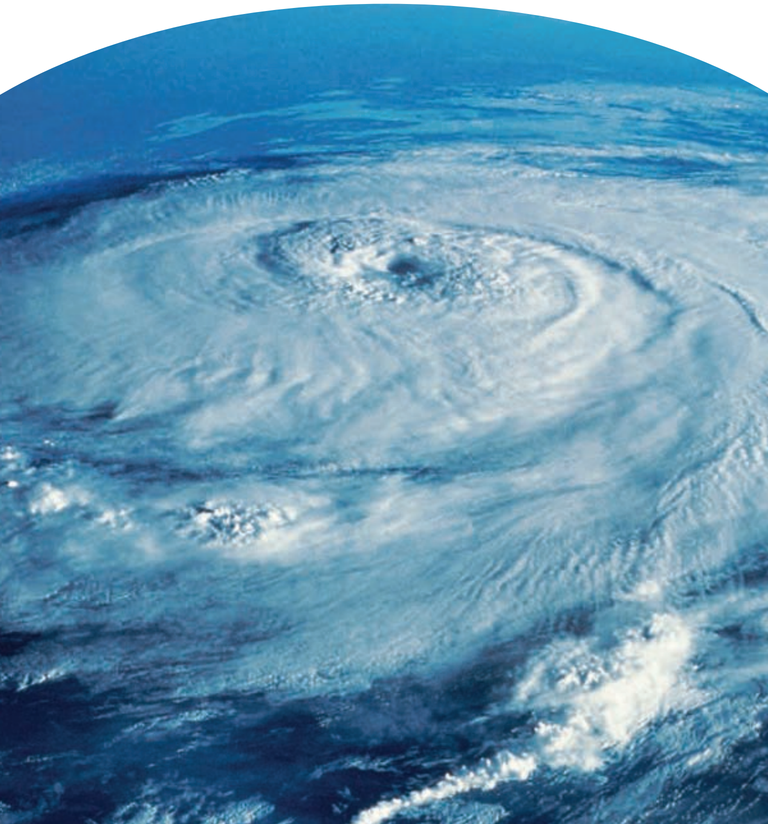
Hurricane-prone wind guide

Risk management handbook for properties in hurricane-prone regions



Managing property risk in hurricane-prone regions

When it comes to hurricanes, do you have more questions than answers?

- What are the characteristics of a good wind risk? You probably can name a few, but have you missed something important?
- How do you identify a good wind risk? Knowing the characteristics and evaluating them are very different tasks.
- What standard should be applied? Too liberal, and you are not adequately protected. Too harsh, and you are not using your risk improvement resources wisely.
- Who can help you understand, identify and improve your wind risk?

The challenge

Hurricanes bring extreme conditions, including:

- High winds (rare cases reaching 200 mph)
- Heavy, wind-driven rain
- Wind-borne debris
- Storm surge and coastal flooding
- Wave action and beach erosion
- Water-borne debris
- Tornados

With the exception of tornados, it is possible to design a building to survive the extreme conditions associated with a hurricane.

Meeting the challenge

Hurricane damage becomes a catastrophe when water is allowed to penetrate the building envelope or undermine the building foundation.

Controlling water is the key!

Failed roofs, glazing or cladding can quickly allow wind-driven rain into a building. Once inside, gravity spreads the water down through the building.

What can wind-driven rain damage?	
Interior finish	Dry wall, woodwork, paint, wall paper, flooring
Contents	Storage, machinery, computers, files, furniture
Wiring systems	Electric, telephone, fire alarm, network, door lock, cable TV
Utilities	Electrics, generators, elevators, boilers, chillers, fire pumps

Water and water-borne debris from flood, storm surge and storm water runoff can enter and damage a building. Uncontrolled wave action can scour away soil under and around building foundations. Buildings can become inaccessible, unstable, or even collapse.

Wind

Just as a property can become a highly protected risk for fire, it can also become a "superior" wind risk.

The characteristics of a superior wind risk are those qualities that protect a property from damage due to wind and wind-driven rain. They include:

- Roofs that possess an appropriate wind uplift rating
- Glazing designed to resist wind and wind-borne debris
- Cladding designed to resist wind and wind-borne debris
- Drains (primary and secondary) for roofs, balconies, terraces and similar features

Flood

Hurricanes can also be accompanied by flooding. Flooding can include storm surge, storm water runoff and wave action.

