Building for Resiliency
Fast-Deployment Solutions for Mitigating Flood Damage

FLEX-WALL™

SMART VENT®
Foundation Flood Vents

ILC DOVER
creating what’s next®
ARE YOUR BUILDINGS PROTECTED FROM INUNDATION?

Hurricane Sandy was a wake-up call for New York City...indeed, for every building owner near a coastal area or river. And especially for owners of facilities housing critical infrastructure or high-value assets—hospitals, power generating plants, data and telecommunication centers, government buildings, water treatment facilities, nuclear power plants, and other critical buildings.

How would your vulnerable buildings fare in the face of such a disaster? Can you deploy a protection solution quickly? Is the deployment economical enough to allow you to deploy even when forecasts are not certain? If the storm or other disaster threat bypasses your location, can you have your buildings back in normal operation within hours?

Answers to these and similar questions are crucial to an accurate assessment of the resiliency of your flood protection systems.

The threat and the need for improved resiliency

Flood-event frequency, especially in coastal areas, is projected to rise steadily over the next several decades. The U.S. National Oceanic and Atmospheric Agency (NOAA) notes that sea levels have risen on average about 0.04 to 0.1” per year since 1900, and the rate appears to be accelerating. Using newer satellite altimetry, sea level rise has been measured at an average of 0.12” per year since 1992.

Even conservative projections of future sea level change suggest a rise of 12” to 20” over the remainder of this century, with some estimates much higher. It is no surprise, then, that flooding frequency in coastal areas is expected to increase as well.

Similarly, a recent analysis of U.S. interior stream and river flooding found that the frequency of flood events increased in 34% of more than 770 locations studied, while decreasing in only 9% of locations.
The challenge of traditional flood protection solutions

Until now, for buildings located in flood-prone areas, only a few flood-protection options have been available. And none have offered the versatility and resiliency of flexible barriers.

Historically, the most common system has been stop logs, a system of vertical, slotted posts that hold stacks of horizontal rectangular “logs” that can be erected around the building, or around critical doorways and openings to form a continuous barrier.

The most significant issue with stop logs—and similar aluminum-sheet barricade systems—is that materials must be stored either onsite, in what could otherwise be valuable, revenue-generating space, or offsite, often at some distance from the building they are intended to protect. It can take as long as a week or more to retrieve the truckloads of materials required to erect a barrier around the perimeter of a typical commercial or government building.

For weather-related events, this can mean having to make a decision to deploy or not to deploy well before forecast models have reached a consensus about storm paths and severity. Deploying unnecessarily is expensive; hesitating to deploy to avoid that expense can be catastrophic. Further, because of the unpredictable nature of some natural disasters, like earthquakes or dam breaks, and terror-related acts that can cause flooding, it can be virtually impossible to retrieve and erect a stop-log or barricade system in time.

The quick-deployment solution

Recognizing the weaknesses in existing flood mitigation technology, ILC Dover began its development of a quick-deployment system. Using its experience in fabric barrier technology—originally perfected in its manufacture of space suits to protect American astronauts from the hazards of outer space, and expanded in a number of critical industries—the company set out to configure a flood mitigation system that would offer full flood protection, using equipment that could be stored in place and deployed by building maintenance or security staff.

System design objectives were established after a careful analysis of available systems. They were:

- Point-of-use storage—to allow the facility to stay open until the last possible moment, and reopen faster
- Quick-deployment architecture—to assure minimal set-up times
- Low operational impact—simple to install, compared to existing common solutions
- Low stowed volume—to fit in tight spaces located at the point of use
- Low maintenance—based on minimal mechanical complexity
- High reliability—proved via simple designs and robust construction

