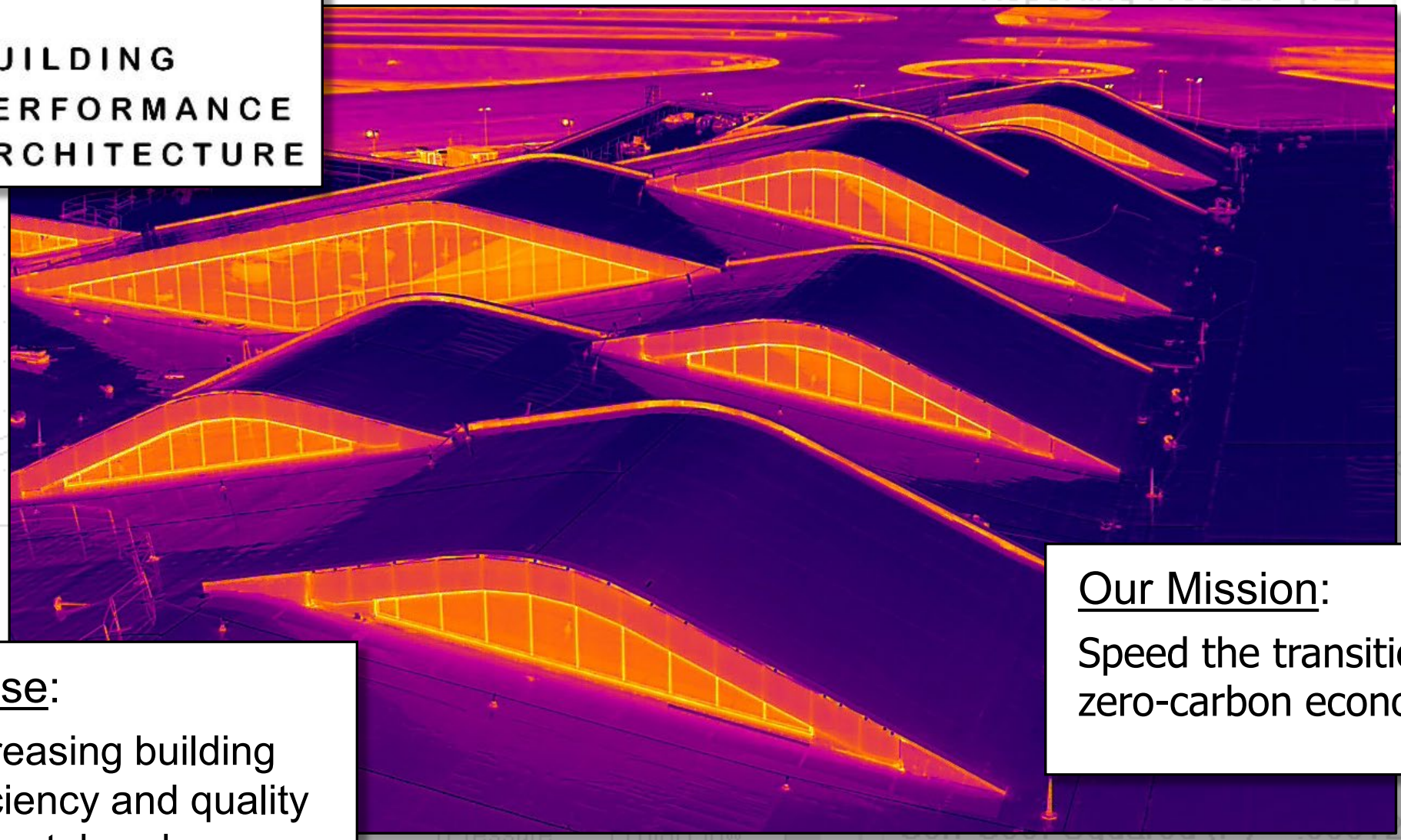
Adventures in QA/QC:

Climbing Over the Walls of Shame

phius con

MILWAUKEE 2025

BUILDING PERFORMANCE ARCHITECTURE



Our Purpose:

Greatly increasing building energy efficiency and quality through expert, hands-on QA/QC.

Our Mission:

Speed the transition to the zero-carbon economy.

13 Passive Building verification projects since 2013

QA/QC on the Terms QA and QC

Quality Assurance:

- A system for ensuring products or services meet specified requirements by preventing errors and improving processes, rather than just detecting errors
- Proactive and systematic
- Aiming to be right the first time

Quality Control:

- The process of inspecting, testing, and reviewing products or services to ensure that they meet predefined quality standards before reaching the customer
- Still systematic, but reactive
- Correct the problems found

QA/QC on Phius Projects

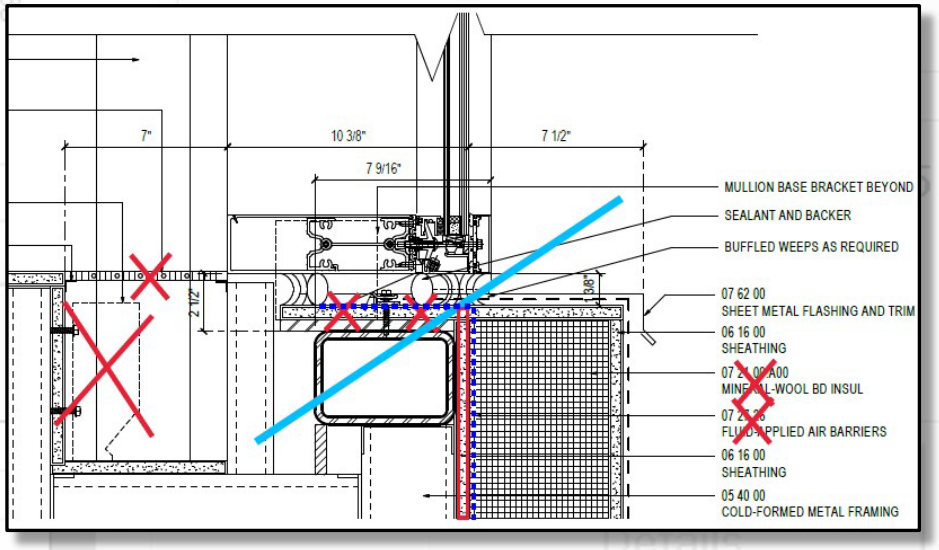
(Verifiers perform these important functions)

Quality Assurance:

- Understand program requirements
- Write the QA/QC plan
- Design team orientation
- Dwelling unit energy modeling
- Design review (required by ENERGY STAR)
- Construction team orientation

