

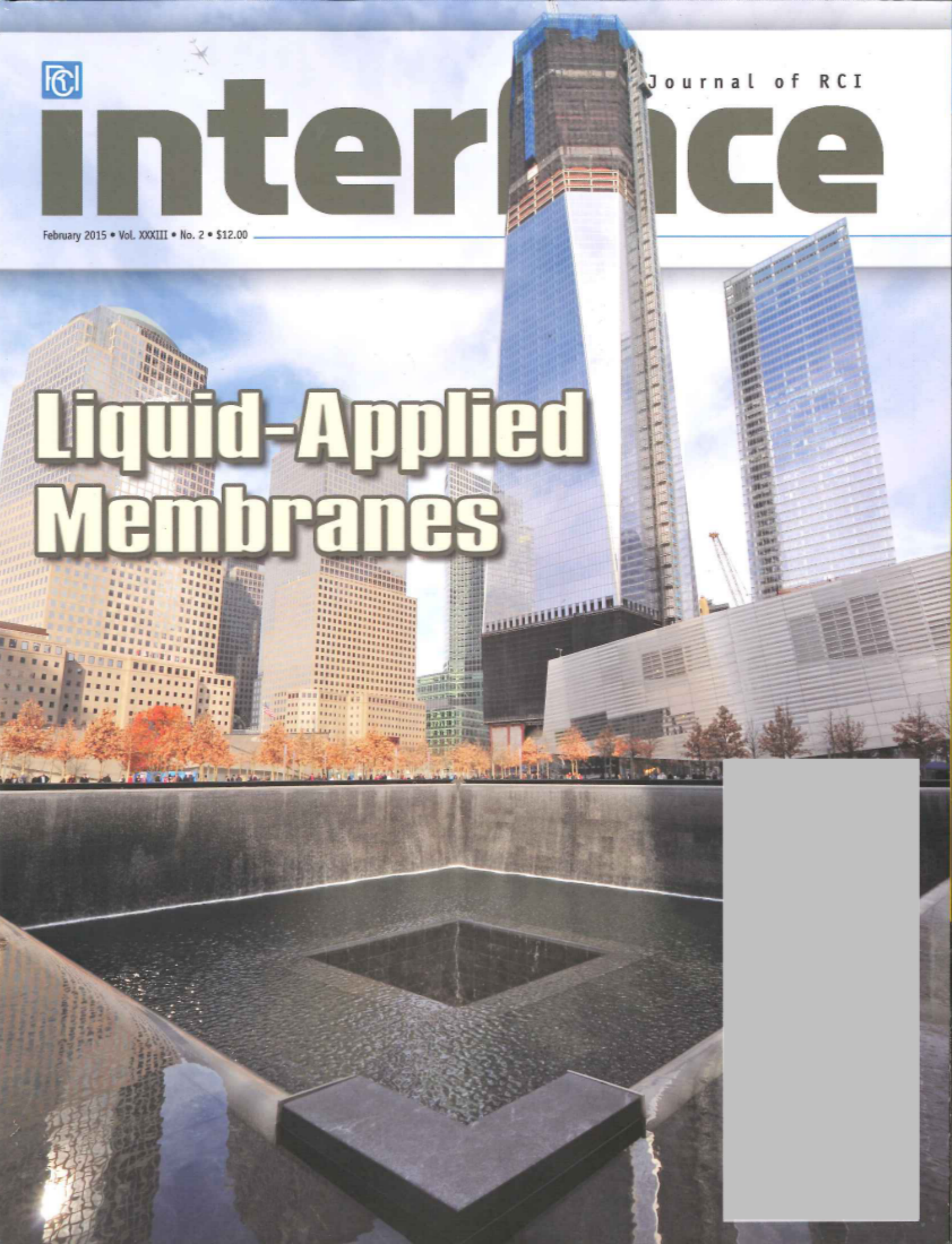


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Liquid-Applied Membranes





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As a building envelope consultant, it pains me to visit a project only to see the water-resistive barrier (WRB) whipping in the breeze and self-adhesive flashings (SAFs) coming apart at the seams. I think, “That might become a leak issue, and there’s got to be a better way.” For some time, clever contractors, in an effort to prevent vulnerable wall construction from becoming water infiltration problems, resorted to using a variety of foundation or roof coatings that were not particularly sanctioned or purpose-

tested for exterior walls. Then, about 20 years ago, a few manufacturers began offering liquid-applied materials specifically designed as WRBs, air barriers, and flashings.

