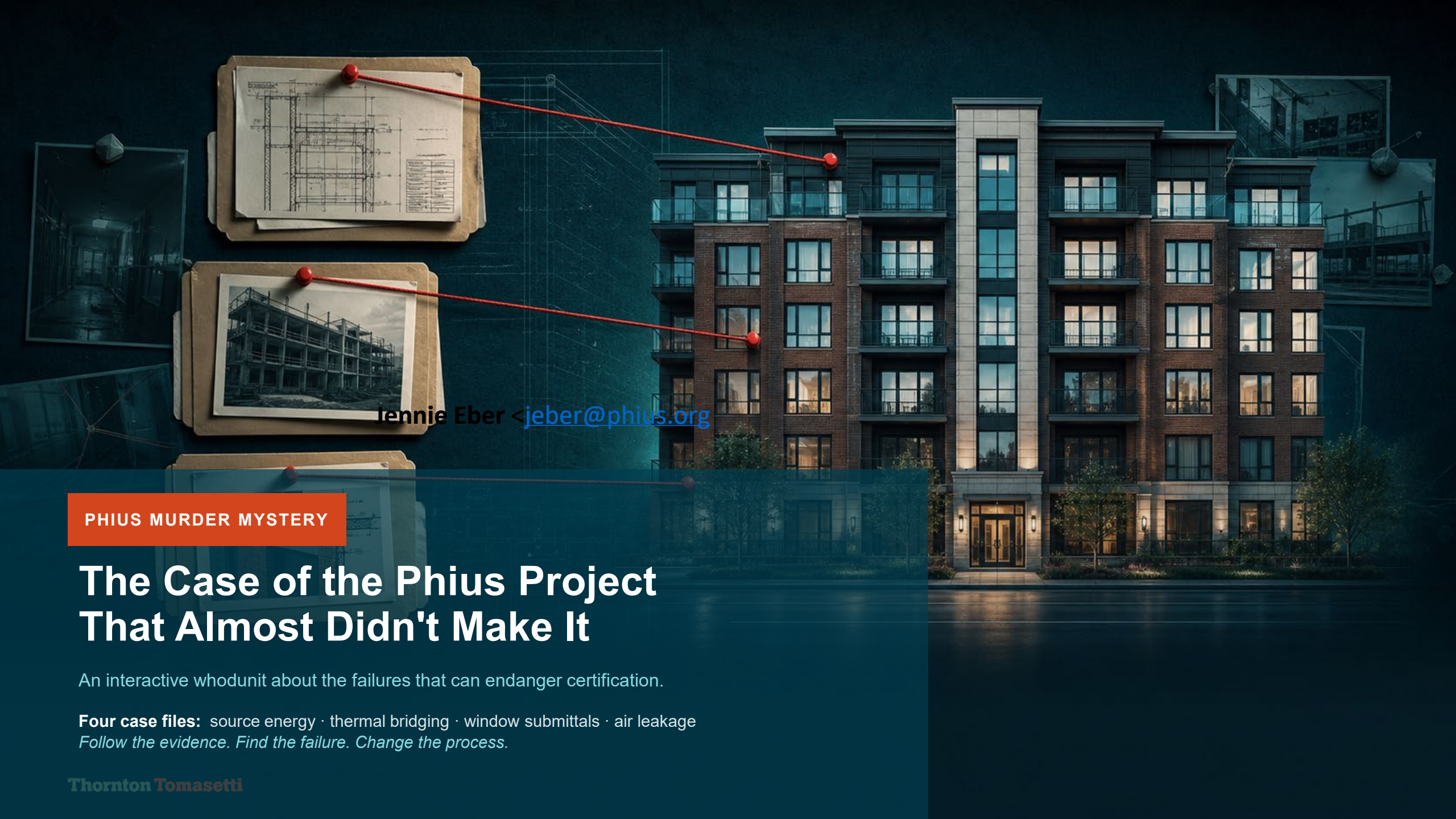


Phius Murder Mystery:

**An Interactive Whodunit Game Focused on Uncovering and Solving
Issues That Can “Kill” Phius Certification**





PHIUS MURDER MYSTERY

The Case of the Phius Project That Almost Didn't Make It

An interactive whodunit about the failures that can endanger certification.

Four case files: source energy · thermal bridging · window submittals · air leakage
Follow the evidence. Find the failure. Change the process.

Thornton Tomasetti

WHO ARE YOUR PRESENTERS?

Defendant 1



Rheannon DeMond

CPHC, BAP, NZE Designer

Senior Associate | Sustainability & Resilience
Project Manager / Passive House Lead

15+
YEARS

3M+
SQ FT PHIUS / PASSIVE HOUSE

- Sustainable design, building science, and high-performance construction.
- Multifamily housing, student residences, schools, and institutional buildings.
- CPHC since 2015

Defendant 2



Prudence Ferreira

CPHC, LEED AP BD+C

Vice President | Sustainability & Resilience
Principal in Charge / Passive House & Energy Modeling Lead

