



Air Flow Control – Critical Design Considerations in Improving Energy Efficiency and Durability of Building Enclosures

**WHY GREEN BUILDINGS CANNOT BE BUILT
WITHOUT AIR BARRIER SYSTEMS**

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DESIGN

INVESTIGATE

REHABILITATE



- **Overview**
- **The Air Barrier Commissioning Process**
- **What's Really Happening Out There?**
 - **Typical Air Barrier Design**
 - **Typical Air Barrier Construction**
- **Summary**

- Intent of Air Barriers
 - Reduce uncontrolled air leakage through building enclosures
 - Reduce heating and cooling loads (energy use)
 - All climates
 - Reduce condensation in enclosure due to air infiltration
 - Primarily in cooling climates
 - Reduce condensation in enclosure due to air exfiltration
 - Primarily in heating climates

- An air barrier is:
 - **2009 IECC:** Material(s) assembled and joined together to provide a barrier to air leakage through the building envelope. An air barrier may be a single material or a combination of materials.
 - **ASHRAE 90.1-2010:** The combination of interconnected materials, assemblies and sealed joints and components of the building envelope that minimize air leakage into or out of the building envelope.

- An air barrier is not:
 - A single material
 - A few extra lines in one specification section
 - An afterthought
 - Something that the contractor “figures out” in the field

From our experience with air barriers on projects:

- An air barrier ends up being:
 - A single material
 - A few extra lines in one specification section
 - An afterthought
 - Something that the contractor “figures out” in the field

Air Barrier Commissioning

- Air Barrier Commissioning is a continuous process that lasts from conceptual design to the completion of construction.
- Commissioning firms/agents need to be closely involved with the design and construction process.

The Commissioning Process

- Design Phase Commissioning:
 - Coordination with architect regarding general building systems and geometry
 - Identification of the primary plane of air tightness
 - Material selection and specification
 - Continuous review of design & construction drawings
 - Details!
 - Details!!
 - Details!!!
 - Specification of realistic and achievable performance criteria

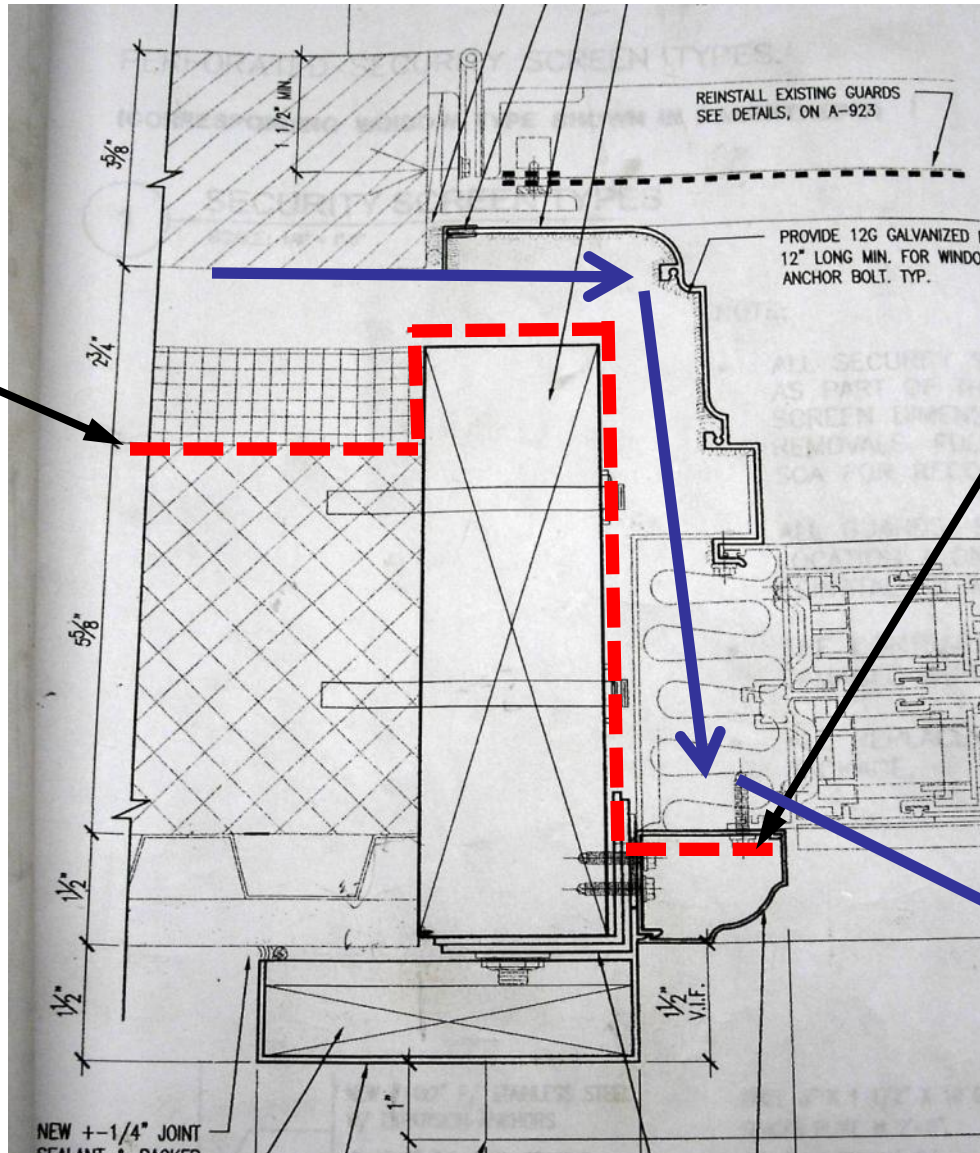
- Construction Phase Commissioning:
 - Preconstruction & subcontractor coordination meetings
 - Early identification of conflicts
 - Mockup construction review and testing
 - Field support and redetailing, if necessary
 - Random inspection and component testing
 - Whole building air tightness testing (as soon as practical)

What's Really Happening Out There?

