Air Barrier Integration: Don’t Entangle Yourself in These Common Pitfalls

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Abstract

In many respects, the air barrier industry is still in its infancy, and there is a vital need for education of design professionals, contractors, installers, and building owners. Of particular concern is integration of air barrier systems into the building envelope in a way that windows, doors, curtainwalls, and other openings and penetrations are constructed to be airtight and/or weathertight. The speaker will review many of the common methods for proper detailing and installation of building envelope components. Emphasis will be placed on the Air Barrier Association of America’s (ABAA’s) programs to facilitate developing, designing, and constructing better buildings. Attendees will participate in a review of conventional, unique, and new detailing and installation methods that are both successful and practical, as well as some examples of details and installation methods that don’t work.

Speaker

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**AIR BARRIER INTEGRATION: DON’T ENTANGLE YOURSELF IN THESE COMMON PITFALLS**

We have heard for some time now about the benefits of air barriers and their contributions in improving airtightness of building envelopes. These benefits include lower energy costs; lower initial equipment investment; enhanced occupant comfort; reduction or elimination of unwanted condensation; the reduction of building envelope damage; mold and costly claims; reduced risk to engineers, architects, and builders; and a smaller environmental footprint. What perhaps appears to be a straightforward and simple concept—airtight construction—is not necessarily as simple and easy to implement as one might think as demonstrated by reports from the field.

One of the primary concepts of air barrier design as presented by the Air Barrier Association of America (ABAA) and others in the industry is the importance of air barrier continuity. What this means is not only specifying and installing the manufactured air barrier products in accordance with the manufacturer’s requirements, but also designing the tie-ins of those products with the other building components. Tie-ins of air barrier products (e.g., spray polyurethane foam, liquid-applied membrane, sheet-applied membrane, building wraps, board products) at system components such as windows, doors, roofing transitions, poured-in-place concrete curbs and slabs, and flashing details are of particular concern. ABAA not only lists all of the approved air barrier products on the market, it also recognizes the importance of these other building components and the associated tie-ins as part of the air barrier system.

It is important to note that from an air barrier perspective, the building envelope includes all sides of the building—i.e., exterior (and sometimes interior) walls, the lowest-level floor(s), and the roof (or sometimes the upper level or the highest floor-level ceiling).

ABAA defines an airtight assembly as one that, when laboratory tested in accordance with ASTM E2357, *Standard Test Method for Determining Air Leakage of Air Barrier Assemblies*, has a leak rate of no more than 0.04 cfm under a differential pressure of 1.57 psf. The tested assembly also must accommodate movement of building materials by providing expansion and control joints as required. Likewise, the U.S. Army Corps of Engineers (USACE) has adopted the same standard and, further, has developed its own on-site USACE test protocol for airtightness of completed entire buildings with a leak rate of no more than 0.25 cfm under a differential pressure of 1.57 psf when tested in accordance with ASTM E2178, *Standard Test Method for Air Permeance of Building Materials*. The ABAA standard applies only to a defined lab-tested wall assembly, whereas the USACE standard applies to the entire building, and therefore accounts for leaks that may occur in windows, doors, and other intentional openings.

ABAA and the air barrier products industry has developed specifications, and product manufacturers have developed details to assist designers and builders in integrating manufactured air barrier products into the building envelope in an effort to ensure airtightness and continuity. ABAA specifications list critical areas within the building envelope where attention is needed. These critical areas include:

- **Roof-to-wall transitions**
- **Door, window, curtainwall, and storefront openings**
- **Wall-to-foundation transitions**
- **Expansion joints**
- **Transitions between dissimilar envelope systems**
- **Transitions between dissimilar materials**

  - Plumbing, mechanical, electrical, and structural penetrations
  - Floors over unconditioned space
  - Canopies, overhangs, and exterior vestibules
  - Walls between conditioned and unconditioned spaces

Let’s look at each of these areas.

**ROOF-TO-WALL TRANSITIONS**

Roof-to-wall transitions are particularly important and often overlooked. One of the reasons this particular detail becomes a challenge is because not only is there a transition between an air barrier material that is specified on a wall to a membrane roofing system component (which also serves as an air barrier), but there are also different trades involved, and sequencing becomes important. For example, in Figure 1, we have a drawing detail where a low-slope single-ply roof transitions to a parapet...
and then an exterior wall with a fluid-applied air barrier system applied to gypsum sheathing. The designer must make a decision as to which component within the roofing system is also the air barrier component. It could be the single-ply membrane; it could be a vapor barrier associated with the roofing system, if a vapor barrier was provided.

