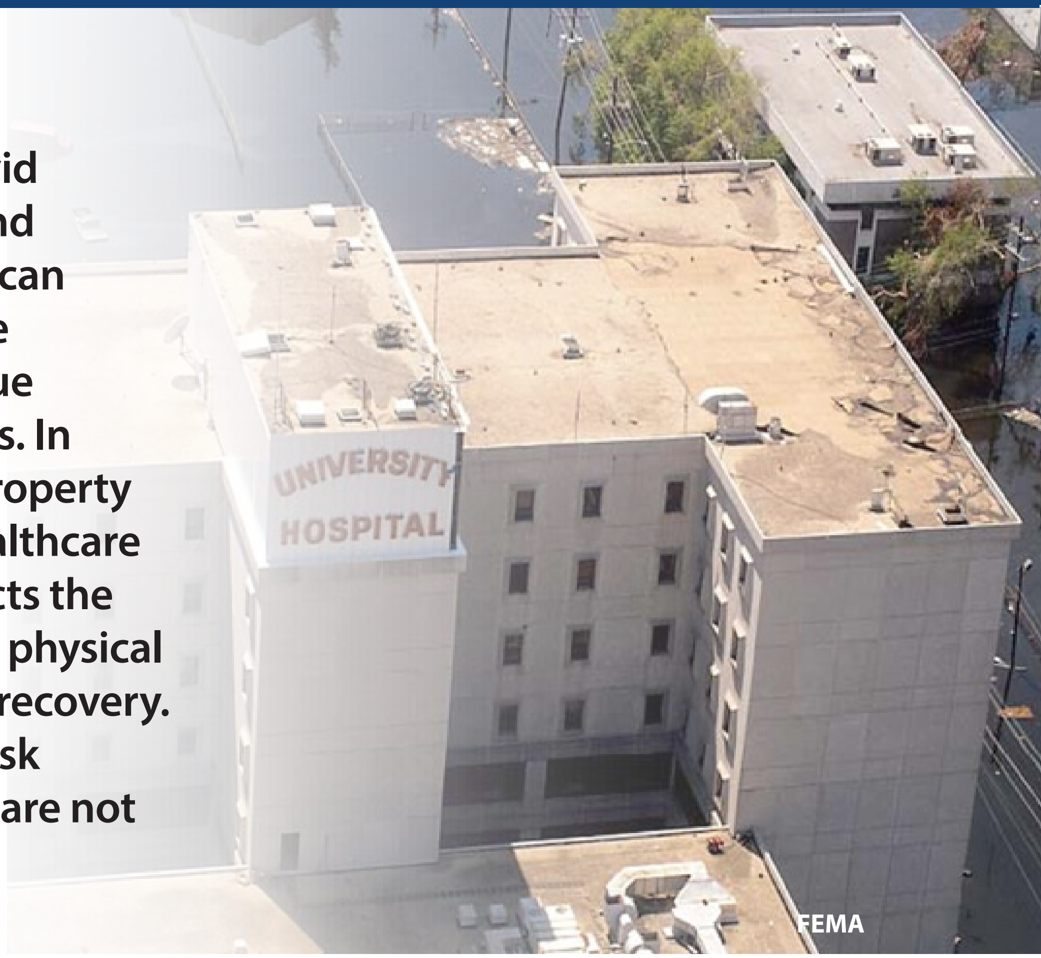
A PRESCRIPTION FOR DISASTER RESILIENCE:
The Importance of Mitigation for Healthcare Facilities

The recent anniversary of Hurricane Sandy was a vivid reminder that hospitals and other healthcare facilities can be vulnerable to extensive damage and loss of use due to extreme weather events. In addition to devastating property damage, disruption of healthcare operations adversely affects the surrounding community's physical well-being and economic recovery. All too often, lives are at risk when healthcare facilities are not resilient and reliable.



University Hospital in New Orleans surrounded by floodwaters after Hurricane Katrina.

Sandy forced many hospitals and other healthcare facilities to close due to damage from strong winds, storm surge, and/or loss of power for many days. Unfortunately, the patients needing hospitals and healthcare facilities don't go away when the power goes out. Regardless of weather-related conditions, ventilators, dialysis machines and other equipment must remain functional, and emergency surgeries must take place. In fact, demand can *increase*, as the entire community may view hospitals as places of refuge or one-stop shops for healthcare needs that may otherwise be handled by smaller outpatient facilities that are closed or inaccessible due to the disaster.