- Where to begin?
 - Inadequate detailing
 - Over-reliance on contractor for air barrier design
 - Impractical testing with unachievable criteria
 - Focus on minor issues while ignoring the “big picture”
 - Lack of field quality control

- End result:
 - Poor air barrier performance
 - Increased energy use
 - Increased condensation potential

Inadequate Details

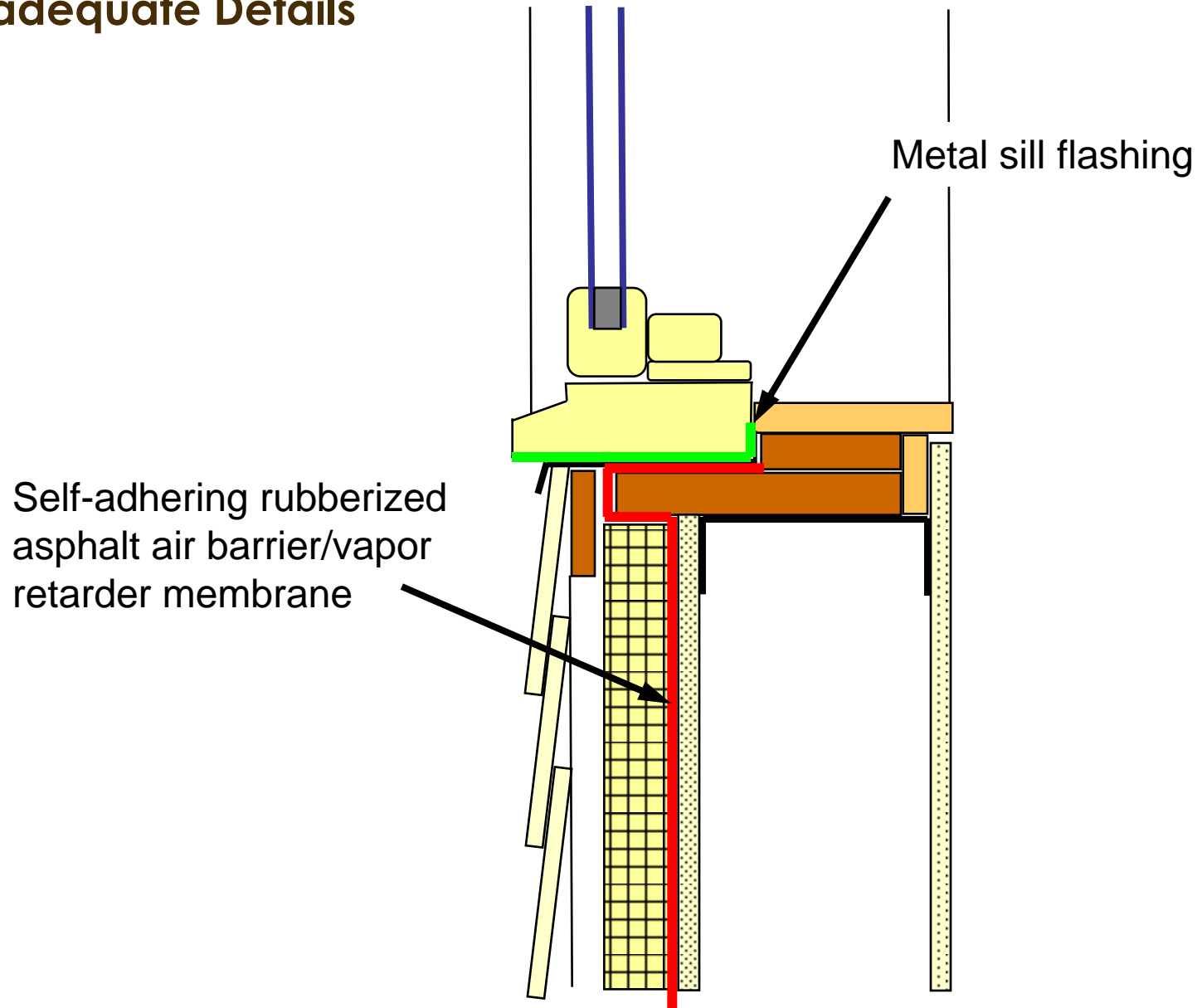


Air Barrier?

Window tie-in?

