



Understanding the Hazard

Wind from Tropical Storms

Natural Hazards

With proper knowledge and preparation extensive wind damage can be avoided — even in the most severe storms. This document identifies areas in a building that are most vulnerable to damage, and how to substantially reduce the risk.

UTH topic categories:

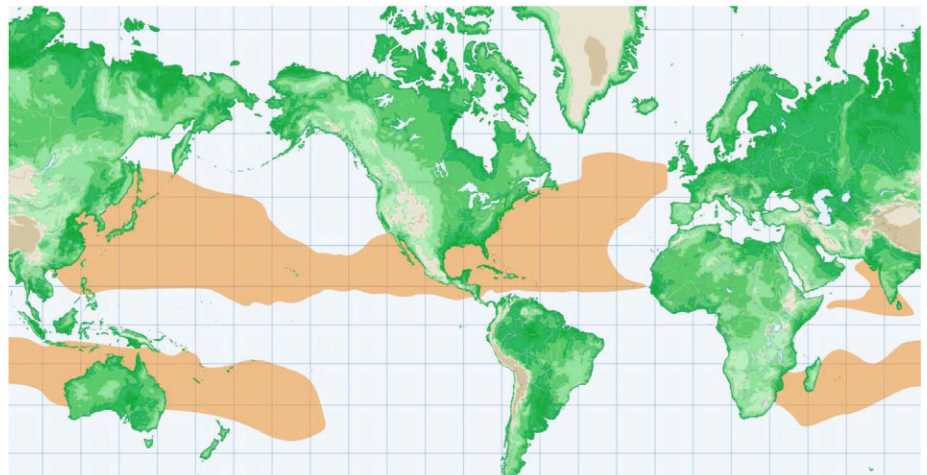
- Construction
- Equipment
- Fire Protection
- Human Element
- **Natural Hazards**
- Process Hazards

This series of publications is designed to help you understand the everyday hazards present at your company's facilities. For more information on how you can better understand the risks your business and operations face every day, contact FM Global.



The Hazard

No peril can match the wind of a severe tropical storm (hurricanes, typhoons and cyclones) in its ability to cause widespread devastation. So it comes as no surprise that wind has been one of the most significant contributors to FM Global client losses. During a recent 10-year period, 9% of all the damage sustained by FM Global clients was related to wind. Approximately 70% of all wind losses are attributed to damage during severe tropical storms.



Worldwide regions exposed to major tropical storms (hurricanes, cyclones, typhoons)

The costliest impact of these storms is the damage that results when the building's envelope is torn open and lets wind and rain into the facility. Below are the most frequent and damaging ways that the building envelope can be opened:

- Roofing covering and insulation tear up and off from the deck or other supports.
- Roof-mounted equipment becomes dislodged, opening the roof deck and tearing the roof covering.
- Lightweight wall covers such as exterior insulation finish systems (EIFS) or aluminum panels tear away from the structure.
- Windows are broken by windblown debris, such as surrounding trees or gravel from nearby roofs.
- Windows are blown in by the pressure exerted on the building.

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What You Can Do at Your Facility

Now:

- Screw down the flashing. This part of the building is subject to the strongest forces and is critical to keeping the covering in place.
- Secure roof-mounted equipment. Loose equipment can be dislodged, causing damage to the roof and allowing water to enter the building.
- Know your weaknesses. If a roof is suspect, create a contingency plan to ready yourself for a storm. The corners of the roof will likely fail first, so plan to move or cover the stock under these areas.
- Ask your FM Global engineer whether the roof will withstand likely wind forces.

Soon:

- Provide additional fastening in the corners and perimeter of the roof to meet FM Global recommendations.

Tropical Storm Facts

Tropical cyclones are known by many names. In the South Pacific and Indian Oceans they are cyclones, in the Western Pacific they are typhoons and in the Eastern Pacific and Atlantic Oceans, they are hurricanes.

Tropical cyclones spin around a central low-pressure core. The direction of circulation is governed by the rotation of the earth. Storms in the Northern Hemisphere spin counterclockwise, while storms in the Southern Hemisphere spin clockwise.