When I talk with architects and builders, few have heard of fluid-applied wall barriers, and those who have only know of one or two. Today, there are two-dozen manufacturers that offer spe-

cialized fluid-applied water barriers and air barriers (see *Photos 1 and 2*); some products double as robust flashings, while others are dedicated flashings designed for horizontal features and challenging odd penetrations (see *Photo 3*). A typical layup consists of a solid substrate, a liquid-applied barrier,



Photo 2 – Fluid-applied WRB, air barrier, and flashings applied to residential project.

Photo 1 – Fluid-applied WRB and air barrier applied to commercial project.



Photo 3 – Fluid-applied WRB and flashings applied to an irregular penetration.

and a drainage plane. The balance of the exterior wall assembly may include continuous insulation, a slip sheet (especially for cement plaster), and/or cladding.

FLUID-APPLIED WRB ADVANTAGES OVER SHEET MATERIALS

Fluid-applied WRB, air barrier, and “paint-on flashing” chemistries have matured and are here to stay. These rugged coatings offer and provide a number of advantages over their sheet barrier cousins (building paper, house wraps, and self-adhesive peel-and-stick membranes):

1. **Stay put.** Fluid- (or liquid-) applied water-resistant barriers, air barriers, and flashings remain as applied, providing primerless adhesion to most sheathings and construction substrates, including wood or gypsum sheathing, CMU, metal, vinyl, or combinations.
2. **Long exposures.** They are resistant to wind, sun, and the elements from three months to a year and longer before the permanent cladding must be installed.
3. **Tested.** These fluid-applied materials far exceed code requirements and minimum test standards.¹ As a result, long service is anticipated.
4. **Monolithic, multi-directional, and self-terminating.** Tie-ins are readily accommodated; thus, trade sequencing conflicts are reduced. The need for skillful sheet cutting, fitting, and complicated “origami” installations is eliminated. In particular, recessed windows and odd penetrations are easily and seamlessly flashed with liquids.
5. **Chemistries.** They are well vetted and have mature formulations (see “Chemistries” section).
6. **Easy application.** There is a fast learning curve. Fluid-applied WRBs, air barriers, and flashings may be sprayed, brushed, rolled, or troweled (see Photos 4-7).
7. **Inspection and touch-ups.** These fluid-applied materials are easily inspected, touched-up, or repaired, as necessary.



Photo 4 – Fluid-applied WRB being sprayed.
Photo courtesy of Dow Corning.



Photo 5 – Fluid-applied WRBs and flashings may be brushed.



Photo 6 – Fluid-applied WRB being rolled. Photo courtesy of Prosoco.

- 8. **No build-up.** No more rough openings crowded with self-adhesive flashing overlaps.
- 9. **Air barriers.** I-Codes, which have been adopted in many states, require air barriers.² Air barriers must be continuous. Air changes per hour (ACH) are quantified using blower door testing. Inspecting a sheet-applied air barrier for air leaks can be challenging. Fluid-applied air barriers are either there or they are

not. Where fluid is applied, an air barrier is assured.

- 10. **No fasteners.** While all wall barriers are peppered with cladding fasteners, fluid-applied barriers (as compared with sheet barriers) lack the typical thousands of staple penetrations, thereby reducing the risk of leaks.
- 11. **Cost.** Material cost is comparable per square foot to SAF, making liquid flashing applications cost-effective. Bulk wall areas may be



Photo 7 - Silyl-terminated polymer (STP) flashing being troweled.



*Photo 8 - Fluid-applied WRB and flashing at pipe penetration and brick ties in process.
Photo courtesy of STO Corp.*

less cost-effective, but are desirable for all the above reasons. The result is more value on the wall, with less cost in labor. Fluid-applied weather barriers and air barriers pay dividends in reduced life cycle maintenance and repair expenses.

