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Multi-family Unit Compartmentalization:

Why and How to Deal with a Complicated Detail

Produced by EnergyPro Exchange (EPX) | 2021

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Learning Objectives

- Understand why multi-family Unit Compartmentalization is important
- Understand the challenges of achieving targeted performance
- Understand the approaches currently available for compartmentalization

One of the more complex aspects of multi-family air-sealing is the interface between units. The nature of the construction techniques, sequencing, and trade training all make for a very challenging environment to achieve targeted separation levels.

This paper explores why Unit Compartmentalization is essential from a mandated and performance perspective.

We will also explore the challenges noted above and address them using currently available approaches and methods.

Part 1:

Why Unit Compartmentalization is Important

Mandated Performance

There are multiple scenarios in which a project may need to comply with a Unit Compartmentalization performance metric. These primarily include building code requirements and above code performance program requirements.

These requirements have various levels of stringency and thus difficulty. Depending on the code, local amendments, and program requirements, buildings may require either whole or Unit Compartmentalization testing.

The following are some of the compartmentalization requirements across the US and Canada (all in CFM50/ft2):

- LEED® Mid-rise (pre-requisite): 0.30
- ASHRAE™ 62.2: 0.30
- ENERGY STAR® Multifamily High Rise: 0.30

As is apparent, there is broad programmatic consensus on the need for, and the appropriate level of, compartmentalization that should be targeted.

Building Performance

Regardless of any mandated need to consider and pursue Unit Compartmentalization, there are also performance-based reasons to do so. The transmission of air between units has been a problem for building operators for years. Occupant complaints about odor and smoke are the most obvious of these issues. Anyone who has ever smelled bacon cooking from another unit has experienced this directly.

We now have a concern about the transmission of airborne viral organisms. While there is no evidence that this ought to be an actual concern for occupants, having clean and healthy air is likely a concern regardless.

Compartmentalization can also help with a building's fire resistance. Intuitively, inhibiting airflow through buildings in any fashion represents an improvement in this effort. Performance program mandates exist primarily for energy efficiency, while also improving occupant comfort and health issues. Unit Compartmentalization done well reduces HVAC loads and improves ventilation performance.

One of the biggest, if not the biggest, benefits of Unit Compartmentalization is moisture control. In multi-family buildings, most moisture flow occurs through air infiltration. By reducing the air infiltration between units and from outside to inside, moisture flow is also reduced.

> *"The primary benefit to improved airtightness is reduced heating and cooling energy use. Greatly reducing or eliminating uncontrolled air leakage also increases occupant comfort and reduces the risk of air leakage-based condensation failures of building enclosures. In mixed-humid and hot humid climates, these measures improve the ability of space conditioning systems to control interior humidity levels. In multi-family construction, research has shown that good compartmentalization is vital for fire, smoke, odor, contaminant, and sound control. In multistory/high-rise construction, compartmentalization can ensure more reliable suite ventilation in buildings with common ventilation systems. These issues are summarized in the literature search presented by Finch et al. (2009), and are covered in work by Hill (2005, 2006). Environmental tobacco smoke is an airborne contaminant of particular concern; measurements of compartmentalization before and after retrofit airtightness measures were studied by the Center for Energy and Environment (CEE 2004)."*
>
> *- Building Science Corporation*

How bad are these building performance issues?

According to research from the Building Science Corporation's Building America report:

> *"[...]it is common for, 10%–40% of the air coming into apartments to originate from other units, not from the exterior. It is reported that 100% of air leakage is supplied from other units in some instances. The research also warned that improving indoor-to-outdoor airtightness in apartment buildings without addressing unit-to-unit airtightness might result in greater pollutant exposure to occupants."*

In summary, effective compartmentalization achieves the following beneficial effects:

- Moisture control
- Odor control
- Ventilation control
- Pressure control (the taller the structure, the more this is true)
- Sound control
- Fire and smoke control
- Heat loss and gain control

Part 2:

Challenges to Unit Compartmentalization

Overview

The primary focus for air-sealing in multi-family structures has been on the building envelope. This has been driven by the fact that most of the energy-related impact comes from leakage to the outside. While this is true, it ignores the myriad health, safety, durability, and comfort issues noted above that are only addressed through attention to Unit Compartmentalization. Given that the primary focus has traditionally been on leakage to the outside, new techniques and methods are needed to address unit separation.

