Spray Foam

Myths and Reality

Presented to: CACEA Canadian Association of Consulting Energy Advisors

Presented by: Trevor Trainor, M.A.Sc.
President, Building Science Specialist
Bawating Building Science

BBS BAWATING BUILDING SCIENCE

About the Presenter:

Trevor Trainor is the President of Bawating Building Science. He is a member of the Thessalon First Nation and has established himself as an expert in design, analysis and research related to building enclosure systems.

He brings a wealth of knowledge and experience at every level of the design and construction process. In addition to his experience as a custom home builder, he has over 10 years experience as a Building Science Consultant and Researcher.

He has been involved in the planning and execution of dozens of enclosure-related research projects and hygrothermal modeling studies and hundreds of forensic investigations, enclosure design projects, enclosure testing and construction quality review projects.

BAWATING BUILDING SCIENCE

Introduction

- What are the different types of spray foam?
  - What are could/should they be used for?
- A review of ‘The Building Enclosure’
- A functional analysis of closed cell spray foam
- Application issues and site review techniques

BBS
BAWATING BUILDING SCIENCE

Types of Spray Foams

Open Cell

2-Part Foam

Closed Cell

2-Part Foam

2-Part Kits

2-Part Foam

Canned Foam

1-Part Foam

Polyol Resins + Isocyanurate

BBS
BAWATING BUILDING SCIENCE

Open Cell Spray Foam

Open Cell

- Commonly known as ½ pound
- Density ranges from:

  0.5 lbs/ft^3 (7 kg/m^3) to 1.0 lbs/ft^3 (14 kg/m^3)
- Water-blown
- Can be applied in thick layers
- Vapour Permeance of 28 perms @ 2 inches

  (1600 ng/s m^2 Pa)
- Thermal performance ranges from

  R-3.5 /inch to R-4.3 /inch

Image from: buildersontario.com

BBS
BAWATING BUILDING SCIENCE

Open Cell Spray Foam

Open Cell

- In cold climates, should only be used exterior to an air and vapour barrier
- Can be difficult to install in air tight manner

  (see case study below)
- Can be used for exposed floors since subfloor can act as air and vapour barrier but only if detailed properly

Image from: buildersontario.com

BBS
BAWATING BUILDING SCIENCE

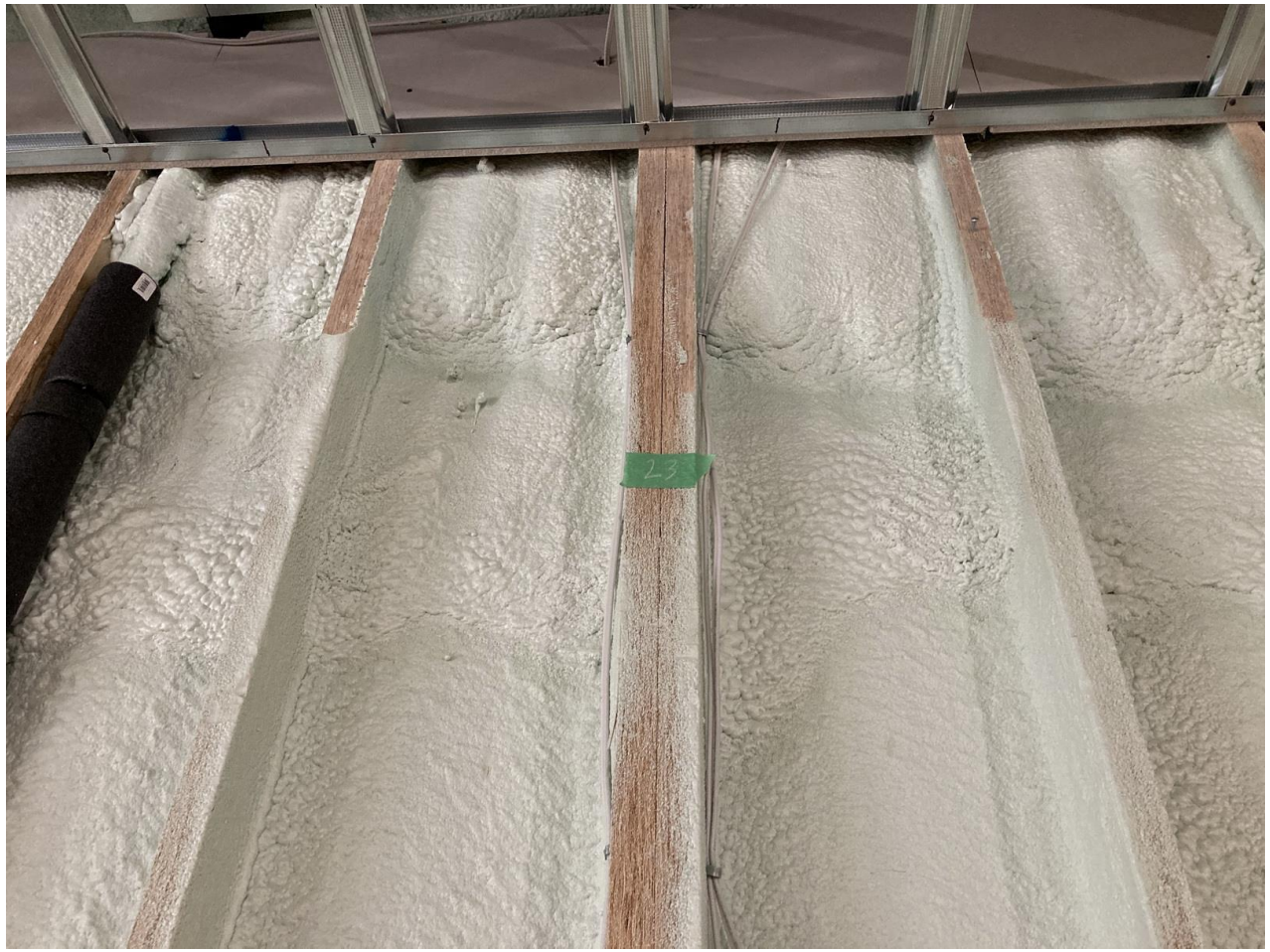
Closed Cell Spray Foam

Closed Cell

- Commonly known as 2 pound
- Density of approx. 2 lbs/ft^3 (33 kg/m^3)
- Uses blowing agents
  - Jan. 2021 – blowing agents changed from HFCs to HFOs
- Applied up to 2 inches per pass
- Vapour Permeance of less than

  1 perm @ 2 inches (60 ng/s m^2 Pa)
- Thermal performance ranges from

  R-5 /inch to R-6 /inch



BBS
BAWATING BUILDING SCIENCE

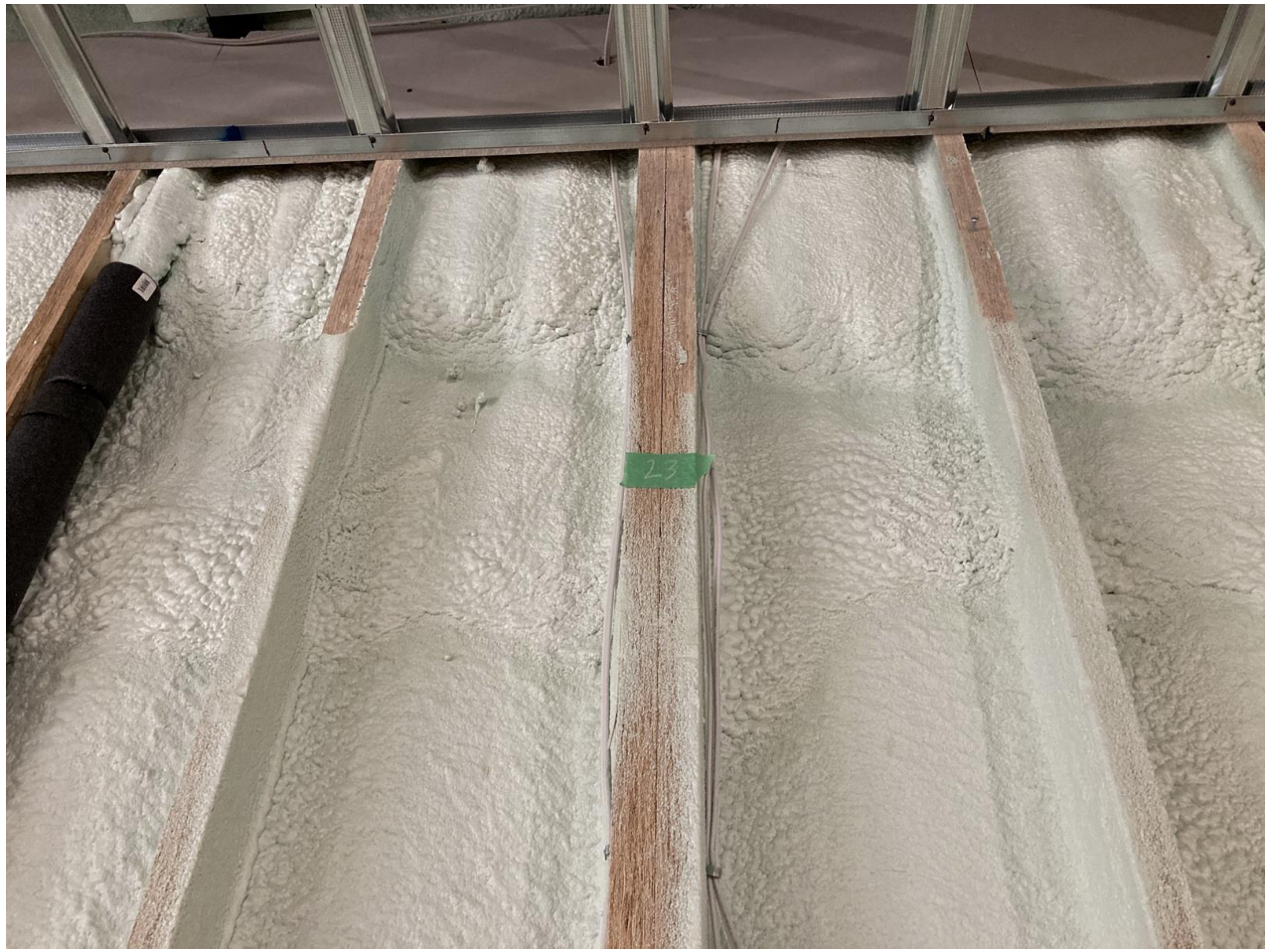
Closed Cell Spray Foam

Closed Cell

- In accordance with the Montreal Protocol, blowing agents transitioned from HFCs to HFOs in Jan. 2021

	Pre-2021	Current
Blowing Agent	HFCs	HFOs
GWP	1500	0 - 1
R-Value / inch	5.5 - 6.5	5.0 - 6.0

HFC = Hydrofluorocarbons
HFO = Hydrofluoroolefins



BBS
BAWATING BUILDING SCIENCE

2-Part Kits

- Utilizes two pressurized canisters and a gun that mixes the chemicals as they are sprayed
- Portable and can be effective for small air sealing/insulating jobs
- Density is approx. 1.75 lbs/ft^3 (12 kg/m^3)
- HFO - blown
- Can be applied in thick layers
- Vapour Permeance of 6.4 perms @ 2 inches

  (336 ng/s m^2 Pa)
- Thermal Performance approx. R-6 per inch

Image from: rona.com

BBS
BAWATING BUILDING SCIENCE

Canned Spray Foam

- One part polyurethane foam in pressurized canisters with a spray nozzle
- Portable and effective for targeted air sealing of gaps
- Different formulations for different levels of expansions
- Window/Door – low expansion
- Water-based

