FEMA Building Science Branch
Keeping Critical Facilities Safe from Flooding: FEMA’s Recommendations from Hurricane Sandy MAT Report

Observations, Conclusions, Recommendations, and Technical Guidance
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Outline

1) Mitigation Assessment Team (MAT) Overview
2) MAT Conclusions and Recommendations - Critical Facilities
3) Sandy MAT Impacts
4) Questions and Answers

Note on MAT Recommendations and Building Code/Regulation Updates

1) Building code/regulation updates adopted based on Sandy MAT recommendations shown in **bold**.
2) Building code/regulation updates proposed based on Sandy MAT recommendations shown in *bold italics*.
### Team Members

- FEMA
- National Institute of Standards and Technology (NIST)
- International Code Council (ICC)
- National Association of Home Builders (NAHB)
- Department of Housing and Urban Development (HUD)
- Industry
- Academia
- National subject matter experts

### Partners

- NJ and NYS Local
- NJ and NYS Sea Grant
- NJ and NYS Association of State Floodplain Managers (ASFPM)
- NJ Builders Association
- NYC Mayor’s Office
- NYC Dept. of Building
- Department of Energy (DOE)
- NY American Institute of Architects (AIA)
- Department of Health and Human Services (HHS)
- Environmental Protection Agency (EPA)
- Federal Alliance for Safe Homes (FLASH)
- Institute for Business and Home Safety (IBHS)
MAT deployed in four sub-teams:

- *Coastal unit*
- High-Rise, Police, Fire, Municipal, and Schools unit
- ▲ *Historic unit*
- ♦ Hospitals and Other Critical Facilities unit
Conclusion: Elevated critical building systems resulted in a functioning building post-event.

Recommendation: Protect critical building systems in basement or subgrade areas susceptible to flooding by relocating, elevating, dry floodproofing (with emergency power for drainage pumps), or designing system and component redundancy (RAs 2 and 4)

NYC Local Laws 83/13 (Backflow Prevention), 99/13 (Raising Building Systems), and 100/13 (Relocate and Protect Building Systems in Floodprone Areas)
**Conclusion:** Fuel tanks often not adequately designed or protected against flood

**Recommendations:**
- Dry Floodproof fuel tanks located below-grade per ASCE 24 or design to resist buoyancy and crushing pressures
- Redundancy should also be considered when the facility is in flood zone
Conclusion: Shared subgrade areas can allow water to enter into adjacent buildings

Recommendation: Implement measures to ensure that flooding from one area does not damage other areas or buildings:

• Dry floodproof
• Wet floodproof
**Conclusion:** Below-grade sections of elevators are vulnerable to inundation

**Recommendation:** Elevate or floodproof elevator system components in accordance with FEMA NFIP Technical Bulletin 4
Conclusion: Different code requirements for emergency power system components result in inconsistent flood protection:

- Generator
- Fuel Tank
- Controls
- Fuel pumps & distribution
- Fuel supply and delivery

Recommendations: 1) Emergency power system components require consistent protection to ensure functionality during flood. Building owners should provide emergency power systems for facilities.
**Recommendations:** (continued)

2) Critical infrastructure needs to withstand and rapidly recover from all hazards. Lower floors should be floodproofed or evacuated and preparedness plans should include a contingency for lack of access to or from the building post-event.

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**Disaster Plans**

Traditional disaster plans often center on how a facility will mitigate a single event. The events of Hurricane Sandy illustrate the importance of expanding disaster planning to account for simultaneous events like flooding and loss of power.
Conclusion: Inadequate or vulnerable interior drainage systems contributed to inundation of basements

Recommendation: To address ground saturation and increased seepage into basements, facility owners should install sump pumps that are tied to emergency power systems
**Conclusion**: Facilities not identified as “essential” or “critical” (Risk Category IV) by building codes (but are to a community) may not be required to meet higher standards.

**Recommendation**: In addition to those facilities identified by the building code, the local jurisdiction should determine which facilities are critical or essential and should meet flood resistance design criteria, performance goals, and governing standards for Risk Category IV buildings.
Conclusion: Building systems disrupted when directly inundated or intentionally shut down pre-event to reduce damages. Loss of utilities affected facilities’ ability to function and provide service.