20+
YEARS

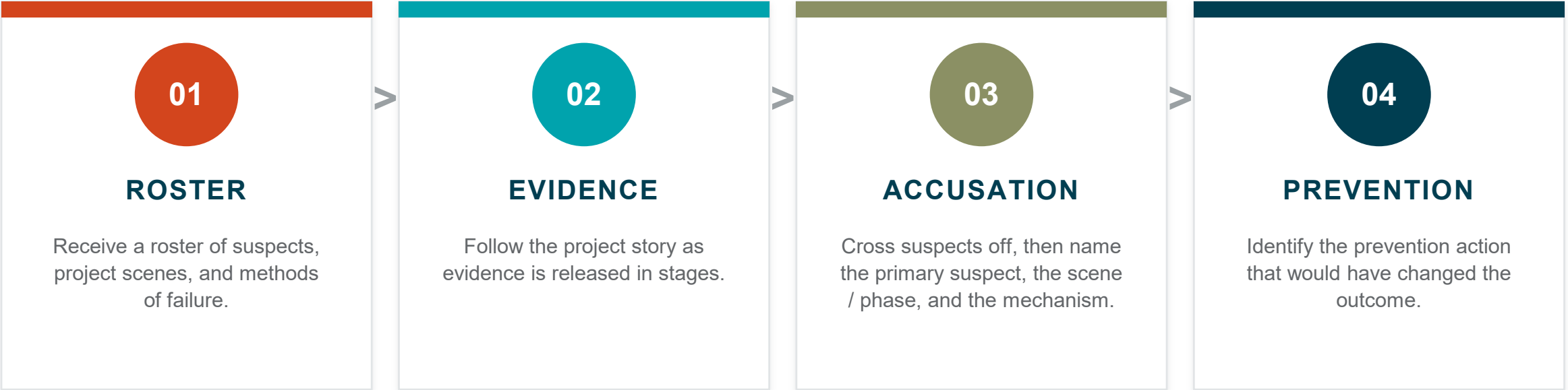
5M+
SQ FT PASSIVE HOUSE

- Sustainability consulting across residential, commercial, institutional, and manufacturing projects.
- Work spans seven climate zones; PHIUS Board and Technical Committee member.
- CPHC since 2009

FROM MODEL TO FIELD: PERFORMANCE THAT SURVIVES REVIEW AND CONSTRUCTION.

How to Win the Investigation

Work every case the same way — from the roster to a prevention action.



EVERY CASE — IDENTIFY FOUR THINGS

- **Primary suspect**
- **Project scene / phase**
- **Failure mechanism**
- **Prevention action**

Suspect rule: name one primary suspect and up to two contributing suspects.

Clue-style rules: suspects are technical conditions, assumptions, and decisions — not people.

The Suspect Roster

Eight conditions under investigation across the whole project.

SUSPECT 01

The Model Assumption

Inputs stand in for reality until verified.

SUSPECT 02

The Value-Engineered System Package

Average-performance systems chosen to protect first cost.

SUSPECT 03

The Limited Solar Opportunity

Not enough on-site roof for meaningful offset.

SUSPECT 04

The High-Load Appliance Package

Premium features add energy above the Energy Star baseline.

SUSPECT 05

The Fossil-Fuel Pool Boiler

The only combustion source on the site.

SUSPECT 06

The Unverified Submittal

Product data that never returned to the model.

SUSPECT 07

The Uncoordinated Detail

Intent that a connection quietly bypassed.

SUSPECT 08

The Test-Boundary Blind Spot

Components left outside the tested zone.

CALLOUT Some suspects are root causes. Others are contributing conditions or red herrings.

The Scenes and the Methods

Where a failure can emerge, and the mechanism that does the damage.

SCENES	METHODS OF FAILURE
1 Early feasibility & target-setting	Source-energy penalty
2 Design coordination	Thermal bridging
3 Product submittals	Performance mismatch
4 Construction	Air leakage
5 Verification & testing	Unverified handoff

The Composite Project and the Initial Verdict

One fictional/composite 13-story multifamily brick project targeting Phius certification.

The project begins with a credible compliance strategy. As design develops, evidence reveals gaps between owner priorities, model assumptions, details, submittals, and field conditions.

INITIAL VERDICT
Certification is at risk



Source energy

Feasibility



Brick shelf angle

Coordination



Window shop drawings

Submittals



Fan coil units

Construction / test

DISCLOSURE Adapted from real-world project patterns; presented as one composite narrative, not a literal project record.

CASE FILE 01

The Source-Energy Conspiracy

PHASE Early feasibility & target-setting

The miss: the project is not meeting the source-energy target — but the model does not yet tell us why.

Stakes: source-energy compliance is repeatedly missed.

Constraint: on-site solar capacity is limited.

The rule: name one primary suspect and up to two contributing suspects.

CASE FILE 01

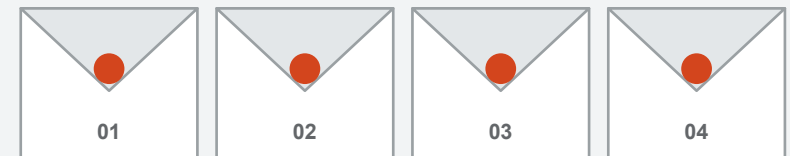
ILLUSTRATIVE

SOURCE ENERGY vs. TARGET



Source energy repeatedly exceeds the target.

SEALED EVIDENCE • FOUR CLUE ROUNDS



Source-Energy Suspect Roster

Six technical conditions under investigation — the answer is not yet labeled.

SUSPECT 01

**The Average-Performance
Mechanical Package**

SUSPECT 02

**The Electric-Resistance Water
Heaters**

SUSPECT 03

**The High-Load Appliance
Package**

SUSPECT 04

The Limited Solar Opportunity

SUSPECT 05

The Natural-Gas Pool Boiler

SUSPECT 06

**The Owner/Tenant Utility-Cost
Split**

CALLOUT Some suspects are root causes. Others are contributors or pathway complications.