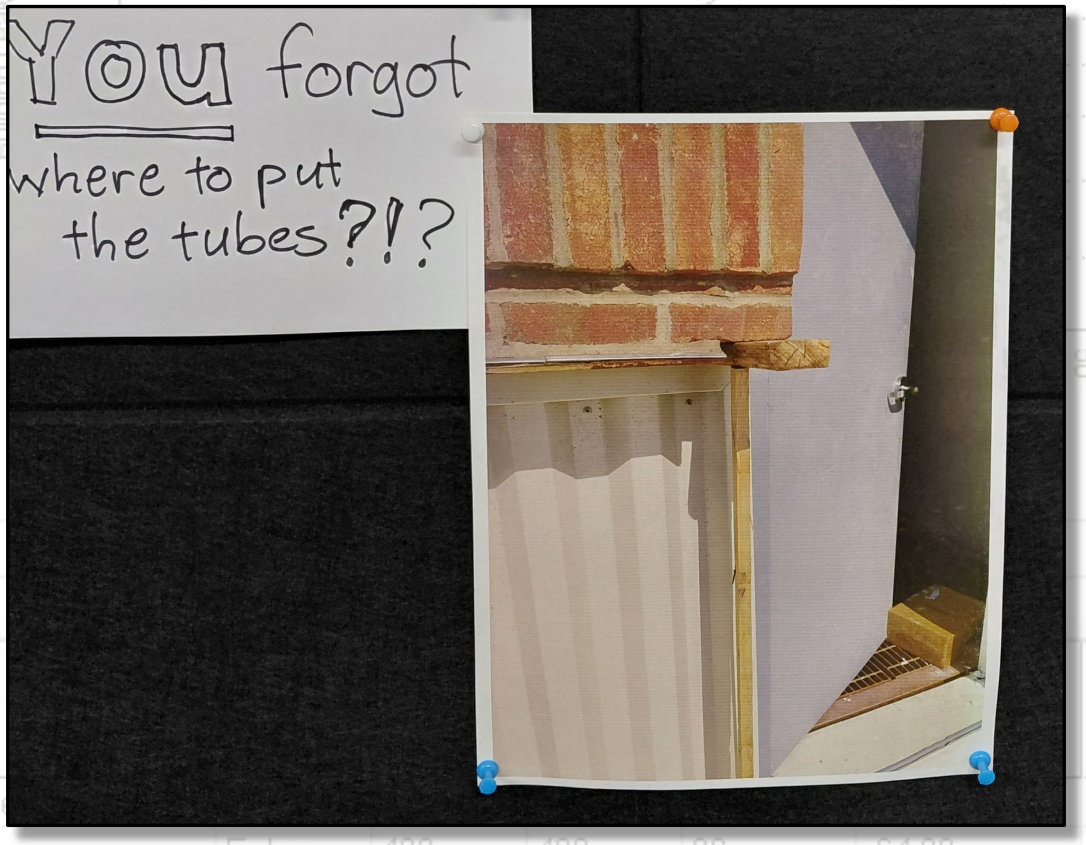
Quality Control:

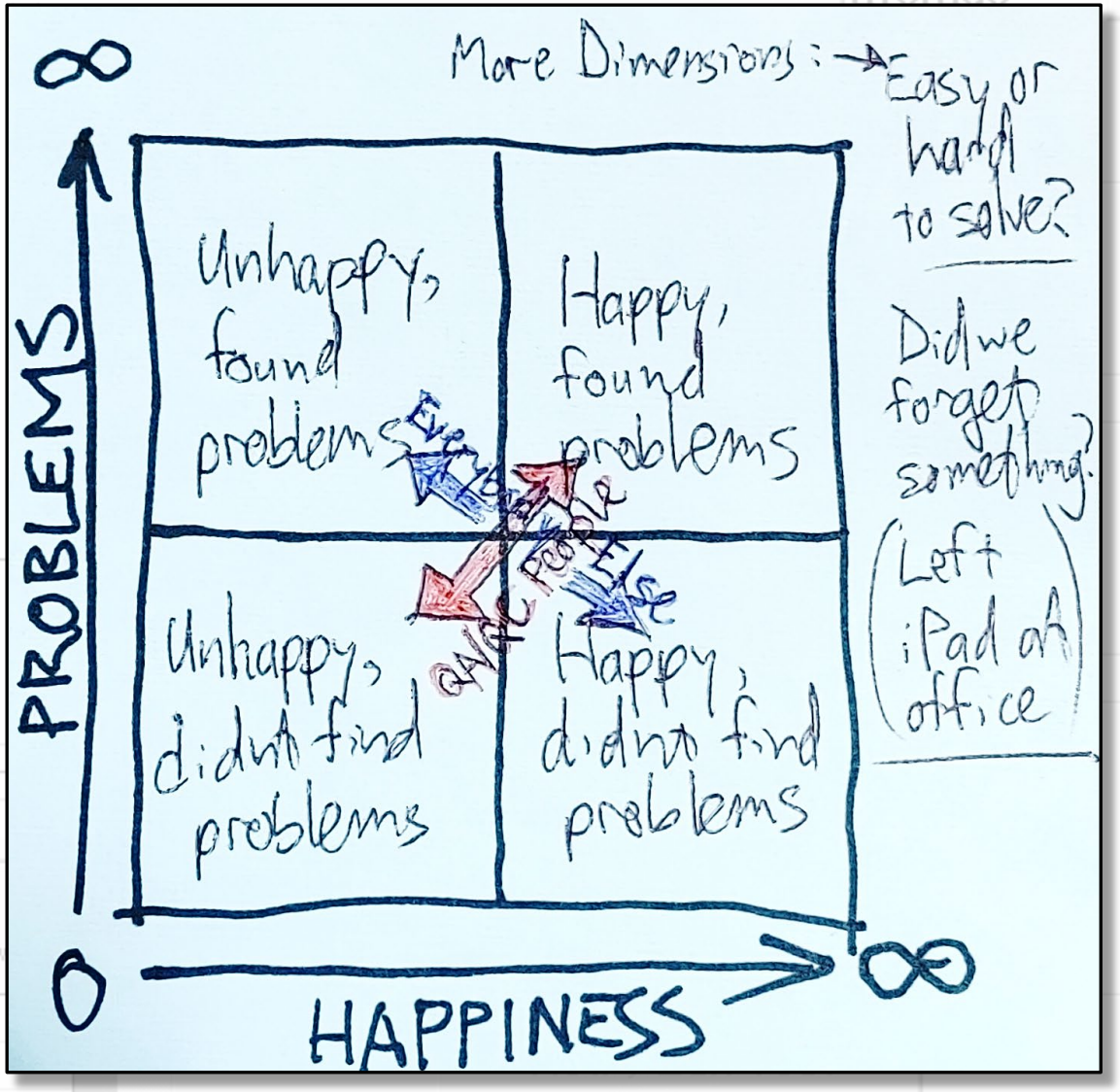
- Field testing and inspection
- Meetings and communication
- Reporting and documentation



