavity insulation
+ Framing
+ Sheathing
+ Vapor barrier
+ Continuous insulation
+ Siding

And C402.1.5 is for Compliance Performance Alternative -

A+B+C+D+E <= Zero

- A is the sum of the UA Dif for envelope assemblies
- B is the sum of the FL Dif for slab edge
- C is the CA Dif for below grade walls
- D is the excess vertical glazing area
- E is the Excess skylight area

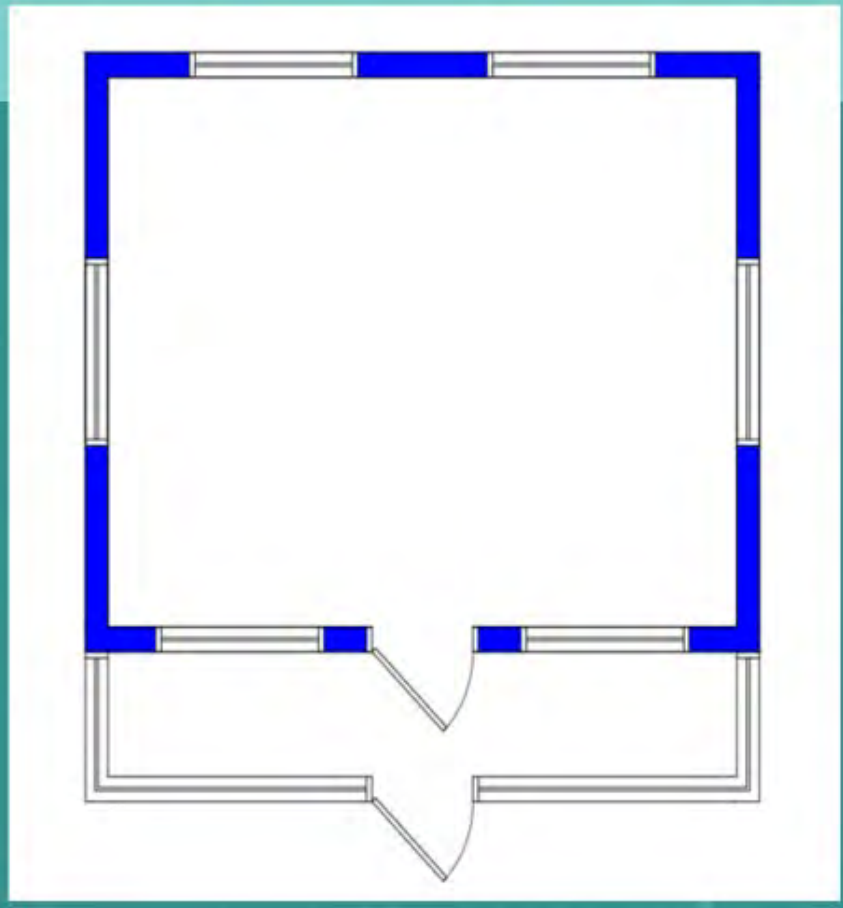
# Walls are 5 x better

Options for additions:

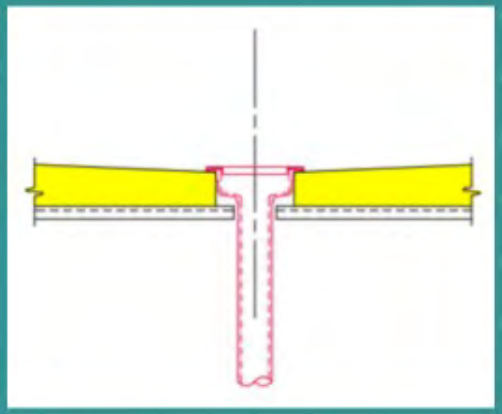
- Additon alone complies
- Addition PLUS existing building complies

IECC Comm. Zone 5

- Walls: U-0.064
- Windows: U-0.38



# Roof Drains



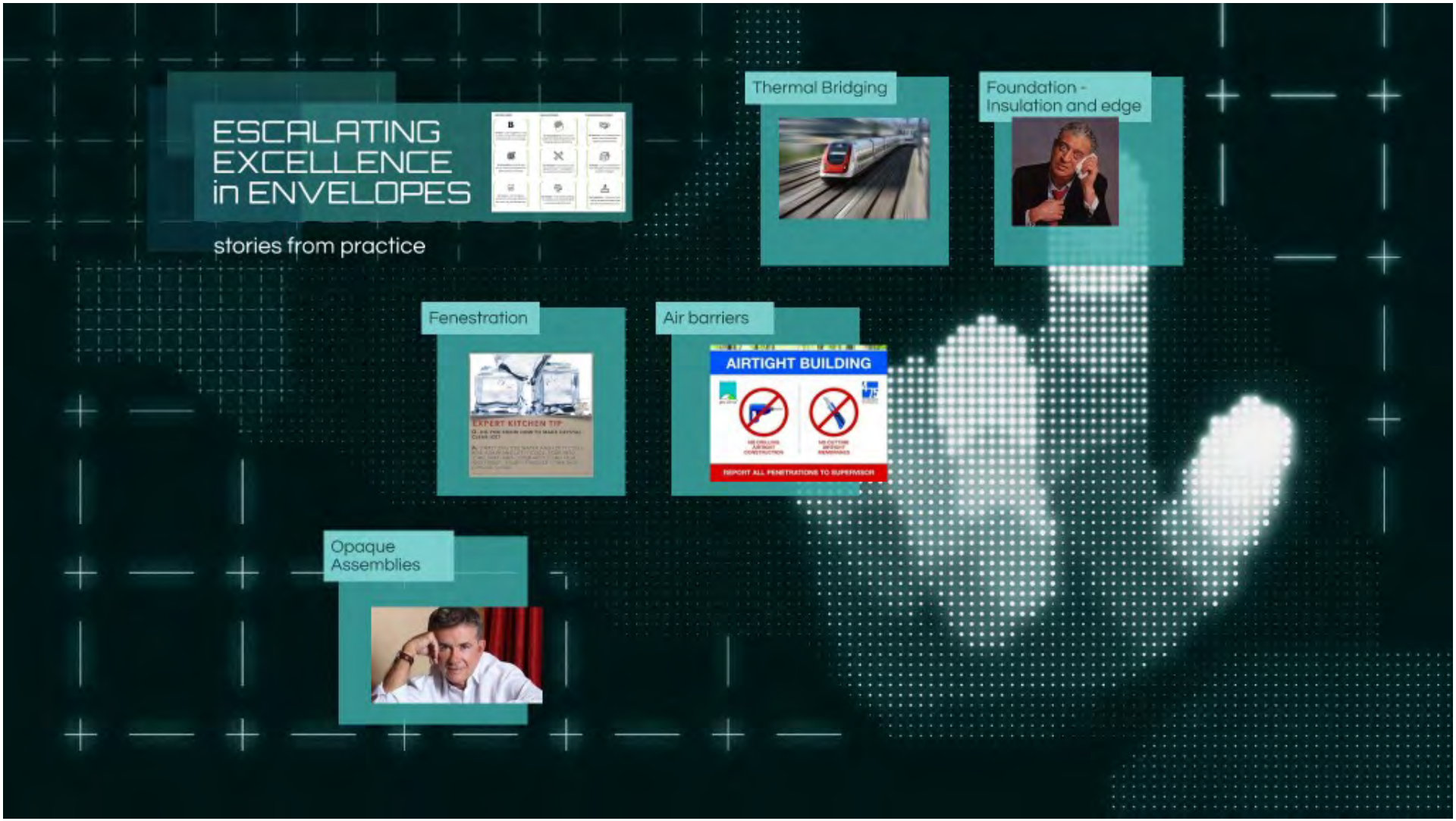
ECCC 2015 Climate Zones 5 and 6

- Insulation Above Roof - U-0.032 (R-31.25)
- Polyisocyanurate LTTR R-5.7/inch
- Prescriptive R-Factor or
- Unpitched Prescriptive U-Factor: 5.5" Thick

4" at drain –> R-22.8 R Max needs to be R-36 –> 6.5"
3" at drain –> R-17.1 R Max needs to be R-40 –> 7.0"
2" at drain –> R-11.4 R Max needs to be R-46 –> 8.0"
1" at drain –> R- 5.7 R Max needs to be R-51 –> 9.0"

Habits

# Habits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# Fenestration

# Let's clear this up.

The Code says - Windows are valuable in so many ways: balance of light, visibility, and energy control


What do you need to know:

- U-factor
- SHGC
- VT
- Projection above window
- Infiltration rating

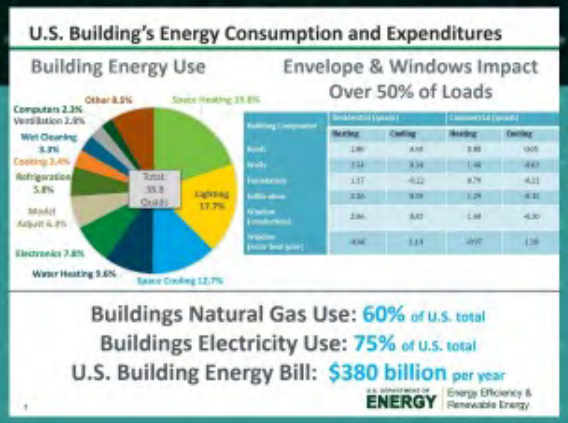
As well as:

- Daylight Zone
- WWR
- Controls
- Installation details

Issues

Excellence

# Windows are complex




A big design issue is WWR.

Windows are never as good as walls and yet so many "green buildings" are fully glass buildings.

Solutions:

- Good windows
- Placed where needed
- Installed correctly
- With daylighting controls

What window?