Clue Round 1: What Is the Project Fighting?

Release these three clues, then test which suspects stay plausible.

1

EVIDENCE 01

Source-energy results repeatedly miss the target.

2

EVIDENCE 02

Available on-site solar cannot provide enough offset.

3

EVIDENCE 03

The project is market rate.

THEORY BOARD

PLAUSIBLE

STILL UNCONFIRMED

Sort suspects as the clues land.

PROMPT

Which suspects are now plausible, and which are still unconfirmed?

Clue Round 2: Follow the System and Appliance Choices

The cumulative penalty builds across three choices.

1

Mini-split heat pumps have average performance.

2

Water heating uses electric resistance.

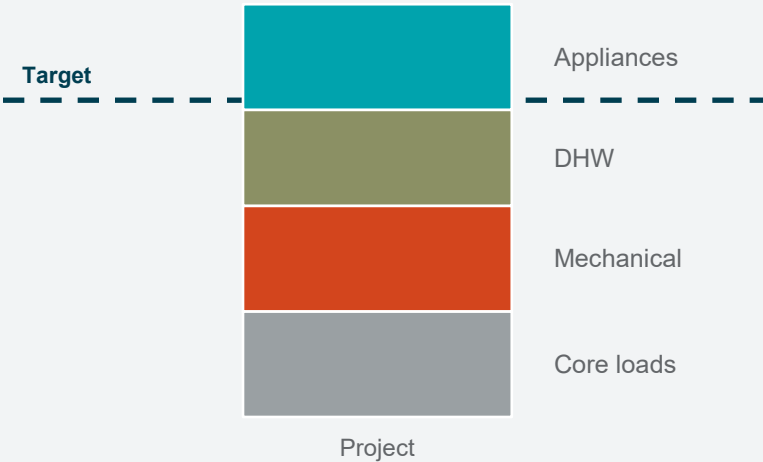
3

Appliance selections use more energy than baseline Energy Star appliances — ice makers and higher-end systems.

PROMPT Which suspect combination creates the cumulative penalty?

SOURCE-ENERGY STACK

ILLUSTRATIVE



Stacked choices push the total above target.

Clue Round 3: Find the Motive and the Pathway Complication

Separate what hurts the source-energy number from what blocks the pathway.

SOURCE-ENERGY IMPACT

Does the pool boiler meaningfully move the source-energy number — or is the shortfall mostly systems, appliances, and limited solar?

PATHWAY CONSEQUENCE

The only fossil-fuel system blocks the Zero pathway and triggers an electrification-readiness requirement.

1

Tenants pay utility bills; the owner pays for central systems.

2

The outdoor pool is heated by a natural-gas boiler.

3

The gas boiler is the only fossil-fuel system on site.

4

The gas boiler blocks the Zero pathway and creates an electrification-readiness requirement.

PROMPT Is the pool boiler the culprit, a contributor, or a separate pathway complication?

Checkpoint: Make a Provisional Accusation

Commit to a working theory before the final clue — you can revise it later.

PROVISIONAL ACCUSATION

Primary suspect:

Contributing suspects:

Scene:

Mechanism:

Evidence still needed:

TEAM CONFIDENCE

Low

Building

Medium

Strong

Certain

Mark where your team stands.

Final Clue: What Can the Owner Accept?

Ownership and who-pays decide which corrections are feasible.

CLUE Compliance was achieved with heat-pump dryers plus the higher-efficiency ERV.

Heat-Pump Dryers

INITIALLY REJECTED → LATER ACCEPTED

First rejected as infeasible; tenants pay the utilities, so the owner saw little payback. Reconsidered once needed for compliance.

Higher-Efficiency ERV

ACCEPTED

Accepted readily — a central appliance the owner buys and controls, so the upgrade aligns with who pays.