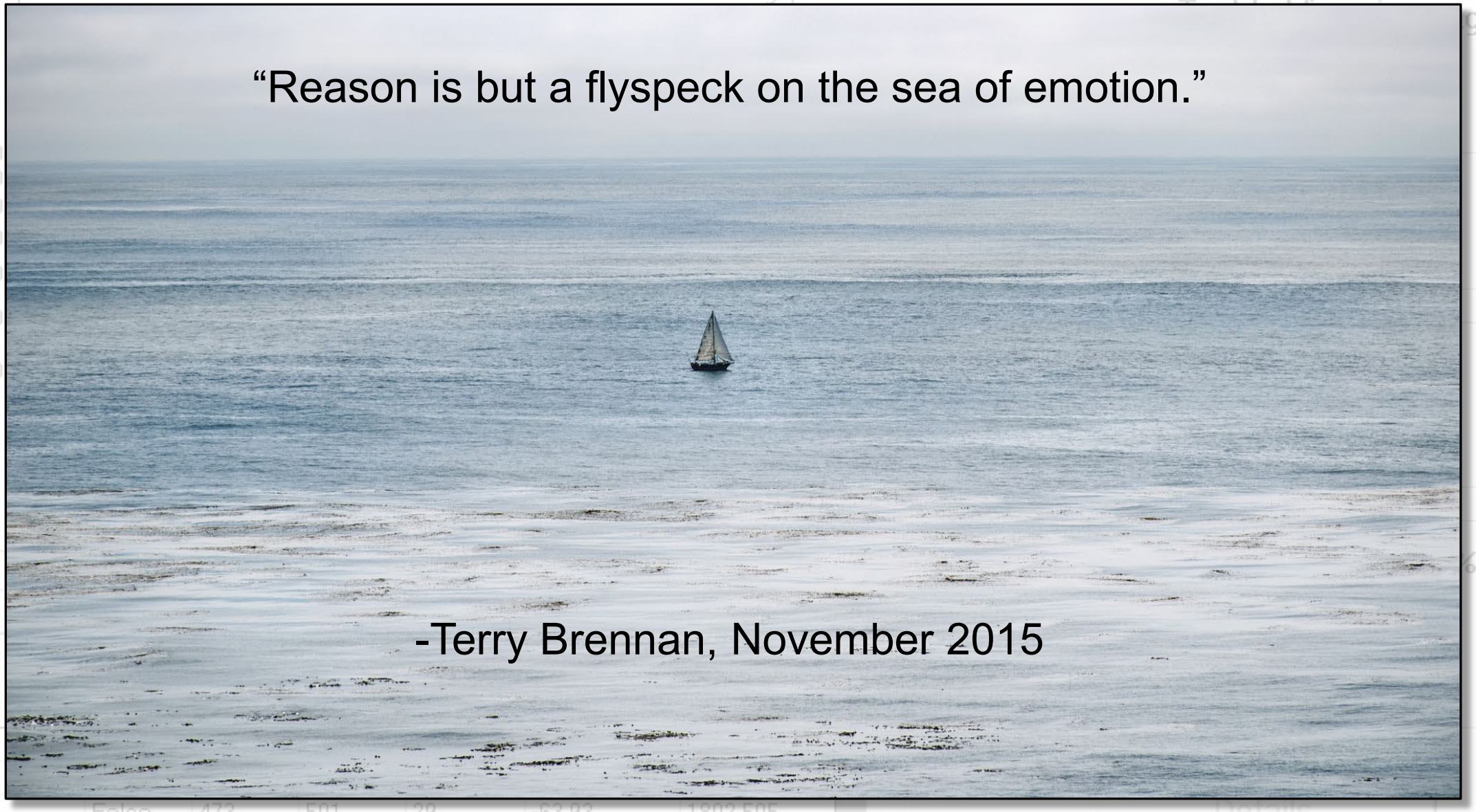
An Emotionally-Complex Discipline

Seen on BPA's Wall of Shame:





Emotions in High-Performance Construction



Shame

NL CENTRAL	W	L	PCT	GB	WCGB
Milwaukee Brewers z	96	65	.596	-	-
Chicago Cubs w	91	70	.565	5.0	+8.0
Cincinnati Reds	83	78	.516	13.0	-
St. Louis Cardinals	78	83	.484	18.0	5.0
Pittsburgh Pirates	71	90	.441	25.0	12.0

Shame Happens:

- Design Team
- CPHC
- Contractor
- Verifier

Shame may have evolved as a self-preserving response of an individual to anger within social groups. It blocks off interpersonal bridges.

"Shame is a master emotion. It is a binding emotion. It binds and interferes with other emotions. Shame is designed to keep us out of trouble…"

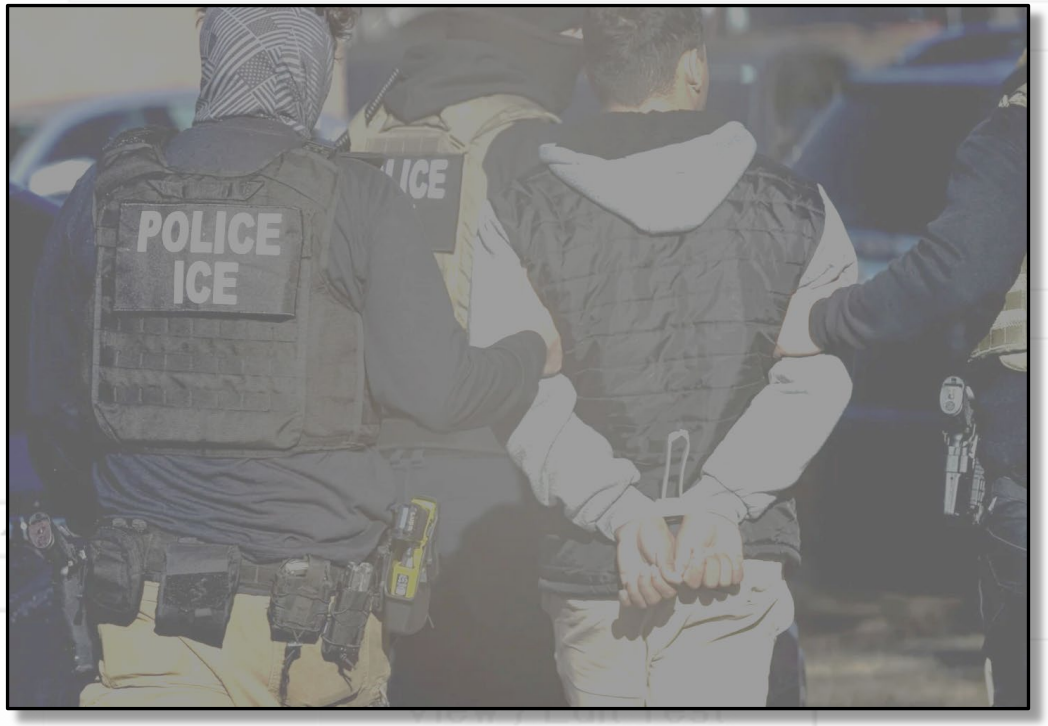
- from Embracing Shame, by Bret Lyon and Sheila Rubin

Shame in Our Culture

We've got a problem with shame in the United States.

Two reasons for early European Immigration: Liberation and Exploitation

- The exploitation system is winning for now.
- The winners deflect all shame onto others.
- Those who favor liberation for all may be ashamed that this is happening.
- Moment of Silence
- Conditioned responses: Denial, anger, fear



Building Verifiers Are on the Front Lines of Shame

"They try to turn everything into a science experiment."

"The operator did not have the proper training to operate the testing equipment and therefore the accuracy of the results is in question."

"The energy consultant for Phase 2 said that he has no intention of testing the kitchen exhaust because of the option 3 compliance method."

"Think about your client and my client! Requiring this change could cost the Owner $30,000."

QA/QC Redefined

Quality Assurance:

- A system for avoiding getting into shame-inducing situations.
- Preventing shame.

Quality Control:

- Exposing shame-inducing problems.
- Correcting the problems and healing the shame.