*not the best method for air sealing around windows

Image from: kent.ca

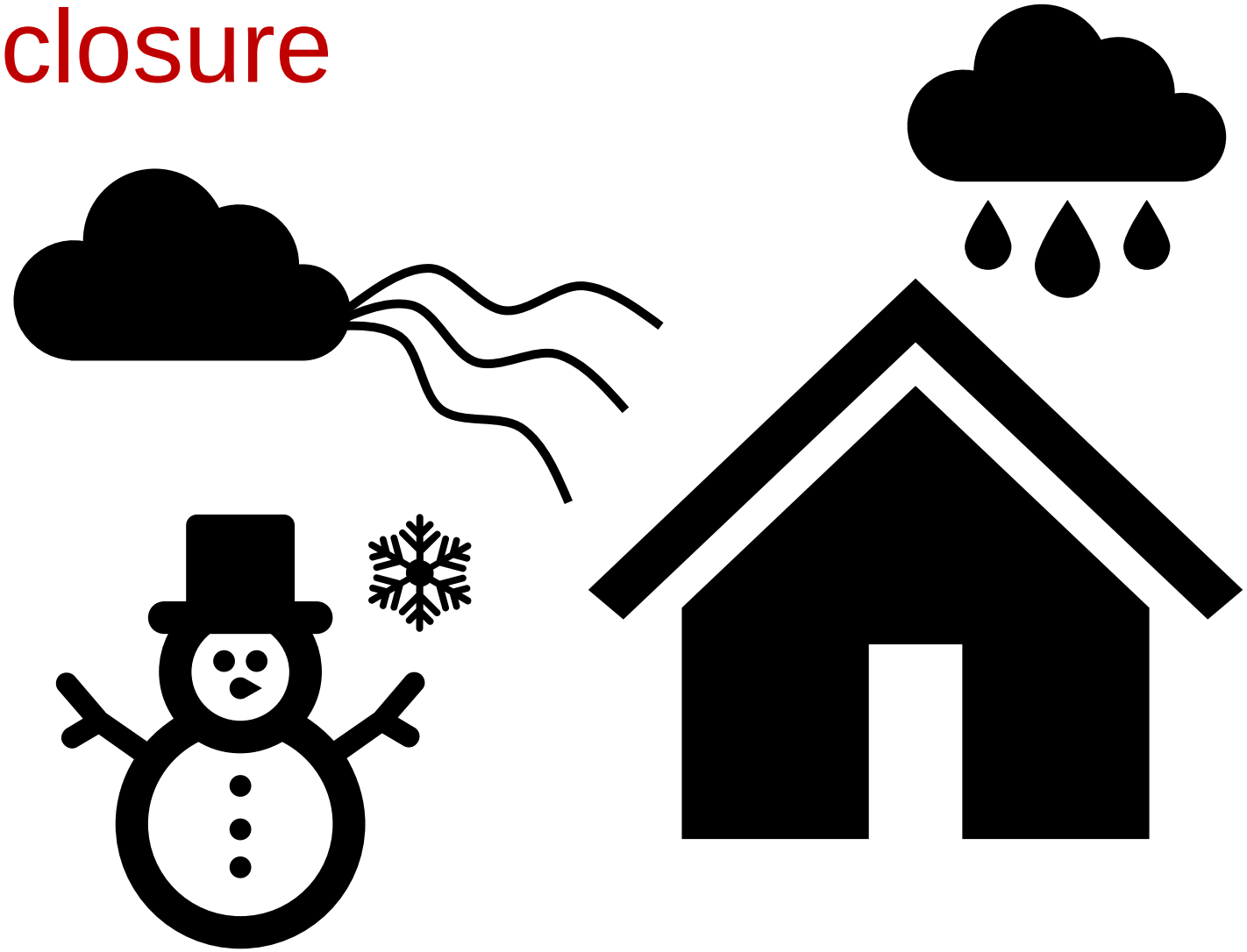
BBS
BAWATING BUILDING SCIENCE

The Building Enclosure

- Structure

- Functional Layers

- Water Control
- Air Control
- Thermal Control
- Vapour Control



BBS
BAWATING BUILDING SCIENCE

Functional Analysis

- Like all building materials, spray foam can work well, or fail miserably based on the design of the system and the quality of the installation

- The first thing we must consider is:

What is the intended function of the spray foam?

BBS
BAWATING BUILDING SCIENCE

Functional Analysis

- One of the great benefits of spray foam is that it is capable of performing all four of these control functions with proper specification, design and installation

BAWATING BUILDING SCIENCE

Water Control

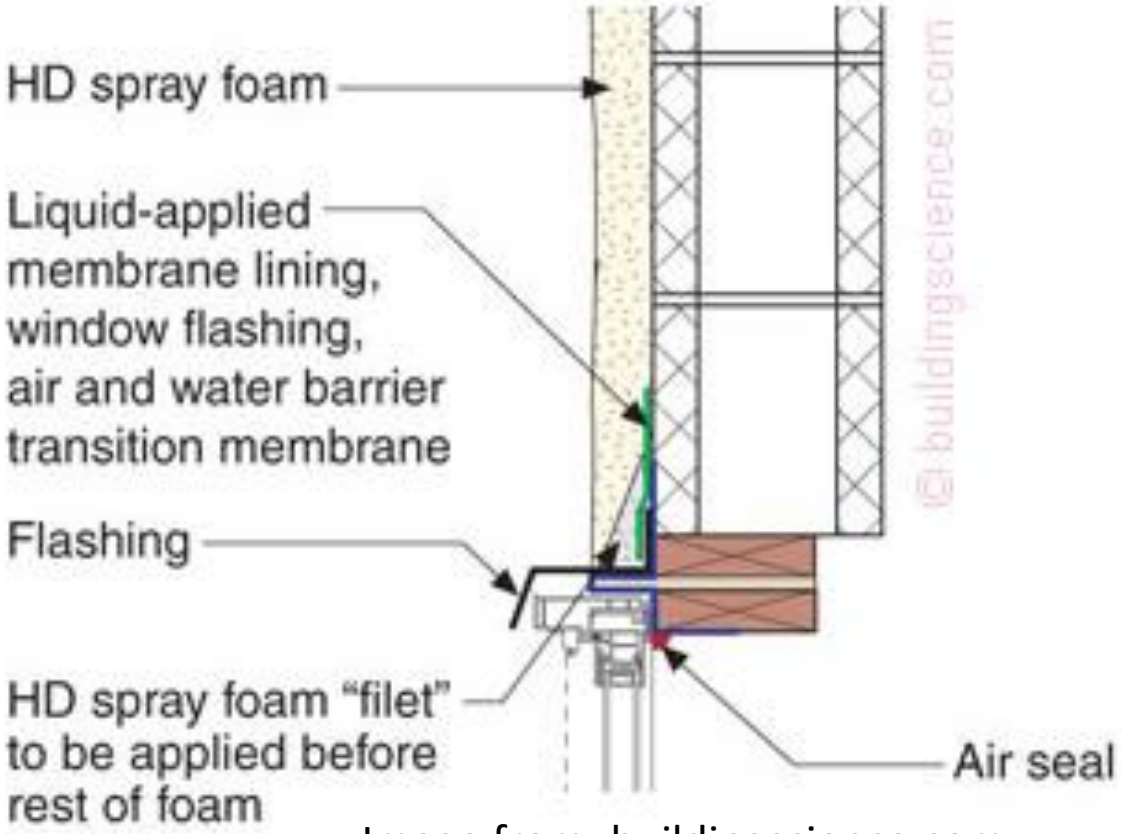
- When applied continuously to the exterior of a building, spray foam can act as the primary water control layer

Image from: buildingscience.com

BBS
BAWATING BUILDING SCIENCE

Water Control

- The key to successful application as a water control layer is integration of windows and doors, cladding attachment and penetration detailing



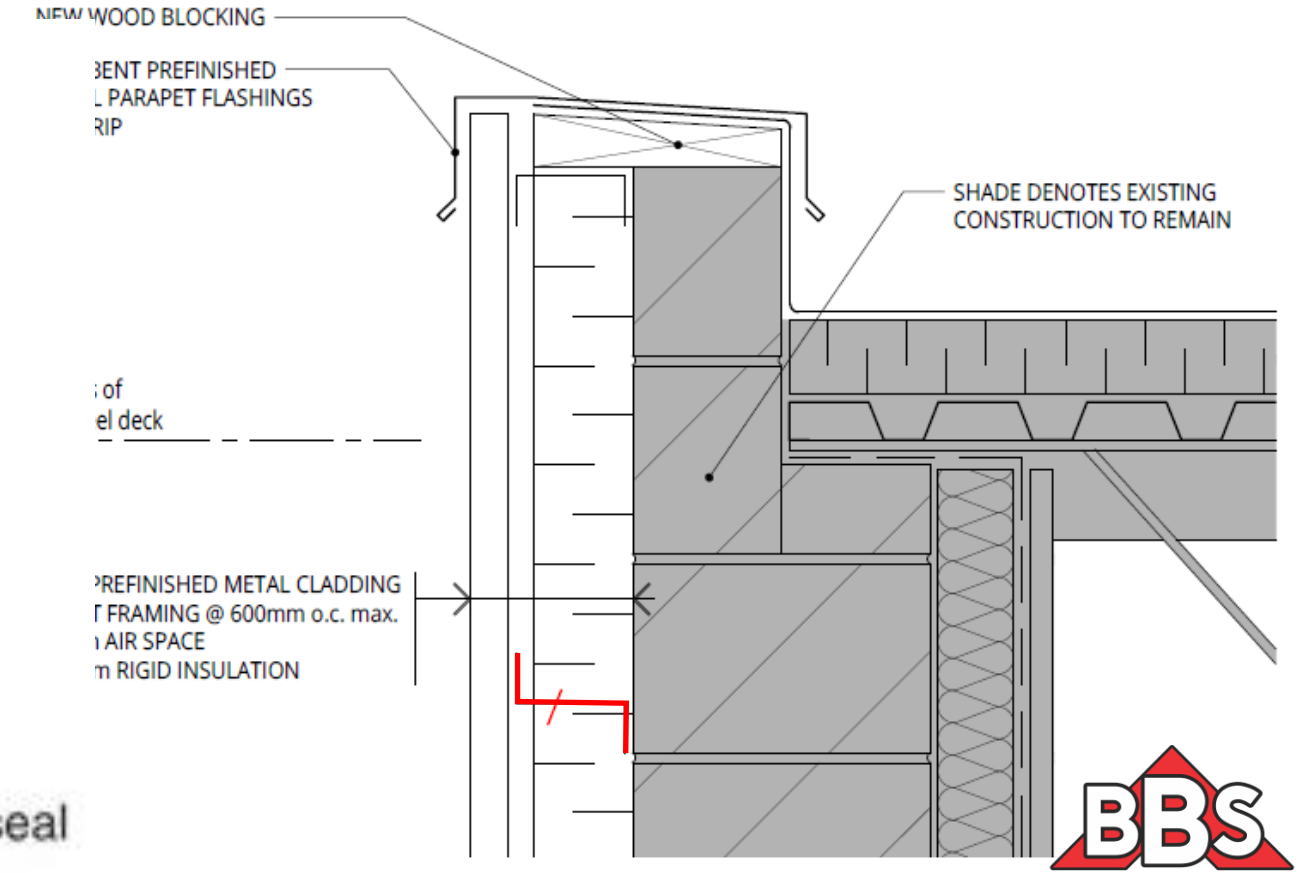


Image from: buildingscience.com

BAWATING BUILDING SCIENCE

Water Control

- For high performance air and water control, a separate air/water barrier should be used

BBS
BAWATING BUILDING SCIENCE

Air Control

- What differentiates spray foam from other insulations a typical residential applications is that it is also acting as the **air barrier**

- Like many building materials, spray foam is air impermeable
- Air will not flow through spray foam, but can it flow around it?
- Installation continuity and detailing at transitions and penetrations is key

BBS
BAWATING BUILDING SCIENCE

Spray Foam Myth #1

Spray foam will make your building air-tight

Reality:

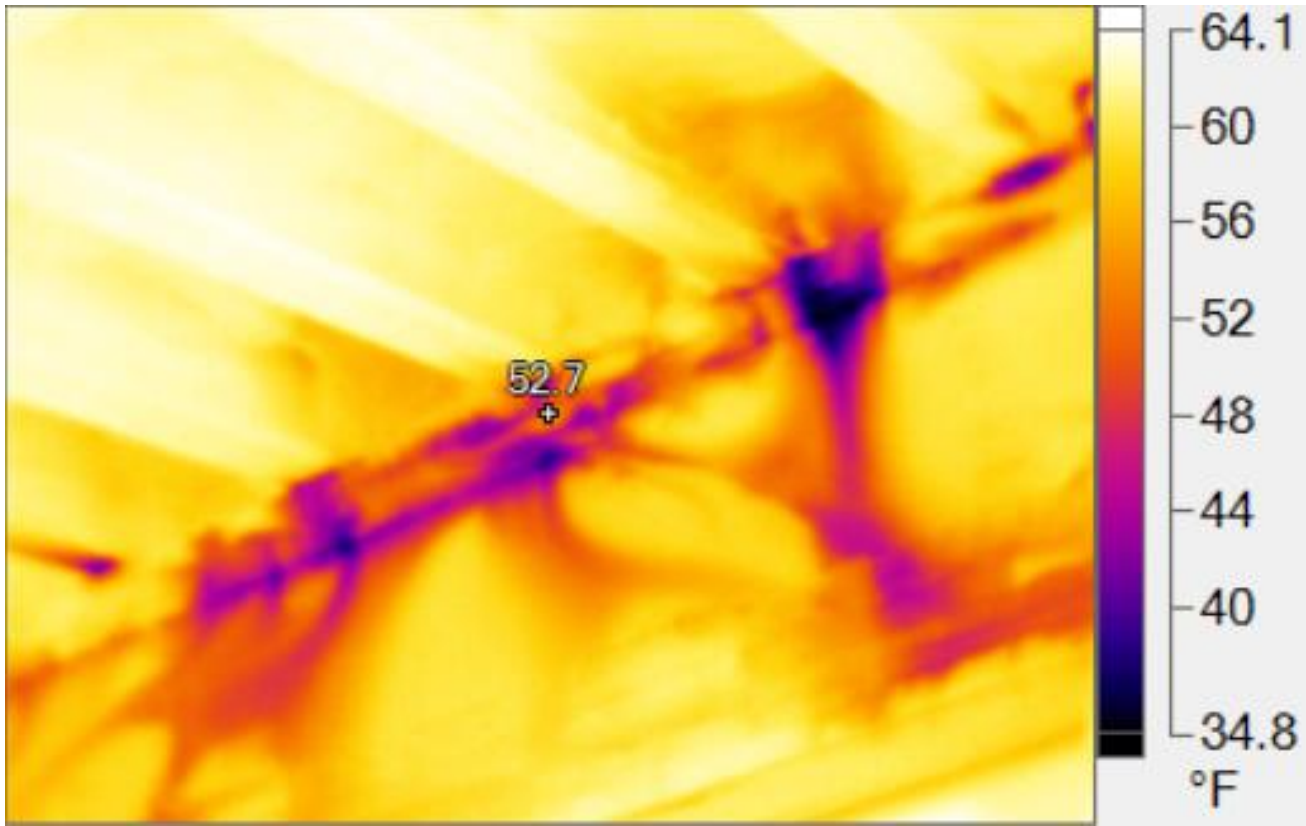
Like many building materials, spray foam is air impermeable. However the continuity of the application, and the detailing of penetrations are keys to whole building air tightness.