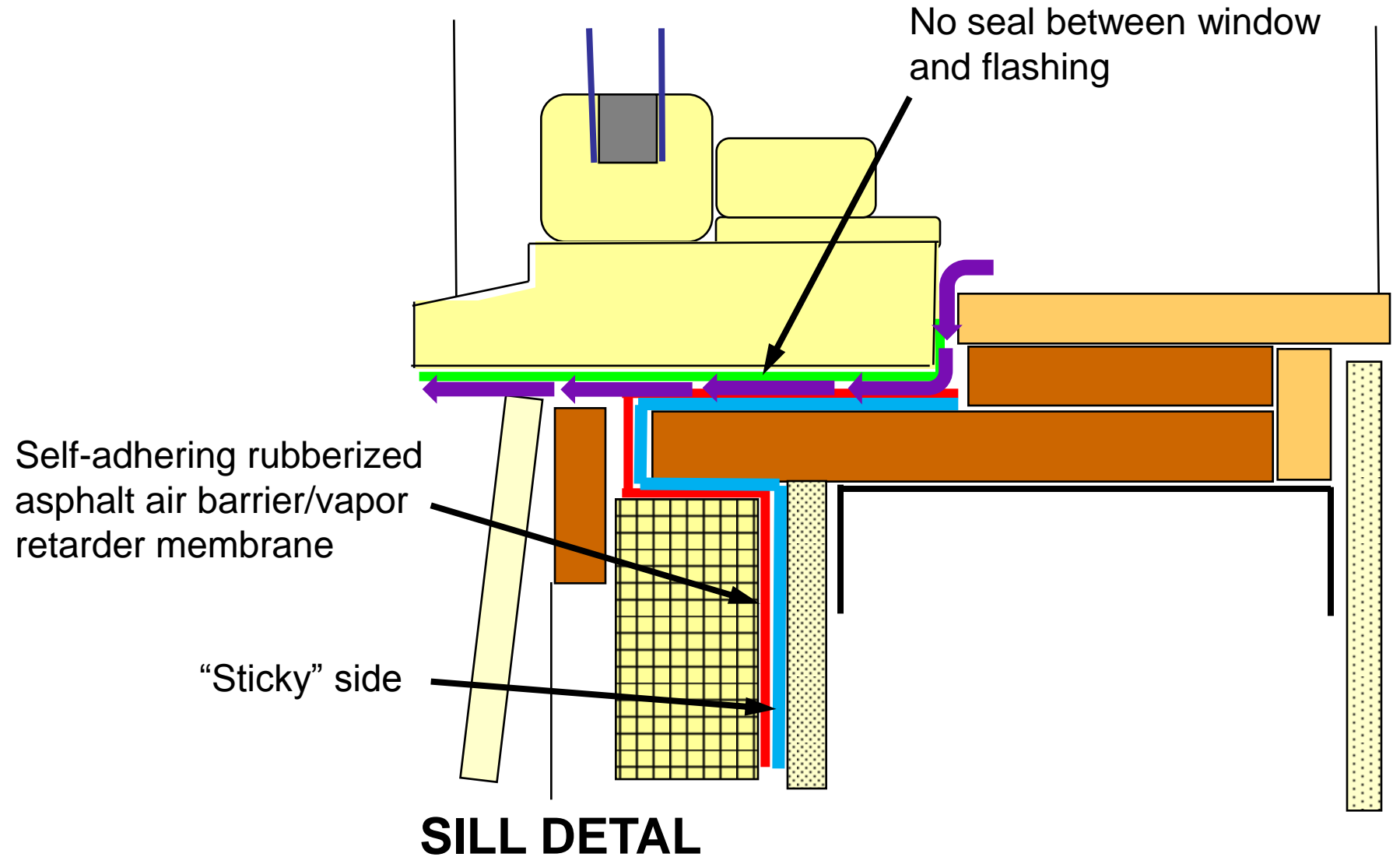
Airflow path

Inadequate Details

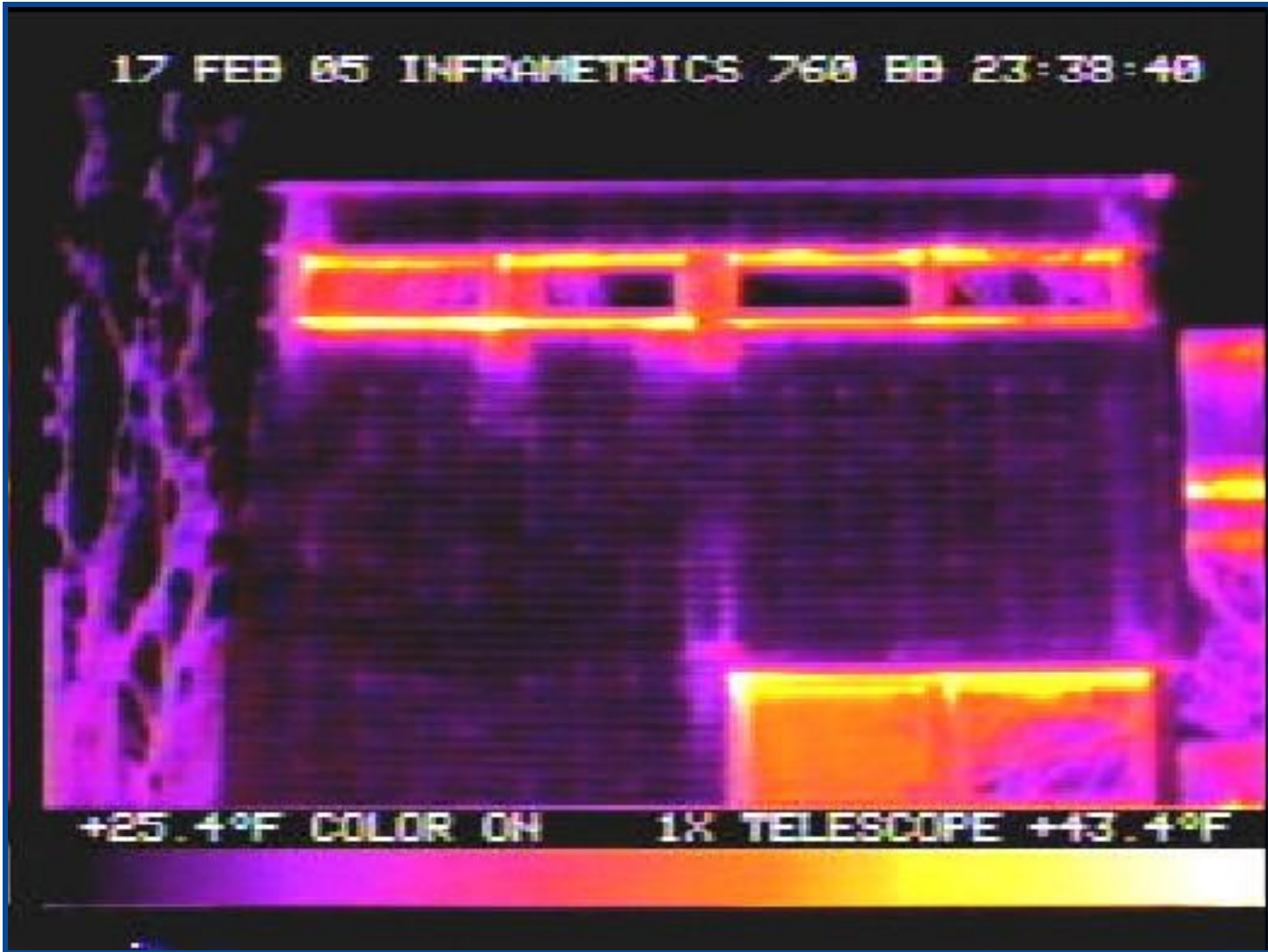


