

On Contemplating Humans and Barriers

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1 Introduction

Three of the top reasons for building failure are water (delivered in bulk between materials), water (moved by diffusion or capillary action through materials) and water (carried by air around materials). For these reasons, the installation of comprehensive, durable, and effective air barriers (AB) and water-resistive barriers (WRB) is essential in modern construction, be it standard code-built or high-performance and Passive House structures. We need our materials to perform and we need the installers to succeed in getting them on the buildings in a comprehensive, durable, and effective manner, all the while maintaining project schedules and budgets. If we do not integrate the appropriate materials with fastidious detailing by the installers, we will see failures.

Among construction materials categories, AB and WRB selections have seen terrific development in the past decade in what is offered. Selection and training require diligence and continuous updating, particularly when engaging a new type of material or a new installer. Through analyzing the constraints a building will see through the predicted life of the AB and WRB, one can effectively choose from myriad options if, and only if, those products are installed as-designed. We must all understand that any product installed incorrectly is subject to potential failure—and products don't install themselves: there's always a fallible human in the middle.

2 The Nine Contemplations of Successful Installed Barriers

Viewed systematically, we can approach this situation with an understanding of human and product limitations and still succeed in the critical tasks.

Implementing the following nine fundamentals can facilitate successful installations:

1. Product selection
2. Product confirmation prior to installation
3. Substrate and installation conditions
4. Tools materials and access
5. Training
6. Quality control (QC) review during work
7. Protection during construction
8. QC review prior to cover
9. Preparation for unforeseen circumstances

2.1 Product Selection

For cost-effective implementation of these critical performers in our buildings, the author turns to many types of products separated into the following categories:

- Sealants
- Structural sheet goods
- Tapes
- Membranes
 - › Mechanically fastened
 - › Self-adhering
 - › Fluid-applied

For success, you need to know your product—and not just how to get it on buildings, but also how to treat it before its implementation and after project completion. These concerns include but are not limited to:

- Adhesion capacities both short and long-term
- UV exposure limitations
- Moisture transfer characteristics
- Compatibility with the other building products
- Installation constraints
- Manufacturing and distribution limitations
- Skill level and knowledge requirements of the installers

There are numerous resources available in getting to know a product. The author divides these into two categories:

- Desk research is dependent on many subjective limitations, from the priorities of the source to the parameters of the testing as well as the conditions of the installation. Some main sources of desk research are:
 - › Reviewing documentation provided by the manufacturer.
 - › Technical support from the manufacturer or distributor.
 - › Manufacturer’s associations (such as the ABAA or NABA)
 - › Colleagues, articles, and historical experience from previous installations
- Field research is invaluable and should be approached with enough lead time for resolving follow-up questions or concerns. On unfamiliar installations or new products, this should include:
 - › Having the product in hand.
 - › Constructing mock-ups.
 - › Performing adhesion evaluations.
 - › Air and water testing on a fully detailed installation.

2.2 Product Confirmation

The potential for receiving the incorrect product is significant. There are many humans involved in getting a product from the manufacturer into the hands of the installer, with numerous possible moments when a product could be mishandled or substituted with another. Best practices to minimize or altogether avoid such errors include:

- Confirming that the correct product as specified is the one ready for installation. Many manufacturers have multiple products that can be utilized in similar circumstances, though they can have drastically differing characteristics.

- Confirming that the product will be used prior to any expiration date. Many products are delivered and then not installed for weeks or even months. This concern is particularly important with materials that require a bond based on a chemical reaction. This chemical reaction can occur between the material and the substrate or within the material itself.
- Confirming that the product you have on-hand is what was specified in stage 1. If it is not, do not move ahead without confirmation that it is a suitable substitute. If it is not a suitable substitute, go back to stage 1 and re-specify with an appropriate product.

2.3 Substrate and Installation Conditions

Ensure the substrate is correct and prepared for installation of the specific material. There is a terrific variety of constraints for site conditions under which various ABs and WRBs can be applied. This is a strength for our work but can have detrimental consequences; construction teams may need to substitute materials based specifically on this constraint (go back to stage 1). The conditions to assess are:

- Structure
 - › Dimensional stability and integrity
 - › Predicted movement after installation from sources such as swelling, deflection, cracking, checking or expansion/contraction
- Temperature and weather
 - › During installation
 - › While exposed during construction
 - › If the building will see unconditioned exposure outside of the product's parameters after installation but prior to building conditioning
- Moisture in substrates. These can affect bonding but can also potentially get trapped, leading to damages to the WRB, AB, or even the structure.
- Contamination of the substrate with dirt or construction debris, which could affect bonding

2.4 Tools, Materials, and Appropriate Access for Proper Installation

Every material has specific needs for installation equipment. With preparation, the installations can be smooth and successful. Without preparation, teams are frequently wasting labor, materials, and project schedules. Certain materials are subject to damage or poor installation without the intended means and methods, such as tapes—which may need rollers or specialty squeegees; membranes may require specific fasteners and tools. Sealants and fluid-applied materials can tenaciously adhere to all the wrong locations.