The characteristics of a good flood risk are those qualities that protect a property from water damage. They include:

- **Elevation** of buildings and important structures above or otherwise protected from storm surge, storm water runoff and flood
- **Water-borne debris protection** for portions of buildings and important structures exposed to debris carried by storm surge, storm water runoff and flood
- **Wave action protection** for building foundations and important outside structures exposed to soil erosion associated with wave action

Managing wind – building design

Zurich approach

Zurich superior wind risk guidelines begin with selecting an appropriate "basic wind speed." The basic wind speed maps in ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, should be applied for sites located in the U.S. or its possessions. For other locations, equivalent local wind speed data should be used.

- **Roofs.** Select roof systems that are listed by a nationally recognized testing laboratory to withstand the wind uplift pressure calculated using ASCE/SEI 7-05.
- **Cladding and glazing.** Select cladding and glazing that will resist the wind pressures calculated using ASCE/SEI 7-05.

For buildings located in wind-borne debris regions, cladding and glazing should be approved for both wind pressure and wind-borne debris (large and small missile resistance).

For all ASCE 7-05 wind load calculations, an Importance Factor (I) of 1.15 should be used.

Discussion

Since Hurricane Andrew in 1992, Miami-Dade County in Florida has been a leader in developing and implementing test standards for building products that address:

- Resistance to wind
- Resistance to wind-borne debris
- Resistance to water infiltration

Miami-Dade approvals include roofing, cladding and glazing systems.

Testing for cladding and glazing addresses water leakage, pressure resistance and impact resistance. For impact resistance, a product can be submitted for two tests, large missile and small missile. Large missile tests involve a 6' wood 2" x 4" striking the test sample at 50 feet per second (34 mph). Small missile tests involve ball bearings striking the test sample at 80 feet per second (50 mph). Each missile test is followed by wind loading for 9,000 cycles.

The Miami-Dade approval process starts with tests conducted by a Miami-Dade approved testing laboratory. Successful products are submitted to Miami-Dade for final approval. Final approval is signified by the issuance of a Notice of Approval (NOA).

All current NOAs are available for review and download at the Miami-Dade Web site. Each NOA will provide a description of the approved products, method of application and applicable ratings. NOAs will confirm maximum pressure resistances ratings as well as any missile impact ratings.

The rating of each approved product must be checked to make sure it meets or exceeds the rating required for a specific job or application.

Miami-Dade on the Web

To search for Miami-Dade approved products for wind, go to the following Web page.

http://www.miamidade.gov/buildingcode/pc-search app.asp

Managing wind – wind-borne debris regions

Wind-driven debris is an issue for buildings located in "wind-borne debris" regions. These regions are defined in the International Building Code to include:

- Areas within one mile of a coast with a "basic wind speed" at or above 110 mph
- Areas with a "basic wind speed" at or above 120 mph
- Areas within the state of Hawaii

Minimum ratings for building in wind-borne debris regions

Exposure	Cladding and glazing section	Rating
Wind pressure	All	Rated for pressures calculated using ASCE/SEU 7-05
Wind-borne debris	Within 30 feet above grade	Rated as "large missile resistant"
	Between 30 and 60 feet above grade	Rated as "small or large missile resistant"

Managing wind – best practices

Zurich approach

When pursuing Zurich superior wind risk guidelines, consider the best practices outlined below.

Discussion

Since Hurricane Andrew in 1992, Miami-Dade County in Florida has been a leader in developing and implementing test standards for building products that address the following:

- Consider a penthouse to house rooftop equipment rather than having rooftop equipment exposed to wind.
- Select louvers that are approved to avoid wind-driven rain carry-over into the building or penthouse.
- Secure small rooftop equipment such as stacks, exhaust fans, and air intakes with corrosion-resistant fasteners less than 6" on center between equipment, transition pieces and roof curbs.
- Secure exhaust fan cowlings with wire rope to the curb or roof deck.
- Avoid rooftop ductwork.
- Follow FEMA guidelines for securing lightning rods. See Bibliography.
- Arrange satellite dishes so the dish, unsecured supports, and ballast (concrete blocks) can be removed to a secure location before a storm.

- Design the connections of large rooftop equipment to the building per ASCE/SEI 7-05 guidelines.
- Where rooftop equipment is supported on vibration isolators, provide stops to limit vertical travel due to wind uplift.
- Protect cooling towers with equipment screens designed for the wind loads per ASCE/SEI 7-05.
- Face fasten perimeter roof edge flashing rather than using hidden hook strips.
- Design parapets per ASCE/SEI 7-05.
- Secure steel decks with screws rather than welds. Avoid wood nailers in areas with termite exposure (e.g. Hawaii, Virgin Islands).
- Avoid rooftop walking pad in wind-borne debris regions.
- Use fully-adhered roof systems rather than mechanically fastened systems that can suffer progressive tear-off once failure begins.