Water-resistive barriers—whether sheet or fluid-applied—are typically designed to resist and drain incidental moisture. Through error or lack of maintenance, water that gets behind the cladding can challenge the WRB. Several chemical formulas are used for fluid-applied wall barriers and to seal wall penetrations such as service pipes and brick ties (see *Photo 8*). Some are designed for the more challenging flashing applications, such as recessed windowsills, sill pans, other narrow horizontal conditions, and odd penetrations. A few formulas are available for open-joint rain screen systems. While fluid-applied materials are robust, they are considered dampproofing materials. Fasteners should not penetrate horizontal surfaces, and fluid-applied flashings should not be used on horizontal surfaces over a foot wide or where bona fide waterproofing materials should be used. Where hydrostatic pressure is anticipated, impermeable waterproof membranes should be used.

CHEMISTRIES

The available fluid-applied wall barrier and flashing chemistries vary somewhat, but can generally be categorized as bituminous, acrylic, silicone, or silyl-terminated polymer (STP).

Bituminous

Bituminous coatings (rubberized asphalts) were among the first wave of fluid-applied weather and air barriers about 20 years ago. Typical applications are thick—up to 100 mils or more. Rubberized asphalts have been associated with some problems: cracking, wrinkling, blistering, and melting. Moreover, asphalt-based membranes tend to fail National Fire Protection Association (NFPA) 285 flammability testing.³ While rubberized asphalts may be used in low-rise and residential construction, manufacturers are typically recommending their other chemistries. As a result, our applications or evaluations herein do not include rubberized asphalts.

Acrylics

Acrylics (including latex formulas) have been used as roof coatings since the 1960s, as elastomeric wall coatings for several decades, and since about the year 2000 for fluid-applied weather barriers and air barriers. Typical application is between 40 and 60 wet mils, generally considered a

medium-thickness coating; at 50% solids, the yield is 20-30 dry mils. Acrylics should be applied under favorable drying conditions. Some acrylics that lack viscosity or elasticity require reinforcing fabric to bridge seams and joints. Acrylics are sprayed, rolled, or brushed. Spraying is often accomplished in one coat, while hand applications require two or more coats in order to achieve the required mils. Because some acrylic formulas may pinhole or crack, multiple coats provide much-valued redundancy. Of the couple of dozen liquid-applied acrylic weather barriers and air barriers available, about half may also serve for more challenging horizontal flashing conditions.

STPs

STPs are available in two versions: polyethers (STPEs) and polyurethanes (STPUs). STPs were developed in the 1980s and have enjoyed a great reputation in use as construction sealants since 1999. STPs have been offered as liquid-applied wall barriers and window flashings since 2006. Several manufacturers offer STPEs and STPU systems. Almost 100% solids, they are applied 12 to 25 mils and are considered thin coatings. Wall coatings may be sprayed or rolled, but their flashing siblings are generally caulked and troweled. They dry to the touch in about two hours and may be applied to damp surfaces. STPs are moisture-cured, so applications in cold and/or low-humidity conditions benefit from a misting.

Silicones

Ninety-percent solids, silicones are sprayed in one coat (about 20 mils) or rolled in two coats. Silicone coatings have been used for more than 20 years as exposed barrier systems, so long exposures are possible. Apply them to dry surfaces only. Silicones are fire-resistant. Almost nothing adheres to silicone (except silicone); for example, a large wall area may represent a bit of a challenge when marking fastener locations.

There are few disadvantages regarding fluid-applied barriers and flashings. Fluid-applied materials must be applied to properly prepared substrates and in acceptable weather. Conversely, some sheet barriers can span wide gaps (even open studs) and can be installed in less-favorable weather. It's possible that fluid-applied materials may be overkill for some applications. However, if it's worth building, it's worth building well.



Photos 9 and 10 – The problem child: the typical recessed window. Water intrusion damage from improperly applied or sealed SAF in a typical recessed window flashing installation.



THICKNESS MATTERS

The thicknesses of sheet materials are factory-controlled, so their performance characteristics (barring improper installation) are known. Fluid-applied materials' in-service performance is, to some extent, applicator-dependent. Fortunately, these robust materials are forgiving. As a practical matter, liquid-

applied barriers and flashings applied within 10% of the manufacturer's recommended thickness provide their prescribed performance. They must be applied void-free (without holidays).

