

PROTECTING ROOFS FROM NATURE'S FURY

USING FM GLOBAL'S DATA SHEETS

By David B. Cox

As more and more of the world's population moves into wind-storm-prone areas, the frequency and severity of wind-related catastrophes are on the rise. When property owners put themselves in the path of Mother Nature, they want to feel confident that their facilities are built soundly, with robust materials that meet or exceed codes derived to minimize loss.

Roof consultants play a key role in ensuring the integrity of commercial property. This begins with understanding how wind can compromise a roof and result in exposing a building's valuable contents.

More than 30 years ago, before American Society of Civil Engineers (ASCE) Standard 7, *Minimum Design Loads for Buildings and Other Structures*, the wind standard used in the United States was American National Standards Institute (ANSI) A58.1. Many felt this standard was difficult to apply to commercial roofs. In response to this need to simplify the load calculations, commercial property insurer FM Global developed the first issue of Property Loss Prevention Data Sheet 1-28, "Wind Design." Its sole purpose was to simplify wind-load calculations for flat commercial roofs with the development of a very simple and easy-to-use table.

By simply knowing the wind

speed, roof height, and exposure, the roof pressure could be found quickly, without any calculations. Although there are many good computer-based programs on the market to help calculate roof pressure, the tables developed by FM Global are still widely used today due to their simplicity and ease of use.

The key factor in any wind-load calculation is that the pressure across the entire roof is not uniform. There are higher pressures in the perimeter and corners of the roof. The perimeter can see a 68 percent increase, while the roof corners can experience up to a 153 percent increase—not small increases, to say the least. If the roof cover or roof deck is not designed for these higher pressures, the roof can be lost in moderate winds.



Failure started in the perimeter. © 2008 FM Global. Reprinted with permission. All rights reserved.

“There are higher pressures in the perimeter and corners of the roof.”

When calculating the wind load on a commercial roof system, there are two items often discussed but not always understood. These are the need for a factor of safety and the role the “Importance Factor” has in commercial roofing.

Scientific research and product testing conducted by FM Global have shown that fastener placement on insulation boards has a significant effect on the wind-uplift resistance of the assembly. In one example, research conducted with a 4-ft x 4-ft x 1.5-in polyisocyanurate insulation board covered with a built-up roof (BUR) showed a dramatic change in performance simply by rearrangement of the fasteners on the board. Fasteners evenly placed 12 inches from the board's edge failed at 105 psf by fracture of the insulation board. When fasteners were evenly spaced six inches from the edge of the board, the test failed at 160 psf by the screws pulling out of the deck (160 psf / 105 psf = 1.52). As actual fastener placement can vary widely from board to board, this difference illustrates the need for a safety factor to be used in the design.

Using a 2.0 factor of safety will allow for small variations in



A safety factor should be used in the design. © 2008 FM Global. Reprinted with permission. All rights reserved.

fastener placement and a small amount of loss (0.48) due to weathering over the life of the roof system.

“A minimum safety factor of 2.0 should always be used in roof design.”

Wind-speed maps used in today’s building codes—referenced in FM Global’s data sheets—all come from the same source, ASCE 7-05. But the wind speeds shown on these maps are based on a 50-



Product testing and certification engineers conduct a wind-uplift test at the FM Global Research Campus in West Gloucester, RI. © 2008 FM Global. Reprinted with permission. All rights reserved.

*Edge flashing failure. © 2008 FM Global.
Reprinted with permission. All rights reserved.*



year mean recurrence interval (MRI). Sometimes confusing, the term 50-year MRI means there is a two percent chance in any given year that these wind speeds will be exceeded. Because these probabilities are statistically independent, during the approximately 50-year life of the building, there is a 64 percent chance that the wind speeds shown on the map will be exceeded.

Not only does changing the Importance Factor from $I = 1.0$ to $I = 1.15$ (recommended by FM Global) increase the pressure by 15 percent, it also changes the MRI from 50 to 100 years, or a one percent chance that the wind speeds will be exceeded in any given year. Note that these probabilities can add up quickly. During the course of 50 years, there is a 40 percent chance that the wind speeds shown on the map will be exceeded.

A building with a 50-year life has a 64 percent chance that the wind speeds will be exceeded. Changing the Importance Factor to 1.15 reduces the probability to 40 percent.

Once adjustments have been made to the wind load (Safety Factor and Importance Factor), a roof system can be selected that has been tested to meet or exceed the expected uplift pressures. FM Approvals, a business unit of FM Global, tests roof systems and provides a simple rating system based on fire testing and uplift resistance. The FM 1-90 rating has become a common specification for commercial roofing. The number "1" represents Class 1 interior fire classification, and the "90" denotes the wind load in the field of the roof at 90 psf—not 90 mph.