National Rater Field Checklist:

Please note that the Rater (BPA) will be inspecting built conditions, and your design should show how the building will meet the requirements in the following sections or items in this checklist:

- Item 1.5 and all sub-items
- Item 4.9
- Section 5: HVAC System (all items in this section)
- Section 6: Duct Quality Installation (all items in this section)
- Section 7: Dwelling-Unit & Common Space Mechanical Ventilation System (all items in this section)
- Section 8: Local Mechanical Exhaust (all items in this section)

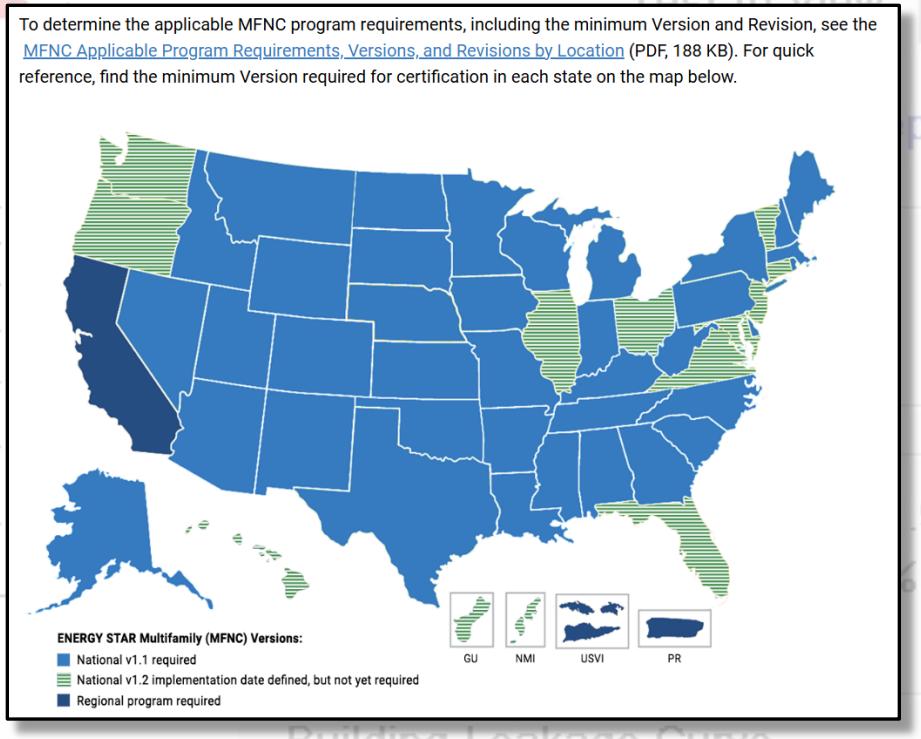
We can apply things we learn from QC in the current project into QA for the next project.

Healing Shame

- If we nurture people through their shame, then it can become part of a healthy process: Relationship, Rupture, Repair
- Build relationships and success over time.
- Offender apologizes and/or promises to behave differently next time.
- Offendee offers compassion and acceptance of the offender, if not their actions.
- Support and learning (technical and emotional) to enable better results in future.

QA: Know the Program Requirements

- Several programs to track.
- Sometimes, program version requirements may change in the middle of a project, especially if they are linked to new incentives that the client wants.
- What is the best way to handle program requirement changes for your client?
- Get the building permit to confirm its date.



"...our hands are tied on timeline. If IRS issues different guidance on 45L timeline for ZERH versions we will let everyone know right away, but I don't expect the timeline to change."

QA: Create the QA/QC Program

Flr1, A	Apt.Type	#Beds	Insp. #s
A102	E.1	2-Bed	
A103	I.1	Effic.	
A104	H1	1-Bed	
A105	H1	1-Bed	3,6,7,9
A106	H2	1-Bed	
A107	D	2-Bed	
A108	H3.1	1-Bed	
A109	I.1	Effic.	
A110	H3.1	1-Bed	
A111	H3.1	1-Bed	2,
A112	B	2-Bed	
A113	B	2-Bed	
A114	E	2-Bed	1,
A115	H3	1-Bed	

Flr2, A	Apt.Type	#Beds	Insp. #s
A201	I	Effic.	3,6,7,9
A202	E.1	2-Bed	3,6,7,9
A203	I.1	Effic.	2,
A204	H1	1-Bed	2,
A205	H1	1-Bed	
A206	H2	1-Bed	
A207	D	2-Bed	
A208	H3.1	1-Bed	
A209	I	Effic.	
A210	H3	1-Bed	
A211	H3	1-Bed	
A212	B	2-Bed	2,
A213	B	2-Bed	
A214	E	2-Bed	
A215	H3	1-Bed	

Flr3, A	Apt.Type	#Beds	Insp. #s
A301	I	Effic.	
A302	E.1	2-Bed	1,
A303	I.1	Effic.	
A304	H1	1-Bed	
A305	H1	1-Bed	
A306	H2	1-Bed	3,6,7,9
A307	D	2-Bed	
A308	H3.1	1-Bed	
A309	I	Effic.	2,
A310	H3.1	1-Bed	
A311	H3.1	1-Bed	
A312	B	2-Bed	2,
A313	B	2-Bed	2,
A314	E	2-Bed	
A315	H3.1	1-Bed	

Flr4, A	Apt.Type	#Beds	Insp. #s
A401	I	Effic.	2,
A402	E.1	2-Bed	2,
A403	I.1	Effic.	
A404	H1	1-Bed	
A405	H1	1-Bed	
A406	H2	1-Bed	
A407	D	2-Bed	
A408	H3.1	1-Bed	
A409	I	Effic.	
A410	H3	1-Bed	
A411	H3	1-Bed	
A412	B	2-Bed	
A413	B	2-Bed	2,
A414	E.1	2-Bed	3,6,7,9
A415	H3	1-Bed	3,6,7,9

Flr5, A	Apt.Type	#Beds	Insp. #s
A501	I	Effic.	
A502	E.1	2-Bed	2,
A503	I.1	Effic.	1,
A504	H1	1-Bed	
A505	H1	1-Bed	
A506	H2	1-Bed	
A507	D	2-Bed	
A508	H3.1	1-Bed	2,
A509	I	Effic.	
A510	H3	1-Bed	3,6,7,9
A511	H3	1-Bed	
A512	B	2-Bed	
A513	B	2-Bed	
A514	E.1	2-Bed	
A515	H3	1-Bed	

Flr6, A	Apt.Type	#Beds	Insp. #s
A609	I	Effic.	2,
A610	H3	1-Bed	1,
A611	H3	1-Bed	
A612	B	2-Bed	3,6,7,9
A613	B	2-Bed	
A614	E	2-Bed	
A615	H3	1-Bed	

Flr1, D	Apt.Type	#Beds	Insp. #s
D101	I	Effic.	
D102	E.1	2-Bed	
D103	I.1	Effic.	3,6,7,9
D104	H1	1-Bed	3,6,7,9
D105	H1	1-Bed	
D106	H2	1-Bed	
D107	D	2-Bed	
D108	H4	1-Bed	
D109	G	2-Bed	
D110	G	2-Bed	
D114	H3	1-Bed	
D115	I	Effic.	

Flr2, D	Apt.Type	#Beds	Insp. #s
D201	I	Effic.	2,
D202	E.1	2-Bed	
D203	I.1	Effic.	
D204	H1	1-Bed	
D205	H1	1-Bed	
D206	H2	1-Bed	1,
D207	D	2-Bed	3,6,7,9
D208	H4	1-Bed	
D209	G	2-Bed	2,
D210	G	2-Bed	
D211	B	2-Bed	
D212	B	2-Bed	
D213	H3	1-Bed	2,
D214	H3	1-Bed	
D215	I	Effic.	

