Specifying to Reduce Risk and Improve Performance of Perimeter Edge Metal Systems

By Jason Hildenbrand and David Allor

Figure 1 – The integrity of the perimeter flashing has been identified as the critical first line of defense against roof failure.

Matthew, Irma, Maria, Katrina, Dorian. These and other devastating and costly storms of the 21st century, and the subsequent storm damage forensics, have taught the architectural and engineering (A/E) community and construction industries many valuable lessons.

But it does not take a hurricane. According to data from the Insurance Information Institute (III), global natural catastrophes and human-made disasters resulted in $144 billion in insured losses in 2017. There were 301 disaster events in 2017, of which 183 were natural disasters, accounting for $136 billion in insured losses. North America accounted for the majority of insured losses in 2017, with about $119 billion and almost 83 percent of the world's insured losses. Most of those losses resulted from severe storms and hurricanes, as well as wildfires and flooding. According to the National Oceanic and Atmospheric Administration (NOAA), as of July 9, 2019, there had been six weather and climate disaster events in the first six months of 2019 alone, with losses exceeding $1 billion each across the United States. These events included two flooding events and four severe storm events.

One thing is clear: the prevalence of destructive storms is increasing, as is the likelihood of insurance claims.

SPECIFYING TO REDUCE RISK

By focusing on key components when designing a commercial roof—or, more precisely, the perimeter edge metal system—a designer can significantly improve the building's performance in high wind events without breaking the bank (*Figure 1*).

After several hurricanes in the early 2000s, studies of roofing damage conducted by the Roofing Industry Committee on Weather Issues (RICOWI), in conjunction with Factory Mutual (FM) and SPRI, reported that nearly 60 percent of damaged roofs were caused by failure at the perimeter (*Figure 2*). Poor workmanship and/or substituted lighter-gauge materials resulting from value engineering were identified as the primary reasons for the roof failures.

Furthermore, based on FM's findings, it was determined that the integrity of the perimeter flashing was the critical first line of defense against roof failure.

Figure 2 – Studies of roofing damage conducted by RICOWI, in conjunction with FM and SPRI, reported that nearly 60 percent of damaged roofs were caused by failure at the perimeter.

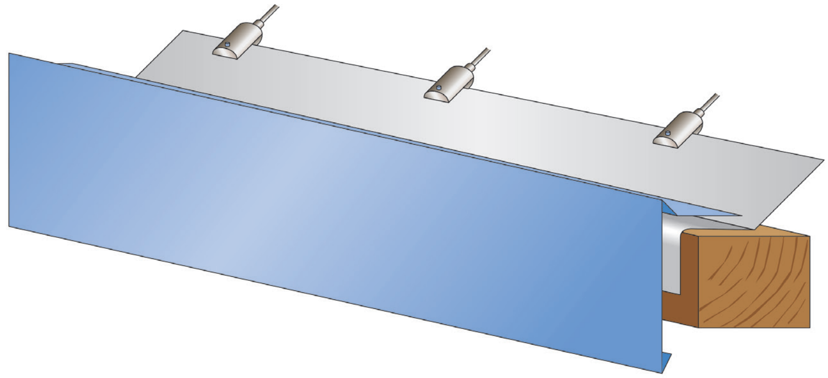


Figure 3 – The RE-1 test pulls the membrane at a 25-degree angle to the roof.

The message is unequivocal: When edge metal fails, the roofing system cannot withstand the associated wind loads and progressively fails as well.

Value engineering has become a standard part of many construction projects, and large roofing projects are no different. The result is that specified edge metal systems are frequently value engineered out of a project or substituted for shop-bent and untested products to save a few dollars. Unfortunately, building owners do not generally understand the added risks to the roofing system associated with roof edge components that are not ANSI/SPRI/FM4435/ES-1 tested. Additionally, the owner could be misinformed about these risks by the design team.