This article reviews some basic mitigation and disaster planning issues for hospitals and other healthcare facilities. More detailed information is available from a variety of sources, including FEMA 543 *Design Guide for Improving Critical Facility Safety from Flooding and High Winds.*[1] The focus of this article is to explain why hospital/healthcare disaster preparedness is important to the community, identify the core elements of structural and operational disaster planning, and describe to business and community leaders why this is a priority as they work to assure that their localities are storm-ready.

Workers clean utility equipment at Bellevue Hospital in New York City after Hurricane Sandy in 2012. Note the orange line painted on the wall showing the water depth.

PROACTIVE VS. REACTIVE MITIGATION

Local building code improvements and mindsets often change only after severe weather devastates a community or region, which is usually too late. In most cases, the cost of hardening a facility is far less than the cost of reconstruction or rebuilding. Even worse, many hospitals and healthcare facilities face the real possibility of never re-opening following extensive damage. Never re-opening was the case for several hospitals after Hurricane Katrina and was under consideration in places like Galveston, Texas, (2008 Hurricane Ike) and Joplin, Missouri (2011 tornados), where major healthcare institutions are reopening only after extensive and expensive rebuilding efforts. Healthcare administrators should not consider proactive mitigation to be just a capital improvement that can be put aside until more money becomes available; it is critical to both the immediate and long-term bottom line. Mitigation investments protect physical assets and business operations, and they also help preserve the organization's financial stability.

Proactive mitigation projects for healthcare facilities typically include strengthening building envelope components and utilities; flood protection for buildings and equipment; emergency power improvements; water and wastewater sanitation securement; and emergency preparedness and business continuity planning, as discussed in this article.

HARDENING BUILDINGS TO BETTER WITHSTAND HIGH WINDS

High winds occur in all parts of the United States, not only in the Gulf Coast and Atlantic Seaboard "hurricane zones." The best way to protect healthcare facilities against wind damage is to harden the building envelope—including the roof cover system, roof deck, windows, walls, large shipping/receiving doors and personnel doors. Hospitals located in hurricane-prone areas should use impact-rated window and frame systems that include a product approval based on strict testing requirements, such as Miami-Dade or FM Approvals. As an example of resilient rebuilding, the new Mercy Hospital in Joplin, Missouri, which is replacing the previous hospital destroyed by an EF-5 tornado, will include impact-rated laminated window and frame systems. These systems are designed to withstand 140 mph winds for larger-size windows and 250 mph winds for smaller windows; both are impact resistant. The smaller windows have passed testing criteria that include withstanding penetration of a 15-pound 2' x 4' piece of lumber shot at 100 mph. Since this is a tornado-prone area, the test criteria used exceeds typical 2' x 4' impact tests.

The importance of building strong holds true for many other building materials and systems, such as roof cover systems, perimeter roof flashing, doors, various wall systems, and fire protection systems. For example, when hospitals build new facilities or expand existing facilities, they should use reinforced structural concrete roof decks. Post-storm investigations of hospitals have proven that reinforced concrete decks with a fully-adhered roof cover system perform well during high winds. Even in instances where portions of the roof cover system were torn or peeled back, no interior water intrusion occurred, and there was no damage to medical equipment or interior finishes, or interruption of business operations. Structural concrete decks also can provide the option of future expansion upward, which is advantageous to medical campuses that are land-locked by development.

Medical facility damaged by high winds during 2004's Hurricane Charley in Florida.

PROTECTING AGAINST STORM SURGE/FLOODING

Along with high winds, coastal properties or facilities near rivers and other bodies of water are vulnerable to storm surge/flooding. Facilities that are protected by local area flood protection (LAFP) systems such as levees and dams also may be exposed to flooding if there is a failure in the LAFP. The best way to prevent flood damage is to build facilities away from coastal or inland bodies of water. However, if this is not possible because of the need for proximity to the patient population, IBHS recommends elevating the building three feet above FEMA's Base Flood Elevation (BFE) level, or protecting vital equipment from flooding as outlined in the remainder of this section.