Flr3, D	Apt.Type	#Beds	Insp. #s
D301	I	Effic.	
D302	E.1	2-Bed	
D303	I.1	Effic.	
D304	H1	1-Bed	
D305	H1	1-Bed	
D306	H2	1-Bed	2,
D307	D	2-Bed	2,
D308	H4	1-Bed	3,6,7,9
D309	G	2-Bed	3,6,7,9
D310	G	2-Bed	2,
D311	B	2-Bed	
D312	B	2-Bed	
D313	H3	1-Bed	
D314	H3	1-Bed	
D315	I	Effic.	

Flr4, D	Apt.Type	#Beds	Insp. #s
D401	I	Effic.	
D402	E.1	2-Bed	
D403	I.1	Effic.	
D404	H1	1-Bed	
D405	H1	1-Bed	2,
D406	H2	1-Bed	
D407	D	2-Bed	
D408	H4	1-Bed	
D409	G	2-bed	
D410	G	2-bed	
D411	B	2-bed	1,
D412	B	2-bed	2,
D413	H3	1-Bed	3,6,7,9
D414	H3	1-Bed	
D415	I	Effic.	2,

Dark borders signify areas served by a single ERV unit. For Test Plan Item 11.

ENERGY STAR MEP (5-10) Sample Set

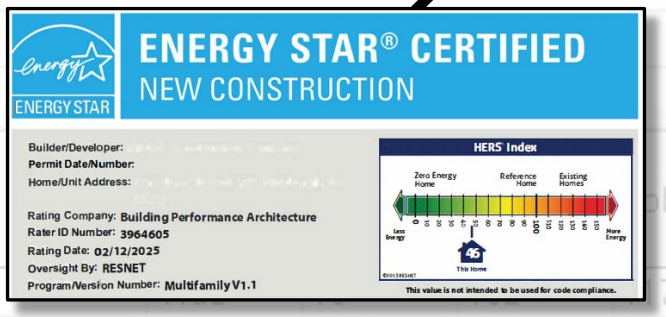
Apt.#	#Beds	Level	Sample#	Stacked	Apt #
B109	Effic.	Bot	1	X01	A201
C106	1-Bed	Bot	2	X02	B402
C107	2-Bed	Bot	3	X02	A202
B211	1-Bed	Mid	4	X03	C203
B212	2-Bed	Mid	5	X03	D103
C203	Effic.	Mid	6	X04	B304
B304	1-Bed	Mid	7	X04	D104
C314	1-Bed	Mid	8	X05	B405
C315	Effic.	Mid	9	X05	A105
B402	2-Bed	Mid	10	X06	C106
B405	1-Bed	Mid	11	X06	A306
C408	1-Bed	Top	12	X07	C107
B513	2-bed	Mid	13	X07	D207
B610	1-Bed	Top	14	X08	C408
A105	1-Bed	Bot	15	X08	D308
D103	Effic.	Bot	16	X09	B109
D104	1-Bed	Bot	17	X09	D309
A201	Effic.	Mid	18	X10	B610
A202	2-Bed	Mid	19	X10	A510
D207	2-Bed	Mid	20	X11	B211
A306	1-Bed	Mid	21	X12	B212
D308	1-Bed	Mid	22	X12	A612
D309	2-Bed	Mid	23	X13	B513
A414	2-Bed	Mid	24	X13	D413
A415	1-Bed	Mid	25	X14	B314
D413	1-Bed	Top	26	X14	A414
A510	1-Bed	Mid	27	X15	B315
A612	2-Bed	Top	28	X15	A415

- Written plan
- Contractors can incorporate you into construction schedule
- Enables Verifier team expansion
- Confirm the plan with Phius – peace of mind on all sides

QA: Design Team Orientation

phius certified verifier

- Especially helpful for first-time Phius project teams.
- Verifier provides the team with perspective that the CPHC might not cover.

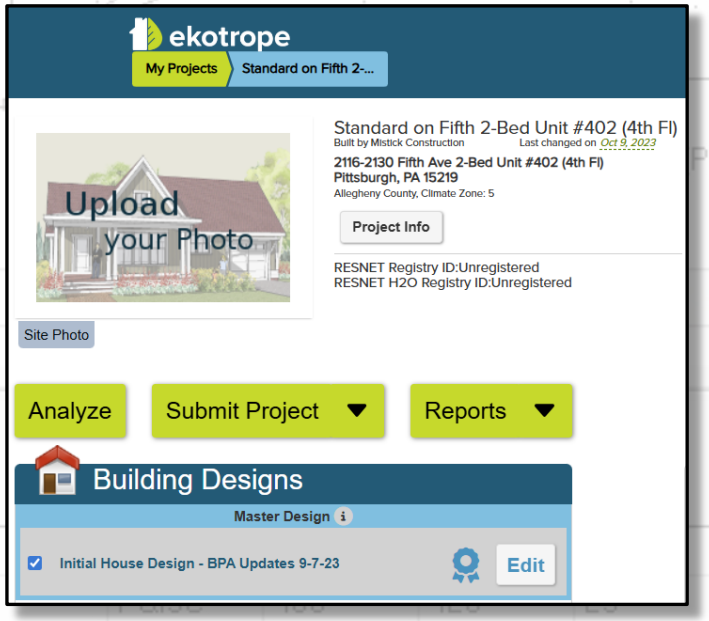


EPA Indoor airPLUS QUALIFIED HOMES

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

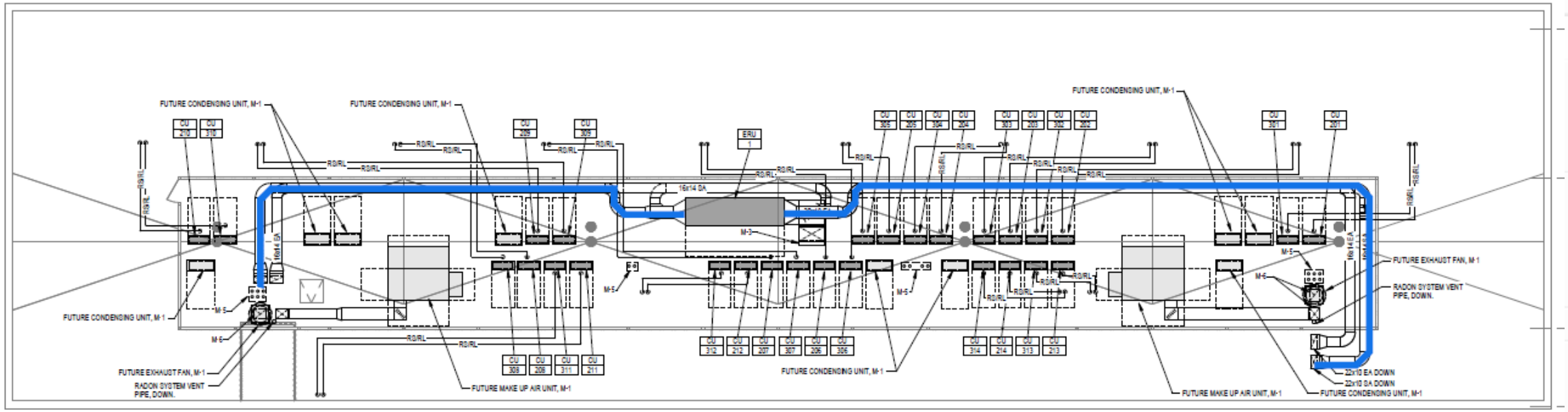
QA: Energy Modeling

- ERI Path & ASHRAE Path – Verifier has important role in building design.
- Increase production capacity by having HERS Provider move you off zero. Verifier QC the models & use them for iterations.
- Anyone here received exemption from modeling in the ASHRAE Path?