THE STANDARD

The SPRI standard, which addresses the design wind loads and wind resistance testing of edge metal systems (except gutters) used to secure the perimeters of low-slope membrane roof systems, was first published in 1994 (*Wind Design Guide for Edge Systems Used with Low Slope Roofing Systems*). This standard has since been revised, reapproved, and officially recognized as an American National Standards Institute (ANSI) standard in 1998.

Besides specifying three methods for testing roof edge systems (i.e., RE-1, RE-2, and RE-3), the ANSI/SPRI ES-1 standard outlines the basic requirements of wind resistance design and testing for roof edge securement and perimeter edge systems.

FM Global revised its edge metal testing standard, FM 4435, in 2011 to match ES-1 test methods (but not FM's design methods). As a result, the test standard for roof coping and fascia systems is commonly referred to as ANSI/SPRI/FM 4435/ES-1, *Design Standard for Edge Systems Used with Low Slope Roofing Systems*. This standard was incorporated into the 2018 International Building Code (IBC), and is available on the SPRI website at https://tinyurl.com/y3lhkm7r.

THE BUILDING CODE

Edge metal systems were first included in the IBC in 2003. The IBC, published by the International Code Council (ICC), establishes minimum regulations for building design and construction and is currently in use or has been adopted in 50 states, Puerto Rico, and the U.S. Virgin Islands, among others. While adoption of the code varies by state, leaving some items to the authority having jurisdiction at state or local levels, all roofing projects subject to the IBC are generally required to have an edge metal system that meets defined performance requirements.

In IBC 2018, roof edge requirement language in Chapter 15 (1504.5) states: "Low-slope built-up, modified-bitumen, and single-ply roof system metal edge securement, except gutters, shall be designed and installed for wind loads in accordance with Chapter 16 and tested for resistance in accordance with Test Methods RE-1, RE-2, and RE-3 of ANSI/SPRI ES-1, except basic design wind speed, *V*, shall be determined from Figures 1609.3(1) through 1609.3(8) as applicable."

RE-1

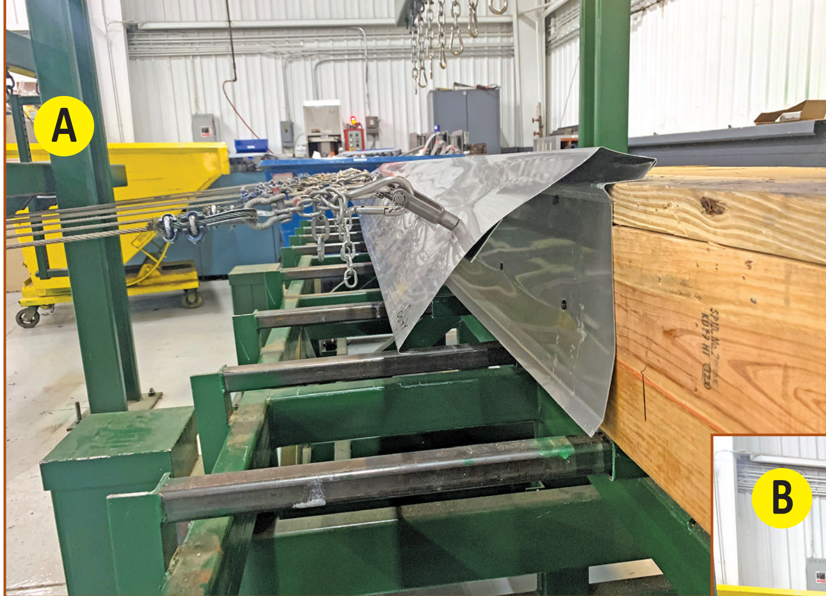
The RE-1 test simulates the effects of a billowing membrane experienced by mechanically attached and ballasted membrane roof systems. The test evaluates the edge system's ability to terminate the membrane. The test pulls the membrane at a 25-degree angle to the roof (*Figure 3*). The edge system load rating is determined by the force per linear foot at which the membrane becomes free from the roof edge system.

