Fire Wall Testing And Air Leakage Control To Aid In Construction Tolerances And In Litigation

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Thanks to:
Robby Schwarz
BUILDTankinc
robby@buildtankinc.com
And his permission to incorporate "10 Strategies: Meeting Air Sealing and Code Requirements for Townhouse Area Separation Walls"

August 6, 2025

Summer Camp XXVII

Twenty-Seventh Westford Symposium on Building Science

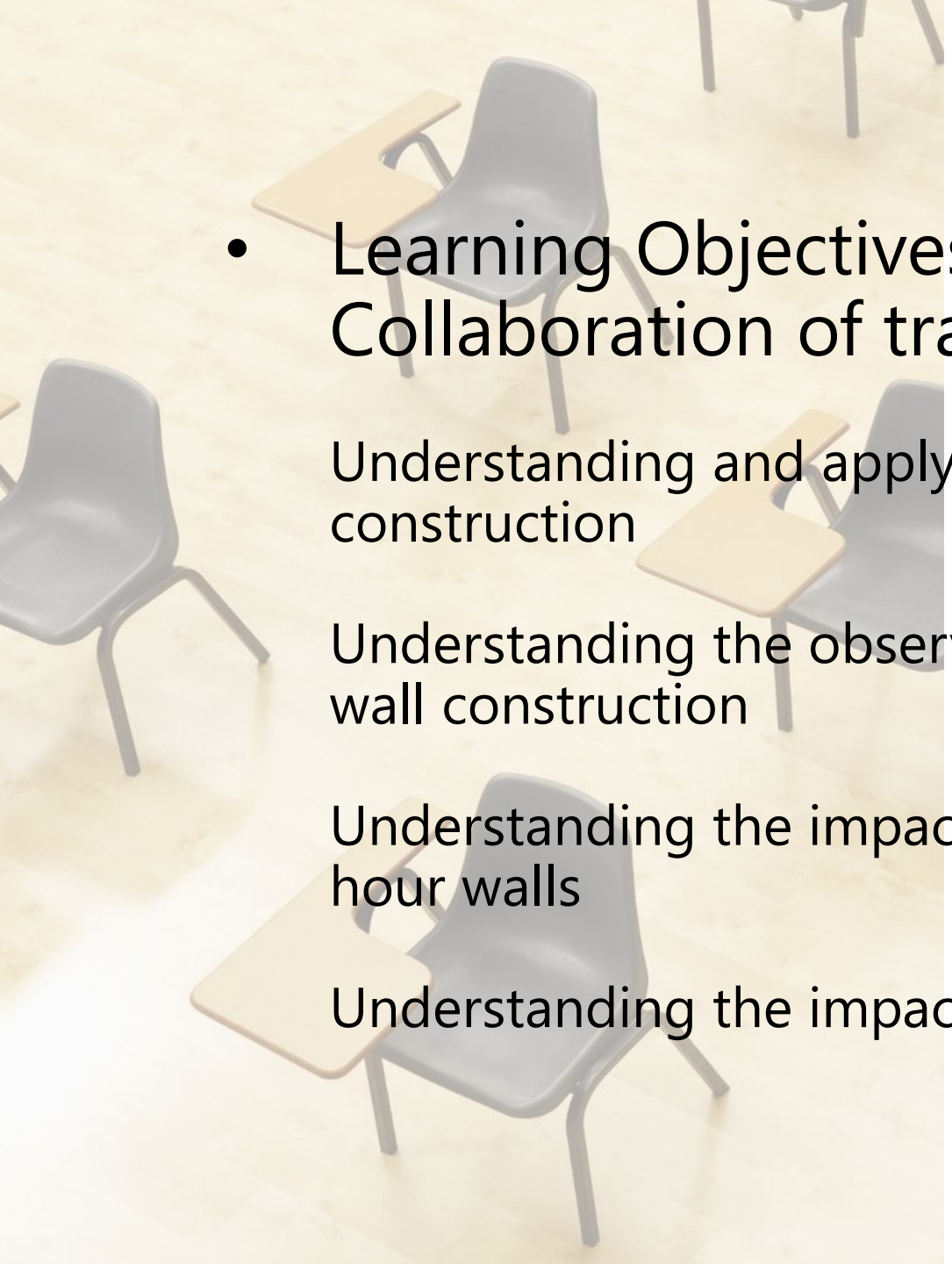
Schedule

0-5 Review of the history of passive fire wall construction in multi-family and commercial applications

5-45 Review of alleged defective work and standard investigation findings from both visual and intrusive testing, review of air-tightening

45-75 Review of testing that was performed and the findings based on a multitude of both proprietary and non-proprietary testing

Q and A



- Learning Objectives:
  Collaboration of trades and the End Product

  Understanding and applying the provisions of 2-hour wall construction

  Understanding the observation criteria for quality assurance in fire wall construction

  Understanding the impacts of tolerances on the construction of 2-hour walls

  Understanding the impacts of air sealant at critical interfaces

Fire Basics - The Tetrahedron

Oxygen from the air
Heat
Fuel Source

Without one – No Fire

Developing Your Conclusions

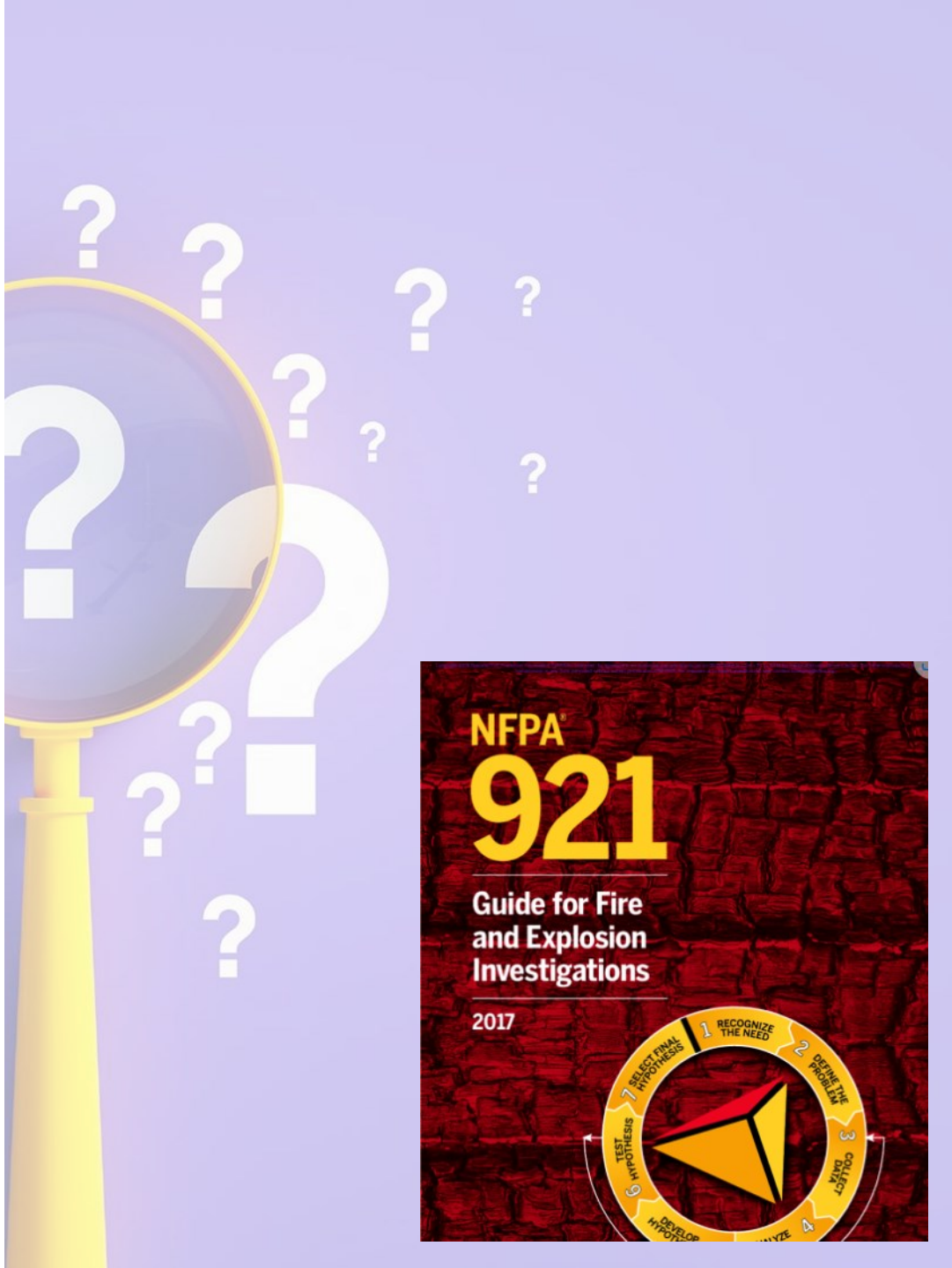
NFPA 921 – 4.3.5 and 4.3.6 – Hypothesis

Inductive Reasoning:
Based on empirical data the investigator has collected through observations, knowledge, training and experience

Deductive Reasoning:
The investigator does not have a valid or reliable conclusion unless the hypothesis can stand the test of careful and serious challenge.

Compare the Hypothesis
All Known Facts
Body of Scientific Knowledge
Testing of the Hypothesis
    Lab, Calculations, Modeling
Disprove the Hypothesis (find out why it is not true by each specific component in the assembly)

This will prevent “Confirmation Bias” that is formed solely on supporting data



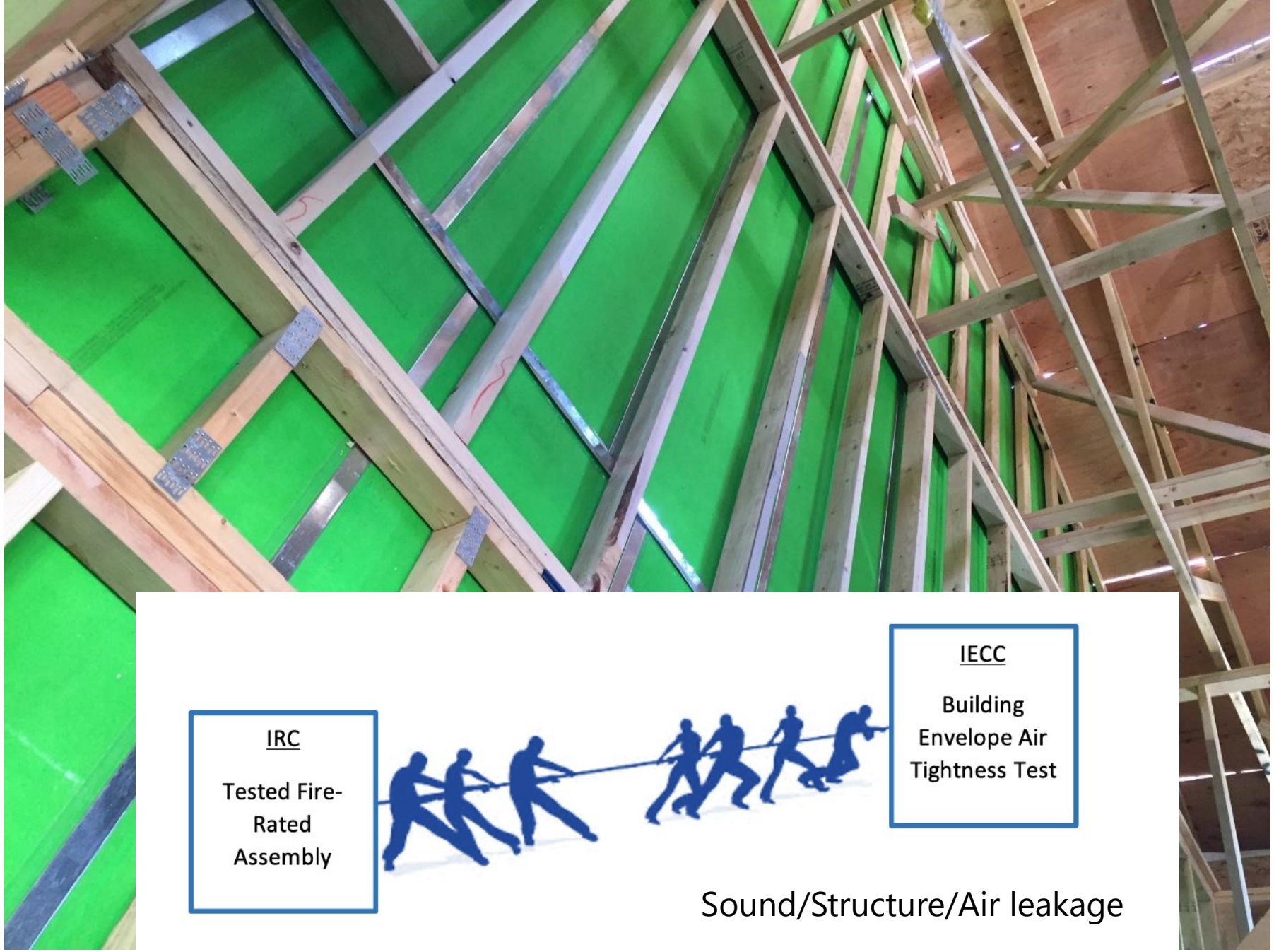
The Fire Wall

- **Interdisciplinary Requirement Not just the Architect**

- Civil Engineer – Laying out the buildings per setbacks
- Architect – Type of Use, Layouts, Materials, Assemblies
- Structural – Type of Structure, the materials
- Mechanical/Plumbing/Electrical – Systems that interrupt or pass
- Building Science – Assemblies that work, reduce air losses, control the environment

- Structure – Sound – Resistance – Reduction in Air Loss

What constitutes the UL fire rated assembly?


IRC
Tested Fire-Rated Assembly
IECC
Building Envelope Air Tightness Test
Sound/Structure/Air leakage

Combine your fire prevention needs with your air barriers

- Newport Partners a consulting firm headquartered Davidsonville MD coordinated research on behalf of HUD/PD&R
- Field research was conducted at Thrive Home Builders townhouse project in Wheat Ridge Colorado
- NFPA managed an Advisory Group
- This session is designed to inform stakeholders of the key issues involved in building safe and energy efficient in ASWs in townhouses
- Our goal is to provide strategies to make the process easier and ultimately more affordable

RESOURCE DEVELOPMENT | Newport Partners LLC

Newport Partners, LLC

- A Strategy Guide for Air-Sealed Townhome Area Separation Walls That Meet Energy and Building Codes

Executive Summary

Townhomes are an important part of the housing market, especially when it comes to affordability. They provide living space and some outdoor space, often at a lower relative cost to homebuyers than single-family detached homes. With smaller lots and shared interior walls, or area separation walls (ASWs), townhomes are often more cost-effective to construct than single-family detached homes (exhibit 1). However, the tension between air sealing requirements in the International Energy Conservation Code (IECC) and requirements for fire-rated assemblies between townhomes in the International Residential Code (IRC) has caused significant challenges in both construction and code enforcement (exhibit 2).

Exhibit 1. Townhome Area Separation Walls Under Construction

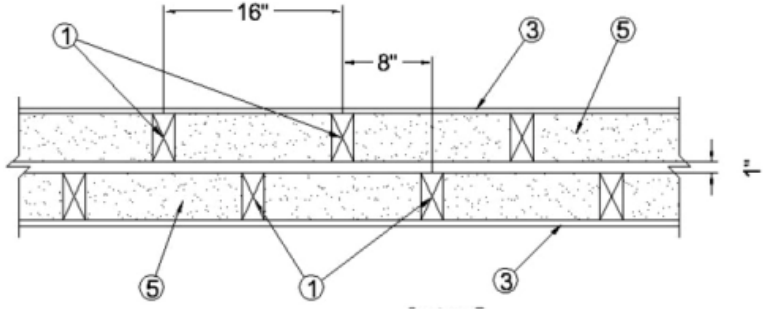
Photo Credit: Newport Partners

Exhibit 2. Code Tension Between Air Sealing Requirements in the IECC and Requirements for Fire-Rated Assemblies Between Townhomes in the IRC

IECC = International Energy Conservation Code. IRC = International Residential Code.

A Strategy Guide for Air-Sealed Townhome Area Separation Walls That Meet Energy and Building Codes

Two One Hour and One Two Hour



Because the (2) separate assemblies provide the same level of fire protection between units (ie, Double 2-hour walls versus the Single 2-hour wall), the subject of this memo discusses the equivalency of the two separate systems of which, under section 104.2.7 “Modifications,” the building department properly approved.

The construction of the Single 2-hour, in lieu of the Double 1-hour, was approved because the 2 constructions were documented as equivalent in the 2003 International Residential Code (IRC), of which the City had knowledge of by the time the Double 1-hour wall was constructed but after the permits were issued (See R317.2 – 2003 IRC attached).

In short, the fire-resistive separation walls, as constructed, were deemed to be equivalent to the originally designed wall, as well as met the intent of the minimum requirements of the 1997 Uniform Building Code, because of the knowledge of the 2003

International Residential Code. As for the 1-hour fire resistive assemblies between the garages, these also are acceptable based on the UBC formal interpretation of section 503.2 (See 503.2 UBC interpretation attached).

Area Separation Walls (Sections 504.6.2., 504.6.3., and 504.6.4.)

UBC 504.6.2. requires that the required area separation walls in R-1 VN buildings be constructed with a minimum of 2-hour rated assemblies.

When a 2-hour rated assembly is used, Section 504.6.4. requires that the area separation wall extend above the roof 30-inches, or the 2-hour wall is allowed to terminate at the bottom side of the roof deck provided additional measures are taken to install 1-hour fire-resistive construction within 5-feet of the area separation wall termination (see Section 504.6.4.).

Section 504.6.3. requires that the separation walls extend to the outer face of the exterior wall of the building unless there are enclosed horizontal projecting elements such as porches or balconies.

In these cases, the area separation wall must extend to the end of the horizontal projecting element, but only if it is enclosed

GA-620-2019
GYPSUM AREA SEPARATION FIREWALLS

Introduction

Gypsum Area Separation Firewall systems provide the advantages of both fire-resistance and noise reduction between neighboring townhouses and other attached dwelling units. Gypsum Area Separation Firewalls are efficient, nonloadbearing, 2-hour fire resistance rated gypsum panel systems that can provide code compliant STC ratings exceeding 60.

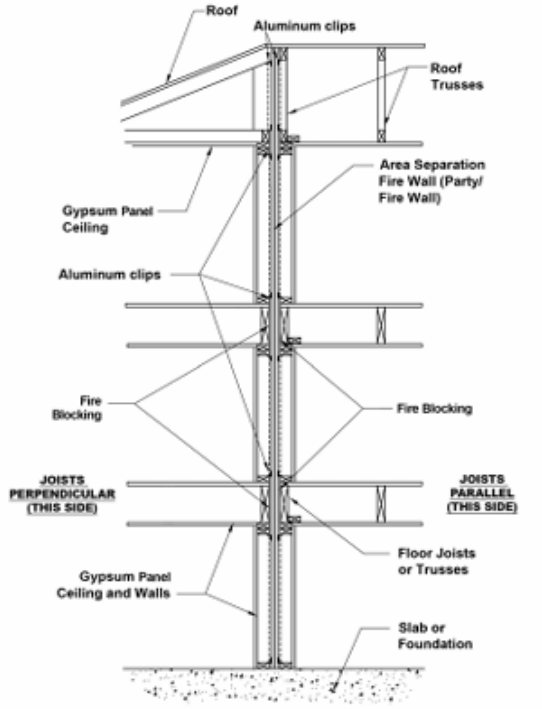


Fig 1 – Typical Gypsum Area Separation Firewall Construction

Printed in U.S.A.

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962 Wayne Avenue, Suite 620
Silver Spring, MD 20910
301-277-8686

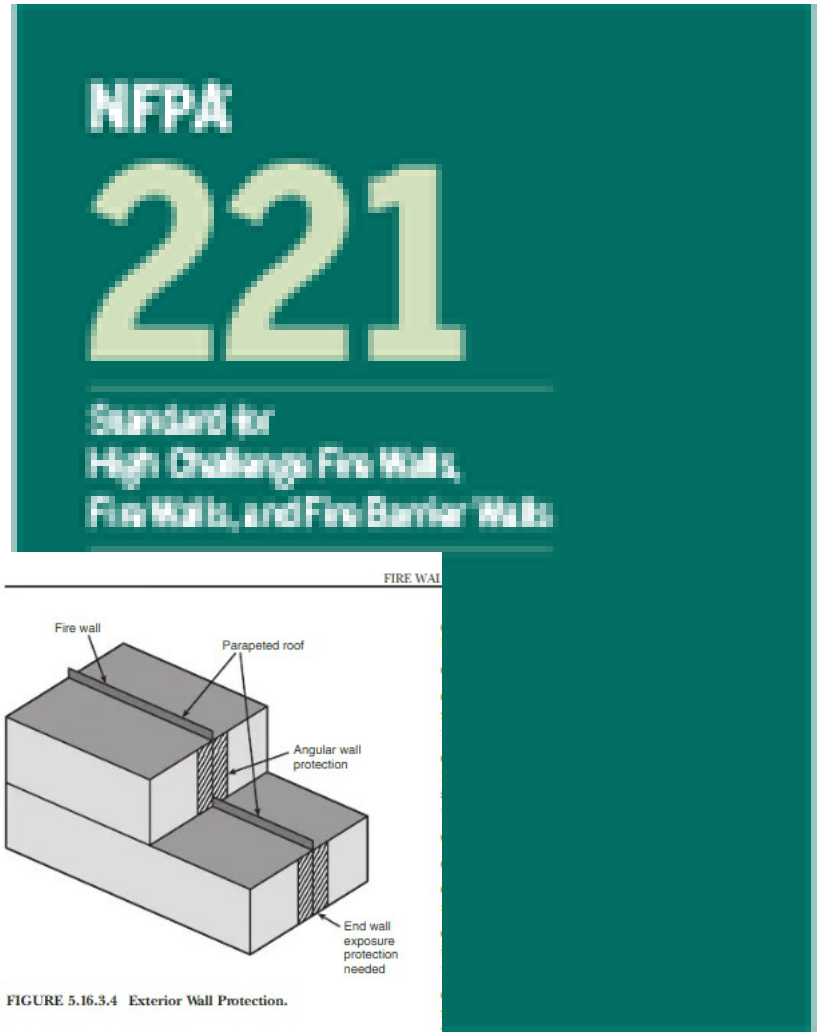
*Microsoft Word - GA-620 GYPSUM AREA SEPARATION FIREWALLS FINAL 031319.doc

NFPA 221 (1929-2021)

Standard for High Challenge Fire Walls, and Fire Barrier Walls

6.2 Structural Stability:
6.2.1 Fire walls shall be designed and constructed to remain stable after collapse of the structure due to fire on either side of the wall.
6.2.2 fire walls constructed in compliance with the requirements of Sections 6.3, 6.4, 6.5 shall be deemed to provide the required stability.

6.4.2 Framework
6.4.2.1 Structural framing on either side of the wall shall line up horizontally and vertically and shall support the roof.
6.4.2 The framework on each side of the fire wall shall be continuous and tied together through the wall.
6.4.2.3 The frame work on each side shall be designed so that it resists the maximum lateral pull that can be developed due to the framework collapse on the opposite side.
6.5 Double Fire Walls
6.5.1 A double frame wall consists of two back to back walls
6.5.2 There shall be no connections, other than to the flashing between the walls.
6.5.3 Each fire walls shall be supported laterally by the building frame on its respective side and shall be independent of the fire wall and framing on the opposite side.

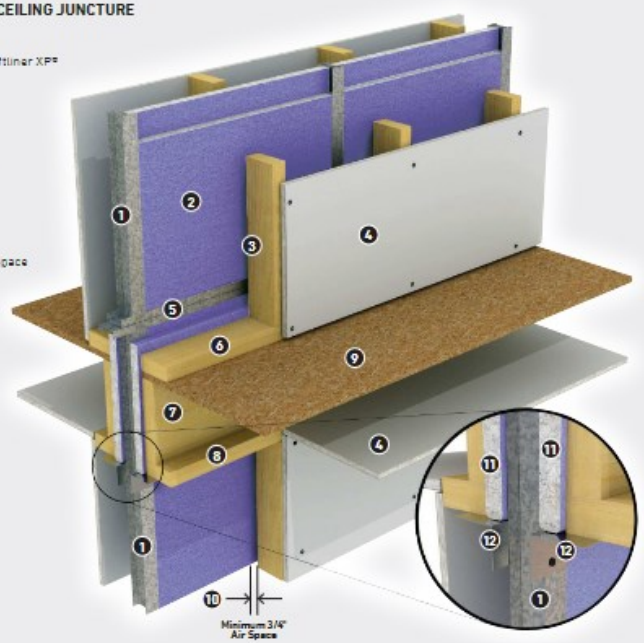


2-Hour Area Separation Wall System

The 2-hour area separation wall system is a 2-hour fire wall consisting of 2" (50.8 mm) light-gauge steel H-Studs that secure two layers of 1" (25.4 mm) shaftliner panels friction-fit between studs and a minimum 3/4" (19.1 mm) air space on each side.

TYPICAL FLOOR/CEILING JUNCTURE

1. H-Stud
2. Two Layers 1" Shaftliner XP®
3. Wood Stud
4. Gypsum Board
5. Double C-Track (Back-to-Back)
6. Bottom Plate
7. Rim Joist
8. Top Plate
9. Subfloor
10. Minimum 3/4" Air Space
11. Fire Blocking 1" eXP® Shaftliner or Mineral Wool
12. ASW Clip



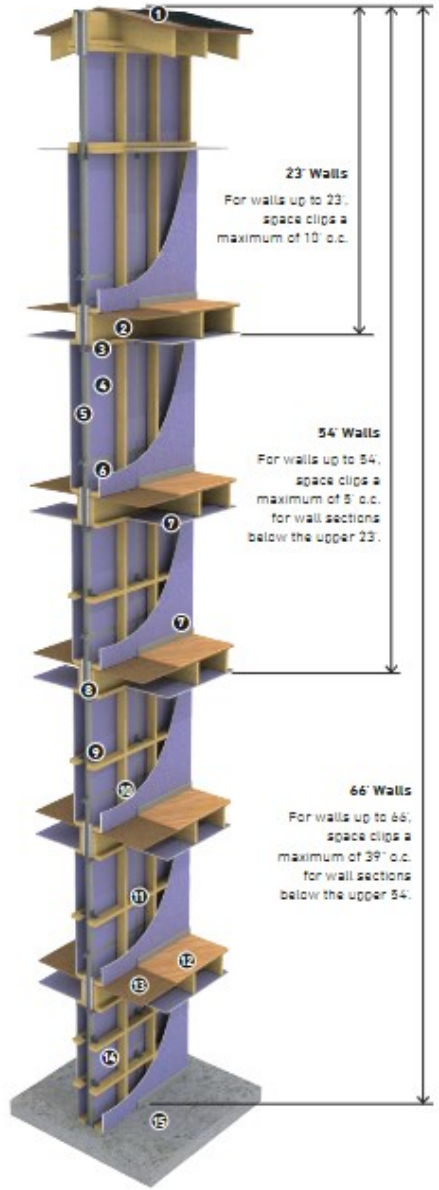
AREA SEPARATION WALL LIMITING HEIGHTS

1. Roof
2. Rim Joist
3. Top Plate
4. Two Layers eXP® Shaftliner
5. H-Stud
6. Double C-Track (Back-to-Back)
7. XP® Gypsum Boards
8. Fire Blocking 1" eXP® Shaftliner or Mineral Wool
9. ASW Clip
10. Wood Stud
11. Horizontal Blocking
12. Finish Floor
13. Subfloor
14. Minimum 3/4" Air Space
15. Concrete Slab or Foundation


ASW Clip


H-Stud

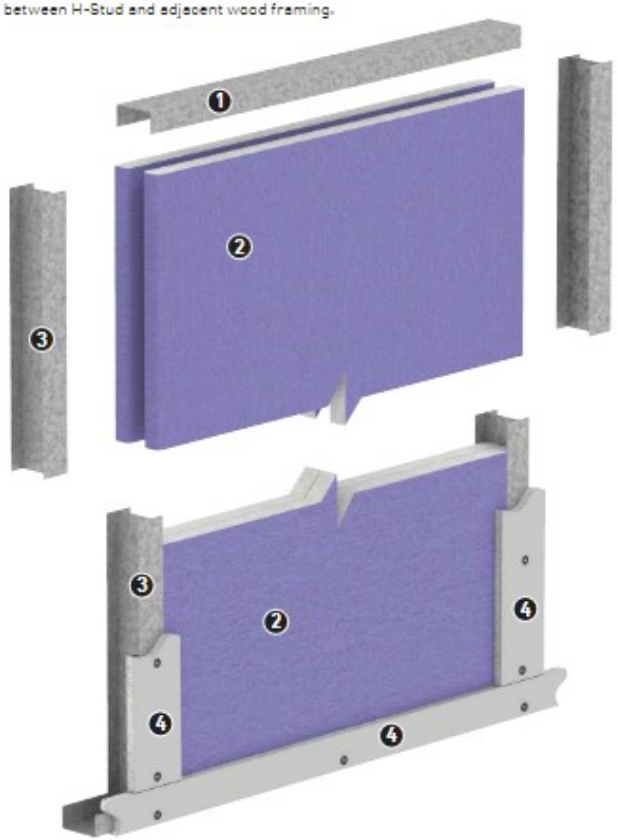

C-Track



BASIC COMPONENTS OF 2-HOUR AREA SEPARATION WALL

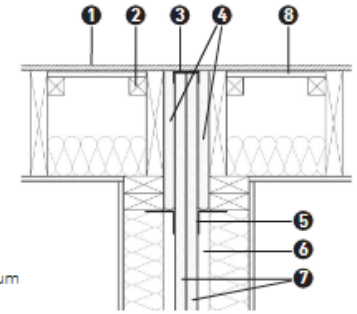
1. 2" C-Track
2. 1" eXP® Shaftliner or Shaftliner XP®
3. 2" H-Stud
4. 1/2" Fire-Shield C™ Gypsum Batten

* Battens not required when 3/4" air space is maintained between H-Stud and adjacent wood framing.