SILL DETAIL

Inadequate Details



Inadequate Details

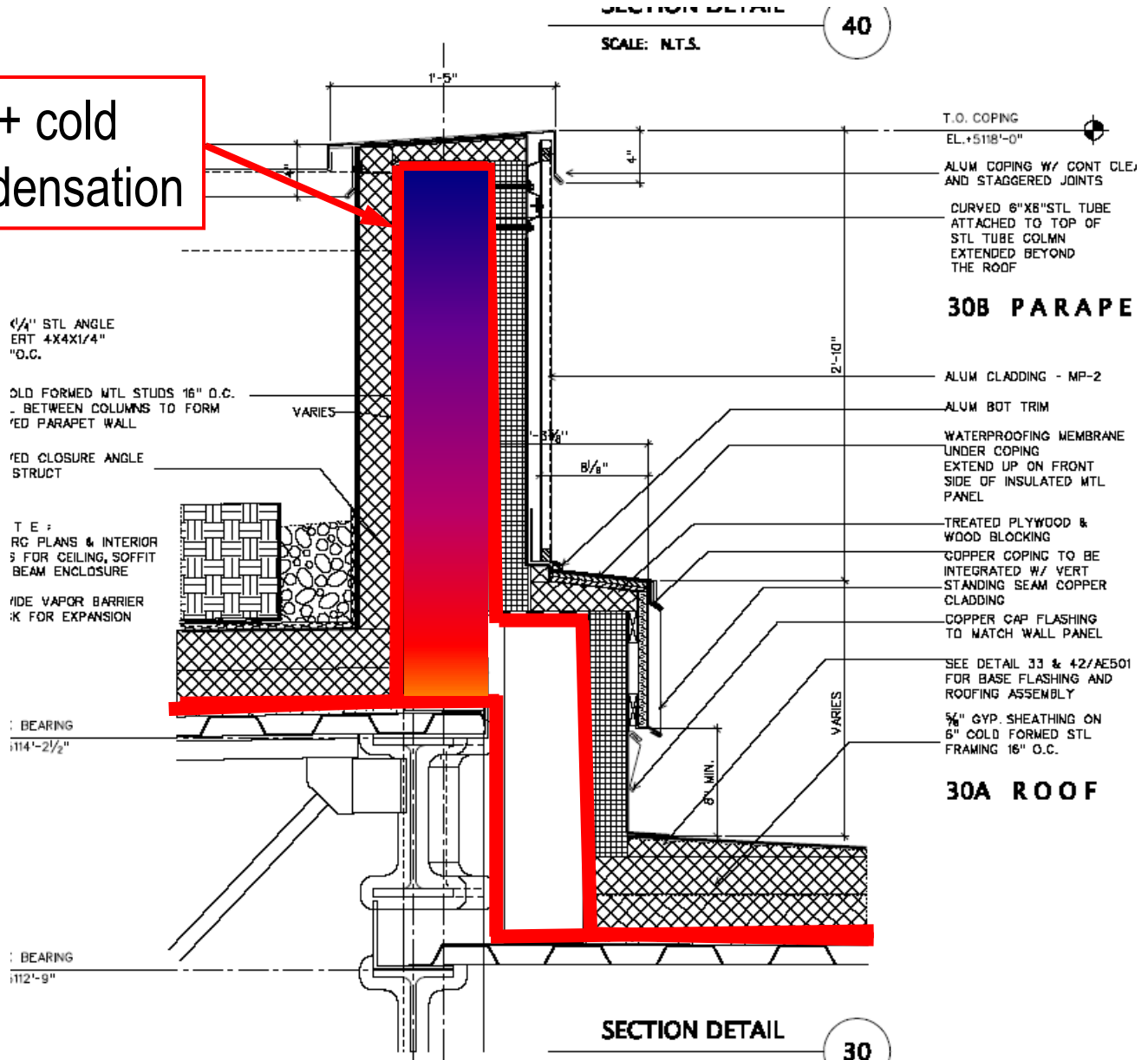