In the Northern Hemisphere the winds on the eastern side of the storm are typically strongest. In the Southern Hemisphere, the western side of the storm offers the strongest winds.

During a windstorm, damage to the building's structural frame seldom occurs. Yet, a very small breach in the building envelope can destroy a large area of the interior. For this reason, keeping the building envelope sealed is one of the most effective ways of preventing windstorm damage at your facility.

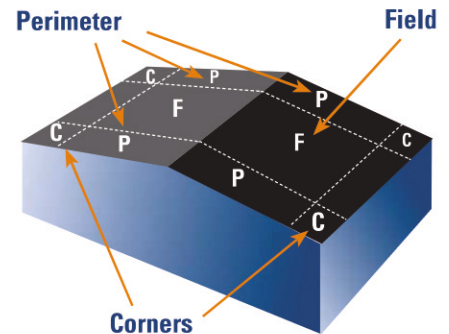
Science of the Hazard

Keeping the building envelope in one piece through a storm is a simple matter of wind resistance. If the roof, walls and windows can withstand forces exerted by wind and wind-borne debris, your facility will survive.

How does wind act on the building?

Wind forces on a building create an action similar to that of wind passing over an aircraft wing. Changes in the wind's direction as it passes over and around the building result in uplift or suction forces. These forces vary dramatically in magnitude on different parts of the building. For example, at the **perimeter edge** of the roof the uplift

force can be approximately 70% higher than on the main (**field**) part of the roof. In the **corners**, the wind forces can be nearly 160% higher. In the case where a single window or door fails, positive pressure can be created within the building envelope to further increase total wind load to the roof. Clearly, this means that if the corners of the roof experience the strongest force, these are the areas that will probably fail first. FM Global's loss experience bears this out. It also tells us that if these small corner areas are reinforced with increased fastening, they are less likely to fail.



Engineers have understood this issue for some time and have developed design standards that take into account these different forces. However, as with most engineering standards, the choices made in the design process will have a dramatic impact on the resulting strength. Many are surprised that, while the building might be "designed to code," the wrong choices can mean that it will still suffer damage in a windstorm.

Codes deal more with design loads than with ways to resist those loads.

FM Approved roofs use tested systems that were designed by their manufacturers to meet FM Approval. This goes well beyond the theoretical design approach. FM Approved roof systems are actually load-tested and verified to meet specific wind pressure parameters and then listed accordingly.

What windspeed should I design for at my facility?

Windspeed selection is the most fundamental choice that designers make in calculating wind forces. However, selecting a speed off a map needs to be done with an understanding of the event being described by that windspeed.

What You Can Do at Your Facility

3 Second Gust Windspeed*		60 Second Mean Windspeed
187 mph (300 kph)	Cat V	156 mph (250 kph)
158 mph (255 kph)	Cat IV	131 mph (210 kph)
133 mph (215 kph)	Cat III	111 mph (180 kph)
115 mph (170 kph)	Cat II	96 mph (155 kph)
88 mph (140 kph)	Cat I	73 mph (120 kph)

It is important to know which basis is being applied when discussing the intensity of a windstorm. Windspeed can be measured by various averaging times, such as the 3-second gust and 60-second mean. The comparison above shows the relationship between these two measurements. For example, a windspeed at the threshold of a Category III hurricane is 133 mph by the 3-second gust windspeed, which compares to 111 mph by the 60-second mean windspeed.

**These wind speeds are over water and are effective at a height of 33 ft. (10 m) in open terrain.*

Wind maps are developed through a statistical analysis of windspeed measurements. The maps most often represent the annual probability or likelihood of the windspeed being equaled or exceeded. For example, a 50-year wind map might show a 2% probability that a given windspeed will be exceeded. This level of probability sounds remote at first, but don't be misled to think this is a storm that will occur only once every 50 years. Remember that it is a 2% probability of exceedence per year. Statistically, this means that if your facility life is 30 years, you have a 46% overall probability that the windspeed will be either equaled or exceeded.

Do you want to roll the dice?