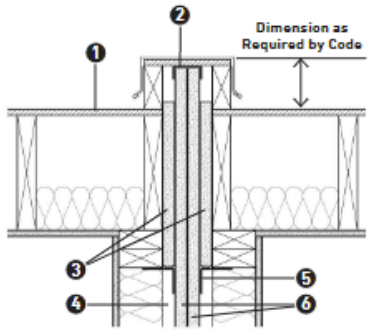
ROOF JUNCTION DETAIL

1. Roof Deck
2. 2x2 Wood Ledger
3. 2" C-Track
4. Gypsum Board or Mineral Wool Fire Blocking
5. ASW Clip
6. Minimum 3/4" Air Space
7. 1" eXP Shaftliner or Shaftliner XP
8. 5/8" Fire-Shield Gypsum Board, 4' each side when roof deck is not constructed with fire-



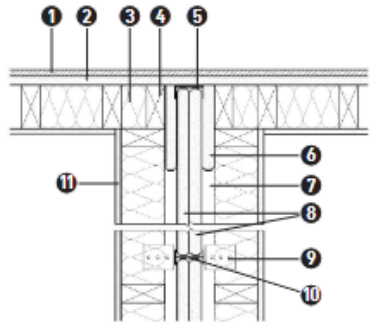
ROOF PARAPET DETAIL

1. Roof Deck
2. 2" C-Track
3. Gypsum Board or Mineral Wool Fire Blocking
4. Minimum 3/4" Air Space
5. ASW Clip
6. 1" eXP Shaftliner or Shaftliner XP



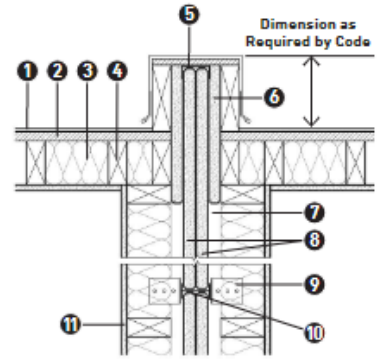
EXTERIOR WALL JUNCTION DETAIL

1. Siding
2. 5/8" eXP Fire-Shield Sheathing
3. Insulation
4. 2x4 Wood Stud
5. 2" C-Track
6. Gypsum Board or Mineral Wool Fire Blocking
7. Minimum 3/4" Air Space
8. 1" eXP Shaftliner or Shaftliner XP
9. ASW Clip
10. 2" H-Stud
11. Gypsum Board



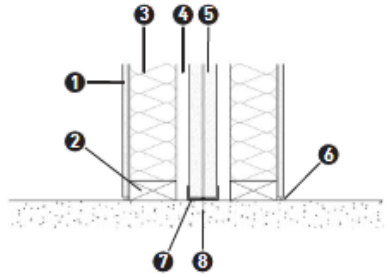
EXTERIOR WALL INTERSECTION DETAIL

1. Siding
2. Plywood or OSB Sheathing
3. Insulation
4. 2x4 Wood Stud
5. 2" C-Track
6. Gypsum Board or Mineral Wool Fire Blocking
7. Minimum 3/4" Air Space
8. 1" eXP Shaftliner or Shaftliner XP
9. ASW Clip
10. 2" H-Stud
11. Gypsum Board



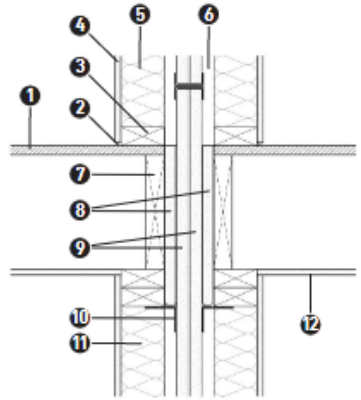
FOUNDATION DETAIL

1. Gypsum Board
2. 2x4 Wood Plate
3. Insulation
4. Minimum 3/4" Air Space
5. 1" eXP Shaftliner or Shaftliner XP
6. Sealant
7. 2" C-Track
8. Fasteners 24" o.c. Max.



FLOOR INTERSECTION DETAIL

1. Subfloor
2. Sealant
3. 2" Wood Plate
4. Gypsum Board
5. Insulation
6. Minimum 3/4" Air Space
7. Rim Joist
8. Gypsum Board or Mineral Wool Fire Blocking
9. 1" eXP Shaftliner or Shaftliner XP
10. ASW Clip
11. 2x4 Wood Stud
12. Ceiling



Gypsum Association

GA-620-2019
GYPSUM AREA SEPARATION
FIREWALLS

Introduction

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Note: Always use back-to-back C-runners between courses in Gypsum Area Separation Firewalls. Do not substitute a single H-stud for the specified back-to-back C-runners.

Erect shaft liner panels and H-studs in the same manner as for the first section of wall, except that starting and ending procedures may vary depending on the exterior wall intersection detail.

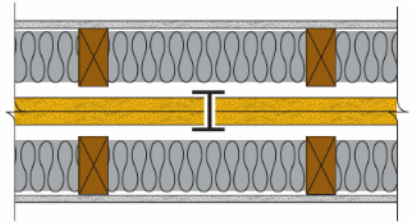
13. Install code approved fire blocking on both sides of the Gypsum Area Separation Firewall at each floor and the roof line. Fire blocking should fit tightly between the truss and framing area to the shaft liner panel.

14. At top floor, the Gypsum Area Separation Firewall may either extend to the top of a parapet wall or terminate at the underside of the roof deck. When terminating at the underside of the roof deck, the roof decking material for 4 ft (1220 mm) on either side of the wall shall be either Fire Retardant Treated plywood or gypsum panels.

15. At roof intersection the walls are capped-off with C-runners.

Fire and Sound

2-Hour Fire Rating
Design Reference: UL U373, UL U375, ULC W312, WHI GP/WA 120-04, cUL U373, cUL U375, GA ASW 0810

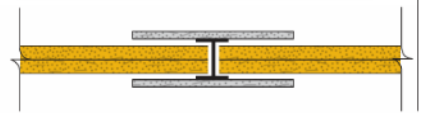


65-69 STC Sound Trans.
Test Reference: RAL TL 10-291

Two layers 1" (25.4 mm) DensGlass Shaftliner inserted in H-Studs 24" (610 mm) o.c. Min. 3/4" (19 mm) air space on both sides must be maintained between liner panels and adjacent framing.

Sound Tested with 2" (51 mm) x 4" (102 mm) stud wall with 1/2" (12.7 mm) ToughRock gypsum wallboard each side of assembly and 3-1/2" (89 mm) fiberglass insulation in stud space both sides.

2-Hour Fire Rating
Design Reference: WHI 495-0743



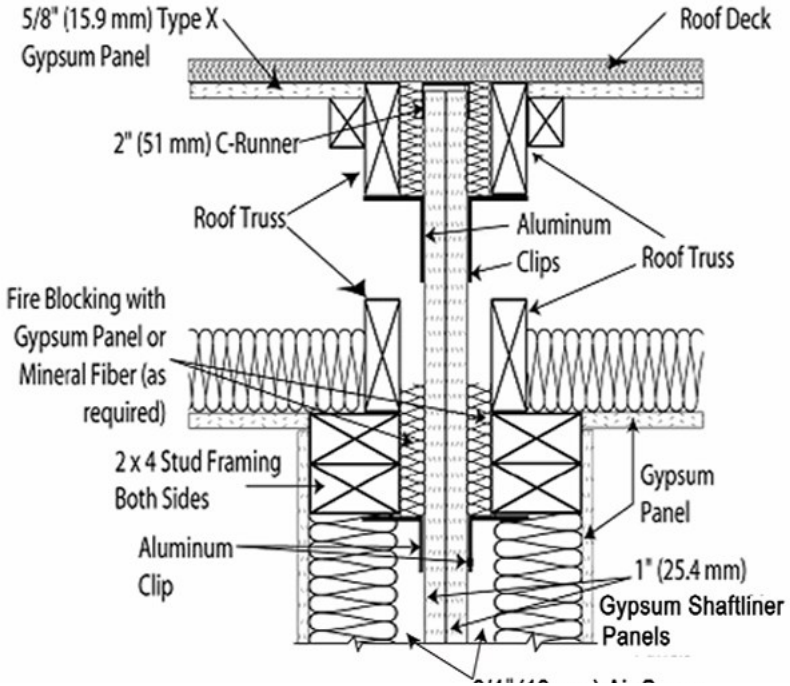
35-39 STC Sound Trans. Est.
Part. Thickness: 3" (76 mm)

Two layers 1" (25.4 mm) DensGlass Shaftliner inserted in H-Studs 24" (610 mm) o.c. Metal covered using 6" (152 mm) wide 1/2" (12.7 mm) DensArmor Plus® Fireguard C® interior panels or 1/2" (12.7 mm) ToughRock Fireguard C® gypsum board.

CAUTION: For product fire, safety and use information, go to buildgp.com/safetyinfo.

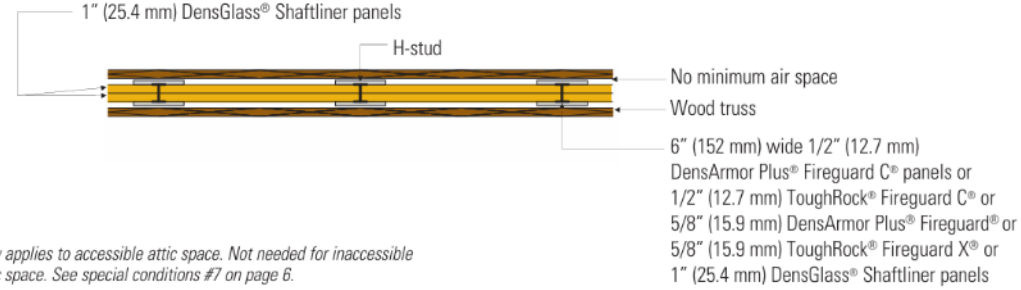
GYPSUM ASSOCIATION

Fig 8 – Roof Intersection with Parallel Roof Trusses



Details continued

Attic–Adjacent to Trusses*

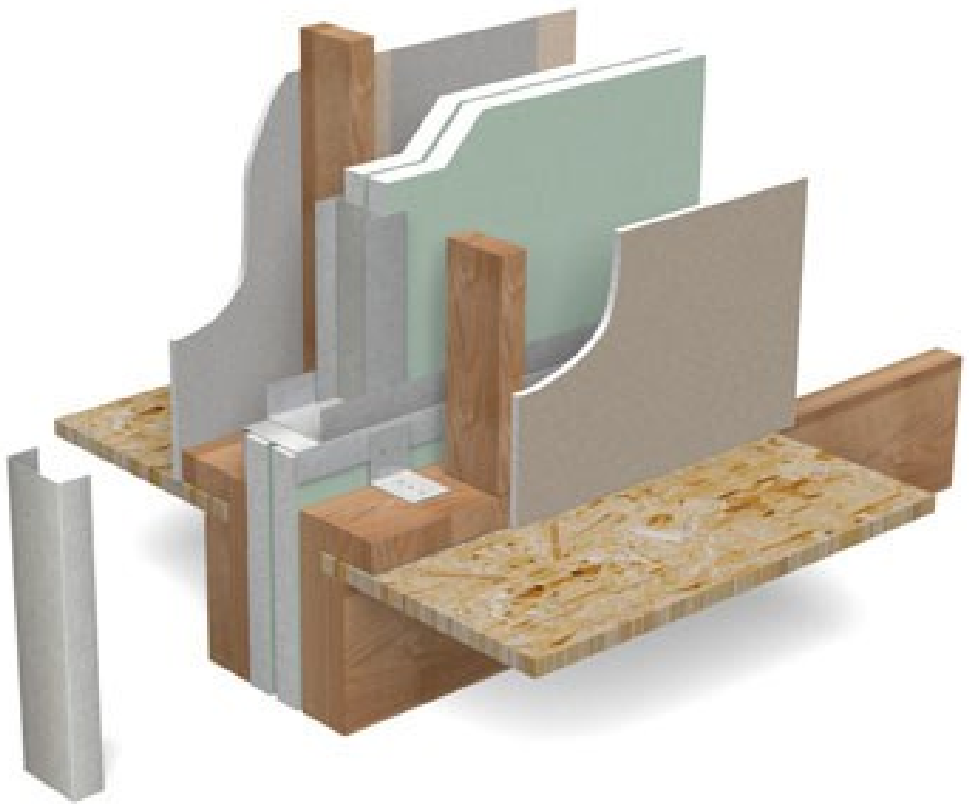


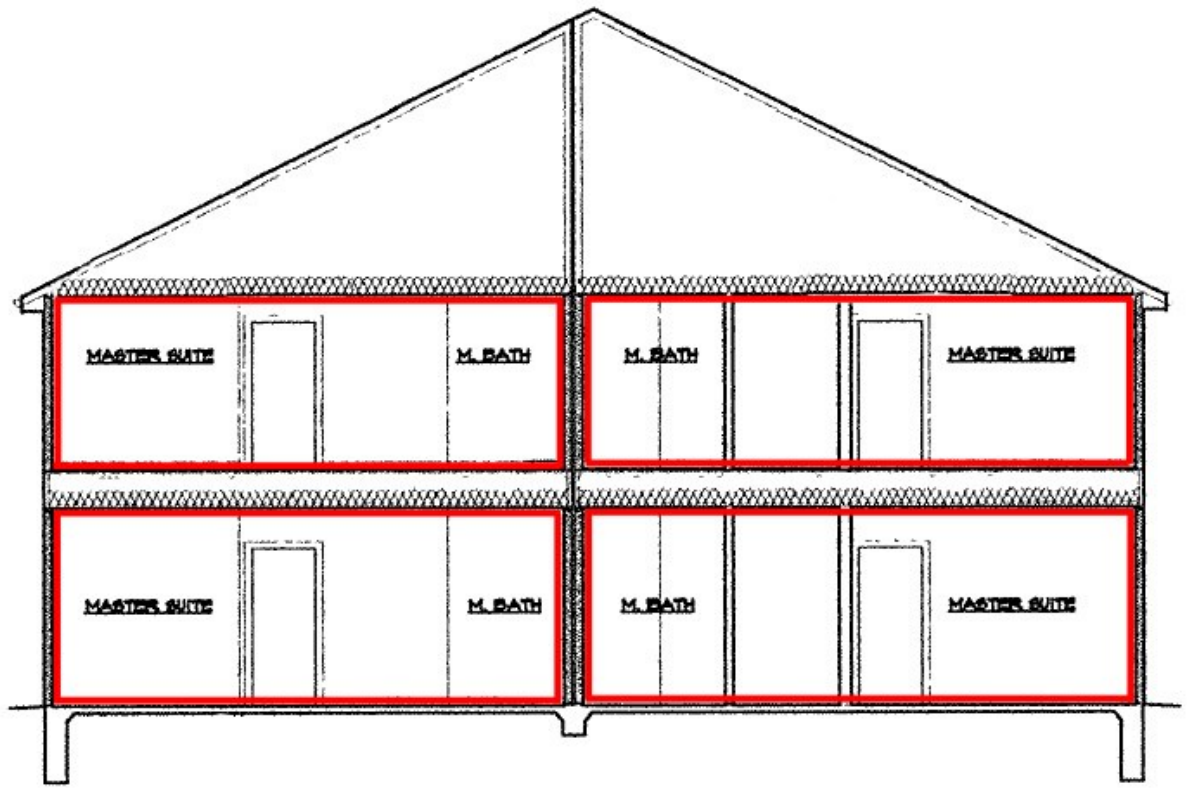
**Only applies to accessible attic space. Not needed for inaccessible attic space. See special conditions #7 on page 6.*

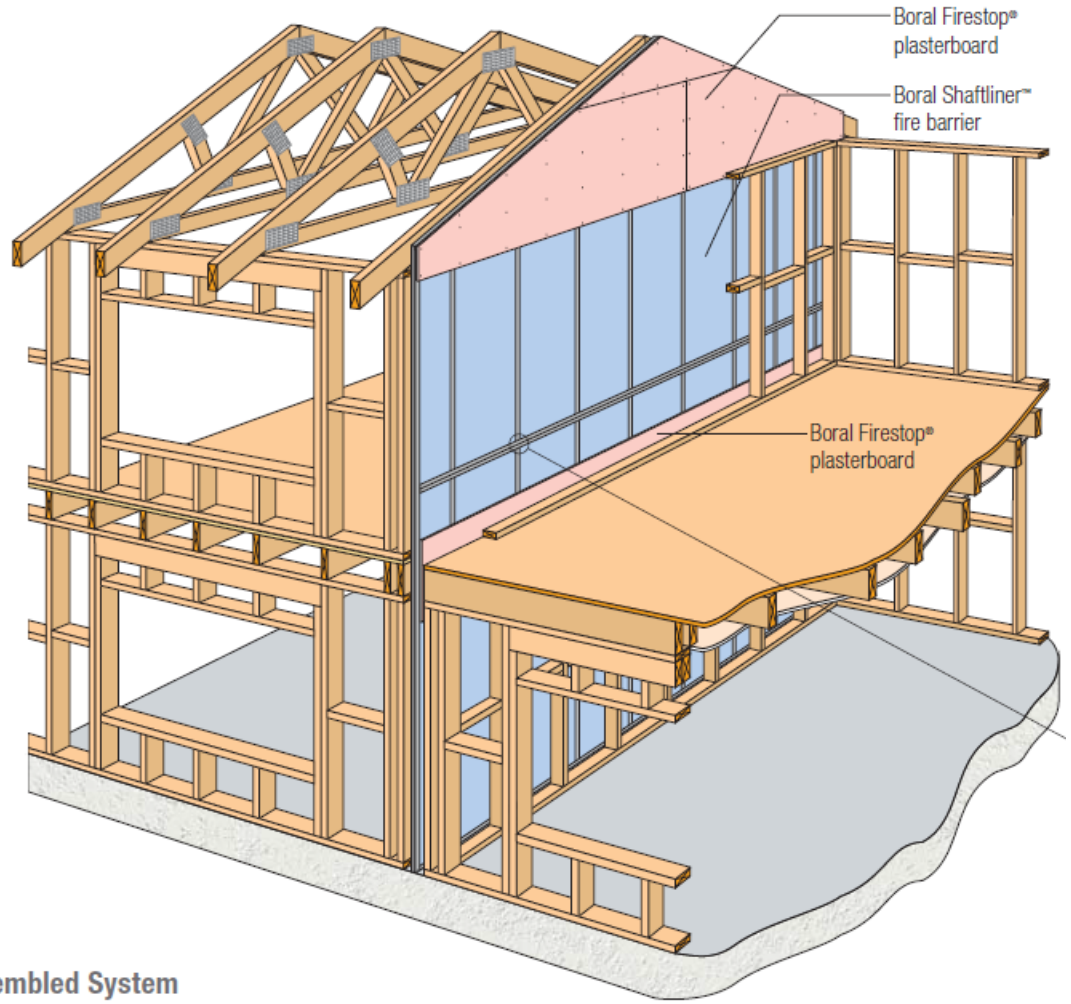
CFM/SQFT of Unit Envelope Area

https://abmichigan.com/improving-occupant-comfort-multifamily-buil

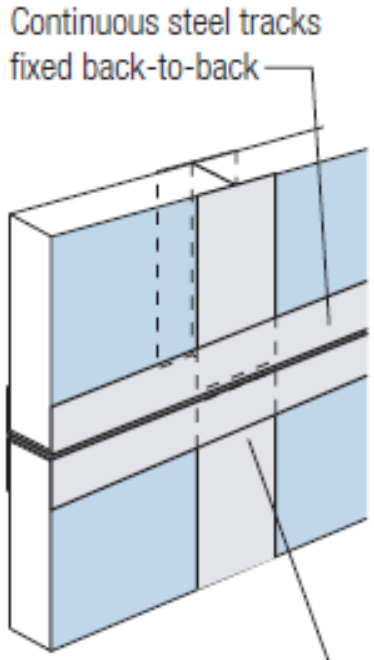
Compartmentalization

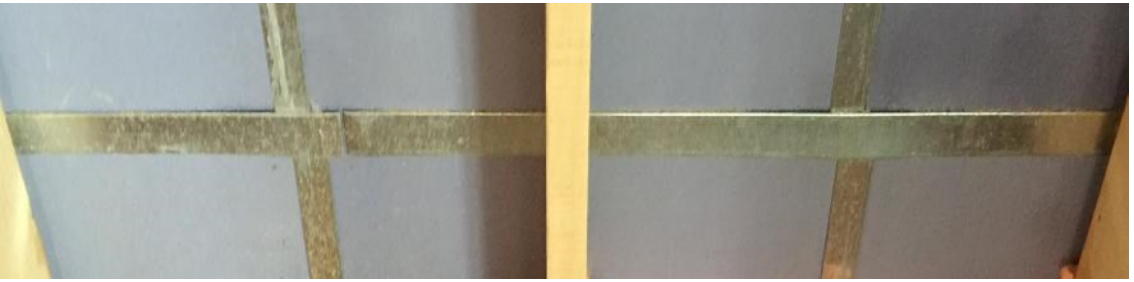


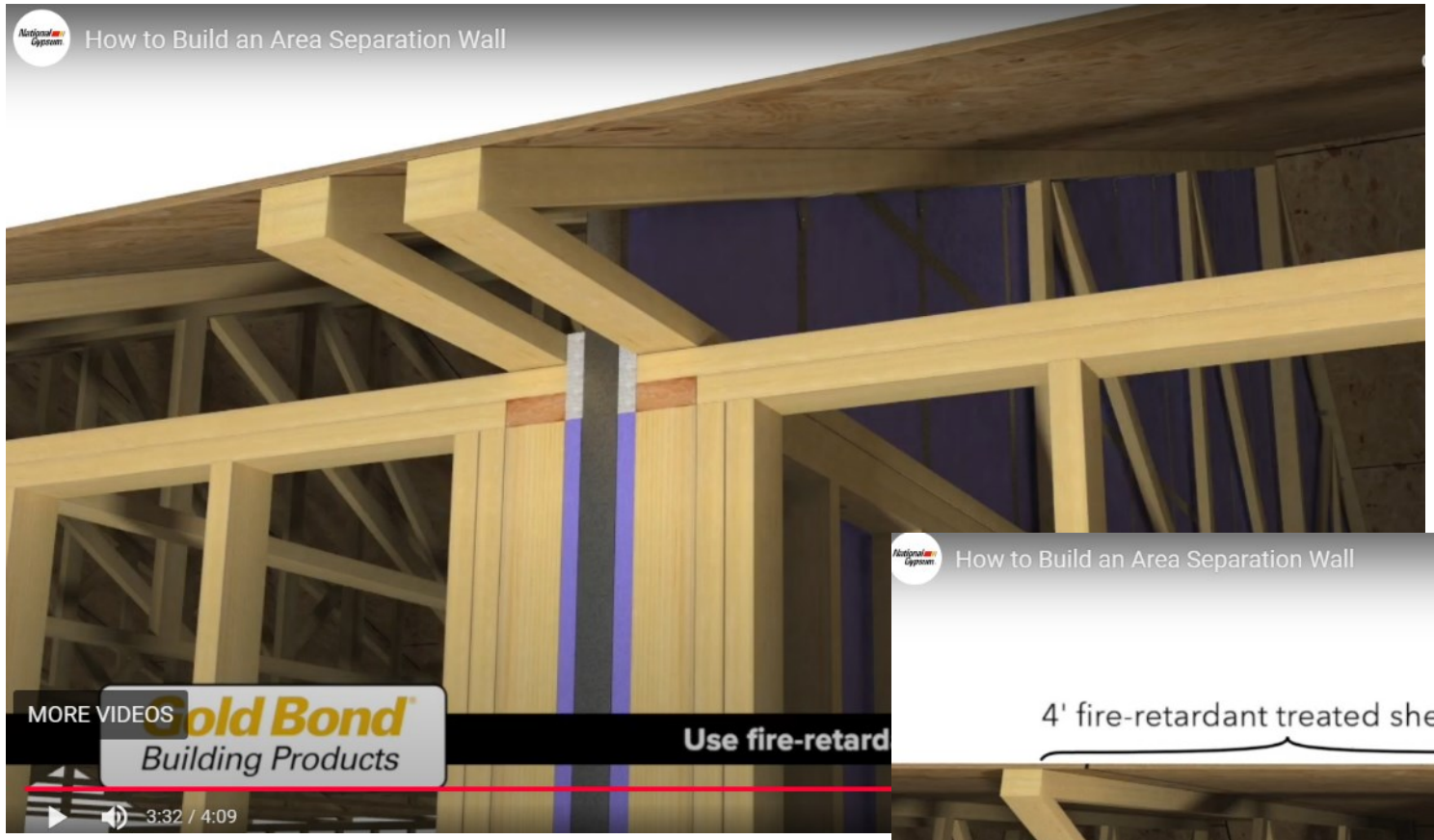


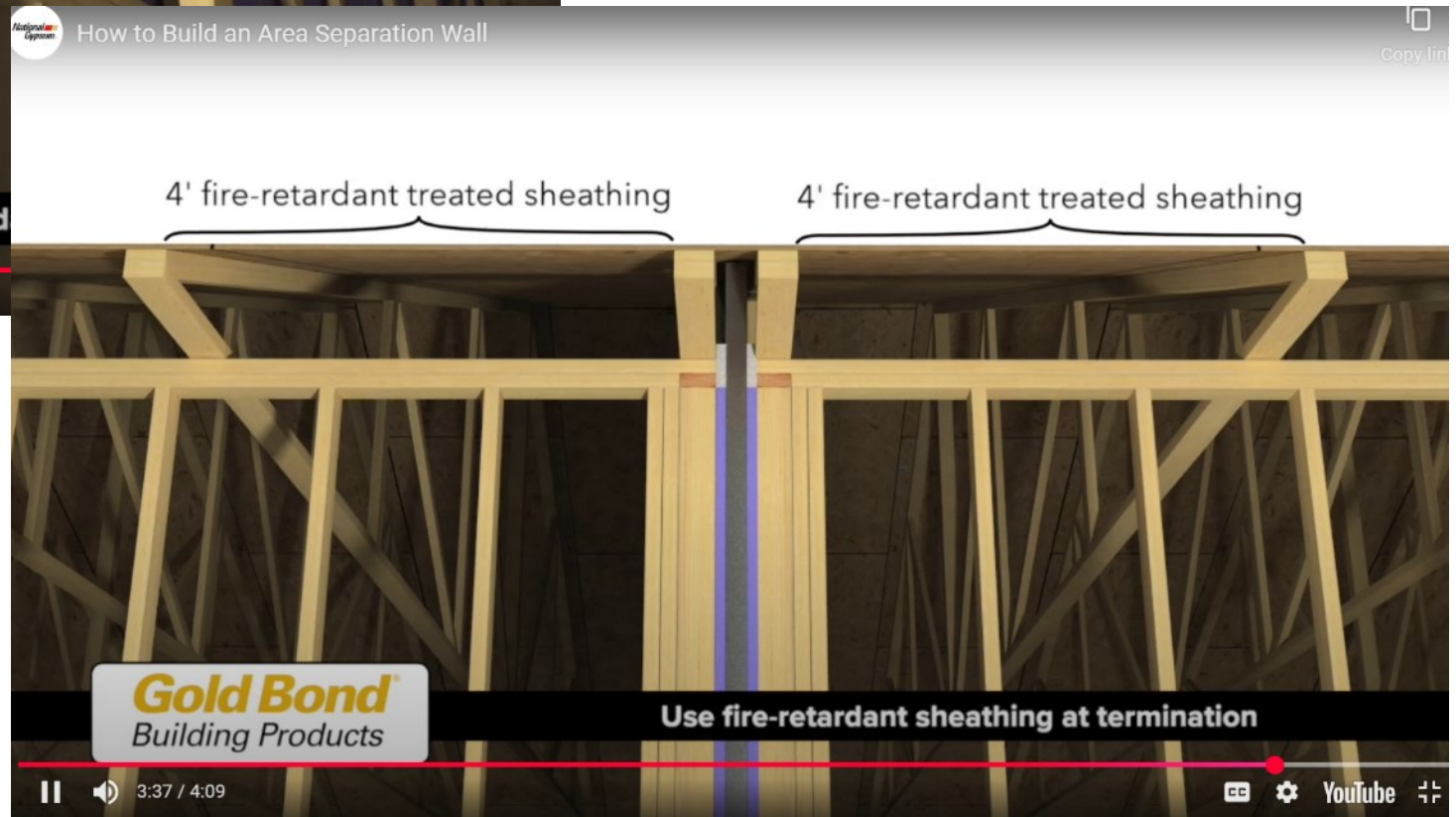


Assembled System
(Separation by Shaftliner™ fire barrier at eaves not shown for clarity)






How to Build an Area Separation Wall
MORE VIDEOS
Gold Bond
Building Products
Use fire-retard
3:32 / 4:09

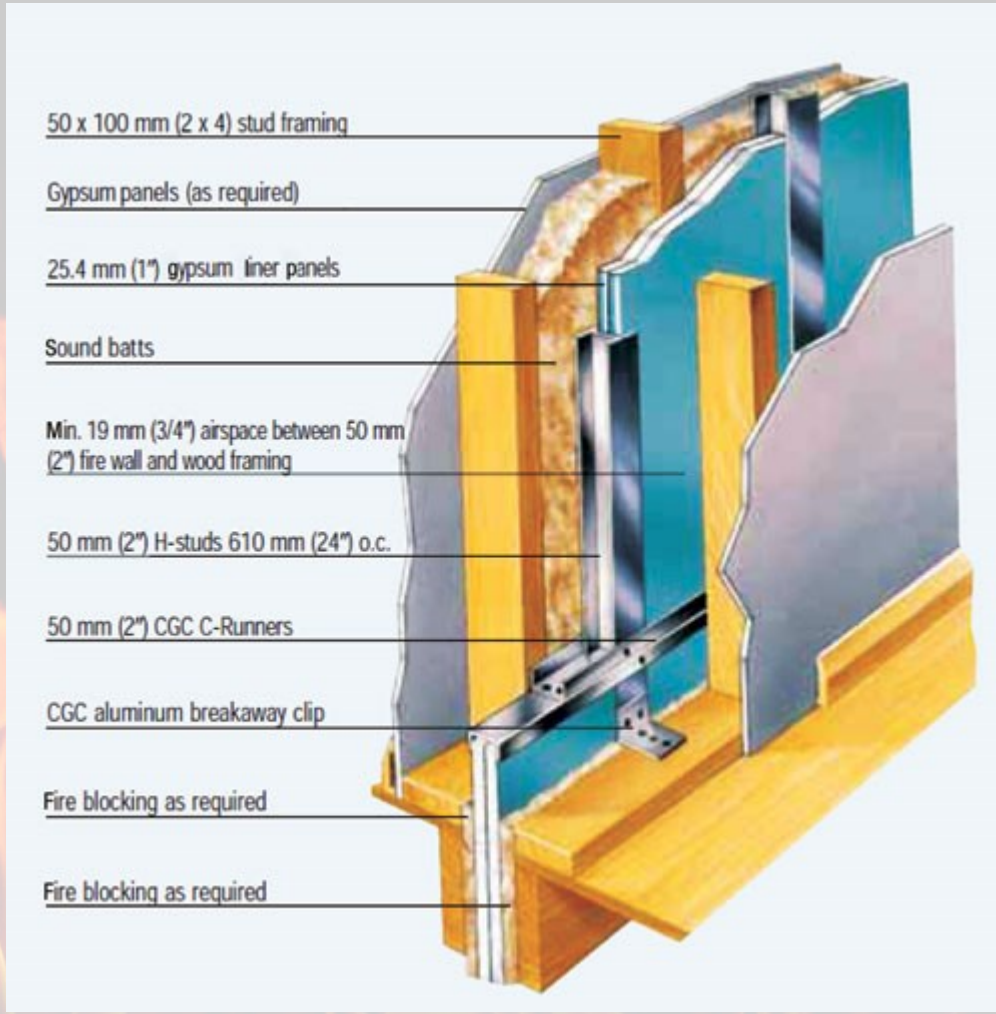

How to Build an Area Separation Wall
Copy lin
4' fire-retardant treated sheathing
4' fire-retardant treated sheathing
Gold Bond
Building Products
Use fire-retardant sheathing at termination
3:37 / 4:09
YouTube