ILC Dover Flood Mitigation Products and Their Application Points

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<th>Flood Mitigation Product</th>
<th>Description</th>
<th>Application Points</th>
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<tr>
<td>Flex-Wall™</td>
<td>Flexible wall and posts that are raised from a box below grade (vertically deployed) or from a box adjacent to an opening (side-deployed)</td>
<td>Wide flood zones, Stairwells, Doors, Below-grade window wells</td>
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<tr>
<td>Flex-Cover™</td>
<td>Flexible cover that is attached to a grating or vent to seal an opening</td>
<td>Ventilation shafts, Intake/exhaust openings</td>
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<td>Flex-Gate™</td>
<td>Flexible roll-out door that packs into a small space at point of use, similar to a store-front security door, that deploys horizontally or vertically</td>
<td>In-ground stairwells, Doors, Parking garage portals, Below-grade loading dock portals, Emergency Exits, Rail and vehicular tunnel portals</td>
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<tr>
<td>Resilient Tunnel Plug</td>
<td>Inflatable barrier expands to create a plug that conforms to and seals the full perimeter of the opening</td>
<td>Vehicular tunnels &amp; portals, Rail tunnels and tunnel portals</td>
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- Lightweight materials—to facilitate safe & rapid manual operation
- Conformal materials—adaptable to any opening
- Scalable—easily sized and configured to structural profile and expected loading

The result of ILC’s design effort is its Flex-Wall™, Flex-Gate™, Flex-Cover™ and Resilient Tunnel Plug systems. Together, they represent an advanced structural technology that can meet the resiliency needs of government and commercial buildings and infrastructure, worldwide.

**Flex-Wall™**

For commercial and government buildings—the topic of this white paper—the most commonly used technology is the Flex-Wall™ barrier.

Taller Flex-Wall™ systems use a flexible Kevlar® composite woven into an extremely tough mesh fabric with a polyurethane-coated nylon to serve as the water barrier. The Flex-Wall™ (and Flex-Gate™) barrier is supported by rugged structural members; yet, with their softgoods base, these systems can be deployed easily by one or two persons, often in a matter of minutes.

Even a full-perimeter, 8’ Flex-Wall™ flood barrier can be erected around a typical commercial building in a matter of a few hours, because all materials are stored at the point of use, and have only to be extended and locked in place.

Once conditions are safe, Flex-Wall™ systems can be stowed as efficiently as they’re deployed. After a flood event, a resumption of normal operation can be expected in hours or a day or two, depending on clean-up requirements—rather than the days or weeks required to clean, dismantle and cart the components of stop-log or aluminum-plate systems to storage facilities.

If no flooding occurs, Flex-Wall™ stows quickly and normal operations can usually be resumed in about the same amount of time required to deploy.

The Flex-Wall™ system allows this because it is typically installed in a horizontal trench just below grade, or in a vertical container installed at the side of a doorway or portal opening. Because the Flex-Wall™ material is flexible, it can be packed into a small container.

For instance, the flexible barrier portion of an 8’ vertical wall fits in a space just 8” x 8”. Total trench cross-section, then, can be the 8” x 8” space for the wall plus enough additional space for the support posts, lying flat. With such small size, the Flex-Wall™ system requires minimal infrastructure modification for installation. The Flex-Wall™ can be scaled in height and length to fit any application, and self-contained so no special tools or training are required for operation.

**Vertically deployed Flex-Wall™**

Within the trench housing the system, the flexible wall is clamped to the base of the container and sealed so leakage past the barrier remains well within acceptable standards. In its stored condition, it looks the same as a storm drain on a road, or a sill in a doorway.
The Flex-Wall™ consists of a container, post mounts, posts, the flexible wall, a clamping plate, and a lockable cover. Deployment of the system is simple and can be accomplished in minutes by a single operator.

The deployment steps are:

- Unlock & open the container
- Lift / rotate the posts and place them in the mounts
- Lift the cover and attach it to the tops of the posts
- Sealing the flexible wall at the end terminations is accomplished by a gasket on the end posts that interfaces with a wall, or another post in a circular configuration. The Flex-Wall™ can be designed to curve around any object or structure, and is therefore adaptable to most installation locations.
**Side-deployed Flex-Wall™**

For some doorway and portal openings, deploying the Flex-Wall™ from the side of the opening makes more sense. In such cases, the storage container is mounted to one side of the opening and a receiver is mounted to the other. In time of need, the Flex-Wall™ fabric barrier is extracted from the storage box, stretched across the opening, and affixed to the receiver on the far side. For wider openings, a center support beam may also be employed.