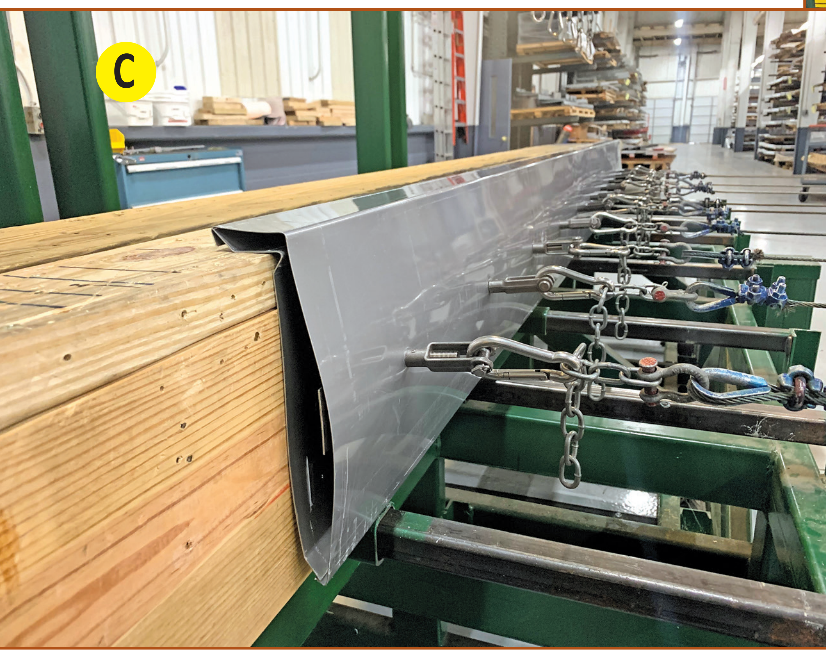
RE-2

The RE-2 test evaluates the ability of the fascia to resist the calculated design wind pressure. The RE-2 test is applicable only to fascia systems with an exposed horizontal component of four inches or less. The test pressure is calculated using the following formula:

Pressure = Outward Force @ Failure / (Face Height x Face Length).

When it comes to specifying roofing edge systems, understanding the code and testing procedures is important.





Figures 4A, 4B, and 4C – In the RE-2 test, a distributed load is applied to the vertical face of the fascia in order to simulate the pressure created by wind velocity.

A distributed load is applied to the vertical face of the fascia in order to simulate the pressure created by wind velocity (*Figure 4*). The load is cyclically applied until any one of the roof edge system components fails. The highest simulated pressure applied without failing is considered the system rating.

RE-3

The RE-3 test evaluates the ability of coping systems with exposed horizontal components exceeding four inches to resist wind pressure on both the vertical and horizontal surfaces. The test applies simultaneous simulated wind loads on both vertical and horizontal surfaces (*Figure 5*).

Two tests are required to fully evaluate coping systems: one test on the exposed face and top surface simultaneously, and a second test on the back surface and top surface simultaneously. The test pressure of the lowest-performing side is used as the system rating. The formula to determine the pressure for each surface is the same as the RE-2 test. The rated pressure must be greater than or equal to the calculated designed wind pressure for the project under consideration.

WIND PRESSURES AND CRITERIA

Wind or design pressures are determined based on calculations that take a number of factors into consideration, including the building's height, location, and use, as well as local wind speeds. The wind speeds are provided in the ASCE 7 wind maps found in Chapter 16 of IBC 2018, *Minimum Design Loads and Associated Criteria for Building and Other Structures.*

It is important to note that ES-1 requirements are project- (not product-) specific, which means that a product that meets the ES-1 wind design requirements for one building may not be appropriate for another building (*Figure 6*). Additionally, any changes to an edge product can affect ES-1 performance, so if the product was not made exactly as tested with the same type and gauge of material, the same angles, and installed with the same fasteners and spacing, it cannot be considered to meet the ES-1 requirements. Lastly, roofing specifiers should be aware that no edge metal supplier has any blanket ES-1 certifications. They do not exist!