In our opinion, in some cases, using the single-ply roofing membrane as the air barrier may be a good decision. Therefore, in this example, the detailing needs to be such that the single-ply roof membrane transitions to and preferably laps over—in a weather-lapped fashion—the wall air barrier system. Such a transition usually occurs by using a transition membrane where the two systems can lap over each other somewhere on the parapet wall—usually on the outside face of the wall with a roofing membrane that may be fastened to the wood blocking (Figure 2). In Figure 1, it can be seen that we do not have continuity of the air barrier or thermal barrier, creating opportunities for large air leaks to occur at the parapet wall. Designers also need to be cautious—particularly in cold climates—to consider the effects of potential condensation from occurring inside of parapets and should appropriately apply the proper design techniques for addressing the possibility of condensation occurring within cold parapet assemblies.

In another example, Figure 3, we have a fluid-applied air barrier system applied to the exterior wall assembly, canopy, and soffit extending all the way onto the roof deck, where it will ultimately be weather-lapped and sealed to self-adhered air barrier membrane, which is installed as part of a standing-seam metal roof.

Consider Figure 4 as an example of a wall-to-roof assembly where there is no air barrier in the roofing system. Such a scenario includes a sloped shingle or standing-seam metal roof installed over a weatherproof underlayment and where the building thermal insulation may be at the top-floor ceiling line in the floor of an attic. Such an assembly may include an air barrier that consists of gypsum board comprising either the finished top-
Figure 5 – An example of a storefront type window head condition where the air barrier system turns into the rough opening to accommodate transitioning at the sealant joint at the back of the window frame.

Figure 7 – A primary air seal created with sealant, transitioning the wall air barrier transition membrane to the window frame.

Figure 6 – An example of a robust design where a silicone sheet creates a weather and primary air seal, and a backer rod and sealant joint also create a secondary air seal.

floor ceiling, or part of a fire-rated assembly, all of which is installed below the attic.

Transition of the air barrier system from the wall to the ceiling can occur quite easily in this scenario, as long as careful detailing and coordination occur during design and construction. The exterior wall air barrier component can transition to the ceiling by lapping over the top plate of the wall construction, and sequencing to allow for its proper installation. Transition can occur to the gypsum board air barrier at the ceiling level via either a self-adhered membrane or several other methods. The designer should make every effort to ensure that the gypsum ceiling board and accessories, which are now air barrier components, are detailed continuously throughout the entire upper floor.

DOOR/WINDOW/CURTAINWALL/STOREFRONT OPENINGS

This is another particularly important area where we see either a lack of detailing, changes in products, or construction that do not align with the drawn details. There have been significant changes in the way buildings are thermally insulated, with more and more insulation moving outboard of the exterior sheathing line. This necessitates the need for window and door systems to move outward as well to better align the insulated glazing and thermal breaks with the plane of the insulation. In extreme cases, the entire window assembly is outboard of the exterior sheathing line. This makes for some challenging detailing and the need to properly support the window frame.

Take, for example, a typical storefront window head detail in Figure 5, where an air barrier product on the exterior sheathing may also serve as a weather barrier. It is important at times for the designer to consider the likely multiple functions of an air barrier product as the air barrier system transitions from one component to another. For example, for weathertightness, the air barrier component (which also serves as the weather barrier in this case) on the sheathing may transition to a through-wall flashing at a window head to allow for liquid...
water to be directed to the exterior. Such a transition does not provide an airtight assembly (cavity air can easily get behind the through-wall flashing at its ends). The wall air barrier product must transition into the opening and is commonly sealed to the window frame on the interior side. This transition to the inside of the rough opening is often done with a self-adhered transition membrane or a liquid flashing. The window sealant on the exterior side of the window assembly creates a primary weather seal, and the backer rod and sealant joint on the inside of the window assembly create the primary air seal. The air seal should be continuous around all four sides of the window frame. This critical sealant joint is one that we find is most often missing. Additionally, there is a third sealant joint—what we refer to as painters’ caulk—applied to the inside of the window system that is for cosmetic purposes. It does not provide an air

In the case of curtainwall systems (Figure 6), designers are more recently adopting a technique of bringing the air barrier system into the glazing pocket of the curtainwall. Such an approach does provide both a weather seal and an air seal at the same location, although caution should prevail. Most of the self-adhered transition membranes are not appropriate for installation into glazing systems. Such a scenario requires use of a specialty transition sheet such as those commonly manufactured from silicone, which can transition from the window assembly to either the face of the wall or to the face of the rough opening, where it is adhered to the air barrier.