As with all forms of air leakage, one of the primary challenges is knowing whether the air sealing was done correctly or not. Testing during the final phases of construction tells us the answer. But this isn't particularly helpful in terms of achieving performance objectives. Different approaches must take this into account as well.

Some professionals believe that firestopping achieves much of what we are seeking with proper Unit Compartmentalization. However, firestopping is not a universal solution. It isn't focused on the same issue, and firestopping is still subject to the same problems as traditional air-sealing (see below).

Traditional Construction

The conventional approach to Unit Compartmentalization is through a standard practice of manual, point-applied sealants. This is typically foam and caulk with backing materials as needed and as allowed by code. Some backing materials are installed before the actual air-sealing sequence to allow separation that would otherwise be difficult to achieve (for example, pre-drywalling soffits and chases that will be sealed later).

This traditional approach can be effective. But results are inconsistent at times, and the process suffers from two key challenges; the imperative to train and supervise trades and the complexity of sequencing steps properly. When done correctly, it works, as demonstrated by Steven Winter Associates.

While this is reassuring, we should note these projects are somewhat self-selecting in that they are, by design and execution, meant to be high-performing buildings. Without the attention of industry leaders like Steven Winter, this performance level is less likely to be achieved.

> *"In the database, 88% of units tested in the Steven Winter Associates portfolio meet this threshold. While most of the projects participated in some sort of utility program that required compartmentalization, and therefore are not fully representative of typical practice,* ***it clearly shows that the threshold is within reach for builders that make an effort****."*
>
> *- Sean Maxwell writing in GBA*

Sequencing

Sequencing any project is a known challenge. Even without introducing new and potential unfamiliar steps, it can be challenging to ensure projects flow smoothly through the intended sequence. Unit Compartmentalization is not common or required on projects executed outside of programs that specify high-performance construction or jurisdictions requiring unit-level envelope leakage testing. As a result, Unit Compartmentalization is inherently outside the norm.

Thus, a series of air-sealing measures and blocking measures need to be incorporated into the construction sequence. As these are non-standard items, they will need to have particularly good on-site oversight to achieve success.

These items include but may not be limited to:

- Sealing bottom plates to sub-floor on perimeter and party walls
- Sealing and/or blocking on rims
- Sealing drywall at top plates (optional), bottom plates, and around all windows and doors (either with spray-applied or conventional gasket)
- Sealing drywall at all interior walls (either with spray-applied or conventional gasket)
- Seal any HVAC penetrations into the conditioned space
- Seal all penetrations from HVAC dedicated spaces to adjacent conditioned and unconditioned spaces
- Seal HVAC closets and enclosures from conditioned space
- Seal all electrical penetrations
- Seal all plumbing penetrations
- Seal all lighting fixture penetrations

This is not an exhaustive list. Each project should be evaluated at the planning stage to ensure adequate scopes, plan details, and specifications are generated to ensure compliance and a chance of success.

Typically, someone with building enclosure experience should be consulted to detail project-specific Unit Compartmentalization needs.

Trade Training, Engagement, and Supervision

Air-sealing is similar to other trades in one particular area. There is tremendous turnover in staff, and it takes constant training and supervision to maintain a consistent level of performance. This is difficult for even the best, most quality-focused contractors. Project teams should be aware that all trades struggle to retain their best employees. Trade availability is one of the primary concerns of builders and shows no signs of being alleviated any time soon.

Regardless of trade availability, training and supervising these details' proper execution is not an inconsequential issue. If conventional means are being applied, it's highly recommended that mock-up structures are used to ensure trades are clear about how and where to perform the work.

Project managers also need to be trained, as they are unlikely to be familiar with the details unless or until they've gained that experience. Project managers will need to be particularly diligent in the early phases of a project, where these details are first expected to be executed.

Attention to detail is critical to proper Unit Compartmentalization. Air leakage rates are not linear with relationship to air leakage sites. Air will simply find the path of least resistance until the leakage sites' size is reduced to the point of increasing the pressure in the structure, and then rates drop at a more logarithmic rate. Thus, air leakage sites must be substantially and effectively dealt with to achieve the desired Unit Compartmentalization.

To simplify, getting halfway there doesn't get you halfway there; you have to get much closer to perfect to reach your project goals.

Testing for Compliance

Testing for Unit Compartmentalization is complicated and time consuming.

