REPORT TO
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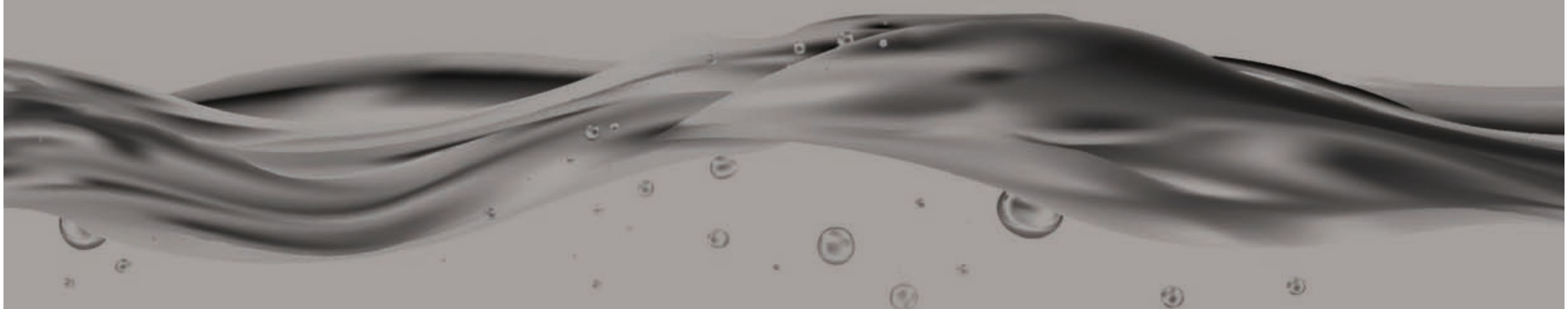

# BUILDING RESILIENCY TASK FORCE

**FULL PROPOSALS | JUNE 2013**

# Report Contents

## I. Full Proposals



## II. Costing information

## Reading this Report: Proposal Implementation

The 33 proposals in this report address resiliency in a wide range of buildings, including commercial buildings, multifamily residences, hospitals, and 1–3 family homes. There are five ways a proposal may be implemented:

### required upgrade

In a few crucial cases, such as providing basic water supply in residential buildings during black outs, the Task Force has recommended retroactive requirements for existing buildings. "Required Upgrade" proposals would apply to all new construction and renovations, and would also require existing buildings to comply by a specifiedfuture deadline. Buildings that are not requiredto perform these upgrades should still consider these proposals "Recommended."

### new code

"New Code" proposals would be applicable at the time of new construction or renovation, but would not retroactively apply to all existing buildings. Building types not affected by the new code should still consider these proposals "Recommended."

### remove barrier

Many Task Force proposals focus on improving resiliency by removing obstacles and giving owners more options. "Remove Barrier" proposals are not required for any building sector, but the changes recommended will make it easier for buildings to become more resilient.

### recommended

Codes set a legal minimum standard for construction, but for increased resiliency many owners will choose to do more. "Recommended" proposals cover a wide range of voluntary practices, though not every proposal will apply to every building. Taken together, the many best practices in this report represent the advice of the city's experts on resiliency and should be seriously considered.

### further action

Continued effort is needed to develop complete code recommendations in some areas. "Further Action" proposals will receive additional consideration, either by the city or by the Task Force under an extended mandate.

This full report and a report summary are available at http://www.urbangreencouncil.org/BuildingResiliency.

# 1 Prevent Storm Damage to Homes

## I. Summary

**Issue:**
Flooding, precipitation, high winds, storm surge, wave action, and wind-/water-borne debris can damage homes. Much of this damage can be prevented with targeted design and construction measures.

**Recommendation:**
Require new and replacement windows to be wind-resistant. Recommend anchoring framing to foundations and strengthening foundations and basements in existing homes. Develop custom requirements for attached homes that present unique challenges.

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## II. Proposed Legislation, Rule or Study

*Amendments to the New York City Building Code:*

1. Add new sections to Chapter 16 as follows:

   a. UV-resistant urethane caulking sealant shall be used for all exterior window and door assemblies (no silicone or latex caulking).
   b. All new windows, including those in existing buildings, shall use a net design wind pressure and suction of 30 pounds per square foot.
   c. Doorframe fasteners shall be of length sufficient to penetrate adjacent structural members by at least 1 1/2”. Wood screws should be minimum #12. Nails should be minimum 12d. Tapcons should be at least 3/16” diameter. Spacing shall be such that the first fastener is located within 6” of the end of the jamb (one fastener at the top and bottom of each side) and then at no more than 16” spacing along vertical sides and top of frame.
   d. Door hinge and strike plate fasteners shall be at least 3” in length or of sufficient length to penetrate adjacent structural members by at least 1-1/2”.
   e. Window frame fasteners shall be of length sufficient to penetrate adjacent structural members by at least 1 1/2”. Wood screws should be minimum #12. Nails should be minimum 12d. Tapcons should be at least 3/16” diameter. Spacing shall be such that the first fastener is located within 6” of the end of the jamb (one fastener at the top and bottom of each side) and then at no more than 12” spacing around the perimeter.

## III. Supporting Information

**Expanded Issue and Benefits:**

**Storm Surge Retrofits**
Most of the structural damage to small homes during Sandy was caused by the storm surge. Requirements already exist to mitigate the effects of storm surge on new construction, substantially damaged homes, and those undergoing substantial alterations. Uses within flood zones that are not being raised and wet-floodproofed remain vulnerable to major structural damage and a risk of collapse in future storm surge events. Raising an existing house, rebuilding or reinforcing its existing foundation, and backfilling an existing basement or cellar will decrease these risks; however, these measures may be prohibitively expensive if no supplemental funding sources are available to homeowners.

For existing homes located in Coastal A and V Zone areas that are not required to implement storm surge retrofits, the following wet-floodproofing and structural improvement measures are recommended:

1. Elevate structure above Design Flood Elevation ("DFE") (BC G304.1.1.1 for Zone A; BC G304.2.2 for Zone V)
2. Backfill basement to grade (BC G304.1.1.1 for Zone A; BC G304.2.2 for Zone V)
3. Rebuild or reinforce foundation to address flood loads, e.g. add interior piers (ASCE 24 Sections 1.5 and 1.6 for Zone A; BC G304.2.1 and ASCE 24 Sections 1.5 and 1.6 for Zone V)
4. Provide foundation flood openings in Zone A or open foundation in Zone V (ASCE 24 Section 2.6.1 for Zone A; BC G304.2.3 for Zone V)
5. Provide anchorage between superstructure and substructure (ASCE 24 Section 1.5 for Zone A; BC G304.2.1 and ASCE 24 Section 1.5 for Zone V)
6. Remove non-structural interior partitions below the DFE unless otherwise required by code

**Windows and Doors**
While the NYC Building Code specifies wind load design pressure requirements for windows and doors in new construction and substantial renovation, three areas related to building apertures remain to be addressed:

1. **Wind load**: NYC Building Code §1609.6.3.3 "Components and cladding" under the Simplified Design Procedure II currently references a net design wind pressure and suction of 30 pounds per square foot (psf). However, §1609.1.2 "Minimum Wind Loads" references 20 psf. The Task Force proposes requiring compliance with the more stringent 30 psf measure and further recommends that compliance be mandatory for all homes. Replacing windows to meet the current wind load performance standards will also bring windows into compliance with the current energy code.

2. **Installation**: When windows and doors are blown or forced in, precipitation and debris damage will increase and the positive pressure created by these openings might

contribute to roofs being forced upward. Research has shown that strengthening windows and doors can raise the wind speed required to lift the roof off of a house by one or two hurricane intensity categories. Thus, it would be prudent to require new door and window installation measures (such as longer screws and nails) to strengthen envelope assemblies. Using UV-resistant caulking increases durability and has considerable beneficial structural effect with regard to increases in wind load resistance.

3. **Protection:** For reasons noted above, window and door protection in the form of permanent or removable hurricane shutters can significantly improve a building's ability to withstand storm events. Shutters should be stored on the premises and installed upon notification from any New York City agency in the event of an approaching storm event.

**Anchorage Measures**

A common mode of failure observed by NYC Department of Buildings inspectors following Sandy was the dislocation of some houses from their foundations. These were typically one or two story wood frame buildings that were not securely attached to their foundations and that were easily moved upward or laterally by the storm surge. Masonry walls adhere to the foundation due to mortar, but wood frame buildings rarely have any positive attachments. Anchoring wood frame buildings to their foundations as described in NYC Building Code Section 2308.6 in all instances where alterations expose sills over foundations in Coastal A and V Zones, even if the alterations do not trigger the requirements of NYC Building Code Appendix G, will improve resistance to storm surge, floods, and wind pressure. Such anchors will also improve the capacity of the masonry foundation or crawlspace masonry walls to resist water pressure by providing support at the top, with the floor structure acting as a diaphragm connecting the walls. Anchors or tie-ins installed without the benefit of direct design calculations do not provide full protection for flood or wind, but their marginal contribution to building survival is expected to be significant. The effectiveness of this measure depends upon properly reinforced foundations and proper connections between sill plates and floor joists or superstructure.

**Attached Homes**

FEMA currently does not provide guidelines on addressing attached 1-2 family dwellings of the historic 'brownstone' or 'rowhouse' typology located in flood zones. These structures are often, though not always, constructed of masonry walls and have shared party walls. In most cases, they cannot simply be raised onto new foundations for compliance. An appropriate set of guidelines to bolster the resiliency of these homes should be determined by a Joint Task Force consisting of representatives from NYC and federal agencies, including FEMA.

Current federal regulations prohibit dry-floodproofing 'rowhouse' type structures because they are a residential use. However, it is likely that some elements of dry-floodproofing would be effective and appropriate for this housing type. In some cases, the only method of fully protecting these homes is to abandon use of the level below the DFE, which often eliminates a large percentage of the owner's living space, and significantly reduces the value of the home. In some cases, another story could be added to preserve value where portions of the building located below DFE must be abandoned and where the building structure can support such an addition, but this option will be limited by financial considerations, as well as zoning and/or landmark restrictions. FEMA currently will not provide the same funding to add a story that is provided to those who wish to elevate their homes (maximum of $30,000).

The Joint Task Force should submit its findings to the Department of City Planning and other relevant city agencies, and seek resolution of any conflicts between recommended building amendments and local zoning and landmark restrictions.

**Cost:**

Cost estimates were provided by Gerard Romski, Averne by the Sea:

1. Wind load (require new windows to withstand 30 psf) was not quantified.

2. Installation (Home Depot prices as of 3/15/13):

    a. Sealant - No additional labor cost for installation of sealant, and less expensive materials than silicone are available. A 10oz tube of sealant will provide approximately 49 linear feet of caulking, enough for more than two 3'x7' doors. Example products include:
    - DAP Dynaflex Latex-$4.33 per 10oz tube
    - Sonnenborn NP-1 Urethane-$5.75 per 10oz tube
    - GE WD Supreme Silicon-$7.97 per 10oz tube

    b. Fasteners - Additional labor to install longer screw and nail fasteners is zero to negligible. Additional labor to install increased number of fasteners was not quantified. Additional labor required to install Tapcon fasteners into concrete or masonry was not quantified. Example products include:
    - Tapcon 3/16 in. x 2-3/4 in. Climaseal Steel Flat-Head Phillips Concrete Anchors (75-Pack) $16.82 ($0.22 each/15 required for 3'x7' door)
    - Wood Screws-Crown Bolt #10 x 3 in. Zinc-Plated Flat-Head Phillips Drive Wood Screw (50 pack) $10.26 ($0.21 each/15 required for 3'x7' door)
    - Nails-Grip-Rite #11 x 3 in. Bright Steel Smooth-Shank Finish Nails (1 lb. Pack/124 count) $3.47 ($.03 each/15 required for 3'x7'door)

3. Protection (hurricane shutters) was not quantified.

**Sources:**

1. FEMA 2011 Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas (4th ed.), http://www.fema.gov/library/viewRecord.do?id=1671
2. The American Society of Civil Engineers ASCE 24-05 Flood Resistant Design and Construction
3. FEMA 2009 Recommended Residential Construction for Coastal Areas P-259
4. FEMA 2012 Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures P-550
5. FEMA RA1, February 2013 Improving Connections in Elevated Coastal Residential Buildings

# 2 Launch a Design Competition for Raised Homes

## I. Summary

**Issue:**
New York City has 71,000 buildings located in the new 100-year flood zone. New buildings in these areas will have to build above the flood line, and other homeowners may decide to voluntarily raise their homes. This will impact the city's architecture, streetscapes, and accessibility.

**Recommendation:**
Launch a competition to design a streetscape of attractive raised homes that fit the character and aesthetic of existing neighborhoods and remain accessible to people with disabilities. The competition should address both detached and attached homes.

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## II. Proposed Legislation, Rule or Study

The city should launch a Design Challenge that incorporates the items described below. Because each neighborhood has its own character, design solutions will vary for each neighborhood. Building designs should include detached, semi-attached, and attached, and both single-family homes and townhouses.