**Side-deployed, boxed-out Flex-Wall**

In some critical-infrastructure applications, provision must be made to allow egress from a building after the Flex-Wall™ protective barricades have been deployed. In such cases, a boxed-out configuration of a Flex-Wall™ system will provide the same flood protection as a system mounted flush to the face of the building. At the same time, a series of step points can be built into the vertical storage and receiver members, both inside and outside the Flex-Wall™ structure, to allow climbing out of the building.

**Other ILC Dover Flood Protection Systems**

**Stairwell Flex-Gate™**

ILC’s Flex-Gate™ systems are designed to provide fast protection for below-grade stairways leading to parking garages, basement access doors, below-grade utility vaults and the like. These systems include a stainless steel box mounted at one end of the stairwell, holding a rolled CSM-coated, Kevlar-reinforced fabric mesh similar to that used for Flex-Wall™ systems.
When deployed, the Flex-Gate™ is merely extended along a set of guide rails at the edge of the opening, and locked into place at the top of the stairway, effectively sealing it.

When properly installed, Flex-Gate™ systems withstand vandalism, can resist a 16’ head of water with minimal leakage, and can be deployed by one person in about ten minutes in 30mph winds—yet, when stowed, they do not encroach on the stairwell they protect.

**Portal Flex-Gate™**

The Portal Flex-Gate™ is larger than the stairwell/doorway Flex-Gate, but the design is very similar. The difference is that the larger systems can be equipped with a drive motor that operates similarly to a garage-door opener to simplify operation.

However, every system also has a manual back-up to assure deployment and retraction capability in the event of power outages.
Thorough testing proves adherence to rigorous specifications

At its Flood Mitigation Test Bed facilities at its Frederica, DE headquarters, ILC Dover has exhaustively tested all of its Flex-Wall™ and Flex-Gate™ systems to establish benchmark performance data and to prove adherence to applicable industry standards and specifications.

Testing requires that both the stowed systems and the deployed systems be able to withstand expected adverse events without compromising function.

At left: Two 8´ spans of 4´ high, vertically deployed Flex-Wall™ (5´ to base of trench), challenged with 3´ of water. Portal Flex-Gate, 14´tall x 16´ wide, challenged with 15´ of water. Deployment in 5 minutes by a crew of one.

Same Flex-Wall™ as above is impacted by 670-lb., 12˝ diameter log at 5 fps, with no damage and no change in leakage rate.

Portal Flex-Gate, 14´ tall x 16´ wide, challenged with 15´ of water. Deployment in 5 minutes by a crew of one.

Support post impacted by 1,000-lb. log at 5 fps. Resultant permanent deformation less than 1˝ (FM spec requires permanent deformation less than 6˝).
ABOUT ILC DOVER

ILC Dover has been developing solutions for flood mitigation and other deployable barriers for infrastructure protection needs for many years. In the 1990s we designed and manufactured Stream-Saver™ inflatable pipe plugs to prevent accidental discharges from chemical plants, and Vapor Guard™ flexible covers for wastewater treatment facilities. More recent efforts include the development of the Resilient Tunnel Plug for the Department of Homeland Security, and our Flex-Gate™ solutions for the New York Metro Transit Authority. These products leverage technology solutions from our product base including the space suits for NASA, airships, chemical and biological protective equipment, and specialty inflatable structures. All of our products are designed and tested to prove their reliability because they are designed for preservation of life or protection of costly equipment.

High reliability products designed and manufactured by ILC Dover include space suits, airships, personal protection equipment and Radomes. Learn more about us at www.ilcdover.com

Contact Information
For information on products and services please contact:

Smart Vent Products, Inc.
430 Andbro Drive, Unit 1
Pitman, NJ 08071
877.441.8368
flexwall@smartvent.com
www.smartvent.com