From TEC, the manufacturer of the most widely used blower door equipment:

> *"In order to test the leakage of the enclosure, you may need to set up blower doors in each separate space and maintain an equal pressure within the entire building enclosure. Occasionally, adjacent spaces like this are well connected to each other and act more like one large, open space. This presents a special condition that may require some different testing techniques."*

The procedure for testing in this situation is to perform guarded blower door testing. The protocols for such testing are not necessary to replicate here, but can be referenced here, where the quote above came from. So, while we know that Unit Compartmentalization is very important for occupant health, satisfaction, comfort and energy efficiency, it's not easy to confirm. As codes move increasingly to requirements for both whole building and Unit Compartmentalization testing, testing capacity will grow. However, the cost and disruption to the schedule will be unavoidable.

Additionally, as noted above, finding potential issues early on is not feasible, and we are left with finding issues at or near the final stage when solutions are few and far between, and likely to be expensive.

Part 3:

Alternate Methods and Technologies

AeroBarrier™

AeroBarrier air sealing technology is a way to eliminate issues with manual air sealing. It is a proprietary system using spray-applied air sealant. The fluid itself is a safe, non-toxic, water-soluble organic compound. The sealant has been GreenGuard Gold certified and is not on the Red List (source International Living Future Institute). This proven approach to air sealing is based on technology developed in 1993, as a duct sealing system called AeroSeal. AeroBarrier and AeroSeal are available in most markets, currently with hundreds of installers in North America. Both systems are applicable in all building types, residential and commercial.

AeroBarrier is typically installed near a project's completion phase. It is a process in which the atomized sealant is introduced to a pressurized space and accretes on the edges of air leakage sites, eventually sealing them. AeroBarrier is able to seal gaps up to ½". While there are many instances where leakage sites might exceed ½", it is a standard of performance that can be included in scopes of work for framers, HVAC, etc. to ensure the system can work without additional blocking.

The AeroBarrier process enables the contractor to "dial-in" a specified leakage rate. The system runs until the desired leakage rate is achieved. At completion, the contractor gets a certificate of completion with before and after leakage rates that may or may not need to be verified by a third-party contractor.

In that it is a complete process, AeroBarrier presents a solution that addresses each of the issues noted above. The likelihood of failure and problems with trades, sequencing, and testing are navigated with AeroBarrier air sealing.

AeroBarrier may appear to be more expensive than conventional means of achieving Unit Compartmentalization. However, that cost perspective doesn't consider the externalities noted above; trade acceptance, capability and capacity, the likelihood of failure, and sequencing challenges.

In a pilot program with AeroBarrier performed in Canada, one large production builder who builds all ENERGY STAR ® homes (roughly 200 to 400 multi-family buildings per year) resulted in the following findings:

Time Study to Achieve 1.5 ACH@50

- Followed and tracked builder's crew responsible for airtightness across a 6-month study
- Tallied labor and materials used to achieve current results
    - 16 additional hours across 3 visits: @ $55 for $880
    - Caulking, Foam & Tape per house: $1050 for Townhomes
    - Site Super Time: Approximately 3 hours

The study authors have calculated an estimated savings of $800 - $1,200 using AeroBarrier compared to other methods.

In another pilot study, AeroBarrier was applied at final on three units after all conventional sealing was done, achieving an average 62% improvement compared with fiberglass, mineral wool, and spray foam applications. A comparable study across twelve units showed a similar 60% reduction in air leakage.

Part 4:

Summary

Undeniable Value

The value and importance of Unit Compartmentalization for builders, owners, occupants, and portfolio holders is clear. Truly, every stakeholder in the process benefits from getting this right. Though we don't think such a benefit exists, there should even be a potential insurance reduction in occupant health and fire protection.

The challenges around properly executing Unit Compartmentalization are myriad but hardly impossible to overcome. Additionally, there exists at least one alternative to the conventional approach.

Transparency Disclosure

This paper has been produced with the data support of AeroBarrier, whose product is discussed as one of the available technologies for achieving proper Unit Compartmentalization. No funding was provided directly for this research. AeroBarrier is however, a partner of the Energy Professional Exchange (EPX).

This paper is authored by Steve Byers, CEO at EnergyLogic and Managing Director at EPX, with considerable assistance from EPX member Building Knowledge Canada and input from EPX member SK Collaborative.

EPX is a collaborative of leading energy rating and energy services companies and partner organizations. EPX serves clients across the US and Canada in all facets of residential and commercial construction.

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