**Street Wall Character**
It is unlikely that all homes will be raised simultaneously, therefore leaving some homes below the Design Flood Elevation (DFE), and others above. This will result in inconsistent exterior facades and street walls that are out of character with New York City's historical streetscape. The Design Challenge should:

1. Implement standards for consistent exterior design of buildings.
2. Address exterior façade materials.

**Enclosures Below the First Floor**
Basement and/or cellars will be removed, causing a significant loss of habitable and/or storage space. The Design Challenge should examine the affected areas below the DFE that will be exposed and consider design solutions for:

1. Screened walls that allow for privacy but maintain transparency to ensure that these spaces do not become habitable. Vegetated screen walls should be considered.
2. Allow for the use of these areas as protected outdoor storage with specific limitations on what is stored and methods/materials to use as storage. (This may require the first floor to be raised higher than the DFE.)
3. Safe, effective lighting.
4. Rodent and pest control.

**Street Access to Homes**

Raising the first floor of homes will require changes to entrance stairs. NYC currently has architectural precedent for building a raised first floor - the English style townhouse. The Design Challenge should:

1. Explore solutions for installing stairs for homes:
    a. With front yard setbacks, which provide space for the installation.
    b. With no setback to the street wall, which are not suitable for the installation.
    c. Where stairs must be installed within the home, requiring an entrance below the DFE.
2. Incorporate solutions addressing the sidewalk, which may need to be redesigned to accommodate the entrance stairs.
    a. Address new setback requirements (zoning) that may be required to allow for stoop style staircases.
3. Consider street wall character impacted by the aesthetics of exterior stairs.
4. Consider ADA accommodation.

**Storefront Street Access**

Mixed-use low-rise buildings with commercial spaces will lose their street front access if they are elevated above the street. The Design Challenge should consider the relationship between streetscape and storefront, including:

1. Access for ADA compliant design, which necessitates ramps in addition to stairs.
2. Sidewalks that must be redesigned to accommodate access if ramps within the property line cannot be accommodated.
3. Review of precedents such as Tribeca, where manufacturing building loading docks have been transformed to commercial access.

**Rear Landscape Connection**

As interior floor elevations will no longer meet rear yard elevations, the Design Challenge should address how the rear yard can be accessed in a sustainable and innovative manner.

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## III. Supporting Information

**Expanded Issues & Benefits:**

The manner in which buildings address public streets is among the most critical and defining elements of urban form and contributes dramatically to the character of a given neighborhood. Consider the difference between a sidewalk adjacent to a series of Brooklyn stoops and a sidewalk alongside the windowless brick wall of a parking garage. The former is intimate in scale, visually interesting, provides opportunities to sit and relax, and encourages chatting with your neighbors. The latter is inhumane in scale and encourages only that you pass it as quickly as possible. The public street is the element that stiches together a city and enables the creation of a community rather than a densely populated mass of separate individuals. As we consider how homes in the flood zone might be elevated, it is critical that it be done in a manner that is consistent with the values of New York City urbanism established over several centuries while directly addressing and responding to our current requirements of universal access and sustainability. A design competition will bring the knowledge and training of the architecture and engineering communities to bear on this important issue and should ensure that myriad perspectives are considered, including those of local communities and laypersons.

Although the difficulty of the challenge should not be underestimated, the experience of New Orleans following Hurricanes Katrina and Ruth offer successful examples of carefully organized design competitions that provided highly regarded, cost-effective, sustainable solutions to similar problems.

**Implementation:**

Create a committee to organize the Design Challenge, whose duties will include preparing a detailed description of the program, determining the specific areas in the neighborhoods for design, organizing a panel of judges and establishing a timeline. The city could partner with the AIA New York City Chapter, an organization with substantial experience launching innovative design competitions. The AIA's Design For Risk and Reconstruction (DFRR) committee is particularly knowledgeable on this subject matter.

**Cost:**

The city may undertake a design competition with or without cash prizes in conjunction with relevant professional associations. No cost estimation was performed for this proposal.

**Sources:**

1. Designing the Future of New Orleans: Prototype House Competition
   http://archrecord.construction.com/news/katrina/competition.asp
2. Design by Many: Passive House New Orleans
   http://www.designbymany.com/challenge/passive-house-new-orleans
3. USGBC 2012 Natural Talent Design Competition
   http://openarchitecturenetwork.org/competitions/naturaltalent/2010
4. GreeNOLA: Global Green USA Sustainable Design Competition for New Orleans
   http://www.globalgreen.org/articles/global/82
5. Make It Right: New Orleans
   http://makeitright.org/see/new-orleans/

# **3** Relocate & Protect Building Systems

## I. Summary

**Issue:**
The first and lower floors of many existing buildings are at risk because they are below flood level, and essential building equipment is often located on these lower floors.

**Recommendations:**
Building owners should consider relocating equipment above the flood level and follow best practices when floodproofing. Require fire protection equipment to be raised in new construction and enhance standards for hospitals.

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## II. Proposed Legislation, Rule or Study

The following items are covered by Appendix G governing construction in flood zones. Add clarification language found in supporting material to other parts of the code.

**Electric Services**

*Amendments to the New York City Electrical Code:*

1. Amend paragraph (A)(1) of Section 230.70 as follows:

   **(1) Readily Accessible Location.** The service disconnect means shall be installed at a readily accessible location above the design flood elevation either outside of a building or structure, or inside nearest the point of entrance of the service conductors.

**Sprinkler and Fire Standpipe Control Valves**

*Amendments to the New York City Building Code:*

1. Add a new Section 8.15.1.1.1.9 to Appendix Q BC Q103 as follows:

   **8.15.1.1.1.9** Sprinkler control valves shall be OS&Y valves or located above the design flood elevation.

2. Add a new Section 6.2.2 (8) to Appendix Q BC Q105 as follows:

   **(8)** Fire standpipe control valves shall be OS&Y valves or located above the design flood elevation.

**Fire and Sprinkler Booster Pumps**
**(Note: Prohibits installation below design flood elevation)**

*Amendments to the New York City Building Code:*

1. Add a new Section 8.16.1.9.2 to Appendix Q BC Q102 as follows:

   **8.16.1.9.2** Dry pipe valve related electrically operated alarm appurtenances shall be located above the design flood elevation.

2. Add a new section to Appendix Q BC Q104 as follows:

   **Location of Sprinkler Booster Pumps:** (1) Sprinkler booster pumps shall be located in a two hour rated room.
   (2) Sprinkler booster pumps shall have direct access from a two hour rated passageway or stairway.
   (3) Sprinkler booster pumps shall be installed above the design flood elevation. In buildings with occupied floors less than 300 feet in height above the lowest level of Fire Department vehicle access where locating the sprinkler booster pump above the design flood elevation is not feasible, the sprinkler system shall be supplied by gravity tanks in accordance with Section 9.1.4(4).

3. Add a new section to Appendix Q BC Q105 as follows:

   **Location of Fire Pumps:** (1) Fire pumps shall be located in a two hour rated room.
   (2) Fire pumps shall have direct access from a two hour rated passageway or stairway.
   (3) Fire pumps shall be installed above the design flood elevation. In buildings with occupied floors less than 300 feet in height above the lowest level of Fire Department vehicle access where locating the automatic fire pump above the design flood elevation is not feasible, the fire standpipe system shall be supplied by gravity tanks in accordance with Section 9.1.4(4).

**Electrically Powered Fire Protection Equipment**

*Amendments to the New York City Building Code:*

1. Add a new exception to Sections 903.3.10.1, 903.2.10.1.3, and 904.1 as follows:
   **Exception**: Electrically activated water and non-water fire extinguishing systems shall be located above the design flood elevation.

2. Add a new Section 6.9.4.4 to Appendix Q102 as follows:

   **6.9.4.4** Electrically operated water flow detection devices serving sprinkler systems shall be located above the design flood elevation.

3. Add a new Section 7.2.6.6.5 to Appendix Q102 as follows:

   **7.2.6.6.5** Air compressors serving sprinkler systems shall be located above the design flood elevation.

4. Add a new Section 7.3.2.6 to Appendix Q102 as follows:

   **7.3.2.6** Pre-action sprinkler systems shall be located above the design flood elevation.

5. Add a new Section 7.3.3.3 to Appendix Q102 as follows:

   **7.3.3.3** Deluge sprinkler systems shall be located above the design flood elevation.

6. Add a new Section 7.4.1.5 to Appendix Q102 as follows:

   **7.4.1.5** Combined dry pipe and pre-action sprinkler systems shall be located above the design flood elevation.

*Amendments to the New York City Fire Code:*

1. Add a new Section 902.14 as follows:

   **902.14** Electrically activated sprinkler systems shall be located above the design flood elevation.

2. Add a new Section 904.2.1 as follows:

   **904.2.1** Electrically activated non-water fire extinguishing systems shall be located above the design flood elevation.

The following items are proposed to be newly covered by code.

**Fire Command Stations and Alarm Systems**

*Amendments to the New York City Building Code:*

1. Add a new Section 907.8.1.1 to Chapter 9, Section BC 907 as follows:

   **907.8.1.1** Where a zoning indicator panel and associated controls are positioned in a lobby level located below the design flood elevation, a second zoning indicator panel and associated controls shall be provided. The second panel shall have all of the annunciation and control functionality as the primary panel. The location of the second panel shall be at a level at least five feet above the design flood location and approved by the department and the Fire Department. The transfer of control to the secondary location shall be by a means that is approved by the Fire Department. All power supplies including the dedicated transfer switch for the secondary zoning indicator panel, and all elements of the fire alarm system backbone shall be located at least five feet above the design flood elevation.

**Fuel Oil Tanks and Supply**

*Amendments to the New York City Mechanical Code:*

1. Add the following exception to Section 1305.6.2:

<u>**Exception**: For buildings located in a special or moderate flood hazard area, fill piping shall terminate three feet above the design flood elevation or the fill termination shall be an approved watertight terminal opening complying with Section 1305.6.5.</u>

2. Add a new Section 1305.7.2 (5) as follows:

   <u>**(5)** For buildings located in a Special Flood Hazard Area, normal vent pipes shall terminate three feet above the design flood elevation.</u>

3. Add the following to the end of Section 1305.8.2:

   <u>For buildings located in a Special Flood Hazard Area, emergency vent pipes shall terminate three feet above the design flood elevation.</u>

**Medical and Compressed Gas Storage Tanks**

*Amendments to the New York City Plumbing Code:*

1. Add a new Section 1201.2 as follows:

   <u>**1201.2** Medical and compressed gas storage tanks, oxygen tanks, and other cryogenic system storage tanks serving buildings located within flood zones shall be designed, constructed, installed, and anchored to resist at least 1.5 times the potential buoyant and other flood forces acting on an empty tank during design flood conditions, in accordance with ASCE/SEI 24 and the New York City Building Code. Storage tanks serving critical facilities shall be elevated above the design flood elevation and must maintain service to the facility.</u>

*Amendments to the New York City Fire Code:*

1. Add a new Section 2703.2.4.3 as follows:

   <u>**2703.2.4.3** Hazardous material storage tanks serving buildings located within flood zones shall be designed, constructed, installed, and anchored to resist at least 1.5 times the potential buoyant and other flood forces acting on an empty tank during design flood conditions, in accordance with ASCE/SEI 24 and the New York City Building Code. Storage tanks serving critical facilities shall be elevated above the design flood elevation and must maintain service to the facility.</u>

2. Add a new Section 3003.3.3 (6) as follows:

   <u>**(6)** Stationary compressed gas containers serving buildings located within flood zones shall be designed, constructed, installed, and anchored to resist at least 1.5 times the potential buoyant and other flood forces acting on an empty tank during design flood conditions, in accordance with ASCE/SEI 24 and the New York City Building Code. Compressed gas containers serving critical facilities shall be elevated above the design flood elevation and must maintain service to the facility.</u>

3. Add a new Section 3203.1.3.4 as follows:

**3203.1.3.4** Stationary cryogenic containers serving buildings located within flood zones shall be designed, constructed, installed, and anchored to resist at least 1.5 times the potential buoyant and other flood forces acting on an empty tank during design flood conditions, in accordance with ASCE/SEI 24 and the New York City Building Code. Cryogenic containers serving critical facilities shall be elevated above the design flood elevation and must maintain service to the facility.

4. Add a new Section 3503.1.2.1 as follows:

**3503.1.2.1** Stationary flammable gas storage containers serving buildings located within flood zones shall be designed, constructed, installed, and anchored to resist at least 1.5 times the potential buoyant and other flood forces acting on an empty tank during design flood conditions, in accordance with ASCE/SEI 24 and the New York City Building Code. Flammable gas containers serving critical facilities shall be elevated above the design flood elevation and must maintain service to the facility.

**Hospitals**

*Amendments to the New York City Building Code:*

1. Add the following definition to Section G201 in alphabetical order:

**AREA OF MODERATE FLOOD HAZARD**. The land in the floodplain delineated as subject to a 0.2 percent or greater chance of flooding in any given year. Such areas are designated on the Flood Insurance Rate Map (FIRM) as X-Zones (Shaded). Such areas are also known as the 500-year floodplain.

2. Modify the definition of "DESIGN FLOOD ELEVATION" in Section G201 as follows:

**DESIGN FLOOD ELEVATION**. The applicable elevation specified in ASCE/SEI 24, Tables 2-1, 4-1, 5-1, 6-1, 7-1, depending on the structural occupancy category designated in ASCE/SEI 24, Table 1-1. For Category IV structures that are hospitals, the design flood elevation shall be the elevation of the flood having a 0.2 percent chance of being equaled or exceeded in any given year, including wave height.

3. Add a new Section G304.1.2 (2.3.1) as follows:

**G304.1.2 (2.3.1) Critical Facilities.** In I-2 occupancies that are hospitals providing acute medical care, generators and emergency power fuel pumps shall be accessible for maintenance and repair during moderate or special hazard flood conditions.