In the past, building codes have always provided some method of calculating the uplift pressure in the field of the roof. However, they have only made slight reference to the higher wind pressures in the perimeter and corners of the roof system, with few, if any, guidelines on how to address those higher loads. This lack of direction by the building codes and loss history prompted FM Global to develop FM Global Data Sheet 1-29, *Roof Deck Securement and Above-Deck Roof Components*, and a simple prescriptive fastening method for the perimeter and corners of the roof.

Although the types of roofing systems have grown over the years and have become more complex in design, FM Global Data Sheet 1-29 continues to provide a simple, prescriptive solution for insulation boards, base sheets, and single-ply covers.

Today, FM Global Data Sheet 1-29 is focused on existing roof systems and details,

Get In Tune...

New Playing
1:16
Versico LLC
Specs and Submittals
★★★★★
1 of 1
-3:46

TPO EPDM PVC

...with what Versico has to offer.

- Single-Ply Roofing Systems
- Warranties
- Accessory Products
- Architectural Specifications
- Insulation
- Awards Programs

A Single Source for Single-Ply Roofing



Please visit Versico at the RCI Convention, booth 806.

For more information call 800-992-7663 or log on to www.versico.com.

how to best increase the uplift resistance, and to meet increasingly higher wind-load requirements. All modes of failure and all components of the roof system must be reviewed, as the mode of failure can quickly move from one section of the roof to another. The entire roof system, including the deck as well as any adhered sections of the assembly, must be tested to know the uplift limitations of the entire system.


At one time, 20-gauge, narrow-rib steel decks with joist spacing 5 ft on center were common. Today, typical commercial roof decks are 22-gauge, wide-rib, with joist spacing 6 ft apart or greater. This allows much greater upward deflection into the roofing components, which affects securement of the steel deck and all of the above-deck roofing components.

The roof deck, which provides the structural support for the roof assembly, should have adequate strength and rigidity to prevent the above-deck layers from flexing significantly and pulling apart due to wind uplift. Also, as the width of single-ply membranes continues to increase, the roof cover places a greater concentrated load (line load) back on selected sections of the steel deck. FM Global Data Sheet 1-29 provides

simple prescriptive methods to ensure adequate steel-deck attachment.

Understand wind dynamics.

Remember that there are substantially higher uplift pressures in the perimeter and corners of a roof. If these higher pressures are not addressed, the roof could be severely damaged in high winds. FM Global Data Sheet 1-28 helps the professional to calculate the uplift load, and FM Global Data Sheet 1-29 provides simple prescriptive

solutions to best resist these higher pressures for both the roof deck and the above-deck components. 

Additional information on all of the items discussed in this article can be found inside FM Global Data Sheets 1-28 and 1-29. Free copies of many of the wind- and roof-related data sheets can be obtained by visiting www.RoofNav.com.

David B. Cox



David B. Cox is the corporate windstorm specialist for FM Global, responsible for coordination of windstorm activities for over 1,500 engineers worldwide. Dave is involved in consulting with policyholders and account teams on windstorm exposures, impact analysis, and mitigation techniques. He began his career with FM Global in 1981 as a field engineer. In the 27 years since, he has been a staff engineer, a senior engineer, and a loss investigator. Dave is involved in both engineering and underwriting. His responsibilities include research and preparation of FM Global Property Loss Prevention Data Sheets dealing with windstorm, commercial roofing systems, construction, and the building envelope. He has a B.S. degree in engineering from the University of South Florida, and is a member of NRCA, RCI, and ASCE.



Put Garland on Top to Protect What's Inside

- High-performance roofing, restoration, and maintenance solutions
- Comprehensive roof-asset management
- Knowledgeable local representatives whose #1 priority is keeping your facilities dry



The Garland Company, Inc.
800-741-3157 • www.garlandco.com

DON'T MANDATE GREEN, HPO SAYS

The Homeowner Protection Office (HPO) of Vancouver, British Columbia, has urged municipalities not to mandate green roofs on residential projects. The announcement grew out of a task force organized in 2007 on the subject of green roofs. The group determined that while it is "feasible to design, install, and maintain a green roof that performs as well as a conventional roof system," it has not been demonstrated that a green roof is as "cost-beneficial" from a "triple bottom line" perspective. The HPO cited limited skilled workers, few accepted standards, minimum levels of quality control, and concern that maintenance would be improperly handled.