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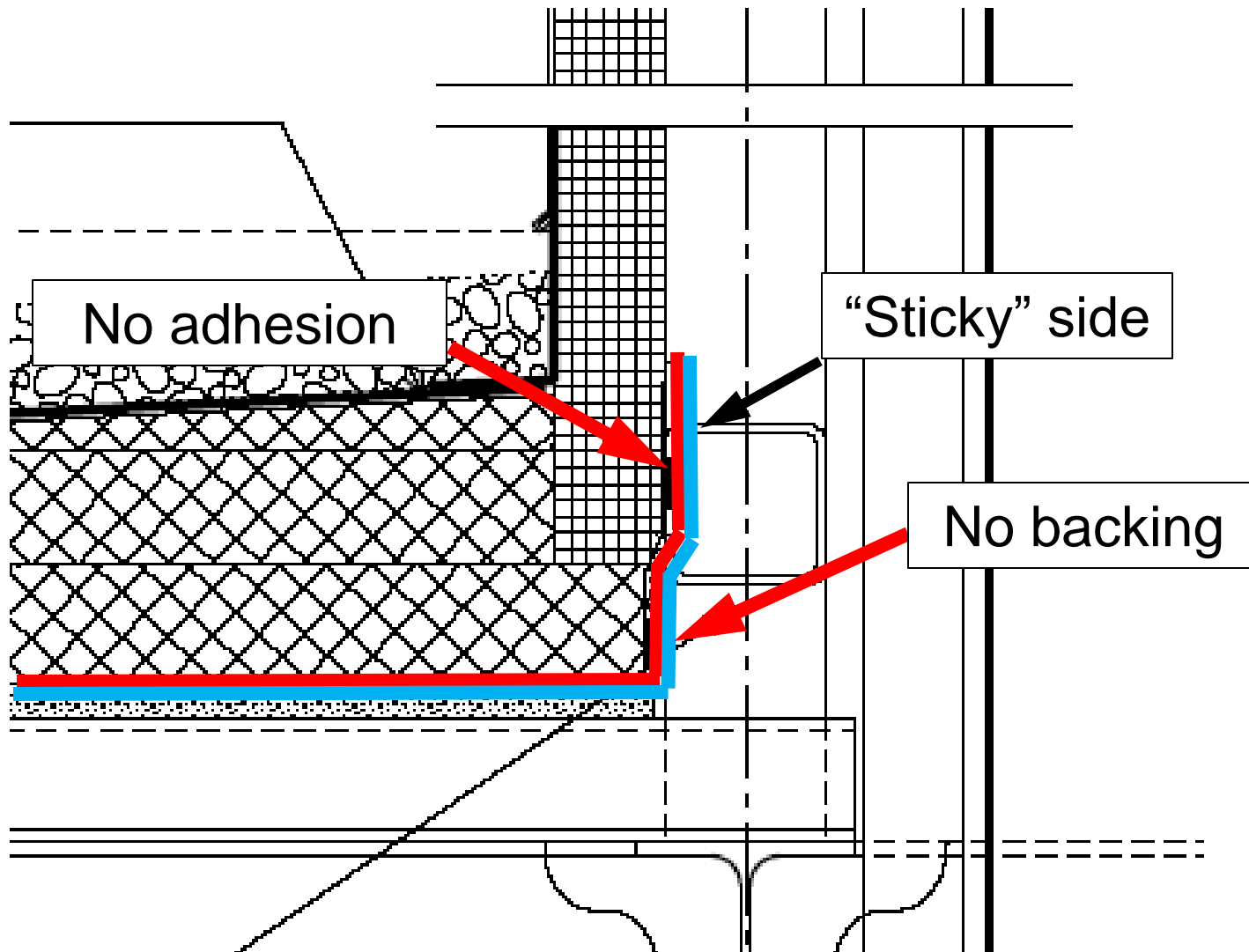