4. Add a new Section G304.3 as follows:

**G304.3 X-Zone Construction Standards.** The following standards shall apply to post-FIRM construction and substantial improvements located within X-Zones.

**G304.3.1 Critical Facilities.** In I-2 occupancies that are hospitals providing acute medical care, all post-FIRM new buildings and substantial improvements shall comply with the standards outlined in Section G304.1.2.

**Fresh Air Intakes for Sewer Piping**

*Amendments to the New York City Plumbing Code:*

1. Add a new Section 1002.6.1 as follows:

   **1002.6.1** A relief vent or fresh air intake for a building trap serving a building located in Special Flood Hazard Areas shall be carried above grade and shall be terminated in a screened outlet located outside the building at a height above the design flood elevation.

**Reduced Pressure Zone Backflow Preventers**

*Amendments to the New York City Plumbing Code:*

1. Add the following sentence to the end of Section 608.13.2:

   These devices shall be installed above the design flood elevation in flood zones.

2. Add the following sentence to the end of Section 608.13.3:

   These devices shall be installed above the design flood elevation in flood zones.

## III. Supporting Information

**Expanded Issue and Benefits:**

If given the option between elevating critical equipment and providing flood protection on a lower floor, elevation is encouraged. Maintaining the integrity of dry floodproofing is difficult over the long term, and future alterations may unintentionally compromise floodproofing. Dry floodproofing often depends on manual strategies such as closing submarine doors, hatches, and other movable water barriers, and as a result can be defeated through simple human error during flood preparation. Elevating certain systems may have unintended consequences during non-flood emergencies and as a result, building owners (especially those responsible for critical buildings) must balance all risk factors to determine which systems, if any, are suitable for elevation above the design flood elevation (DFE).

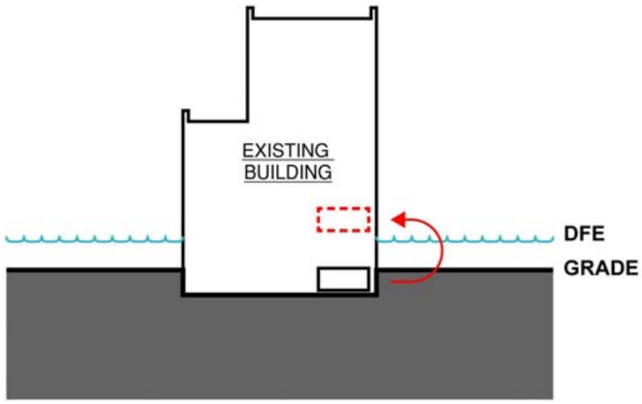


Figure 1: Moving critical utilities and attendant equipment above the DFE.

To encourage building owners to relocate critical building equipment above the DFE, the city and/or state could provide owners with incentives to move essential and/or critical building equipment and utilities above the DFE, such as zoning incentives, tax rebates, or direct offsets of incurred costs.

For some building systems, existing building codes in effect for new construction and substantial alterations already include provisions for flood resistance. However, some new code language is still recommended to make flood protection requirements more clear. The building systems affected by this clarifying code language are:

A. Electric, water, and natural gas services
B. Electrical, mechanical, and HVAC equipment
C. Fire pumps and associated fire protection equipment
D. Elevators
E. Incoming IT services

For other building systems, some new code language is recommended. This would apply to any new construction or substantial alterations where the building code applies. The building systems affected by this new code language are:

F. Fire command stations and alarm systems
G. Fuel oil tanks and supply
H. Medical and compressed gas storage tanks
I. Fresh air intakes for sewer piping
J. Reduced pressure zone backflow preventers

## Part 1. Relocation/Elevation of Equipment

### A. Electric, Water, and Natural Gas Services

Submersion of electrical utility services up to the first point of switch disconnect is a safety concern and can lead to excessive or irreparable damage to both utility and building systems and increase the recovery time for such systems.

To the extent possible, buildings should utilize submersible utility and electrical equipment below DFE for all equipment and wiring supplying the main building service. Where building systems are being relocated above the DFE, buildings should consider the installation of utility isolation switches to limit the extent of unprotected cable within the building.

Currently, building-owned end line boxes are not submersible and submersible boxes are not generally available in the industry. Code changes could influence the industry in securing or designing submersible end line boxes with fused disconnects, which would alleviate the impacts of flooding. Submersible cable connections could also be required, but these requirements would need to be reviewed by the Department of Buildings.

In the future, the city could consider requiring all new or significantly renovated larger buildings to provide utility space for transformation assets above the flood zone. However, this alternative would place significant additional costs on building owners, including the potential loss of valuable retail and/or commercial space. An additional supporting document with diagrams and more details about potential alternate electric installation strategies is available from the Building Resiliency Task Force.

For inside gas meters/regulators, there is minimal risk of service interruption from having service piping points of entry or meters/regulators below the flood elevation. For further reference, NYC Fuel Gas Code 301.11 Flood Hazard states the "appliance, equipment, and system installations" shall comply with Appendix G, but not the utility owned gas service piping. Aboveground gas service points of entry should be left in place unless the building is raised on piles, since there are potential risks associated with moving gas service equipment indoors or elevating gas service points of entry.

In existing buildings, it is best practice to relocate the existing water service and gas piping (and any appurtenances) such that service will not be interrupted during a flood event. Note that gas meter rooms do not require flood protection because submerging gas meters does not interrupt gas service.

It is recommended that gas regulator vents for all building types be located above the flood elevation or constructed so as to prevent water from entering or accumulating within the regulator vent piping.

Similarly, all domestic water and gas booster pumps should be located above the flood elevation. Note that booster pump failures are caused by electrical interruptions. Booster pumps are sealed and do not allow water to infiltrate the gas piping.

**Implementation**:

The recommendations may be difficult to implement due to space planning restrictions. However, the technology and means are readily available.

### B. Electrical, Mechanical, and HVAC Equipment

Submersion of electrical equipment and wiring generally causes irreparable damage and prevents operation of other building systems. Damage is more catastrophic if electrical equipment is energized when submersion occurs. Accordingly, as best practice, existing buildings should consider relocating equipment above the flood line.

Appendix G requires these items to be elevated or protected in new construction as well as existing buildings with substantial improvements. These buildings will need to identify suitable space, with an acceptable pathway and intercept method above the DFE for this equipment.

The following are best practice recommendations for mechanical equipment:

1. Control panels deemed critical to the functioning and habitability of a building should be located in a floodproof area or above the DFE.
2. Provide standby power for the control system head end. If critical systems will not function without the BMS system (for example, when there is no manual override for control loops), standby power should be provided. Standby power should also be provided for systems that require monitoring during an emergency (for example, demand reduction controls, fuel oil, and/or generator monitoring).
3. Locate head end above the DFE to avoid replacement following a flood event.
4. Split direct digital control (DDC) systems into below-DFE and above-DFE zones so that loss of submerged areas does not impact the rest of the building. The communication network and power source for these panels should be separated by their relationship to the DFE. This will keep communication errors from a damaged panel creating excessive "traffic" on the network, thus slowing or freezing communication on the balance of the network. Additionally, the power source for BMS equipment at or below the DFE should not service equipment above the DFE. If properly arranged, an equipment short will not interrupt power to panels operating above the DFE.
5. Prohibit DDC panels located below flood elevation from serving devices located above flood elevation.
6. Store software and program updates off-site in a secure location.
7. Include a "manual operation mode" in emergency planning documents.

## C. Fire Pumps and Associated Fire Protection Equipment

As a best practice, existing buildings should relocate all non OS&Y fire standpipe and sprinkler control valves, fire pumps, jockey pumps, dry pipe valve equipment, and electrically released fire protection systems and their appurtenances above the DFE. In lieu of a pumped water supply, the city should consider allowing the use of gravity water tanks in buildings 300 feet in height or less, and should consider revising the "Fire Pump Testing" memorandum issued by DOB in 2010, which includes conflicting information regarding fire pump testing and location requirements. The revision should allow the waterproofing of fire pump rooms, as opposed to relocating them, to provide for both accessibility and flood protection.

The costs associated with this proposal will include the relocation of all equipment above the flood elevation and rerouting of piping and device wiring below grade to accommodate the relocation. It is straightforward to implement and the technology is readily available, but space planning issues may arise.

## D. Elevators

Elevators may be rendered inoperable by submerged cabs, call buttons, controllers, or elevator pits. Elevator equipment is not generally designed to be water resistant, and power and control circuits that extend below the DFE could short out controllers located above the DFE if submerged while energized.

The following are recommended as best practice for elevators:

- Tractor elevator equipment and control panels should be located above the DFE.
- Locate hydraulic elevator equipment that is susceptible to water damage above the DFE.
- Call and control circuits that are installed below the DFE should allow for isolation in the event of water infiltration or flooding.
- Emergency protocols need to be established to protect the elevators in the event of water infiltration or flooding.
- Connection to the central control station should be waterproofed.
- Provide automatic visual indication that cars are out of service at the elevator control panel.
- Electrical equipment should, to the extent possible, be constructed and installed to withstand water infiltration or flooding. Mitigation should include waterproof enclosures designed to withstand expected submersion depths. Wiring outside of the waterproof enclosure should be waterproof, although availability of waterproof wiring systems is limited, with most designed for simple outdoor installation rather than flooding. Further product development is required to address this.
- Install a water detection switch in the elevator pit that, when activated, will send the elevators to a floor above the DFE. Where feasible, existing buildings should follow Appendix G Section 7.5.1 and install controls that prevent recall of elevators into flooded areas. This controls should be installed even in areas that are dry-floodproofed, since floodproofing can fail.
- Relocate elevator management system display computers above the DFE.
- Evaluate the feasibility of replacing steel compensation cables with coated compensation chains.
- All switches and wiring installed below the DFE should be waterproofed to the NEMA 4 standard.
- Escalators should not have auxiliary controllers located in the lower end pit if it is below the DFE.

A valuable source of additional information is FEMA Technical Bulletin 4 (November 2010), “Elevator Installation for Buildings Located in Special Flood Hazard Areas.”

## E. Incoming IT Services

All new buildings should consider locating at least one service entry room above the DFE, with all primary building services (e.g., fire alarm system central office connectivity, building management voice and data circuits, etc.) located in this elevated service entry room. It is recommended that incoming IT services be protected within conduit between the building point of entry and the service entry rooms.

## F. Fire Command Stations and Alarm Systems

Fire command stations in lobbies are not always accessible during floods or adverse weather conditions. If the power and/or the head end electronic architecture for the fire alarm system are located in a flood zone, they can become inoperable. As best practice in existing buildings, consider relocating the head end components (inclusive of voice communication system and support power) of the fire alarm system, as well as data gathering panels and any other active element of the fire alarm system backbone above the DFE. (Note: there is no code limitation or guidance regarding the location of the fire alarm system technology head end or data gathering panels. Code and the AHJ only govern the position of the fire command station and any fire alarm system devices.)

This proposal also recommends a new code requirement for a second (redundant) fire command station, which becomes automatically and/or manually operational in the event that the primary panel becomes inoperable. This second fire command station, recommended to be located five feet above the DFE, should be easily accessible via a stairwell. The secondary command station would become the primary head end of the system (replacing the lobby, or primary FCS panel) only through an FDNY approved process that is under the control of the FDNY and Building Management. FDNY must control any transfer between command stations to eliminate confusion during a fire event.

A protocol should be considered that allows the recall position of elevators during a fire alarm activation to be above the DFE, provided that this location is readily accessible from the lobby or the street. It is preferable that the elevators in this scenario recall to the same level as the secondary fire command station.

Additional costs for new construction include the additional fire command center equipment and the potential loss of usable square footage for the secondary fire command center. The installation costs of a secondary fire command center and relocation of DGPs will be minimal. Depending on the design of the building, and the ultimate location of the secondary position of the fire command station, there may or may not be costs associated with the architectural impacts (stair access, mezzanine creation, lost FAR floor space, etc.).

## G. Fuel Oil Tanks and Supply

Flooding of fuel tanks and pumps creates environmental issues, and renders the fuel system inoperable. This proposal recommends raising or floodproofing vulnerable elements of the fuel system.

Costs are minor for new construction projects, but in existing buildings they can be very high. If the fill location is above the design flood elevation, there may be a cost increase for fuel oil suppliers to reach this position. Costs are slightly higher to maintain monitoring and protection systems.

However, the savings from this proposal are considerable. The cost to clean up fuel-contaminated water can be large, especially if there is a spill into a building or public area. If floodwater enters the fuel tank and reaches boilers or generators, the damage can be significant. Additionally, protecting fuel systems helps prevent the need to relocate occupants if a building cannot be occupied due to loss of building heat or lack of emergency or standby generators.

Some of the waterproof equipment required by this proposal is readily available while other products require special order. If these recommendations become law, the products are likely to be more readily available. Alarm devices to sense oil and/or water are available. Submersible rooms are common in the marine industry, but not common to building construction. For protection of tanks above the DFE, existing technology (fire rated room construction, foam fire protection, etc.) that is readily available can be utilized.

Some equipment may be rated for use while being continuously submerged. Equipment rated for this use has an ingress protection (IP) rating of IPX8.

Designers should account for the increase in hydrostatic test pressure of the tank that occurs when vent pipe terminations are raised.

An excellent source of additional information about protecting fuel tanks is FEMA's Hurricane Sandy Recovery Advisory RA6, "Protecting Building Fuel Systems from Flood Damage."