FACTORY MUTUAL REQUIREMENTS

For specifiers working on a building insured by FM Global, or who want to specify a FM-approved edge system, please note that FM uses the ES-1 test method in its FM 4435 standard. Only manufacturers that pay to have their products tested by FM and undergo a detailed auditing process that includes reviewing materials, designs, and manufacturing processes can make FM "tested and approved" edge metal systems. Simply duplicating an FM "approved" edge system design—even if using the same structure and materials as the original approved design—does not mean that the product is FM approved. The latest FM approvals can be found in the RoofNav® website at roofnav.com.

Figure 5 – In the RE-3 test, simultaneous simulated wind loads are applied on both vertical and horizontal surfaces.

EDGE SECURITY BEGINS WITH THE NAILERS

All too often, the nailers are a neglected component when it comes to reroofing. Some consider nailers to be part of the roof, while others consider them to be part of the edge metal system. Regardless of your point of view, nailers are a critically important component, as the quality of the nailer and its attachment to the building play a vital role in holding the edge metal in place. As such, a wood or nailer specification should always be included in the scope of work, particularly for reroofing projects where aged nailers may be cracked, split, or deteriorated beyond use, and should be replaced. Specifiers today have many options when it comes to nailers, including treated wood and newer engineered metal nailers that can be customized for any application.

WIND ZONES MATTER

It is important to remember that proper edge design and code requirements do not just apply to high-wind areas. Roof edge issues have consistently been identified as the root cause of many roofing system failures. RICOWI investigations are not limited to hurricane zones and have continually identified the edge system as critical to the roof system's overall performance. Wind design requirements are based on data and experience collected over many years, which is why wind zone maps are periodically updated. The current version of ASCE 7 contains four maps to reflect the most recent findings. The benefit of using the ES-1 standard is that it is based on the building's location, so "over-designing" the edge system is unlikely, as you would not design for a hurricane-prone region in a non-hurricane-prone region. Instead, in lower-wind zones or where lower design pressures suffice, the code specifies less stringent requirements.

Figure 6 – ES-1 requirements are project-specific, which means that a product that meets the ES-1 wind design requirements for one building may not be appropriate for another building.

For example, a 60-ft.-tall, risk category IV building with a "B" (suburban) exposure in Miami, FL, must be designed to withstand a 190-mph wind speed, per ASCE 7, and would require the edge system to meet or exceed 239 psf vertical pressure and 114 psf horizontal pressure. The same building in Indianapolis, IN, must withstand a 120-mph wind speed, per ASCE 7, and would require the edge system to meet or exceed 95 psf vertical pressure and

45 psf horizontal pressure.

As you can see, because of the exponential relationship of wind speed to the wind pressure, the wind design pressure requirement for the Indianapolis, IN, project is approximately 60% less than an identical project in Miami, FL. The bottom line is that specifying anything less than what is required by code is a risk, as there is no way to know how the edge system will actually perform without proper testing.

When it comes to specifying roofing edge systems, understanding the code and testing procedures is important. Keeping the following items in mind will help roofing specifiers provide the best possible first line of defense for the roofing system.

- Edge metal testing standards, whether referenced as ANSI/SPRI ES-1 or FM 4435, are increasingly part of the building code, and have been since 2003. IBC 2018 requires that fascia systems be tested per RE-1 or RE-2, and that coping systems be tested per RE-3 standards. All should be designed for wind loads according to ASCE 7 maps.
- There is no such thing as a "blanket" ES-1 certification; requirements are based on project- and building-specific criteria.
- It is good practice to request an ES-1 Certificate of Compliance for each profile fabricated.
- RoofNav lists only edge metal profiles that have been tested and approved by Factory Mutual.