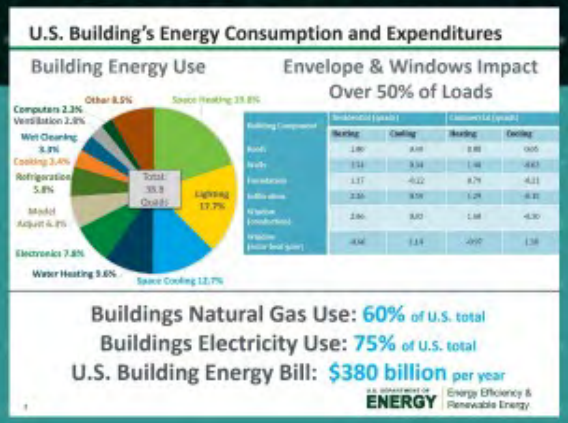
"Thermally broken"

Failures

9.8%

| Building Component | Residential (quads) | | Commercial (quads) | |
|---|---|---|---|---|
| | Heating | Cooling | Heating | Cooling |
| Roofs | 1.00 | 0.49 | 0.88 | 0.05 |
| Walls | 1.54 | 0.34 | 1.48 | -0.03 |
| Foundation | 1.17 | -0.22 | 0.79 | -0.21 |
| Infiltration | 2.26 | 0.59 | 1.29 | -0.15 |
| Window (conduction) | 2.06 | 0.03 | 1.60 | -0.30 |
| Window (solar heat gain) | -0.66 | 1.14 | -0.97 | 1.38 |

# Windows are complex

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Solutions:

- Good windows
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- Installed correctly
- With daylighting controls

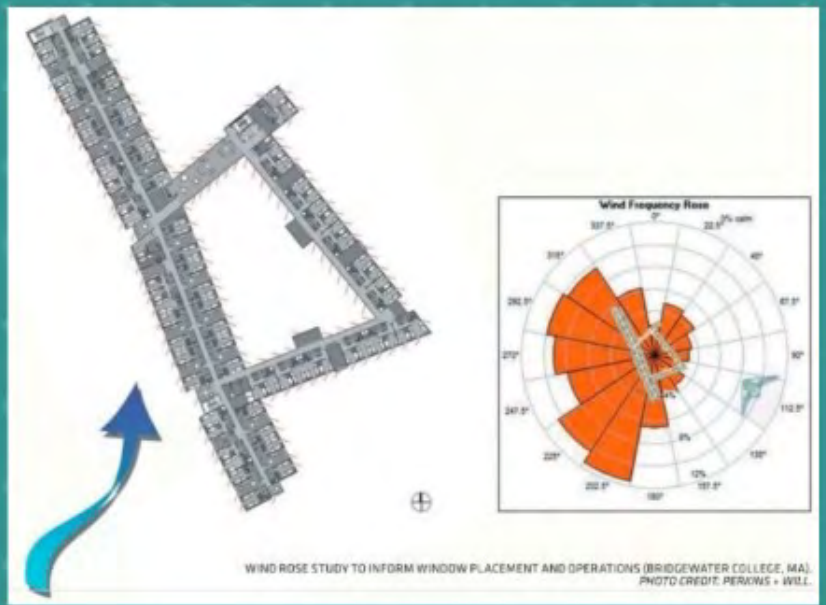
What window?

"Thermally broken"

Failures

## And where?

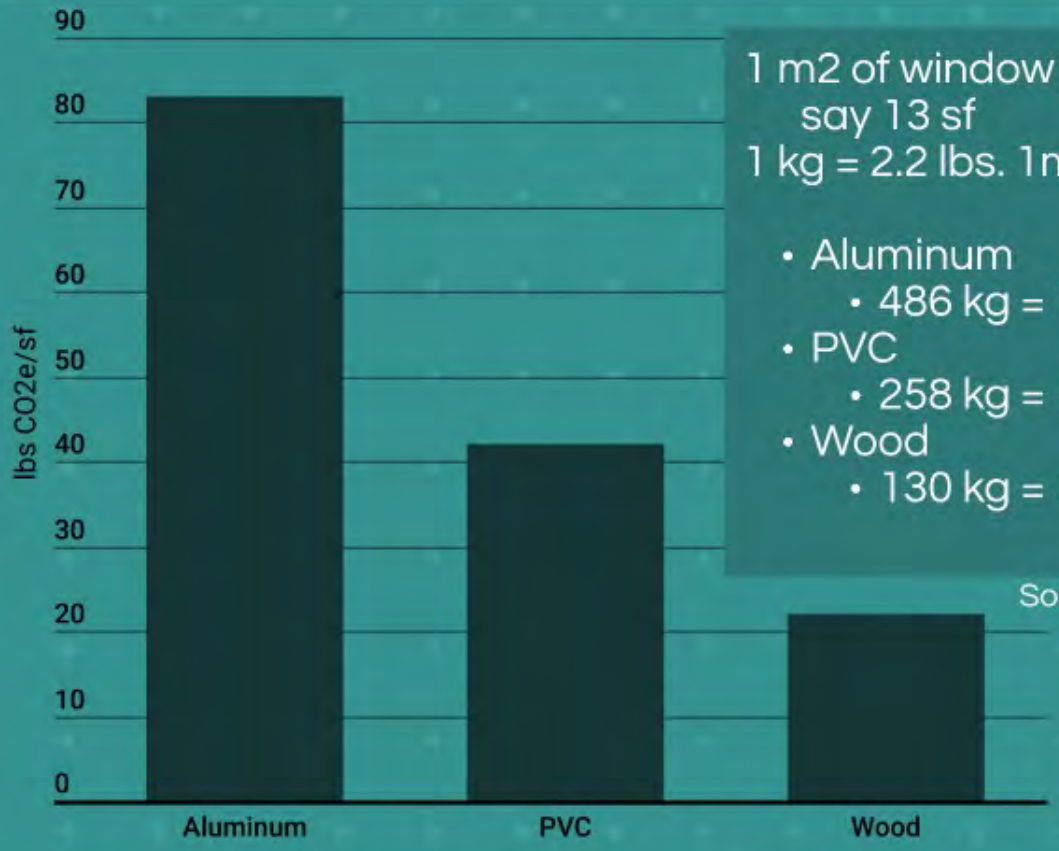
Don't assume more is better
Check full assembly U-factors
And what about embodied carbon?




WIND ROSE STUDY TO INFORM WINDOW PLACEMENT AND OPERATIONS (BRIDGEWATER COLLEGE, MA).
*PHOTO CREDIT: PERKINS + WILL.*

Embodied Carbon

# Embodied Awareness

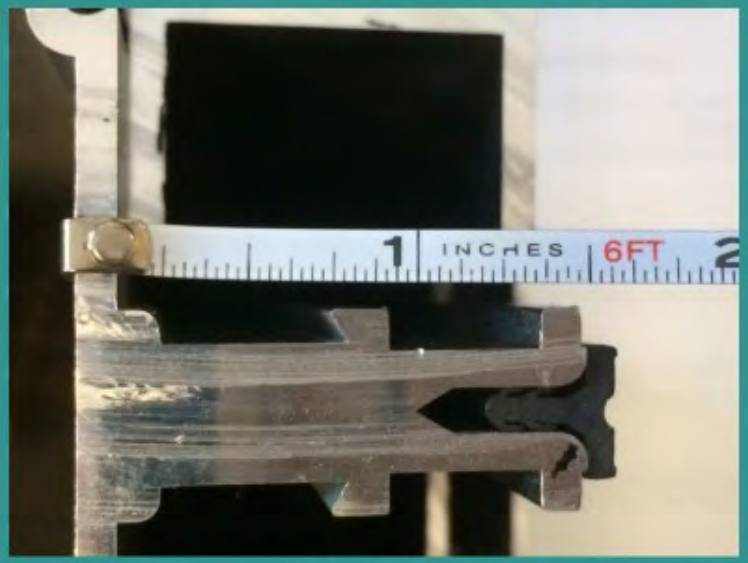



1 m2 of window pane = 10.76 sf add for frame = 12.9
say 13 sf
1 kg = 2.2 lbs. 1m = 3.28 feet

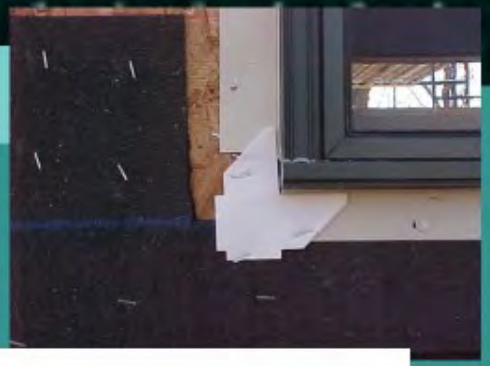
- Aluminum
  - 486 kg = 1070 lbs. /13 sf = 82 lbs. CO2e/sf
- PVC
  - 258 kg = 568 lbs. / 13 sf = 44 lbs. CO2e/sf
- Wood
  - 130 kg = 286 lbs. / 13 sf = 22 lbs. CO2e/sf

Source: http://www.mdpi.com/2075-5309/2/4/542/htm

"Thermal break"



The devil...



"The details are not the details. They make the design."