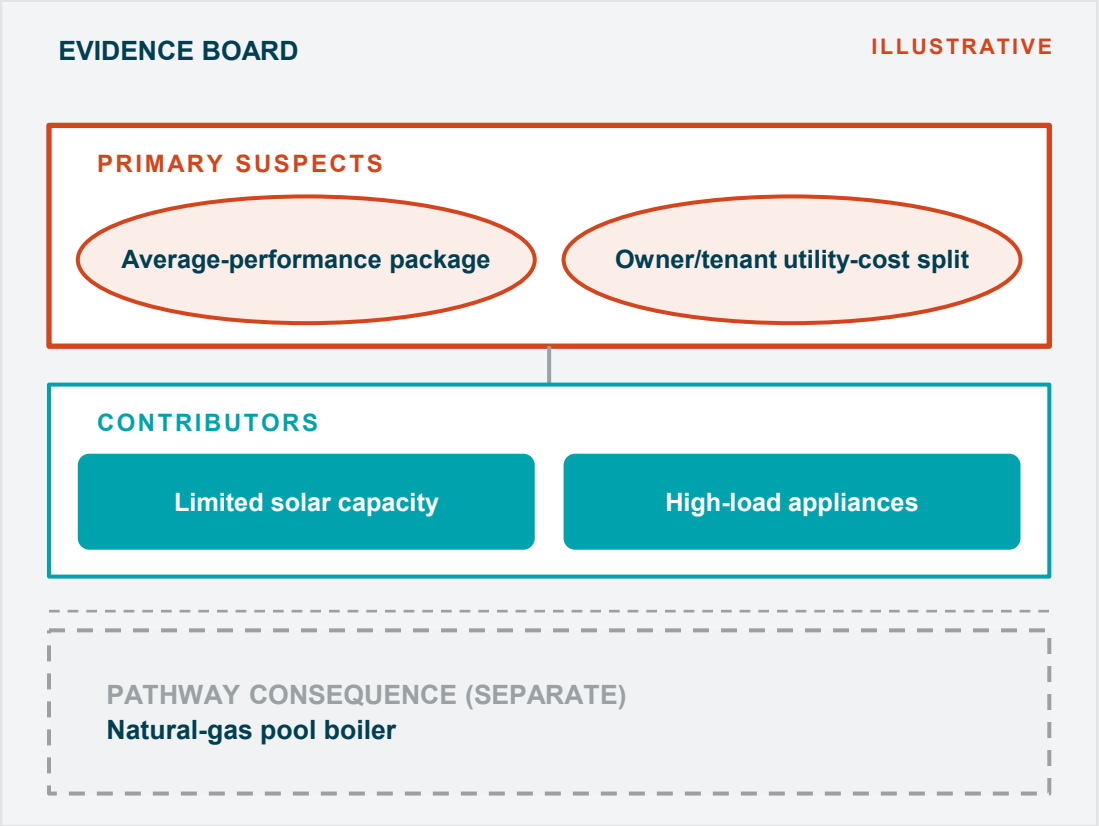


Owner control & who-pays: central systems the owner funds are easier to upgrade; in-unit items billed to tenants face resistance until compliance forces the issue.

PROMPT: Which correction changed the feasible solution set?

Source-Energy Reveal: The Correct Accusation

- PRIMARY SUSPECTS** — the average-performance system/appliance package and the owner/tenant utility-cost split
- CONTRIBUTING** — limited solar capacity and high-load appliances
- PATHWAY COMPLICATION (SEPARATE)** — the natural-gas pool boiler
- SCENE** — early feasibility and target-setting
- MECHANISM** — cumulative source-energy penalties combined with limited renewable offset and pathway constraints
- RESOLUTION** — heat-pump dryers and a higher-efficiency ERV



Source-Energy Prevention Gate

Five feasibility-stage checks that would have changed the outcome.

1

Test system and appliance packages during feasibility — before decisions are locked.

2

Identify who pays utilities and who controls capital decisions — align incentives with the target.

3

Quantify premium appliance features — ice makers and higher-end systems add source energy.

4

Flag fossil-fuel equipment for pathway consequences — Zero eligibility and electrification-readiness.

5

Preserve practical alternatives before the design is locked — keep correction options open.

Clear this gate at feasibility and the source-energy case never opens.

CASE FILE 02

The Steel Bridge

PHASE Structural & envelope coordination

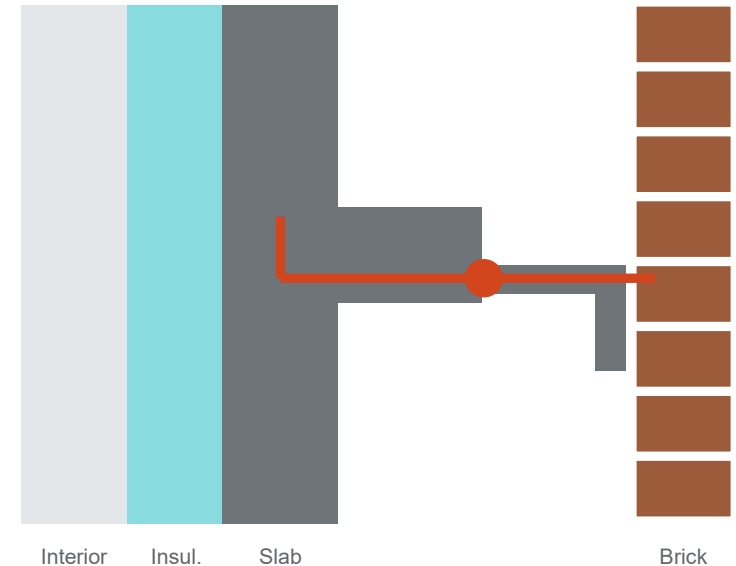
Design intent: all brick attachments must be thermally broken.

Appearances: architectural details and reviews appear to be progressing normally.

The turn: a structural detail reveals a continuous welded shelf angle through the 13-story brick façade.

WALL SECTION

ILLUSTRATIVE



Continuous welded shelf angle = uninterrupted thermal bridge

Shelf-Angle Evidence Release

Intended isolated attachment versus the continuous welded attachment.

INTENDED · ISOLATED ATTACHMENT

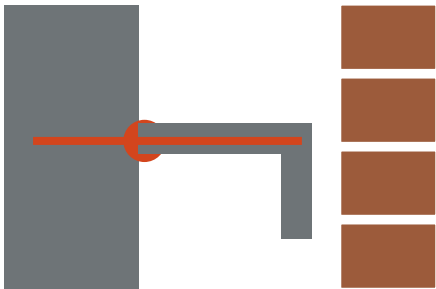


Thermal-break pad — path interrupted

ILLUSTRATIVE

- Requirement: brick attachments are thermally broken.
- Architectural detail: thermal-break strategy appears intact.

AS-BUILT · CONTINUOUS WELDED



Welded — conductive path

ILLUSTRATIVE

- Structural: shelf angle is continuously welded.
- The connection creates an uninterrupted conductive path.
- 3D thermal analysis is needed for the complex connection.