When one is next to the other

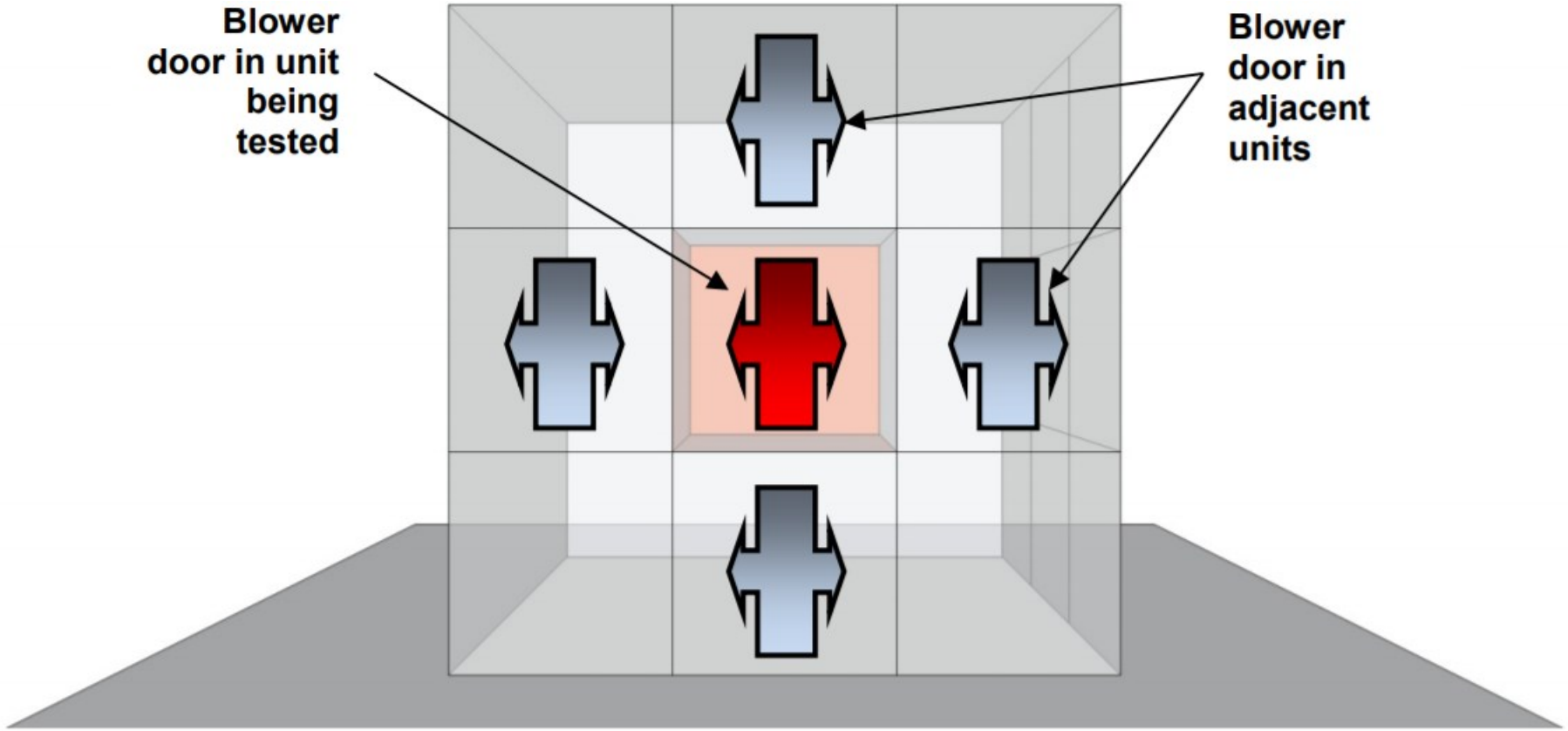
Horizontal Separation
Vertical Separation
Mechanical Separation

Reductions – Sprinklers! Activation! Smoke Control!
Maintenance, Repairs and Replacements (Code changes)

Passive is easy to provide without having to engage the future owners



Guarded



https://pdfs.semanticscholar.org/1d09/4068aac94e1ef32515607df1a7f263db6897.pdf?_ga=2.113266831.907656350.1578976064-1166214141.1578976064

Guarded Testing is not cost effective!

https://www.mncee.org/blog/may-2019/research-sidesteps-obstacles-measuring-air-tightne/

Air Sealing Separation Walls

GA-620-2019
GYPSUM AREA SEPARATION FIREWALLS

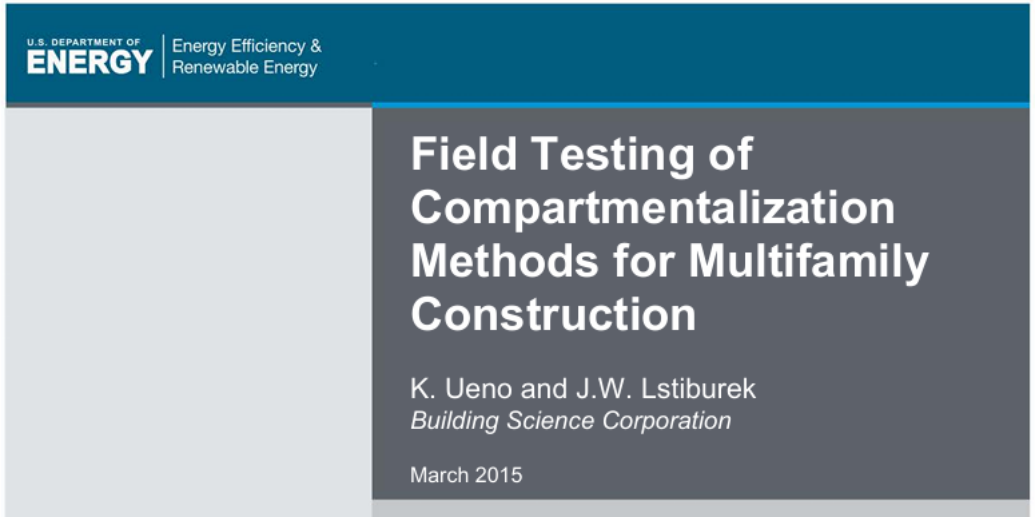
Air Sealing Area Separation Walls

Air sealing area separation walls to reduce leakage between units and between the unit and any outside areas where the wall is off-set to meet energy code requirements is becoming a standard practice. Air leakage is measured via a blower door test, which pressurizes the unit, and measurements are taken to calculate the loss per unit area of wall. When a unit fails (i.e. leaks more than allowed by the code), the most common means of reducing air leakage is to seal all cracks, gaps and voids in all walls along the perimeter of a unit to reduce leakage paths. Such gaps, cracks and voids are at the foot and the head of the wall along the C-channels, at seams in the wall along the H-studs, and at intersections with other walls and the ceiling.

NOTE: For a complete discussion on air leakage and energy code requirements, refer *to Field Testing of Compartmentalization Methods for Multifamily Construction* authored by Kohta Ueno and Joseph Lsitburek, March 2015, as part of the United States Department of Energy's Build America Program.

Many material technologies are available on the market that will effectively seal gaps, cracks and voids. Traditional sealants/caulking materials, spray-applied sealants and membranes, mastics, self-adhered membranes, tapes and spray foams are among just a handful of the technologies available that may prove the best choice in any one application.

Care should be taken when selecting materials for air sealing area separation firewalls. These walls often serve multiple functions, but their intended first purpose is as a fire-resistive barrier. Air sealing materials must therefore be third-party listed and meet the criteria of the pertinent ASTM, UL, or other international standard, or be code compliant as a fire-resistive/fire blocking material. The material must not compromise the fire-rating of the wall.



2.2 Fire-Resistance Rated Assemblies Air Leakage

Some practitioners have examined the issue of air leakage associated with fire-resistance rated assemblies or area separation walls in multifamily buildings. A typical assembly is the Underwriters Laboratories (UL) U347/U373/U336 2-hour rated assembly.

Holton and Prahl (2005) examined the issue of air leakage at these fire-resistance rated assemblies (area separation walls) in multifamily buildings (such as side-by-side townhomes). They noted that poor thermal performance (specifically, air leakage) has negative results for energy efficiency and comfort. One example was air leakage from the party wall into a vented (unconditioned) attic, resulting in heat loss and ice dam issues. Many party wall designs call out

for an air space between the fiberglass batt stud bay insulation and the 1-in. gypsum shaft liner board core, resulting in an air leakage path that can be connected over multiple floors. The authors questioned whether this air gap is actually necessary for fire performance. Many fire-resistance rated walls provide both interior-to-interior and interior-to-exterior separation (because planes shift between units): this condition increases the risk of air leakage.

Field Testing of Compartmentalization Methods for Multifamily Construction

EERE Findings

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Field Testing of Compartmentalization Methods for Multifamily Construction

K. Ueno and J.W. Lstiburek
Building Science Corporation

March 2015

At several interior walls under the vented/unconditioned attic, noticeable air leakage was visible at the top plate (Figure 34 and Figure 35, keyed to "D" in Figure 23). Unfortunately, this indicates that the interior top plate detail (Figure 8) was not executed correctly or consistently.

Figure 34. Interior wall under attic (third floor), Unit 6702

This area was inspected in another unit's attic (Unit 6704; Figure 57). The joints appeared to be sealed with expanding foam where they were inspected; however, access is difficult, so quality control issues are unsurprising.

Figure 57. Vaulted attic and separation wall conditions, Unit 6704

The exterior was examined in the morning with an infrared camera (Figure 58); there was no sign of gross air leakage in the attic at the area separation wall. This would have been manifested as a warm thermal "plume" at the party wall, or significant snow melt/ice damming at the area

4.7 Air Leakage Locations: Area Separation Wall Details

Several of the observed air leaks were associated with details at the area separation walls/ demising walls. A plan of two adjacent middle units is shown in Figure 47, providing a map of some of the following observations. These area separation wall air leaks were found in multiple units; the plan in Figure 47 is meant to show typical connections between two middle units.

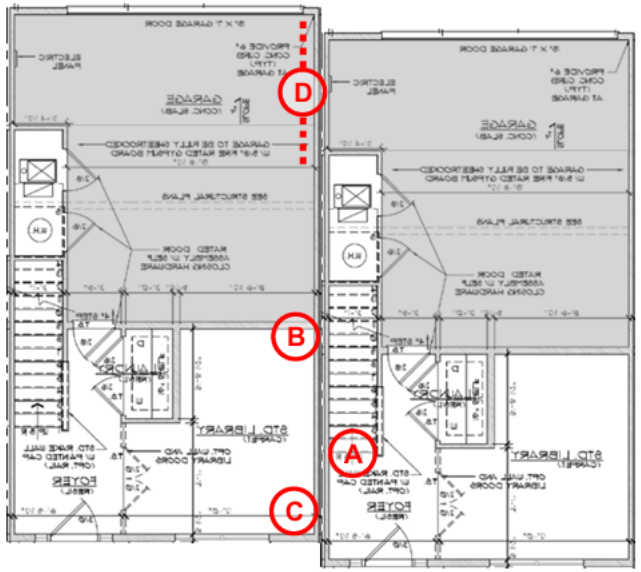


Figure 47. Plan of two adjacent middle units (first floor), with key locations highlighted

separation wall. However, heat loss from the house would be diluted by outdoor air from attic ventilation.

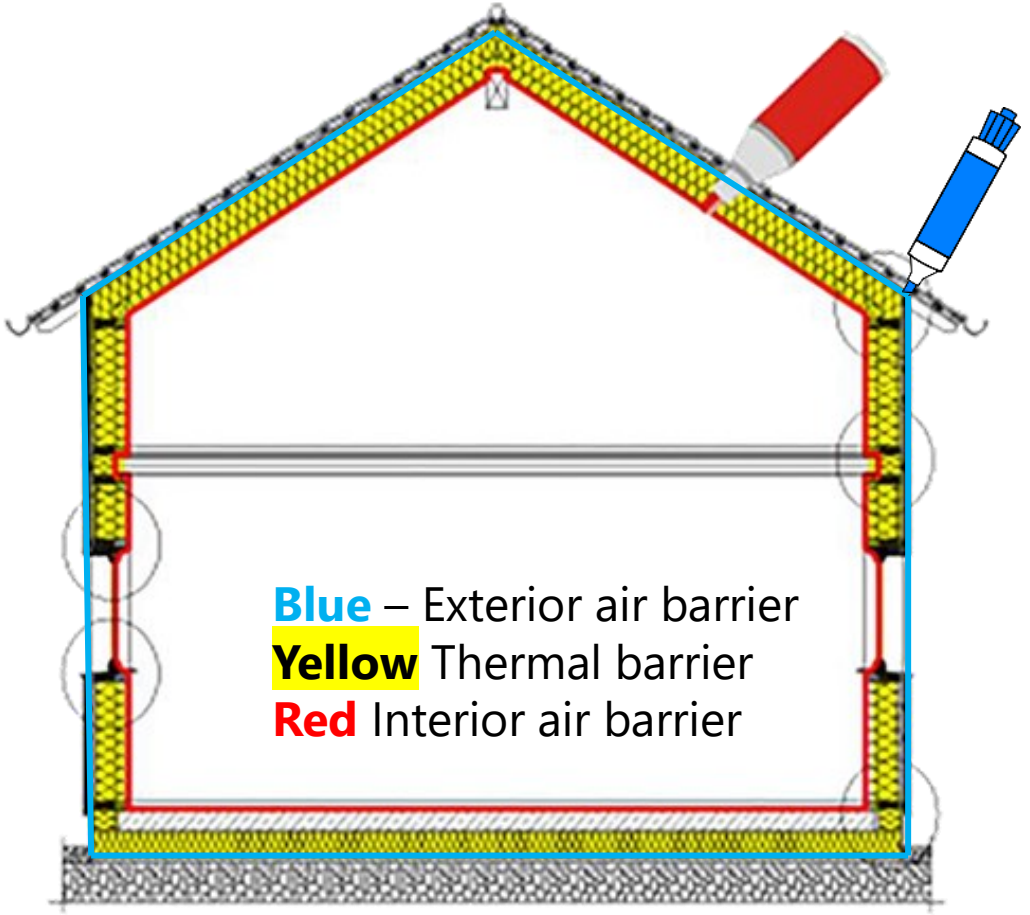
Heat loss and snow melt caused by area separation wall leakage are worse if the stud bay cavity is extended into the attic (unlike these units), creating a "chimney" to direct interior heat to the roof sheathing.

IECC and the Building Thermal Envelope

AEROBARRIER™
Breakthrough Envelope Sealing Technology

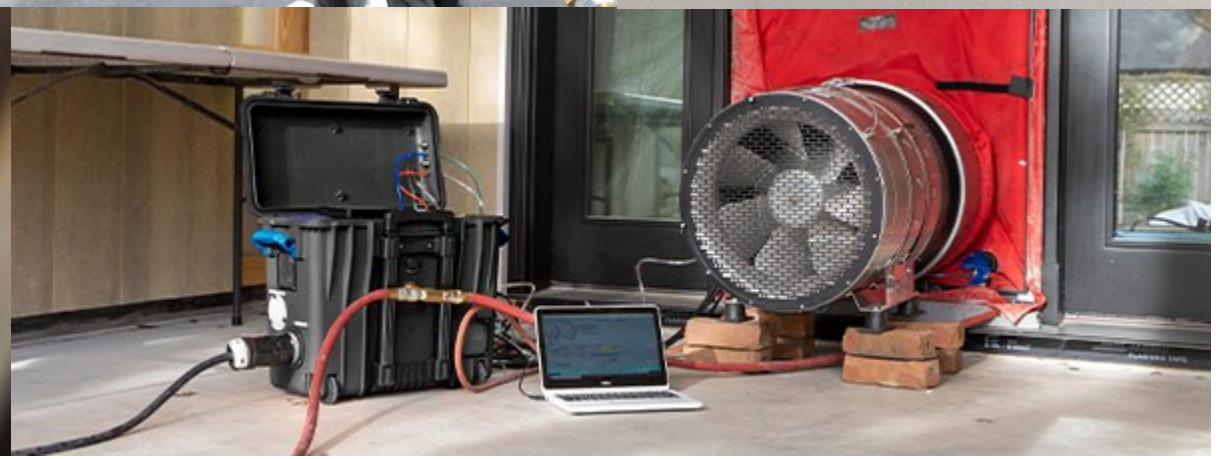
BUILDING THERMAL ENVELOPE.

- The *basement walls, exterior walls*, floors, ceiling, roofs and any other *building* element **assemblies** that enclose *conditioned space* or provide a **boundary between *conditioned space* and exempt or unconditioned space.**

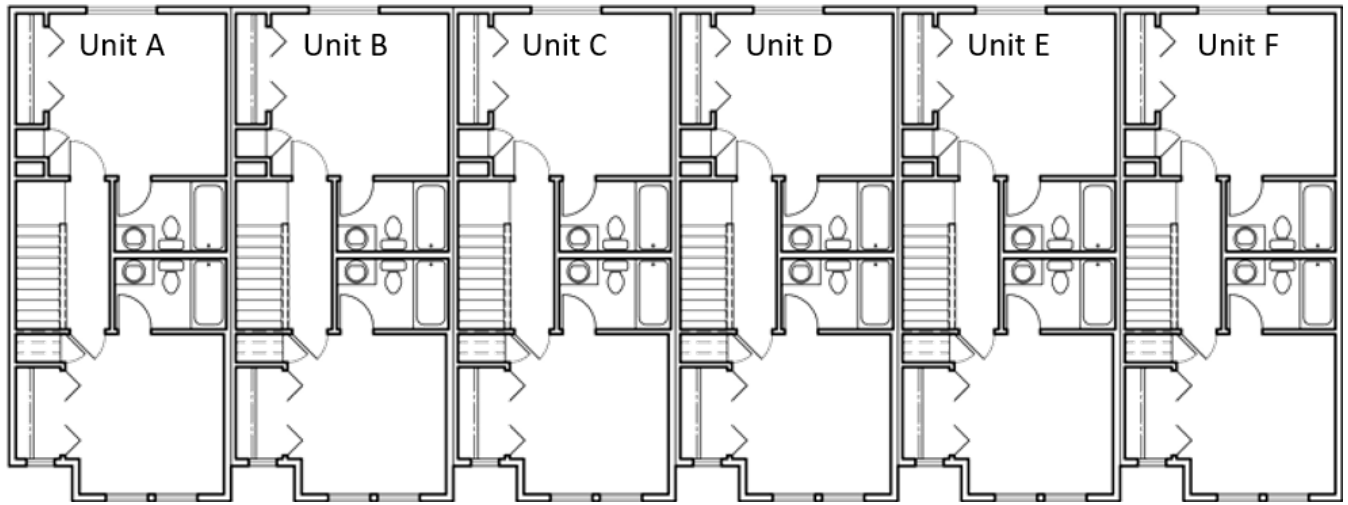


https://energyrecovery.com.au/MVHR/BuildingAirtightness

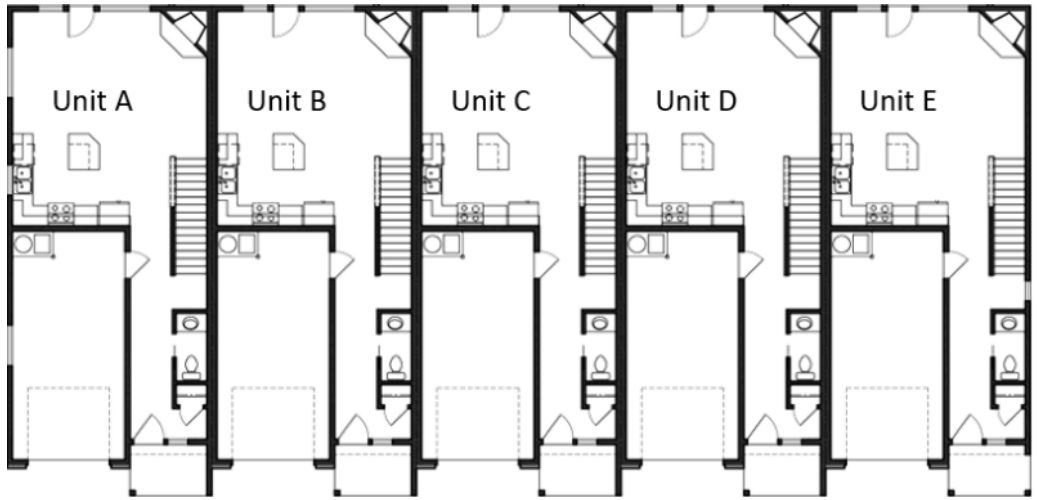
AEROBARRIER™



Dwelling Unit	A	B	C	D	E	F
Aero Barrier Applied	y	N	Y	N	Y	N
Blower door after Aero Barrier Applied **(A,C,E)**		7.32 ACH50		5.67 ACH50		3.73 ACH50
Blower door Pre-Aero Barrier **(some air sealing performed)**	4.96 ACH50	5.97 ACH50	6.23 ACH50	4.81 ACH50	6.44 ACH50	3.76 ACH50
Blower door After Aero Barrier	1.64 ACH50	1.50 ACH50	1.88 ACH50	1.53 ACH50	1.67 ACH50	1.60 ACH50
Final Code Blower door	2.19 ACH50	2.39 ACH50	2.75 ACH50	2.05 ACH50	2.34 ACH50	2.02 ACH50



Dwelling Unit	A	B	C	D	E
Aero Barrier	y	N	Y	N	Y
Blower door after Aero Barrier Applied **(A,C,E)**		7.28 ACH50		6.74 ACH50	
Blower door Pre-Aero Barrier **(some air sealing performed)**	4.63 ACH50	7.24 ACH50	6.43 ACH50	6.62 ACH50	5.10 ACH50
Blower door After Aero Barrier	1.83 ACH50	1.80 ACH50	1.90 ACH50	1.70 ACH50	1.59 ACH50
Final Code Blower door	2.88 ACH50	3.00 ACH50	2.54 ACH50	2.64 ACH50	2.31 ACH50



5 Analysis and Recommendations

5.1 Summary of Air Leakage Results

A summary of the unguarded/nonnulled and guarded/nulled testing is shown in Table 7 (with results in terms of ACH50), and Table 8 (with CFM50/ft^2 enclosure).

Table 7. Unguarded and Guarded Air Leakage Test Results, With ACH50

Unit	Notes	Unguarded		Guarded	
		CFM50	ACH50	CFM50	ACH50
6700	End-improved + taped	1085	3.8	953	3.4
6702	Mid-improved + taped	1329	5.5	1057	4.4
6704	Mid-conventional	1255	5.2	1004	4.2
6706	Mid-improved	1330	5.6	1085	4.5
6708	End-improved	1113	3.9	989	3.5

Table 8. Unguarded and Guarded Air Leakage Test Results, With CFM50/ft^2 Enclosure

Unit	Notes	Unguarded		Guarded	
		CFM50	CFM50/ft^2 Enclosure*	CFM50	CFM50/ft^2 Enclosure*
6700	End-improved + taped	1085	0.22	953	0.20
6702	Mid-improved + taped	1329	0.31	1057	0.24
6704	Mid-conventional	1255	0.29	1004	0.23
6706	Mid-improved	1330	0.31	1085	0.25
6708	End-improved	1113	0.23	989	0.20

* This conversion assumes all enclosure surface area, including adiabatic walls.

In both the unguarded and guarded testing, no units met the 3 ACH50 target of the 2012 IECC. As discussed earlier, when this target is calculated in terms of surface area-normalized leakage, it is stringent for these small three-story townhome units (0.16–0.17 CFM50/ft^2). But the fact that the units do not meet the requirements in the nulled test suggests that the issues are not isolated to area separation wall problems alone (although it might also be due to area separation wall cavity leakage to the exterior).

The results show no improvement associated with taping the exterior sheathing; in fact, some cases were slightly worse. The "conventional" construction middle unit performed better than the "improved" detail middle units.

The intent was to leave the tapes in place and have the builder document the performance over time, after temperature cycling and exposure. However, house wrap was applied to the entire building the next day, so no results were obtained. This experiment could be repeated at other jobsites or at a controlled exposure site.

Figure 74. Test application of two types of adhesive sheathing tape

Figure 75. Test application of two types of adhesive sheathing tape

The literature indicates that taped sheathing is useful for achieving very stringent airtightness targets (e.g., 1 ACH50 and lower). However, if there are more substantial leaks—as was the case here—the difference will likely be difficult to discern.

The units either achieved or were close to the normalized 0.30 CFM50/ft^2 enclosure standard recommended by Lstiburek (2005b) for multifamily units, the target proposed by Maxwell (2014), and the revised target for ASHRAE 62.2 (Brennan 2014). The units would likely consistently achieve the 0.30 CFM50/ft^2 standard with some additional air sealing details and/or technologies (e.g., interior spray-applied latex sealant).

Table 9. Unguarded and Guarded Air Leakage Test Results, With ΔCFM50

Unit	Notes	Unguarded CFM50	Guarded CFM50	Δ CFM50	Δ CFM50 %
6700	End-improved + taped	1085	953	–132	–12%
6702	Mid-improved + taped	1329	1057	–271	–20%
6704	Mid-conventional	1255	1004	–250	–20%
6706	Mid-improved	1330	1085	–245	–18%
6708	End-improved	1113	989	–125	–11%

The shifts from unguarded to guarded testing were 11%–12% for the end units and 18%–20% for the middle units. This is consistent with leakage caused by connections at the area separation walls, and a reduction proportional to the one versus two area separation walls. However, testing indicated that this nulling was not perfect and that outside air was drawn into the area separation wall framing cavity from the exterior.

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Field Testing of Compartmentalization Methods for Multifamily Construction

K. Ueno and J.W. Lstiburek
Building Science Corporation

March 2015

Aero Barrier

Eliminating caulking or gaskets

- Around electrical outlets and
- Other drywall penetrations
- Along ASW and ceiling spaces
- To vented attics.