Wind maps in building codes are good starting points for indicating the wind speeds your facility can expect, but history often tells us a good deal more. For example, if the code tells us to design for a windspeed of 90 mph (145 kph), and three storms with winds exceeding that speed have passed within 100 miles (62 km) in the past 20 years, your facility should probably be designed to withstand a higher windspeed. It may simply be a matter of luck that the storm took a turn or chose a path away from you.

So what does all this mean?

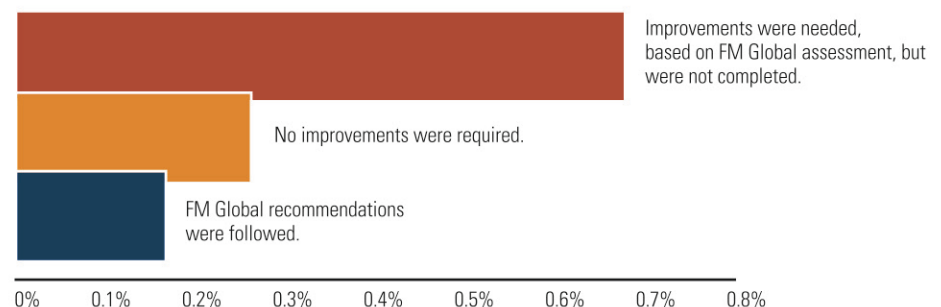
There are two important lessons to take from this:

1. Wind acts on different parts of the building in different ways. The small corner and edge areas of the roof experience significantly more pressure and are often the first to fail. These areas need to be well-secured. Since they are small areas, enhancement is usually inexpensive (a few fasteners in most cases).
2. The wind pressures your facility is designed to withstand should be realistic for its entire lifetime. Life safety-based design codes most often design for a windspeed that is likely to be exceeded while your facility is still standing. Use code wind maps as a starting point and then apply common sense based on history.

Loss Experience

Windstorms contribute significantly to the overall losses of FM Global clients — an average of US\$380 million per year, and over 9% of total losses during a recent 10-year period. Nearly all of these losses could have been prevented.

Effectiveness of FM Global Engineering (percentage of value)



Source: FM Global clients

Need more information?

Ask your FM Global engineer or client service team about the following:

- *FM Global data sheets related to wind design.*

Ordering Information

For additional copies of this publication or other FM Global property loss prevention resources, shop online 24 hours a day, seven days a week at www.fmglobalcatalog.com.

Or, for personal assistance worldwide, ask to speak with our U.S.-based customer services team, Monday – Friday, 8 a.m. – 5 p.m. ET:

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A review of losses following the 2017 Atlantic hurricane season showed FM Global engineering to be very effective at identifying where roofing losses will occur, and how to build new construction or retrofit existing construction economically, to avoid wind losses. More important, FM Global engineering guidelines were very effective at reducing damage. As seen in the chart on page 3, facilities that did not follow FM Global recommendations for roofing enhancements suffered over four times as much damage as those who acted on our advice.

But what about. . .

...the cost of improving my roof?

The focus of FM Global's wind engineering efforts is on the building envelope, not the main frame structure. Our experience has shown that the structural frame, when designed to code, will likely be adequate. A focus on the envelope (typically the roof) normally involves the addition of a few more fasteners, usually at the corners and edges. The cost of improvement might be no more than that for a bucketful of fasteners and the labor of a person with a screw gun.

...the fact that my building meets the code?

Codes are established with the primary goal of life safety in mind. Buildings with high occupancy levels, such as schools, typically require a design that withstands higher windspeeds. In this context, the fact that your facility meets the code does not necessarily mean it is designed to protect your business from the elements during its lifetime.

...the fact my building has been here 20 years and I've never had a problem.

It has even survived a hurricane!

The diameter of the damaging winds of a hurricane, typhoon or cyclone is typically 50 to 100 miles (100 to 200 km), while the storm area can be 100 to 300 miles wide (200 to 500 km). Within these areas the windspeeds vary significantly. Given this range of windspeed and area, it is impossible to predict from past storms how well your facility may survive the storms of the future.

Don't Let This Happen to You. . .



Inadequate securement of the roof deck and above-deck components allowed extensive damage at this facility.