EVIDENCE SEQUENCE

1

Design requirement: brick attachments thermally broken

2

Architectural detail: thermal break appears intact

3

Structural detail: shelf angle continuously welded

4

Welded connection creates a conductive path

5

3D thermal analysis required

Thornton Tomasetti

18

Checkpoint 02: Which Detail Defeated the Strategy?

Vote first — then reveal the suspect.

SUSPECT 1

The insulation

SUSPECT 2

The thermal-break pad

SUSPECT 3

The shelf angle

← *uncoordinated detail*

SUSPECT 4

The connection geometry

GUIDING QUESTIONS

- Is the failure in the insulation, the thermal-break pad, the shelf angle, or the connection geometry?
- Why could a typical architectural review miss it?
- What structural connection preserves the thermal-break intent?

TEAM VOTE Reveal the highlighted suspect only after the audience votes.

Shelf-Angle Reveal: The Weld Created the Bridge

CULPRIT

The continuously welded shelf angle.

MECHANISM

The steel connection bypassed the intended thermal-break strategy.

CONSEQUENCE

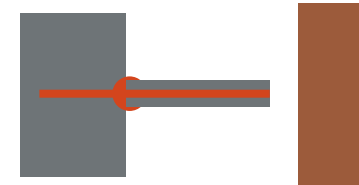
Redesign: mechanically fastened attachments, thermal-break pads, and 3D thermal analysis.

PREVENTION

Coordinate structural load paths and thermal-break continuity detail by detail.

BEFORE · WELDED

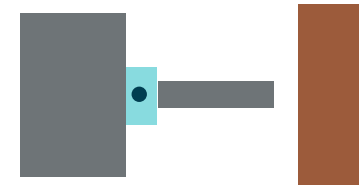
ILLUSTRATIVE



Heat bridges through the weld.

AFTER · FASTENED + BREAK PAD

ILLUSTRATIVE



Fastened + break pad keeps the path interrupted.

Before / after connection detail.

CASE FILE 03

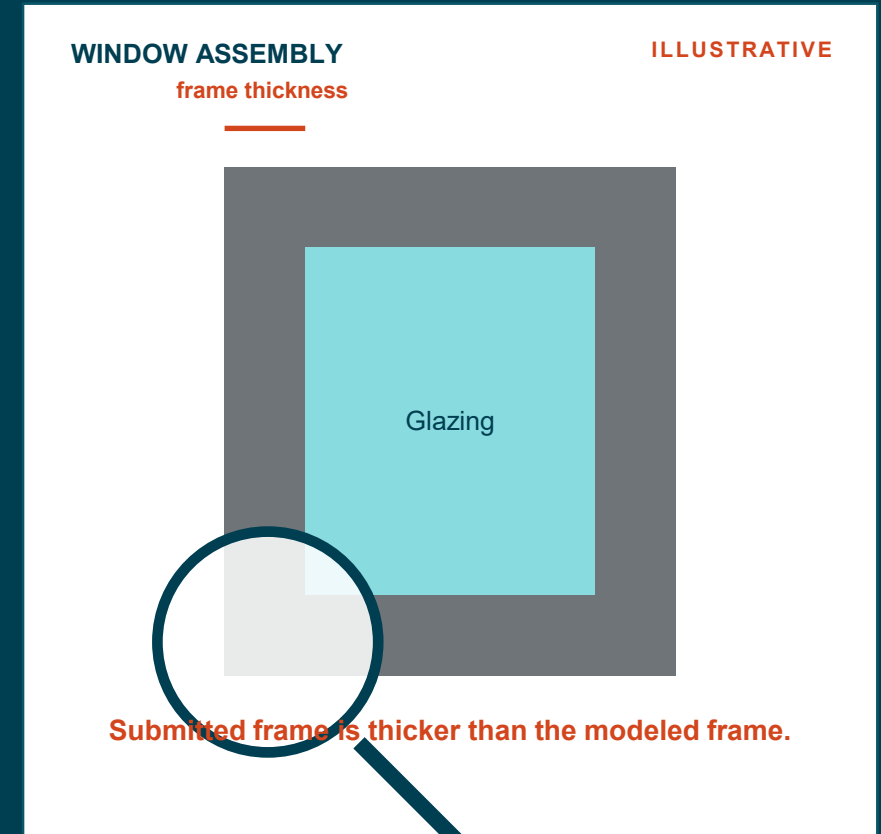
The Window That Changed Shape

PHASE Design & product-submittal coordination

Baseline: Plius window data was used to carry compliance through design.

The clue: the shop drawing showed a thicker frame than the Plius datasheet and model.

Risk: the performance decrease threatened the project's compliance margin.



Window Evidence Release

Model assumption versus the submitted shop drawing.

PHIUS DATASHEET / MODEL

ILLUSTRATIVE



Modeled frame

SHOP DRAWING (SUBMITTED)

ILLUSTRATIVE



Thicker frame

EVIDENCE

- Model input: frame thickness highlighted.
- Shop-drawing section: submitted thickness highlighted.
- Before/after performance comparison.
- Model result: compliance margin narrowing.

CORRECTIVE-ACTION CARD

Additional open-cell spray foam is added in the stud cavity to restore lost envelope performance and recover the compliance margin.

Checkpoint 03: What Changed Between Design and Submittal?

Vote on the suspect, then reconcile the evidence.