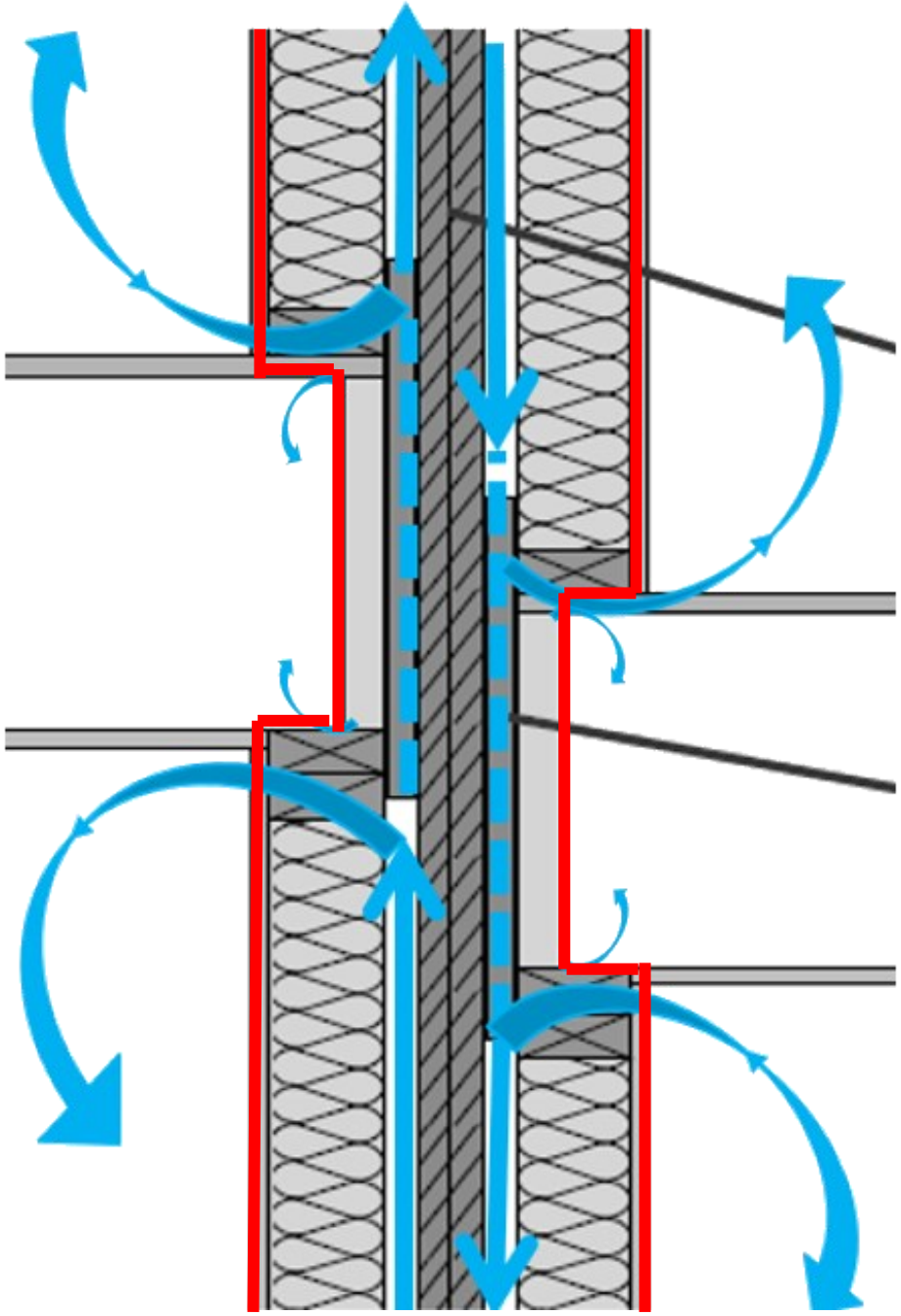
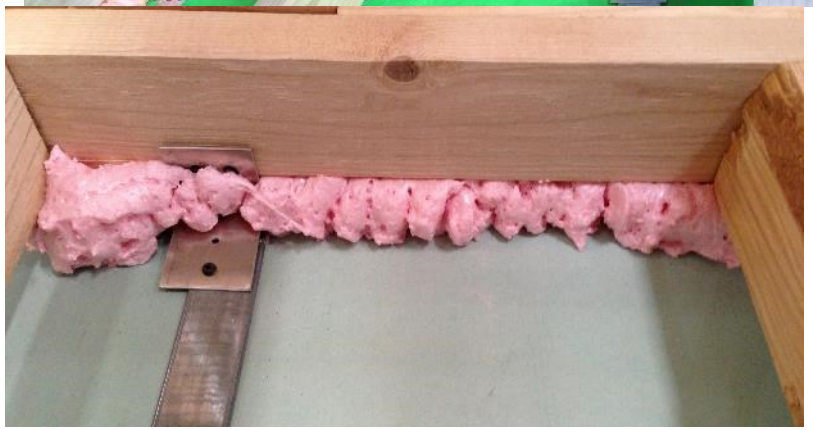
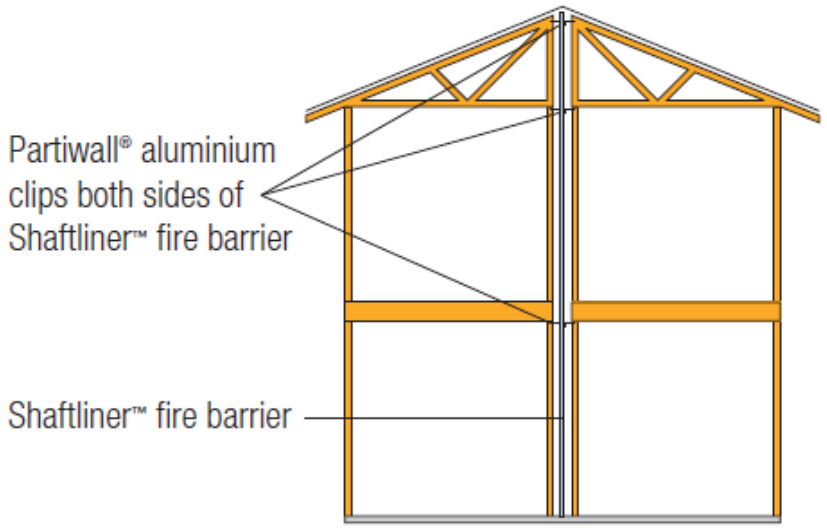
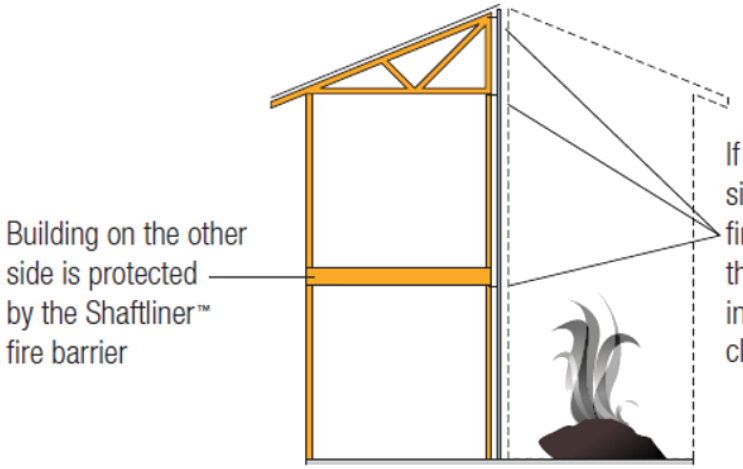


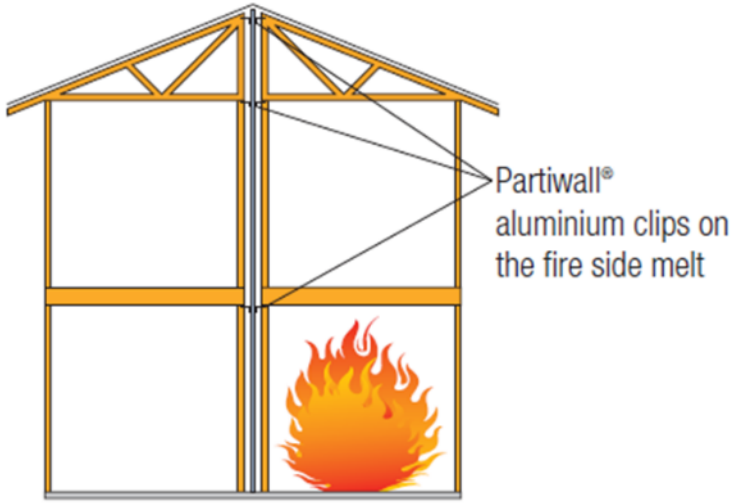
Image from Building America Report – 1508. Kohta Ueno, Joe Lstiburek. March



It all about sealing the gap with cost-effective options that don’t impact compliance


Partiwall® aluminium clips both sides of Shaftliner™ fire barrier
Shaftliner™ fire barrier


Building on the other side is protected by the Shaftliner™ fire barrier
If building on the fire side of the Shaftliner™ fire barrier collapses, the fire barrier is held in place by Partiwall® clips on the other side


Partiwall® aluminium clips on the fire side melt

What occurs – Code Derived to Risk

Material Testing to Assembly Testing

5 Shaft Liner Assemblies

- U336 - **UNITED STATES GYPSUM CO**
- U347 - **NATIONAL GYPSUM CO**
- U366 - **CERTAINTEED GYPSUM INC**
- U373 - **GEORGIA-PACIFIC GYPSUM L L C**
- U375 - **AMERICAN GYPSUM CO**

Standard Test Methods for Fire Tests of Building Construction and Materials

- The test is used to measure and describe **the response of materials and assemblies to heat and flame under controlled conditions** for a specified time period

- When required, the fire exposure is followed by the application of a standard fire hose stream applied in accordance with ASTM E2226

- Hose stream test assesses **the impact, erosion, and cooling effects of a fire fighting like hose stream on a burned assembly**

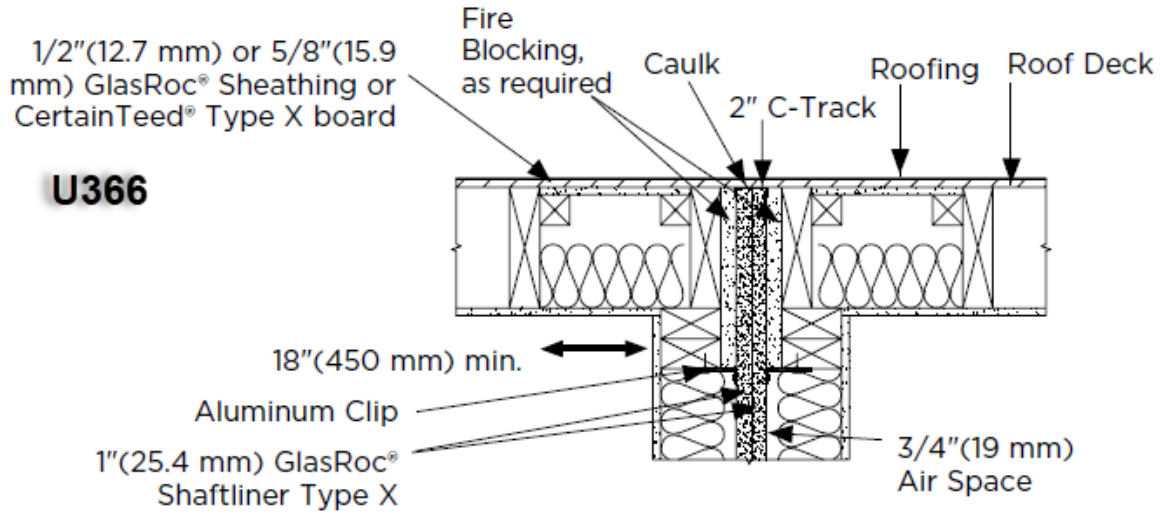
ASTM E 119: Fire Tests of Building Construction and Materials

- **SECTION 703 FIRE-RESISTANCE RATINGS AND FIRE TESTS**

703.2 Fire-resistance ratings. The *fire-resistance rating* of building elements, components or assemblies shall be determined in accordance with the test procedures set forth in ASTM E 119 or UL 263 or in accordance with Section 703.3 (*alternative methods for determining fire resistance*).

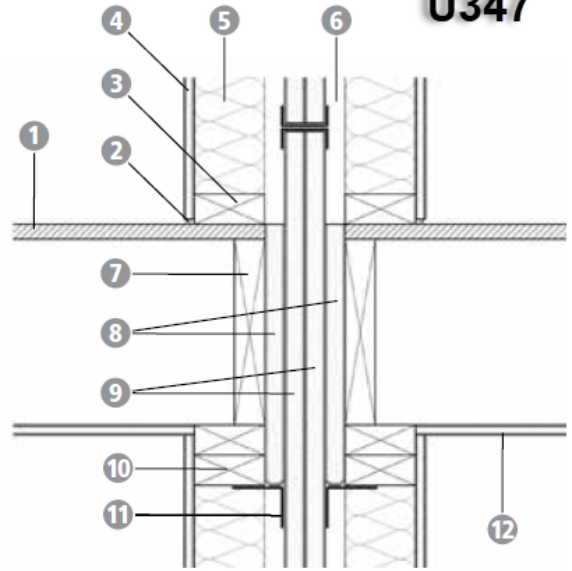
- ASTM E 119 Acceptance Criteria:
  - 4.3 The test standard provides for the following:
  - 4.3.1 For walls, partitions, and floor or roof test specimens:
  - 4.3.1.1 Measurement of the transmission of heat.
  - 4.3.1.2 Measurement of the transmission of hot gasses through the test specimen.
  - 4.3.1.3 For loadbearing elements, measurement of the load carrying ability of the test specimen during the test exposure

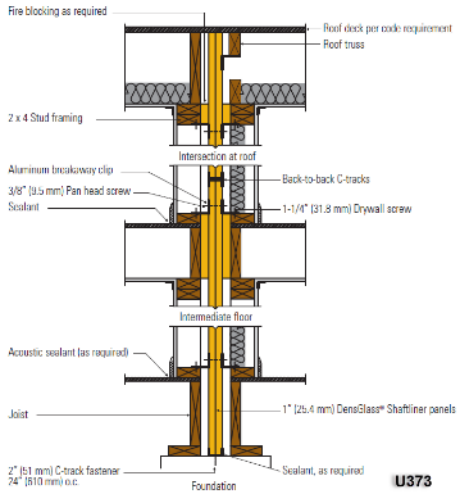
U366



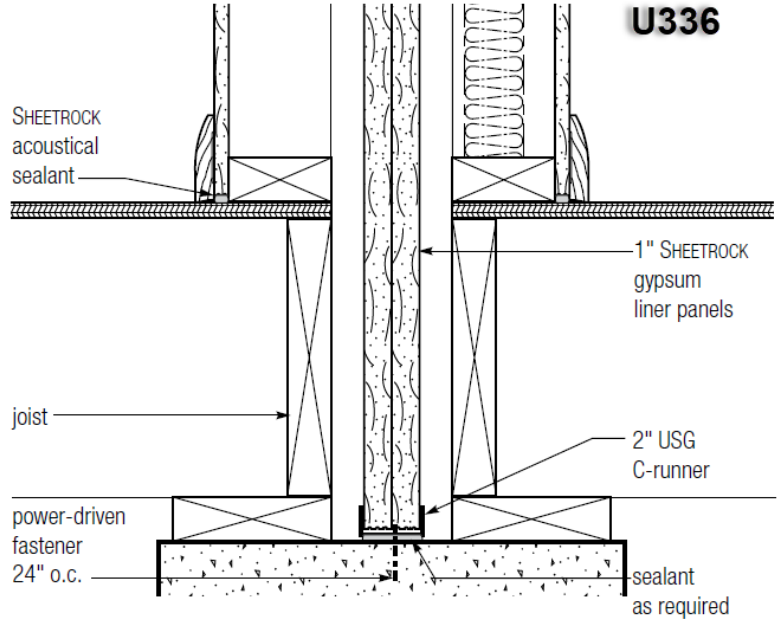
U347

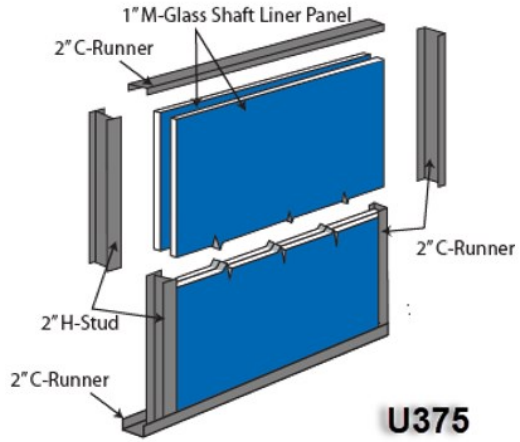
1. Subfloor
2. Sealant
3. 2" Wood Plate
4. Gypsum Board
5. Insulation
6. Minimum 3/4" Air Space
7. Rim Joist
8. Gypsum Board or Mineral Wool Fire Blocking
9. 1" Fire-Shield Shaftliner
10. 2x4 Wood Stud
11. ASW Clip
12. Ceiling





U336





4. Significance and Use

4.2 The test exposes a test specimen to a standard fire controlled to achieve specified temperatures throughout a specified time period. When required, the fire exposure is followed by the application of a specified standard fire hose stream applied in accordance with Practice E2226. The test provides a relative measure of the fire-test-response of comparable building elements under these fire exposure conditions.

The exposure is not representative of all fire conditions because conditions vary with changes in the amount, nature and distribution of fire loading, ventilation, compartment size and configuration, and heat sink characteristics of the compartment. Variation from the test conditions or test specimen construction, such as size, materials, method of assembly, also affects the fire-test-response. For these reasons, evaluation of the variation is required for application to construction in the field.

ASTM E 119: Fire Tests of Building Construction and Materials

4.4 The tests standard does not provide the following:

4.4.1 Information as to performance of test specimens constructed with components or lengths other than those tested.

4.4.2 Evaluation of the degree by which the test specimen contributes to the fire hazard by generation of smoke, toxic gases, or other products of combustion.

4.4.3 Measurement of the degree of control or limitation of

the passage of smoke or products of combustion through the test specimen.

4.4.4 Simulation of the fire behavior of joints between building elements such as floor-wall or wall-wall, etc., connections.

4.4.5 Measurement of flame spread over the surface of test specimens.

4.4.6 The effect on fire-resistance of conventional openings in the test specimen, that is, electrical receptacle outlets, plumbing pipe, etc., unless specifically provided for in the construction tested. Also see Test Method E814 for testing of fire stops

Test Speciman

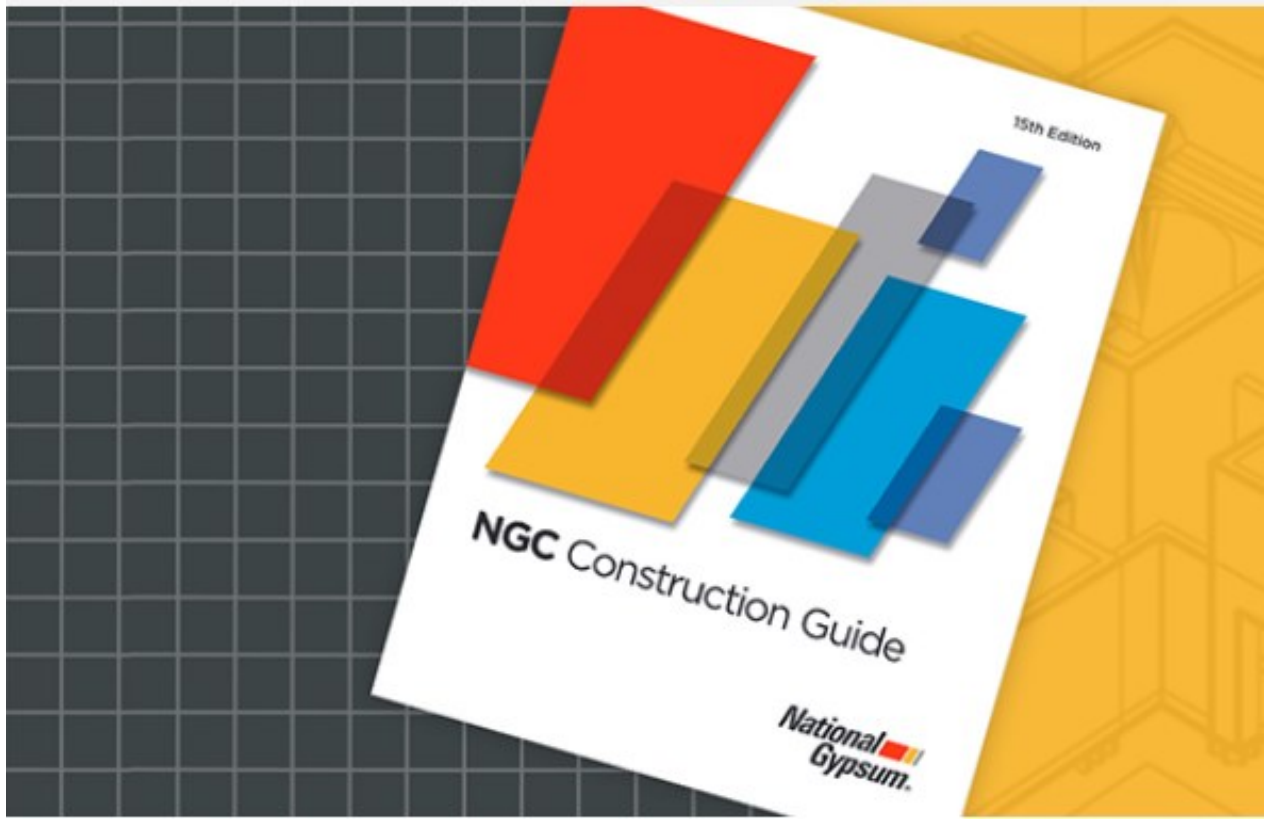
- **Test Specimen**

  5.1 The test specimen shall be representative of the construction that the test is intended to assess, as to materials, workmanship, and details such as dimensions of parts, and shall be built under conditions representative of those applied in building construction and operation. The physical properties of the materials and ingredients used in the test specimen shall be determined and recorded.

  5.2 The size and dimensions of the test specimen specified herein shall apply for classifying constructions of dimensions within the range employed in buildings. When the conditions of use limit the construction to smaller dimensions, the dimensions of the test specimen shall be reduced proportionately for a test qualifying them for such restricted use

The Test

Constructing the walls



[NGC Construction Guide™ | National Gypsum Company]

Gold Bond® Fire & Sound Selector

Fire and Sound Selector

Fire and Sound Ratings

FIRE RATINGS

Fire resistance is the ability of an assembly constructed in a laboratory to contain a fire in a carefully controlled test setting for a specified period of time. ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, is the test standard for determining the fire-resistance rating of partitions, floor-ceiling assemblies, roof-ceiling assemblies, beams and columns. Fire tests may be conducted at any one of several recognized facilities.

Fire-resistance ratings represent the results of tests on assemblies made up of specific materials in a specific configuration. When selecting construction designs to meet certain fire-resistance requirements, caution must be used to ensure that each component of the assembly is the one specified in the test. Further, precaution should be taken that assembly procedures are in accordance with those of the tested assembly. **For copies of specific tests, call 1-800-NATIONAL (628-4662).**

SOUND RATINGS

Gypsum board assemblies are laboratory tested to establish their sound attenuation characteristics. Airborne sound insulation is reported as the Sound Transmission Class (STC). Impact noise, tested on floor-ceiling systems only, is reported as the Impact Insulation Class (IIC). ASTM E90, *Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements*, is the test standard for airborne sound reduction. The test measures the sound transmission loss at 16 one-third octave frequencies to generate a single-number acoustical rating.

When selecting systems based on laboratory performance ratings, it should be understood that field conditions such as flanking paths or air leaks caused by design or workmanship can reduce acoustical performance. For this reason, Gold Bond Building Products, LLC cannot guarantee the performance ratings of specific assemblies in the field.

To achieve maximum sound isolation from an assembly, follow published construction details completely. Use non-hardening acoustical sealant at penetrations and floor, ceiling and wall intersections to prevent flanking paths for sound.

GENERAL NOTES REGARDING FIRE-RATED ASSEMBLIES

1. Unless otherwise specified, the face layers of all assemblies, except those with predecorated surfaces or exterior gypsum sheathing, shall have joints taped and fastener heads treated (minimum Level 2 as specified in GA-214, *Levels of Finish for Gypsum Panel Products*). Base layers in multi-layer assemblies shall not be required to have joints or fasteners taped or covered with joint compound.
2. When not specified as a component of a fire-tested wall or partition assembly, mineral fiber, glass fiber, or cellulose fiber insulation of a thickness not exceeding that of the stud depth shall be permitted to be added within the stud cavity.
3. In floor-ceiling or roof-ceiling assemblies, the addition or deletion of mineral wool or glass fiber insulation in the concealed space between the ceiling membrane and the floor or roof structure could possibly reduce the fire-resistance rating. The addition of insulation to any one- or two-hour fire-resistance rated floor-ceiling or roof-ceiling assembly is permitted provided that one additional layer of gypsum board of the same type specified in the design is added to the ceiling.
4. Additional layers of gypsum board are permitted to be added to any assembly.
5. Stud sizes specified in wood- or steel-stud assemblies are minimums.
6. Stud spacings specified in wood- or steel-stud assemblies are maximums.
7. Beam, joist and truss dimensions specified in floor-ceiling or roof-ceiling assemblies are minimums.
8. Beam, joist and truss spacings specified in floor-ceiling or roof-ceiling assemblies are maximums.
9. The distance between parallel rows of studs in wood- or steel-stud assemblies are minimums.
10. Ceilings supported directly from structural members are permitted to be suspended provided the in place stiffness is equivalent to the tested assembly.

Construction

The Problem

Common Claims in Construction Defects

- Mixing of Products
- Breaches
- Use of H-clips instead of back to back C-Clips
- Lack of ASW Clips (Height)
- Lack of Floor/Ceiling Closure
- Lack of Proper Fasteners
- Lack of ¾ - Inch Air Space

- What variables matter?
- What information is available from manufacturer's regarding their exact testing?
- Multiple Burns Required to determine each variable in relation to loss of functional use.
- And so, we began……


CAUTION!
CAUSE SKIN IRRITATION.
AND INSTALLATION OF THE
TRACT IRRITATION. AVOID
WITH SKIN AND EYES. FOR
INFORMATION GO TO WWW.G


National Gypsum.
eXP
National Gypsum.
eXP
GP
GP


DensGlass
Shaftliner
CAUTION!
DensGlass
Shaftliner
DensGlass
Shaftliner

2022/01/28


GP
DensGlass
Shaftliner


GP
Shaftliner


GP


GP
DensGlass
Shaftliner


0
2


2
3
4
5
6

Breaches

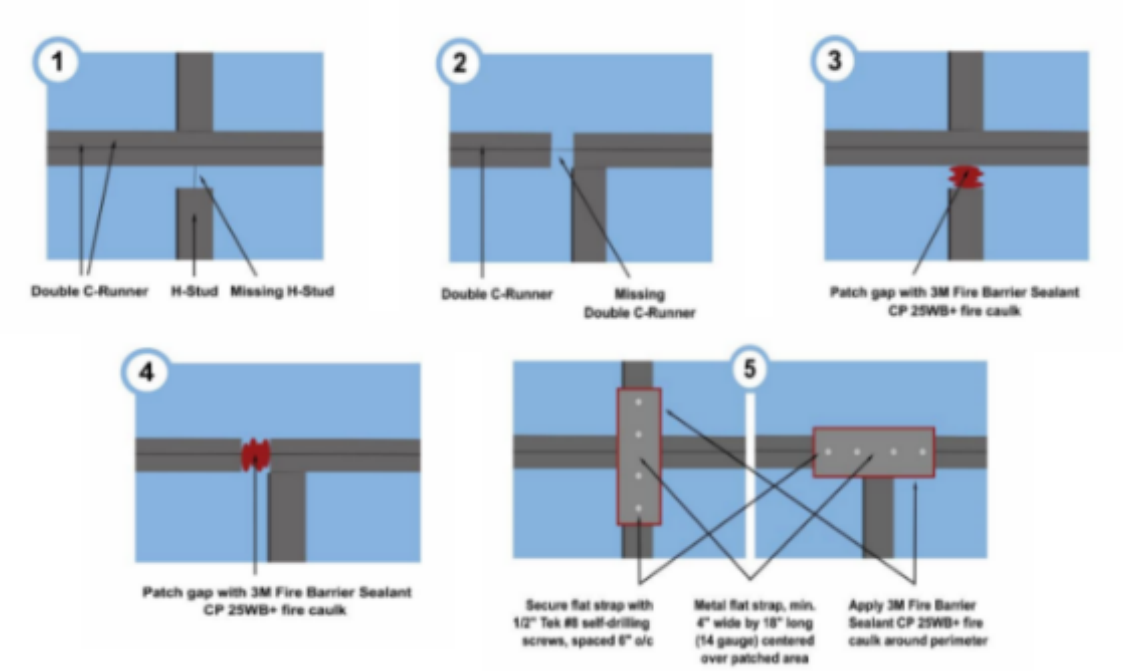
a. Fire-Resistive Wall Assembly – ASWs and ASW Panels with Gaps:

- *Noted locations where the metal ASW components were not provided. :*
- *Discontinuous ASWs and ASW panels with gaps."*

ISSUE: During installation of the ASW System, the vertical H-Studs and or the C-Runner track can be damaged or gaps between framing members can mistakenly be built into the wall (up to 1" maximum). Either of these defects voids the intended 2-hour fire rating.

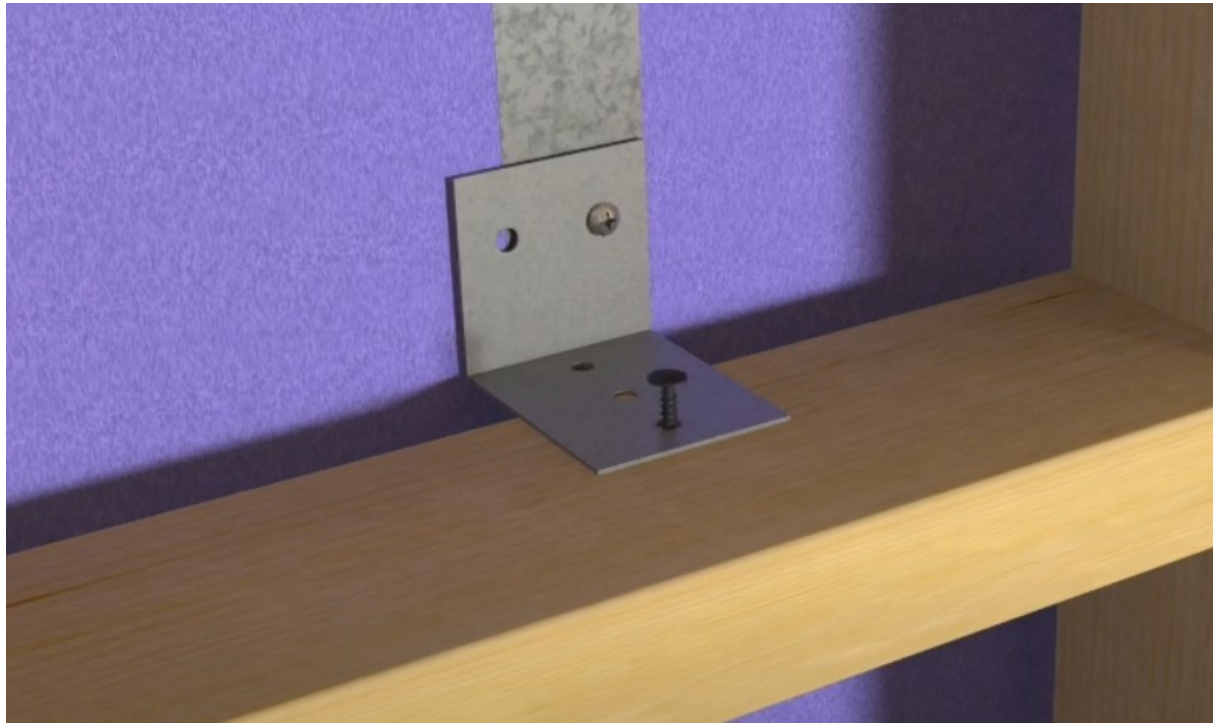
REPAIR:

- Fill the damaged area or the gap/hole with 3M Fire Barrier Sealant CP 25 WB+ fire caulk
- Center over the fire caulking a section of metal flat strap – minimum 4" in width by 18" long (14 gauge)
- Secure metal flat strap to H-Stud or C-Runner Track with 1/2" Tek #8 self-drilling screws, spaced 6" on center
- Apply fire caulk around the perimeter of the metal flat strap
- Duplicate the metal flat strap patch on opposite side of wall

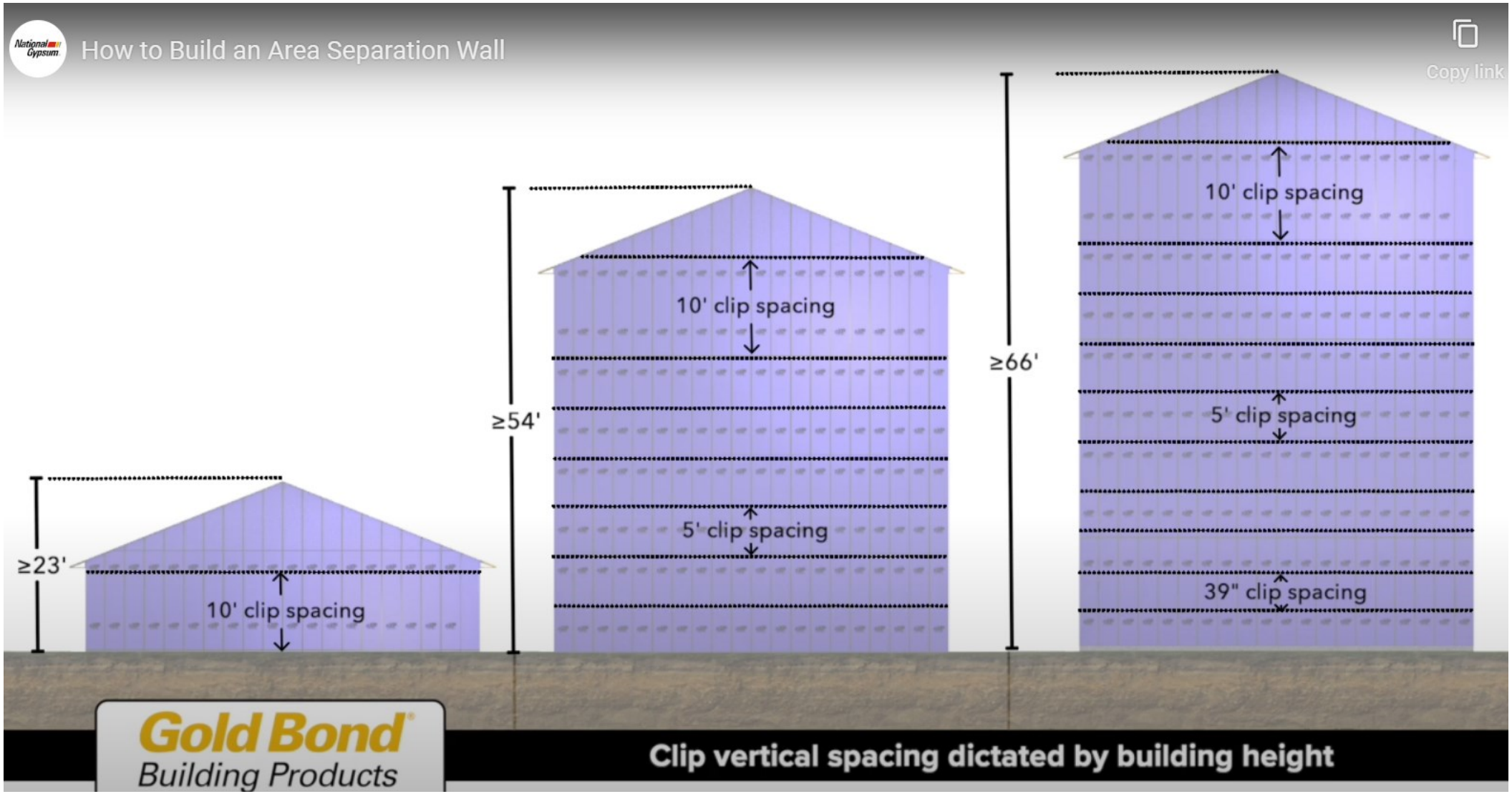


These conditions can be repaired without replacement. For instance, American Gypsum Marketing Bulletin, DCN 2004, June 2020, illustrates the following repair instructions:

Number of Screws and Type



- 1 ¼” Screw – Wood
- 3/8-Inch Pan Head - Channel


How to Build an Area Separation Wall
Copy link
≥23'
10' clip spacing
≥54'
10' clip spacing
5' clip spacing
≥66'
10' clip spacing
5' clip spacing
39" clip spacing
Gold Bond
Building Products
Clip vertical spacing dictated by building height

Define Life Safety – Potential?