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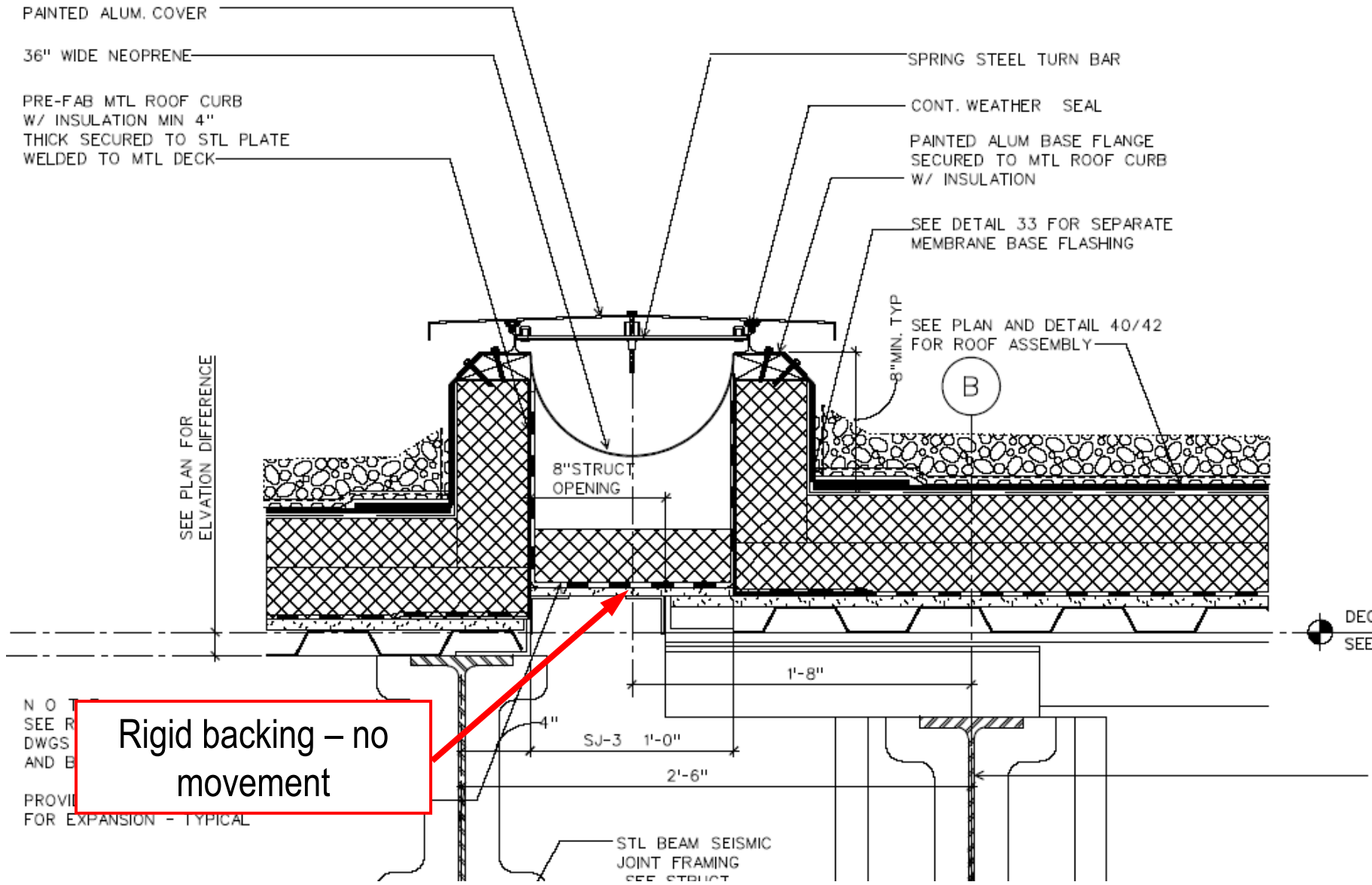
Interior air + cold surface = condensation



Inadequate Details



Inadequate Details



SECTION 01 41 00.00 06

BUILDING AIR BARRIER SYSTEM
05/08

PART 1 GENERAL

1.1 CONTRACTOR RESPONSIBILITY

The Contractor is responsible for the construction of an air barrier system that is contiguous and connected across the six surfaces of the building envelope meeting the performance requirements as outlined in this specification.

The Contractor shall perform a building air tightness test and thermography test to demonstrate that the building envelope is properly sealed and insulated. The testing shall be performed in accordance with the procedures outlined in this specification.

Specifications

3. The Contractor shall ensure that the intent of constructing the building enclosure with a continuous air barrier system to control air leakage into or out of the conditioned space is achieved. The air barrier system shall have the following characteristics:

- a. It must be continuous with all joints sealed.
- b. It must be structurally supported to withstand positive and negative air pressures applied to the building enclosure.
- c. Connection shall be made between:
 - 1) Foundation and walls
 - 2) Walls and windows
 - 3) Walls and doors
 - 4) Different wall systems
 - 5) Walls and roof
 - 6) Walls and roof over unconditioned space
 - 7) Walls, floors, and roofs across construction, control, and expansion joints.
 - 8) Walls, floors, and roofs to utility, pipe and duct penetrations.

4. It is the Contractor's responsibility to ensure that all penetrations through the air barrier system, and all paths of air infiltration or exfiltration, are sealed airtight.