**H. Medical and Compressed Gas Storage Tanks**

Current codes do not address protecting medical or compressed gas tanks during flooding. However, critical facilities must elevate this equipment to maintain service in the event of a flood. Although implementation is simple and required technology is available, the costs for existing buildings may be significant.

The climate modeling performed on behalf of the city and given to the Task Force as guidance predicts that many facilities in the current 500-year flood zone will begin experiencing 100-year floods sometime between the years 2020 and 2050. As such, it is prudent for critical facilities to plan for this contingency. Furthermore, the city should consider requiring critical facilities within the current 500-year flood zone to comply with Appendix G.

An excellent guide to further information for critical facilities is FEMA's Hurricane Sandy Recovery Advisory RA2 (April 2013), "Reducing Flood Effects in Critical Facilities."

**I. Fresh Air Intakes for Sewer Piping**

Locating fresh air intakes for sewer piping above the DFE will prevent water from entering lower levels through these intakes, mitigating water damage and the potential influx of toxic or hazardous materials.

The cost associated with this proposal includes additional fresh air intake piping from each sanitary house trap. This provision should be easy to implement, as the technology and means are readily available and well understood.

**J. Reduced Pressure Zone Backflow Preventers**

Reduced Pressure Principal Backflow Preventers (RPZs) are devices that use two independent check valves plumbed in series with a pressure-monitored chamber in between. The chamber is kept at a lower pressure than the incoming pressure. A differential relief valve is provided on the chamber to relieve excess pressure during a backflow condition. It is imperative that these devices are prevented from being submerged, since they are capable of introducing contaminated water into the potable water supply.

The NYC Department of Environmental Protection (DEP) often allows RPZs to be installed below grade if an engineered calculation is submitted (see NYC DEP Revised Supplement to the NYS Department of Health Handbook for Cross Connection Control pp. 4 and 7). This calculation assumes that the RPZ is discharging at the maximum flow rate based on the incoming water service pressure for a period of eight hours, but does not take into effect environmentally induced flood conditions. If flooding submerges the device and a discharge occurs, the device may not be able to operate as intended. This variance should be disallowed in flood zones for subgrade installations.

Associated costs include the installation, drainage and space requirements both in existing and new construction. This proposal is easy to implement in new construction, but may be burdensome in existing buildings due to increased space requirements and the drainage requirements of the device. The technology and means are readily available.

**Part 2. Best Practices for Floodproofing**

1. Elevate the enclosed lower occupied floors above the DFE in existing noncomplying buildings.

Elevating lower floors above the DFE in existing buildings presents many significant challenges for building owners. Street wall issues, including required transparencies of street walls in certain districts, are at odds with an active street life. Raising the ground floors above the DFE could have a negative impact by potentially creating large expanses of opaque street walls, which may preclude the street level activity intended by the Zoning Resolution. Dry floodproofing, including perimeter floodproofing (barriers/shields) of lower floors, may be a more desirable and feasible mitigation solution for existing and new buildings with street grades below the DFE, but dry floodproofing is only allowed in nonresidential buildings and nonresidential portions of mixed-use buildings. Wet floodproofing is another option that may be considered in lieu of raising floors and equipment; however, this could limit the use of the space at the base of buildings, including the use and enjoyment of the area.

Elevating lower floors of an existing building above the DFE could be achieved in two ways:

A. Raising the entire building (feasible only for smaller scale buildings). Shown in Figure 2A.
B. Removing existing floors and reconfiguring/building new floors above the DFE (requiring a change/limitation of the use of the floors that would remain below the DFE). Shown in Figure 2B.

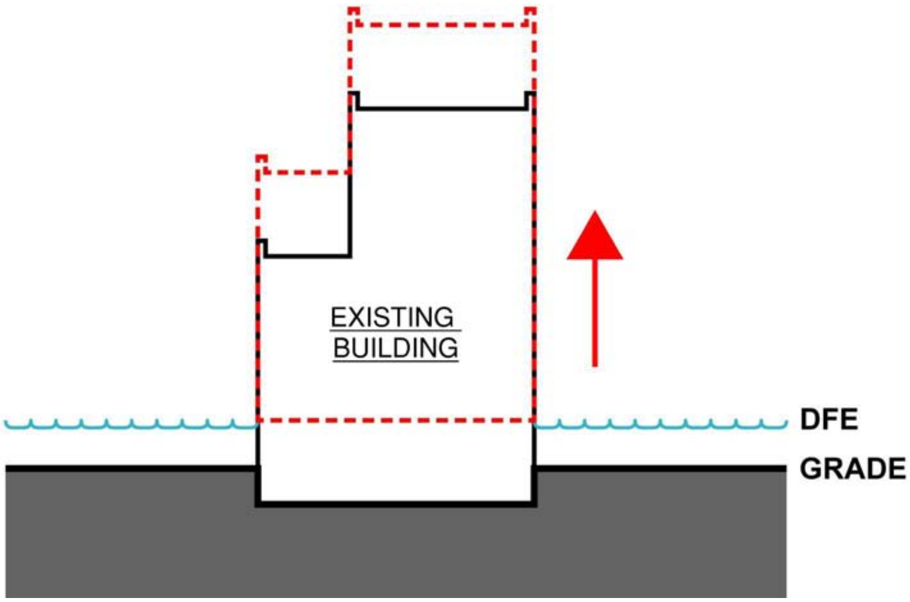


Figure 2A: Raising building above the DFE. (Limitations on use for areas/floors below the DFE).

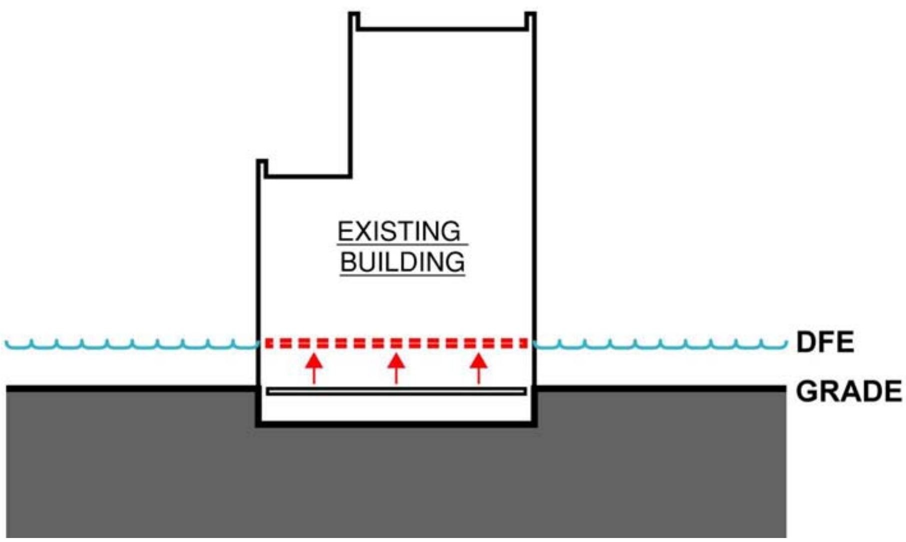


Figure 2B: Raising/reconfiguring lower occupied floors to be above the DFE. (Limitations on use for areas/floors below the DFE).

2. Dry Floodproof Basements

Water entry points at basements must be specifically addressed. Special attention must be given to detailing specific components of these assemblies:

- Sidewalk doors: Frames set within the sidewalks are to be watertight, and doors within

frames to be sealed. Prior to a flood event, the doors must be closed and sealed. Alternately, interior flood doors could be provided at the foundation walls that could be closed during flood events.
- Vaults & utility penetrations through foundation walls: Special attention to the detailing of pipe, conduit, and cable connections into buildings must be addressed. Inspections and flood testing are needed to ensure that all possible water entry points are addressed at walls, ceilings, and floors.

Complexities and issues include:
- Reinforcing existing foundation walls if they are not capable of resisting the additional pressure. Adding reinforcing may impact space and require internal reconfigurations of spaces and equipment locations.
- Complexity of detailing penetrations into foundation walls and interfaces with utility vaults and other components.

3. Dry Floodproof Selected Building Systems and Components

Providing a secondary level of dry floodproofing in and around building systems and components can prevent system inundation as well as greatly reducing cost and time to reoccupy buildings. Selected components, such as fuel oil tanks, pump rooms, or emergency electrical rooms could be waterproofed as “submarine rooms,” so the equipment remains fully functional during a flood event. Specific attention must be paid to the penetrations and openings within the room to ensure watertightness of the assemblies.

Floodproofed areas would need to be indicated on drawings submitted to DOB to ensure that the areas are maintained as floodproofed areas/assemblies. Demarcation of penetrations, wall assemblies, and doors/openings will be required to ensure that future renovations do not compromise the integrity of the floodproof construction.

4. Design Buildings to Resist Hydrostatic Forces From Higher Design Flood Elevations

For buildings with dry floodproofed below grade spaces, flooding can impose additional hydrostatic pressures on perimeter below grade walls and the lowest slabs (structural and nonstructural). The additional “head” of water can compromise the structural integrity of perimeter below grade walls and lowest slabs causing flooding and possibly structural damage.

The design of perimeter below grade walls and slabs to resist hydrostatic forces from flooding in Special Flood Hazard Areas has been implemented through the Building Code (Appendix G) and the Mayor’s Executive Order. However, the design and construction of retroactive applications for critical structures can be challenging. Perimeter foundation walls and lower slabs may require additional reinforcement and support (lateral beams, braces, tie-downs, etc.) to resist additional hydrostatic forces beyond original design requirements.

**Cost:**

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

**Sources:**


1. New York City Building Code (2008) and Appendix G (Flood Resistant Construction).
2. Executive Order No. 233 EMERGENCY ORDER TO SUSPEND ZONING PROVISIONS TO FACILITATE RECONSTRUCTION IN ACCORDANCE WITH ENHANCED FLOOD RESISTANT CONSTRUCTION STANDARDS (February 5, 2013).
3. ASCE 24/SEI and ASCE 7-10.
4. FEMA V Zone Design and Construction Certification.
5. FEMA Maps FIS 360497 and FEMA FIRMs 360497.
6. FM Global Documents:
    a. Flood Emergency Response Plan (FM Global ***Record,*** First Quarter 2003, Volume 80, No.1).
    b. Property Loss Prevention Data Sheets (July 2012).
    c. Property Loss Prevention Data Sheets (Interim Revision October 2012).
7. NYC Zoning Resolution (multiple sections).
8. Manufacturer Product Data/Testing Reports.
9. NYCDOT, “The Rules Related to Revocable Consents,” Title 34, Chapter 7 of the Rules of the City of New York, modified February 4, 2012.
10. US Army Corp of Engineers, St. Paul District, “Flood-Fight Handbook, Preparing for a Flood,” 2009 Addition.
11. FEMA Technical Bulletin 4 (November 2010), “Elevator Installation for Buildings Located in Special Flood Hazard Areas.”
12. FEMA Hurricane Sandy Recovery Advisory RA2 (April 2013) “Reducing Flood Effects in Critical Facilities.”
13. FEMA Hurricane Sandy Recovery Advisory RA6 (April 2013) “Protecting Building Fuel Systems from Flood Damage.”

## NEW CONSTRUCTION

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **3** | **Relocate & Protect Building Systems** | | | | | | | | | | | | | | | | |
| | NO CONSTRUCTION COST IMPACT FOR NEW CONSTRUCTION | | | | | | | | | | | | | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | | | | | |
| | Contingency | | | | | | | | | | | | | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | | | | | |
| | GC Mark-ups | | | | | | | | | | | | | | | | |
| | **TOTAL** | | | | **$0** | | | | **$0** | | | | **$0** | | | | **$0** |
| | **SUBTOTAL** | | | | **$29,150** | | | | **$23,650** | | | | **$23,650** | | | | **$23,650** |
| | GC Mark-ups | | 20% | | $5,830 | | 20% | | $4,730 | | 20% | | $4,730 | | 20% | | $4,730 |
| | **TOTAL** | 620,000 | GSF | $0.06 | **$34,980** | 4,000 | GSF | $7.10 | **$28,380** | 231,000 | GSF | $0.12 | **$28,380** | 15,000 | GSF | $1.89 | **$28,380** |

## EXISTING BUILDINGS

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **3** | **Relocate & Protect Building Systems** | | | | | | | | | | | | | | | | |
| | BEST PRACTICE | | | | | | | | | | | | | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | | | | | |
| | Contingency | | | | | | | | | | | | | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | | | | | |
| | GC Mark-ups | | | | | | | | | | | | | | | | |
| | **TOTAL** | | | | - | | | | - | | | | - | | | | - |

# 4 Remove Barriers to Elevating Buildings & Building Systems

## I. Summary

**Issue:**
Building owners may wish to elevate buildings or building systems, but are restricted by building regulations and zoning height limitations.

**Recommendation:**
Allow building owners to raise telecommunications rooms and to store more fuel above the flood line. Consider allowing zoning relief for buildings elevating to the 500-year flood line.

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## II. Proposed Legislation, Rule or Study

*Amendments to the New York City Electrical Code:*

1. Amend Section 27-3025 as follows:

   Subsection 770.48(A) – Add a new second and third sentence to subsection 770.48(A) to read as follows: All other cables shall be considered to be within the building. Exception: In Special and Moderate Flood Hazard Areas, carrier service cabling shall be permitted to a distance that supports direct delivery to a level five (5) feet above the FEMA 500-year flood plain, even if such a distance exceeds 15m (50 ft).