Q. Okay. So of those 108 units, that's not
100 -- it's not 195 units, correct?
A. No. But as we've already gone over this, they are very consistent in certain aspects, and those aspects are also consistent with the design that we understand was to be constructed. So I think it's very likely that the balance of the units are constructed in a similar fashion.
Q. Okay. So if you're not sure how long it will last --
A. It actually doesn't matter, as long as it's -- it's less than two hours, which is the minimum code requirement.
Q. Okay. And you've given an opinion that you believe that the fire wall assembly is -- and I'll use -- you believe that there is a life safety issue with the construction of the fire-resistive assembly separating the dwelling units at this project?
A. Yes.
Q. And what do you mean by life safety?
A. Well, the -- what is safe is defined by the building code, and that's the minimum standard of safety. And these walls do not meet that standard. So in a fire event, particularly these areas where

120

there's missing walls, those walls will not protect life or property as intended by the code. So that, in my opinion, that's a life safety issue.

Conclusions before your Conclusions (Ipse Dixet)

NFPA 921 – 4.3.9 and 4.3.10 – Bias

Expectation Bias:
Reaching a premature conclusion without having examined all the relevant data. The forensic observer uses a premature determination to dictate the investigation, processes, analysis and ultimately the conclusion.

They chose to use only the data that supports the pre-formed conclusion, without the use of scientific methods and review of all potentially relevant data.

Confirmation Bias:
Different hypothesis may be compatible with the same data. The Scientific Method should be provided to disprove the hypothesis. Confirmation Bias solely relies on the supporting data, and neglects non-supportive data.

The conclusions made from the hypothesis and testing should be based when rigorous testing has disproved the hypothesis

Mixing of Products

Fire-Resistive Wall Assembly – Gypsum Manufacturer Substitutions

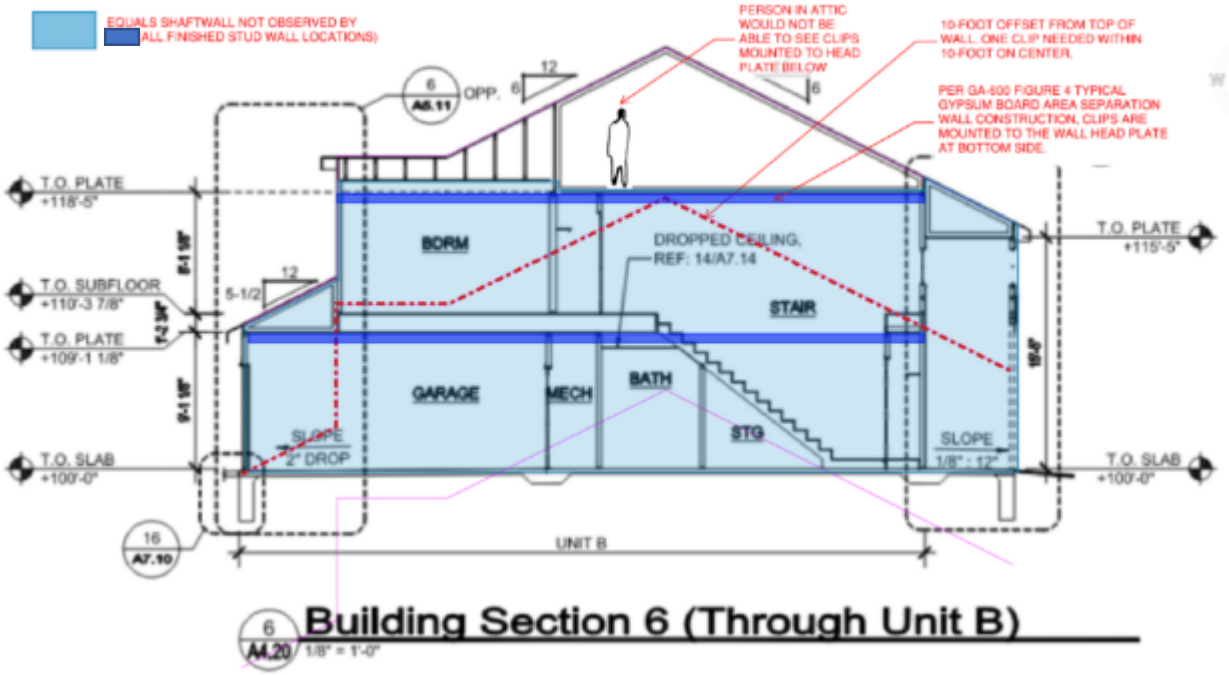
- *The architectural plans reviewed specify Underwriters Laboratories LLC (UL) Design U347 and GA File No. ASW 1005 for construction of the area separation walls at the Project and includes a detail indicating the construction of those assemblies."*

- *The panels used at the Project are not approved for use in the specified UL347 assembly nor do they match the panels indicated on the architectural plans*
- *At this time, it is unclear if the contractor received approval to utilize the materials placed for the assembly specified or if an alternative assembly was utilized. Therefore we are requesting documentation from the Builder demonstrating code-compliant ASW system installed at the Project, considering the gypsum panels installed at the Project are not acceptable for the ASW design specified by the Architect and approved by building department.*

- The failure to utilize the proprietary product does not equate to a failure to perform the intended function of a 2-hour firewall assembly.
- We agree as forensic engineers that testing can be provided to determine the walls' performance, and such testing has been done over the last few years under our direction.

Plaintiffs Conclusion:

- *It is our opinion that the code-required 2-hour fire rating is compromised when the construction of the ASW assembly is closer than 3/4-inch to the framing and/or missing/non-compliant clips/channels are installed. Proximity to framing is important during a fire event to ensure that heat transfer across the ASW assembly does not cause combustion in an adjacent unit for the specified 2-hour rating of the assembly.*
- *Without aluminum clips in areas designated by the UL tested assemblies and the construction documents, the framing supporting the shaft wall can fail and cause failure of the firewall. During a fire event, the aluminum clips on the fire side will melt (as designed), disconnecting the wood framing from the ASW assembly, while the aluminum clips on the non-fire side will provide the structural support for the firewall assembly. Without the required aluminum clips on both sides, the system cannot perform as intended*



From Claimant's Expert

Fire-Resistive Wall Assembly – Utilization of H Channels on Horizontal and 3/4-Inch Separation

- *The referenced assemblies indicate for horizontal seams to be joined with back-to-back "C" channels and vertical seams to be joined with H channels. These components are also indicated by the manufacturers of the ASW panels used at the Project.*
- *At all locations observed, non-compliant steel members used to join the horizontal panel joints at the ASW. The metal ASW components were not provided. As indicated above, during observations of the ASW assemblies at the Project, the following were noted:*

- In order to provide performance-based and ultimately approved testing of as-built assemblies, to properly evaluate the issues through ICC NTA, LLC (ICC NTA) test, and review and determine the performance of the as-constructed shaftliner area separation wall assembly as generally described in UL listed assemblies 336, 347, 366, 373, and 375.

  - The wall assembly was evaluated in general accordance with the following:
    - ASTM E119-18c "Standard Test Methods for Fire Tests of Building Construction and Materials"
    - ANSI/UL 263-2018 "Standard for Safety for Fire Tests of Building Construction and Materials"
    - ASTM E2226-15b "Standard Practice for Application of Hose Stream"

Fire-Resistive Wall Assembly – Aluminum Clip Installation

- *Aluminum clips were utilized to attach the gypsum board "H" channels to the framing members. The clips were noted to be manufactured by Phillips Manufacturing Company (Phillips).*
- *UL's Design No. U347 and all GA specified area separation walls also require aluminum angle clips securing the area separation wall to the adjacent framing. The clips are also specified by the manufacturers of the ASW panels used at the Project. The previously referenced GA-600-2003 Fire Resistance Design Manual states:*

  > *"At intermediate floors metal floor/ceiling track shall be installed back-to-back to secure the top of the lower section of the partition to the bottom of the next section being installed."*

- *Missing and/or non-compliantly installed aluminum clips were noted to occur throughout the Project.*
- *Phillips indicates proper clip installation and fasteners in their publication titled, Installation Recommendations, H-Stud Area Separation Wall Assemblies, Version 1.1, dated 2013.*
  - "Secure Phillips ASW Clips to the studs with one 3/8" Type S pan head screw through the short leg of the clip. Secure the clip to the wood framing with one 8d nail or 1-1/4" Type W screw through the long leg of the clip."

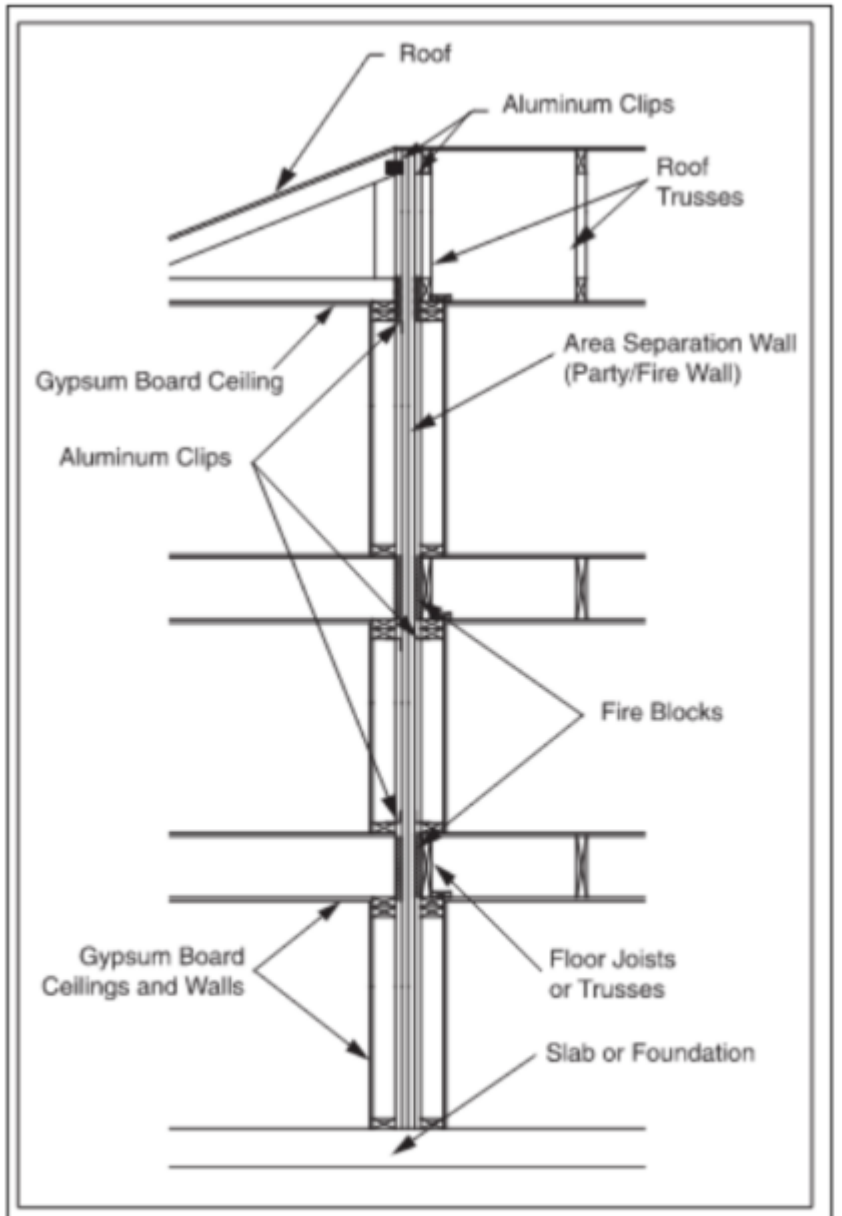
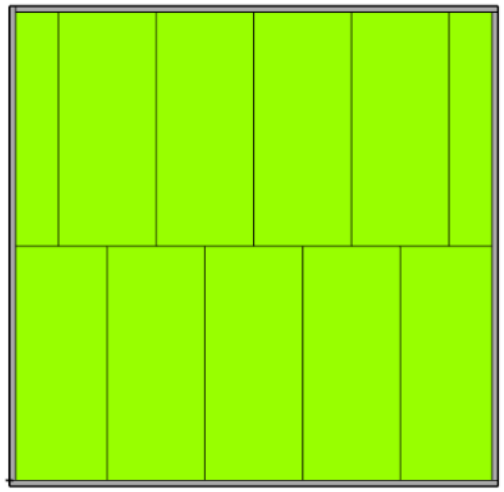


Figure 4
Typical Gypsum Board Area Separation Wall Construction

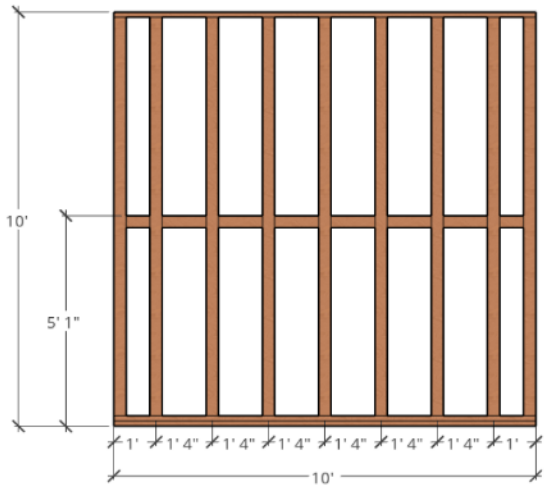
Excerpt from GA, *GA-600-2003 Fire Resistance Design Manual Sound Control Gypsum Systems*, 17th Edition, Dated April 2003.

Proposed Assemblies



Drawing No. 1

Fiberglass faced, gypsum Area Separation panel layout



Drawing No. 2

Skeleton 2x4 framing – 16-in. O.C. with 12-in. edge-to-center on end

Appendix A - Photographs

Photo No. 1
ASW Installation with support wall framing

Photo No. 2
Insulation shelf constructed and attached to wall assembly

Table 1. Material Description.

Material	Manufacturer	Received On
2 ft × 10 ft × 1-in. Sheetrock® Glass-Mat Shaft liner	U.S. Gypsum	09/26/2022
2 in. × 10-ft H-Studs (No. 25 MSG Galv. Steel)	ClarkDietrich	09/22/2022
2 in. × 10-ft C-Runner (No. 25 MSG Galv. Steel)	ClarkDietrich	09/22/2022
2 in. × 2 in. × 2.5-in. AB36 ASW aluminum angle clips (0.063 in. thick)	ClarkDietrich	09/22/2022
2 in. × 4 in. × 10-ft Douglas Fir framing studs	N/A	09/09/2022
3 in. × 6-in. MP36 Mending/Gusset plates	Simpson Strong-Tie	09/22/2022
⅜-in. Type A Pan Head screws, 1¼-in. Type W screws and 16d 3½-in. long shank nails	Various	09/21/2022
Great Stuff Pro Foam sealant	Dow	09/23/2022
Insulation for perimeter of test assembly	N/A	Stock

3.1 Sample Description

The wall assembly consisted of two wood stud framed walls on each side of a shaft liner ASW and had overall dimensions of 10 × 10 ft. The assembly was constructed following the *Burn Test Assembly Construction Specifications* provided by BUILDTank, Inc., which are included in Appendix E.

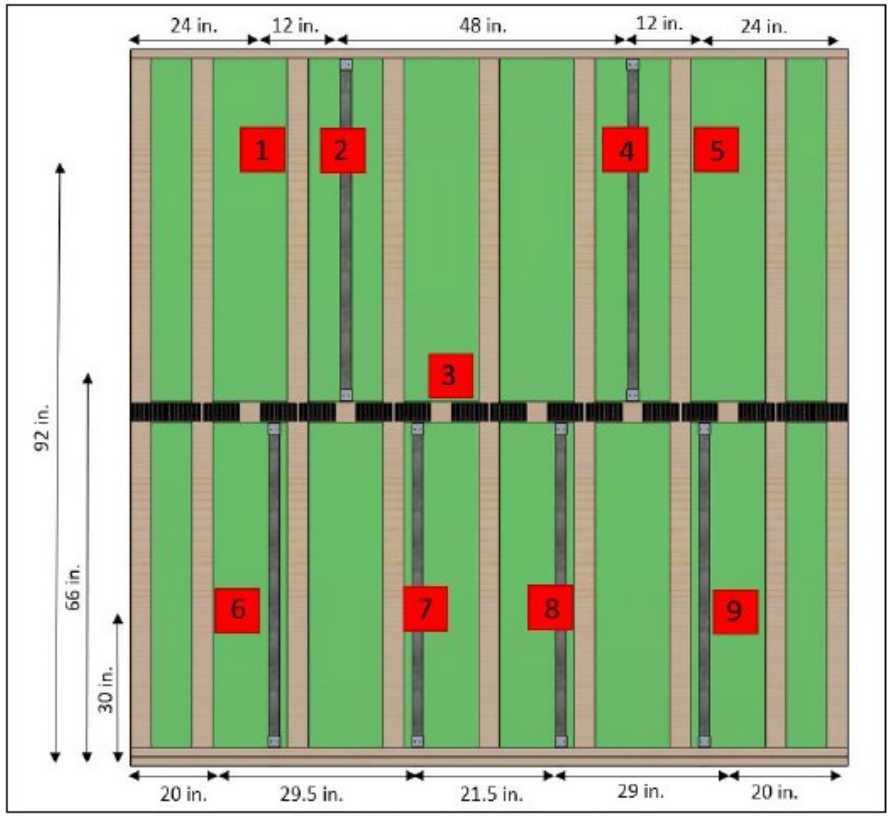


Figure 1. Thermocouple Layout.

Construction of the Walls

Layout

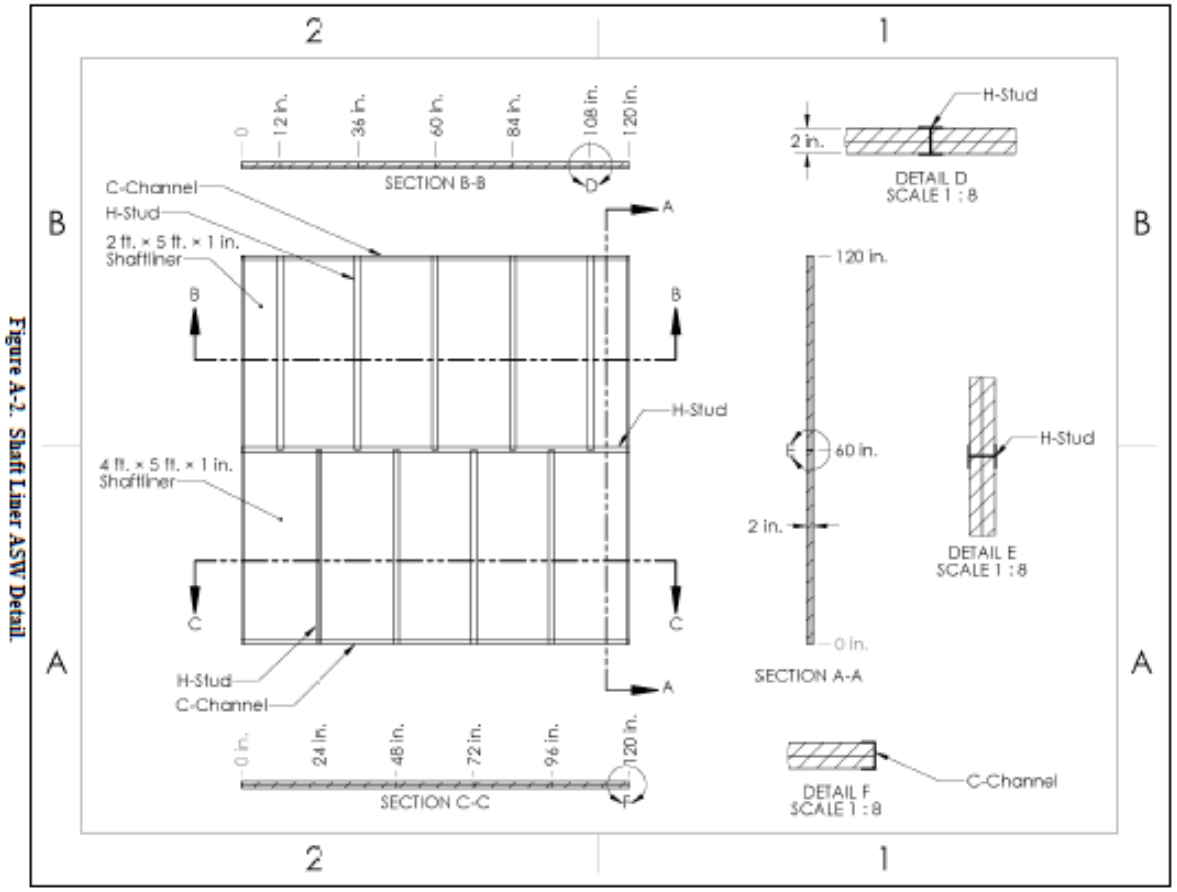


Figure A-2. Shaft Liner ASW Detail

Detailing

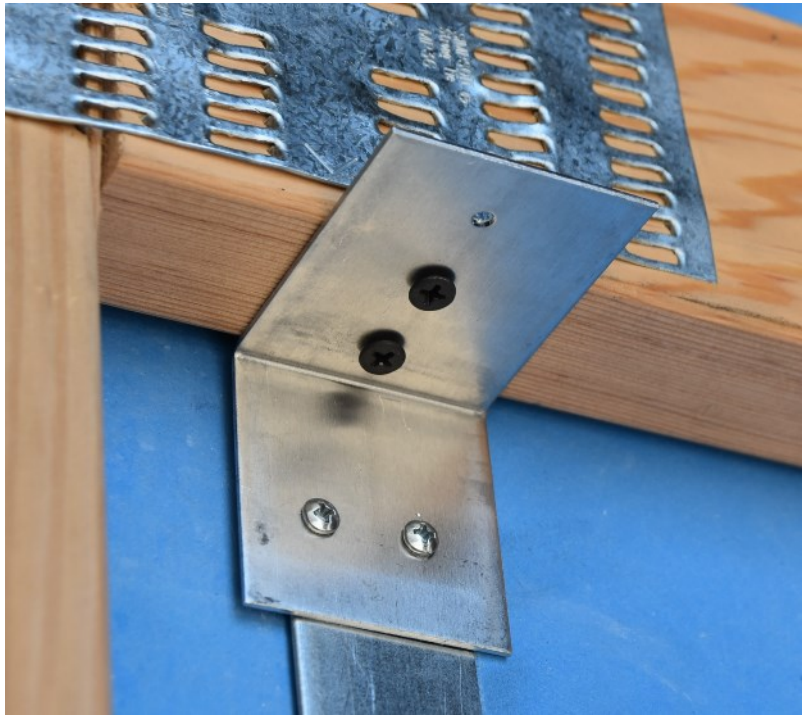
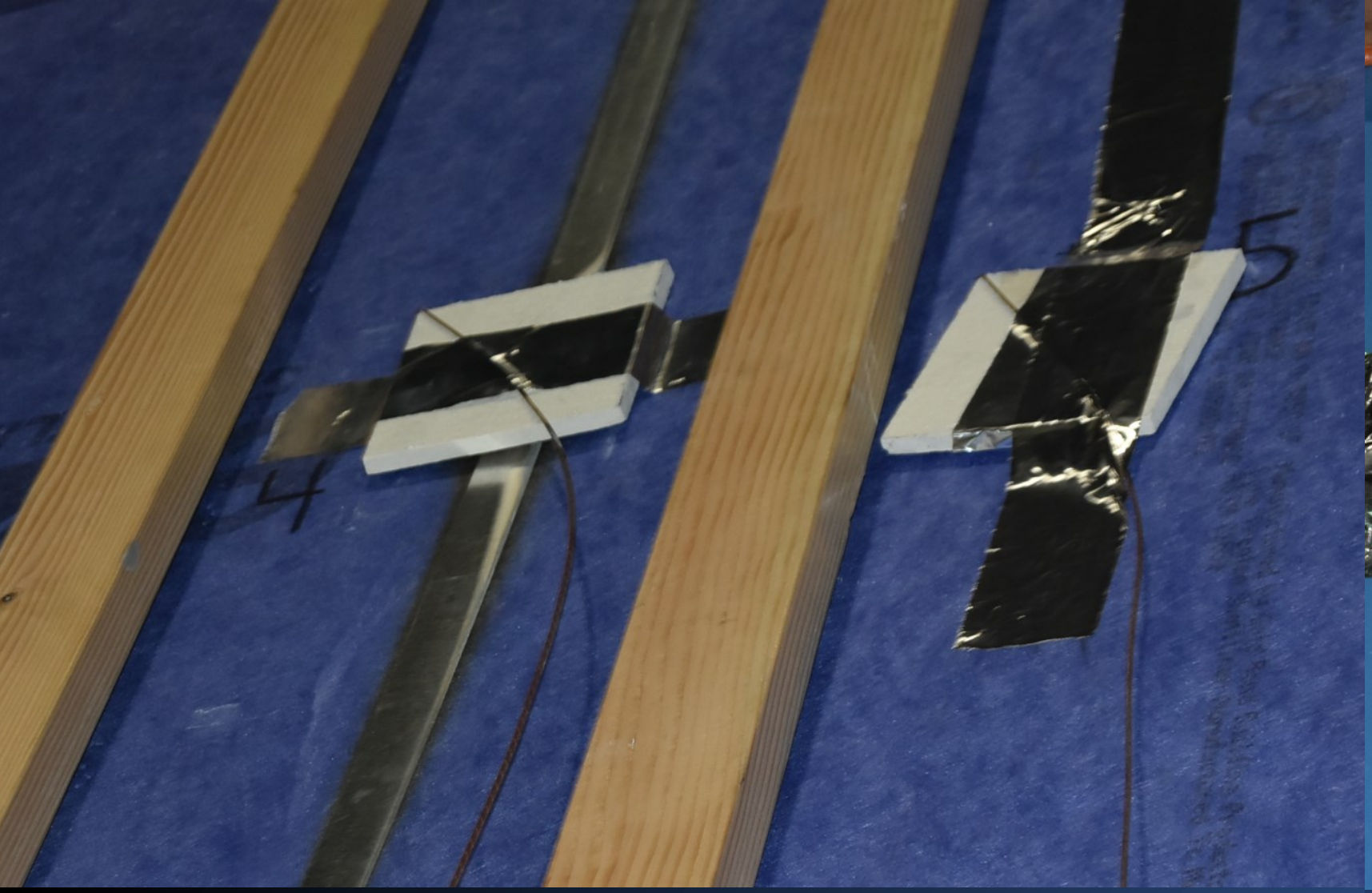
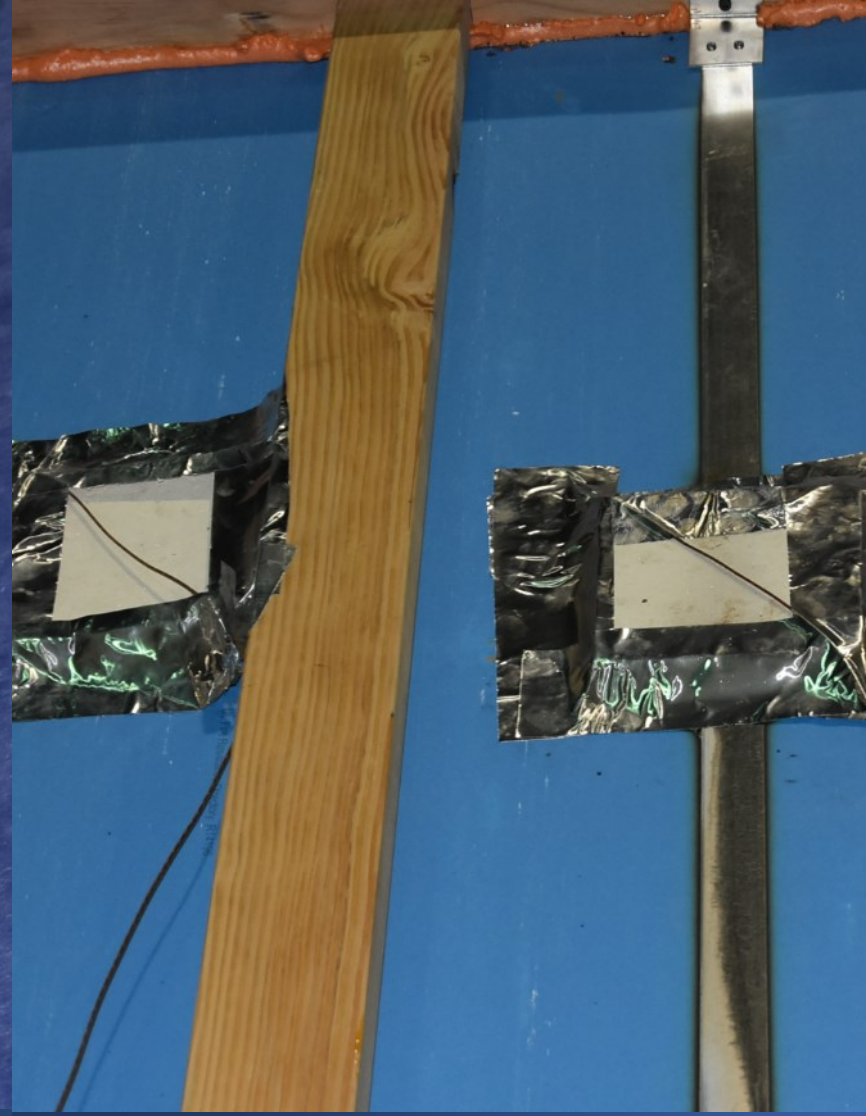