SUSPECT 1 The glazing	SUSPECT 2 Frame geometry ← <i>model/submittal mismatch</i>	SUSPECT 3 Installation	SUSPECT 4 Modeling coordination
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GUIDING QUESTIONS

- Is the suspect the glazing, frame geometry, installation, or modeling coordination?
- What evidence proves the model and shop drawing no longer match?
- What should be reconciled before the product is accepted?

TEAM VOTE Commit to a suspect before the reveal.

Window Reveal: The Model and Submittal No Longer Matched

CULPRIT

The submitted frame thickness differed from the frame in the Phius data/model.

MECHANISM

The thicker frame reduced window performance relative to the modeled assumption.

CONSEQUENCE

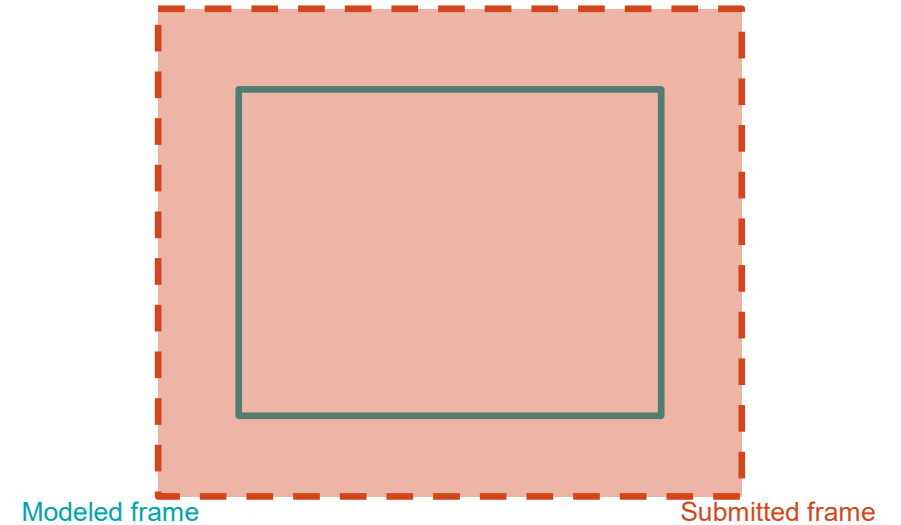
Lost performance; the project needed additional envelope performance.

CORRECTIVE / PREVENTION

Open-cell spray foam in the stud cavity; require a submittal-to-model reconciliation gate.

SMOKING-GUN OVERLAY

ILLUSTRATIVE



Thicker frame



Lower perf.



Foam restores

Cause → effect → correction

CASE FILE 04

The Fan Coil That Lied

PHASE Construction & final verification

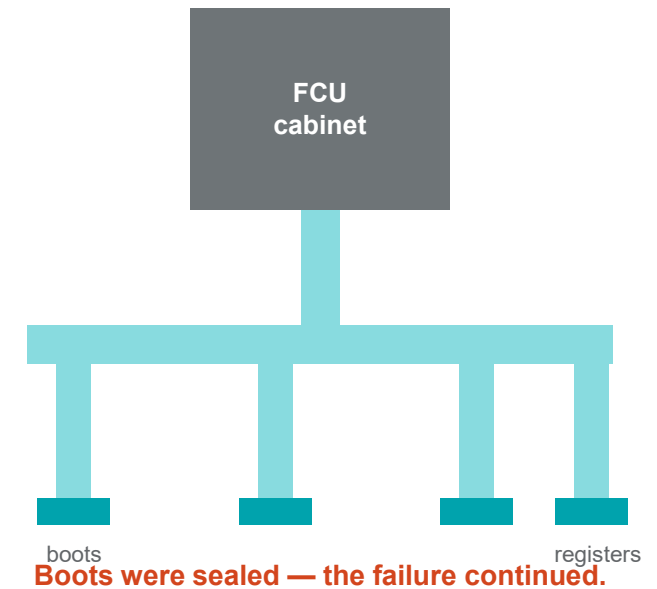
Early signal: earlier duct testing suggested the ductwork was tight.

The failure: fan coil units repeatedly failed the final duct-tightness test.

Dead end: sealing the duct boots did not solve the problem.

AIR DISTRIBUTION

ILLUSTRATIVE



Fan-Coil Evidence Release

Three suspect zones: duct runs, duct boots, and the equipment cabinet.

ZONE 1 · DUCT RUNS

Prior test appeared acceptable.

ZONE 2 · DUCT BOOTS

Sealed to the drywall — failure continued.