Curtainwalls also can be made airtight in a similar fashion as noted above for storefront systems, where the air seal is provided either on the inside of the frame or—in some cases—the extrusions allow for the installation of a backer rod and sealant joint mid-frame. In Figure 6, a specialty silicone transition sheet attached in the glazing pocket, along with an interior air seal, are provided, which creates a robust belt-and-suspenders

Figure 8 – A view of the application of an SPF air barrier system where a self-adhered transition membrane is used to turn the air barrier system into the window rough openings.

Figure 9 – An example of the use of a self-adhered transition membrane to create continuity between the wall air barrier system (currently being installed) and the concrete foundation wall.

Figure 10 – An example of extending a foundation waterproofing to above grade and tying it into the air barrier system.
approach to design. Figure 8 depicts a spray polyurethane foam air barrier system transitioning into window openings with a self-adhered membrane.

When specifying, detailing, and installing nailing flange-type windows, very often industry or manufacturer standards require that the bottom flange remain unsealed to the building air barrier. This is typically done to allow drainage of water that may find its way into the window system to occur, but it is also an opportunity for air leakage to happen. Therefore, it is important that the entire perimeter of the window frame be sealed from the interior to prevent air leakage or even wind-driven water entry from occurring.

WALL-TO-Foundation TRANSITIONS

This transition can be one of the easiest to implement, although also one of the easiest to damage. This is due primarily to the fact that the air barrier products are installed early on in construction, and the foundation portion of the project is often left open until exterior cladding components are completed, allowing significant opportunities for physical damage to occur. If the foundation wall is poured-in-place concrete (poured-in-place concrete is an air barrier), then transitioning to a concrete foundation can be straightforward—simply by adhering or mechanically fastening the system to the wall.

Figure 9 depicts an ongoing installation of an air barrier where it transitions to the foundation wall at the bottom of the sheathing with a self-adhered membrane. If the design calls for a waterproofing system on the exterior foundation walls, then our preference is that the foundation waterproofing system extends all the way up to the top of the first floor through-wall flashing system. Then the air barrier system is lapped over the flashing, creating an airtight and weather-tight assembly (Figure 10). The foundation waterproofing membrane—either fluid- or sheet-applied—provides the continuity to the foundation wall. This approach provides a robust solution but requires particular attention to detail and proper coordination. Very often, the foundation waterproofing subcontractor is long gone by the time the exterior walls are erected, preventing extending the system up to the top of the first floor through-wall flashing.

EXPANSION JOINTS

Expansion joints allow for different portions of the building or its components to move independently of each other while still providing a weather-tight assembly. Typically, when we speak of expansion joints, we think of the joints that are exposed on the exterior cladding of the building. The same concepts apply to the “hidden” expansion joints, which occur behind those that will remain exposed in the finished assembly. These are the expansion joints that occur in the air barrier system. These may be very simple, such as the use of a self-adhered transition membrane, or two pieces of transition membrane adhered back to back and installed with a radius to allow for movement between two adjacent building components that have an air barrier applied to them.

Often overlooked are horizontal expansion joints that occur at every floor level in gypsum board construction. Typically, designers specify slip tracks at the top of infill light-gauge metal frame walls that allow for differential floor-to-floor movement. Such a detail requires the installation of a horizontal expansion joint at the slip track to allow this movement to occur without deflecting or damaging the gypsum sheathing. This joint is often quickly installed following installation of the gypsum sheathing by the use of a router. The air barrier can transition across this expansion joint easily with the use of a transition membrane. Figure 11 depicts an expansion joint in gypsum board sheathing created with transition membrane and integrated into the air barrier.

TRANSITIONS BETWEEN DISSIMILAR MATERIALS

Continuity of the air barrier includes maintaining continuity across dissimilar materials when they occur. This could mean transitioning from a gypsum sheathing installed on an exterior wall to an adjacent concrete masonry unit (CMU) backup wall at a stair tower or transitioning from CMU to a structural steel beam or relief angle. When such transitions occur, particularly with spray polyurethane foam and liquid-applied air barrier systems, the use of a transition assembly is often required. This typically includes a self-adhered membrane or a fabric-reinforced, liquid-applied flashing. Figure 12 depicts the use of transition membrane to provide continuity between gypsum sheathing and structural steel elements.
PLUMBING, MECHANICAL, ELECTRICAL, AND STRUCTURAL PENETRATIONS

We will find that many of the air barrier product manufacturers have developed details for transitioning to the various utilities that penetrate the building air barriers. Likewise, the same can be said for roofing manufacturers. One key element here is the importance of coordination of this work during the construction process. Most often, the air barrier materials are installed very early on in the project’s schedule, and there is a high likelihood that many utility penetrations will get installed after the initial installation of the air barrier materials. This can be problematic—particularly if cladding has already been applied and access to air barrier materials is no longer possible or practical. To the extent possible, the contractor and the subcontractors must coordinate their efforts to ensure that penetrations that occur through covered air barrier components are detailed with effective transitions early in the construction process.