Photo No. 5
Unexposed side of Test Assembly

Photo No. 1
ASW Installation

Constructed Assemblies





Connections and Convection

Control

- 7 Control
- 7.1 *Fire-Resistance Test:*
- 7.1.1 *Time-Temperature Curve:*
- 7.1.1.1 The furnace temperatures shall be controlled to follow the standard time-temperature curve shown in Fig. 1.The points on the curve that determine its character are:
- 1000°F (538°C) at 5 min
- 1300°F (704°C) at 10 min
- 1550°F (843°C) at 30 min
- 1700°F (927°C) at 1 h
- 1850°F (1010°C) at 2 h
- 2000°F (1093°C) at 4 h
- 2300°F (1260°C) at 8 h or over
- 7.1.1.2 For a more detailed definition of the time-temperature curve, see Appendix X1

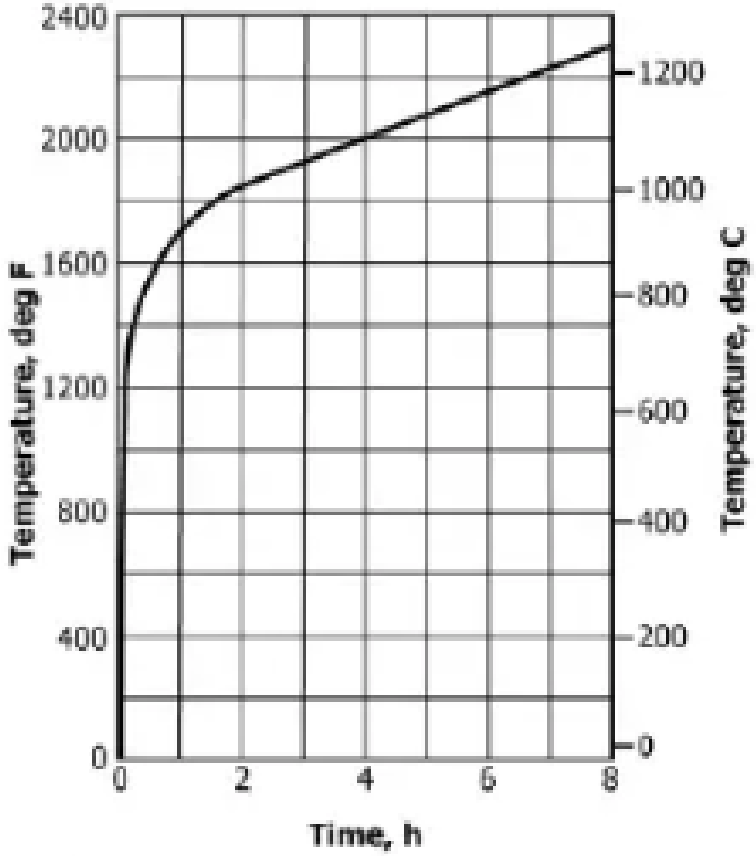


FIG. 1 Time-Temperature Curve

3 Minutes

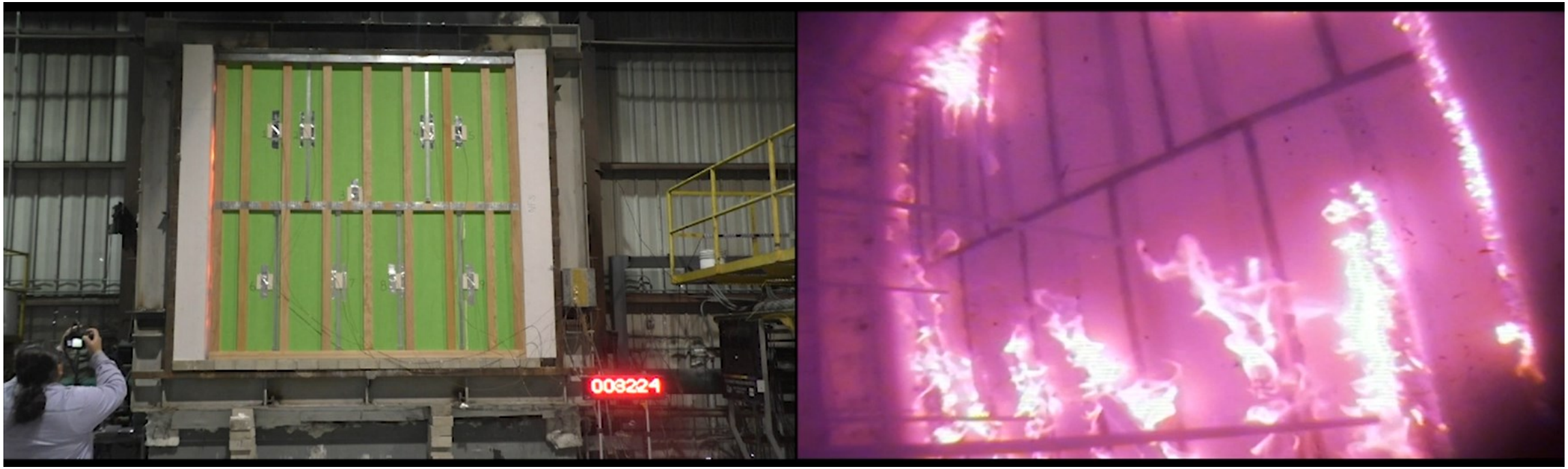
10 minutes

15 Minutes

20 Minutes

27 Minutes Consumption - Purple

Similar to all Results 25 to 30 Minutes Combustibles Consumed



32 Minutes - Green

Photo No. 10

Deflection of ASW at mid-height of wall assembly

Deflection

Edge of Chamber Review

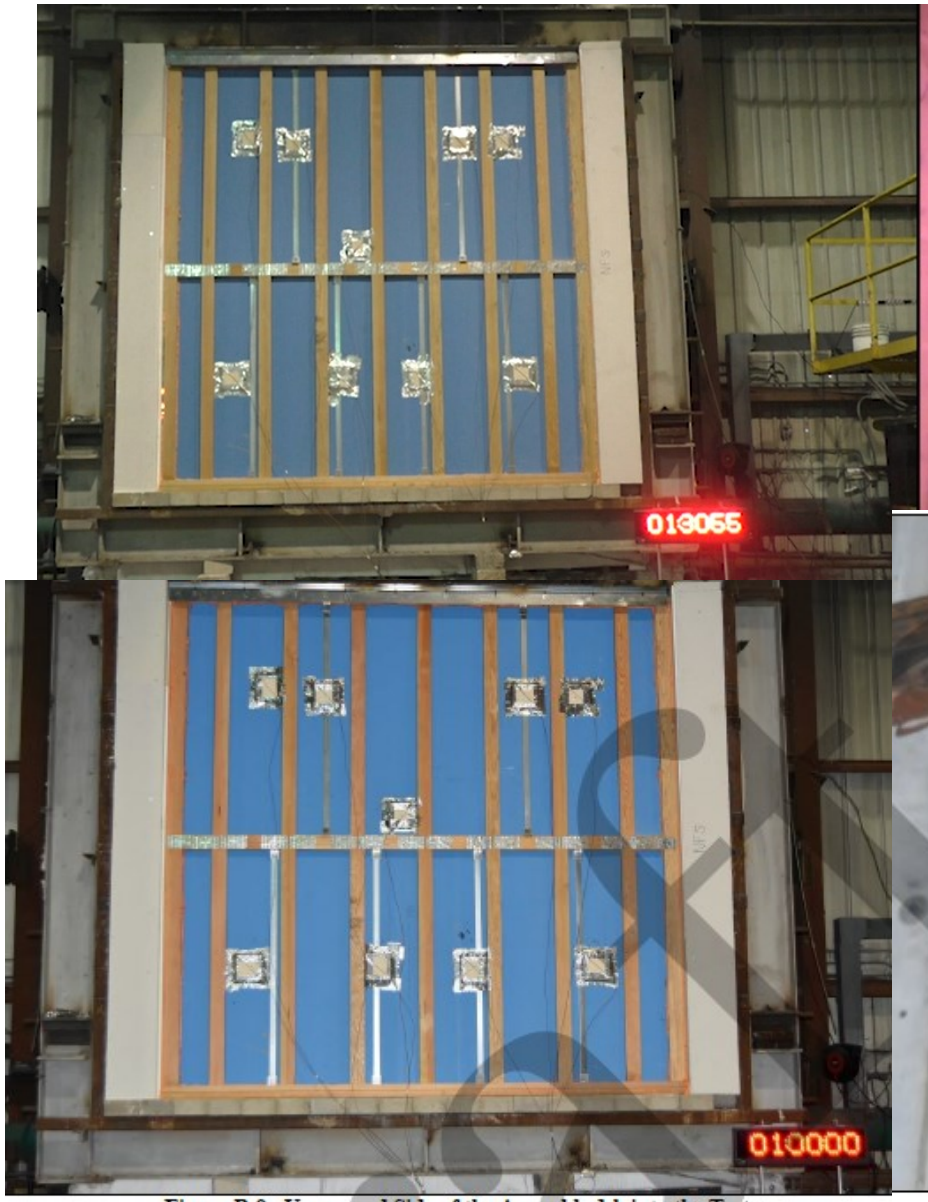


Figure B-9. Unexposed Side of the Assembly 1 h into the Test.

Figure B-10. View of Deflection 1 h 30 min Into the Test.

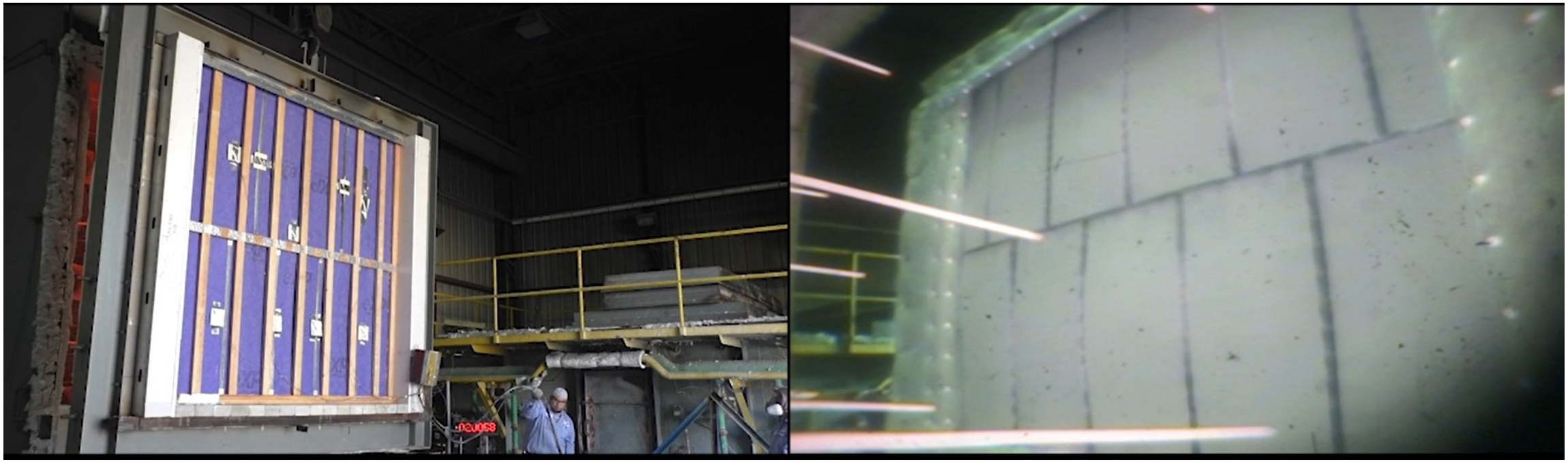
1922 National Board of Fire Underwriters Hose Stream Test

Pioneers to the Insurance Organization and Fire Prevention Codes

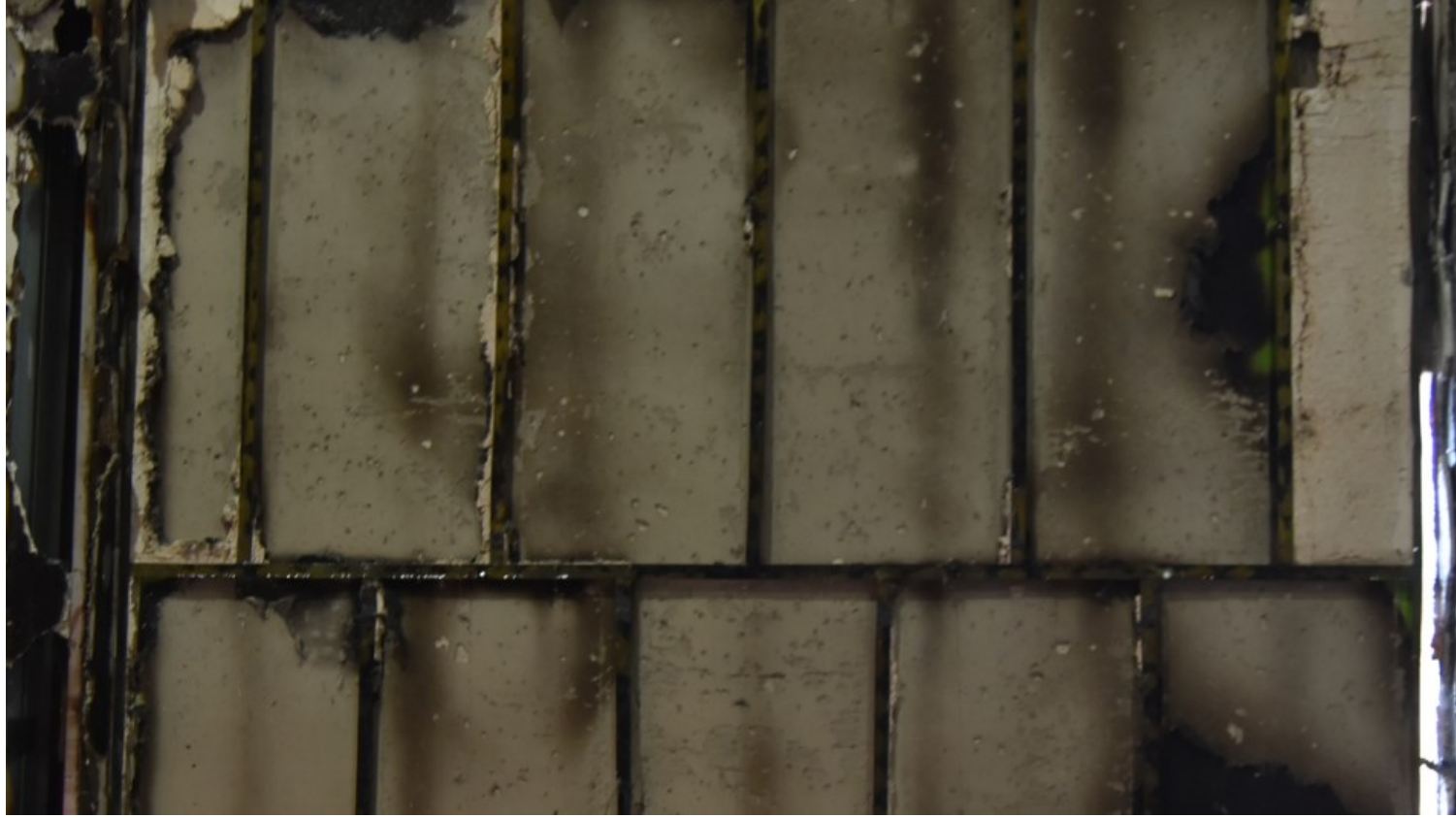
Impact, Erosion and Cooling

2 Hour Hose Stream – Did Not Pass – so…

120 Minutes

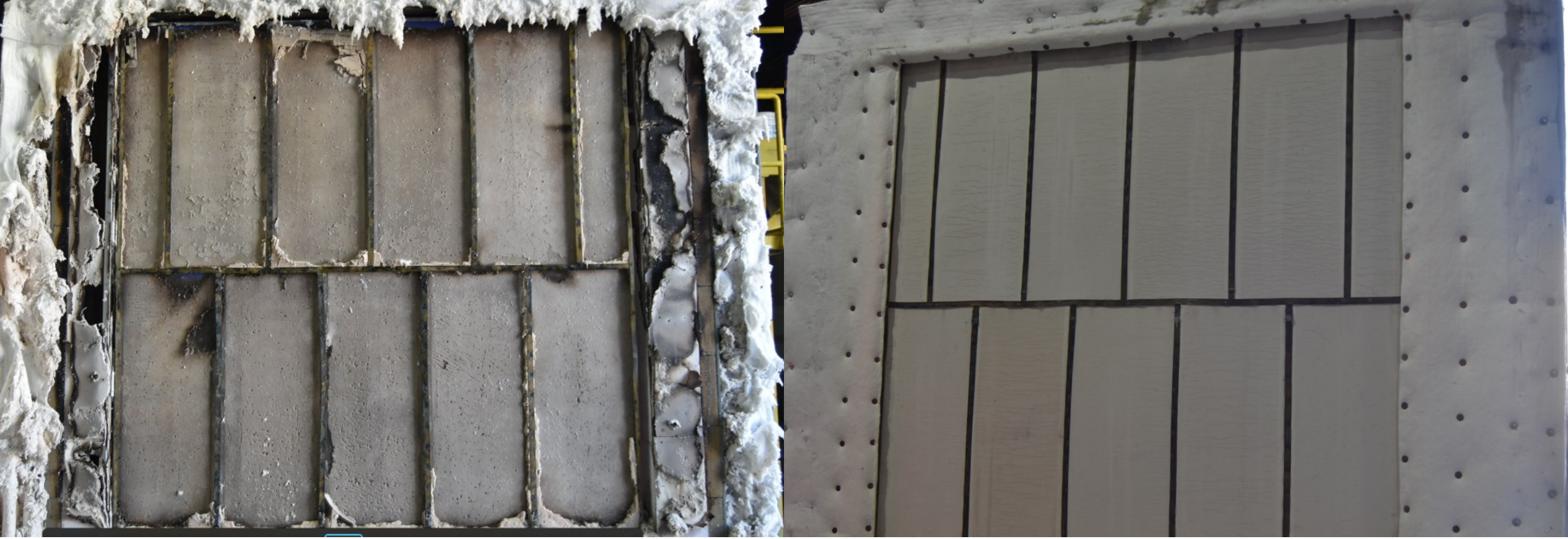


Remove for Hose Stream Test (2 Hour)



- ASTM E119 “Standard Test Methods for Fire Tests of Building Construction and Materials” burn test. Screenshot immediately after 2-hour furnace burn test. Note: wall assembly passed the 2-hour burn test.

Hose Stream



Successful Pass of Hose Stream

Unexposed Side

Hypothesis Disproven

Exemplar photograph of wood framing after 2-hour burn test with shaft wall panels removed showing no damage or charring to wood framing on non-burn side due to breaching or heat transfer.

Timing Review of Performance

4.4 Test Results

At 11:04 AM, the burners were ignited, and the furnace temperature was controlled following the standard time-temperature curve for a period of 120 minutes.

TEST OBSERVATIONS

0:00	Ignitors Lit, Test Started
1:10	2x4 skeleton framing ignition
3:07	Lumber framing self-extinguished
11:24	Insulation shelf dilapidating
24:30	Support wall beginning to fall away from ASW
32:00	Lumber still attached at base of wall up to insulation shelf
46:00	Lumber at base of wall still present, rest of lumber has fallen away
1:00:00	No change to exposed face, 1-1/2-in. deflection at center of wall
1:08:00	No change to exposed face
1:10:00	Deflection: 2-1/4-in. at center of wall, mid-height
1:20:00	No change to exposed face to report
1:30:00	Deflection: 3-1/2-in. deflection at mid-height
1:40:00	No change to exposed face of wall assembly
1:45:00	3-3/4-in. of deflection at mid-height
1:50:00	No changes to exposed face
1:55:00	No changes to report
1:57:00	Flaming still at bottom plate of wall assembly
2:00:00	Burners extinguished; end of fire exposure

**Tabular and graphical data can be found in Appendix B*

HOSE STREAM OBSERVATIONS

0:00	Hose Stream Started
2:20	Fully developed projection of water, Hose stream test concluded

Heat transfer through the channels considered?

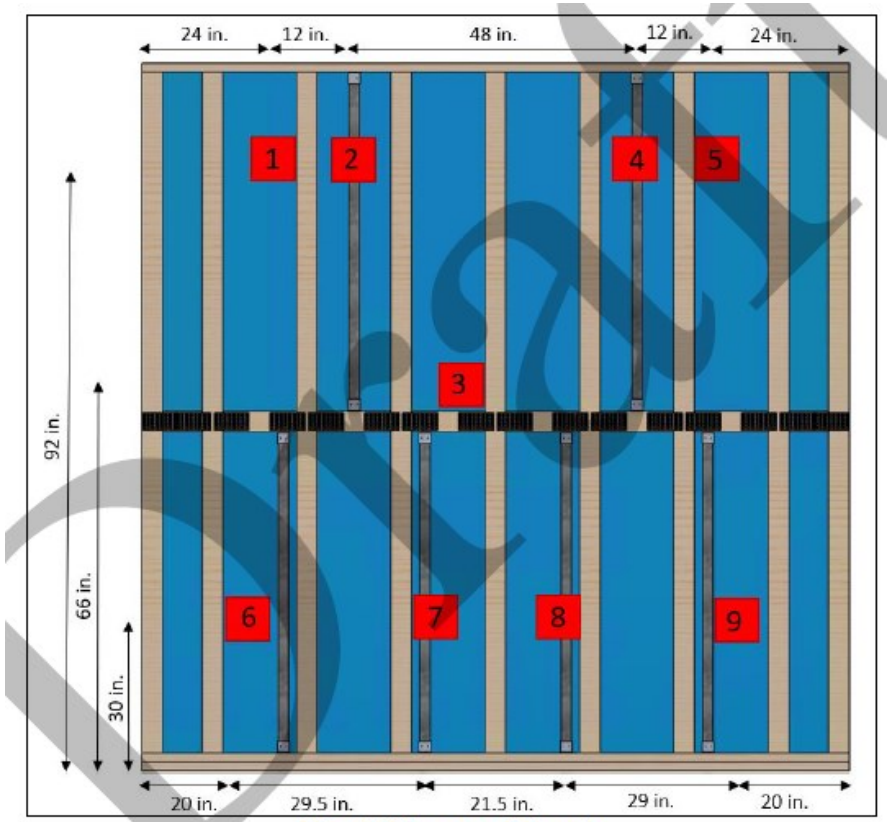


Figure 1. Thermocouple Layout.

Table 3. Summary of Thermocouple Data.

TC	Initial Temperature	Maximum Temperature	Temperature Rise
1	70 °F	188 °F	118 °F
2	69 °F	647 °F	579 °F
3	71 °F	223 °F	153 °F
4	69 °F	370 °F	302 °F
5	70 °F	193 °F	123 °F
6	70 °F	182 °F	112 °F
7	70 °F	504 °F	434 °F
8	71 °F	719 °F	648 °F
9	71 °F	236 °F	165 °F
Average	70 °F	323 °F	253 °F

Graphical Representation

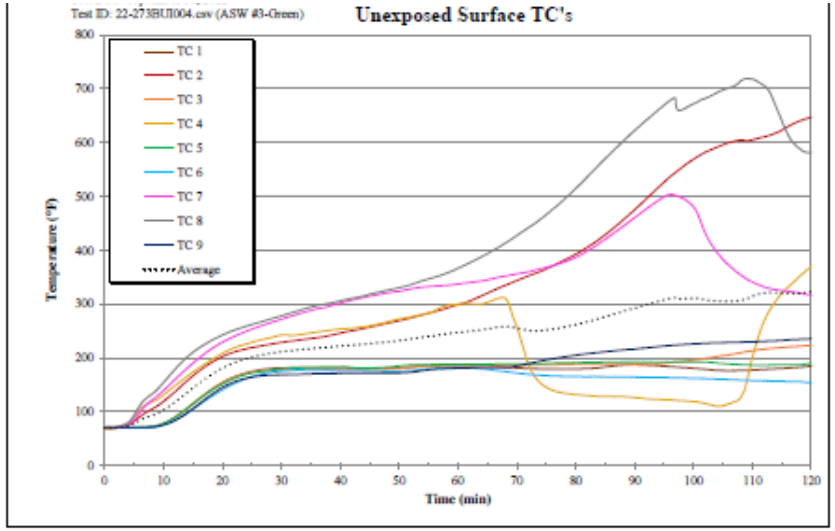


Figure C-1. Unexposed Surface Temperature vs. Time.