Some are applied as thin as 10 mils and others as thick as 120 mils. For a perspective: A typical coat of paint applied at 4 mils dries to 2 mils thick, while a gallon will cover 400 sq. ft. or 12 sheets of plywood. A 10-mil coating will cover five sheets of plywood per gallon, whereas an application of 120 mils will

cover less than one-half sheet of plywood per gallon. Most of the fluid-applied WRB and flashing materials are applied to produce a 20-mil coating; that seems to be the "sweet spot." However, always apply at the rate the manufacturer requires.



Photo 11 – A fluid-applied flashing application to recessed window opening. Step 1: Fasten sheet WRB.



Photo 12 – Recessed window flashing. Step 2: Apply liquid flashing to fabric tie-in transition.



Photo 13 – Recessed window flashing. Step 3: Apply liquid flashing to opening and spread smooth.

WATER VAPOR PERMEANCE

Most fluid-applied WRBs, air barriers, and flashings are designed as substitutes for building paper or house wraps; therefore, they are similarly vapor-permeable—between 10 and 30 perms to aid in outward drying. And while permeance provides only a tiny fraction of drying compared with that provided by ventilation, wall cavities aren't generally ventilated, so the permeance of wall assembly materials is an important strategy. With that said, the various climate zones, HVAC, and wall construction types dictate whether vapor-permeable or impermeable WRBs are appropriate.⁴ Impermeable fluid-applied barriers and flashings are available.



Photo 14 – STP application, best practice. Step 1: Seal joints and seams. Use putty knife to create screed.

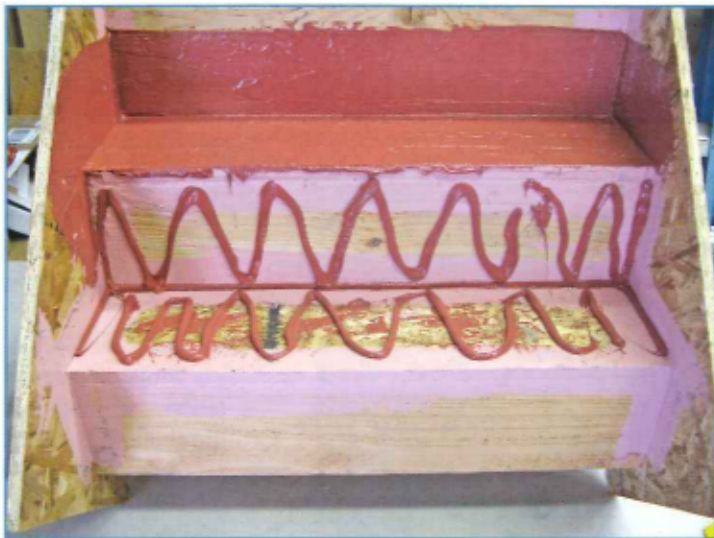


Photo 15 – Step 2: Application of full coat—typically with 4-in. plastic putty knife.

LIQUID-APPLIED FLASHINGS

Recessed window openings in particular present application challenges with SAF, which can require a 20-plus-piece installation origami. One improper lap or seal can (and often does) result in water infiltration damage (see Photos 9 and 10).

Some fluid-applied WRB and air barrier formulas perform double duty as flashings, while others are dedicated flashing formulas. They cure into robust monolithic flashings.⁵ Typical recessed window application is straightforward and can accommodate either fluid-applied WRB or sheet WRB (as shown in Photos 11-13).

A search was conducted, and 20 manufacturers were identified that offer liquid-applied flashings. Fifteen of them offer

single-component systems. The five other systems require two waterproofing components, such as liquid flashing applied over SAF. Our objective was to evaluate the simplest applications; so, while the five other systems may be valid or perhaps superior, they were not evaluated. Stair-step mock-ups that simulate recessed window applications were prepared on which the various fluid flashing systems were applied in order to evaluate the application characteristics and to conduct in-house testing.

Typical Liquid-Applied Flashing Applications

STPs have dedicated caulk-and-trowel formulas. While some manufacturers allow a single application as shown in Photos 11-13, best practice is:



Photo 16 – Some acrylics require fabric reinforcing. Pre-cut fabric is shown.

Photo 17 – Lay fabric into a coat of acrylic, typically working from bottom up. Smooth with overcoat.



Photo 18 – Full coats may be glopped and rolled to achieve mil thickness.



in one coat; however, complex shapes such as recessed windows obtain more uniform coverage with a two-coat hand application.