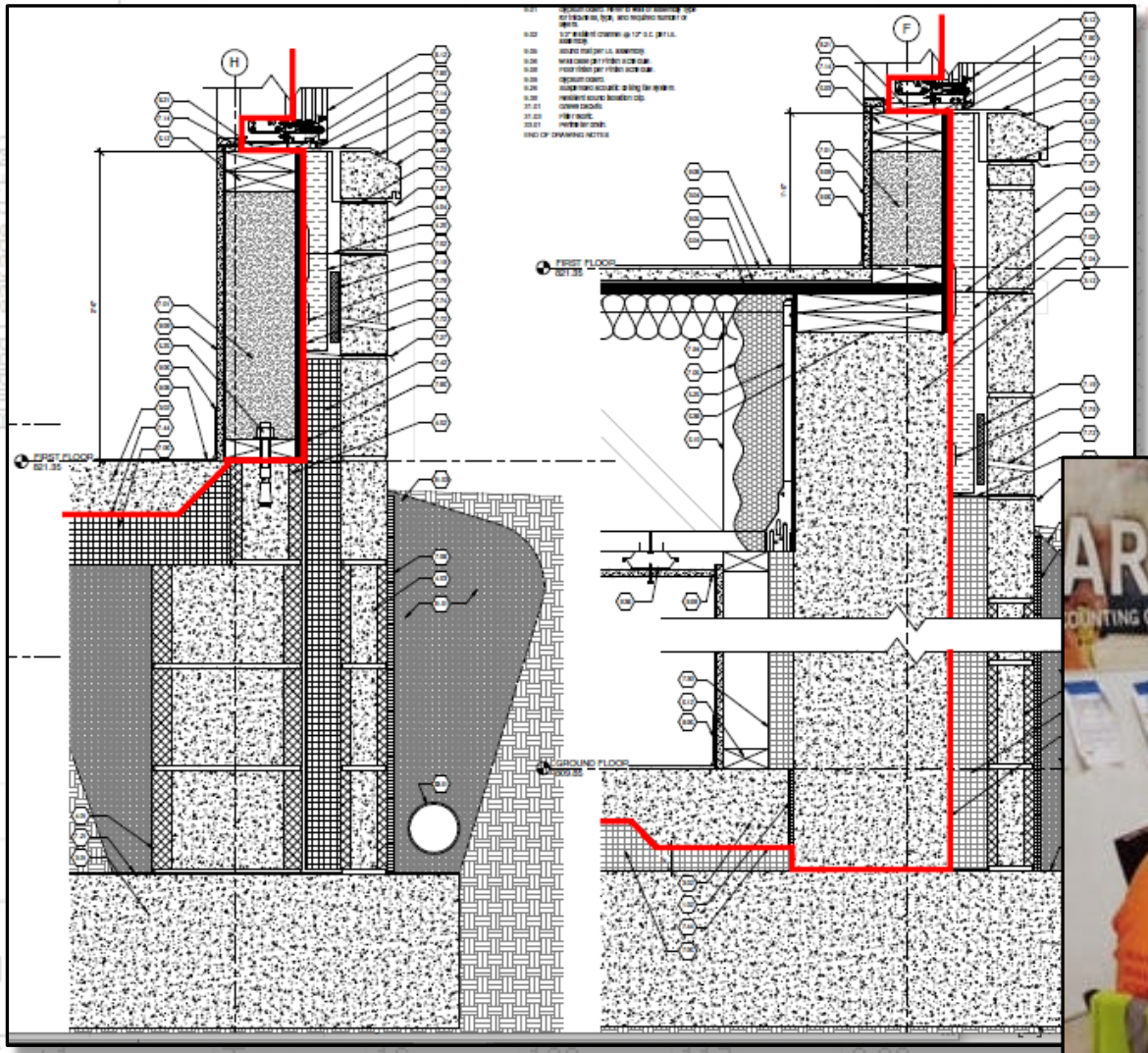
Model	1 Bed Small 2nd flr (41)	1 Bed Small 3rd flr (44)	1 Bed Large 2nd flr (41)	1 Bed Large 3rd flr (43)	2 Bed 2nd floor (41)	2 bed 3rd floor (44)
Updated "As Designed" HERS Index (/ Pass?)	48 / No	51 / No	45 / No	48 / No	42 / No	45 / No
Package 1: LG W/D, R-49.5 Roof, Reduce Vent	42 (-6) / No	45 (-6) / No	40 (-5) / Yes	42 (-6) / Yes	38 (-4) / Yes	41 (-4) / Yes
Package 1 w/ Oxygen8	44 (-4) / No	47 (-4) / No	42 (-3) / No	44 (-4) / No	39 (-3) / Yes	42 (-3) / Yes
Package 1 w/ Greenheck	41 (-7) / Yes	44 (-7) / Yes	39 (-6) / Yes	42 (-6) / Yes	38 (-4) / Yes	41 (-4) / Yes
Pkg 1 100% CD 9/24/25 Update		44 (-7) / Yes				
Package 2: LG W/D, R-49.5 Roof, Reduce Vent, Carrier Vert. HP	42 (-6) / No	44 (-7) / Yes	40 (-5) / Yes	42 (-6) / Yes	38 (-4) / Yes	40 (-5) / Yes
Package 2 w/ Oxygen8	44 (-4) / No	46 (-5) / No	41(-4) / Yes	44 (-4) / No	39 (-3) / Yes	41 (-3) / Yes
Package 2 w/ Greenheck	41 (-7) / Yes	44 (-7) / Yes	39 (-6) / Yes	41 (-7) / Yes	38 (-4) / Yes	40 (-5) / Yes
Package 3: LG W/D, R-49.5 Roof, Reduce Vent, Carrier Cass. HP	42 (-6) / No	44 (-7) / Yes	39 (-6) / Yes	41 (-7) / Yes	37 (-5) / Yes	39 (-6) / Yes
Package 3 w/ Oxygen8	44 (-4) / No	46 (-5) / No	41(-4) / Yes	43 (-5) / Yes	39 (-3) / Yes	41 (-3) / Yes
Package 3 w/ Greenheck	41 (-7) / Yes	43 (-8) / Yes	39 (-6) / Yes	41 (-7) / Yes	37 (-5) / Yes	39 (-6) / Yes
Package 4: R-49.5 Roof, Vent & All Appl "M Eff" (Bosch), Carrier Cass. HP	41 (-7) / Yes	43 (-8) / Yes	39 (-6) / Yes	40 (-8) / Yes	37 (-5) / Yes	39 (-6) / Yes
Package 4 w/ Oxygen8	43 (-5) / No	45 (-6) / No	41(-4) / Yes	42 (-6) / Yes	38 (-4) / Yes	40 (-5) / Yes
Package 4 w/ Greenheck	40 (-8) / Yes	42 (-9) / Yes	38 (-7) / Yes	40 (-8) / Yes	37 (-5) / Yes	39 (-6) / Yes

QA: Design Review



- Analysis of requirements // General knowledge & exp. // Ask questions
- Sometimes the Verifier is the first one to catch a big issue.
- ESTAR, IAP, ZERH, Phius review of 50-unit multifamily – how much $?
- No mixing ventilation & return air with open back air handler! (Told you so)

QA: Contractor Orientation



- Invite as many trades as possible.
- Start an ongoing discussion about how to build this passive building.
- Establish rapport & be relatable – what was that thing about shame?