Data

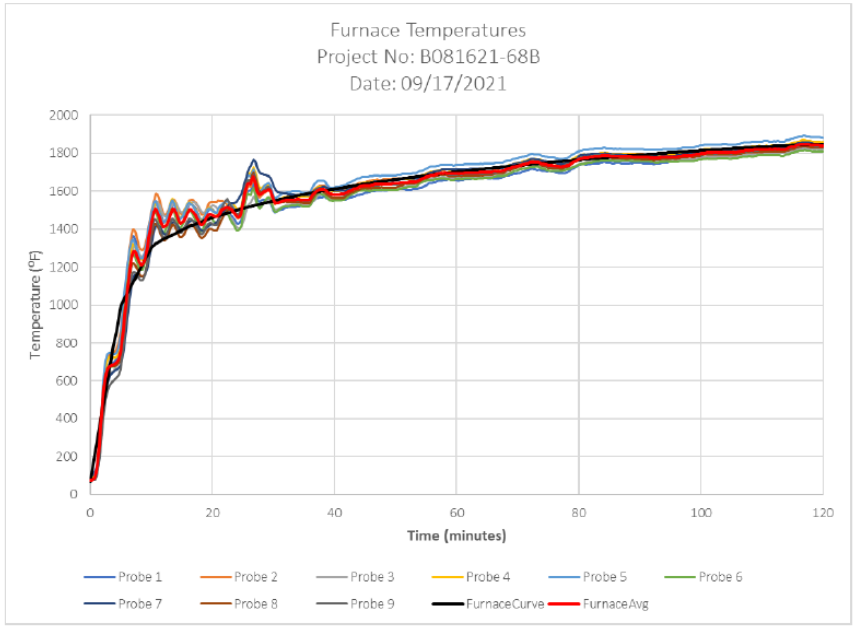


Figure No. 1

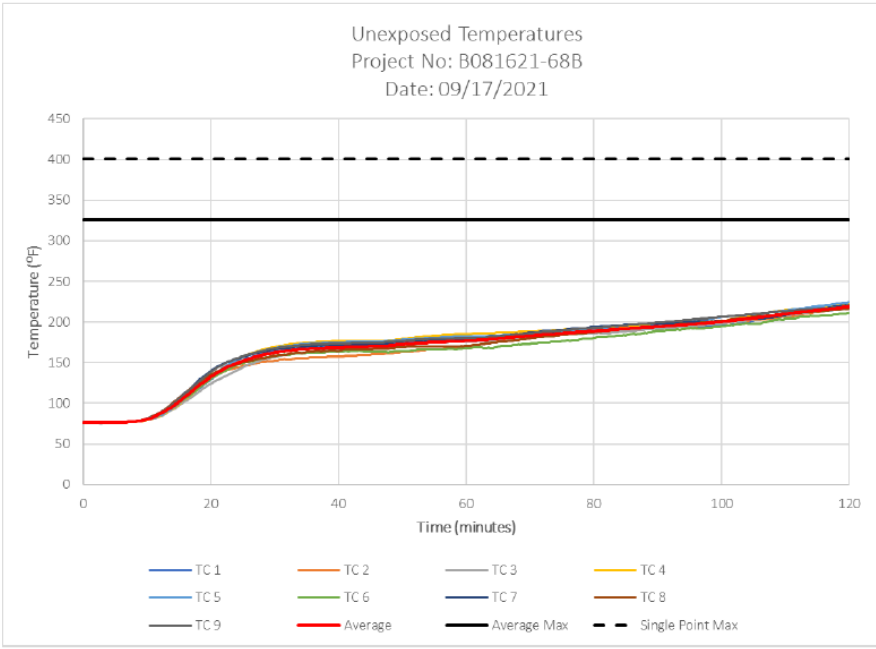


Figure No. 2

Summary of Tests

Table 1 Summary of Fire Wall Assembly Test Results			
Fire Wall Test Assembly	ASTM E119 Burn Test Results (PASS/FAIL)	ASTM E2226-15b Hose Stream Test Results (PASS/FAIL)	Reference ICC Test Report
1. 3/8-inch air gap	PASS	PASS	1
2. Zero air gap	PASS	PASS	2
3. Zero air gap with horizontal "H" track and insulation at wall	PASS	FAIL*(2 Hour)	3, 4
4. Zero air gap with horizontal "H" track with angle clips at top, middle, and bottom of wall	PASS	PASS	5

1. ICC-NAT No. B110220-28
2. ICC-NAT No. B010821-52
3. ICC-NAT No. B081621-68
4. ICC-NAT No. B081621-68A
5. ICC-NAT No. B081621-68B

*Wall assembly retested and passed during B081621-68B

10 Strategies for air sealing ASWs

Strategy 1: Adopt the 2021 IECC for Air Tightness Tradeoffs

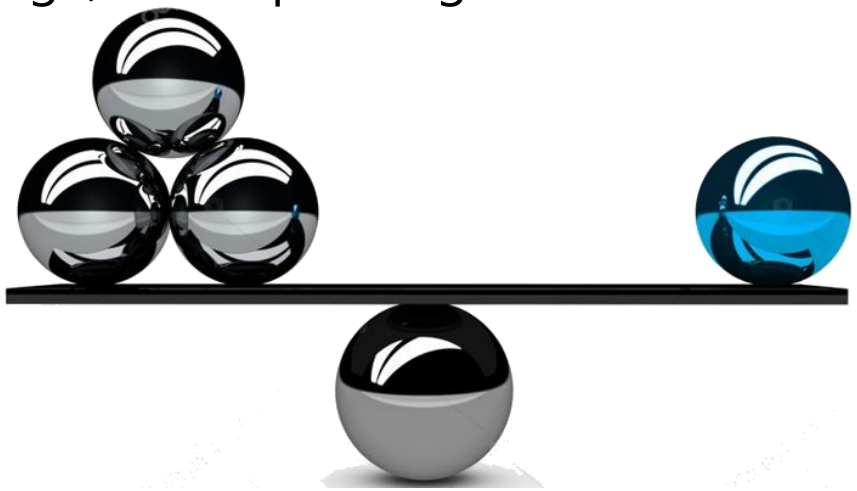
R402.4.1.2 Testing

- The *building* or *dwelling unit* shall be tested for air leakage. **The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 m3/(s × m2)] of dwelling unit enclosure area.**

- Potentially an R405 Building Performance and R406 Energy Rating Index Compliance Strategy

Tradeoff

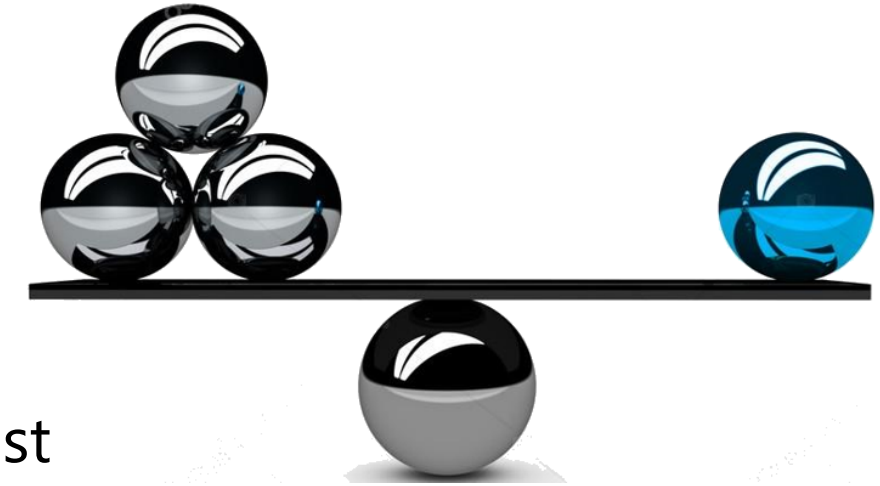
- A trade off refers to putting something **more in one** assembly so you can put something **less in another**
- HOWEVER, **in the IECC's case the energy performance scale remains balanced**
- You can tradeoff R-values, U-values, air tightness, duct leakage, etc. depending on the compliance path you are using



- **The blue ball represents 4.5 ACH50**
- The prescriptive code requires 3 ACH50 in CZ5
- The **3 silver balls balanced the energy equation because they represent better windows, higher R-values, and reduced duct leakage** than is required by the IECC
- Therefore, I **traded off poor air tightness performance for better windows, R-values, and duct leakage**

Tradeoff

How it really works in the Field



- **The blue ball represents**
  - **Attic insulation R38**
  - **No slab edge insulation R0**
  - **No Continuous Insulation**
- The prescriptive R-value path says in CZ5 you must
  - R60 attic Insulation
  - R10 Slab Edge Insulation
  - R5 continuous insulation
- The **3 silver balls balanced the energy equation because they represent better windows, air tightness, and reduced duct leakage** than is required by the IECC
- Therefore, I **traded off LESS ……., for MORE ……**

Strategy 2: Adopt 2021 IECC Compartmentalization Test

R402.4.1.2 Testing

- The *building* or *dwelling unit* shall be tested for air leakage. **The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 m3/(s × m2)] of dwelling unit enclosure area.**

Exception: When testing individual *dwelling units*, **an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 m3/(s × m2)] of the dwelling unit enclosure area,**

- Attached single and multiple family building *dwelling units*.
- Buildings or *dwelling units* that are 1,500 square feet (139.4 m2) or smaller.

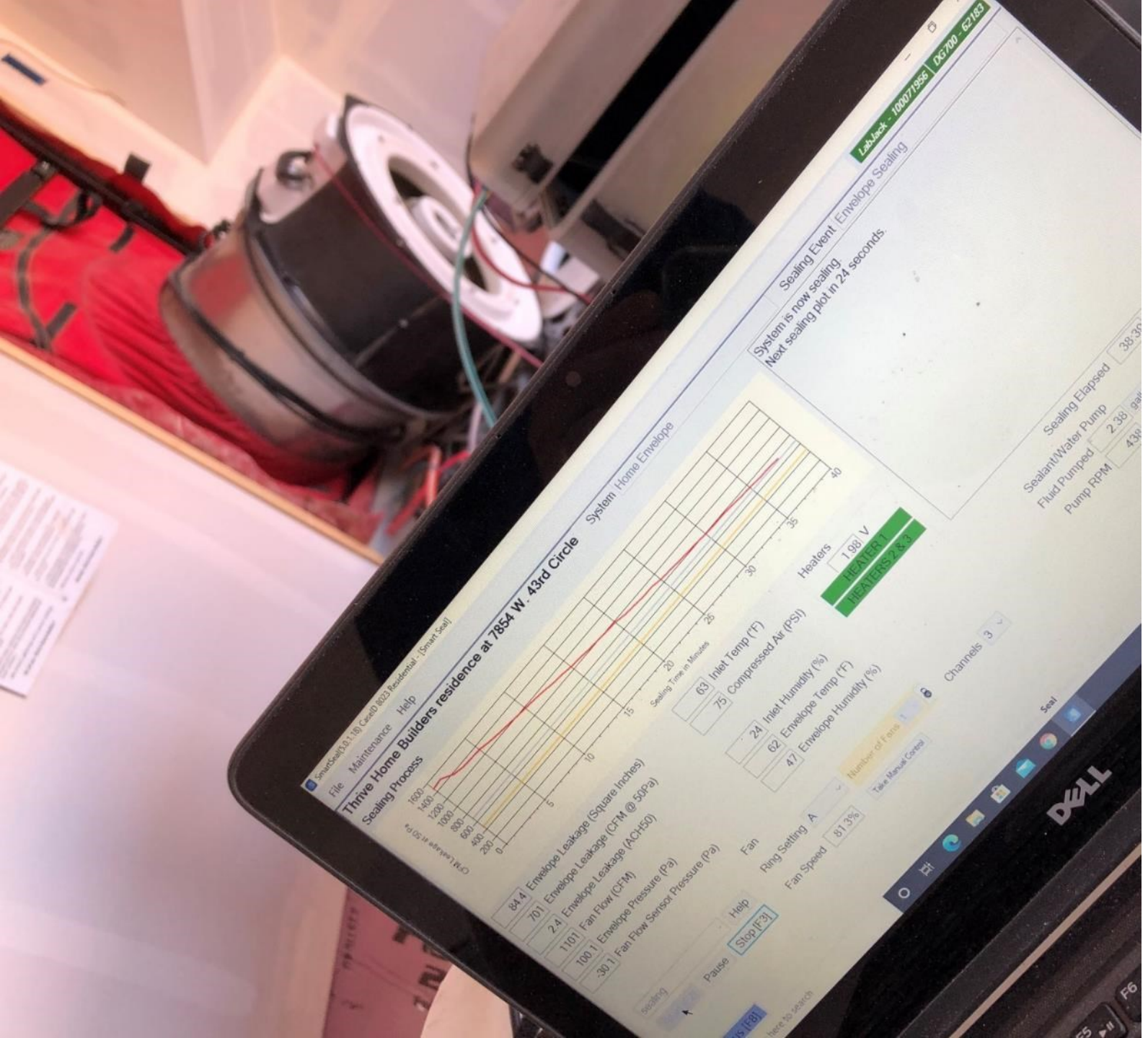
CFM/SQFT of Unit Envelope Area

https://abmichigan.com/improving-occupant-comfort-multifamily-buil

Conclusion

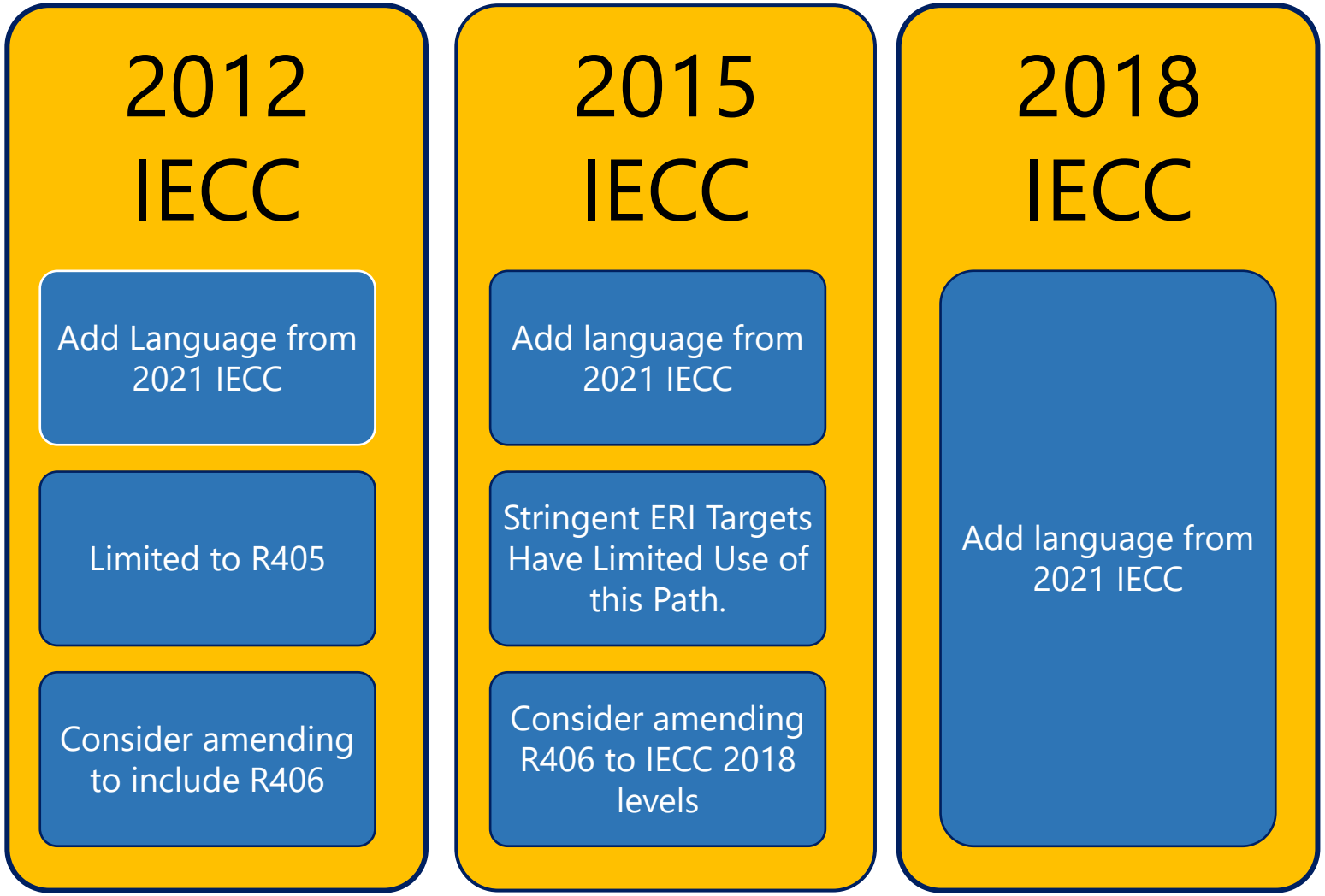
- Six of the ten strategies provided in this guide are regulatory in nature
- Address tension between Energy Codes and Fire Code
  - Model code amendments
  - Local adoption amendments
  - Additional testing
  - Using existing solutions in the code
  - Broad acceptance
- The Energy Code is a Life Safety Code
- Next Steps

https://www.barronheating.com/home-performance



Strategy 3: Add Air Tightness Tradeoffs to 2012, 2015, 2018, IECC

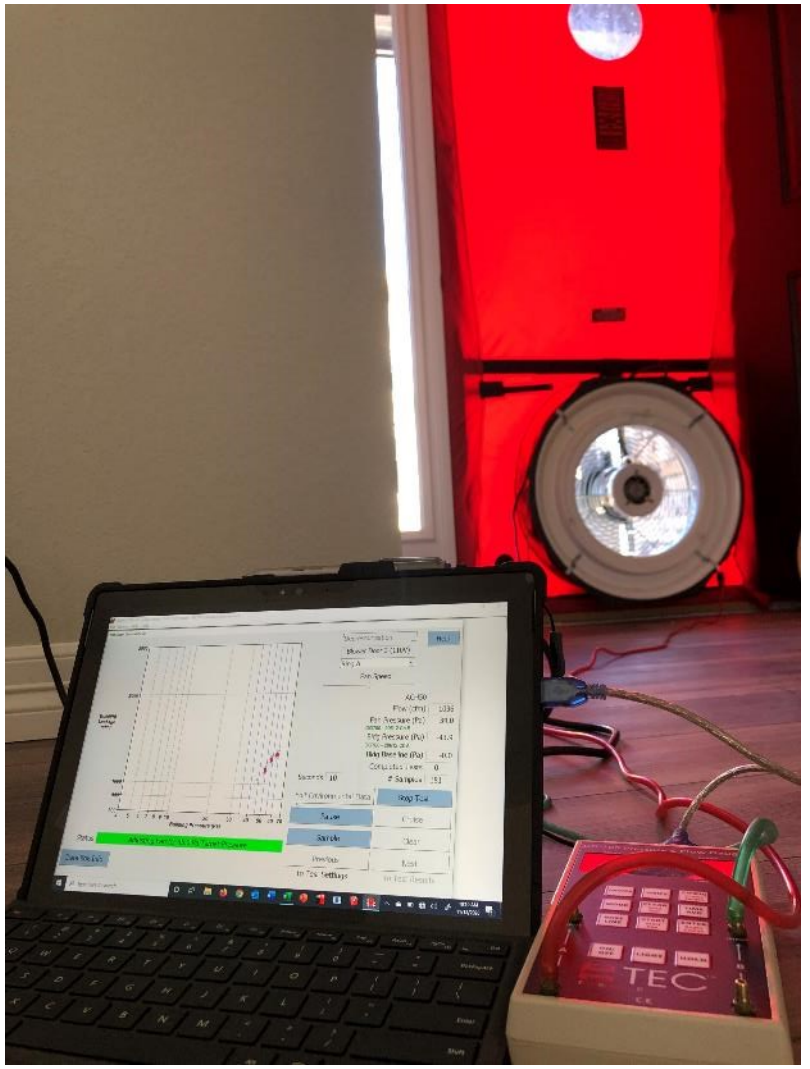
Amend the code during adoption



Amend the code during adoption

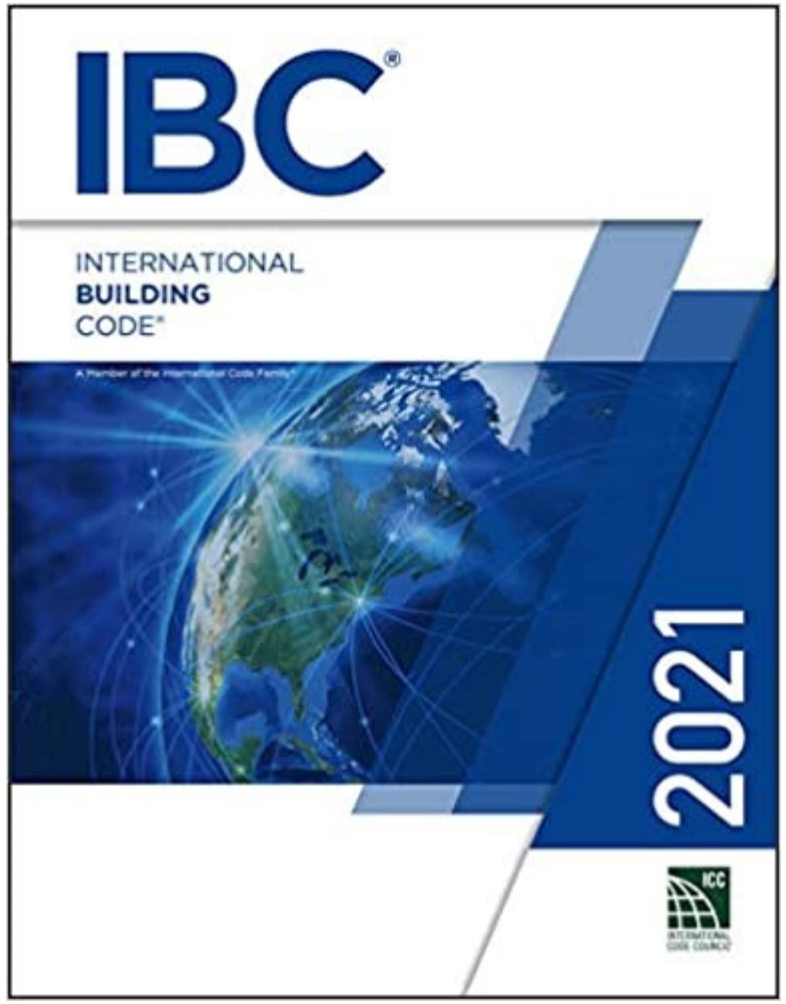
Be careful how you amend the air leakage requirements in the IECC

- R405 and R406 are performance compliance alternatives
- If you allow 5 ACH50 you have to do something more somewhere else
- If not, it is a role back

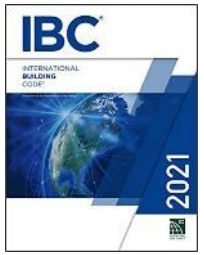


Strategy 4: Amend Residential Code with Options from International Building Code

- Ability to amend the IRC with options listed in the 2018 or 2021 IBC
- The IBC allows **six alternative options for demonstrating compliance with fire-rated assemblies**
- This Strategy is intended to allow builders, designers, or code officials flexibility to **use equivalent approaches while saving the effort and cost of additional testing**



Strategy 4: IBC 703.3 Options

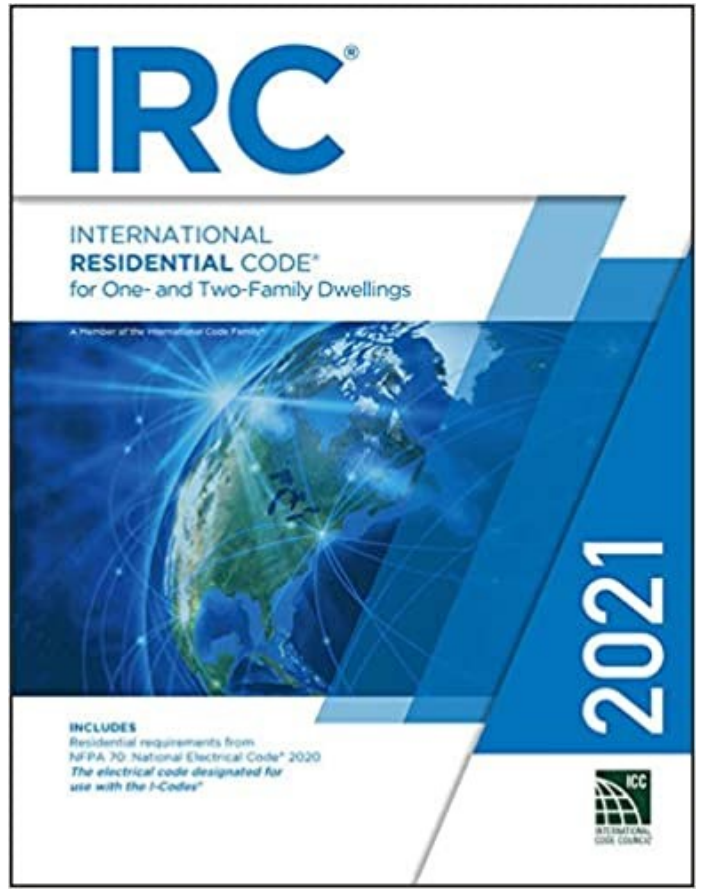


1: Fire-Resistance Designs	Documented to be consistent with E119 or UL263 by Approved Sources
2: Prescriptive Designs	Based on IBC 721/ a guide for building fire rated assemblies
3: Calculations	Based on IBC 722/calculated fire rated assembly
4: Engineered Analysis	Based on comparison to assembly tested to ASTM E119 or UL263
5: Alternative Protection Methods	Based on IBC 104.11/approved equivalent alternative
6: Fire-Resistance Designs	Certified by Approved Agency/code official

Strategy 5: Amend the Code for Additional Materials

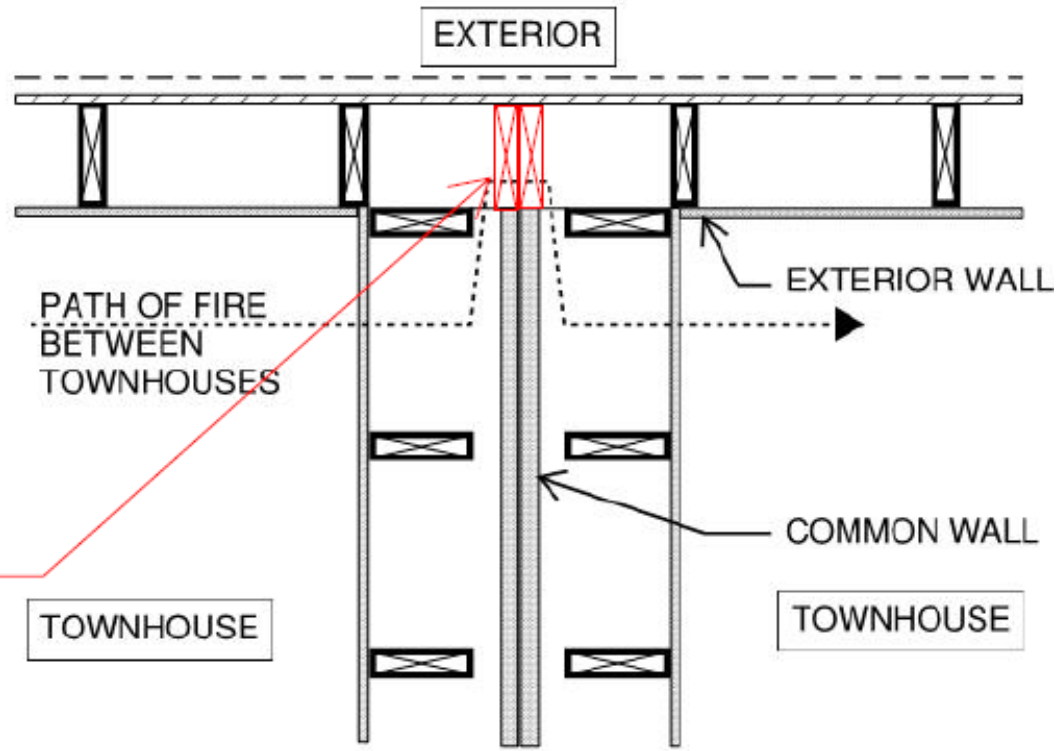
IRC Section R302 Fire-Resistant Construction

- Language could be added to section R302.2 Townhouses
  - R302.2.1 double walls and R302.2.2 common walls,
  - **“For the purposes of this code, caulks and sealants may be added to the tested common wall for air sealing purposes.”**
- The code is not altering ASTM E119 or UL 263 testing
  - It is allowing additional materials to be added to the tested wall
  - Performance criteria for the sealant materials, to ensure fire safety, should be spelled out
  - Air sealants could be allowed but limited in amount or application by the code



Strategy 6: Redefine the Common Wall Area

2021 IRC Section R302.2.2 Common Wall



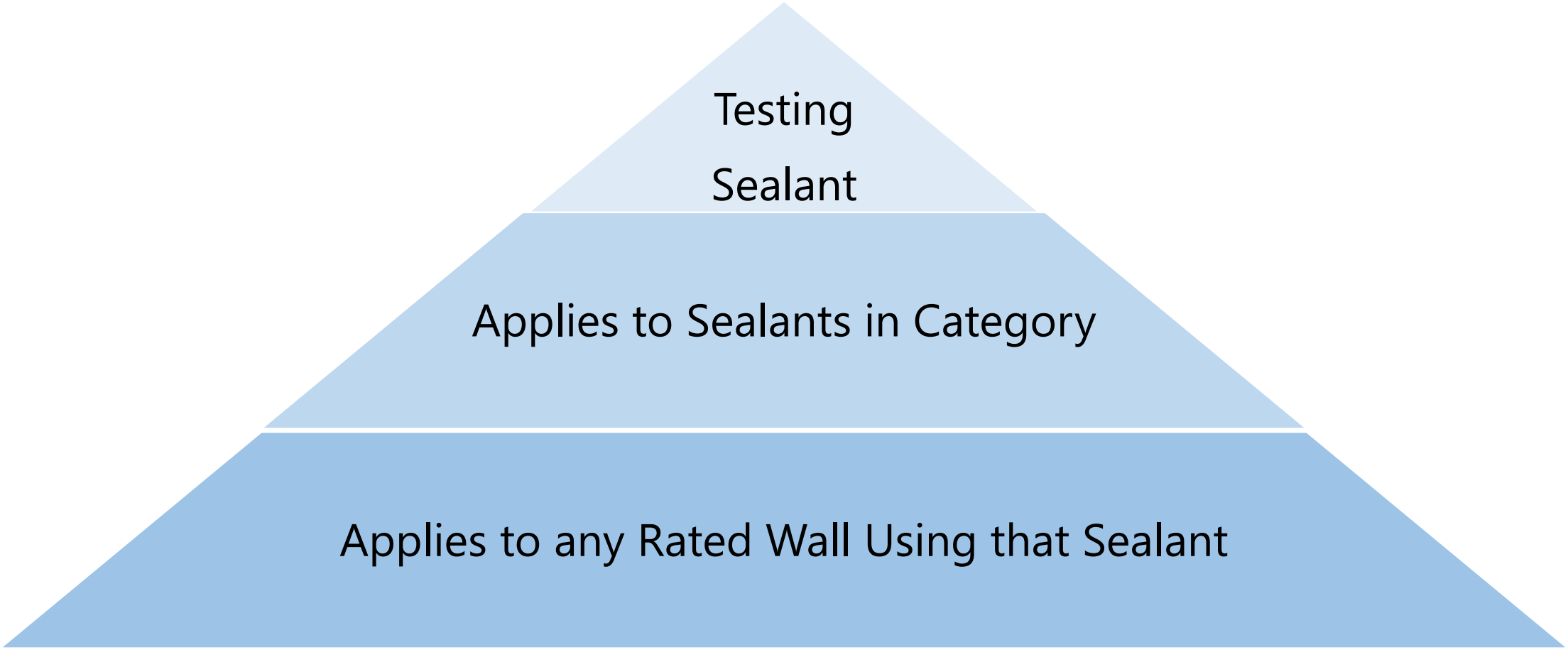
(2) 2x studs allowed by exception, otherwise common wall extends to exterior sheathing

Exception:

- Common walls are **permitted to extend to and be tight against the inside of the exterior walls** if the cavity between the end of the common wall and the exterior sheathing is filled with a minimum of two 2- inch nominal thickness wood studs.

Strategy 7: Test a Broad Class of Materials

Nonproprietary Approach



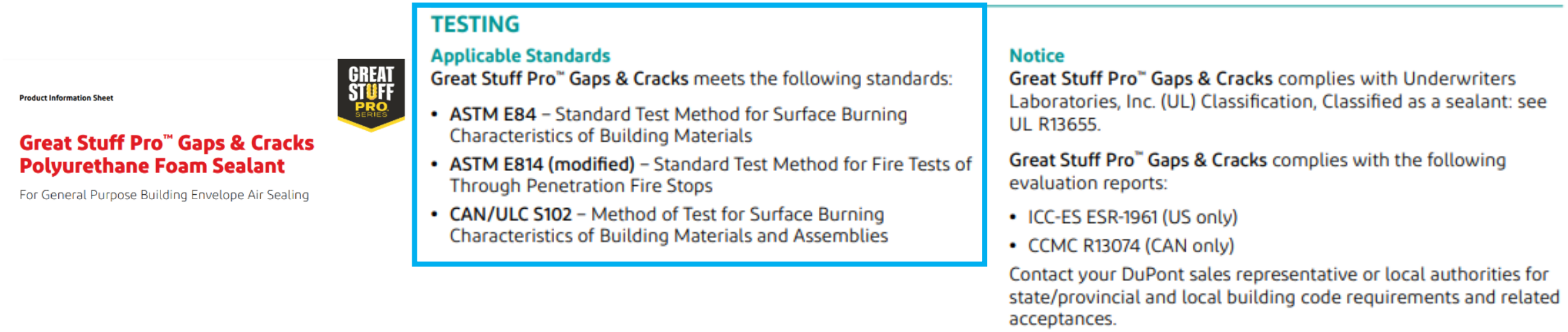
R302.4 Dwelling unit rated penetrations

- **Penetrations of wall or floor-ceiling assemblies** required to be fire-resistance rated in accordance with Section R302.2 or R302.3 shall be protected in accordance with this section.
- R302.4.1.2 Penetration firestop system. Penetrations **shall be protected by an approved penetration fire stop system installed as tested in accordance with ASTM E814 or UL 1479**
- **R302.8 Foam plastics**. For requirements for foam plastics, see **Section R316**

- **R302.9 Flame spread index and smoke-developed index for wall and ceiling finishes**
- **R302.9.4 Alternative test method.** As an alternative to having a flame spread index of not greater than 200 and a *smoke-developed index* of not greater than 450 where tested in accordance with **ASTM E84 or** UL 723

IRC R316

- **R316.3.1 Foam plastic insulation 4 inches thick or less**. Foam plastic insulation installed at 4 inches (102 mm) in thickness or less shall have a flame spread index of not more than 75 and a smoke-developed index of not more than 450 **where tested in the maximum thickness and density intended for use in accordance with ASTM E84 or UL 723**.