Managing water – storm surge

Zurich approach

Zurich flood guidelines recommend locating enclosed building spaces and important outdoor structures above the anticipated storm tide.

Discussion

Storm tide is a combination of storm surge and tide. The "anticipated storm tide" should be based upon a 100-year storm surge and high tide. The 100-year storm surge can be estimated as follows:

1. Determine the wind speed at the site using Figure 6-1 in ASCE 7-05. This figure provides the three-second gust wind speed over land based upon a 50-year Mean Reoccurrence Interval (MRI).
2. Increase the wind speed determined above to a 100-year MRI using ASCE 7-05 table C6-7.
3. Convert the 100-year three-second gust wind speed over land to a one-minute average wind speed over water using ASCE 7-05 table C6-2.
4. Using the Saffir/Simpson Scale, select the hurricane category that includes the wind speed calculated above, and select the greatest storm surge elevation from the range provided.

Saffir/Simpson Scale

Category	Wind speed	Storm surge
1	74-95 mph	4-5 feet
2	96-110 mph	6-8 feet
3	111-130 mph	9-12 feet
4	131-155 mph	13-18 feet
5	>155 mph	18+ feet

Surge tides determined using SLOSH models

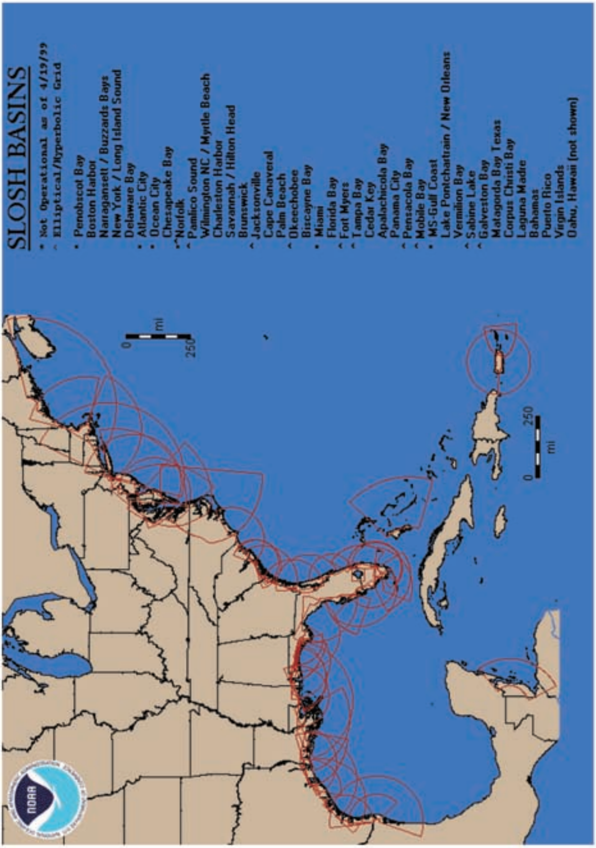
Where SLOSH model data is available, storm tide elevations can be computed by adding the following storm tide components:

Tide:

The tide component should be based upon high tide.

Storm surge:

The storm surge component is a function of several factors, including hurricane pressure, size, forward speed and track. Storm surge elevation increases with hurricane intensity. Storm surge elevations are developed using a computerized model named SLOSH (Sea, Lake and Overland Surges from Hurricanes). SLOSH is used by the National Hurricane Center to estimate storm surge heights based upon either historical, hypothetical or predicted hurricanes. The map on the following page shows the location of available SLOSH model basins.



Available SLOSH Model Basins
http://www.weather.gov/mdl/marine/Basin.htm

SLOSH models cover the U.S. East coast, U.S. Gulf coast, parts of Hawaii, parts of Guam, parts of Puerto Rico and parts of the Virgin Islands. Models have even been developed for some parts of the Peoples Republic of China and India.

For properties close to the water, the elevation of wind-driven waves above the storm tide elevation should be considered.

Water damage from storm surge occurs when the static and dynamic loads associated with the storm surge breach building doors, windows or even walls. In some cases, a building can be dislodged from its foundation.