BBS
BAWATING BUILDING SCIENCE

Spray Foam Myth #1

Spray foam will make your building air-tight

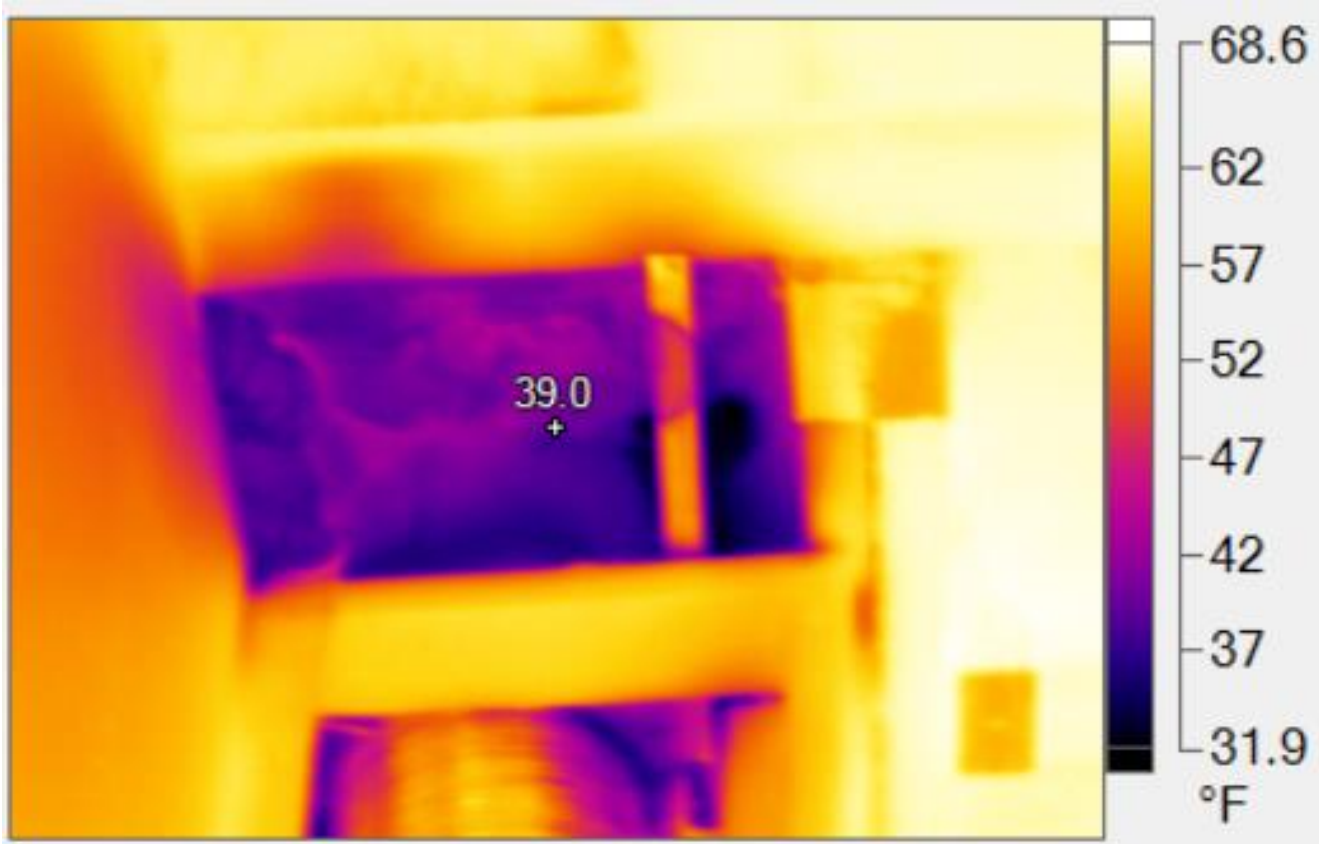
Reality:



Spray Foam Myth #1

Spray foam will make your building air-tight

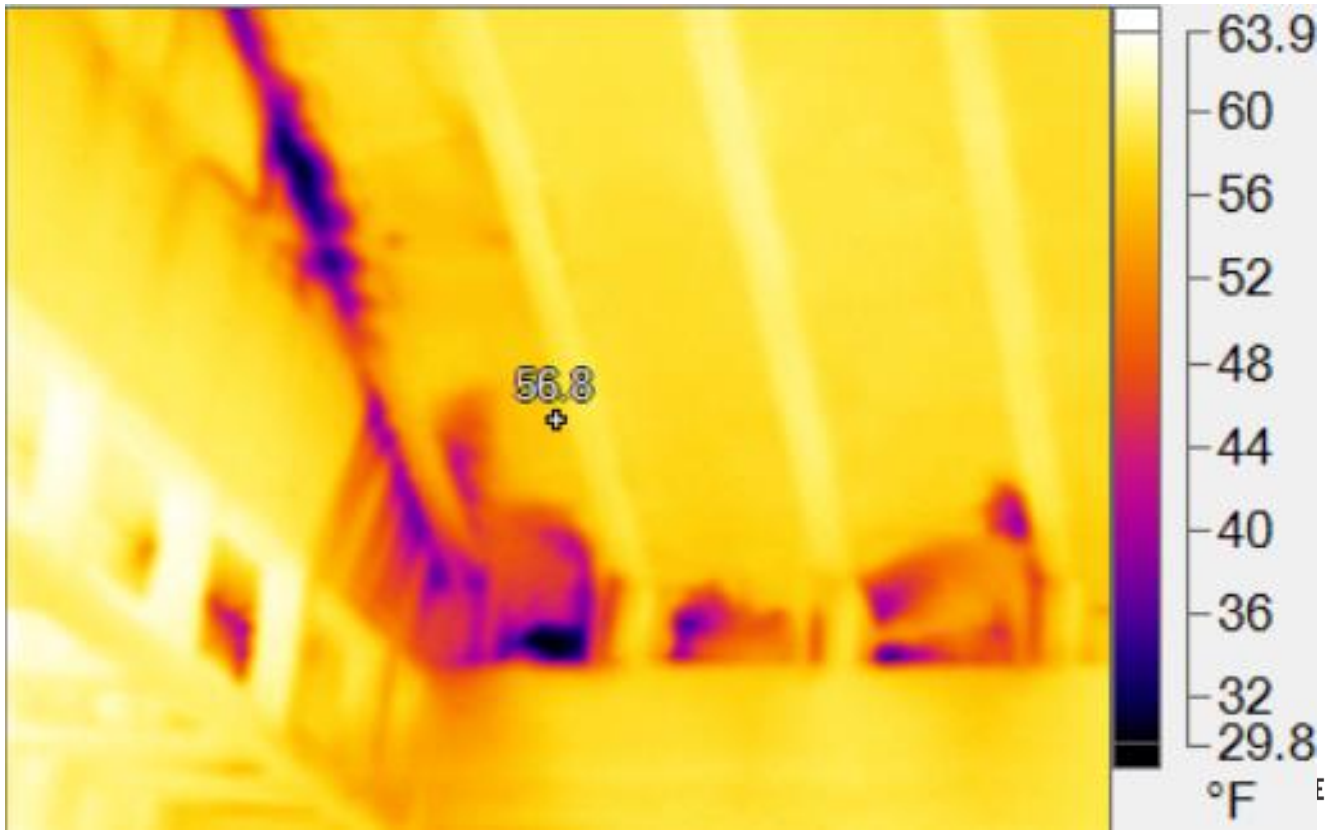
Reality:



Spray Foam Myth #1

Spray foam will make your building air-tight

Reality:



Spray Foam Myth #1

Spray foam will make your building air-tight

Reality:

BBS
BAWATING BUILDING SCIENCE

Spray Foam Myth #1

Spray foam will make your building air-tight

Reality:

Only good design, material choice, and construction quality will make your house air-tight

The only way to know that your building is airtight is through blower door testing

BBS
BAWATING BUILDING SCIENCE

Spray Foam Reality

Closed cell spray foam can be a part of an effective air barrier system……..but:

- There must be adequate access to properly install the spray foam
- It must seal completely to framing members
- Un-foamed joints between framing members must be sealed
- There must be effective transitions to windows/door and the air barrier systems of the roof/ceiling and foundation
  - Spray foam doesn’t like to stick to polyethylene

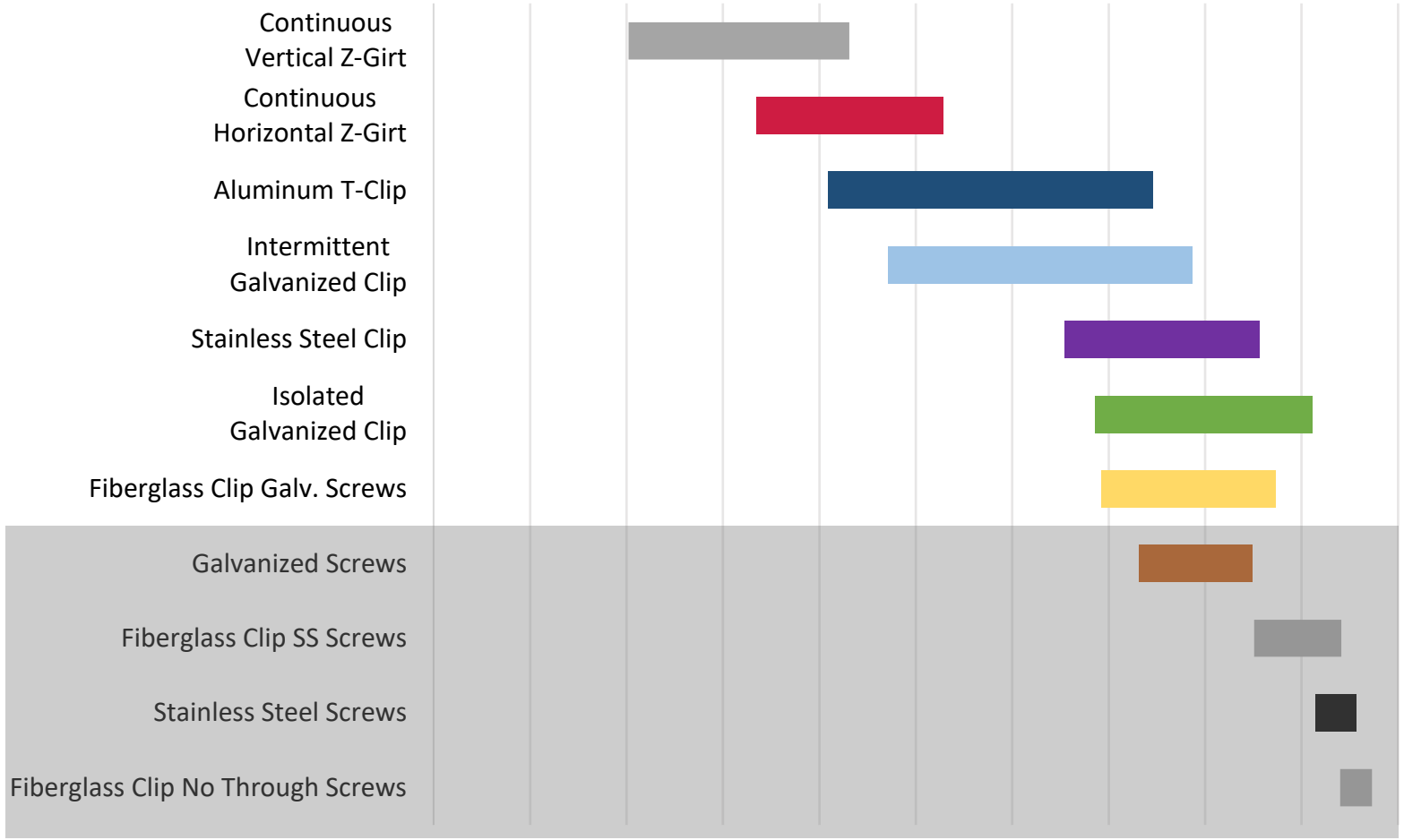
BBS
BAWATING BUILDING SCIENCE

Thermal Control

- Closed cell spray foam has a significantly higher R-value/inch than batt insulation
- Both have reduced effective R-value when installed between studs
  - 25% reduction for wood studs
  - 75% reduction for steel studs
- Even exterior applied has potential thermal bridging issues