Specifications

5. Inspection and testing services are required to verify compliance with requirements specified or indicated.
6. The Contractor is required to coordinate between subcontractors required to provide an airtight building enclosure, customized fabrication and installation procedures and the following:
 - a. Continuity of the air barrier materials and products with joints to provide assemblies. Continuity of all the enclosure assemblies with joints and transition materials to provide a whole building air barrier system.
 - b. Specific quality control requirements for individual construction activities are specified in the sections of the specifications. Requirements in those sections may also cover production of standard products. It is the Contractor's responsibility to ensure that each subcontractor is adequately and satisfactorily performing the quality assurance documentation, tests, and procedures required by each section.

Unachievable Performance Specifications

D. Mockups

Before beginning installation of air barrier, build mockups of exterior wall assembly, at least 150 sq. ft. of each assembly type, incorporating backup wall construction, relieving angle, window or window receptor, door frame and sill, brick ties, insulation, and flashing to demonstrate surface preparation, sequence of installation, crack and joint treatment, and sealing of gaps, terminations, transitions, and penetrations of air barrier membrane.

B. Air Barrier Assembly Air Leakage: Not to exceed 0.01 cfm x sq. ft. of surface area at 1.57 lbf/sq. ft.; ASTM E783.

Unachievable Performance Specifications

- Windows separately specified as having a maximum leakage rate of 0.4 cfm/sf at 1.57 psf

Window air leakage: 3 ft x 4 ft x 0.4 cfm/sq ft = 4.8 cfm

Total allowable air leakage: 150 sq ft x 0.01 cfm = 1.5 cfm

Specification also applied where existing (50-year old) windows were left in place!

Construction Problems

- Polyethylene sheet used as roof air barrier – not ideal, but relatively effective in this application
- No transition from wall to roof barrier



Construction Problems



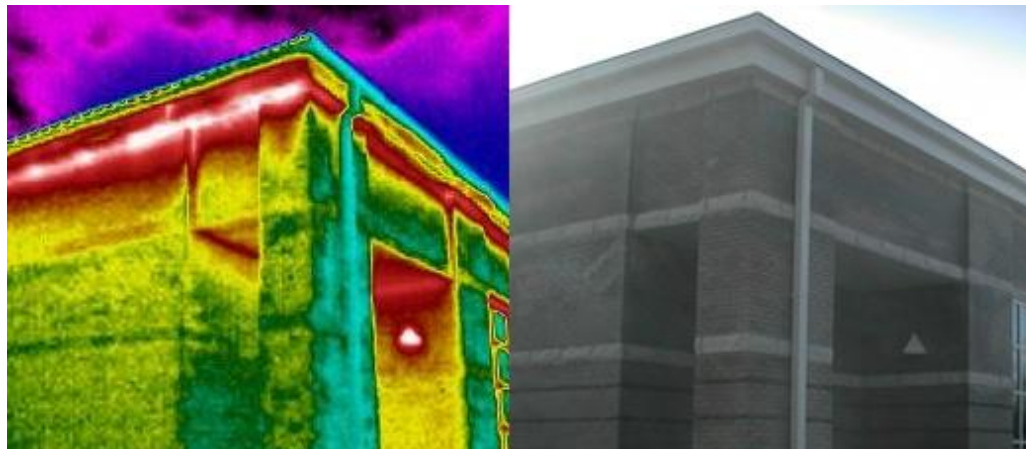
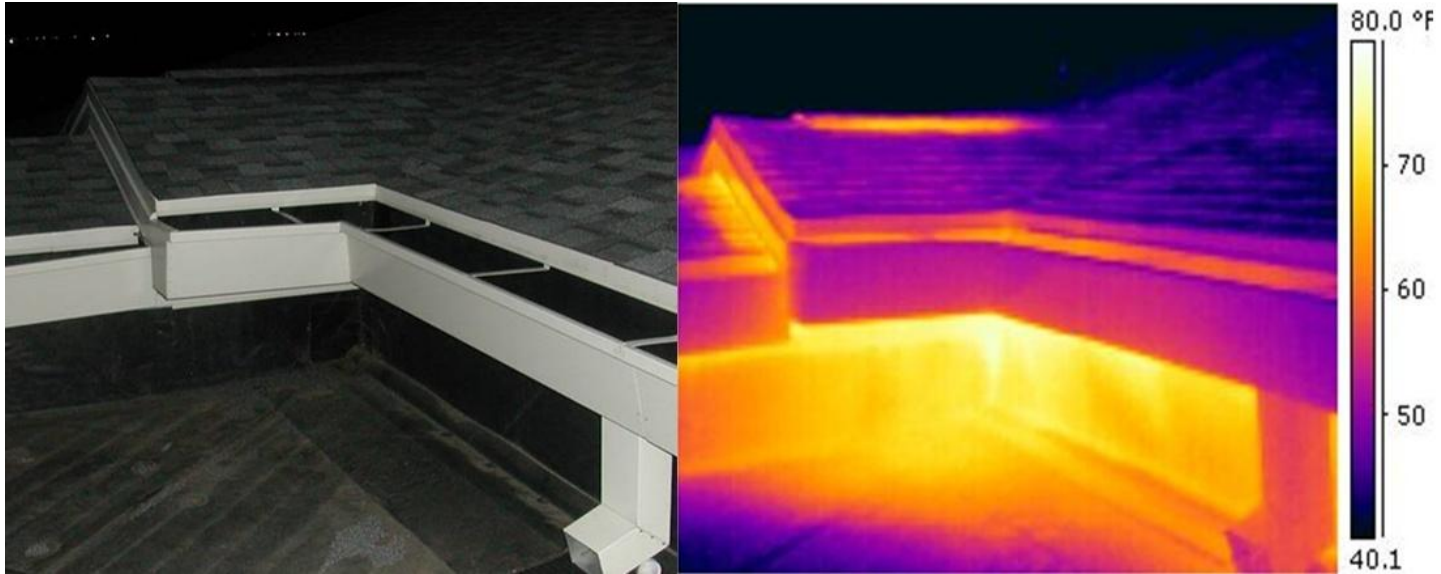
Construction Problems