Lessons learned from Tropical Storm Allison in 2001, have resulted in many hospitals that have been constructed during the past dozen years to place their emergency power systems and utilities on higher floors. However, many existing healthcare facilities have not made retrofit improvements. This was apparent after Hurricanes Katrina and Sandy when many emergency power systems in hospitals failed due to flooding of lower levels where the generators, fuel supply and pumps, and/or electrical switchgear were located. In addition to emergency power systems, other resources that should be raised above potential flood levels or protected include critical medical equipment, medical records, building systems such as electrical distribution systems, HVAC and other utilities located in basements and ground floors. While moving these systems to higher floors and redesigning floor plans to accommodate them is expensive, it is not as costly as doing nothing. The cost of replacing state-of-the-art equipment, the loss of income due to storm damage, and the disruption of patient care all outweigh relocation and redesign expenses prior to a flood.

Another option is utilizing "dry flood proofing" techniques. These measures should anticipate the depth of the water as well as the duration of the flood and the velocity of the flood waters. When estimating flood depths, include a factor of safety, such as one to three feet for very shallow flooding and three feet or more for deep riverine flooding and storm surge. Options include permanent or moveable protection such as:

- sealing penetrations coming into buildings around utilities;
- inflatable water barriers that can be interconnected and stacked;
- permanent swing flood doors or moveable flood gates (as shown below);

- submarine doors, which provide permanent flood protection for deeper water (as shown below);

- flood walls for prolonged deep waters surrounding the building; and
- sand-bagging with plastic sheeting and sealants around doors. This may help protect vulnerable entry points but is very labor intensive, both before the storm and after, when water-logged sandbags and sand must be removed. There also are numerous new water-absorbing sacks that are used like sandbags.

Consult with a professional experienced in these techniques before determining whether they are appropriate for your facility. IBHS has several resources regarding flood protection, including *The Power of Water: How to Prepare and Protect Your Business from Floods* at www.disastersafety.org/news/the-power-of-water-how-to-prepare-and-protect-your-business-from-floods-4.

EMERGENCY POWER

Power is the lifeblood of almost every healthcare facility. It is required for life safety and life-sustaining medical equipment; heating, ventilating, and air conditioning (HVAC) to maintain comfortable temperatures for vulnerable populations ranging from newborns to the elderly; and a wide range of support apparatuses including lights, elevators, phone chargers, food service equipment, laundry machines, and countless other electronic devices.

Given this panoply of needs, "whole hospital" emergency power should be included in newly constructed locations and retrofits installed for existing facilities, typically including a diesel engine generator, automatic transfer switch or storm switch, and fuel supply. There are three main electrical service branches for hospitals: the life safety branch (emergency lighting, evacuations signs, strobes, alarms, etc.); the critical branch (surgery, delivery rooms, ICU, emergency rooms, coronary care, various inpatient critical care areas, one "red" duplex receptacle in patient room, etc.); and the equipment branch (fire pump, refrigeration, medical vacuum and air, HVAC systems, domestic water and sewage pumps, etc.).

While life safety and critical branches are always included in emergency power designs, not all equipment branch items, especially HVAC, are connected in existing facilities. However when emergency power does not include all the equipment branch items, it puts the hospital at a severe operational disadvantage. With the advance of medical technology, there can be 10-12 electronic devices in a standard patient room, but only one red duplex receptacle, which is on the critical branch. Critical care rooms require additional devices, but they only have two red duplex receptacles on emergency power. Without HVAC systems, which are on the equipment branch, patients may be exposed to sweltering heat or chilling cold. Maintaining proper air quality throughout the HVAC system also prohibits mold growth in areas where there may be water intrusion.

Emergency power also should include redundancy such as:

- redundancy for generators ≥ N+1 up to N + N, where N = the number of generators;
- multiple automatic transfer switches;
- multiple fuel suppliers; and
- fuel supply that lasts more than 96 hours.

IBHS also recommends following the requirements of the International Building Code, NFPA 99: Health Care Facilities Code, and NFPA 110: Standard for Emergency and Standby Power Systems.

ADDITIONAL FUEL NEEDS

Following Hurricane Sandy, critical facilities, businesses, and residents throughout the region were without power for an extended period after the storm passed. For those who did have back-up power, such as diesel- and gas-operated generators, re-fueling them was extremely difficult. Healthcare facilities, including hospitals, simply ran out of fuel and were forced to close their doors. Additionally, for hospitals and healthcare facilities that were able to open, employees had difficulty getting to work without gas in their cars. Without a full staff, normal hospital functions and staffing patterns were altered.