BBS
BAWATING BUILDING SCIENCE

Cladding Attachment

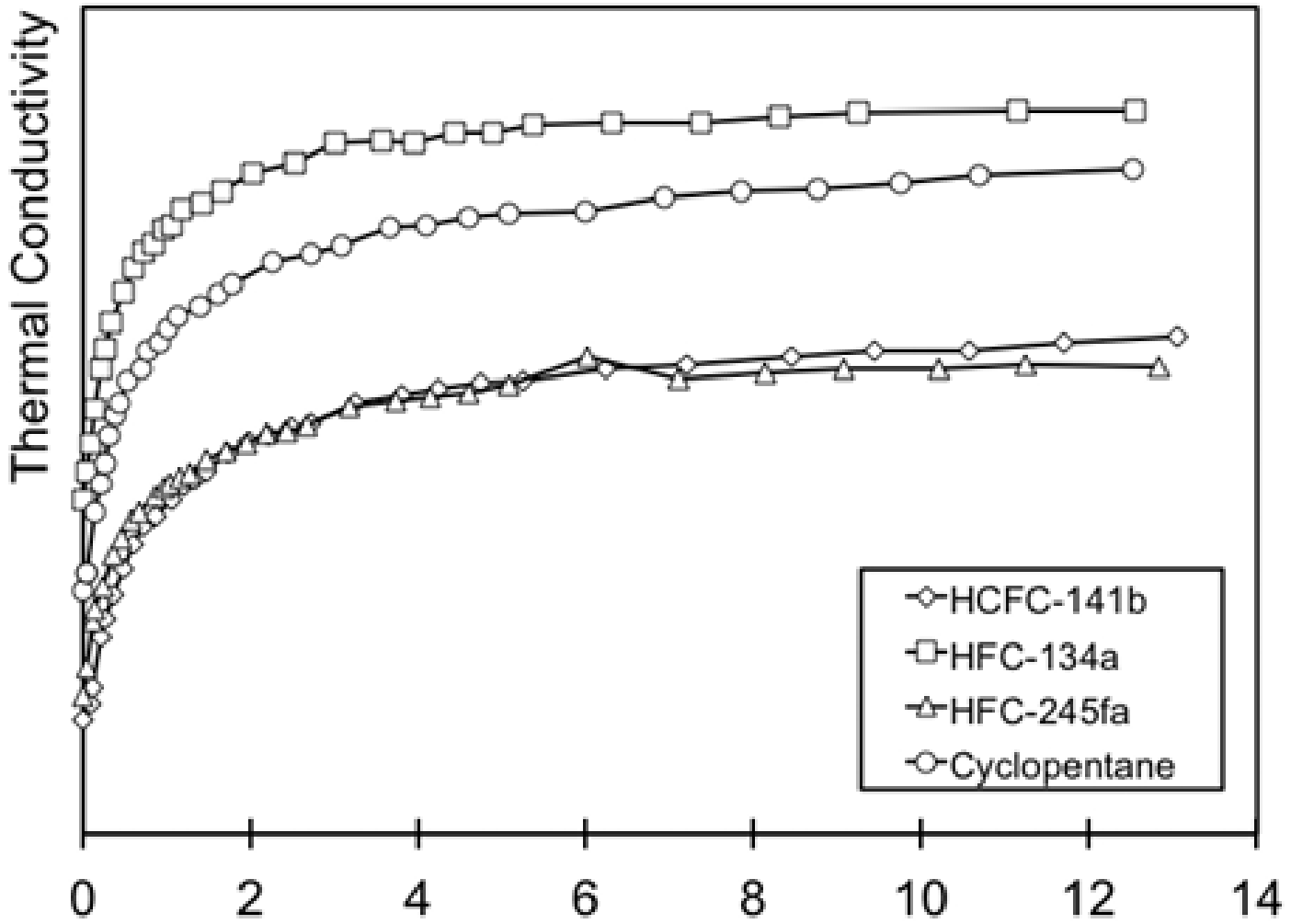


BBS
BAWATING BUILDING SCIENCE

Audience Question:

Q: What is the thermal resilience of spray foam?

A: The R-value of spray foam decreases over time, as blowing agents slowly release from the material

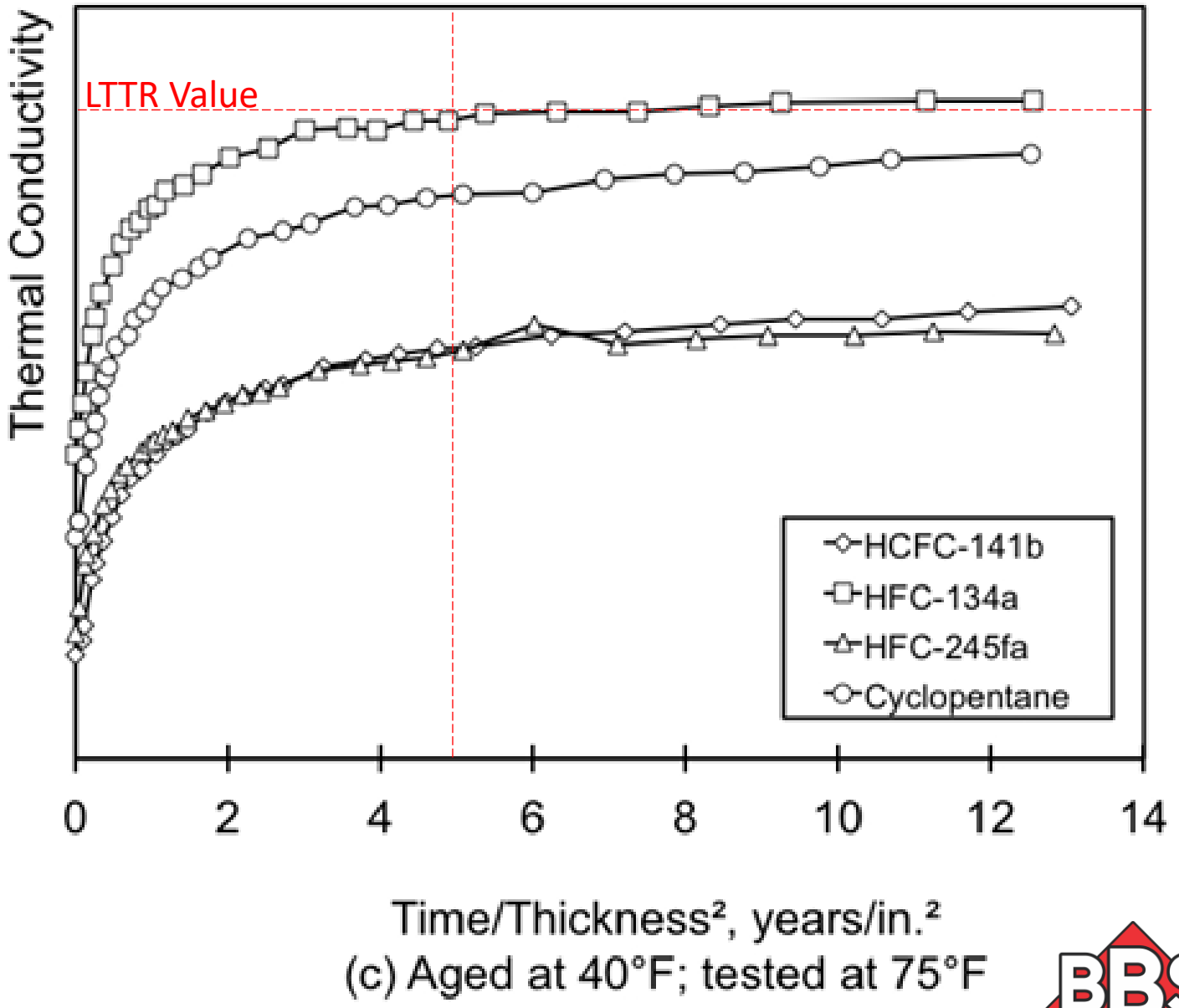


BBS
BAWATING BUILDING SCIENCE

Audience Question:

Q: What is the thermal resilience of spray foam?

A: This decrease is accounted for in the ‘Long-Term Thermal Resistance’ (LTTR) value



BBS
BAWATING BUILDING SCIENCE

Spray Foam Myth #2

A building with R-30 spray foam walls is much better insulated than a building with batt insulation

BBS
BAWATING BUILDING SCIENCE

Spray Foam Myth #2

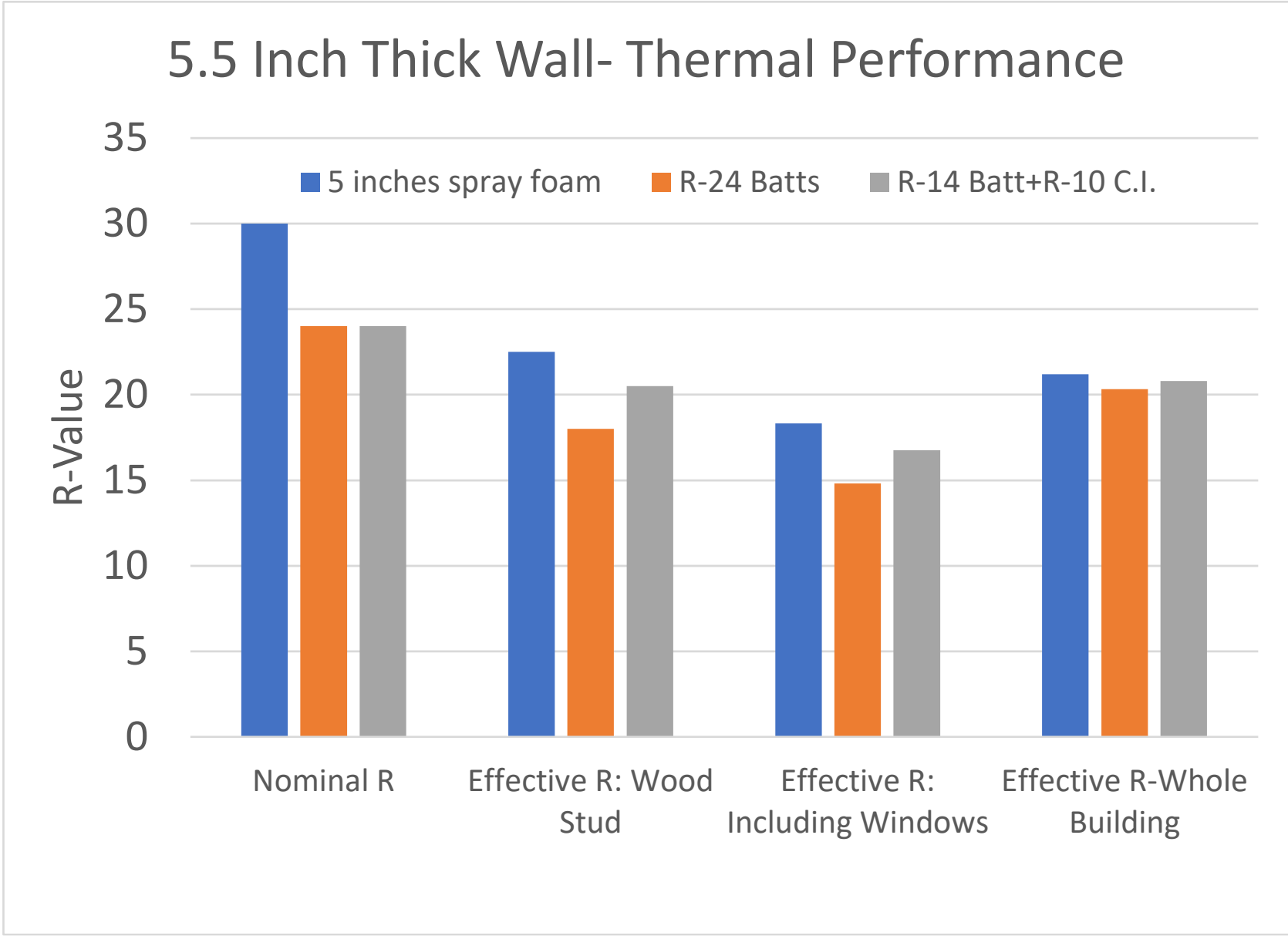
A building with R-30 spray foam is much better insulated than a building with batt insulation