*Charles Eames*

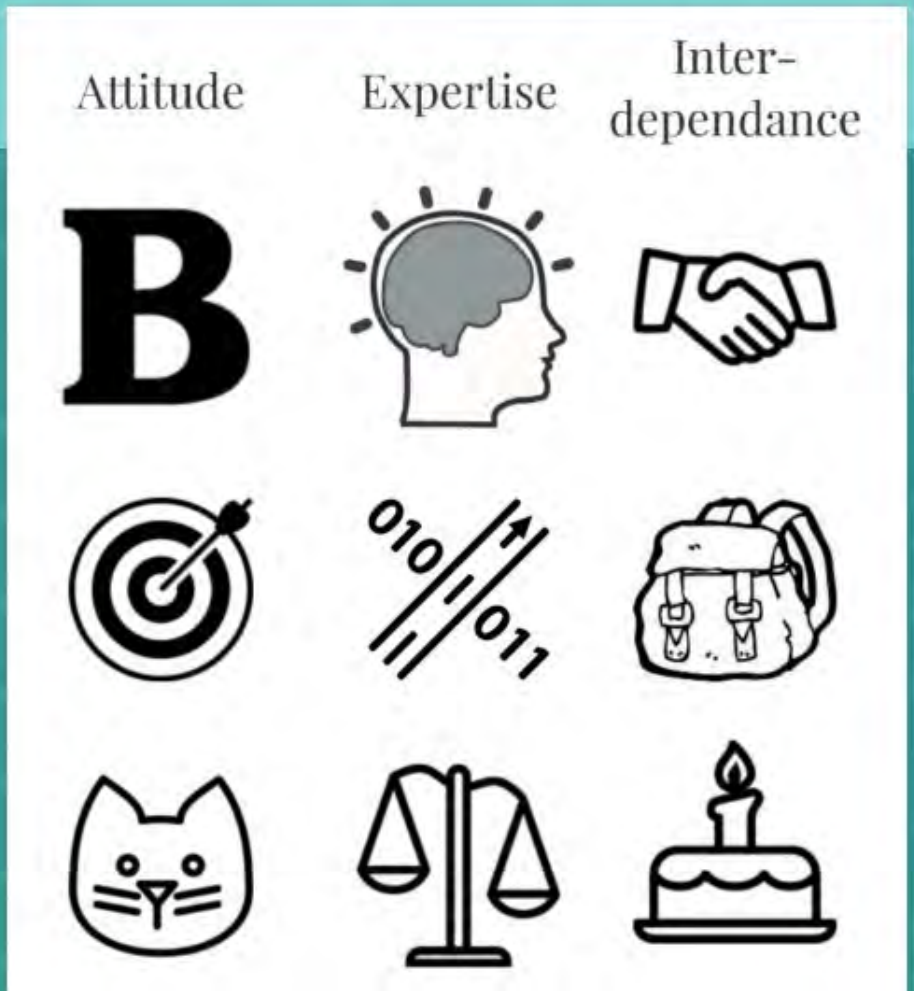
## Mock-up and Test

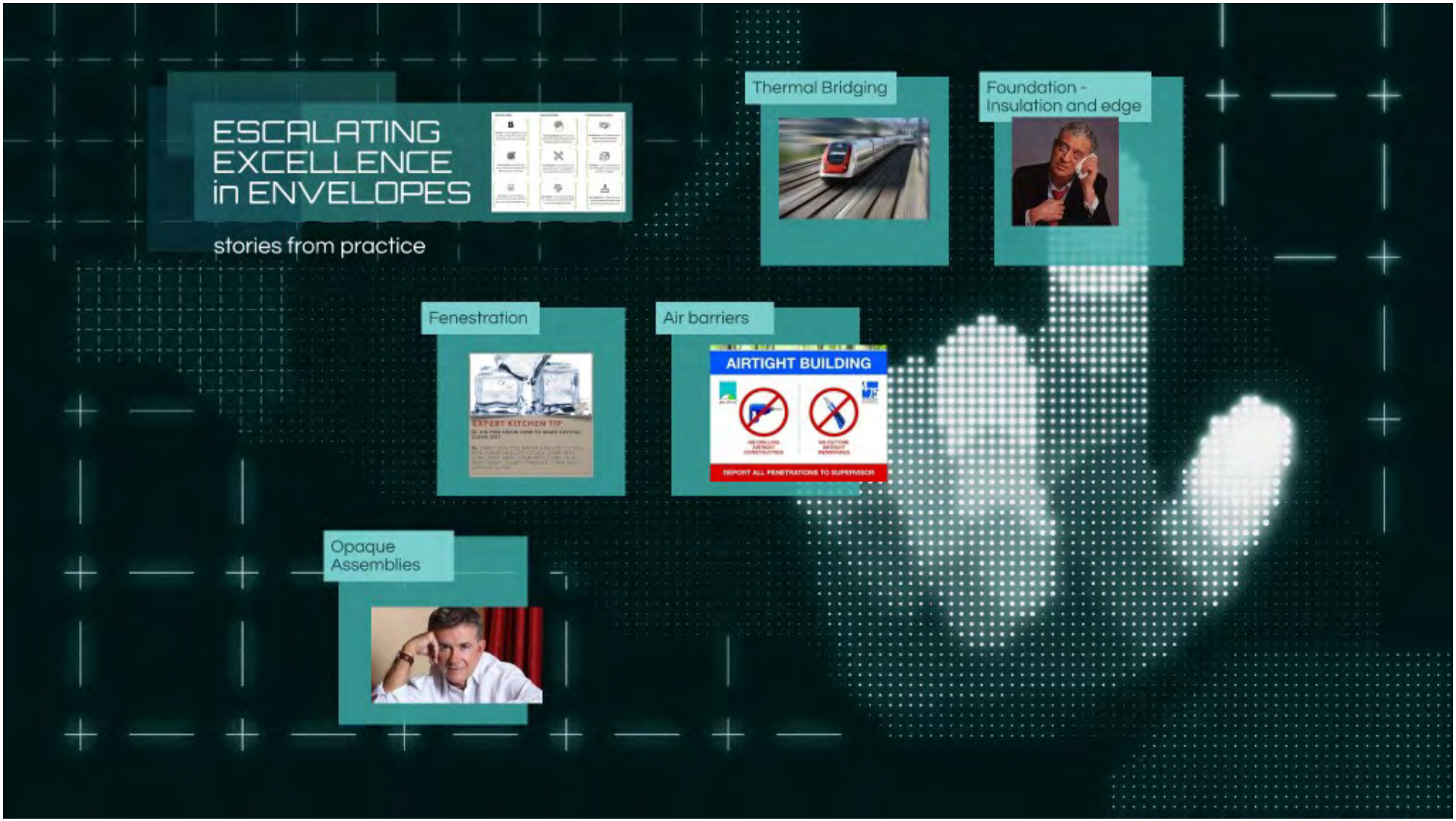
The right details, done right.

Random testing of delivered units?

Habits

# Habits

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# Air barriers

# Sometimes it is better to be dull.

The Code says - Construct a continuous air barrier, including joints, seams, transitions, and penetrations

- Pre-approved or airtight materials
- Tested or pre-approved assemblies


Code lists 19 air barrier materials and assemblies that comply

Examples:

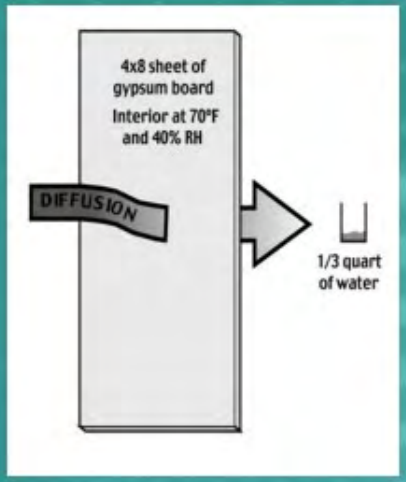
- Mln. 3/8" plywood
- Min. 1/2" cement board
- Open/Closed cell spray foam
- Insulation board
- Painted concrete masonry

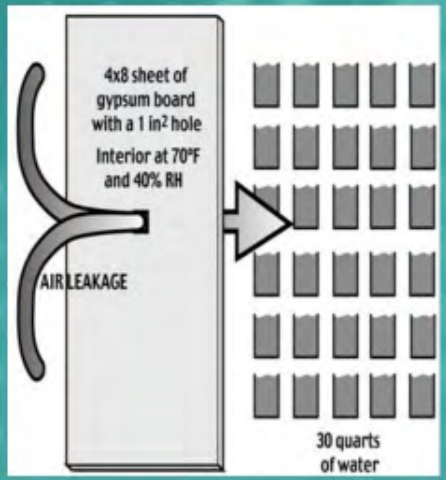
Poor installations

Sole responsibility

# Material and installation

- Right material or assembly
- Installed correctly, including at transitions
- Maintained throughout construction



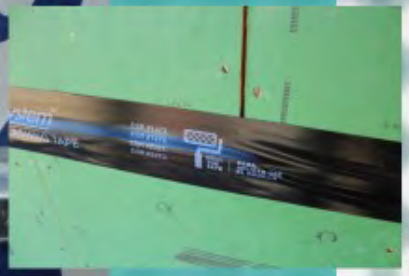




Project 1

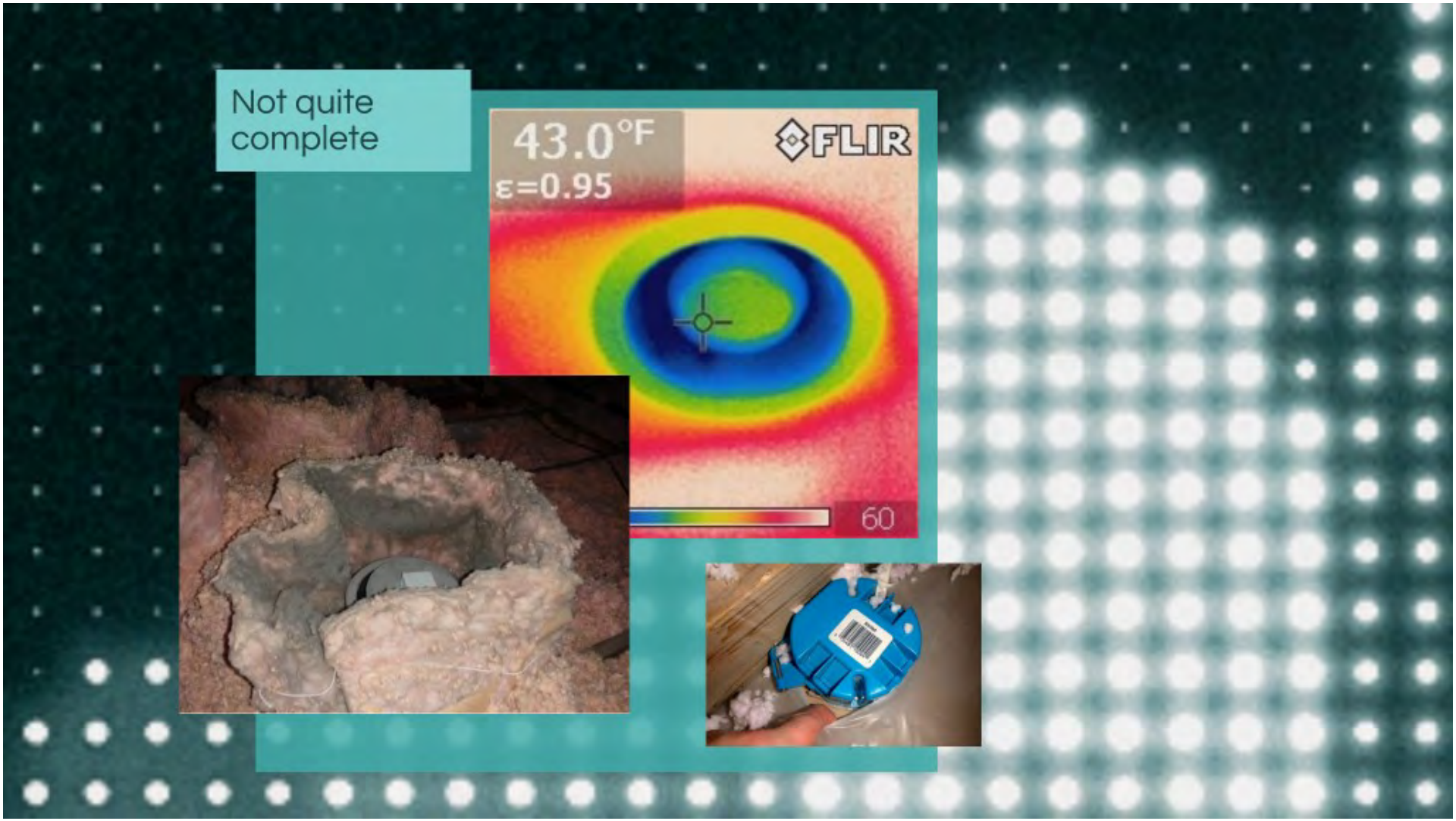
Project 2

Project 3

Good material gone wrong


ystem™
ASHING TAPE
ESR #1473.
ESR #1474.
ESR #2227.
ESR #3373.
ROLL THE TAPE
PARA APLICAR USE EL RODILLO


Not quite complete
43.0°F
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## Good system and good installation


# Whole vs. hole

"I gotta make a hole"

Habits

# Whole vs. hole

"Talk to Joe!"