APPLICATION CHARACTERISTICS

While in-service performance characteristics of fluid-applied materials such as durability, water resistance, permeance, exposure, and sealability are the goals, a difficult application won't endear a specified material to the installer. Any one-off installation may be fine, but the time and effort consumed applying liquid flashings to dozens or hundreds of installations can vary widely, both due to the application method (spray, trowel, roll, or brush) or due to the formulation—in particular, the rheology. The rheological formulation governs the viscosity, sag, stickiness, and number of coats necessary; the ability to touch up and to cover voids; the need for reinforcing; and, ultimately, the ease of the application and the skill set needed to apply. One supposes the rheological properties of these products are by design, but some product application characteristics are dubious. Large projects will likely benefit from the easier, speedier candidates.

After applying two-dozen liquid barrier products, including the 15 fluid-applied flashings to mock-ups, the following application comments were among those reported to the manufacturers:

- Apply STP prestripping to joints and seams and to the inside and outside corners to create a thin shoulder or screed.
- Allow to dry to the touch (typically two hours), or accelerate with a misting of water.
- Apply a single coat of STP flashing over all. The screed enables a thin, uniform application. (see Photos 14 and 15). Skill level required: good.

Acrylic formulations, thicknesses, and applications vary widely. Sealant is used to fill narrow joints and seams, and/or a

reinforcing fabric is laid into a full coat of liquid flashing to bridge joints and seams (see Photos 16-18), typically in sequence from bottom up. Fluid-applied barriers do not require the field of the sheathing to be fabric-reinforced. Allowing for drying, two full coats are typically applied with a 3/4-in. nap roller. Skill level required: fair for unreinforced, and good for reinforced.

Silicone sealant is used to fill joints and seams, followed by two rolled or brushed coats of liquid flashing. Skill level required: fair.

Acrylics and silicones may be sprayed



Photo 19 – In-house seven-day flood testing of fluid-applied flashings.

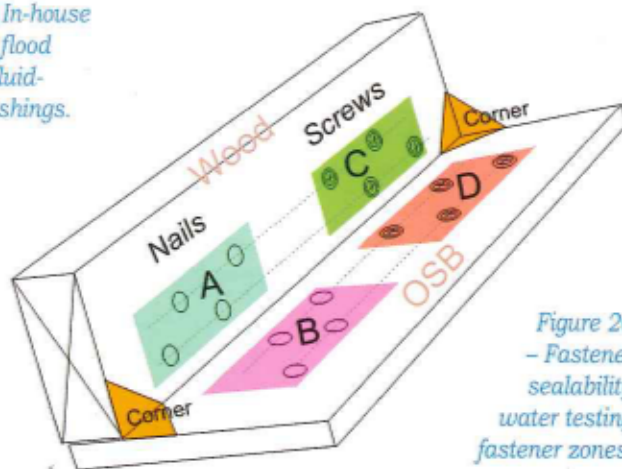


Figure 20 – Fastener sealability water testing fastener zones.

- Easy application—like spreading mayonnaise
- Difficult to achieve an even application
- Application leaves holidays
- Thin coats add labor
- Takes too long to dry
- Skins too quickly to touch-up
- Remains sticky, attracts debris
- Runny; sags on vertical surfaces
- Laborious, difficult application
- Lacks (fabric) adhesion to outside corners
- Like applying mastic
- Better wear gloves; cannot be removed from skin



Photo 21 – Fastener sealability testing of liquid-applied flashing mock-ups in progress.

Applications range from thin to thick, dry to runny, smooth to coarse, and slick to sticky.

IN-HOUSE TESTING

Flood testing and fastener sealability testing were conducted on the liquid flashing mock-ups (see Photos 19-21)—a practical application of ICC-ES AC 148.⁶

1. Flood test: One gallon of water was poured into each “trough” (3 in. deep) and left to challenge the flashings for seven days. The mock-up troughs are made with 2x fir and ½-in. oriented strand board (OSB). Results: None of the 15 mock-ups leaked.
2. Referring to the illustration (Figure

20), eight roofing nails and eight (pointed) screws were fastened in the troughs and flood-tested again—this time for 24 hours. Results: Two of the flashings leaked at the roofing nails (Zone B), and 11 of the 15 mock-ups leaked at the screws (Zone D). Interestingly, only fasteners through the OSB leaked, and none of the leaks dripped from the exposed fastener tips; all soaked through the OSB “grains” and dripped from the end cuts. Although screw sealability is not a standard test requirement, screw fasteners frequently penetrate WRBs.