   Section 800.48 – Add a new second sentence to read as follows: Exception: In Special and Moderate Flood Hazard Areas, carrier service cabling shall be permitted to a distance that supports direct delivery to a level five (5) feet above the FEMA 500-year flood plain, even if such a distance exceeds 15m (50 ft). If the distance of such cabling exceeds 15m (50 ft), it shall be installed in conduit sufficient to protect against the intrusion of water during flood conditions and in conformance with all other requirements of this Code, including grounding, bonding and protection.

*Amendments to the New York City Mechanical Code:*

1. Amend Section 1305.11.1.3 as follows:

   **1305.11.1.3 Inside of buildings; above the lowest floor.** Fuel oil above the lowest floor inside of a building shall be limited to 330 gallons (1249 L) per story. The maximum quantity shall include oversized piping as described in Section 1305.9.12. Piping installations shall comply with the requirements of Section 1305.9.

**Exception:** In areas designated as a Special or Moderate Flood Hazard Area, fuel oil storage on the floor immediately above the design flood elevation shall be limited to the lesser of 3,000 gallons, with no single tank greater than 1,500 gallons or 24 hours of run time for emergency or standby generator(s) served by this storage tank(s). Each tank shall be enclosed in a separate vault (i) with walls, floor, and top having a fire resistance rating of not less than 3 hours, (ii) with such walls bonded to the floor, and (iii) with such top and walls of the vault independent of or connected to the building structure. An exterior building wall having a fire resistance rating of not less than 3 hours shall be permitted to serve as a wall of a vault. The vault shall be located in a dedicated room or area of the building that is cut off vertically and horizontally from other areas and floors of the building by assemblies having a fire resistance rating of not less than 2 hours. Such storage shall be protected with an alternate extinguishing system complying with Section 904 of the *New York City Building Code*.

*Recommended Study by the Department of City Planning:*

The New York City Department of City Planning should perform a study of the effects of allowing elevation to the 0.2% Advisory Base Flood Elevation (ABFE) to receive zoning relief. This would allow building owners who wish to elevate to this higher level of safety to receive the same zoning relief as is currently given to the buildings elevating to the 1% ABFE. The study should include additional height for freeboard, and be applicable to Moderate Flood Hazard Areas (also known as the Shaded-X or 500-year flood zone; the areas where there is a 0.2% annual chance of flooding) in addition to Special Flood Hazard Areas (the 100-year flood zone; the areas where there is a 1% annual chance of flooding).

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## III. Supporting Information

**Expanded Issue and Benefits:**

**Carrier Service Cabling**

The NYC Electrical Code limits the type of cable used for telecom services to 50 feet in length within a building, which may make it difficult to extend cabling to a telecom service room elevated above the DFE. Greater length needs to be allowed so that the room can be raised and the carrier service cabling can be brought to it in a code-compliant manner. This proposal therefore recommends permitting the installation of carrier service cabling to an extended distance that supports direct delivery to a position 5 feet above the 0.2% ABFE.

**Maximum Fuel Tank Size**

In general, reduced fuel storage capacity above the design flood elevation (DFE) limits the duration of operation of emergency generators for life safety systems. By increasing the allowable size of fuel storage tanks, emergency systems, life safety equipment and building systems will remain operable for longer periods of time following a flood event. This increase also minimizes the operational hazards of portable generators, which are typically connected through temporary wiring, and of installed systems, which often require fuel delivery in 55 gallon drums for manual filling of storage tanks. Currently, NYC Mechanical Code Chapter 13 allows no tanks larger than 330 gallons above the lowest level of a building. Allowing larger fuel tanks is addressed in the 2012 International Fire Code, 603.3.2.1 Quantity limits, which may be a valuable reference.

To address this issue, intended for buildings in the Special or Moderate Flood Hazard Areas, are to:

1. Provide a tank design option for an 'intermediary tank' from which fuel stored in bulk could be pumped with a submersible pump to a lower floor or basement, or which could be filled from the street.
2. Directly serve equipment connected to the tank, such as emergency generators and boilers. The proposal is not intended to regulate tanks used as dispensing stations to fill other containers.
3. Provide a performance standard for the hours of equipment runtime.

**Department of City Planning Study**

Executive Order 233 created the Zoning Design Flood Elevation (ZDFE) designation, which allows building owners to elevate lower floors 1-2 feet above the 1% ABFE and suspends height limits to the extent necessary to raise the level of the lowest habitable floor above the ZDFE. However, some owners in Special Flood Hazard Areas may wish to plan for the 0.2% ABFE, and owners in Moderate Flood Hazard Areas may also wish to elevate their structures to prepare for future risks. Therefore, the Department of City Planning should perform a study to consider the effects of modifying the ZDFE height designation to allow elevation as high as the 0.2% ABFE, plus freeboard. The study should encompass both Special and Moderate Flood Hazard Areas.

Because the 0.2% ABFE can be 2-4 feet higher than the 1% ABFE, raising buildings to this higher level may present additional design and planning issues for individual buildings and the streetscape. Therefore, the effects of allowing additional height, while desirable from the perspective of increased flood resilience, should be carefully studied.

Issues to be addressed in the study:

1. It may be desirable to provide a floor area ratio bonus for the relocation of fuel oil from basement levels (generally low value rental space) to above the DFE in order to account for the loss of this valuable amenity space.
2. The reconfiguration of floors may result in a loss of leasable space and reduced ceiling heights, as reconfigured floors may be restricted by floor-to-floor heights, potentially requiring the removal of portions of the floors or the entire floors.
3. Compliance with accessibility regulations (including ADA) as lower floors are elevated.
4. Zero lot line conditions make the implementation of stairs, ramps and elevators that connect the street to higher floor levels challenging.

**Cost:**

No cost estimation was performed for this proposal.

# **5** Remove Barriers to Sidewalk Flood Protection

## I. Summary

**Issue:**
Building owners may wish to install flood barriers on sidewalks, but are deterred by codes that limit sidewalk use and that assume buildings are fully occupied during floods.

**Recommendation:**
Allow underground sidewalk attachments for temporary flood barriers. After evacuation, allow nonresidential buildings to maintain a single entrance/exit for emergency personnel so that flood barriers can be installed.

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## II. Proposed Legislation, Rule or Study

*Amendments to the New York City Building Code:*

1. Amend Section BC G501 Modifications, G501.1 Amendments to ASCE 24-05, Section 6.2.2, Item 3, as follows:

   3. Have either:
   All required means of egress elevated to or above the applicable DFE specified in Table 6-1, capable of providing human ingress and egress during the design flood; or
   At least one elevated door located in close proximity to each required means of egress to the exterior that is to be blocked by flood shields or flood control devices, such that the face of the elevated door itself, and not merely its directional signage, is clearly visible to a person approaching the blocked egress door(s). Such door(s) shall be elevated to at or above the applicable DFE specified in Table 6-1, capable of providing human ingress and egress during the design flood. Such door(s) shall meet all New York City Building Code requirements for a required means of egress to the exterior of the structure including hardware and signage, but shall not be required to comply with the occupant load calculations, unless the structure is intended for occupancy during the design flood. Such door(s) may be accessed by open steps and shall not be required to comply with Chapter 11 of the New York City Building Code if its only purpose is to provide supplemental egress and ingress during conditions of flooding and to provide emergency egress at other times.
   Exception: During conditions of flooding, buildings of non-residential occupancy that have been entirely evacuated except for emergency personnel shall not be required to maintain more than one means of egress complying with the requirements of this section.

2. Amend Section BC 3202 Encroachments by adding a subsection as follows:

   **3202.4.3 Flood related egress.** Temporary stairs and/or ramps may be permitted during flood events for access to flood related egress locations. Construction of temporary stairs and ramps must comply with the requirements of Chapter 11 of this code *and any other regulations affecting such encroachments*.
   [Note: The regulations governing temporary stairs and/or ramps should be developed by the city and incorporated into this code section.]

3. Amend Section BC 3202 Encroachments:

   **3202.1.1 Footings.** Exterior wall and column footings may be constructed to project beyond the street line not more than 12 inches (305 mm), provided that the top of the footing is not less than 8 feet (2438 mm) below the ground or sidewalk level. Foundation walls required to support permitted projections may be constructed to project not more than the permitted projection beyond the street line. Continuous footings for the support and attachment of removable dry floodproofing barriers/shields may be constructed to project beyond the street line not more than 12 inches (305 mm) both at grade and below grade.

*Amendments to NYCDOT Rules Related to Revocable Consent:*

1. Modified on February 4, 2012: Title 34, Section 7-04, Eligible Improvements: Standards; Annual Rates.
   (24) Retaining Walls
   (i) *Standard.* Retaining walls may be constructed only where warranted by existing grade or by a change in grade undertaken with prior approval by the Department of Buildings.
   (ii) *Temporary flood protection*. Removable dry flood proofing barriers/shields may be erected only during flood events.
   ({ii}iii) *Annual rate.* See §7-10.

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## III. Supporting Information

**Expanded Issue and Benefits:**

Many existing buildings located in flood zones have adjacent street grades with elevations below the Design Flood Elevation (DFE). Buildings often have exterior perimeter walls and egress doors at the property lines, presenting significant challenges to building owners that wish to voluntarily incorporate dry floodproofing (flood barriers and/or shields) around the building perimeter.

This proposal modifies egress requirements for evacuated non-residential buildings to more closely resemble the application of ASCE 24 nationally (requiring only one discharge point in an evacuated building). Further discussion with FDNY should clarify the definition of an evacuated building. In the case of very large buildings, multiple egresses may be required, as substantial travel from one end of building to another may not be feasible or advisable.

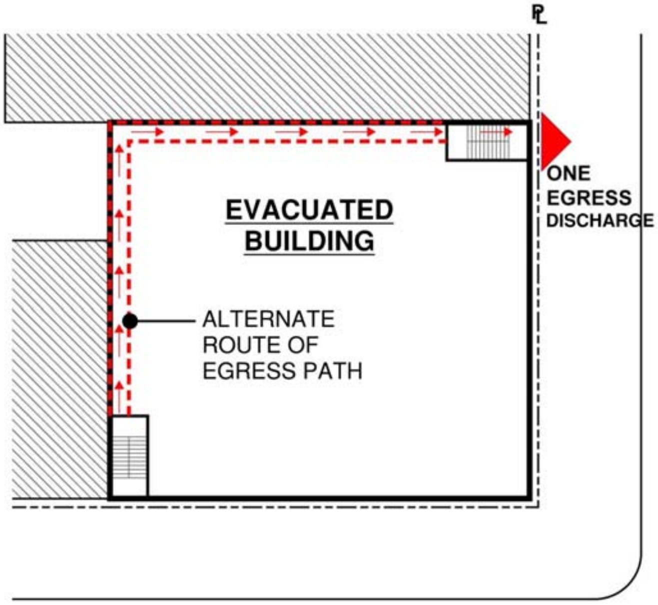


*Figure 1: Diagram for single point egress discharge for evacuated non-residential buildings.*

This proposal allows for the temporary placement of flood barriers (and temporary stairs over those barriers to provide access to building egress discharge points) within the public right of way. These may require physical connections to materials in the public right-of-way (including temporary attachments and bracings to sidewalks.) The placement of barriers and access structures like stairs will require coordination with those agencies or entities with jurisdiction over the right-of-way (ROW) in question, such as the Department of Transportation.

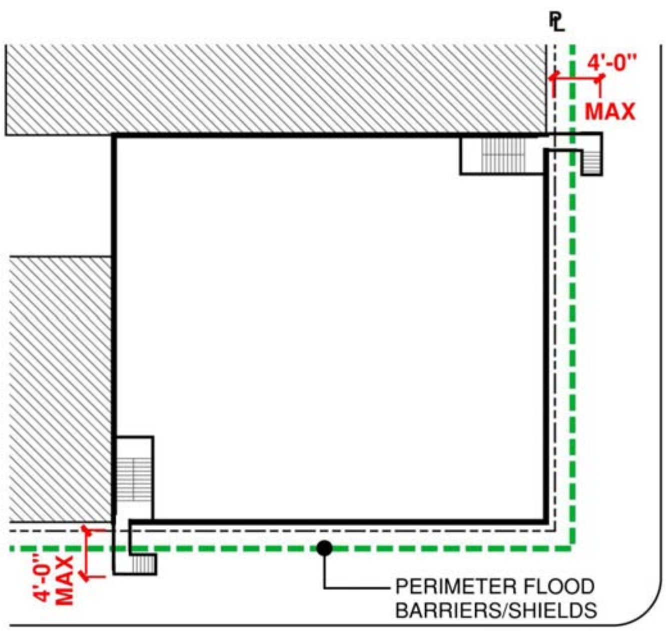


*Figure 2: Diagram showing encroachments into public ROW for flood barriers & temporary stairs.*

In many cases, permanent encroachments within the public ROW (such as haunches projecting from the building foundations) would facilitate the temporary support and attachment of flood barriers. This is especially true in situations (like zero-lot-line buildings) where the position of the exterior wall of the building does not accommodate the placement of barriers inside of the property lines. The allowable dimensions and character of these haunches (or other barrier support encroachments) should be determined in concert with the related agencies or entities with jurisdiction over the public right-of-way, and a process for the application and review of associated consent orders should be developed. Regulatory stakeholders in this process should include, at a minimum: NYC Dept. of Transportation (lead agency), NYC Dept. of Buildings, Metropolitan Transportation Authority, the NYC Parks Department, Con Edison, NYC Fire Department, and the New York Power Authority.

