Ensuring Survivability: Preparation Can Increase the Survivability of a Facility in the Event of an Emergency

The Military Engineer
January/February 2007

The devastation that New Orleans, La., experienced from hurricane Katrina was a natural calamity. But the impact of that same storm on the Mississippi Gulf Coast caused widespread damage many miles inland. Hurricane-force winds demolished buildings, or damaged roofs, doors and windows, rendering buildings non-functional.
With the threat of more severe weather in the future and the possible dwindling of federal funds available to assist after an emergency, facility managers must become more proactive.

Causes of Loss of Function

Understanding the modes of failure in a building envelope will assist in determining preventive steps that can be taken to avoid catastrophic failure of critical building components and systems.

The biggest cause of loss of building functionality is loss of power. A basic classroom building relies heavily on lighting and climate control to function, but a research laboratory's power needs are more critical because research can be ruined due to loss of refrigeration or other climate controls. Because of this, many facilities rely on backup generators to provide contingency power. The downside is that generators require fuel. As the 2005 hurricane season taught us, the evacuation movements of the population will cause shortages of fuel at many locations. Without a safely stored stockpile of fuel, even a back-up generator is useless.

Flooding also can contribute to loss of functionality. Buildings in flood-prone areas, either below sea level or directly in the path of a storm surge, will periodically flood, destroying a building's interior finishes and contents. Structural integrity also may be affected, and can result in the decision to completely demolish and replace a building. The loss of a roof, or roof damage, due to high winds also can cause a facility to lose functionality. Extreme wind pressures can cause roof failure by pulling off the roof assembly, and sometimes the roof structure. Loss of window and doors contribute to roof loss as well. Loss of a roof is just as calamitous as a flood because water will enter the building.

Buildings also may experience damage to wall and cladding systems. Although generally not as vulnerable as doors and windows, cladding systems have failed due to extreme wind pressures and the impact of large projectiles (wind-borne debris). Barrier wall

systems are most vulnerable because they rely on a coating at the exterior of the wall assembly to repel water and typically do not have durable backup material such as concrete masonry or wood sheathing.

Strategies for Facilities Preparedness

Certain measures can be taken to improve the chances that a facility will maintain its functionality even in the most severe weather conditions.

Ensure Reliable Back-up Power. It is vital to have a plan to bring power systems online quickly. Also, just as a homeowner would prepare for a storm by stockpiling batteries, so should a facility manager. Many devices that will be useful during an emergency operate on batteries, including radios, televisions, flashlights and telephones. Facility managers should stock rechargeable batteries, such as car batteries or small solar photovoltaic cells, as well as the means to recharge them.

One reliable power back-up system would be simply relocating key functions to other facilities outside the impact zone, where power is expected to be more reliable. Have a plan to relocate critical materials, such as scientific experiments, records and archives, key computers, etc., in safe locations. If you cannot relocate them, at least store them on shelves to prevent flood damage.

Protect the Roof. The primary mode of roofing failure is typically around the perimeters. Facility managers should reinforce the perimeters by installing additional anchors for perimeter flashing, especially in older buildings that have not been designed to meet current wind code requirements. Depending upon the wall substrate, maintenance personnel or roofers should install additional fasteners or screw anchors with washers on the face of the edge metal or coping face flanges, with the highest priority being at corner zones and about 24-in on-center in the perimeters.

On roofs where adhesion of the roof system is suspect, a system of ballast or weights (such as concrete pavers or even sandbags) can be used at vulnerable perimeter areas. Adding these materials to the roof is typically laborious and time-consuming. Adding mechanical fasteners to membranes may be quicker and more effective.

Building Envelope Protection. Building openings such as doors and windows are vulnerable as well. Normal annealed or tempered glazing will fail if struck by windborne debris. Storm shutters are a time-proven method of storm protection for windows and still one of the most effective means of preventing envelope failure at windows and doors. Plywood panels and steel deck material can be used in lieu of shutters. New lightweight corrugated plastic materials also provide a level of protection for windows and doors.

Window films applied to the inside of the glass also provide a level of protection, but use should be limited to upper floors, as films are generally not tested for large projectile resistance.

Mitigate Storm Water Problems. Flooding aside, the capacity of storm water drainage systems such as roof drains and gutters will affect a building's survivability. In a hurricane, rainfall may be heavy in a short period of time. This can overwhelm roof drains, causing a backup of water weight on a roof beyond its design capacity. Simple maintenance such as routinely clearing debris that could clog drains and maintaining scuppers and secondary drains can prevent damage.

Roof Appurtenances and Accessories. Reinforce or anchor air-conditioning equipment and fans using additional screw fasteners. As a rule of thumb, make sure that the spacing between screw anchors does not exceed 12-ins around the perimeter of any curb. Ducts along the top of the roof also need to be reinforced. The addition of metal or even nylon straps at strategic locations can help reinforce the duct and provide supplemental anchorage down to supports.

Louvers. A major cause of water intrusion is wind-driven rain through louvers. Louvers are simply holes in the walls that are placed to provide air for heating, ventilation, and air conditioning purposes. Most louvers do not have the ability to keep wind-driven rain out. In that case, it is important to treat louvers much the way we would any other opening. An effective way to protect louver openings is to place a shutter or a closed panel over the louver prior to storm impact.

Summary

With an understanding of how and why buildings fail in a major storm event, we can better prepare to meet these challenges with contingency planning, proactive maintenance and facility improvement.

Plan for Facility Survival (sidebar)

- Establish a base of operations from which to coordinate recovery and repair efforts.
- Develop a schedule of milestones for repair work.
- Assign repair tasks to specific individuals or contractors prior to the emergency.
- Stockpile resources such as batteries, fuel, roof repair materials and tarps in a location where they can be quickly retrieved.
- Ensure each department develops a contingency plan and arranges temporary relocation options if necessary.
- Establish cooperative arrangements with educational or private sector entities for temporary relocation of assets or functions.

- Develop a primary and backup communication protocol, and establish team staging and assembly locations.
- Maintain on-call contracts with constructors and consultants to expedite emergency assessments and repairs.

For each roof or wall assembly, develop a repair manual specifying materials and personnel responsible for repairs.