ZONE 3 · FCU CABINET

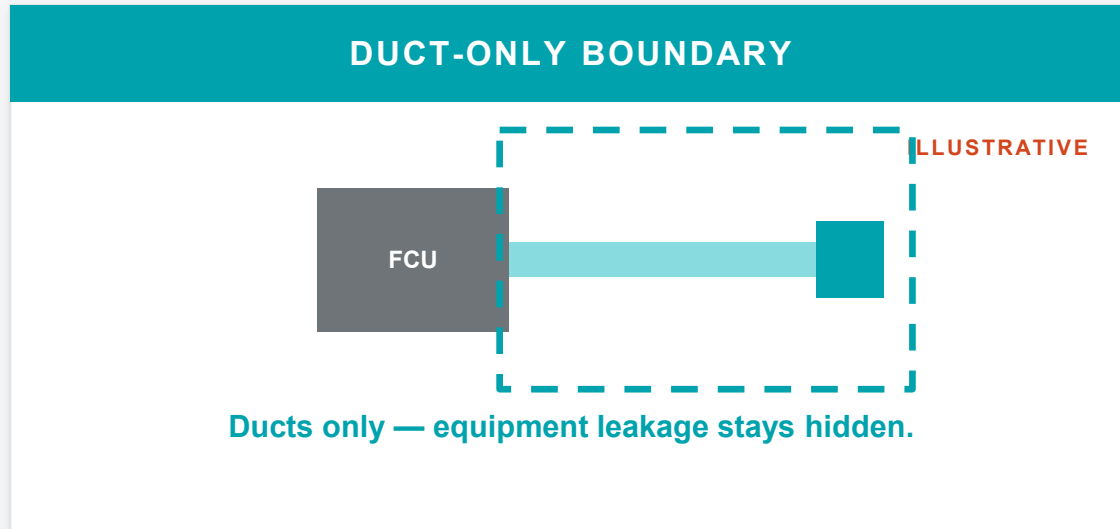
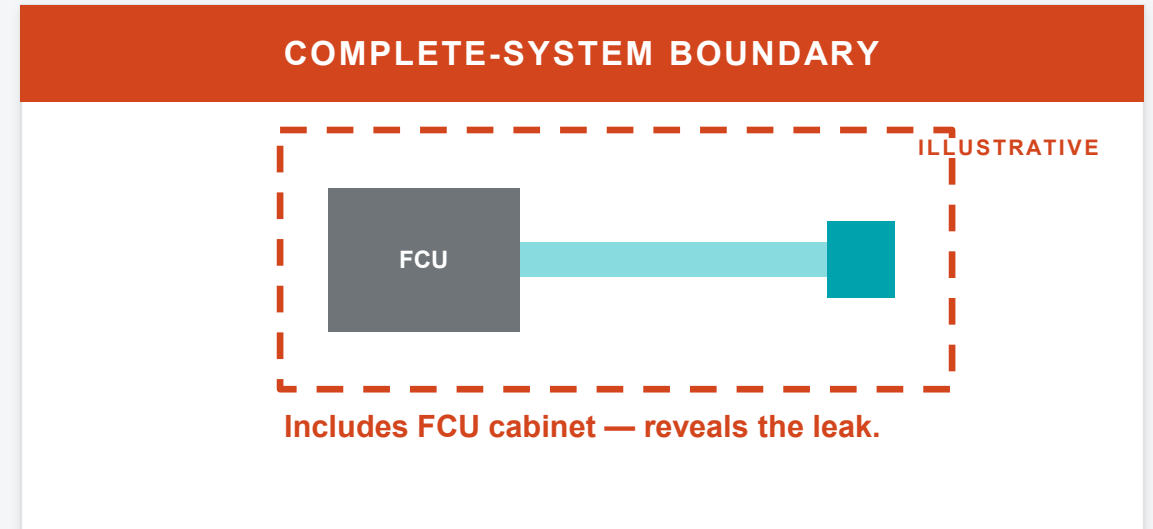
One unit removed: cabinet found highly leaky.

EVIDENCE SEQUENCE

- | | | | |
|---|---|---|--|
| 1 | Prior duct test appears acceptable. | 4 | Failure continues. |
| 2 | Final testing repeatedly fails at fan coil units. | 5 | One unit is removed — cabinet is highly leaky. |
| 3 | Duct boots are sealed to the drywall. | 6 | Every unit requires removal and air sealing to pass. |

Checkpoint 04: What Is Actually Being Tested?

Duct-only test boundary versus the complete installed system.



GUIDING QUESTIONS

- Is the test evaluating duct runs only, or the complete installed air-distribution system?
- What evidence isolates equipment leakage from duct leakage?
- Why did sealing the duct boots fail to solve the problem, and what should have been tested before concealment?

Fan-Coil Reveal: The Equipment Cabinet Was the Culprit

CULPRIT

Leakage through the fan coil unit cabinets.

MECHANISM

Equipment leakage consumed the allowable leakage budget.

CONSEQUENCE

Each unit required removal and air sealing.

PREVENTION

Verify equipment-level air sealing and test the complete installed system before concealment.

LEAKY CABINET → PASSING CONDITION ILLUSTRATIVE

Leaky FCU cabinets



Repeated final-test failures



Remove & air-seal every unit



Complete system passes

Make Your Final Accusation

Each team submits a formal accusation, then compares it to the true sequence.

TEAM ACCUSATION

We accuse _____

The scene was _____

The mechanism was _____

The evidence was _____

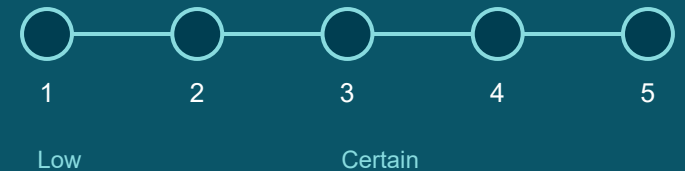
The prevention action was _____

Name a single suspect or a suspect combination.