When water enters a building, it can damage:

- Production equipment and machinery
- Medical diagnostic equipment (MRI, X-ray)
- Emergency generators (and fuel tanks, fuel pumps)
- Fire pumps (including fuel tanks, power supplies and controllers)
- Fire alarm panels and security office
- Boilers
- Chillers
- Electrical equipment (transformers, switch gear)
- Domestic water pumps (including reverse osmosis systems)
- Telephone systems
- Door lock systems
- Cable TV systems
- Laundry equipment
- Kitchen equipment

Managing water – surface water runoff

Zurich approach

Zurich flood guidelines advocate grading insured sites, so surface water runoff is directed away from buildings and important structures.

Discussion

Surface water runoff becomes a concern when the surrounding topography makes it possible to direct rainwater toward high value or critical equipment areas. Heavy rains may overtax drain systems that normally protect these areas, or power failure may impair dewatering pumps that support the drain systems. Should such conditions develop, significant damage could result.

Conditions that raise concern include:

- Large paved areas that support rapid rain water runoff
- Surrounding grade pitched towards building points of entry or important outdoor structures. The pitch may or may not be noticeable to the unaided eye. Topographic site plans may be needed.
- Ramps to below-grade building access points such as truck docks or garage doors
- Dewatering systems that rely upon electric motor driven pumps with no emergency power backup

Areas exposed to storm water runoff can be indoor (first floor, basement) or outdoor (yard storage, tank storage, utility equipment).

Take time to evaluate the reliability of protective measures provided to prevent inundation of their areas.

Reliability can be categorized as follows:

- Passive storm water runoff protection that includes grading, berms and curbs that provide physical barriers to direct water away from important areas
- Active protection that includes mechanical dewatering methods (e.g., sump pumps serving basement level truck docks and similar low-lying areas)
- Manual protection that includes flood gates or flood barriers that are set in place when heavy rain is anticipated

Remember

- Dewater system discharge piping should be equipped with check valves to control backflow. Check valves should receive routine inspection and maintenance.
- Mechanical systems can fail. Pumping systems should be redundant, and electric motor driven pumps should have backup emergency power.
- Do not rely upon manual systems as the only means of protection if there is any concern with the availability of time or staff to place the manual systems. If staff will not be available at all times, manual protection will not be available at all times.

Managing water – flood

Zurich approach

Zurich flood guidelines advocate locating building points of access and other important structures above the 100-year flood elevation.

Where building points of access are below the 100-year flood elevation, provide protection.

Protection may include:

- Raising critical equipment above the 100-year flood elevation
- Securing tanks against buoyancy forces
- Installing flood gates or flood barrier systems to protect points of access
- Installing sump pumps to remove water that passes flood barrier systems

Where important structures (transformers, emergency generators, above-ground fuel tanks) are located outdoors, protection may include:

- Raising equipment above the 100-year flood elevation
- Securing tanks against buoyancy forces
- Relocating fuel pumps outside of tank dikes that can fill with rain water

Discussion

Water damage from flood can occur when building access points or important outdoor structures are located below the 100-year flood water elevation. For the U.S. and its territories, the 100-year flood elevation is determined using FEMA flood maps.

Managing water – water-borne debris

Zurich approach

Zurich flood guidelines advocate protecting buildings and other important structures from water-borne debris. Provide suitable barriers to protect exposed features.

Discussion

Vehicles, trash dumpsters, fuel storage tanks, sheds, fallen trees and other objects can be readily carried by moving water. Per FEMA, only one foot of water is needed to float most vehicles.

Building walls that are within reach of water from storm surge, storm water runoff or flood should be of substantial design to resist the loads associated with the impact of such debris.

Where building walls and important outdoor structures could be damaged by water-borne debris, protective barriers should be provided.

Managing water – wave action

Zurich approach

Zurich flood guidelines advocate protecting beach-front buildings and important structures from wave action that could:

- Impair access
- Damage landscape and hardscape
- Undermine foundations
- Damage underground or under-floor utilities
- Lead to collapse

Discussion

Wave action is a powerful force that can readily scour away sand and soil during severe storms.