3. Adhesion and compatibility testing: While the various liquid flashings were applied to a number of common substrates and adhesive materials and vice versa without apparent unfavorable or unexpected results, chemical compatibility testing is beyond the scope of our evaluation and is essentially a moving target since material formulations may change without notice. Refer to



Photo 22 – Tie-in to sheet WRBs and flashings made easy.

manufacturers' current installation instructions and recommendations.

4. Tie-ins: Manufacturers report that fluid-applied flashings are often used in tandem with sheet WRBs. Tie-ins can be accomplished as easily as setting the leading edge of WRB into a bead of sealant and over-coating with liquid flashing. Fiber mesh tape can serve as a bridging material (see Photo 22). Some manufacturers require the use of specific materials. It should be noted that while fluid-applied coatings adhere to most materials, most adhesive materials adhere well to acrylics, not well to STPs, and not at all to silicone.
5. Assurance water testing should be conducted when the WRB and flashings are complete and before the cladding is installed (see Photo 23).

FINDINGS

- Since STP WRBs and flashings are typically several times the cost of acrylics per unit, some manufacturers tout considerably thinner applications than others, even though the formulations may be similar.
- In general, the thinner flashings leaked (at the fasteners) more than the thicker applications.
- The less-viscous acrylics tend to require reinforcing fabric. One that did not require fabric cracked along a joint.
- One product did not have enough

initial tack to keep the outside corner of reinforcing fabric in intimate contact with the substrate.

- There does not appear to be an obvious water-resistance advantage that favors one chemistry or system over another.
- Fluid-applied barriers and flashings offer some superior qualities. Nail sealability is good simply because the fastener remains in intimate contact with the elastic material.



Photo 23 – On-site water testing of fluid-applied WRB and flashings.

Screw sealability is fair (but good for its intended purpose). However, these materials are not “self-sealing” or “self-healing”—they do not contain cold-flow properties. If a nail is removed, the hole will remain.

FLAMMABILITY

Structure fires and water intrusion each account for billions of dollars of damage annually. However, fires kill and injure thousands, while leaks don't.

For the past 20 years, NFPA 285 flammability testing was applied to plastic exterior insulation systems such as EIFS and continuous insulation. This is an elaborate, dramatic, and expensive two-story lab test. The 2012 IBC requires NFPA 285 testing be applied to wall assemblies over 40 ft. As noted earlier, rubberized asphalts within assemblies typically don't pass, while the other chemistries do generally pass. The 2015 IBC 1403.5 exempts fenestration flashing materials from NFPA 285 testing and provides WRBs with certain exceptions.

In order to gain a practical sense regarding the flammability issue, simple burn-testing of the 15 liquid-flashing materials was conducted. The flashing samples were lit with a candle. All of the STPs went up in flames. The silicone sample could not be lit with a candle, BBQ lighter, or a soldering torch. Five of the seven acrylics readily lit and burned, while two lit with persistence,

foamed a bit, and then self-extinguished, exhibiting intumescent qualities.

At present, there are at least three fluid-applied flashings and three fluid-applied WRB/air barriers available that manufacturers describe as flame-resistant.

CHOICES

With all of the variants available, how does one choose which liquid-applied barrier and/or flashing to use? The choice will settle on a number of factors:

- One-day, one-trip, or damp/cold-day applications favor STPs. If more than one drying day is available, acrylics or silicones work well. Acrylics are easy to clean up and so are cross-trades-friendly.
- While liquid-applied barriers and flashings are tough to beat, one may be more appropriate than another for a particular use.
- Liquid-applied wall barrier and flashings may be used with compact drainage planes, drained cavity wall, and rain screen systems. Some may be used as a membrane for thin-set masonry veneers.

As far as which ones are “best,” the marketplace will decide. Building and fire codes represent minimum standards. As designers and specifiers, the materials we recommend can be of significant consequence—sometimes even the difference between life and death. Build it well; build it once.