In discussions with the city, the clear preference was for barriers that protect entire blocks or neighborhoods, rather than single buildings. It is hard to predict the effects that individual building barriers may have on neighboring structures, making it difficult to evaluate plans for proposed barriers and grant permits. Flood protection systems located in the public right-of-way will be deployed more uniformly, and with better city control over the timing of when they are erected and removed, if they are designed to protect groups of buildings.

If whole blocks or neighborhoods do not have flood protection, individual buildings may desire to protect themselves using temporary storm barriers. If egress over the temporary storm barriers requires temporary stairs or ramps that encroach into the public right-of-way, the city would need to balance the value of this protection against the public needs of evacuation and safe use of sidewalks and roadways. The intent of this proposal is not to specify the details of temporary ramps and stairs, but to recommend the city discuss and develop regulations governing the conditions under which these encroachments could be allowed. In doing so, the city should consider factors including but not limited to the width of the sidewalk and street, the width of the stair or ramp, alternate means of egress that might be employed, operational concerns involving the permanent fixtures to which temporary structures would be attached, and the timing of when obstructing means of egress would be allowed to be erected and when they would be required to be removed.

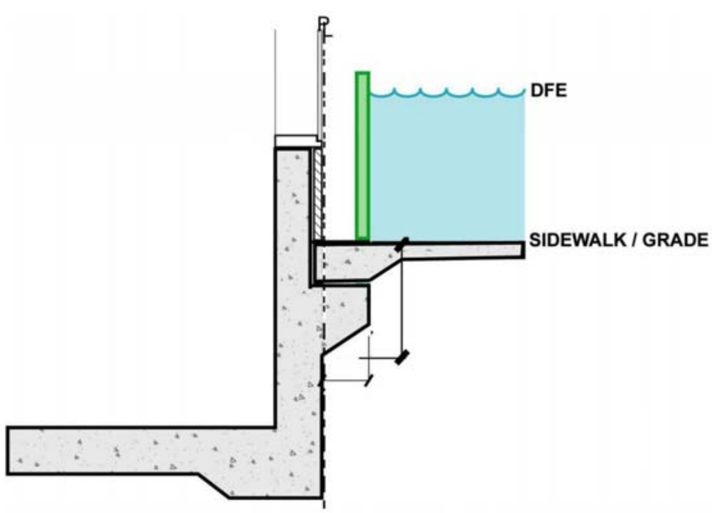


*Figure 3: Diagram showing encroachments into public ROW for flood barriers attachment and support.*

Each building should have in place an Emergency Preparedness Plan (EPP) that, 1) outlines a process to ensure that all non-essential building occupants have vacated the building, 2) describes the layout of temporary flood protection measures coordinated with relevant agencies, 3) indicates any temporary ramps or stairs (over flood barriers) required to allow building access to occupants and emergency personnel, and 4) addresses the placement and installation of any egress signage needed to accommodate alternate egress route(s). The EPP should make it clear that temporary dry floodproofing measures (such as removable barriers or sandbags) that encroach upon the public right-of-way are only permitted when a Flash Flood Emergency or Coastal Flood Emergency has been declared, and the EPP should indicate the number of days post-event that such temporary structures will be allowed to remain (as determined by the City of New York).

Appendix G of the New York City Building Code includes guidelines for the design of flood barriers and/or shields design, including requirements for flood barrier systems to resist loads as identified in ASCE 7. Appendix G also requires inspections to confirm the proper installation of flood barriers and/or shields, as well as the inspection of required egress signage (per ASCE 24, Section 6.2.3, Item 3).

Sandbags are among the most common components of temporary flood barriers and are a viable method to restrict water flow into buildings. The US Army Corp of Engineers recommends a height-to-width ratio for sandbag barrier construction of 1:3, with a recommended maximum height of 5 feet. Regulations pertaining to sandbag barriers should limit their use to flood events and should restrict their placement to sidewalks and other areas adjacent to buildings that do not impede the street or any other recognized access pathways for emergency vehicles.

**Cost:**

No cost estimation was performed for this proposal.

**Sources:**

1. US Army Corp of Engineers, St Paul District, Flood- Fight Handbook- Preparing for a Flood, 2009 Edition
2. ASCE 24
3. ASCE 7

# 6 Add Backup Fire Safety Communication

## I. Summary

**Issue:**
Loss of power to telecommunications systems and flooding that damages underground phone and data lines can cut off communication between buildings and the Fire Department.

**Recommendation:**
All large buildings in flood zones should consider having a backup wireless fire communication system, and new large critical buildings must have backup phone and data connections. Mandate the use of storage batteries with a life of at least eight hours to serve buildings' fire and life safety communication systems.

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## II. Proposed Legislation, Rule or Study

As a best practice, buildings in the Special Hazard Flood Area (100-year flood zone) over 75 feet above the lowest level of Fire Department vehicle access, or having a total gross area exceeding 100,000 square feet, should have one of the two lines to the supervising station (as required by the Fire Code) be wireless.

The Fire Code should be modified to require Group I-2 occupancies (hospitals) to require communication systems to the supervising station to have two different carrier sources entering the building at separate service points of entry. Additionally, the Building Code should be modified so that all new buildings that are classified as I-2 and are hospitals providing acute medical care located in areas of special or moderate flood hazard shall be designed with two independent points of entry for telecommunications and IT services, such that backup services are available when services from the primary supplier are disrupted.

*Amendments to the New York City Electrical Code*:

1. Amend Subsection 700.12(A) as follows:

   Storage batteries shall be used as a source of power for emergency and life safety telecommunications systems and shall be of suitable rating and capacity to supply and maintain the total load for a minimum period of eight hours, without the voltage applied to the load falling below 87 1/2 percent of normal.

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## III. Supporting Information

**Expanded Issue and Benefits:**

After Superstorm Sandy, telecommunication carriers experienced different timelines for recovery of services due to varying installation methods and locations of both street network infrastructures and central office facilities. As a result, as of February 2013, more than three months after loss of telecommunications from Superstorm Sandy, there were still 171 commercial properties in lower Manhattan that did not have operational traditional life safety circuits.

NYC Fire Code currently requires two lines of communications to the supervisory station. FDNY has advised that wireless communications are allowed as one of these lines. Requiring a secondary (dual or redundant) telecommunications carrier, and in some cases wireless in addition to wired circuits, to service Fire Department communication systems enhances a building's critical life safety system and building management telecommunications connectivity.

The installation of dual telecommunications carriers in a building for an essential use, like Fire Department communications, encourages nonessential building functions to also use this dual arrangement, thereby increasing the building's overall resiliency without any added cost. This proposal does not identify or mandate if and/or how the building will incorporate additional communication functions, as these will remain individual business decisions.

As telecommunications carriers move to fiber optic cables rather than traditional copper circuits, having different circuit technologies will provide added resiliency to buildings.

For hospitals, redundant communication carriers are of particular importance, so the proposal is extended to include all communications, not just the supervisory station. This includes contact with emergency services, external communications for patient transfer and evacuation, and access to critical records that may be stored electronically off-site. As a best practice, hospitals should also maintain a satellite phone since both wired and wireless systems can be disrupted by the same event.

**Cost:**

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

## NEW CONSTRUCTION

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 6 | **Add Backup Fire Safety Communication** | | | | | | | | | | | | | | | | |
| | Furnish and install incoming secondary service conduit from property line to telecommunications service entry room (4" electrical conduit) | 100 | LF | $840.00 | $84,000 | | | | | 100 | LF | $420.00 | $42,000 | | | | |
| | Furnish and install incoming service cable (by service provider - not included in this estimate) | | | | by others | | | | | | | | by others | | | | |
| | | | | | $0 | | | | | | | | $0 | | | | |
| | | | | | $0 | | | | | | | | $0 | | | | |
| | | | | | $0 | | | | | | | | $0 | | | | |
| | | | | | $0 | | | | | | | | $0 | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$84,000** | | | | | | | | **$42,000** | | | | |
| | Contingency | | 10% | | $8,400 | | | | | | 10% | | $4,200 | | | | |
| | **SUBTOTAL** | | | | **$92,400** | | | | | | | | **$46,200** | | | | |
| | GC Mark-ups | | 20% | | $18,480 | | | | | | 20% | | $9,240 | | | | |
| | **TOTAL** | 620,000 | GSF | $0.18 | **$110,880** | | | | **N/A** | 231,000 | GSF | $0.24 | **$55,440** | | | | **N/A** |

## EXISTING BUILDINGS

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 6 | **Add Backup Fire Safety Communication** | | | | | | | | | | | | | | | | |
| | Furnish and install incoming secondary service conduit from property line to telecommunications service entry room (4" electrical conduit) | 100 | LF | $840.00 | $84,000 | | | | | 100 | LF | $420.00 | $42,000 | | | | |
| | Furnish and install incoming service cable (by service provider - not included in this estimate) | | | | by others | | | | | | | | by others | | | | |
| | Patching of drywall | 1 | LS | $500.00 | $500 | | | | | 1 | LS | $500.00 | $500 | | | | |
| | | | | | **$0** | | | | | | | | **$0** | | | | |
| | | | | | $0 | | | | | | | | $0 | | | | |
| | | | | | **$0** | | | | | | | | **$0** | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$84,500** | | | | | | | | **$42,500** | | | | |
| | Contingency | | 0.1 | | $8,450 | | | | | | 0.1 | | $4,250 | | | | |
| | **SUBTOTAL** | | | | **$92,950** | | | | | | | | **$46,750** | | | | |
| | GC Mark-ups | | 0.2 | | $18,590 | | | | | | 0.2 | | $9,350 | | | | |
| | **TOTAL** | **620,000** | **GSF** | **$0.18** | **$111,540** | | | | **N/A** | **231,000** | **GSF** | **$0.24** | **$56,100** | | | | **N/A** |

# **7** Safeguard Toxic Materials Stored in Flood Zones

## I. Summary

**Issue:**
The NYC Department of Environmental Protection requires facilities that store hazardous chemicals to file a risk management plan, but it does not require special protection for chemicals stored in flood zones.

**Recommendation:**
Require toxic materials in flood zones to be stored in a floodproof area.

---

## II. Proposed Legislation, Rule or Study

*Amendments to the Rules of the City of New York:*

1. Add a new paragraph (5) to subdivision (a) of section 41-05 as follows:

   (5) Determination whether the facility, or portions of the facility, lie within the area of special flood hazard (100 year floodplain) as mapped by the Federal Emergency Management Agency on the Flood Insurance Rate Map.

2. Amend subdivision (d) of section 41-05 by deleting paragraph (2) as follows:

   (d) These filing requirements shall not apply to:
   (1) Facilities where the only hazardous substances present during the preceding calendar year were in mixtures in which the total content of the hazardous substance was less than the Threshold Reporting Quantity per container unless such hazardous substance was present at the facility in an aggregate amount equal to or greater than the Threshold Reporting Quantity.{; and
   (2) Owners or tenants of residential buildings that contain no commercial or manufacturing enterprise.}

3. Add a new paragraph (5) to subdivision (b) of Section 41-10 as follows:

   (5) Determination whether the facility or portions of the facility lie within the area of special flood hazard (100 year floodplain) as mapped by the Federal Emergency Management Agency on the Flood Insurance Rate Map.

4. Add a new paragraph (9) to subdivision (b) of Section 41-11 as follows:

(9) If the facility or portions thereof lies within the area of special flood hazard (100 year floodplain) as mapped by the Federal Emergency Management Agency on the Flood Insurance Rate Map, the risk management plan shall include engineering measures that flood proof any chemicals, processes, and or operations within the floodplain, operating measures to ensure that chemicals, processes, and or operations shall be located in portions of the facility that are above or beyond the floodplain, or an approved operational plan to relocate chemicals above the floodplain in advance of a flood event.

After revising these rules, the City of New York should modify the Facility Information Forms (FIF), Risk Management Plans (RMP) and the regulatory review procedure at the Department of Environmental Protection and the New York Fire Department to take into account: the location of facilities in the floodplain; and measures to mitigate or prohibit storage of certain categories of chemicals within the 100 year flood plain. Additionally, the City of New York should consider expanding the categories of chemicals or buildings required to file RMPs.