Also, careful consideration should be given to certain types of utility penetrations where air leaks can bypass the air barrier system through pipes, conduits, and chases. For example, electrical conduits that exit a building—either through a wall or underground and extend out to other locations on the site such as site lighting or exterior receptacles, transformers, etc.—can also provide a conduit for air leakage. For a small number of buildings, the amount of air leakage can be significant, and consideration should be given to addressing it. This may require sealing the interior of conduits where interior conduits, pipes, and chases are sealed to prevent air leakage. Figure 13 shows the use of transition membrane to detail around a roof drainpipe prior to the application of liquid-applied air barrier products.

Floors Over Unconditioned Space

This can be one of those issues that is often bypassed or forgotten. However, examples include cantilevered floors that extend past a lower level, or floors over crawl spaces that are ventilated to the exterior. Such assemblies should also be constructed air-tight. Floor systems constructed of concrete have an advantage because the concrete itself can act as the air barrier as long as penetrations and perimeter conditions are sealed to an air barrier component. Other floor systems, such as plywood or wood sheathing, require either special attention to the joints or the application of an air barrier in the assembly below. As always, it must transition to the exterior walls to create continuity.

Canopies, Overhangs, and Exterior Vestibules

These building elements are very often overlooked as a large source of air leaks through the building envelope. During the design process, the designer should make a determination as to whether or not the canopy, overhang, or vestibule is included as part of the building envelope. Appropriate detailing should be employed to either include all of the canopy or overhang components within in the building envelope or to allow the building envelope line to bypass them, separating them from the rest of the building with an air barrier.

One particularly overlooked condition is that of an overhang where a metal roof deck assembly cantilevers or spans over an exterior wall, creating a large overhang of several feet or more. This condition can also occur at canopies. Fluted metal decks become an area that warrants particular attention because each of the metal deck flutes—both upper and lower—create a small duct capable of transferring large volumes of air.

Figure 12 – The use of a self-adhered transition membrane to create continuity between the gypsum board system and adjacent structural steel system.

Figure 13 – A well-executed roof pipe drain penetration detail prior to the application of a fluid-applied air barrier product.
decks, one detail that can work well but requires a high level of coordination is to transition the air barrier through the metal deck using spray foam plugs and self-adhered transition membrane. This technique can be useful when transitioning through a very large overhang where it does not make sense to extend the air barrier around the overhang or when working with interior partitions that also are air barrier assemblies. Figure 14 depicts the use of an SPF plug and metal strap as part of an installation to allow an air barrier membrane to penetrate through the insulation and tie into the metal strap on both the upper and lower portions of the deck. This allows the metal deck to cantilever past the building line outside of the building envelope. Figure 15 depicts metal roof deck spanning over a loading dock. Similar techniques can be used to seal the upper and lower flutes in the metal deck to create continuity in the air barrier system.

Very often, canopies and overhangs include ventilated soffit components to address cavity or attic ventilation. The designer needs to be aware of this so that these vents do not allow a clear path to the interior of the building through the canopy or overhang. Figure 16 shows a canopy that is best left outside of the envelope—therefore requiring disciplined detail work to ensure that all of the penetrations are sealed and the air barrier remains continuous.

WALLS BETWEEN CONDITIONED AND UNCONDITIONED SPACES

In a number of building types, the building may be separated into spaces with entirely different environmental conditions that warrant separation—either from an air-tight perspective, a vapor-tight perspective, or both. Examples of this include hospital operating rooms, natatoriums, museums, and various manufacturing facilities. When design requirements include significant variations in the building’s interior environments, an air barrier is required. If properly detailed, gypsum and other board products can be very effective in this scenario where there are no weather barrier requirements. An example would be an office warehouse where the office component is air conditioned and heated and the warehouse is not.

Integration of the air barrier system starts with good design and good detailing and requires clear communication during construction and attention by the contractor and subcontractors. By following a number of the examples provided above, our industry can develop and build better buildings.