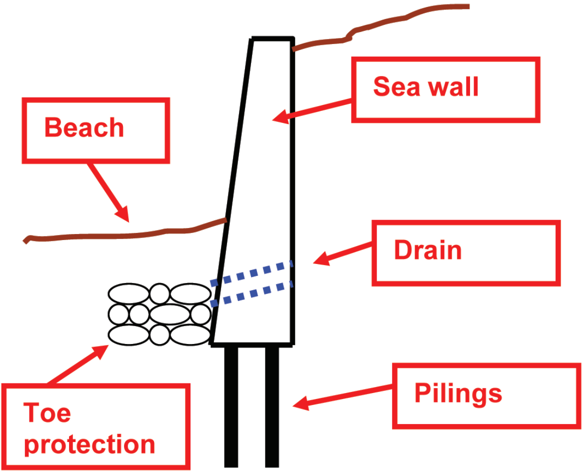
Buildings supported on piles may not fail if undermined; however, building access may be impaired, and underground and under-floor utilities may be damaged.

Outdoor features such as transformers, emergency generators, fuel storage tanks, pools, hardscaped and landscaped areas, and parking lots are also subject to damage by the cyclic pounding of wave action.

Seawalls of suitable design should be provided to protect building foundations and important structures from damage due to the scouring action and loads associated with wave action.

Sea walls should be designed by an engineering firm experienced in this type of work. Sea wall features typically include:

- **Pilings.** Piling supports the sea wall to avoid sea wall failure if scouring occurs under or behind the sea wall.
- **Toe protection.** A layer of protective stone at the sea wall toe (seaside) to preclude scouring of sand from under and behind the sea wall.
- **Wall height.** Sea wall height extended above the surge water elevation to preclude overtopping which can scour sand out from behind the sea wall.
- **Wing walls.** Wing wall features protect sea wall ends from wave action.
- **Drains.** Drains relieve water (and the associated hydrostatic pressure) that will accumulate behind a sea wall.



Managing water – roof drainage

Zurich approach

Zurich superior wind risk guidelines advocate providing adequate primary and secondary drainage systems for building roofs, balconies, terraces and other similar features.

Discussion

Water damage from inadequate drainage can occur if heavy rains exceed available drain capacity or if drains become obstructed.

Roofs that have solid perimeter walls or parapets rely upon drains or scuppers for the removal of rain water.

Mechanical codes require primary drains and secondary drains. Secondary drains are provided in the event primary drains are obstructed or overtaxed.

Primary drains are located at the roof level while secondary drains will typically be 2 inches higher. Raising secondary drains provides an added degree of protection against obstruction from debris and sediment.

Primary drains can be piped away underground to a remote point of discharge. Secondary drains, however, are to terminate at a visible above grade location. An example would be scuppers through parapet walls.

Flat roof buildings that are pitched to interior drains (as opposed to pitched to roof edges) also require primary and secondary drains at the low interior points. Should a primary drain be obstructed, the weight of accumulated water could cause the roof to sag. Sagging would allow further water accumulation and further sagging. This cycle could continue until the roof fails.

Balconies with solid perimeter walls also require primary and secondary drains. If a primary drain is obstructed and no secondary drain is provided, a balcony can fill with accumulated rain water. This water standing against a sliding glass door can readily force its way past the door with significant amounts of water entering the building.

Hurricane plans

Zurich approach

Zurich superior wind risk guidelines advocate developing and implementing a hurricane plan.

Discussion

Most hurricane plans should include the following:

Before hurricane season begins:

- Review and update the plan.
- Verify equipment and supplies are on hand.
- Verify a roofing company contract is in place.
- Schedule an inspection of building roofs, rooftop equipment, walls, windows, and doors.
- Verify emergency generator testing and maintenance is current.
- Inspect and test any dewatering pumps.
- Verify shutters and installation hardware are ready, and staff is trained for installation.
- Establish procedures with local authorities for re-entering site after a hurricane.

During hurricane season:

- Check the National Hurricane Center web site daily.
- Sign up for National Hurricane Center Tropical Cyclone Advisory Mailing List. See Bibliography.

During a hurricane watch (36 hours before):

- Inspect building roofs, make needed repairs, remove loose equipment and debris, verify drains are clean.

- Fill fuel tanks (emergency generators, diesel fire pumps, water heaters).
- Inspect outside drains and catch basins, clear as needed.
- Secure loose outdoor equipment.
- Back-up computer data.
- Ship out as much stock as possible.
- Verify all stock is skidded.
- Review construction projects, secure loose equipment and supplies, install temporary wind bracing.

During a hurricane warning (24 hours before):

- Protect or relocate vital business records.
- Anchor portable buildings or trailers.
- Secure outdoor storage that cannot move indoors.
- Install manual protection features (shutters, flood barriers).
- Elevate critical equipment off floors (i.e. computers).
- Move critical equipment form sub-grade areas.
- Cover critical equipment or stock with waterproof tarps.
- Initial orderly shutdown of production and processes that rely on normal power.
- Turn off fuel gas service.
- Turn off non-essential electrical systems.
- Verify all fire protection systems are in service.