Historically, this phase of building enclosure construction has been tackled with basic tooling and materials. Though there are few products that require costly tooling (predominantly limited to spray applications), we have moved on from just needing a stapler, a utility knife, and an extension ladder.

2.5 Installer Training

Review the available resources prior to installing any product. In some cases, one individual will be performing the majority of the 9 fundamentals; however, in many cases the division of labor can lead to missing critical junctures and should be systematically addressed. Historically the author has commonly

witnessed gaps in training among those specifically tasked with installing the materials. Clearly defining responsibilities between crew members can lead to success despite complicated sequencing and detailing.

One such structure is as follows:

1. **Superintendent:** Fully trained in the installation, knows how to perform the work, inspects the finished product and any likely complications that could arise. Also has contacts for further technical support, if it is needed.
2. **Site Lead:** Trained by the Superintendent if not by others and is in charge of the actual installation.
3. **Installers:** Complete the majority of the work at hand under supervision by the Site Lead. These individuals may change regularly, so complete training may not be desired.

2.6 QC Review During Work

A trained individual should conduct the inspection at the installation. This would ideally be a person who has performed this task on numerous projects. Many manufacturers will assist in this review because they want their products used appropriately.

This review should be scheduled for after a small portion of the work is performed and then repeated as the work progresses, especially if installation conditions change. Some common changes include alternate personnel, weather, substrate and accessibility, or sequencing.

Note that the most difficult locations to inspect are also likely to be the most difficult in which to achieve a comprehensive installation. Starting with these difficult locations can quickly reveal likely deficiencies in the work. Additionally, areas predicted to see the highest levels of impact and exposure require fastidious work. Ensure such locations receive due review.

2.7 Protection of Installed WRBs and Abs During Construction

Many details require the installation of ABs and WRBs before they are protected by subsequent work/layers. Damages can come from exposure to natural causes such as weather, UV radiation, and structural movement. But WRBs and ABs can be easily altered by humans who are not aware or concerned with their integrity.

It is common to see damage in particularly complicated locations where it is difficult to notice and/or repair, such as at wall-to-roof, slab-to-foundation, foundation-to-wall, or window and door installations. Ideally, the products will be selected to resist such effects, but additional precautions may be warranted, including temporary covers, signage, or warnings. If possible, phasing this work to occur shortly before the final covering is installed will limit damage and needed repair.

2.8 Quality Control (QC) Review Prior to Covering

For a thorough, comprehensive project, even more critical than fundamental #2.6, is a quality control review just prior to covering. This can reveal damage to installed materials or poor work that was not evident upon initial review. Those responsible for this review need to have an up-to-date understanding of the project detailing and schedule as a whole, in addition to a thorough knowledge of the AB and WRB; otherwise elements can become inaccessible for review or repair.

Integral to this phase is having the resources at-hand (materials and labor) to implement fixes. Commonly, this review takes place shortly before covering. In such cases, these repairs must be accomplished without delay.

2.9 Being Ready for Unforeseen Circumstances

As ABs and WRBs are main controllers to potential building damage (water, water, water), if one waits to find problems with installations until the problems are obvious, effects to the building can be devastating. A trained and experienced crew should always be ready to be presented with developments they have neither seen before nor learned about, whether while using time-tested and known materials or when first implementing a new product.

A team which is ready for surprises will not be shocked when they arise and is more likely to detect complications when they are less evident than those who are only concerned with a narrowly viewed task. Contemplation of unfamiliar results during construction can carry untold benefits.

3 Conclusion

Those who venture into less-charted waters will see new rewards but also new challenges. The Passive House community has been a leader in adapting, adopting, and inventing new details as well as new applications for existing materials. As we demand more performance and durability from our building enclosures and less capacity from our mechanical systems, we are demanding unprecedented performance from Air barriers and water-resistive barriers. For this we are utilizing a wide array of materials, some are old but many are newer.

With this adventurous spirit comes new challenges, and we will continue to experience unforeseen complications. With thorough planning, training and review, these challenges will be learning experiences rather than building failures.