- Much easier to do initially than after-the-fact

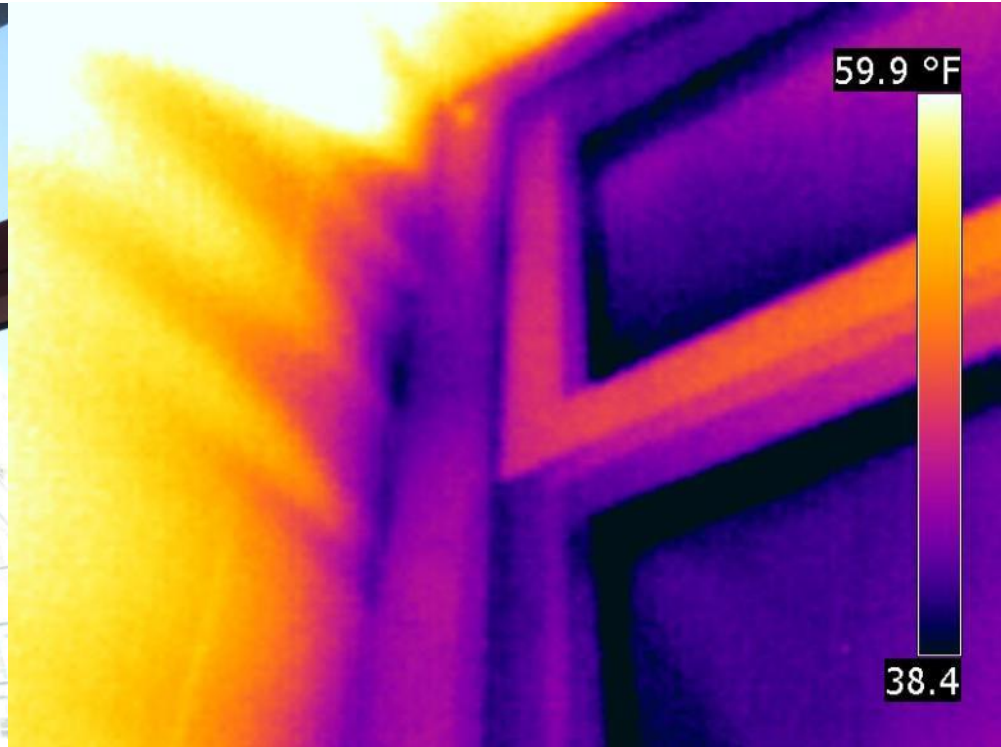


Construction Problems

More Roof-to-Wall Problems



Construction Problems



Other Construction Issues

- Pressure to complete the building leads to cutting corners
 - Over-reliance on sealants and spray foam as air barrier transitions
 - Quick fixes may pass testing initially but not provide the same long-term performance as a well-designed air barrier

- Air barrier testing often misunderstood by both designers and contractors.
- Quantitative testing often specified: 0.04 cfm/sq ft for air barrier assemblies”
 - Test is relatively difficult and expensive
 - Results aren’t very useful – if test result is 0.05 cfm/sq ft, what does that mean for repairs?

- Qualitative testing often more useful
 - Locates actual air leakage sites
 - Provides clear results that can be used to define repair procedures
 - Faster and less expensive
 - Consequently- more practical and more likely to happen
- Qualitative testing should also include basic field inspection – holes almost always = leaks
 - Often ignored in favor of testing

Whole Building Testing

- Very difficult to work into the schedule
- Ideally:
 - Air barrier system is complete
 - Cladding is not yet installed – air barrier fully exposed to allow for inspection and repair
- Realistically
 - Test is 2 days before occupancy
 - Air barrier is concealed, leaks difficult to locate
 - What do you do if the building fails?

Test Sequencing

- Test at “25% completion
- Contractor notified us at 100% completion
- “This area was done at 25% we just forgot to call you to test it then.”
- What happens when it fails?



Test Sequencing

- Similar issue with spot adhesion tests
- Contractor complaint: testing during the construction will slow us down too much and throw off the schedule (winter approaching)



Summary

- The air barrier is a complicated building system that cannot be simply left to the contractor
- The air barrier commissioning process is intended to prevent the kinds of design and construction problems in this presentation
 - Involvement in design
 - Review of construction documents
 - Coordination with contractors
 - Sufficient field presence
- The sensitivity of air barriers to small defects make the commissioning process critical to successful performance

Thank you.

QUESTIONS?

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