"I gotta make a hole"

Habits

# Whole vs. hole

"Talk to Joe!"

"I gotta make a hole"

Joe witnesses and assigns repair after installation

Habits

# Whole vs. hole

"Talk to Joe!"

Air barrier is whole!

"I gotta make a hole"

Joe witnesses and assigns repair after installation

Habits

# Whole vs. hole

"Talk to Joe!"

Air barrier is whole!

"I gotta make a hole"

Joe witnesses and assigns repair after installation

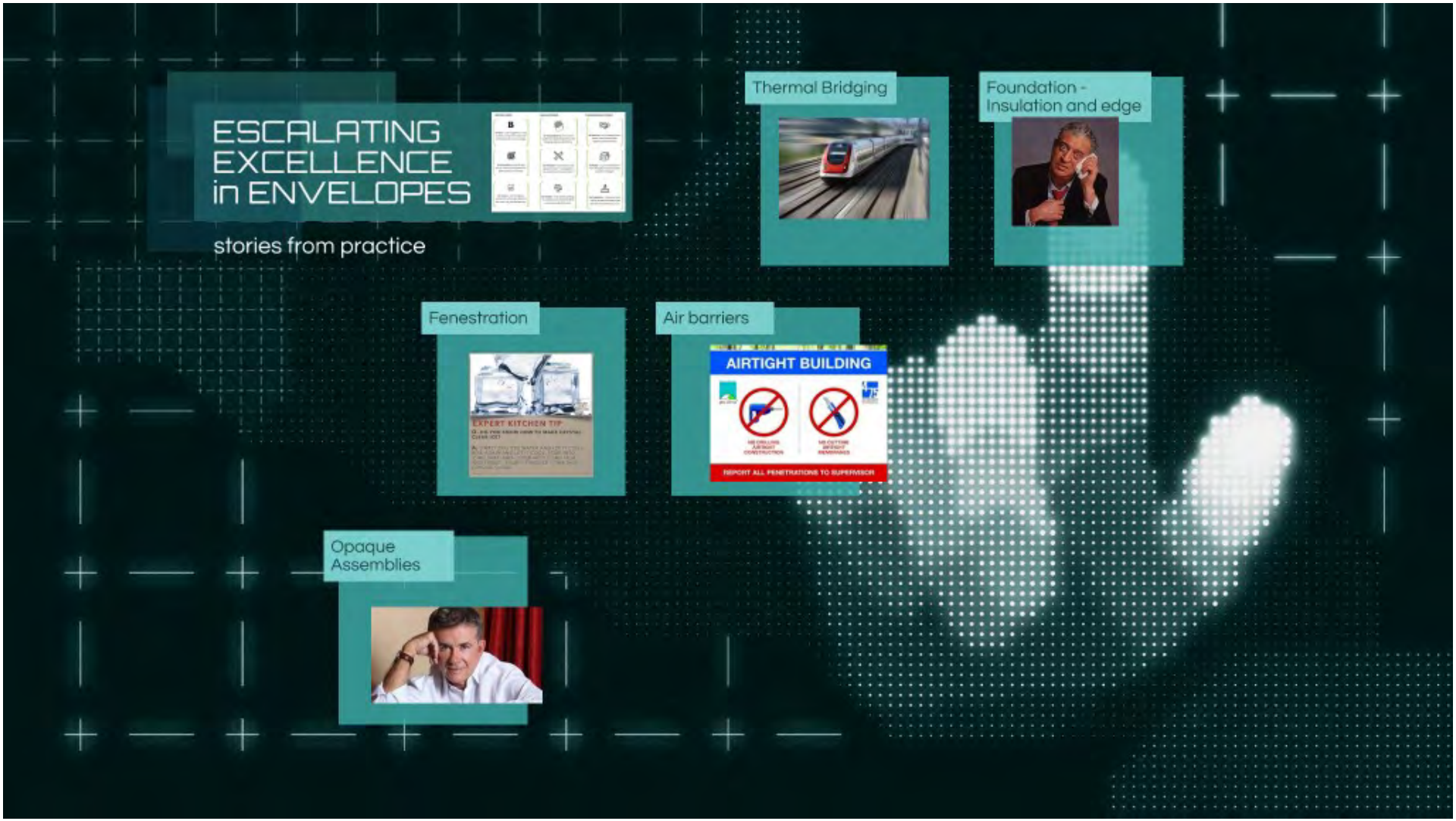
Yay, Team!!!

Habits


Yay,
Team!!!

# Habits

| Attitude | Expertise | Inter-dependance |
| --- | --- | --- |
| B |  |  |
|  |  |  |
|  |  |  |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# Thermal Bridging

# High-speed travel

The Code says -
do the calculations and prove the efficacy

Prescriptive R-value:
- Follow R-value charts
- There is NOTHING about other thermal bridging (woefully inadequate)

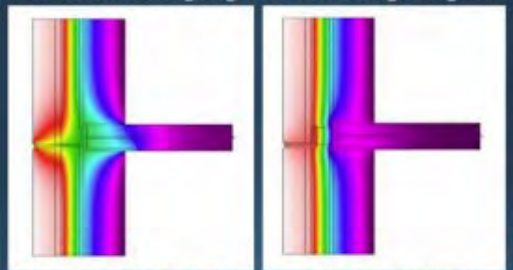
All other paths:
- Calculate conductive heat loss
  - UxA for stud wall assemblies
  - UxA, CxA, or FxL for all other bridging conditions
- Calculate area-weighted UA to determine compliance

Then build it correctly!

Issues

Excellence

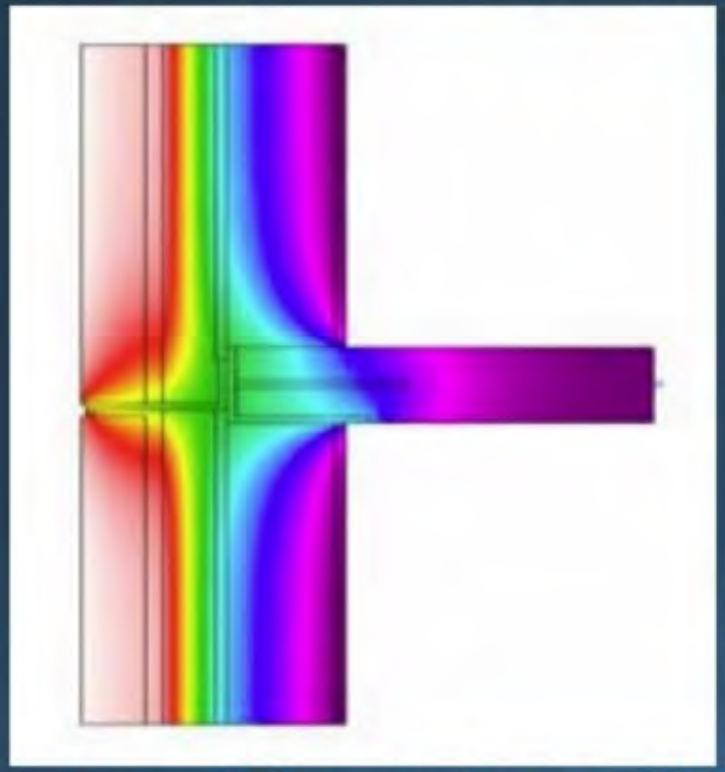
Thermal Bridging at Relieving Angles



**Unmitigated Detail:**
U-Factor for 36" height = 0.44

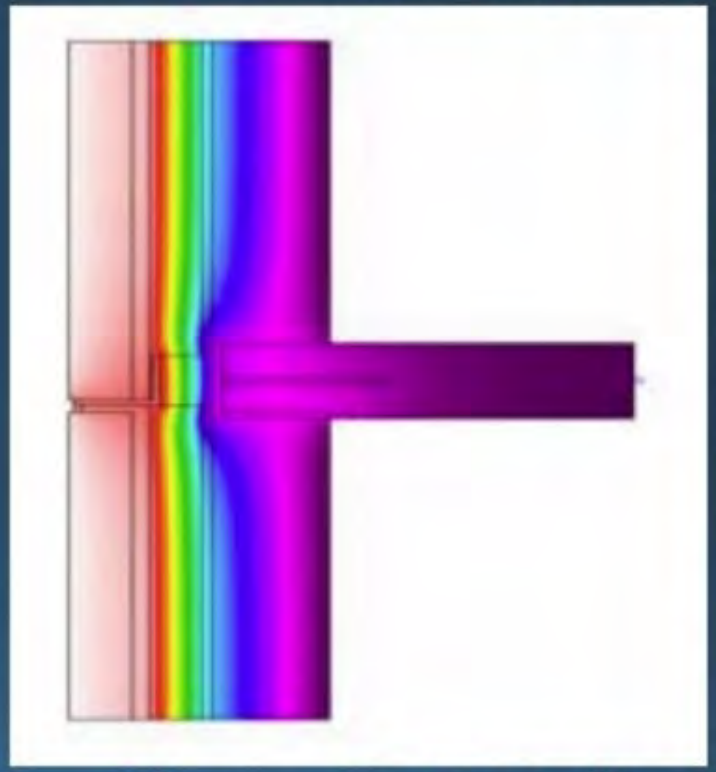
**Alternate Detail:**
U-Factor for 36" height = 0.13