During a hurricane:

- If a team is to remain with the building, verify needed equipment and supplies are provided including communication equipment.
- Anticipate loss of normal power, loss of emergency power and loss of public water.

After a hurricane:

- Consult with team on site (if any) for needed equipment and supplies.
- Include cameras to document conditions.
- Survey site for hazard (live electrical wires, broken glass, leaking fuels, damaged building features, undermined paving or sidewalks). Control hazards.
- Reinforce loss prevention programs (control of smoking, hot work, and fire protection impairments).
- Verify status of fire protection, manage impairments, and expedite repairs.
- Initiate salvage efforts as conditions permit, reduce further damage, separate damaged and undamaged goods, save all damaged goods, avoid accumulations of combustibles in area with impaired fire protection.
- Maintain contact with corporate management and your insurance broker.
- Contact Zurich to report claims.
- Clear roof drains.

Equipment and supplies may include:

- Emergency lighting
- Lumber, nails
- Tape
- Sandbags, sand
- Tarps
- Power (battery powered) and hand tools
- Chain saws
- Nonperishable food and water
- Two-way radios

Emergency power

Zurich approach

Zurich superior wind risk guidelines advocate emergency power systems to maintain important utilities during and after a hurricane. During a hurricane, expect to lose normal power. After a hurricane, expect delays restoring normal power. Important utilities include:

- **Dewatering pumps.** Where electric motor-driven pumps are used to control and remove accumulated water, loss of power can result in the inundation of below-grade areas.
- **Chillers.** Chillers are needed to maintain air conditioning. Air conditioning may be needed to maintain normal building use (e.g., suitable patient conditions in a hospital) and to avoid unwanted conditions (e.g., mold growth).
- **Refrigeration.** Perishable products in cold storage can be lost if refrigeration is interrupted for an extended period.
- **Process control.** Industrial processes rarely operate on emergency power, but they often rely upon emergency power to bring operations to a safe shutdown.

Discussion

Where emergency generators are provided, verify they are arranged for reliable service. For example:

- Make sure all needed loads are connected to the generator.
- Operate emergency generators weekly.
- Test emergency generators under load at least annually.
- Verify the fuel supply is reliable. Where diesel engine-driven generators are supplied from day tanks filled from bulk tanks via fuel oil pumps, verify the fuel oil pumps and their power supplies are not subject to interruption. Consider storm surge, surface water runoff, flood, accumulation of water in fuel tank dikes, etc.
- Secure fuel oil tanks to resist buoyancy forces.
- Terminate fuel oil tank fill and vent lines above flood and surge water elevations.
- Arrange emergency generator air intakes so they will not carry wind-driven rain into engine air intakes.

Zurich Services Corporation's Risk Engineering

Zurich approach

Zurich Services Corporation's Risk Engineering conducts Hurricane Risk Assessments to evaluate named wind risk quality.

Discussion

At each property survey in hurricane-prone regions, Zurich Services Corporation's Risk Engineering conducts a Hurricane Risk Assessment. Risk quality is evaluated, and risk improvement advice is developed. The account team (client, broker and Zurich) then works together to develop an action plan to address wind risk improvement and any desire to pursue a superior wind risk grading.

ZURICH

Risk Engineering

Policyholder
Risk Improvement Report

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Zurich Services Corporation
Hurricane Survey Report

Parent Company:	**ABC Healthcare**
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Date of Assessment:	2/15/2006

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Zurich superior wind risk solutions

Zurich approach

Do not wait for the next hurricane season to take action.

Discussion

Establish a plan today.

- **Step 1** – Team – Make sure the full team is in the loop – insured, broker and Zurich.
- **Step 2** – Assess – Zurich Services Corporation's Risk Engineering will conduct a Hurricane Risk Assessment. The result will include wind risk improvement advice and follow-up action items.
- **Step 3** – Evaluate – How does the property compare to Zurich superior wind risk guidelines? Is superior wind risk an appropriate goal? Is more data needed?
- **Step 4** – Decide – If superior wind risk is a valid goal, map out a plan to achieve or validate each superior wind risk characteristic.
- **Step 5** – Implement – Take corrective action to improve features that do not meet superior wind risk guidelines. Zurich Services Corporation's Risk Engineering will assist with the review and acceptance of plan before work begins.

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