CHALLENGES

- **Cost.** The perception persists that fluid-applied barriers and flashings are too expensive. When the benefits are accounted for, fluid-applied materials are often justified, which explains their increasingly common use.
- **Who shall install?** The painter, the window installer, sider, framer, waterproofer, the GC? None of the above? Fluid-applied WRBs, air barriers, and flashings should be well identified on the plans, in the specifications, and in the bid documents. Wall barriers should be a topic of discussion at preconstruction meetings in order to determine the one or more subcontractors who will apply the liquid barrier and flashing systems.

CLOSING THOUGHTS

WRBs are an interesting concept: Everything on one side is water-insensitive, and everything on the other side is very water-sensitive. That’s a tall order for any one material to be responsible for, let alone often the thinnest, cheapest material used on a building. But there we have it. Building paper and nonadhesive flashings meet the code. Building wraps and SAF offer some advantages. Liquid-applied barriers and flashings offer many advantages that may


be of real value—both during construction and for in-service reliability. Which WRB is prudent for your project? Saving money, time, and making work easier with the prospect of a better result is the holy grail of value engineering. The WRB represents both a challenge and an opportunity. One thing’s for certain: It’s definitely not your father’s WRB anymore! 



Photo 24 – The author applied 15 different manufacturers’ “paint-on flashings” to mock-ups for the 2014 Westcon Symposium and 2015 RCI SoCal Hawaii Winter Workshop presentations.

REFERENCES

1. #15 asphalt-saturated felt is deemed a WRB (but not an air barrier) by code. Grade-D, asphalt-treated kraft paper must meet or exceed a code-minimum 10-minute water-resistance per test method ASTM D779, *Standard Test Method for Water Resistance of Paper, Paperboard, and Other Sheet Materials by the Dry Indicator Method*. Known as the “boat test,” the standard was withdrawn in 2011 because it does not separate water resistance from permeance; however, the standard remains a point of reference. Other WRB testing: ICC-ES AC 212, *Acceptance Criteria for Water Resistive Coatings Used as WRB Over Exterior Sheathing*, which includes extensive environmental cycling; ASTM E331, *Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference*; AATCC Test Method 127, developed in 1968, is a five-hour hydrostatic pressure test.
2. The Air Barrier Association of America (ABAA) maintains a listing of states and local governments that

have adopted air barrier requirements. Air barrier materials are tested per ASTM E2178, *Standard Test Method for Air Permeance of Building Materials*; air barrier assemblies are tested through ASTM E2357, *Standard Test Method for Determining Air Leakage of Air Barrier Assemblies*.

3. NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components*.
4. WRB vapor permeance is 10 perms minimum per ICC, IRC 5 perms minimum as tested per ASTM E96, *Standard Test Methods for Water Vapor Transmission of Materials*. 10 perms or greater is considered vapor-permeable. Vapor-permeable, fluid-applied barriers and flashings range from 10 to about 30 perms. Some sheet WRBs range to 200 perms. However, materials over 50 perms may not meet air barrier air permeance requirements. Primers, temperature, and humidity can also significantly affect the vapor permeance of an assembly. The subject of vapor permeance of wall assem-

blies is broad. In some cases, hygrothermal modeling may be useful to sort through the variables of a specific project. An excellent primer on recommended permeance of various wall assemblies is Building Science Corp. BSD-106, “Understanding Vapor Barriers,” Joseph Lstiburek, 2006.

5. “Flashings” provide 24-hour water resistance minimum: ASTM E2112, *Standard Practice for Installation of Exterior Windows, Doors and Skylights*.
6. In addition to WRB and air barrier qualifications, manufacturers’ testing of liquid flashings includes ICC-ES AC 148, *Acceptance Criteria for Flexible Flashing Materials* (fluid-applied flashings become flexible flashings when cured), which includes UV exposure testing and nail sealability per ASTM D1970, *Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection*.



Charlie Saul

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— Falling Tape Measure Kills Delivery Man —

A one-pound tape measure fell 50 stories and killed a man delivering sheet rock to a construction site in Jersey City, New Jersey, in November. The tape measure became dislodged from a workman’s belt on the 50th floor and struck construction equipment 10 to 15 feet from the ground. It then ricocheted and struck Gary Anderson, 58, of Somerdale, New Jersey, who had just stopped to speak with another worker. Anderson was not wearing a hard hat, although he had one in his pickup truck at the time.