# Thermal Bridging at Relieving Angles



**Unmitigated Detail:**

U-Factor for 36" height = 0.44



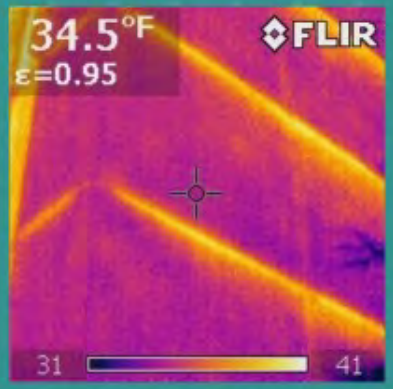
**Alternate Detail:**

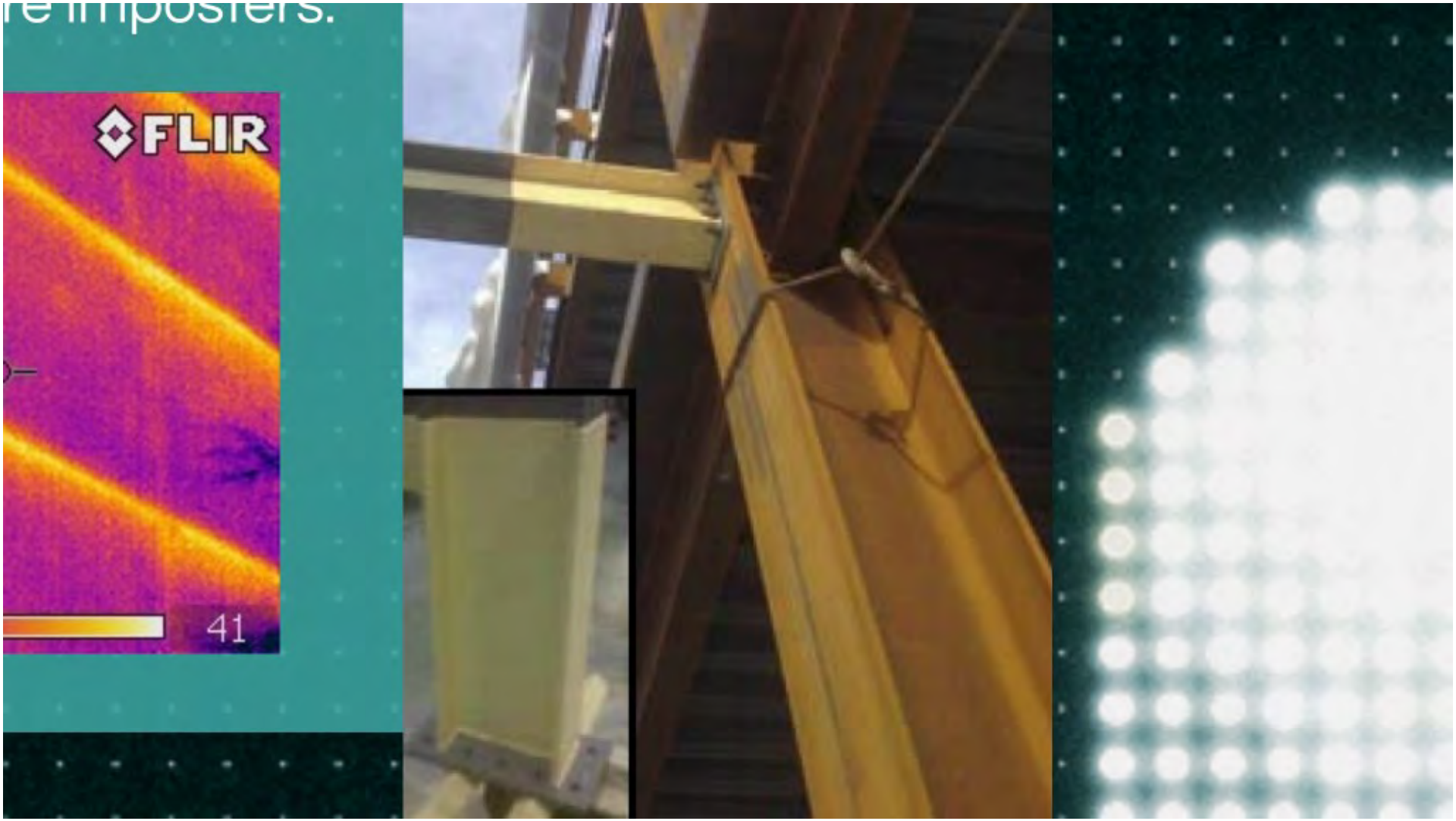
U-Factor for 36" height = 0.13

# "Skin of Our Teeth"

Insulative coatings (example):

- Aerogel insulation in paint
- R-4.1 per inch (WOW)
- Means R-0.1 to R-0.2 in total (wow)
- Install on steel 24" out to exterior and interior
- There are imposters.





re imposters.
FLIR
41

Who is responsible?

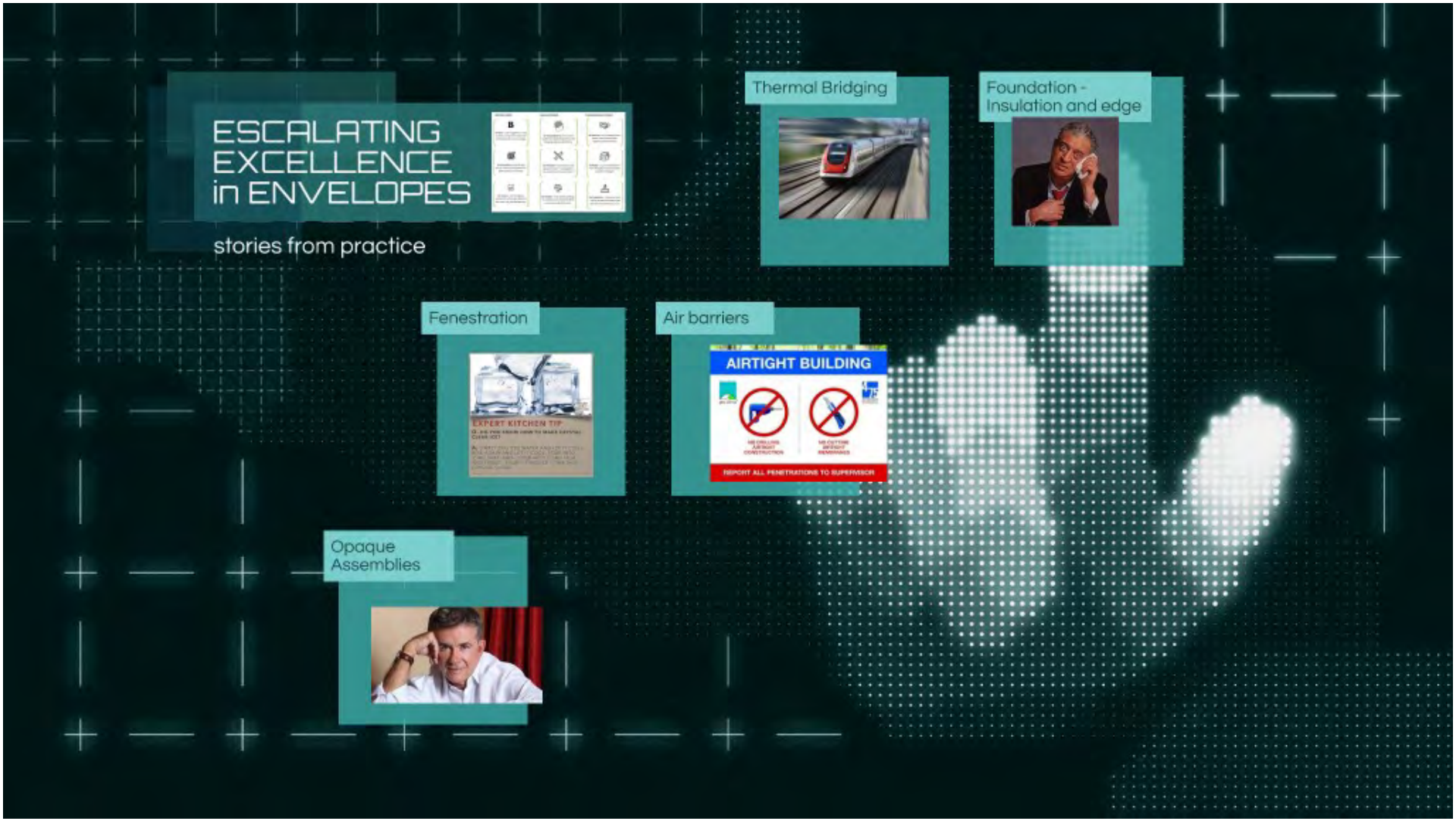

Does YOUR energy modeler put in Thermal Bridging information?


Habits


MSTBA

# Habits

| Attitude | Expertise | Inter-dependance |
| --- | --- | --- |
| B |  |  |
|  |  |  |
|  |  |  |