Product Information Sheet

Great Stuff Pro™ Gaps & Cracks Polyurethane Foam Sealant

For General Purpose Building Envelope Air Sealing

GREAT STUFF PRO SERIES

TESTING

Applicable Standards

Great Stuff Pro™ Gaps & Cracks meets the following standards:

- **ASTM E84** – Standard Test Method for Surface Burning Characteristics of Building Materials
- **ASTM E814 (modified)** – Standard Test Method for Fire Tests of Through Penetration Fire Stops
- **CAN/ULC S102** – Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

Notice

Great Stuff Pro™ Gaps & Cracks complies with Underwriters Laboratories, Inc. (UL) Classification, Classified as a sealant: see UL R13655.

Great Stuff Pro™ Gaps & Cracks complies with the following evaluation reports:

- ICC-ES ESR-1961 (US only)
- CCMC R13074 (CAN only)

Contact your DuPont sales representative or local authorities for state/provincial and local building code requirements and related acceptances.

CF 812 WD low-pressure door and window foam

Ultimate ●●●●●

Low-pressure foam for air-sealing, filling and insulating doors and windows without warping the frames or jambs

From $37.25

☐ Compare

CF-AS CJP all-season fireblock foam

Ultimate ●●●●●

Helps reduce the spread of flames and smoke in residential type V-B and commercial non-rated construction

From $37.75

☐ Compare

HILTI Foam Systems

CF-AS CJP All Seasons Crack and Joint
Insulating Filler Foam

Product Description

CF-AS CJP All Seasons Crack and Joint Pro is a high performance, high yield polyurethane foam for filling around penetrations and general gap/crack applications in non fire-rated assemblies. This product is ideal for reducing air, sound, dirt, and water infiltration. CF-AS CJP complies with ASTM C 1620, the industry's first specification on aerosol foam sealants. **NOT FOR USE AS A FIRESTOP.**

Applications For Use

- Pipe / cable penetrations
- Blank opening gaps / cracks
- HVAC ducts
- Electrical junction boxes
- Base plate cracks
- Concrete formwork voids
- Metal decking seams
- General insulating

Testing / Approvals

- UL 723
- ASTM C 1620
- ASTM E 90
- ASTM E 283
- ASTM G 21
- UL 1715
- EPA Method 24
- ICC ES – ESR 2179

ICC ES ESR 2179

Technical Data

https://www.hilti.com/c/CLS_CONSTRCUT_CHEM_7132/CLS_FOAMS_132

Example: Test Two-Part Foam

Strategy 8: Additional testing of individual UL assemblies

This is a proprietary approach testing a specific assembly with specific materials

New Burn Testing for Air Sealing

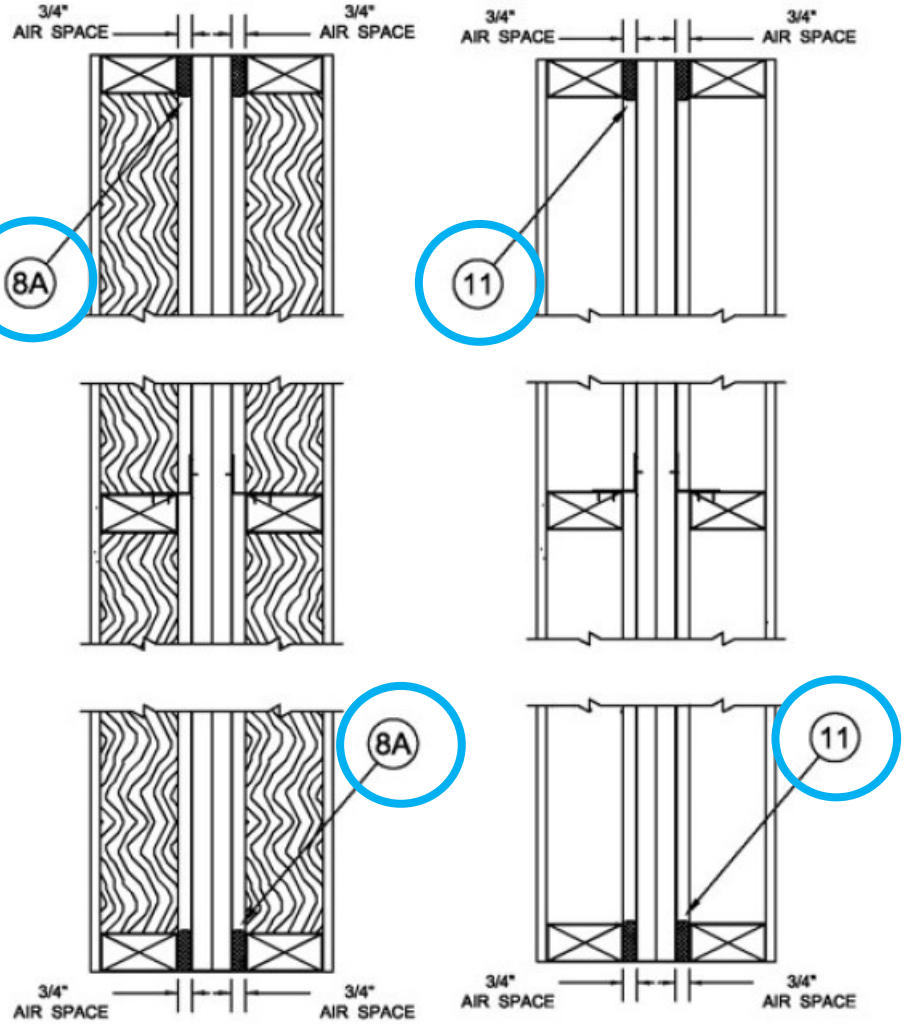
- Spray Polyurethane Foam Alliance Coordinated Burn Testing
- **7 sealant products** were tested using UL 94, a Standard for Testing of Flammability of Plastic Materials
  - All seven products were tested, and **all passed**
- **One** sealant was selected as representative and tested in a full-scale UL263/ASTM E119 assembly burn test
  - Probable that it was the worst performer in the small-scale test?
  - **This product passed**
- UL agreed that any product passing the small-scale test will be considered as passing the UL263/ASTM E119 large-scale test
- The sealant manufacture must follow through with listing in the BXUV guide and all have not done that. Probably due to additional UL fees
- If another manufacture wants to be listed, they have to fund and pass the small-scale test and reimburse the project sponsors through SPFA for a portion of the large-scale testing cost

BXUV.Gernaral Provisions - Fire-resistance Ratings - ANSI_UL 263__UL Product iQ.pdf

Shaft Liner Assemblies Allowing Air Sealing

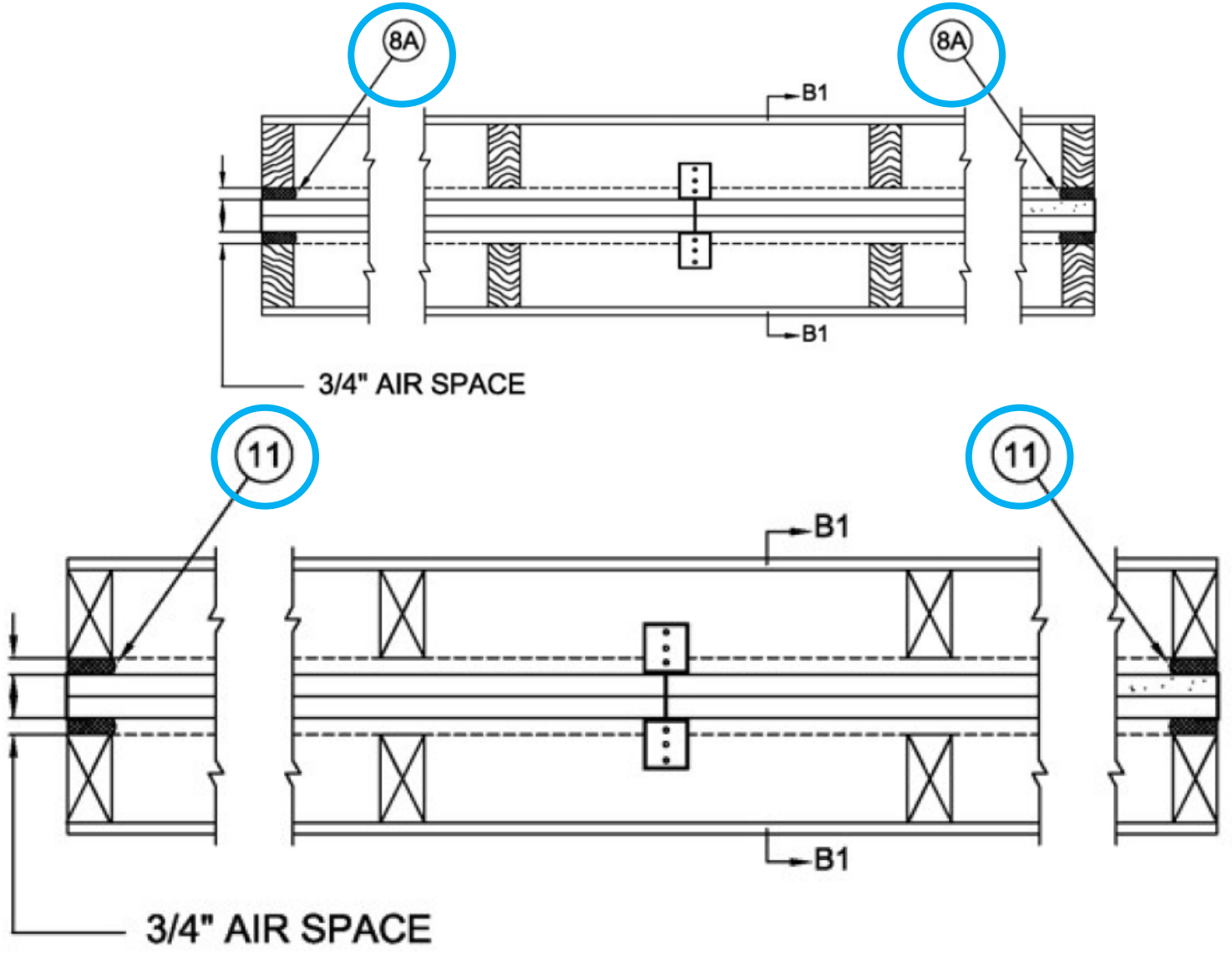
Updated December 2020

- U336 - **UNITED STATES GYPSUM CO**
- U347 - **NATIONAL GYPSUM CO**
- U366 - **CERTAINTEED GYPSUM INC**
- U373 - **GEORGIA-PACIFIC GYPSUM L L C**
- U375 - **AMERICAN GYPSUM CO**



SECTION B1-B1

SECTION B1-B1



CONFIGURATIONS B and D

EXPOSED TO FIRE FROM EITHER SIDE

BXUV Language

- 8. **Caulking and Sealants* — (Optional - Intended for use as an air barrier - Not intended to be used as fire blocking) - A bead of sealant applied around the partition perimeter in the 3/4 in. air space between wood framing (Item 4) and shaftliner panels(Item 3) to create an air barrier.**

- **DUPONT DE NEMOURS, INC.** — Great Stuff Gaps & Cracks, Great Stuff Pro Gaps & Cracks, Great Stuff Pro Window & Door
- **ICP ADHESIVES & SEALANTS INC** — Handi-Foam Fireblock, Handi-Foam Fireblock West, and Fast Foam Fireblock

*

- *** Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada),respectively.**

Installation Process

Not spelled out in the BXUV Guide

Option #1

- Air seal gap
- Place Fire Stop material on top

Option #2

- Place solid gypsum in ¾-1” gap and air seal

Strategy 9: Field Solution with Innovative Technology

CASE STUDY

Energy Efficient, Healthy Homes

PROJECT OVERVIEW

PROJECT
3-Story Rowhomes

BUILDER
Thrive Home Builders

CONTRACTOR
Rocky Mountain AeroBarrier

LOCATION
Wheat Ridge, CO

RESULTS
Pre-leakage: 5 ACH50

Post-Leakage: 1.6 ACH50

Reduction: 70%

Thrive Home Builders Eliminates Stress of Meeting Code with AeroBarrier

Home builders in the greater Denver area deal with exacting air tightness levels. While some builders might avoid cities with strict enforcement of low air tightness levels, Thrive Home Builders has turned this challenge into an opportunity. In fact, continuous innovation has differentiated Thrive locally and established it as a nationally recognized pioneer.

"We felt it was important to build a brand around energy-efficient homes," said Bill Rectanus, Thrive's Vice President of Home Building Operations. "Making it an option for homeowners doesn't work. But they will pay for a better home. We made energy efficiency a brand standard, regardless of price point."

As a result, every new Thrive home is designed to meet the highest standards, including LEED®, EPA Indoor airPLUS, Zero Energy Ready Homes, and Energy Star®. This has fueled innovation at Thrive – innovation focused on better ways to create healthy, energy-efficient homes within these standards.

> In addition to sound and odor mitigation, AeroBarrier ensures air from each garage doesn't infiltrate any of the homes.
>
> **Bill Rectanus** – *Vice President of Home Building Operations*
> *Thrive Home Builders*

AEROBARRIER
Air Sealing Technology from Aeroseal

225 Byers Road, Suite 1
Miamisburg, OH 45342
877-959-8421
info@aerobarrier.net

AEROSEAL.COM/AEROBARRIER

ABR-CaseStudies-Thrive.pdf

Field Evaluation with Innovative Aerosolized Air Sealant

Field Evaluation with Innovative Aerosolized Air Sealant

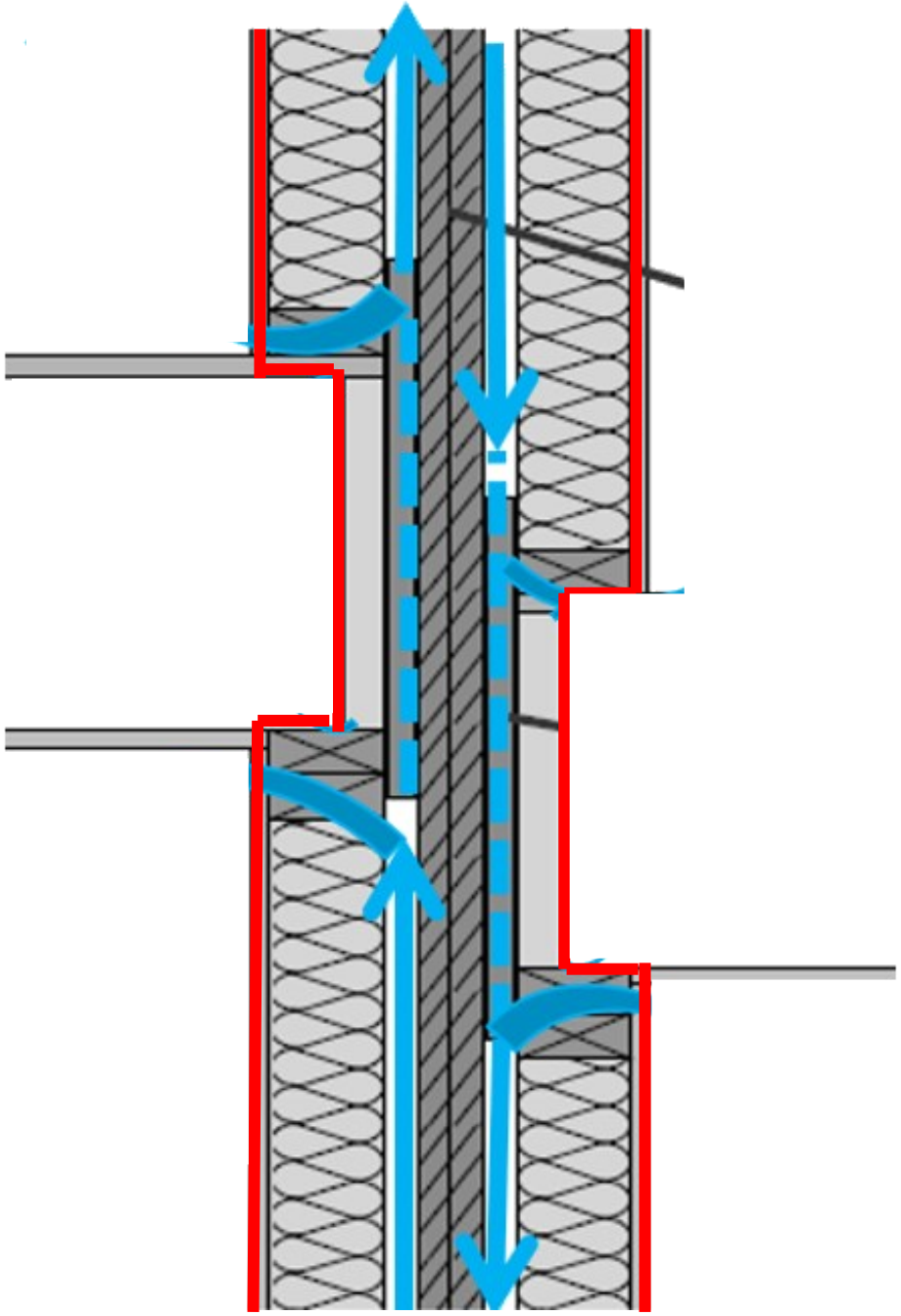


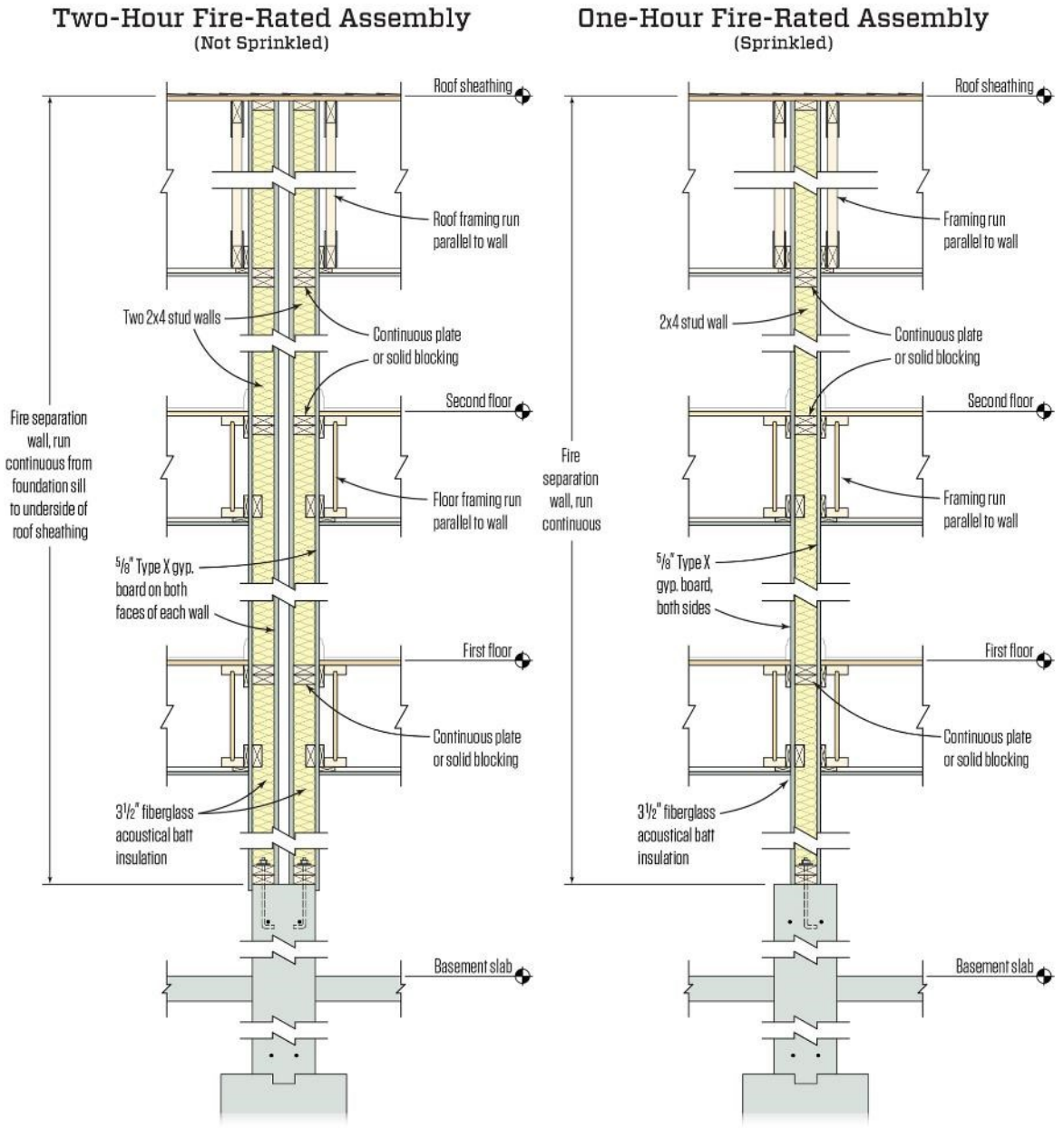
Image from Building America Report – 1508. Kohta Ueno, Joe Lstiburek. March

Strategy 10: Add Fire Sprinklers

https://spectrumforfireprotection.com/blog/automatic-fire-sprinkler-market-to-exhibit-rapid-surge-in-consumption-in-the-covid-19-crisis-2026/

Fire Sprinklers

- Fire sprinkler system **reduces the requirement** for 2-hour separation wall down to a 1-hour wall
- What are the issues with 1-hour walls?
  - Needed on both sides
- Jurisdictions my allow for a reduction of the number of fire hydrants in a community if fire sprinklers are installed which could offset innovative air sealing techniques
- Issues with fire sprinklers and the IECC



http://hotcore.info/kareff-07079.html

2021 IECC Table R402.4.1.1
Air Barrier, Air Sealing, and Insulation Installation

- New language in Component Sections:
  - Rim Joist
  - Basement, crawls space and slab foundations
  - Shaft Penetrations
  - Narrow cavities
  - Garage separation
  - Recessed lighting
  - Plumbing wiring or other obstructions
  - Footnote b
    - Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at the rim joist

TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.

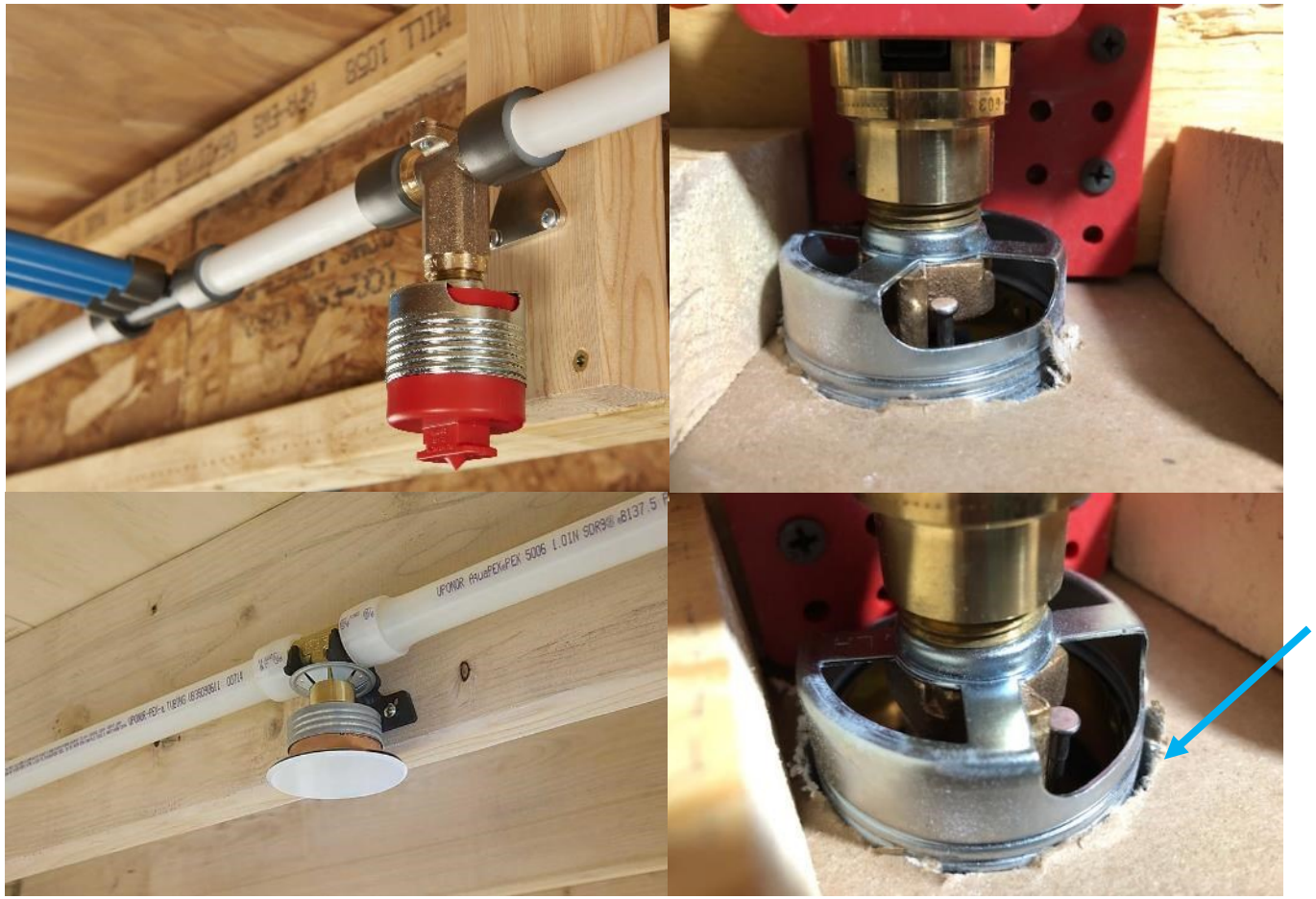
Table 402.4.1.1
Component – Concealed Sprinklers

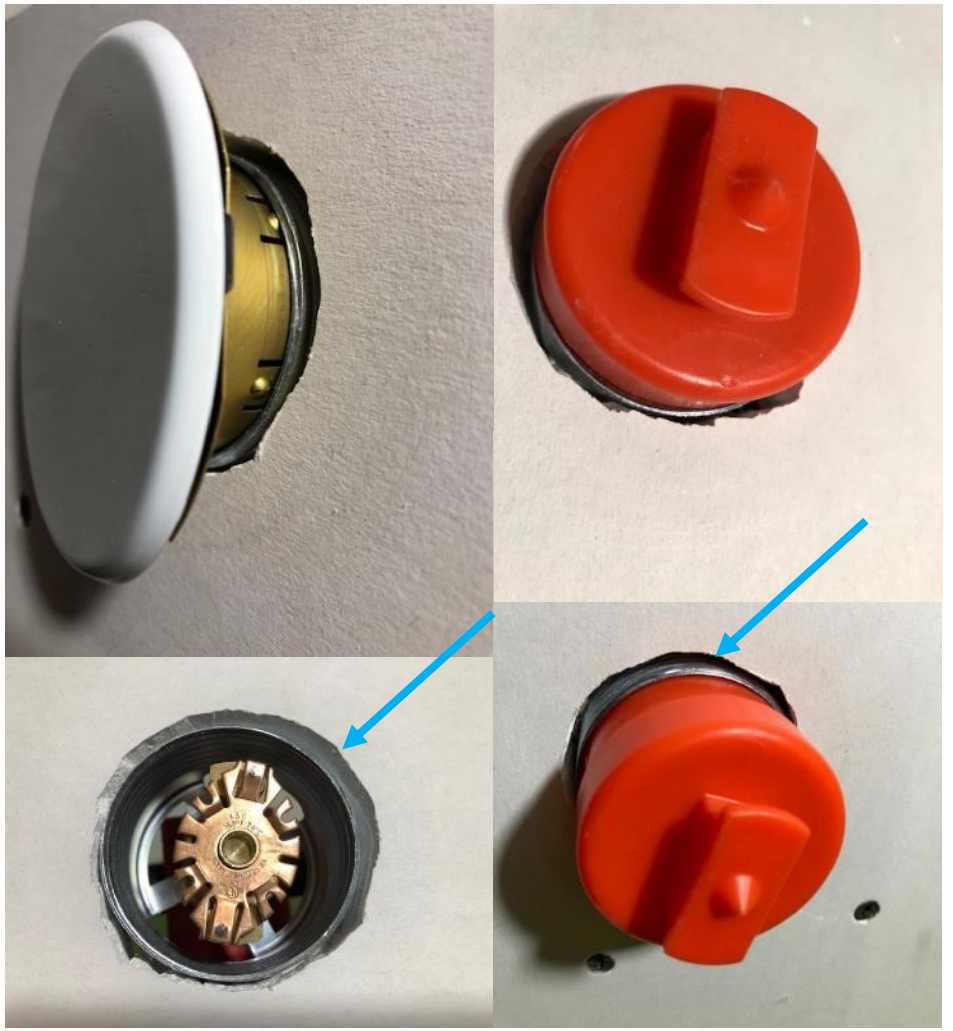
Air Barrier Criteria

- When required to be sealed, concealed fire sprinklers **shall only be sealed in a manner that is recommended by the manufacturer**. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings

Insulation Installation Criteria

Fire Sprinklers and air leakage?





https://www.multihousingnews.com/post/rehau-upgrades-residential-fire-sprinkler-system-with-fitting-technology/

Conclusions: The Summary Version

Although the assemblies are not compliant with strict UL requirements, they in fact do not represent any life-safety issue.

- Clips Matter – 5 feet O.C.
- Horizontal Restraint Required
- Fuel Source is likely eliminated very quickly in a two-hour scenario = reality of risk to occupants or structure
- Separation of Structure matters (one side falls)
- Hose test likely unrealistic for attic separation structure salvage during fire fighting operations
- Clips do not burn away (melt)
- Combustibles do not provide alternate fuel source on the non-exposed side
- Fire Retardant products at boundaries will provide protection. On the exposed sides, fire will not be contained, so this is limited to the interstitial space discussions.
- Construction Defect Claims can be sorted into variables of risk, and repairs do not require a full removal and reconstruction.

Conclusion

- Six of the ten strategies provided in this guide are regulatory in nature
- Address tension between Energy Codes and Fire Code
  - Model code amendments
  - Local adoption amendments
  - Additional testing
  - Using existing solutions in the code
  - Broad acceptance
- The Energy Code is a Life Safety Code
- Next Steps

https://www.barronheating.com/home-performance/

Thank you

Edward L. Fronapfel, PE, CBIE, F.ASCE, F.NAFE…

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303-229-2200