Recommendation: Design new buildings, repairs to existing buildings, and systems supporting critical functions to resist disruption. Owners and operators should provide emergency power systems to reduce outages. Suggested approaches:

- Establishing and maintaining connection points for temporary facilities
- Establishing and maintaining redundancies
- Prioritizing which electrical systems will utilize back-up power or emergency generators

- Protecting elevator service
- Using flood damage-resistant materials
- Limiting use of lower floors
- Elevating temporary equipment
- Consider intentional, controlled shutdown, where appropriate
Conclusions:
• Emergency evacuation is difficult and dangerous
• Most hospitals experienced complete power loss, including back-up systems. Hospitals struggled to provide care, perform evacuations in the dark and start up quickly after the event

Recommendation: Healthcare facilities should plan for extended complete power loss and associated loss of other utilities by developing emergency plans that include emergency operations, training exercises, and procurement of emergency systems and supplies

Proposed announcement from HHS, Centers for Medicare and Medicaid Services (CMS) providers/suppliers
Conclusion: Key equipment on lower floors is vulnerable to flooding (i.e., CT scanner, MRI machines, refrigeration equipment for blood banks, vital records, etc.)

Recommendations:

• Healthcare facilities should prepare key records in advance of a storm to aid continuity of patient care in the event of power loss or evacuation.

• Facilities should identify back-up spaces for critical functions that cannot be moved, and may want to consider subcontracting non-critical functions, as part of their planning process. (RA 2)

NYC Local Law 95/13 – Healthcare Facilities
Conclusion: Many subway and rail facilities were in flood hazard areas, and were major sources of flooding to the tunnel system

Recommendations:

• Develop and execute a more robust plan for moving critical assets (rail/subway cars) out of high hazard areas

• Install barriers and floodgates to prevent floodwater entry into transit facilities at key points

NYC Local Law 109/13 – Flood Barriers
Conclusion: Availability of fuel for generators and vehicles, as well as the ability to deliver it, was sharply reduced in the affected areas, affecting critical facilities and key assets.

Recommendations:

• Any facility that must be functional during and immediately after a disaster event should include plans for maintaining fuel supplies during emergency situations including:
  • Fuel for generators
  • Emergency employees
  • Work vehicles
  • Coordination with a fuel supplier

• Protect subgrade fuel pumps from flood damage and arrange for emergency power for gas stations that need to remain operational. If emergency generators are not installed, consider a dedicated circuit to quickly connect portable generators.


**Conclusion:** Quality of planning and preparedness for Hurricane Sandy at buildings visited varied greatly

**Recommendations:** Vulnerability assessments should…

- Identify all critical and essential facilities within area subject to flooding
- Provide mitigation goals that address current building code compliance, local floodplain ordinances, preparedness and mitigation, continuity of operation, and measures to minimize damage and recovery efforts
Conclusions:

• NFPA 99 flood provisions not consistent with ASCE 24, and ASCE 24 is not listed in NFPA 99 Chapter 2, “Referenced Publications.”
• NFPA 99 contains flood provisions for protecting emergency power systems and communication systems but is only referenced by Section 407.10 “Hyperbaric Facilities” in the IBC.

Recommendations:

• Revise NFPA 99 to include ASCE 24 as a referenced publication and revise the flood criteria to be consistent with or more restrictive than ASCE 24.
• Revise IBC to reference NFPA 99 for other portions of hospitals that serve or support critical functions other than hyperbaric facilities.
Part 3: Sandy MAT Impacts

Hurricane Sandy MAT Report
• Released November 2013

Courses
• 26 total, 1031 participants reached

Presentations and Briefings
• 21 total, 1452 participants reached

Forums and Meetings
• 8 total, 2021 participants reached

Other Resources
• Hurricane Sandy Recovery Advisories and Fact Sheets
• Hurricane Sandy – Building Science Activities and Resources web page
Sandy Recovery Advisories (RAs)

Non-Residential Building and Critical Facility RAs

**RA2** *Reducing Flood Effects in Critical Facilities* (April 2013)
- Elevation and dry floodproofing of essential utilities and equipment
- Mitigation measures for electrical service and distribution systems, data systems, HVAC, water/wastewater systems, emergency power systems, and elevators

**RA4** *Reducing Operational Interruptions to Mid- and High-Rise Buildings During Floods* (March 2013)
- Protecting critical building systems by elevating and floodproofing
- Emergency power considerations

**RA6** *Protecting Building Fuel Supplies from Flood Damage* (April 2013)
- Retrofit of fuel systems in existing buildings
- Preparing for flood event in unmitigated buildings
MAT Recommendation: **NJDEP**, in coordination with the NJDCA and FEMA, should review the FHCA rules that apply specifically to buildings and other structures to identify and resolve inconsistencies. NJDEP rules should refer to the requirements of the UCC.