## III. Supporting Information

**Expanded Issue and Benefits:**

In the event of significant flooding, storage of hazardous materials in spaces that are within floodplains and are not protected from such events can lead to serious environmental contamination and present a significant threat to human health. For example, the flooding of the Mississippi River in 1993 and New Orleans in 2005 resulted in severely contaminated water. In New Orleans, floodwaters were found to contain elevated lead levels, and bacteria associated with sewage was at least ten times higher than acceptable to public health officials. This contamination threatened the health of both rescue workers and remaining residents, especially children, who were in direct contact with the floodwaters.[i] Reports indicate that toxic chemicals in the floodwaters in New Orleans will negatively impact human health for a decade.[ii] Here in New York City, OSHA advocated protective measures for residents and recovery workers following Sandy, indicating that Sandy floodwaters contained toxic chemicals as well as sewage and soil related bacteria.[iii]

As the consequences of inaction are significant, and as preventative measures are relatively simple, it is crucial that New York City require the safe storage of hazardous materials within the 100-year floodplain. Of the roughly one million buildings in the City, it is anticipated that less than 750 will be impacted by the preventative measures proposed here.
While several New York City programs address toxic chemical storage, none contain provisions to secure such substances within the floodplain. The Community Right-to-Know program, administered by the New York City Department of Environmental Protection (NYC DEP),

[i] Christine Lagorio, EPA: Danger in the Drinking Water, CBS NEWS, Sept. 7, 2005, available at http://www.cbsnews.com/stories/2005/09/07/katrina/main823891.shtml.
[ii] Geoffrey Lean, Cover-up: toxic waters ‘will make New Orleans unsafe for a decade, THE INDEPENDENT, Sept. 11, 2005, available at http://www.waterconserve.org/shared/reader/welcome.aspx?linkid=46033.
[iii] OSHA Fact Sheet, Keeping Workers Safe during Hurricane Sandy Cleanup and Recovery, December 2012. http://www.osha.gov/Publications/OSHA_FS-3610.pdf

requires disclosure of information on the handling of hazardous substances through annual filing of a Facility Inventory Form (FIF). Buildings that exceed minimum threshold quantities must also submit an annual Risk Management Plan (RMP), which includes a Risk Assessment, a risk reduction plan and emergency response procedures. The NYC DEP reviews the RMP, inspects the facility and forwards the RMP to the New York City Fire Department for their review, but no aspects of this process specifically deal with the protection of hazardous substances during flood events.

Similarly, Appendix G of the New York City Building Code includes rules for construction in or around the 100-year floodplain but does not include any special guidance with regard to storage of hazardous materials within the floodplain. Requirements are limited to the construction and location of tanks and sewage facilities, and apply only to newly constructed facilities or substantial alterations of existing facilities, outside the purview of significant portions of construction and renovation work in the City.

Since New York City already has programs addressing the general storage of hazardous materials minimal work is necessary to implement this proposal. This proposal simply requires an additional determination within the RMP as to whether or not the facility lies within the 100 year floodplain. DEP would then inspect the facility to determine the adequacy of the chemical storage as a part of their current inspection practices.

Additionally, the benefits of the Community Right-to-Know program should be extended to residential buildings. A relatively small number of residential buildings would be impacted and the benefits of safeguarding toxic or hazardous substances from floods in residential areas greatly outweigh any costs.

**Implementation:**

Since programs addressing the storage of toxic chemicals already exist in New York City, the implementation of the proposal will require minimal additional effort. Modification to the DEP program will involve:

1. revising the notification and filing provisions of the RMPs;
2. DEP staff modifying their forms and procedures to require the RMP filing to address this issue;
3. amending the RMP filing to include a determination as to whether the project lies within the 100-year floodplain;
4. including flood plain boundaries in DEP staff evaluations; and
5. if the facility is located within the 100-year flood plain, the DEP determination of appropriate storage procedures.

**Cost:**

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

## NEW CONSTRUCTION

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 7 | **Safeguard Toxic Materials Stored in Flood Zones** | | | | | | | | | | | | | | | | |
| | NO CONSTRUCTION COST IMPACT | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | | | | | |
| | Contingency | | | | | | | | | | | | | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | | | | | |
| | GC Mark-ups | | | | | | | | | | | | | | | | |
| | **TOTAL** | | | | $0 | | | | $0 | | | | $0 | | | | $0 |

## EXISTING BUILDINGS

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 7 | **Safeguard Toxic Materials Stored in Flood Zones** | | | | | | | | | | | | | | | | |
| | NOT COSTED | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | | | | | |
| | Contingency | | | | | | | | | | | | | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | | | | | |
| | GC Mark-ups | | | | | | | | | | | | | | | | |
| | **TOTAL** | | | | - | | | | - | | | | - | | | | - |

# **8** Prevent Sewage Backflow

## I. Summary

**Issue:**
During floods, sewage can backflow into buildings.

**Recommendation:**
Require valves on building sewage lines to prevent sewage from entering the building.

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## II. Proposed Legislation, Rule or Study

*Amendments to the New York City Plumbing Code*:

1. Add a new Subsection 715.1.1 as follows:

   **715.1.1** – Building drains serving buildings located in Special Flood Hazard Areas shall be provided with a backwater valve at its point of exit from the building and downstream from the building trap.

2. Add a new Subsection 1002.6.1 as follows:

   **1002.6.1** – Backwater valves shall be provided on the building storm drainage system in accordance with PC 715 for all buildings located in Special Flood Hazard Areas.

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## III. Supporting Information

**Expanded Issue and Benefits:**

The use of backwater valves can help minimize damage to below-grade levels during a flood event. Floodwater from either coastal or surface flooding will be prevented from entering the building through the sewer, bringing potentially toxic and hazardous materials inside.

Backwater valves do not prevent building discharges from exiting the building, as they are only in the “closed” position when the sewers are full and threaten to backflow into the building. These periods are generally brief and, in any case, no building sewage can be discharged into the sewers when the sewers are full, regardless of the presence of backwater valves.

**Cost:**

The cost associated with this proposal includes installation of backwater valves on each storm point of entry. Backwater valves are already required by the Plumbing Code for buildings subject to overflow from the public sewers. As a result, in most cases this proposal merely clarifies the location of the valve and does not represent an additional cost.

There may be additional maintenance requirements associated with backwater valves. Backwater valves of the hinged flap type can become hung up and not work when needed, a problem increased in the absence of proper maintenance. As a result, the NYC School Construction Authority specifies the use of floodgate valves to avoid this issue.

This provision should be easy to implement, as the technology and means are readily available and well understood.

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

**Sources:**

1. NYCPC Chapters 7, 10, & 11.

## NEW CONSTRUCTION

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 8 | **Prevent Sewage Backflow** | | | | | | | | | | | | | | | | |
| | Architectural revisions | | | | $0 | | | | $0 | | | | $0 | | | | $0 |
| | Furnish and Install backwater valve | 1 | ALW | $10,000.00 | $10,000 | 1 | ALW | $5,000.00 | $5,000 | 1 | ALW | $10,000.00 | $10,000 | 1 | ALW | $5,000.00 | $5,000 |
| | Relocate pipe and fresh air intake above the design flood elevation | 100 | LF | $150.00 | $15,000 | 100 | LF | $150.00 | $15,000 | 100 | LF | $150.00 | $15,000 | 100 | LF | $150.00 | $15,000 |
| | Wire mesh screen and fresh air intake | 1 | ALW | $1,500.00 | $1,500 | 1 | ALW | $1,500.00 | $1,500 | 1 | ALW | $1,500.00 | $1,500 | 1 | ALW | $1,500.00 | $1,500 |
| | Demolition | | | | Not Required | | | | Not Required | | | | Not Required | | | | Not Required |
| | | | | | $0 | | | | $0 | | | | $0 | | | | $0 |
| | **SUBTOTAL DIRECT WORK** | | | | **$26,500** | | | | **$21,500** | | | | **$26,500** | | | | **$21,500** |
| | Contingency | | 10% | | $2,650 | | 10% | | $2,150 | | 10% | | $2,650 | | 10% | | $2,150 |
| | **SUBTOTAL** | | | | **$29,150** | | | | **$23,650** | | | | **$29,150** | | | | **$23,650** |
| | GC Mark-ups | | 20% | | $5,830 | | 20% | | $4,730 | | 20% | | $5,830 | | 20% | | $4,730 |
| | **TOTAL** | 620,000 | GSF | $0.06 | **$34,980** | 4,000 | GSF | $7.10 | **$28,380** | 231,000 | GSF | $0.15 | **$34,980** | 15,000 | GSF | $1.89 | **$28,380** |

## EXISTING BUILDINGS

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 8 | **Prevent Sewage Backflow** | | | | | | | | | | | | | | | | |
| | Architectural revisions | | | | $0 | | | | $0 | | | | $0 | | | | $0 |
| | Furnish and Install backwater valve | 1 | EA | $10,000.00 | $10,000 | 1 | ALW | $5,000.00 | $5,000 | 1 | EA | $10,000.00 | $10,000 | 1 | ALW | $5,000.00 | $5,000 |
| | Relocate pipe and fresh air intake above the design flood elevation | 100 | LF | $150.00 | $15,000 | 100 | LF | $150.00 | $15,000 | 100 | LF | $150.00 | $15,000 | 100 | LF | $150.00 | $15,000 |
| | **Wire mesh screen on fresh air intake** | 1 | ALW | $1,500.00 | **$1,500** | 1 | ALW | $1,500.00 | **$1,500** | 1 | ALW | $1,500.00 | **$1,500** | 1 | ALW | $1,500.00 | **$1,500** |
| | Demolition of existing conditions | 1 | ALW | $7,200.00 | $7,200 | 1 | ALW | $3,000.00 | $3,000 | 1 | ALW | $7,200.00 | $7,200 | 1 | ALW | $3,000.00 | $3,000 |
| | | | | | **$0** | | | | **$0** | | | | **$0** | | | | **$0** |
| | **SUBTOTAL DIRECT WORK** | | | | **$33,700** | | | | **$24,500** | | | | **$33,700** | | | | $24,500 |
| | Contingency | | 0.1 | | $3,370 | | 0.1 | | $2,450 | | 0.1 | | $3,370 | | 0.1 | | **$2,450** |
| | **SUBTOTAL** | | | | **$37,070** | | | | **$26,950** | | | | **$37,070** | | | | $26,950 |
| | GC Mark-ups | | 0.2 | | $7,414 | | 0.2 | | $5,390 | | 0.2 | | $7,414 | | 0.2 | | $5,390 |
| | **Individual Proposal Total** | **620,000** | **GSF** | **$0.07** | **$44,484** | **4,000** | **GSF** | **$8.09** | **$32,340** | **231,000** | **GSF** | **$0.19** | **$44,484** | **15,000** | **GSF** | **$2.16** | **$32,340** |

# **9** Plant Wind and Flood Resistant Trees

## I. Summary

**Issue:**
People, property, buildings, and utility lines can be at risk from trees damaged by high winds and flooding.

**Recommendation:**
In waterfront areas accessible to the public, require wind and salt-tolerant trees and regular tree pruning. Encourage private owners to follow the same practices.

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## II. Proposed Legislation, Rule or Study

*Amendments to the New York City Department of City Planning Zoning Resolution:*

1. Amend Article VI, Chapter 2, Section 62-655 as follows:

   (a) (1) Single tree pits
   Required trees within Special Flood Hazard Areas shall be planted in well-drained soil with rooting space recommended at 300 cubic feet ("CF") per small tree (maximum mature height 25 feet), 700 CF per medium tree (maximum mature height of 40 feet), and 1000 CF per large tree (mature height over 70 feet). A single tree pit shall have a minimum dimension of five feet with a minimum exposed area of 30 square feet and a minimum depth of three feet, six inches. The balance of the soil volume may be under pavement by using structural soil. Only tree pits planted with ground cover shall count towards meeting a minimum planting area requirement.

   (a) (2) Continuous tree pits
   Required trees within Special Flood Hazard Areas shall be planted in well-drained soil with rooting space recommended at 300 CF per small tree (maximum mature height 25 feet), 700CF per medium tree (maximum mature height of 40 feet), and 1000 CF per large tree (mature height over 70 feet). A continuous tree pit is a planting area containing two or more trees. Continuous tree pits shall have a minimum width of five feet and a minimum depth of 3 feet, 6 inches, and a {length as required to meet a minimum of five feet from the trunk of the tree to the end of the tree pit} minimum exposed area of 50 square feet. The balance of the soil volume may be under pavement by using structural soil.

*Amendments to the New York City Department of Parks and Recreation Tree Planting Standards:*

1. Amend Sample Tree Pit Configurations as follows:

   Required trees within Special Flood Hazard Areas are recommended to be planted in as large a soil volume as practicable. For reference, the minimum recommend soil volume is at least 300 CF of soil per small tree (maximum mature height 25 feet), 700 CF of soil per medium tree (maximum mature height of 40 feet), and 1000 CF of soil per large tree (maximum mature height more than 70 feet).

2. Amend New York City Approved Street Trees as follows:

   To support this proposal, NYC Department of Parks and Recreation should reconcile the March 2013 "Tree Planting Standards" (www.nycgovparks.org/pagefiles/53/Tree-Planting-Standards.pdf), which contains a "New York City Approved Street Trees" list that does not address flood zone tolerance, with the "Street Trees for New York City" and website lists (http://www.nycgovparks.org/sub_your_park/trees_greenstreets/images/street_trees_for_nyc.pdf and http://www.nycgovparks.org/trees/street-tree-planting/species-list) also released by the department that do address flood zone tolerance. These documents should indicate "coastal tolerance" by showing high, medium or low resistance to coastal salt and wind. The NYC Department of Parks and Recreation Greenbelt Native Plant Center Salt-Tolerant Species list and other sources including the Local Law 399 native plant list should be used as references.

   Because of the need for pruning to reduce the risk of tree failure, the Department of Parks and Recreation should consider incorporating, as appropriate, additional maintenance requirements into Maintenance and Operations agreements for new waterfront public access areas created pursuant to zoning. For tree planting sites within a Special Flood Hazard Area, trees should be required to be inspected every seven years by a certified arborist or Department of and Recreation forester. Actions recommended by the certified arborist or forester to remove, prune or thin a tree should be required to be implemented by the property owner within the following dormant season.

*Best Practice:*

In flood zones, required trees shall be selected with reference to the list in Department of Parks and Recreation Tree Planting Standards "New York City Approved Street Trees".