ESCALATING
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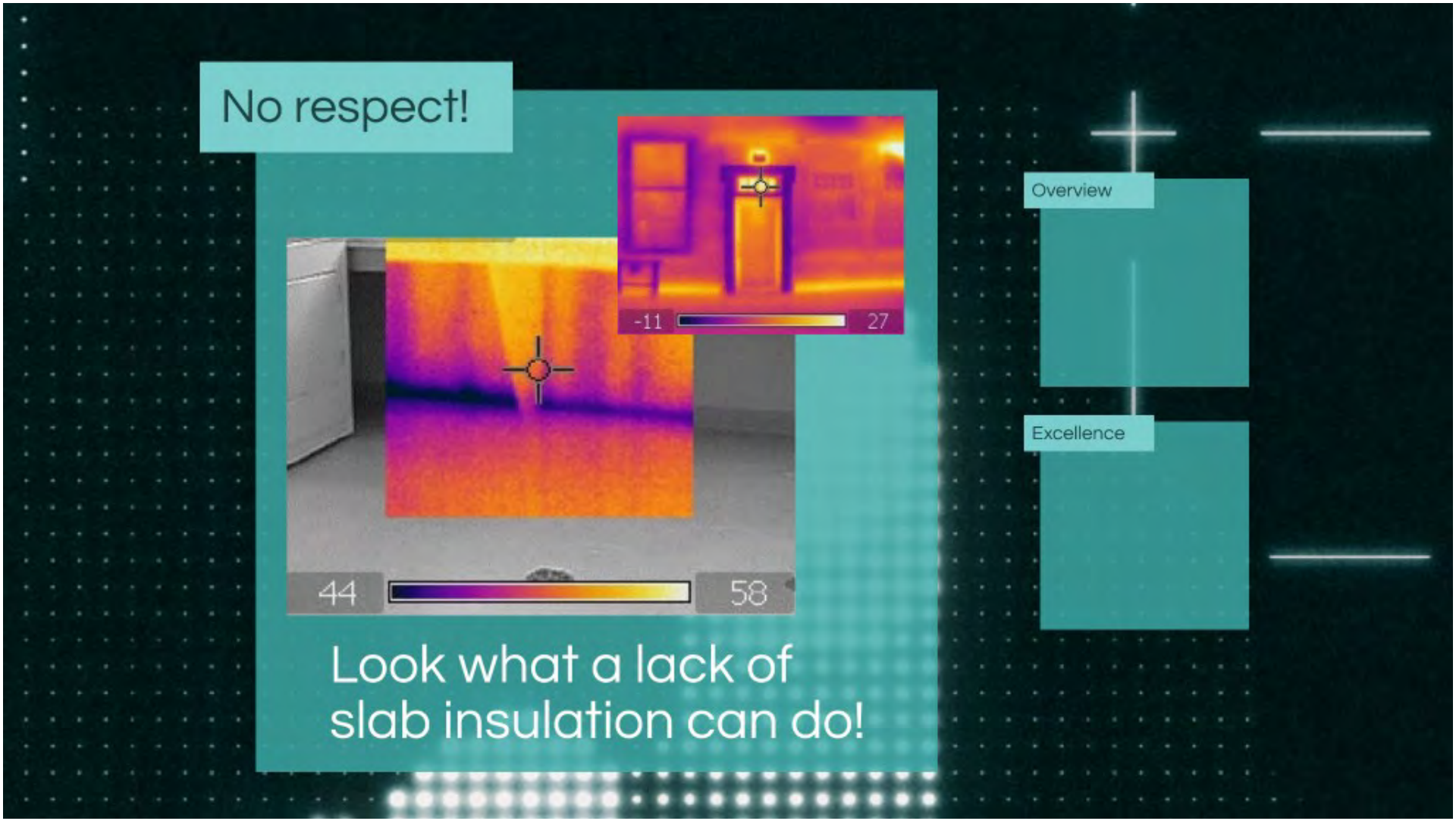
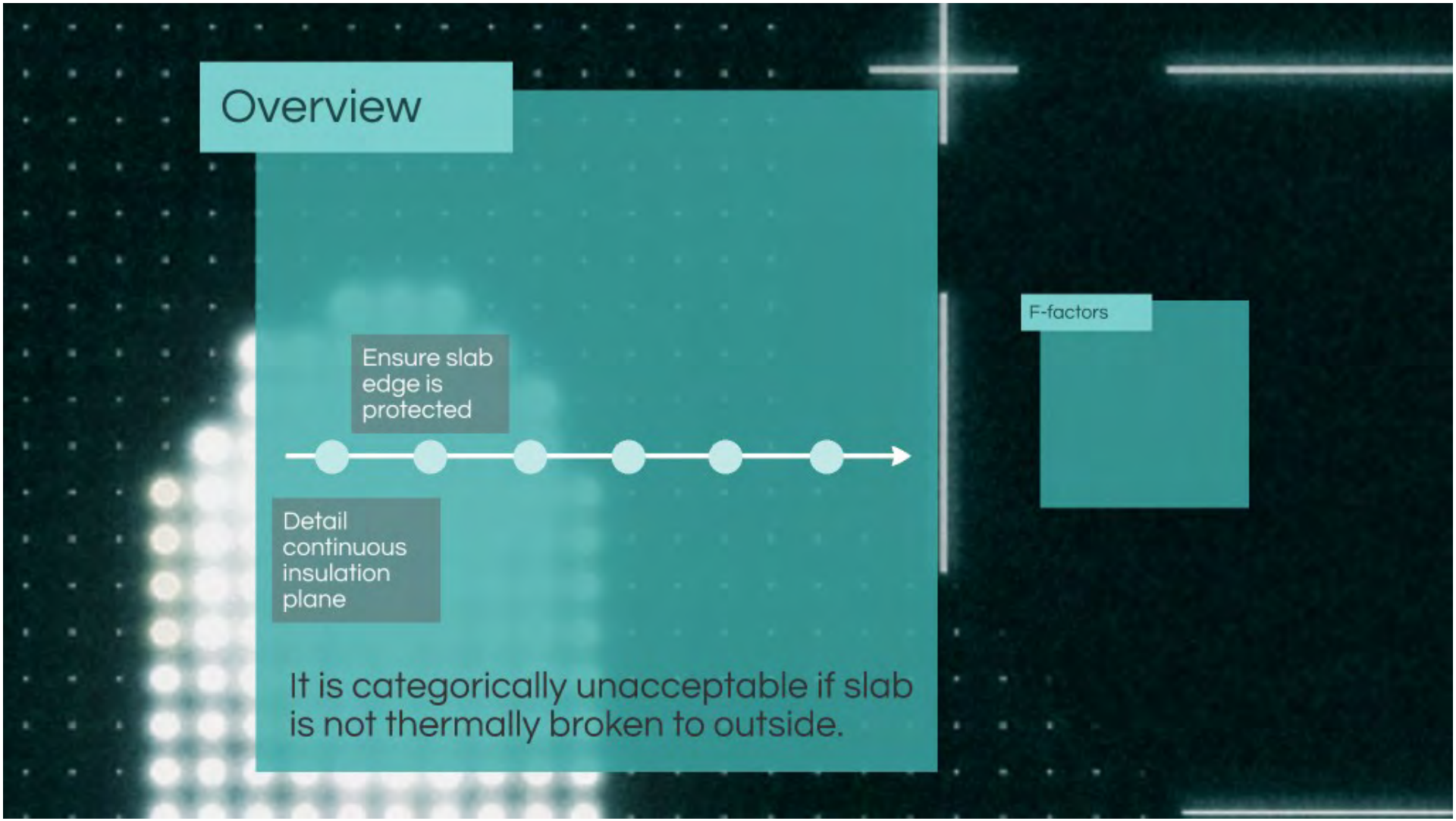
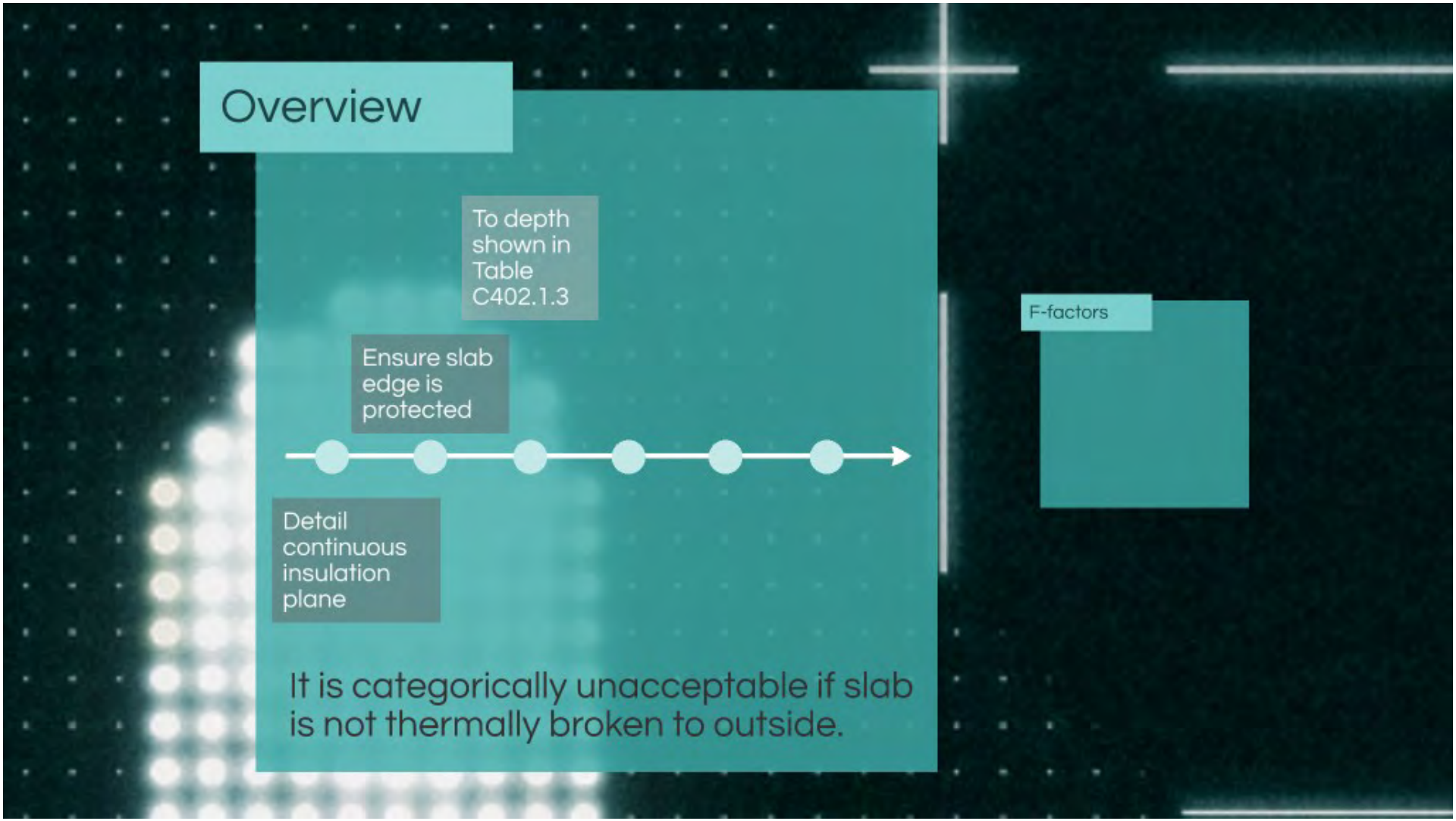
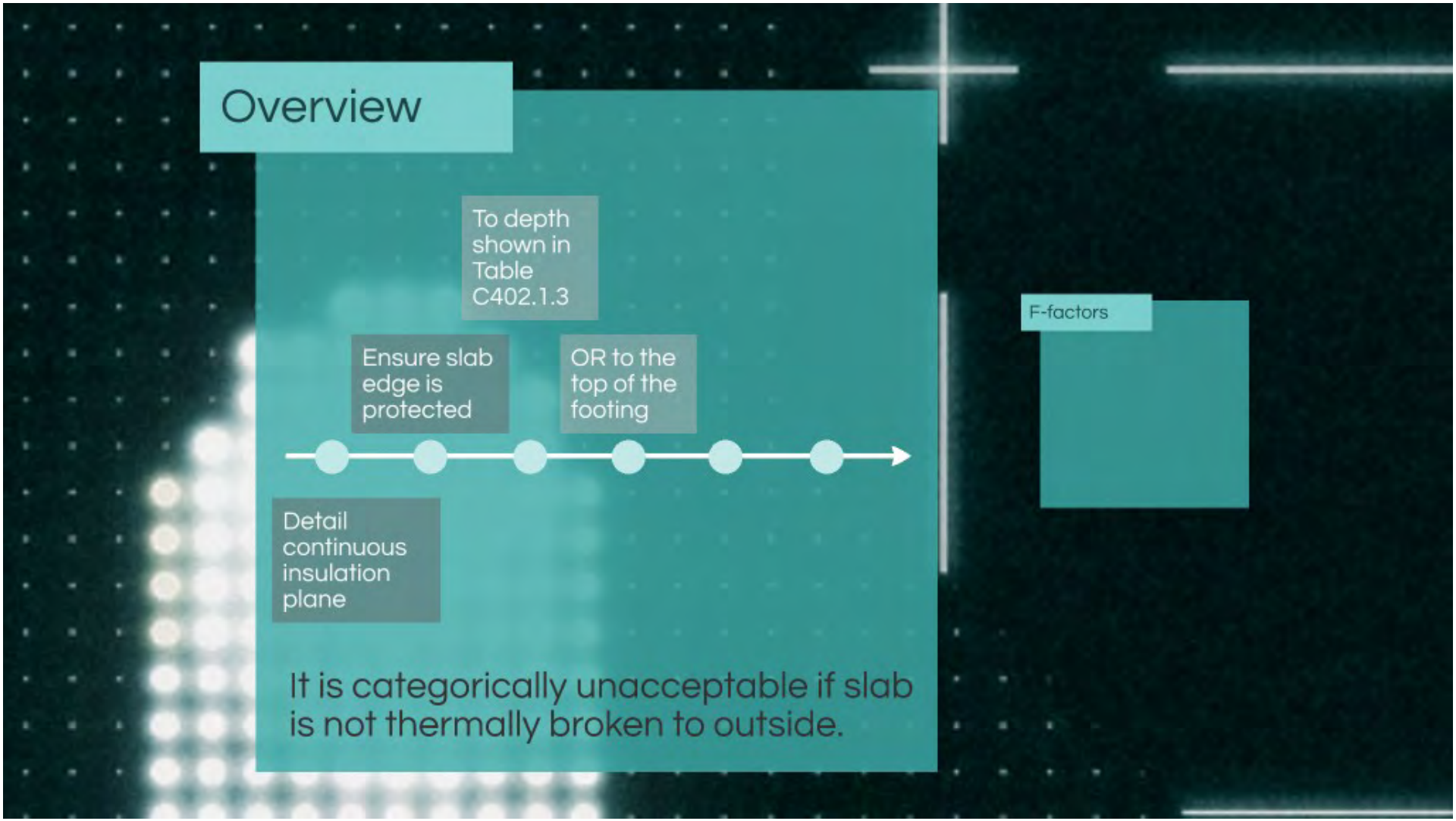
Foundation -
Insulation and edge
Fenestration
EXPERT KITCHEN TIP
Air barriers
AIRTIGHT BUILDING
REPORT ALL PENETRATIONS TO SUPERVISOR
Opaque
Assemblies