This fuel shortage problem occurred in Florida following Hurricane Andrew in 1992, and subsequent storms. In 2007, Florida enacted a state law requiring emergency power for gas stations, and several northeastern states have proposed or enacted similar legislation since Hurricane Sandy. This is an important resiliency measure all states should consider, given the prevalence of widespread power outages following severe weather events.

POTABLE WATER AND WASTEWATER SYSTEMS

Uncontaminated potable water is another critical component of healthcare. In anticipation of a possible operations problem from the local water department or line breakage from a natural disaster, an alternative water source should be included in disaster preparation. For hospitals, this may include the use of onsite water storage tanks, freshwater wells with the wellhead above flood levels, and/or stored bottled water.

For wastewater systems, it is imperative to prevent sewage back-up into the lower floors. This can be done by placing a backflow prevention device on main sewage lines. Also, onsite lift stations and sump pumps must be connected to emergency power.

HABITATIONAL AND HEALTHCARE SUPPORT SERVICES PLANNING TOOLS

In addition to hospitals, assisted living facilities, nursing homes, residential homes for the elderly, rehabilitation facilities, prescribed child care centers, outpatient diagnostic centers, medical laboratories, walk-in clinics, pharmacies, and other healthcare operations play a vital role in serving the health needs of a community and facilitating its recovery from a disaster. Therefore, it is essential that they also harden their facilities and prepare their operations in a proactive manner.

IBHS' FORTIFIED for Safer Business™ (FFSB) program is intended to help habitational and healthcare support facilities (and other small/medium-size businesses) better prepare for disasters by housing their operations in buildings that are well-designed and properly constructed for the natural hazards that are likely to occur in their region. In November 2012, Pee Dee Nephrology in Florence, South Carolina, became the first healthcare facility to receive a FFSB designation for a single story, 10,000 sq. ft. medical office building. In addition to preventing or reducing property damage, this milestone means that Pee Dee Nephrology will be in a much better position to open immediately after a major storm and provide dialysis and other vital medical services to their patients. This type of mitigation for habitational and healthcare support facilities also reduces the demand on hospitals, which otherwise might be called upon to provide emergency services to patients who cannot access their regular outpatient facilities. IBHS believes that FFSB standards are appropriate for a wide range of supporting medical service facilities, although additional requirements are recommended for hospitals and other large institutions. The FFSB standards can be found at: www.disastersafety.org/fortified/safer_business/business-property-owners.

The Carrell Group designed and built the Pee Dee Nephrology medical office using FORTIFIED for Safer Business™ standards. The above photo shows Fred Malik (left), FORTIFIED programs manager, Grant DuBose (center), Carrell Group vice president/operations, and Bruce Carrell (right), Carrell Group president, at the medical office's designation ceremony.

Healthcare support facilities also should have well-documented emergency response and business continuity plans in place well in advance of a storm. Creating and implementing these plans can mean the difference between quickly resuming operations and remaining closed indefinitely or even permanently. IBHS's streamlined OFB-EZ™ program, based on the Institute's original Open for Business® (OFB) program, is a property protection and recovery planning toolkit. The program helps small and midsize outpatient-type locations and other small businesses better understand the risks they face; plan how to contact key suppliers, vendors and employees; understand how to access data; and identify where to go for help after a disaster. To learn more and download the free toolkit, visit www.DisasterSafety.org/open-for-business. Additional business emergency planning recommendations before a storm are available in IBHS' article *How to Navigate Stormy Weather: Emergency Preparedness and Response Planning* at www.disastersafety.org/commercial_maintenance/navigate-stormy-weather-emergency-preparedness-response-planning.

Hospitals and other healthcare facilities exist to protect the physical well-being of the people who live in their communities. It is critical for those in the community to help protect the well-being of the healthcare institutions that serve their needs, by making sure their buildings are disaster resistant and their operational planning is disaster-ready.

---

[1] *FEMA 543 publication Design Guide for Improving Critical Facility Safety from Flooding and High Winds: http://www.fema.gov/media-library-data/20130726-1557-20490-1542/fema543_complete.pdf.*