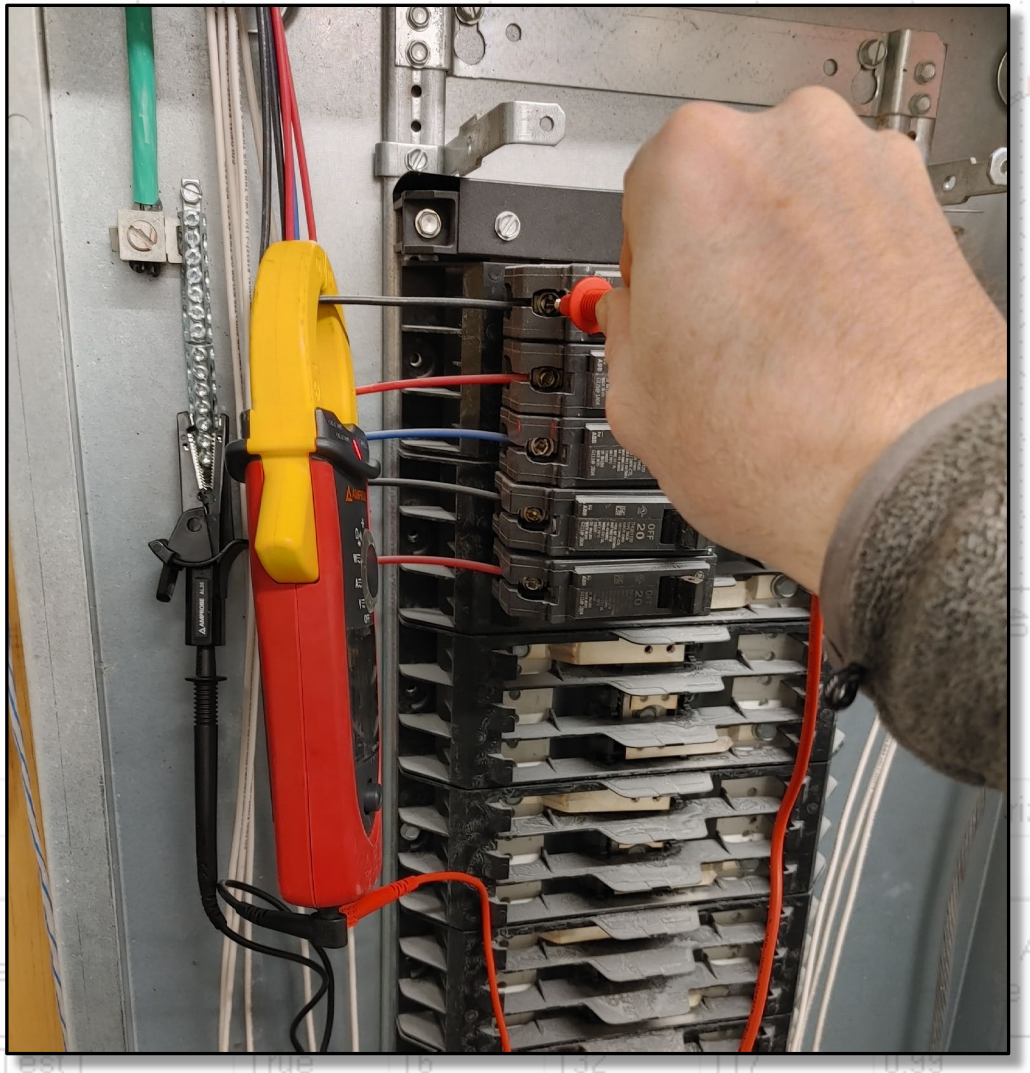
QC: Ventilation Balancing

- Single family – Verifier D.I.Y.
- Multifamily & Non-Residential: TAB Contractor.
- Can use TAB Contractor's measurements – Verifier confirm a subset. How many?
- Show up on TAB Contractor's first day – make sure they use Phius tolerances and tell them what their report must have.
- They will do it their way if you let them.

2.1.7	2.1.8			
Duct R-Value (Exhaust)	Type of ERV/HRV defrost	Airflow (cfm) from TAB report	Fan Power (Watts)	Electric Efficiency (W/cfm)
	[Select]			-

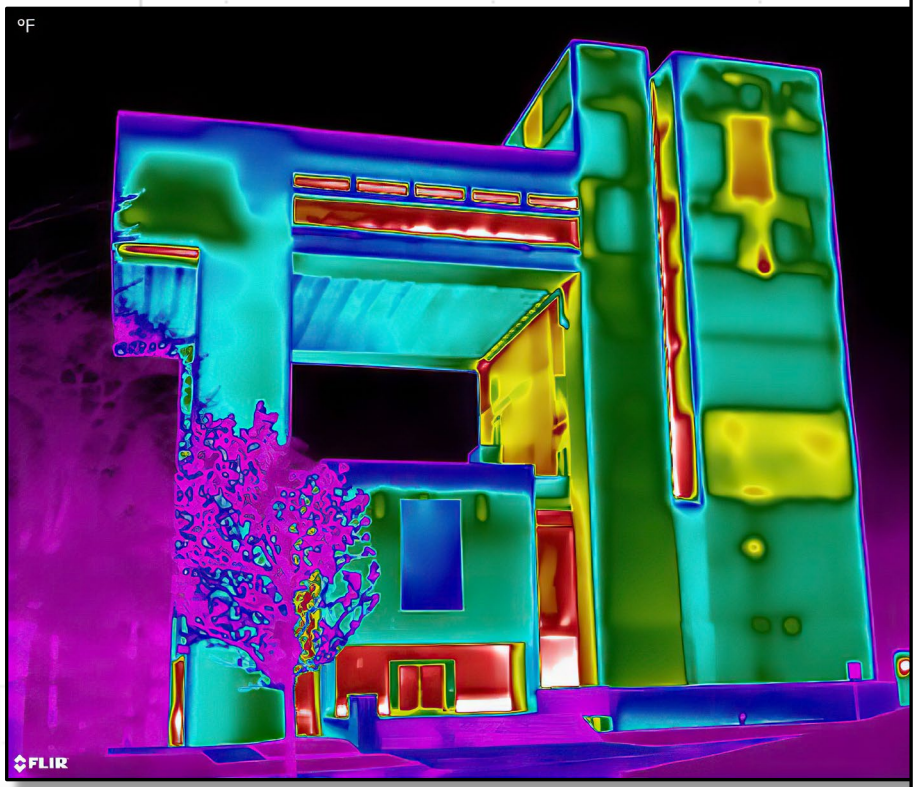
Airflow		Room Pressure Difference	Status		
Design (cfm)	Verified (cfm)		≥Design	Within +5cfm or	<1 Pa Pressure
100	99		Not acceptabl	t acceptal	Ok
100	125		Ok	t Acceptal	Ok
100	119		Ok	Ok	Ok
100	124		Ok	Ok	Ok