SCORING

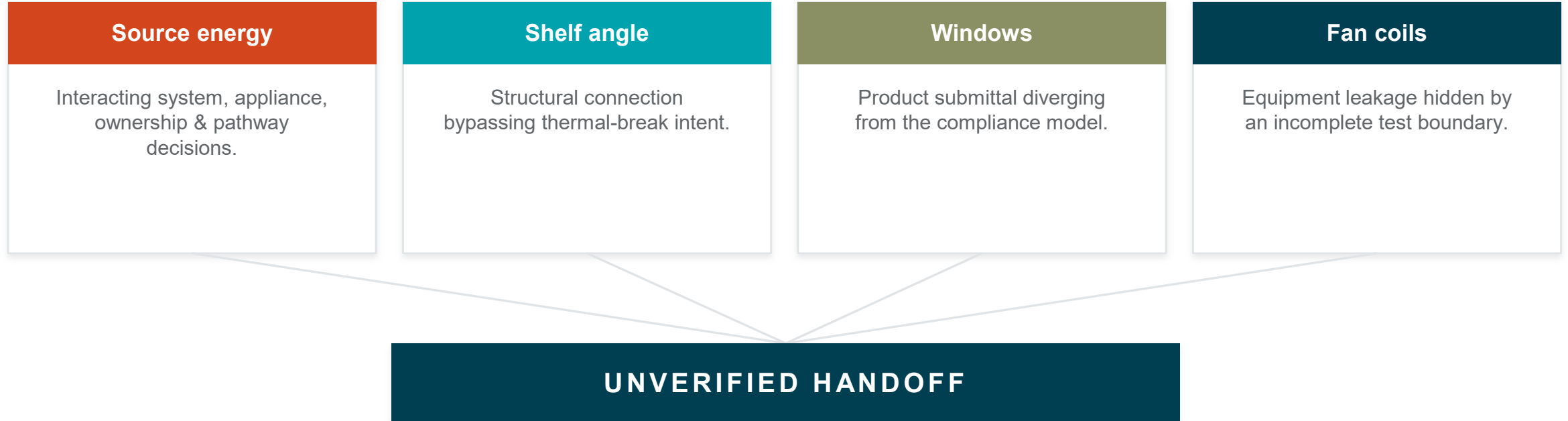
- Correct suspect or suspect combination
- Correct scene / phase
- Correct mechanism
- Correct prevention action

TEAM CONFIDENCE



Four Case Files, One Pattern

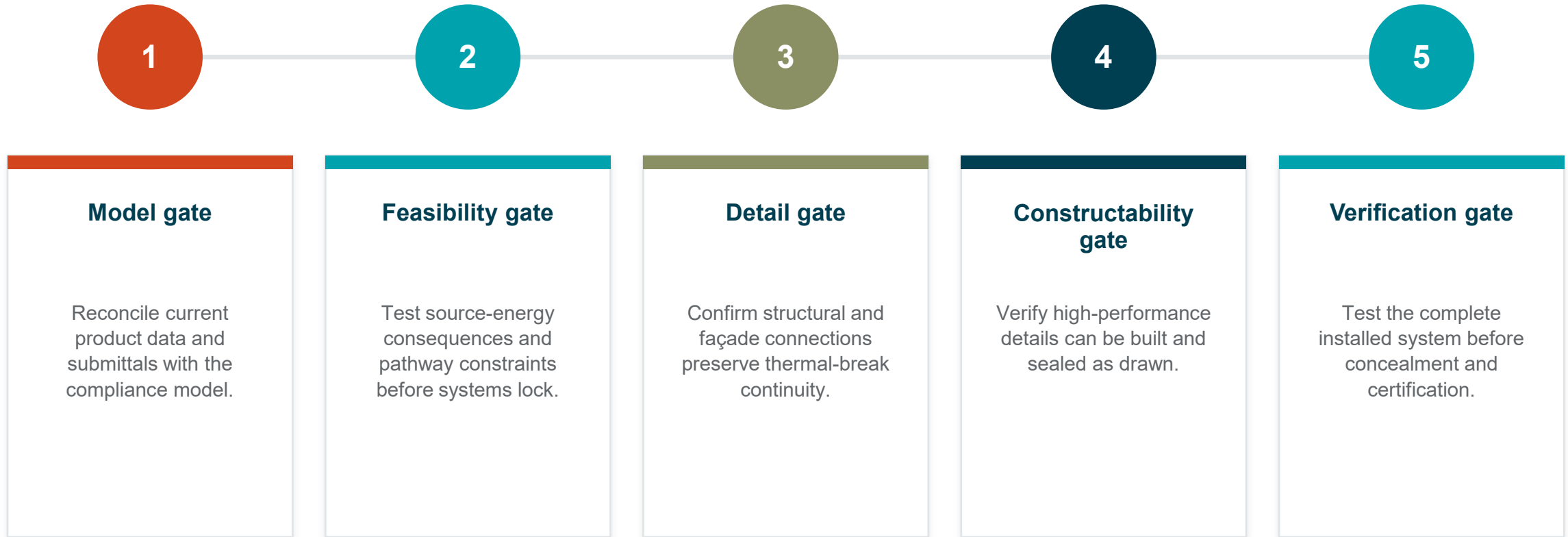
Different weapons — the same underlying failure mode.



The project was not killed by one villain. It was repeatedly exposed by unverified handoffs and the late discovery of consequences.

The Prevention Toolkit

Five gates along the project timeline.



Each gate maps to one of the four cases — verify before you hand off.

Write a Different Ending

- Small gaps accumulate across feasibility, design, submittals, construction, and testing.
- The strongest defense is disciplined coordination plus timely verification.
- The goal is not to assign blame — it is to make failure harder to create and easier to catch.
- Case closed means the process improved — not that the project got lucky.

SOURCE ENERGY
PREVENTED

SHELF ANGLE
PREVENTED

WINDOWS
PREVENTED

FAN COILS
PREVENTED

CERTIFICATION
PATH PROTECTED