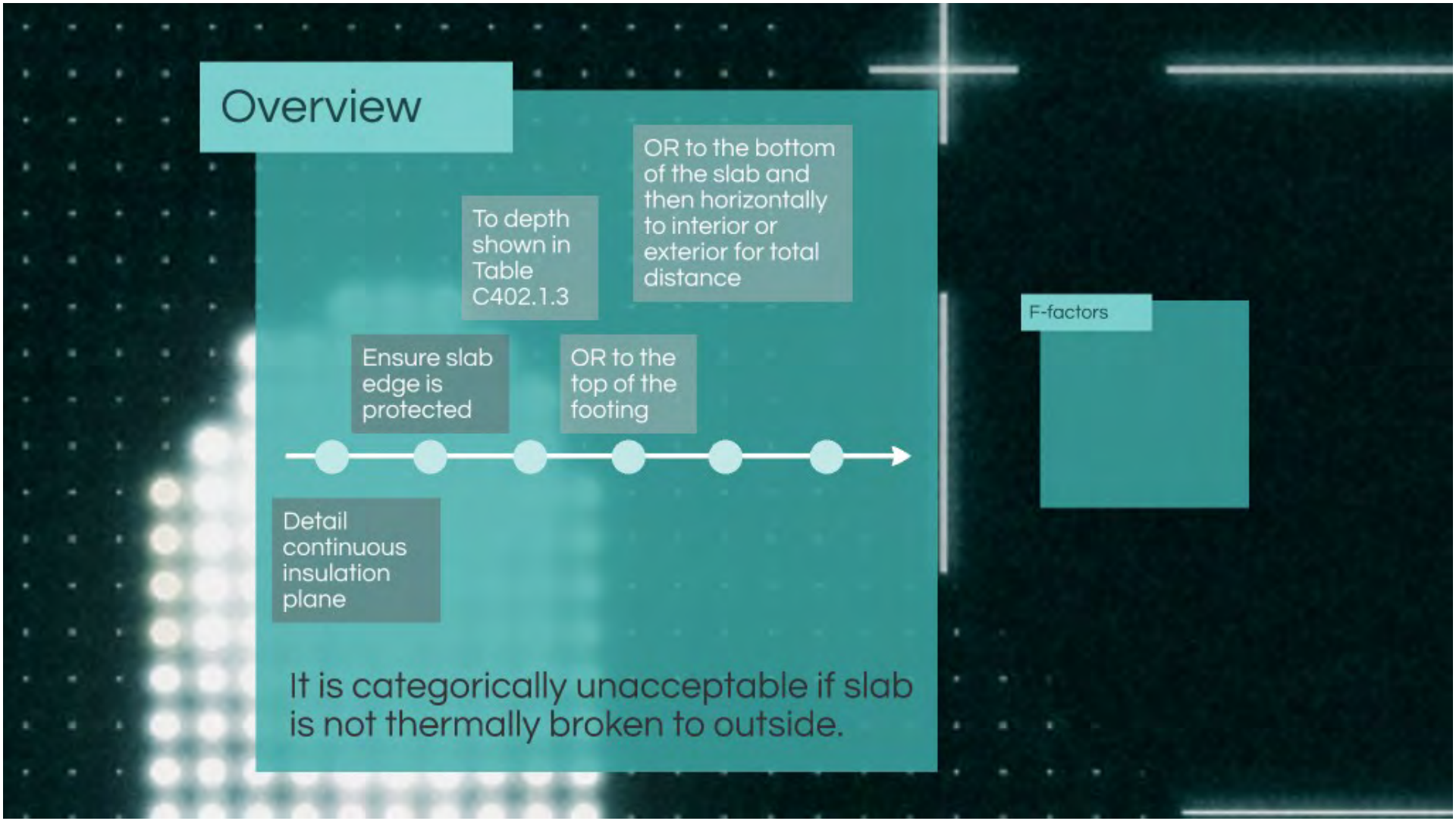
# Foundation - Insulation and edge

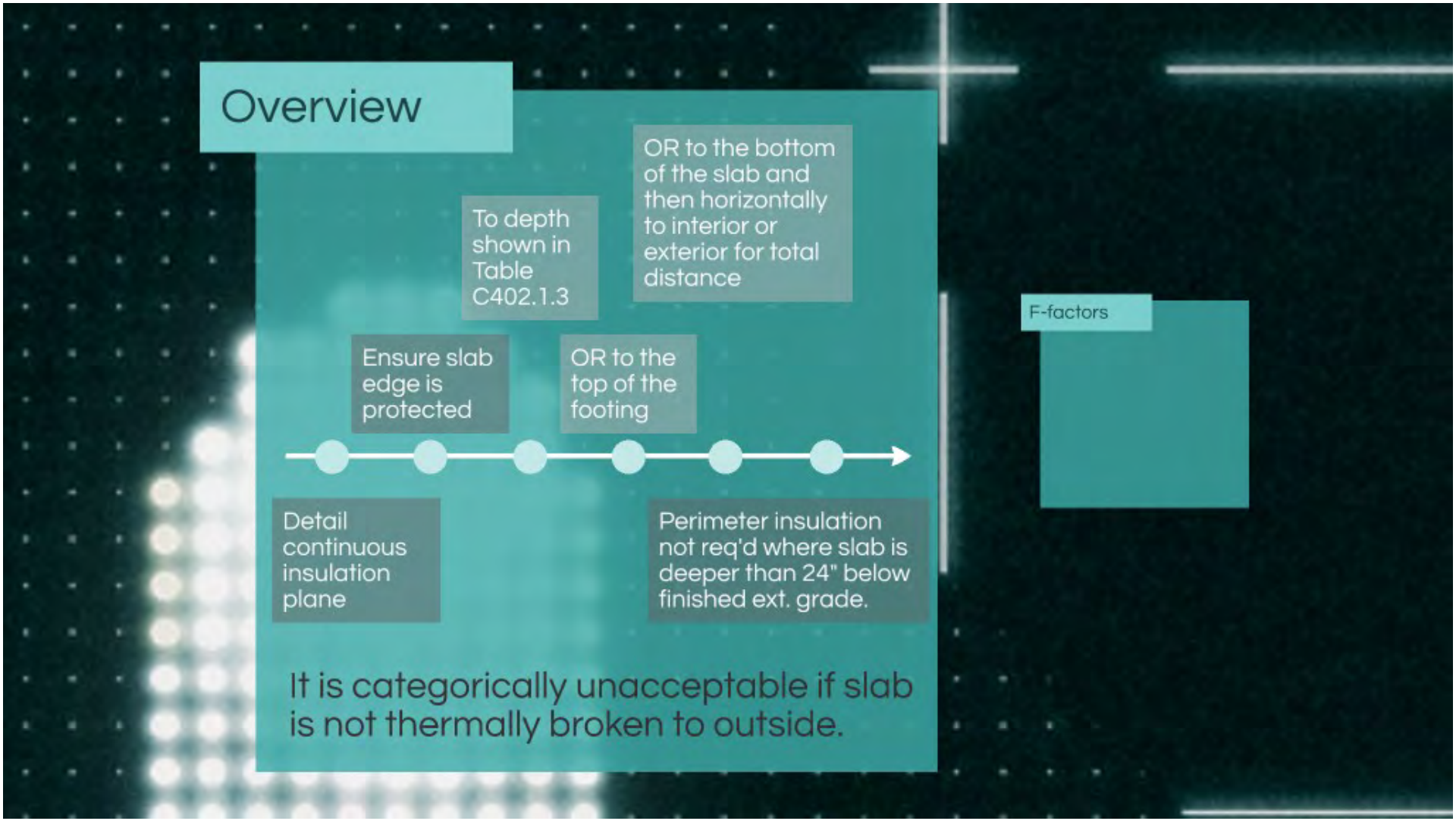

No respect!
-11
27
44
58
Look what a lack of slab insulation can do!
Overview
Excellence


Overview
Ensure slab edge is protected
Detail continuous insulation plane
F-factors
It is categorically unacceptable if slab is not thermally broken to outside.