Reality:

There are many other factors that contribute to the thermal performance and to the overall heat loss of a building

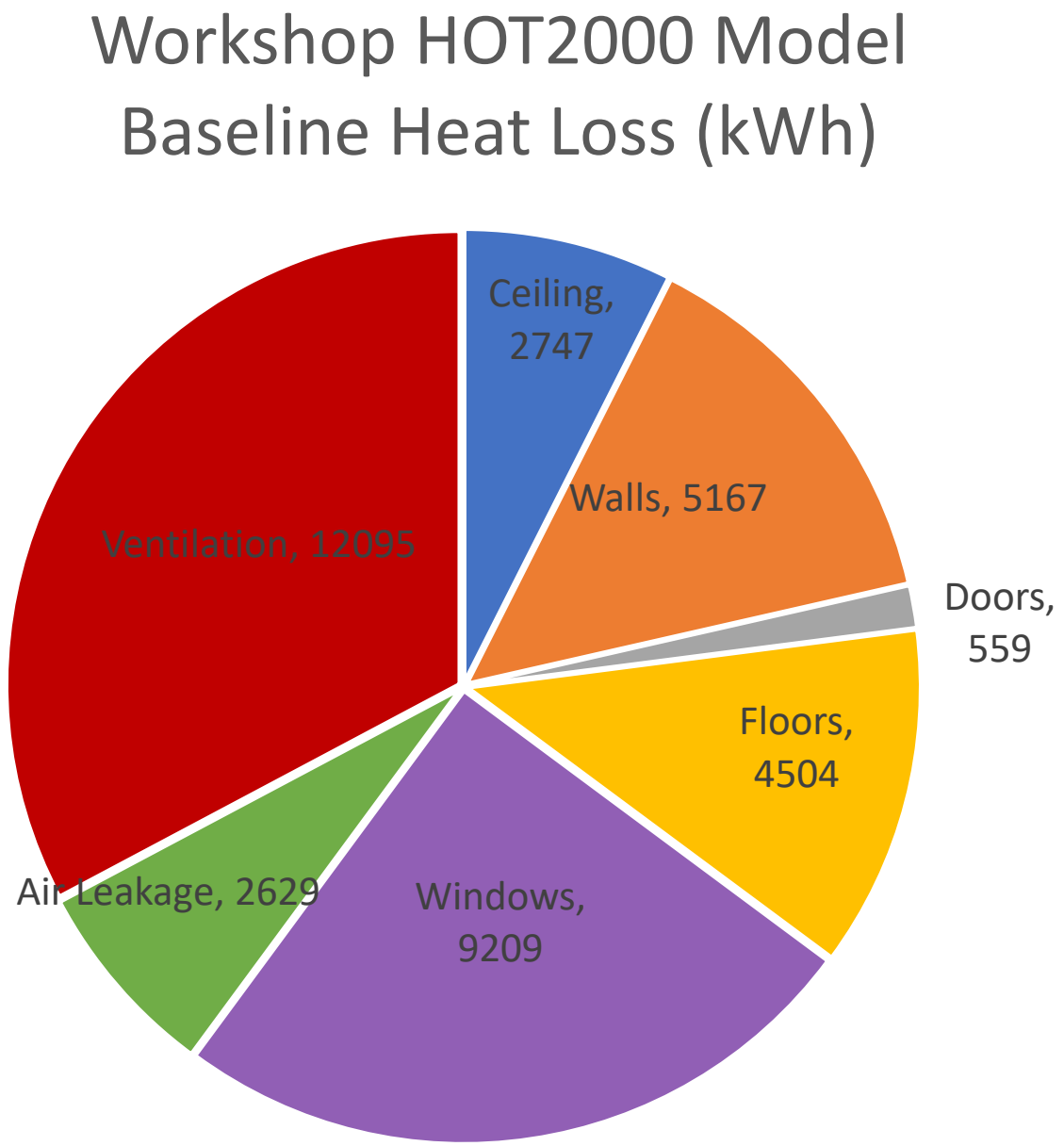
BBS
BAWATING BUILDING SCIENCE

Spray Foam Reality



BBS
BAWATING BUILDING SCIENCE

Spray Foam Reality



Heat loss through clear-wall is a small percentage of over all heat loss in a building

BBS
BAWATING BUILDING SCIENCE

Vapour Control

- Spray foam as a vapour barrier is often discussed but rarely an issue.
- By code (OBC), closed cell spray foam is vapour barrier at 2 inches thick
- Open cell spray foam does not qualify as a vapour barrier
- Two-Part kit spray foam does not qualify as a vapour barrier

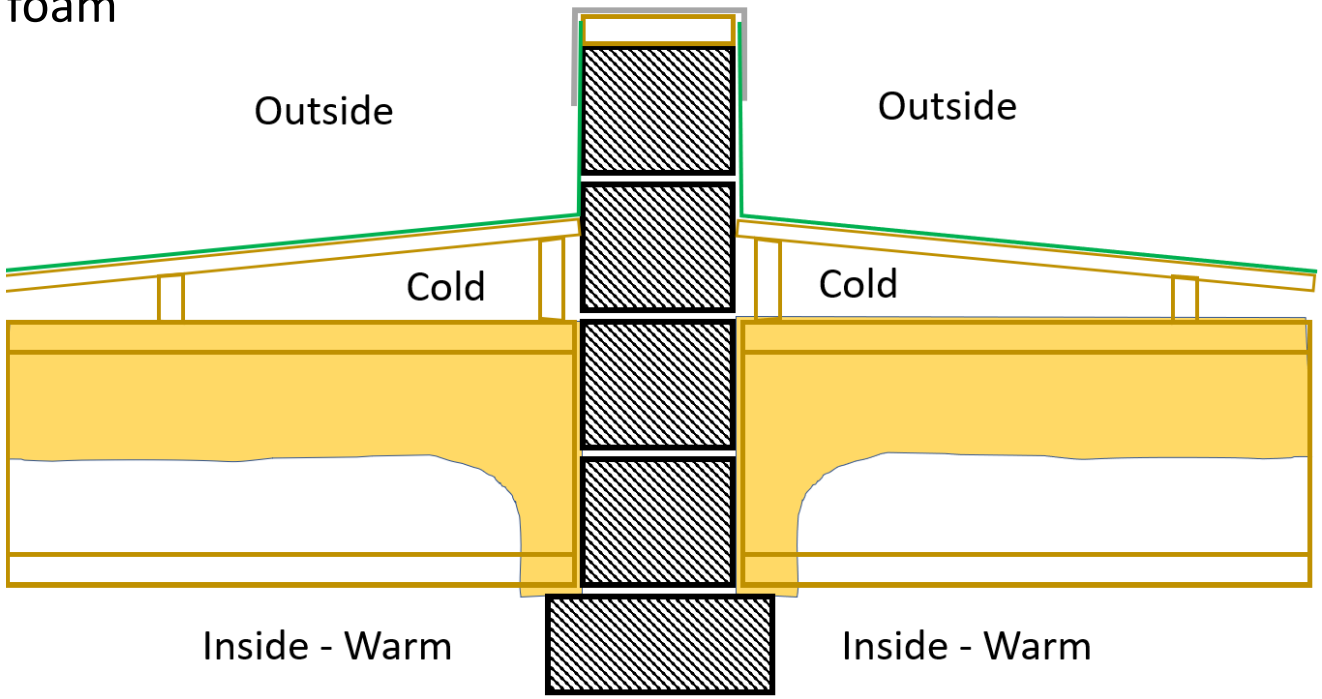
*** Most condensation-related problems are due to air leakage, not vapour flow**

BBS
BAWATING BUILDING SCIENCE

Case Study

- Flat Roof Townhouse with Patio

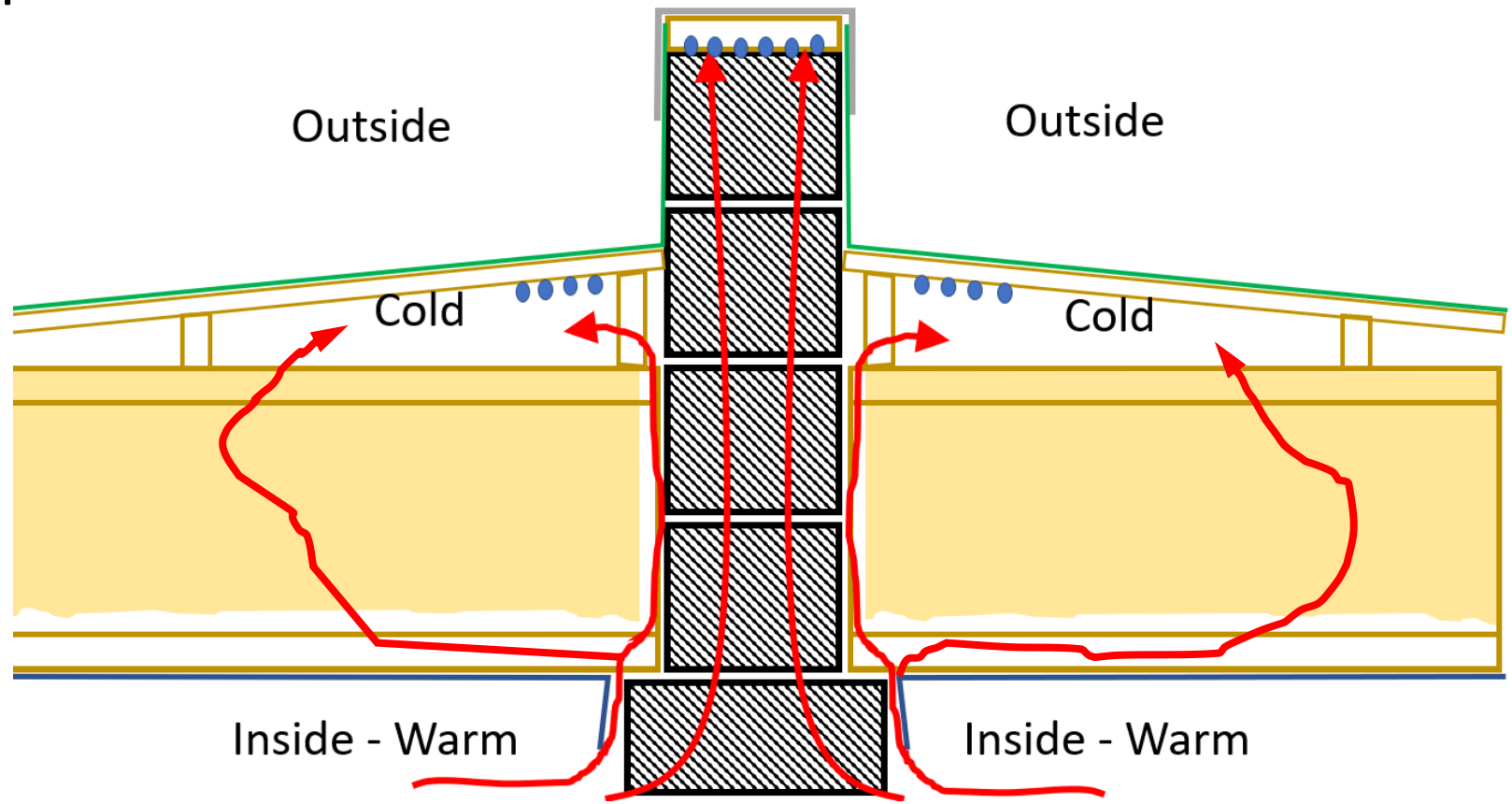
As designed with **closed** cell spray foam



BBS
BAWATING BUILDING SCIENCE

Case Study

As built, with **open** cell spray foam and poly air/vapour barrier



BBS
BAWATING BUILDING SCIENCE

Case Study

This was an **air leakage** problem, not a roof leak and not vapour flow problem

BBS
BAWATING BUILDING SCIENCE

Code Requirements (NBCC)

9.10.17.10. Protection of Foamed Plastics

(See Note A-3.1.4.2.)

1) Except as provided in Sentences (2) and (3), foamed plastics that form part of a wall or ceiling assembly shall be protected from adjacent space in the *building*, other than adjacent concealed spaces within *attic or roof spaces*, crawl spaces, wall assemblies and ceiling assemblies

a) by one of the interior finishes described in Subsections 9.29.4. to 9.29.9.,

b) provided the *building* does not contain a Group C *major occupancy*, by sheet metal that

i) is mechanically fastened to the supporting assembly independent of the insulation,

ii) is not less than 0.38 mm thick, and

iii) has a melting point not less than 650°C, or

c) by any thermal barrier that meets the requirements of Sentence 3.1.5.15.(2).