**Impact:** NJDEP, in conjunction with NJDCA, is reviewing its regulations as of January 31, 2014.

MAT Recommendation: NJDCA and NJDEP, in cooperation with FEMA, should develop one or more courses specifically addressing the flood provisions of the NJDEP rules and the UCC.

**Impact:** NJDCA and Rutgers University partnered with FEMA to prepare two courses and deliver them three times to 263 participants statewide.
MAT Recommendations: DCEA should consider code amendments to:

- **Modify the building code to require Category II non-residential buildings to be elevated or protected to or above the BFE plus 2 feet (equivalent to existing New York State amendment to residential code)**
- Specifically refer to local laws for flood damage prevention where FIS and FIRMs are specifically adopted by title and date
- **Modify R324.3 (coastal high hazard area) to refer to ASCE 24**
- **Restore the I-Code language for historic buildings in flood hazard areas to ensure they are treated as required by the NFIP**

**Impact:** Modification of freeboard, R324.3, and historic building requirements proposed
### MAT Recommendations and Code Change Impacts: New York City

<table>
<thead>
<tr>
<th>MAT Recommendations</th>
<th>Recent Laws Amending 2008 NYC Codes</th>
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<tbody>
<tr>
<td>Establish mechanism for special inspections</td>
<td>Local Law 29/13 – Raising and Moving of Buildings</td>
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<tr>
<td>Protect critical building systems in subgrade areas</td>
<td>Local Laws 83/13 – Backflow Prevention, 99/13 – Raising Building Systems, and 100/13 – Relocate and Protect Building Systems in Floodprone Areas</td>
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<tr>
<td>Protect critical function areas from flooding</td>
<td>Local Law 95/13 – Healthcare Facilities</td>
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<td>Review mapping procedures</td>
<td>Local Law 96/13 – Flood Maps</td>
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<td>Install barriers to prevent floodwater entering transit stations</td>
<td>Local Law 109/13 – Flood Barriers</td>
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<tr>
<td>Prepare a plan for maintaining fuel supplies</td>
<td>Local Laws 99/13 – Raising Building Systems, 100/13, and 111/13 – Emergency &amp; Standby Power Systems</td>
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9 of 14 recently enacted NYC Local Laws match MAT recommendations promoted by AIA NY
The U.S. Urban Green Council is one of New York City’s leading advocates for urban sustainability.

The Urban Green Council Building Resiliency Task Force lists 33 proposals (http://www.urbangreencouncil.org/BRTF/Tracker).

Status as of March 31, 2014:
- 16 Implemented into or NYC Building Code local law
- 11 Proposed changes to NYC Building Code or City/State agency resolutions
- 4 Voluntary Practice recommendations

Of the 16 implemented proposals:
- 6 match MAT recommendations
- 4 are related to MAT recommendations
Recent Critical Facility/Key Asset Recovery Actions

Hospitals:
- April 2014 – NYU Langone Medical Center reopens emergency room damaged by Hurricane Sandy.
- February 2014 – Long Beach Medical Center files for bankruptcy.

Utility Infrastructure:
- February 2014 - NY Gov. Cuomo agreement with FEMA for $1.4 billion to support storm repair from Sandy and mitigation efforts to the power grid on Long Island.

Transportation:
- December 2013 - FTA Public Transportation Emergency Relief Program to award $1.3 billion in transit resilience projects in NY and NJ and $3 billion in competitive resilience projects.
FEMA P-942, Hurricane Sandy MAT Report available for download:
http://www.fema.gov/media-library/assets/documents/85922

Seven Recovery Advisories currently available for download:
http://www.fema.gov/media-library/assets/documents/30966

**FEMA Building Science Helpline:**
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http://www.fema.gov/building-science