QC: ERV Power Draw

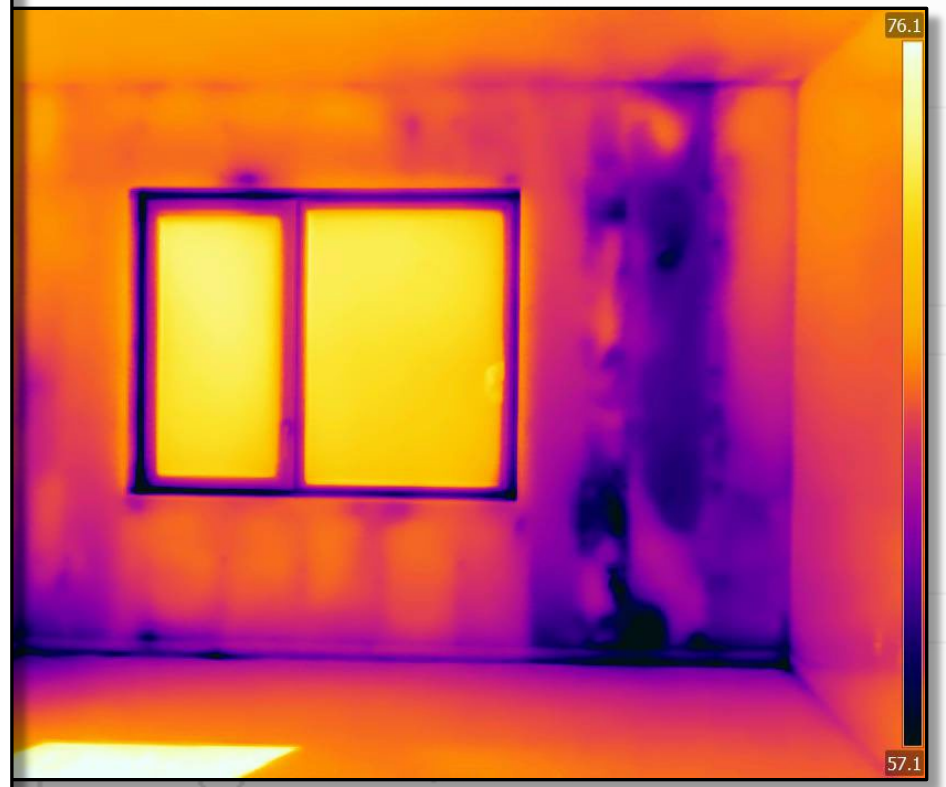


- Unique to Phius – can make a big difference in primary energy results.
- Electrical contractor did not know what a TRMS clamp meter is. What to do?
- Don’t do this alone! “The only way we knew something was wrong was that all the lights in the building dimmed…Okay, see you later!”

QC: Infrared Scan

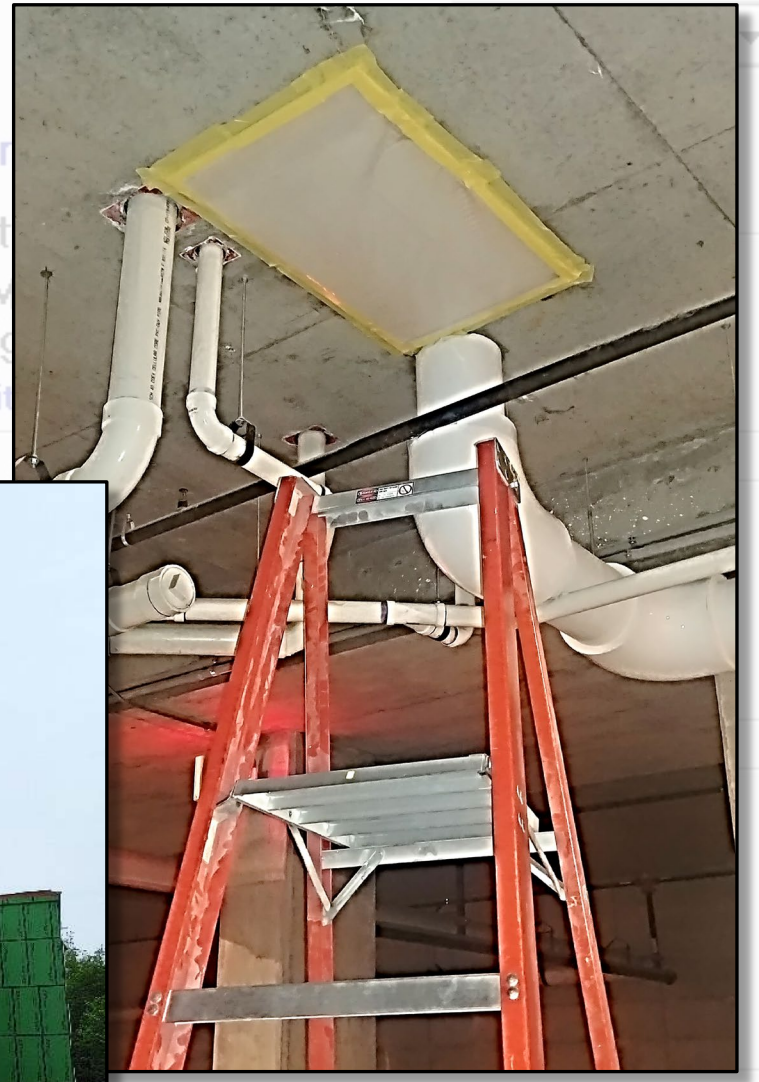


- Get training!
- Interior w/ & w/o blower door.
- Exterior at night.
- Find problems & correct them until the thermal images are boring.
- Will Phius flag problems?



QC: Blower Door

- Sequencing is key for midpoint test.
- Know what needs to be temporarily sealed and what is not allowed.
- “Non-threatening” taped vs. untaped.
- When will the building code catch up, require our expertise, and give recurring revenue?



QC: Equipment

TEC
The Energy Conservatory

Calibration Certificate

Calibration Facility:	2801 21st Ave. S., Minneapolis, MN 55407	**Equipment:**	Minneapolis Blower Door
Calibration Date:	March 6, 2024	**Model:**	3
Customer Name:	Building Performance Architec	**Serial #:**	16272
Customer #:	PI3743	**Temperature (F):**	72.8
Certificate #:	M3-110-16272-03-06-24_new	**Pressure (hPa):**	1001

Fan Flow Calibration Parameters

	Custom (based on Calibration Data)		Published	
Flow Ring	Coefficient (C)	Exponent (n)	Coefficient (C)	Exponent (n)
Open	**526.0**	**0.4781**	**506.8**	**0.4879**
A	**186.2**	**0.4925**	**190.1**	**0.4876**
B	**60.57**	**0.4986**	**60.67**	**0.4955**

- Make sure it works before you travel, or you'll have a long day.
- Make sure it's calibrated. Know where to get it calibrated. Have duplicate equipment to fill in when calibrating.
- Try not to make Galen Staengl drive out from VA.
- Sophisticated verifiers have their own calibration programs and build equipment costs into their fees.

QC: Communication

- Respect – Contractors deal with more than you do.
- Tell them before you leave.
- Reports & documentation – make them useful.
- Submission – who has mastered the Phius system?
- Testing failures: Who pays? (vs. whose fault?) Explicitly discuss and agree on this in advance.

Success!

BUILDING PERFORMANCE ARCHITECTURE

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