(See Note A-3.1.4.2.(1)(c).)

BBS
BAWATING BUILDING SCIENCE

Code Requirements (NBCC)

9.33.6. Air Duct Systems

9.33.6.4. Coverings, Linings, Adhesives and Insulation

5) Except as provided in Sentences (6) and (7), foamed plastic insulation shall not be used as part of an air duct or for insulating an air duct.

6) Foamed plastic insulation conforming to Article 9.25.2.2. is permitted to be used to insulate a galvanized steel, stainless steel or aluminum air duct, provided

a) the foamed plastic insulation applied to supply ductwork is not less than 3 m from the *furnace* bonnet,
b) the temperature within the ductwork where the insulation is installed is not greater than 50°C,
c) duct joints are taped with a product conforming to Sentence 9.33.6.3.(1),
d) return air *plenums* are separated from the foamed plastic insulation, and
e) the foamed plastic insulation is protected
    i) by one of the interior finishes described in Subsections 9.29.4. to 9.29.9.,
    ii) provided the *building* does not contain a Group C *major occupancy*, by sheet metal that is mechanically fastened to the supporting assembly independent of the insulation, is not less than 0.38 mm thick and has a melting point of 650°C or more, or
    iii) by any thermal barrier that meets the requirements of Clause 3.1.5.15.(2)(e).

BBS
BAWATING BUILDING SCIENCE

Spray Foam Myth #3

‘Spray foam is a perfect insulation/air barrier/vapour barrier’

BBS
BAWATING BUILDING SCIENCE

Spray Foam Myth #3

‘Spray foam is a perfect insulation/air barrier/vapour barrier’

Reality:

- **Spray foam is building material that is manufactured on the job site, by a variety of installers, under non-optimal conditions**

- Careful installation and third-party inspection is required to avoid future issues

BBS
BAWATING BUILDING SCIENCE

Application Issues

- Like all building materials, spray foam can work well, or fail miserably based on the design of the system and the quality of the installation.

BBS
BAWATING BUILDING SCIENCE

Spray Foam Installation Standard

- Installers must follow CAN/ULC S705.2
  - Training requirements
  - Marking and labelling
  - Substrate preparation
  - Climate factors
  - Job site set-up
  - Daily Work Record
  - Job site label
  - Testing and sampling

BBS
BAWATING BUILDING SCIENCE

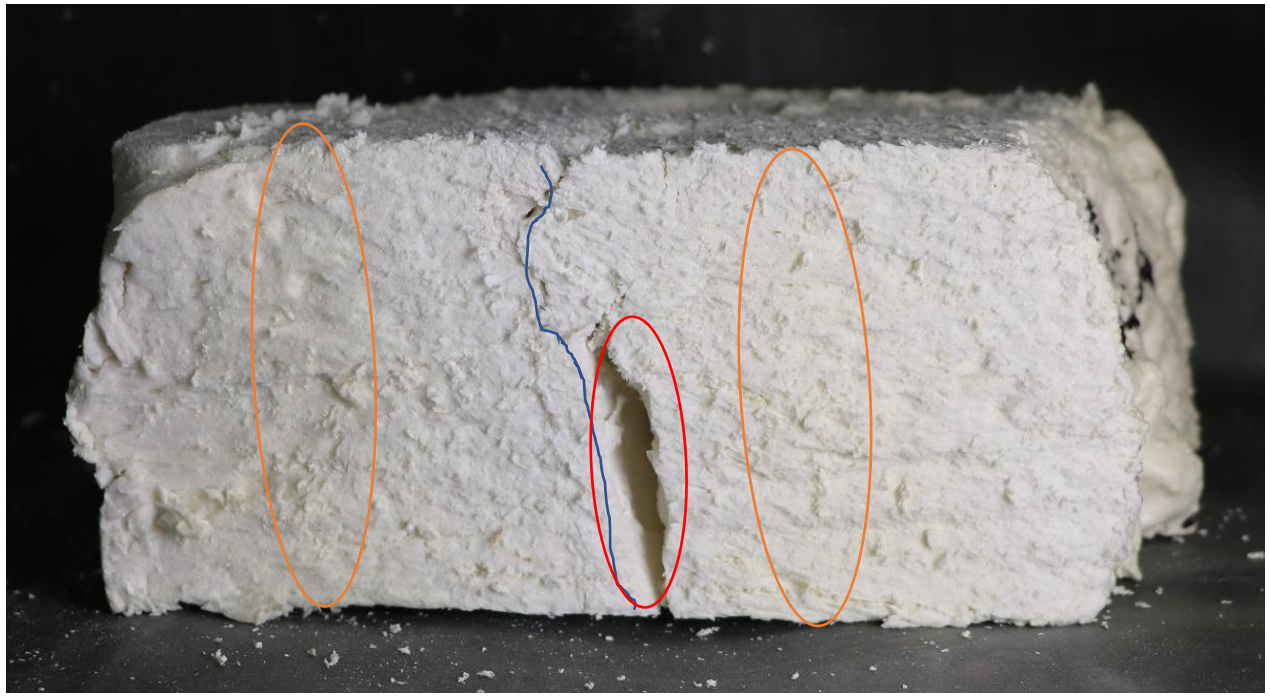
Spray Foam Installation Standard

- Substrate Preparation
  - Wood- less than 19% moisture content, clean and dry
  - Concrete – cured >28 days, dry and clean/free from oil
  - Bare Steel- remove oil, rust, clean and prime
  - Galvanized/Stainless/Aluminum/ PVC – wipe with mineral spirits, dry and prime

BBS
BAWATING BUILDING SCIENCE

Spray Foam Installation Standard

- Material Testing and Sampling
  - Installer to provide sample
  - Cut into cubes and visually inspect
    - Pass lines/pass thickness
    - Scorching
    - Voids
  - Density check
    - Mass/volume



BBS
BAWATING BUILDING SCIENCE

Daily Work Record

General Information

Installer: _____ Installer Certification #: _____

Apprentice: _____ Apprentice Registration #: _____

Project Information

Project Name: _____ Project Address: _____

Customer Name: _____ Construction: ☐ Occupied ☐ Unoccupied

Ventilated 0.3 ACH: ☐ Yes ☐ No Spray Area Isolated: ☐ Yes ☐ No

Material Information

Manufacturer: _____ Product Type: _____

Product Trade Name/Number: _____ Product CCMC #: _____

Iso (A-Side) Lot #: _____ **Resin (B-Side)** Lot #: _____

Expiry Date: _____ Expiry Date: _____

Quantity of Foam Used: _____ LBS _____ KGS _____ Cycles

Equipment Information

Proportioner Model: _____ Hose Length: _____ m / ft

Pressure (A-Side): _____ psi / bar Pressure (B-Side): _____ psi / bar

Primary Heater Temperature: _____ °C / °F Hose Heater Temperature: _____ °C / °F

Environmental Conditions

Ambient Temperature: _____ °C / °F Substrate Temperature: _____ °C / °F

Relative Humidity: _____ % Wind Velocity: _____ kph / mph

Substrate Conditions

Type: _____ Clean: ☐ Yes ☐ No

Dry: ☐ Yes ☐ No Properly Fastened: ☐ Yes ☐ No

Special Conditions

Primer Required: ☐ Yes ☐ No Exterior Coating Required: ☐ Yes ☐ No

Details: _____ Interior Thermal Barrier: ☐ Yes ☐ No

Site Testing

Density Test: mass: _____ g volume: _____ ml Density (g ÷ ml × 1000) = _____ kg/m³

Minimum Required Density: _____ kg/m³ Site Density equal or greater: ☐ Yes ☐ No

Adhesion Test: ☐ Pass ☐ Fail Cohesion Test: ☐ Pass ☐ Fail

Number of Passes: _____ Thickness Per Pass: _____ Total Foam Thickness: _____

Date: _____ Signature: _____ Daily Work Record #: _____

BBS
BAWATING BUILDING SCIENCE

Spray Foam Job Site Label

Job Site Address: _____

Product Name: _____ CCMC #: _____

Company Name: _____

Certified Installer: _____ ID#: _____

Address: _____ Phone: _____

Signed: _____ Date: _____

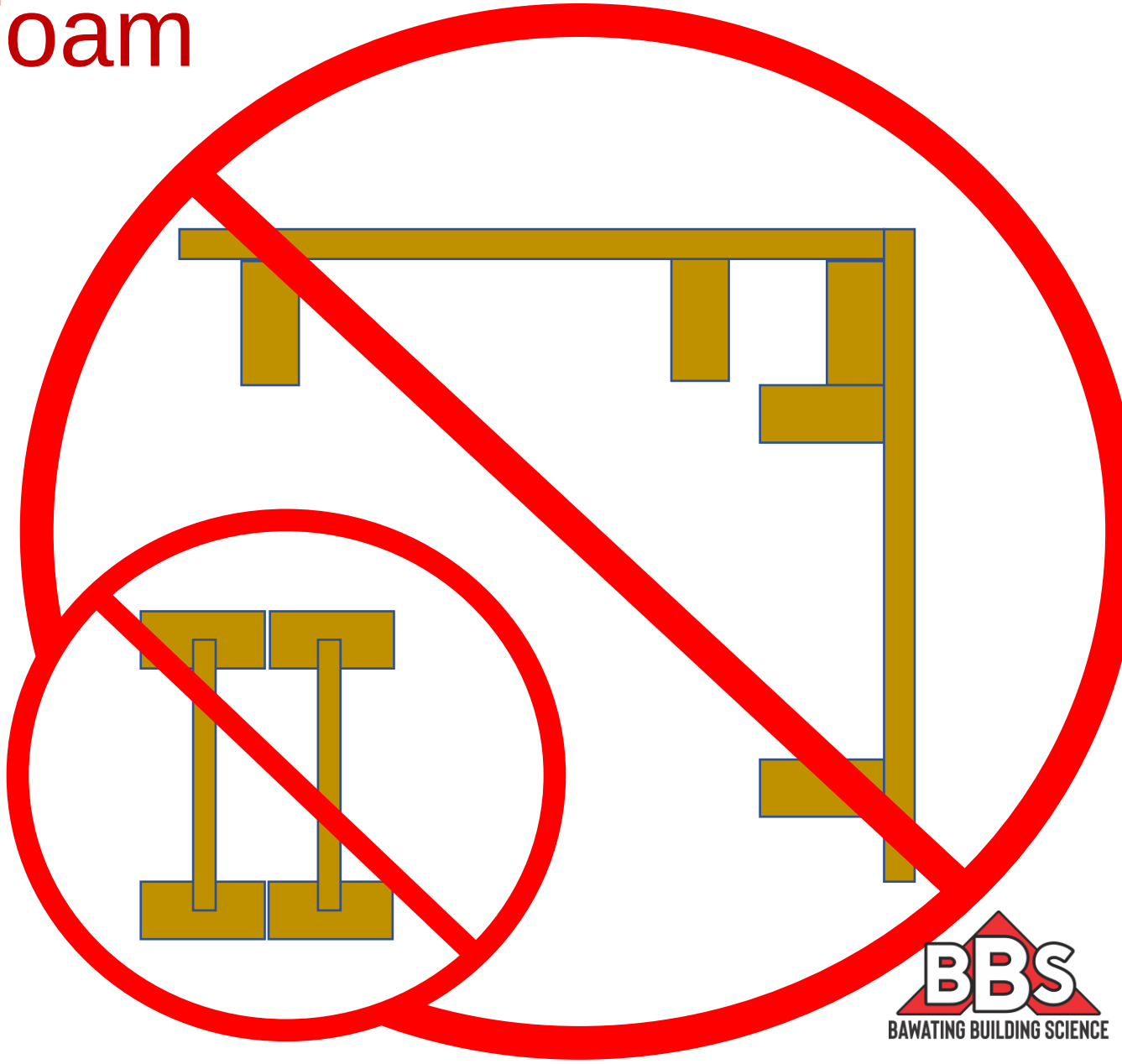
Daily Work Record #: _____

This Job Site certificate indicates that the installed spray applied rigid polyurethane foam insulation meets the CAN/ULC-S705.1 product standard. This product has been installed according to the CAN/ULC-S705.2 installation standard.