Overview
To depth shown in Table C402.1.3
Ensure slab edge is protected
Detail continuous insulation plane
It is categorically unacceptable if slab is not thermally broken to outside.
F-factors


Overview
To depth shown in Table C402.1.3
Ensure slab edge is protected
OR to the top of the footing
Detail continuous insulation plane
It is categorically unacceptable if slab is not thermally broken to outside.
F-factors


Overview
To depth shown in Table C402.1.3
OR to the bottom of the slab and then horizontally to interior or exterior for total distance
Ensure slab edge is protected
OR to the top of the footing
Detail continuous insulation plane
It is categorically unacceptable if slab is not thermally broken to outside.
F-factors


Overview
To depth shown in Table C402.1.3
OR to the bottom of the slab and then horizontally to interior or exterior for total distance
Ensure slab edge is protected
OR to the top of the footing
Detail continuous insulation plane
Perimeter insulation not req'd where slab is deeper than 24" below finished ext. grade.
It is categorically unacceptable if slab is not thermally broken to outside.
F-factors

# Slab on Grade "F- Factors"

ASHRAE 90.1-2013
Appendix A
A.9 Determination of Alt Assembly

U-C- and F- Factors
Slab-on-Grade Floors "no testing or calculations allowed"

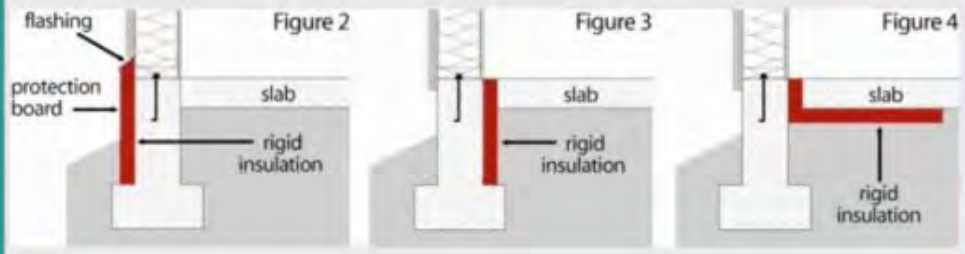
ASHRAE 90.1-2013 Appendix A

Table A6.3.1 Assembly F-Factors
- 6" concrete slab on grade
- defined soil conductivity

Defined Variables include:
- Heated or Unheated slab
- Horizontal and/or vertical insulation
- Extent of insulation
- R-value of Insulation

Undefined variables Include:
- Foundation wall thickness
- Type of concrete
- Type and extent of fill
- Alternate insulation configurations or locations

F Perimeter Slab Insulation



# Slab on Grade "F- Factors"

ASHRAE 90.1-2013
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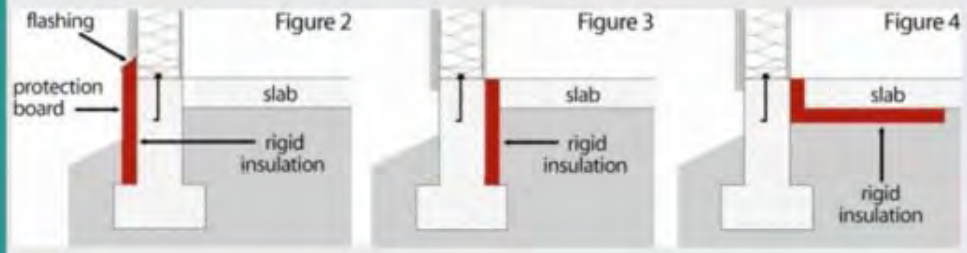
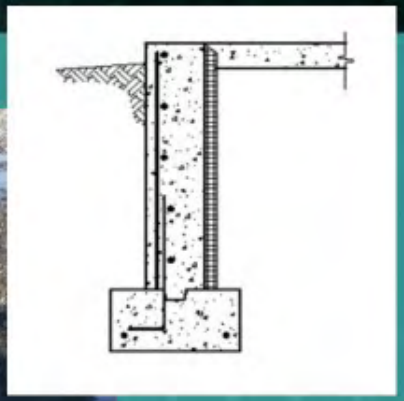
F Perimeter Slab Insulation



# Excellence



IECC-2015 Commercial, Climate Zone 5
Code Compliance Path:

- Prescriptive U C F Factor
- R-10, 24" Horizontal and/or Vertical from top of slab

ASHRAE 90.1-2013 Appendix A
Table A6.3.1 Assembly F-Factors
Unheated 6" thick concrete slab

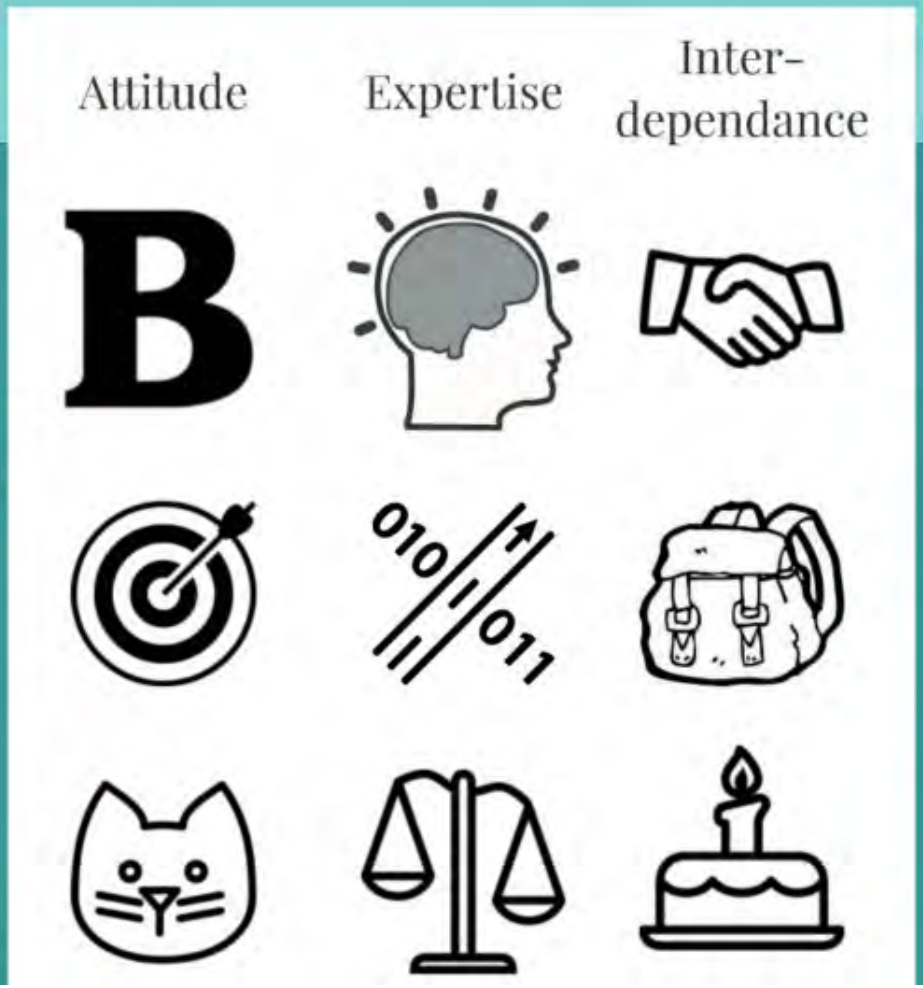
- R-10, 24" vertical insulation is F-0.54/ft
- R-10, 36" vertical insulation is F-0.51/ft
- R-10, 48" vertical insulaiton is F-0.48/ft

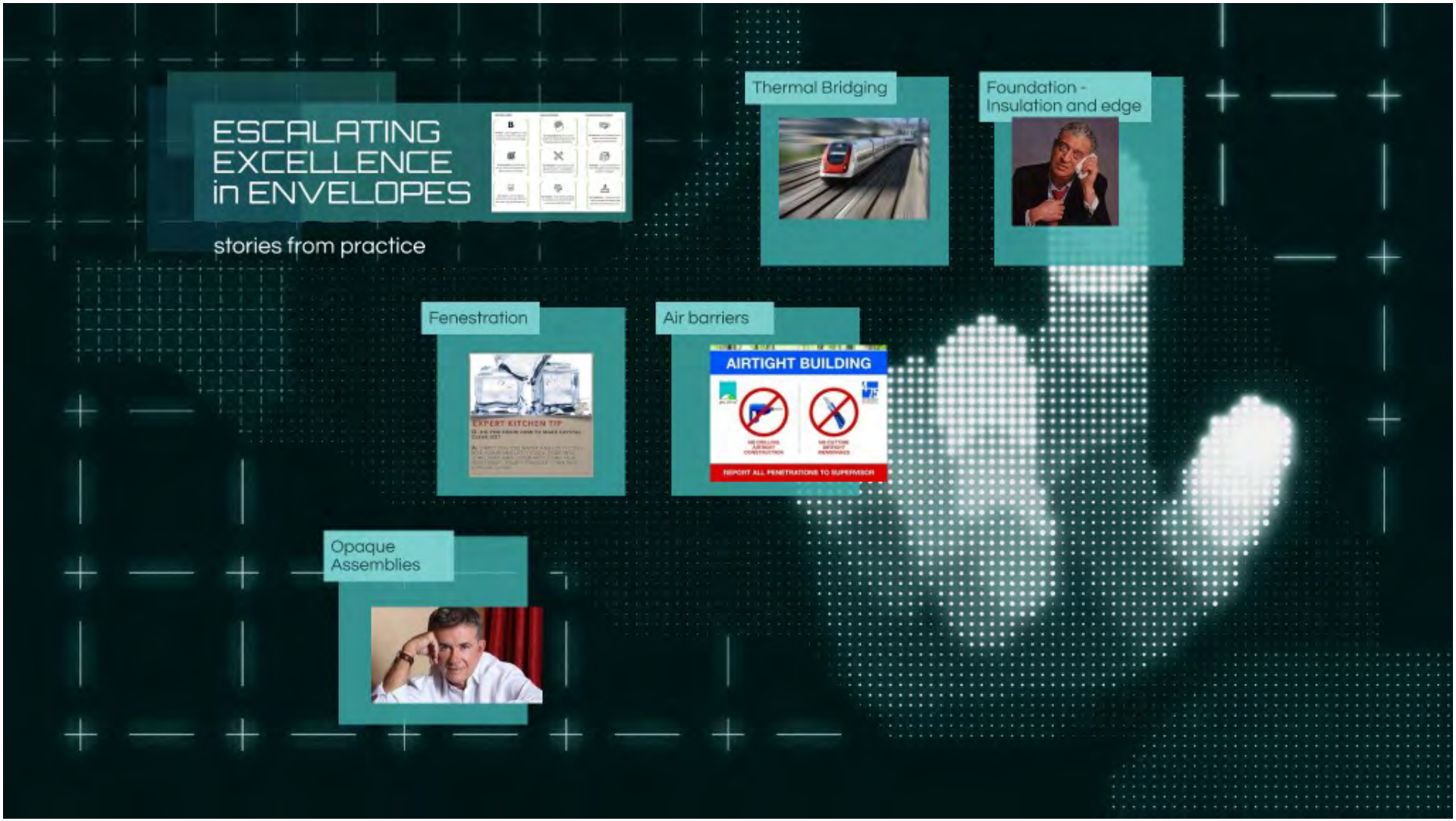
Or...

Habits


Leaving Brooklyn
Fuhgeddaboudit
Marty Markowitz
Borough President
Michael R. Bloomberg
Mayor

# Habits

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