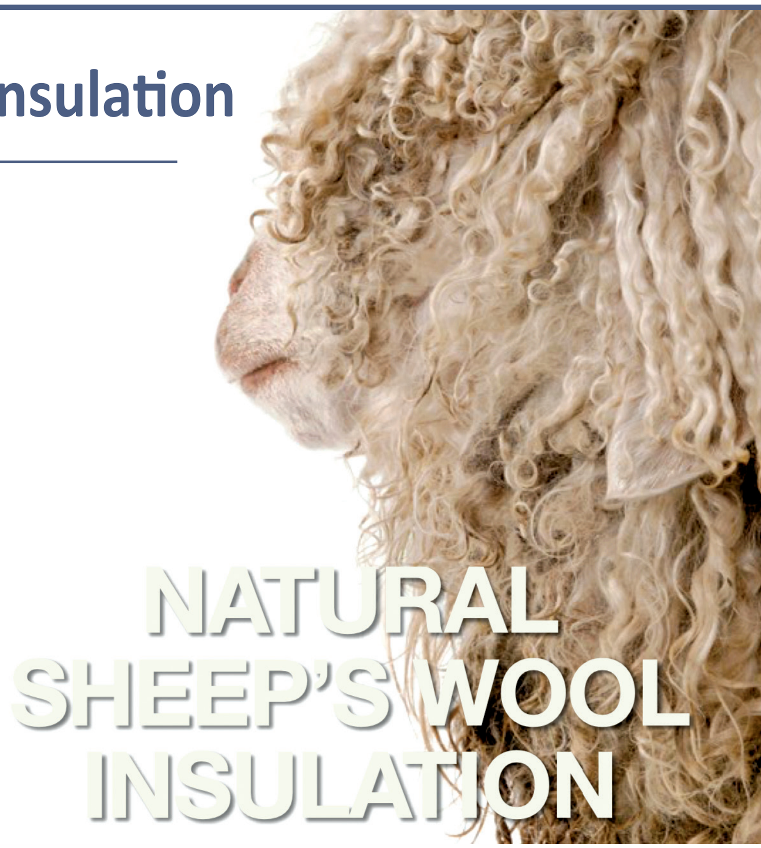
Jason Hildenbrand

Jason Hildenbrand is the edge sales manager for OMG, responsible for managing all sales activities for OMG EdgeSystems. He first joined OMG in 2005 as a field sales representative. Hildebrand was promoted to regional sales manager for the Midwest region in 2009, and then to edge sales manager in 2013. Prior to joining OMG, he was a staff sergeant in the U.S. Army from 1994 to 2004. He is a member of SPRI and CSI.

David Allor

David Allor is the specifier services manager for OMG Roofing Products, focused on perimeter edge metal systems for securing commercial roofs. An active member of CSI, Allor has worked for the past nine years as the company's RhinoBond product manager, where he gained in-depth knowledge of standard work for electromagnetic induction-welded systems.

Sheep's Wool Used as Insulation



Sheep's wool insulation is becoming a popular commodity in the green building industry. It is marketed as being eco-friendly, creating good indoor air quality, and being safe and easy to install. Producers claim the product "requires less than 15% of the energy needed to produce fiberglass insulation." The Healthy House Institute claims it has an R-value of 3.5 to 3.8 per inch of material thickness—higher than fiberglass, cellulose, or mineral wool.

The British sheep wool industry produces over 2.1 million tons of wool a year. The insulation is also catching on in Australia, which produces 55% of the world's raw and processed wool.

Black Mountain Insulation Ltd. (see their logo at right) was established in England in 2007. Its sheep's wool product, Natuwool, according to Black Mountain, is "ideally suited to timber frame structures." It recommends the product for insulation of lofts, rafters, walls, and floors. "Sheep wool fibers draw out moisture," its website claims. Natuwool is made of 90% wool content and achieves a fire performance rating of Euro Class E. Wool insulation "has a unique ability to absorb noxious gases emitted from some building products (e.g., formaldehyde)."

Havelock Wool, in Reno, NV, also produces sheep's wool insulation, using wool from New Zealand. See the wool being processed in Havelock Wool's factory at https://tinyurl.com/uogdb6z, or watch a longer video about the process at https://www.youtube.com/watch?v=hH355AIqqfU.