BBS
BAWATING BUILDING SCIENCE

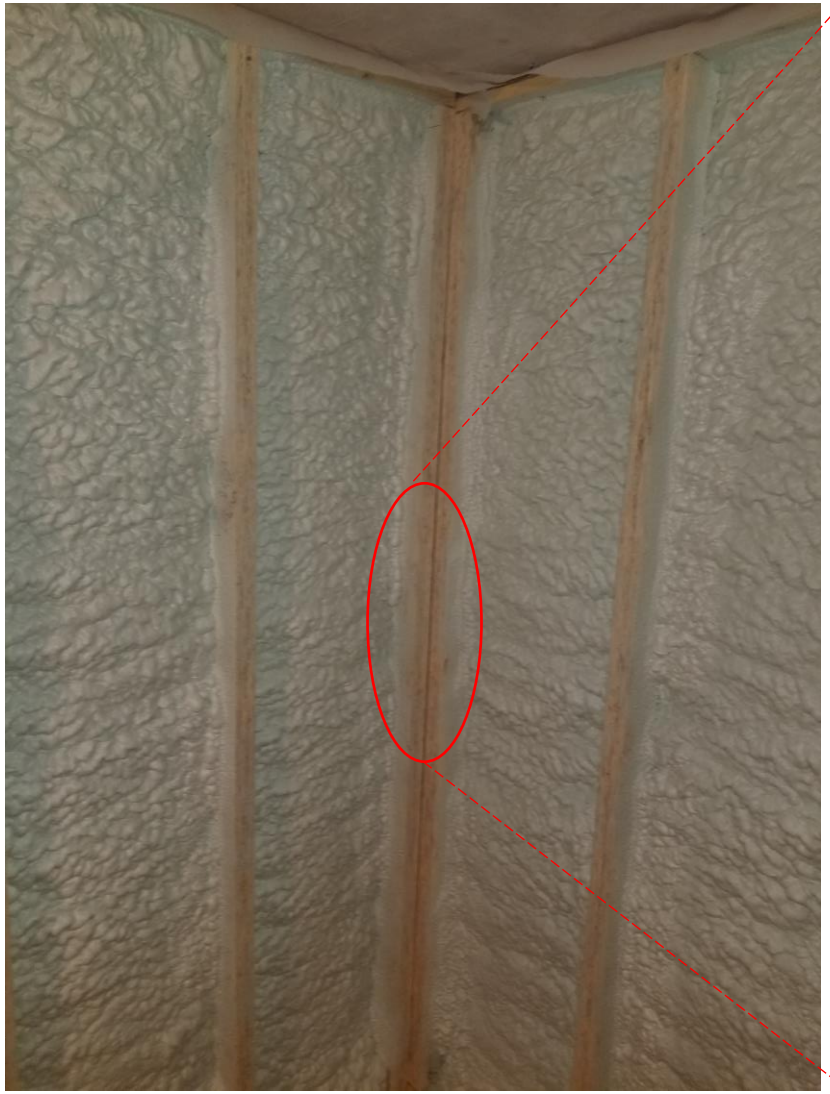
Framing for Spray Foam

- Minimize blocking in spray foam zone – install blocking after if possible
- Inside corners should be 1-stud corners or 1-stud with backer and next stud 16 inches away
- No doubled up I-Joists
- All wood to wood joints (not covered with spray foam) sealed with acoustic sealant



BBS
BAWATING BUILDING SCIENCE

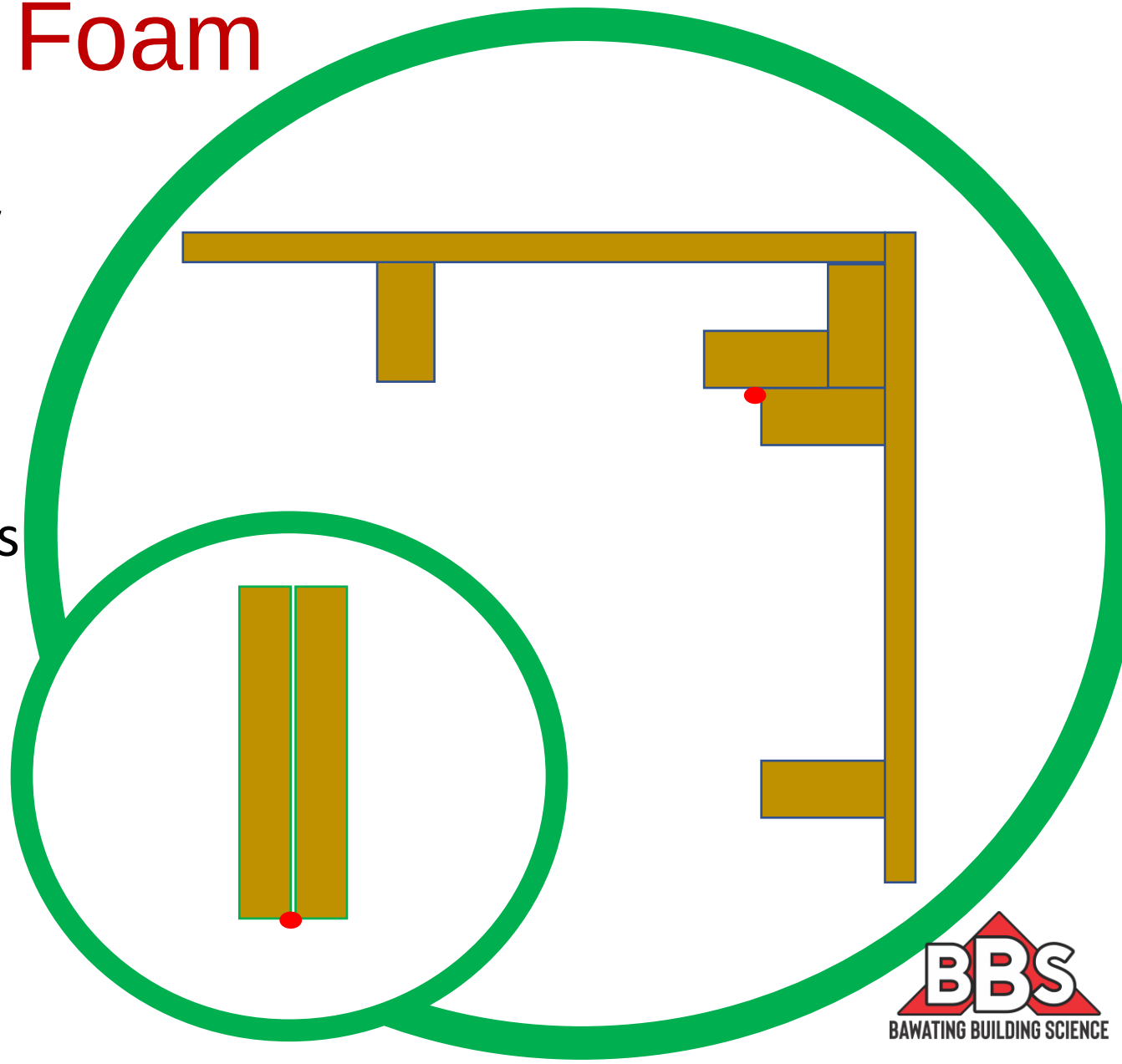
Preparing for Spray Foam



BBS
BAWATING BUILDING SCIENCE

Preparing for Spray Foam

- Create access for installing spray foam in outside corners
  - Seal wood-to-wood joints
- Areas requiring doubled up joists should be solid lumber or gluelam
  - Seal wood-to-wood joints



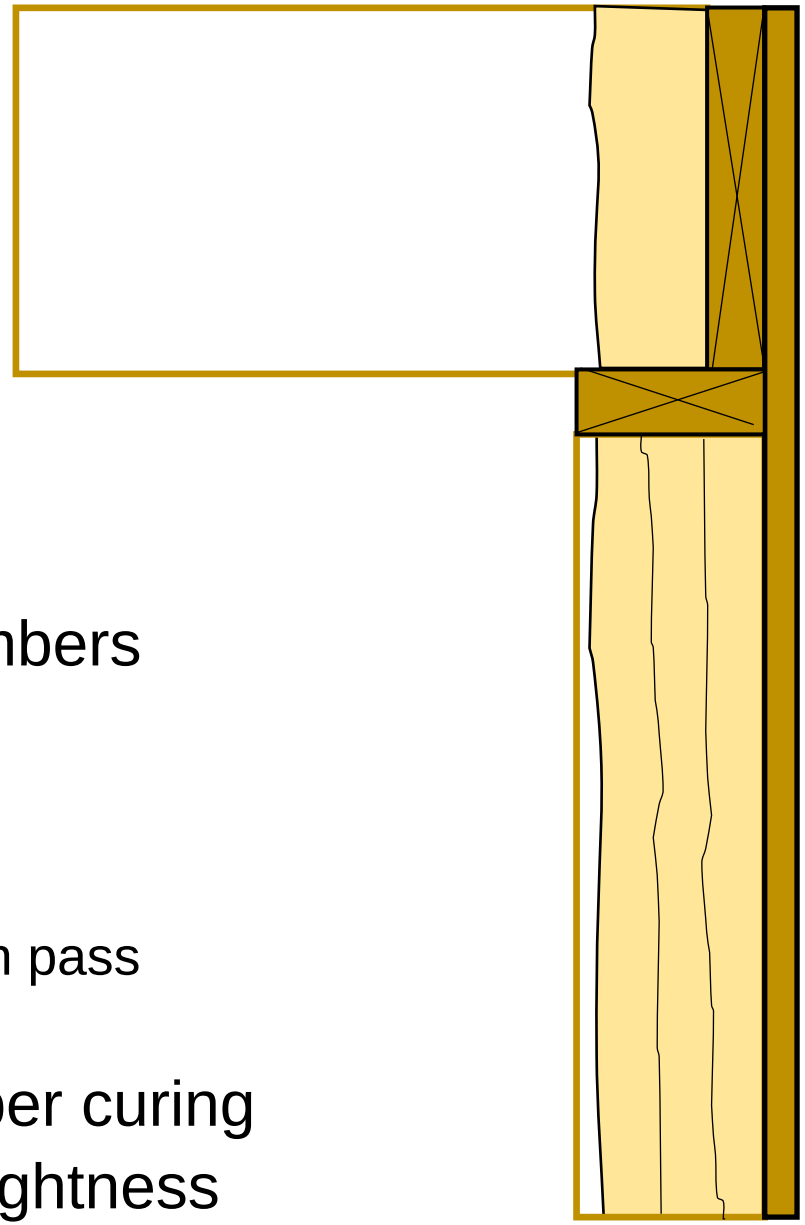
BBS
BAWATING BUILDING SCIENCE

Preparing for Spray Foam

- Vent pipes and plumbing stacks should be stubbed through wall/roof and vents should be un-insulated hard pipes
- No other ductwork should be installed that could interfere with spray foam installation
- Make sure installer has adequate access to all application areas including proper gun access
- Should be solid blocking/backer across openings and gaps
  - Loose fitting batt insulation no sufficient

BBS
BAWATING BUILDING SCIENCE

Inspecting Spray Foam



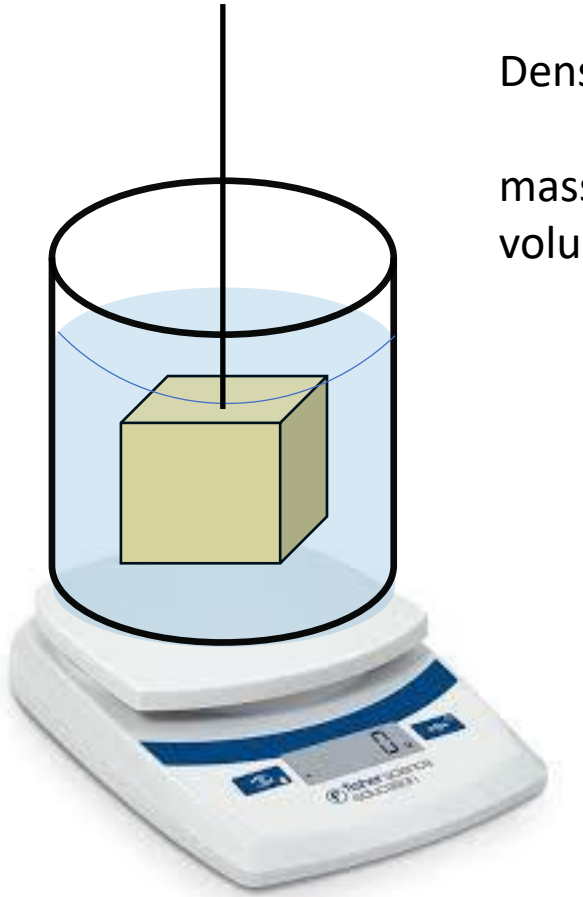
- Installation thickness and passes
  - Can be measured relative to framing members
    - Make sure you understand the assembly
  - Can be checked with probe
    - Can often feel the layers from each installation pass
    - Seal probe holes with interior-grade caulking
  - Proper pass thickness is required for proper curing
  - Multiple, thinner passes can increase airtightness

BBS
BAWATING BUILDING SCIENCE

Inspecting Spray Foam

If you suspect off-ratio and/or poor curing:

- Density check of sample
  - Density = mass/volume (kg/m^3)
- Check measured density against manufacturers specifications



Density of water = 998 kg/m ^{3}

mass of water displaced (g) = volume (m3)

BBS
BAWATING BUILDING SCIENCE

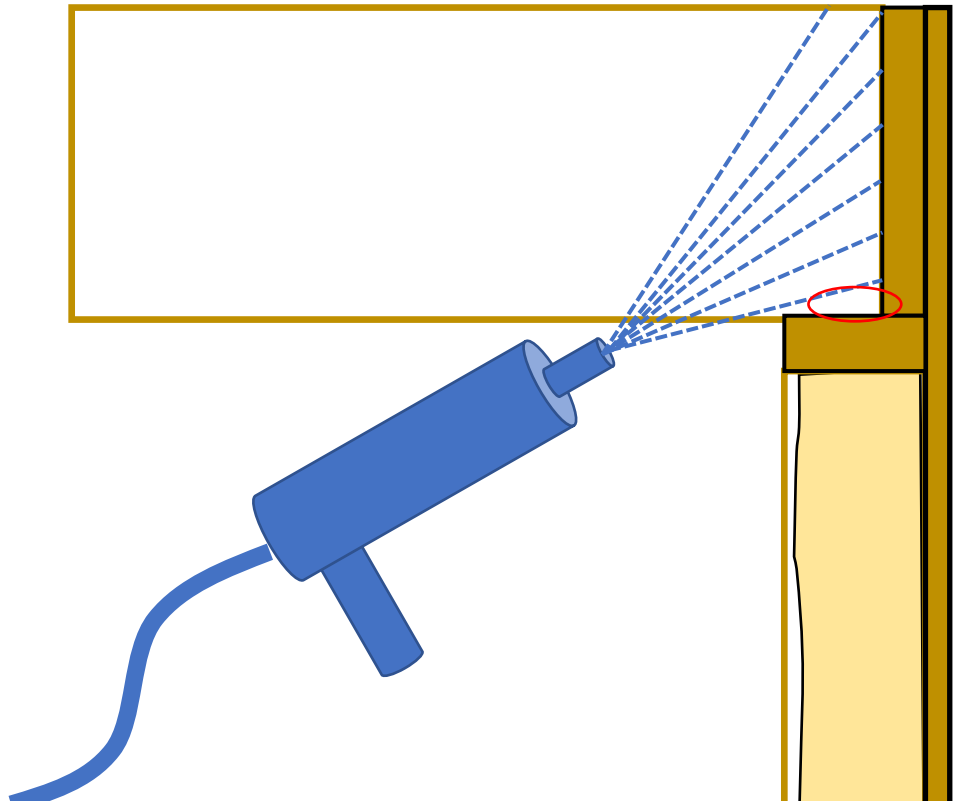
Inspecting Spray Foam

- Visual inspection for surface finish, gaps, cracks and voids
  - Off-ratio foam – spray foam runs = low resin
    - spray foam is hard = low iso
  - Yellowing of foam – UV damage to surface
  - Cracks through foam
  - Voids in foam
  - Dark staining – wood decay
  - Pulling away from wood members
  - **Gaps in foam**

BBS
BAWATING BUILDING SCIENCE

Inspecting Spray Foam

- Visual inspection for voids
  - Check rim joist area for voids



BAWATING BUILDING SCIENCE

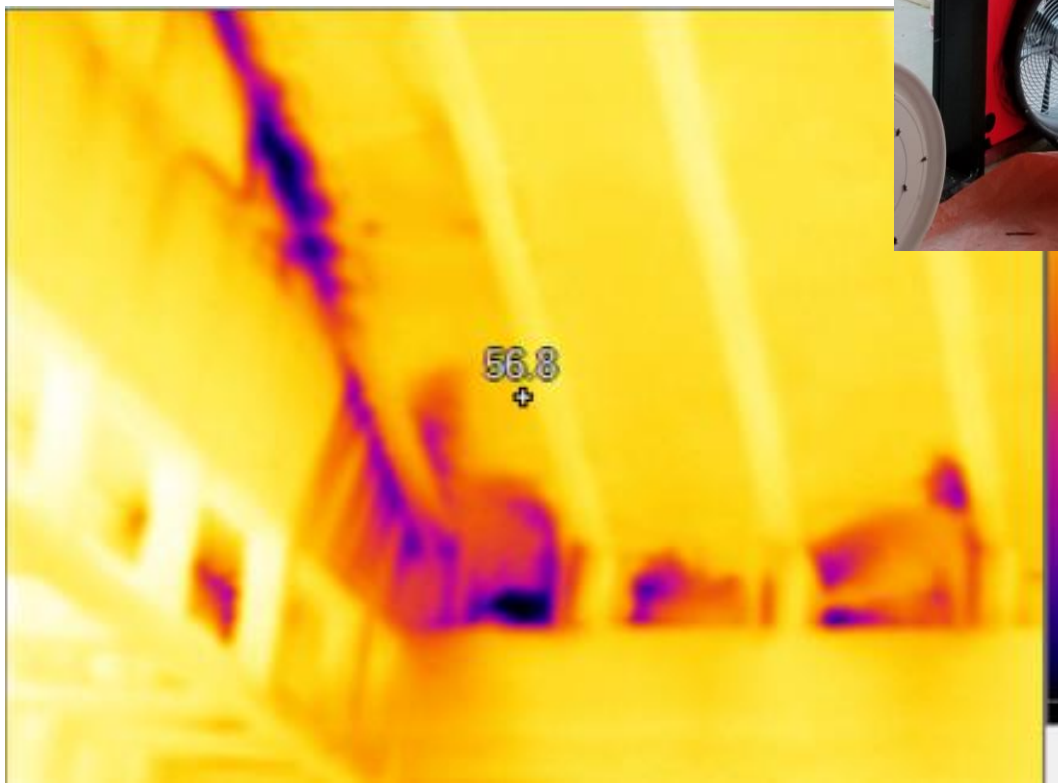
Inspecting Spray Foam

- Visual inspection for voids
  - Check truss supports, peaks and blocking

BAWATING BUILDING SCIENCE

Inspecting Spray Foam

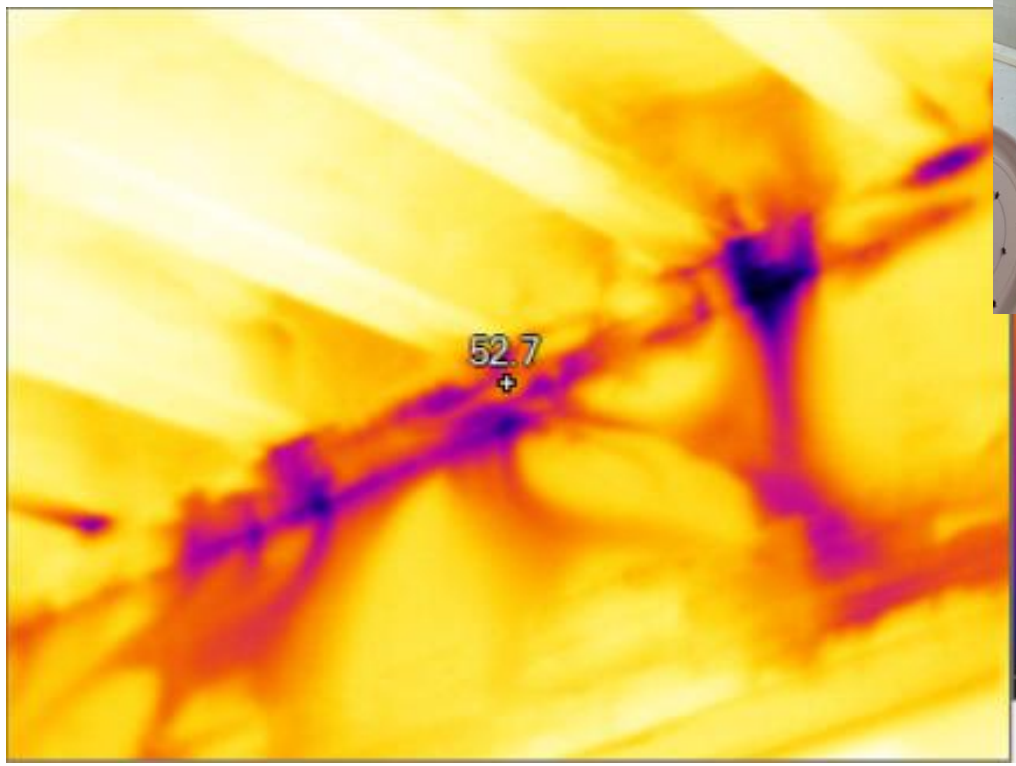
- Building depressurization and air leak detection
  - Manual air leak inspection
  - Infrared themography
  - Smoke pencil

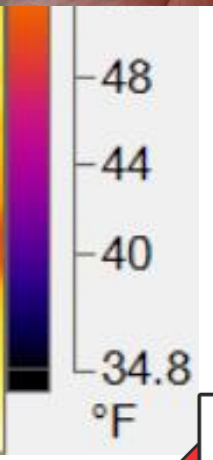


BAWATING BUILDING SCIENCE

Inspecting Spray Foam

- Visual inspection for voids
  - Check rim joist area for voids

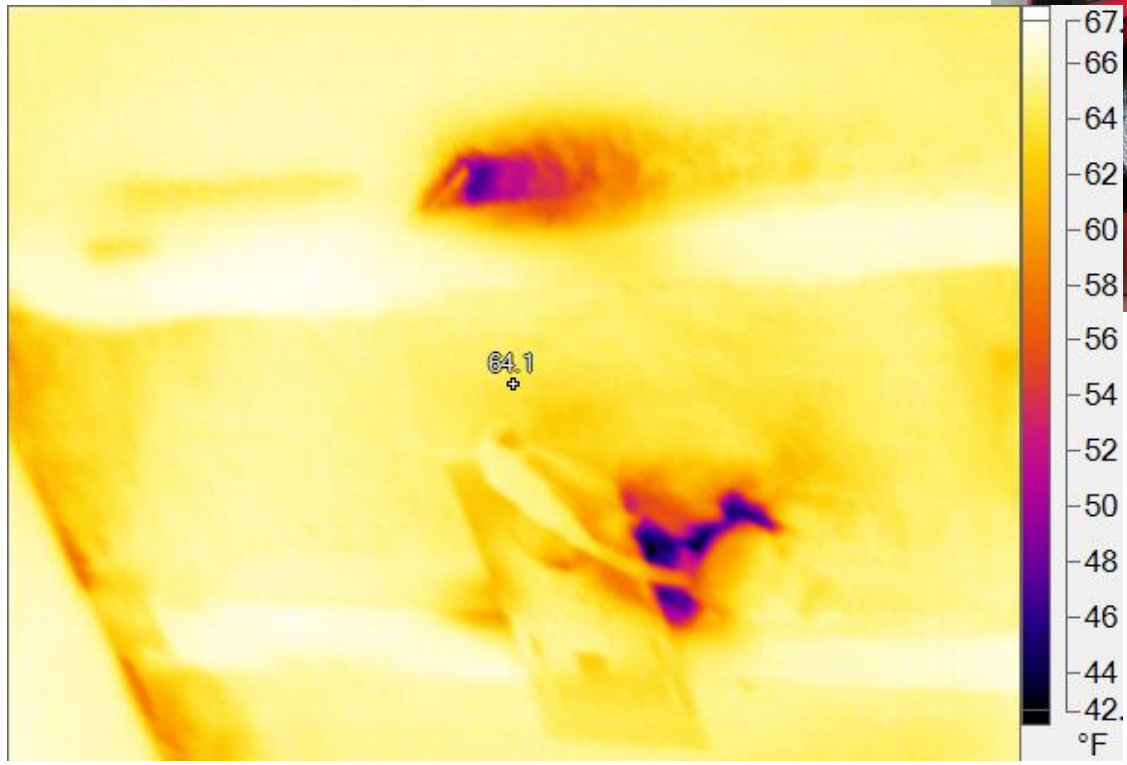




BBS
BAWATING BUILDING SCIENCE

Inspecting Spray Foam

- Visual inspection for voids
  - Check around blocking



BBS
BAWATING BUILDING SCIENCE

Questions…..

Presented to: CACEA Canadian Association of Consulting Energy Advisors

Presented by: Trevor Trainor, M.A.Sc.
President, Building Science Specialist
Bawating Building Science

BBS BAWATING BUILDING SCIENCE

References

- A great article on blowing agents from ecohome:

https://www.ecohome.net/guides/1074/new-hfo-blowing-agents-for-spray-foam-will-make-it-over-1000-times-less-harmful-to-the-climate/

(notice the steel studs and the tight inside corner in the title photo!)

- A more detailed discussion about blowing agents from sprayfoam.com:

https://www.sprayfoam.com/foam-news/the-evolution-of-blowing-agents/3801

- A building science review of spray foam enclosure systems from Joe Lstiburek at Building Science Corp:

https://www.buildingscience.com/documents/building-science-insights-newsletters/bsi-116-interior-spray-foam

BBS
BAWATING BUILDING SCIENCE