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## Section III: Supporting Information

The proposal recommends the following:

1. For tree planting in public access areas in flood zones, trees should have characteristics demonstrated to withstand high winds and salt tolerance and set standards for minimum soil volumes and drainage rates

2. Encourage private property owners to follow New York City Department of Parks and Recreation (NYCDPR) tree species selection criteria when planting near overhead power lines, including planting only small or medium trees (those under 40 feet mature height)
3. Increase frequency of tree inspections and tree pruning to reduce risk of tree failure

**Expanded Issue and Benefits:**

**Wind Resistance**
Three key factors influence a tree's wind resistance: biological characteristics, site and cultural factors:

1. Biological: Tree characteristics which enhance wind resistance include slow-growing hardwood species with an open branching habit, strong branch attachments, good ability to compartmentalize decay, small or fine-textured leaves, straight leader, symmetrical branching habit, and no co-dominant limbs. Each of these characteristics results in a tree that has better than typical structural stability and a smaller mass-to-wind ratio.
2. Site: Site characteristics that encourage wind resistance include well-drained soil allowing percolation rates greater than 0.5" per hour and generous soil volume to allow for radial root spread. This volume should be at least 300 cubic feet per small tree, 700 cubic feet per medium tree, and 1000 cubic feet per large tree based on a soil depth of three feet. Soil may be in-situ or manufactured/imported soil. The roots that stabilize a tree typically grow within 18" of the surface so depth is not as important as total volume to create stability.
3. Cultural: Trees planted in groups are less effected by wind than single trees planted in individual pits or isolated, exposed sites. The suggested minimum group size is five trees planted 10-12 feet apart in adequate soil volume. The 2013 DPR Street Tree Guidelines specifically reference grouped plantings as a good strategy for green streets and similar conditions. This is not recommended as a street tree planting strategy, but is recommended for sites with flexibility to plant trees in groupings.

**Flood Resistance**
Trees may overturn in high winds due to the rapid saturation of soil. This saturation alters the soil structure by allowing soil aggregates to fall apart from reduced cohesion, thereby reducing the friction between the soil and tree roots. Prolonged inundation or soil saturation will result in root rot, spread of fungal disease, loss of oxygen to roots and eventual death (see "Sources"). Additionally, structural damage from construction or excavation work can lead to root loss or damage which reduces tree stability and increases susceptibly to wind.

It is suggested that the recommendations of Local Law Intro 79-A (plants for stormwater tolerance) be incorporated herein. Further, plants that have tolerance to salt are recommended in storm surge locations.

Mitigation of salt (sodium chloride) from storm surge requires dilution of toxic salt build up, typically accomplished by natural rainfall, hand watering, or irrigation. These methods push (or leach) the salt below the root zone and can be used to alleviate damage to leaves that have been inundated with salt water as well. Typically, deciduous species will recover by the following growing season if the above procedures are followed. Likelihood of success is improved by conducting soil tests of salinity content after the storm surge event and again before the following growing season. There is limited direct data on storm surge salt mitigation since it is rarely encountered. Our proposals are largely based on documentation of water to dilute toxic levels of road salt.

**Tree Selection and Planting**

Proper tree selection and planting methods greatly improve tree vitality and are essential to maximizing wind and flood resistance and limiting damage to overhead utility lines. While private property owners are encouraged to use NYCDPR Street Tree Guidelines as a basis for proper tree selection, it would unduly restrict choices on private property to mandate these guidelines. To ensure protection of property and infrastructure, the following guidelines are recommended:

1. Select the right tree for a given location based on wind tolerance, soil characteristics and volume, salinity tolerance, proximity to structures, subsurface infrastructure constraints, overhead utility wires, etc.
2. Specify and provide trees that have strong central leaders, good branching structure, are disease-free, and have been grown within the climatic zone of the installation site.
3. Plant trees with care by careful handling of tree and root ball to avoid damage, digging pits to correct width and depth, using pre-tested soil backfill, ensuring root flare is visible after backfilling, staking properly (only in high wind areas), and watering regularly (especially important in the first year).
4. Provide supplementary water for two years after installation during times of low rainfall (Level 1 drought conditions), remove tree stakes after two years, prune as required to correct crossed limbs and ensure open, symmetrical branching pattern.

**Tree Care**

Trees that are diseased, weak-wooded or have poorly-formed branching structure are at risk of injuring people, falling on power lines, and damaging property. Preventative, regular tree inspection and pruning can greatly reduce the likelihood of these problems occurring. Studies show that regularly pruned trees survived Gulf Coast hurricanes at a rate of 73% compared to 46% of unpruned trees. Currently NYCDPR manages 50% of the City's 5.2 million trees, of which nearly 600,000 are street trees. Street trees are on a cyclical rotation of pruning. There is no pruning requirement for trees on private property. Trees in public parks are pruned based on need, availability of arborists and/or foresters and funding.

To increase the likelihood of tree survival and limit damage following storm events, the city should consider requiring that:

1. Street trees be inspected and pruned on a 7-year cycle.
2. Public park and Green Street trees be inspected and pruned on a 5-year cycle.
3. Trees on private property be inspected and pruned upon transfer of property, substantial alterations (alterations where the value exceeds 50% of the value of the building) or repairs ensuing from storm damage.
4. Additional funding be provided to NYCDPR to increase city-wide Forestry staff and to carry out a more frequent regimen of tree inspections and pruning.
5. Enforcement of existing Local Laws designed to protect public trees against construction impacts (sidewalk sheds, road and infrastructure work) be strengthened.
6. NYCDPR is encouraged to complete a comprehensive tree management plan and compile statistical data of storm and flood resiliency to inform future decisions on tree selection.

**Trees and Climate Change**

The impacts of climate change on trees include earlier bloom and leaf-out time in the spring due to changes in average temperature (studies indicate that for every 1 degree Celsius increase, bloom and leaf-out is 5-6 days earlier), greater variability and frequency in rainfall, increased storm and drought occurrence, greater spread of pathogens, and greater migration of invasive species.

It is recommended that:

1. NYCDPR, other agencies, as well as educational and not-for-profit institutions, participate in on-going data collection and studies related to tracking and recording climate change impacts to tree and plant species.
2. Planting of trees and other species comply with Local Law Intro 399 to increase biodiversity on City-owned property.

**Post Sandy Tree Replacement**

A significant portion of trees lost during Sandy will have had under-sized planting areas. It is recommended that tree pit size be increased where possible. In many cases adjacent paved areas will have been damaged and rebuilding with less paved areas and larger tree pits, or the introduction of structural soils, will be relatively simple.

**Cost:**

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

The following analysis was performed by the authors of this proposal:

There is no cost impact associated with tree selection and purchase, since there are no proposed changes to tree caliper; and price differences among species of the same caliper are generally de minimis.

There is a cost impact to create greater soil volume in sites that are largely paved.

There is a cost impact for private property owners to retain arborists and follow regular tree pruning schedules. For public property, there is a cost impact to allocate more public funding for NYCDPR to hire more arborists/foresters.

Pruning costs NYC $1.87 million annually, or $56.58/tree, per the City of New York Municipal Forest Resource Analysis prepared for NYCDPR by the Center for Urban Forest Research in 2007 (www.milliontreesnyc.org/downloads/pdf/nyc_mfra.pdf).

**Implementation:**

Market availability: There are potential limitations regarding market availability of trees identified in this proposal. There are potential limitations in the number of certified arborists within the NYC area.

Speed of implementation: There are no foreseen constraints to rapidly implementing this proposal. Immediate implementation is recommended because projects undergoing rebuilding should be considering new and replacement tree planting in the next planting season. In addition, the sooner the tree inspection and pruning recommendations are implemented, the less likely it is that trees will cause damage in future storms.

Anticipated difficulties: Allocating dedicated funding in the NYC expense budget for arborists/foresters to inspect and prune trees on public property.

**Sources:**

1. New York City, NY Municipal Forest Resource Analysis, March 2007
2. Urban Forest Recovery Program, University of Florida
3. City of New York Forest Resource Analysis www.milliontreesnyc.org/downloads/pdf/nyc_mfra.pdf
4. US Department of Agriculture Plant Database (provides Fact Sheets about salt and wind tolerance of over 40,000 species of plants in the United States) http://plants.usda.gov/characteristics.html
5. NYC Department of Parks and Recreation Tree Planting Standards 2013 www.nycgovparks.org/pagefiles/53/Tree-Planting-Standards.pdf
6. "Recommended Urban Trees – Site Assessment for Tree Selection and Stress Tolerance" by the Urban Horticulture Institute, Cornell University, 2009. urbanhort@cornell.edu
7. NYC Department of Parks and Recreation "Street Trees for New York City" http://www.nycgovparks.org/sub_your_park/trees_greenstreets/images/street_trees_for_nyc.pdf
8. NYC Department of Parks and Recreation Greenbelt Native Plant Center Salt-Tolerant Species list http://www.nycgovparks.org/sub_about/parks_divisions/gnpc/pdf/salt_tolerant_species_list.pdf
9. Section D-Species Selection in 2012 NYCDPR Tree Planting Standards

## NEW CONSTRUCTION

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 9 | **Plant Wind & Flood Resistant Trees** | | | | | | | | | | | | | | | | |
| | Select trees per NYC approved street tree standards (assume 1 medium tree every 20' on 2 sides of the building) | 15 | EA | $0.00 | $0 | 10 | EA | $0.00 | $0 | 11 | EA | $0.00 | $0 | 8 | EA | $0.00 | $0 |
| | Increase soil volume for tree pits (increase from 300 cubic feet to 700 cubic feet for each) | 222 | CY | $80.00 | $17,800 | 152 | CY | $80.00 | $12,200 | 156 | CY | $80.00 | $12,500 | 119 | CY | $80.00 | $9,500 |
| | | | | | $0 | | | | $0 | | | | $0 | | | | $0 |
| | | | | | $0 | | | | $0 | | | | $0 | | | | $0 |
| | SUBTOTAL DIRECT WORK | | | | $17,800 | | | | $12,200 | | | | $12,500 | | | | $9,500 |
| | Contingency | | 10% | | $1,780 | | 10% | | $1,220 | | 10% | | $1,250 | | 10% | | $950 |
| | **SUBTOTAL** | | | | **$19,580** | | | | **$13,420** | | | | **$13,750** | | | | **$10,450** |
| | GC Mark-ups | | 20% | | $3,916 | | 20% | | $2,684 | | 20% | | $2,750 | | 20% | | $2,090 |
| | **TOTAL** | 620,000 | GSF | $0.04 | **$23,496** | 4,000 | GSF | $4.03 | **$16,104** | 231,000 | GSF | $0.07 | **$16,500** | 15,000 | GSF | $0.84 | **$12,540** |

## EXISTING BUILDINGS

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 9 | **Plant Wind & Flood Resistant Trees** | | | | | | | | | | | | | | | | |
| | Select trees per NYC approved street tree standards (assume 1 medium tree every 20' on 2 sides of the building) | 15 | EA | $0.00 | $0 | 10 | EA | $0.00 | $0 | 11 | EA | $0.00 | $0 | 8 | EA | $0.00 | $0 |
| | Increase soil volume for tree pits (increase from 300 cubic feet to 700 cubic feet for each) | 222 | CY | $80.00 | $17,800 | 152 | CY | $80.00 | $12,200 | 156 | CY | $80.00 | $12,500 | 119 | CY | $80.00 | $9,500 |
| | | | | | $0 | | | | $0 | | | | $0 | | | | $0 |
| | | | | | $0 | | | | $0 | | | | $0 | | | | $0 |
| | SUBTOTAL DIRECT WORK | | | | $17,800 | | | | $12,200 | | | | $12,500 | | | | $9,500 |
| | Contingency | | 10% | | $1,780 | | 10% | | $1,220 | | 10% | | $1,250 | | 10% | | $950 |
| | **SUBTOTAL** | | | | **$19,580** | | | | **$13,420** | | | | **$13,750** | | | | **$10,450** |
| | GC Mark-ups | | 20% | | $3,916 | | 20% | | $2,684 | | 20% | | $2,750 | | 20% | | $2,090 |
| | **TOTAL** | 620,000 | GSF | $0.04 | **$23,496** | 4,000 | GSF | $4.03 | **$16,104** | 231,000 | GSF | $0.07 | **$16,500** | 15,000 | GSF | $0.84 | **$12,540** |

# **10** Clarify Construction Requirements in Flood Zones

## I. Summary

**Issue:**
City regulations for new construction and substantial renovations provide for resiliency in flood zones. However, the requirements are not always clear to design professionals and contractors.

**Recommendation:**
Clarify flood zone construction requirements in code and through a Department of Buildings Bulletin. Allow more flexibility in requirements for enclosures below the flood line.

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## II. Proposed Legislation, Rule or Study

*Amendments to the New York City Building Code:*

1. Amend Section BC G201.2 to add a definition for "Attendant Utilities and Equipment" as follows, in alphabetical order:

   ATTENDANT UTILITIES AND EQUIPMENT. Utilities, plumbing, HVAC, and related equipment, as well as services associated with new construction.

2. Amend Section 5.2.6 of BC G501 as follows:

   **5.2.6 Finishes and other materials.** Interior and exterior finishes, as well as any materials not otherwise provided for in Sections 5.2.1 through 5.2.5, shall be flood damage-resistant materials in accordance with FEMA Technical Bulletin {2-93} 2-08, Flood-resistant Materials Requirement for Buildings Located in Special Flood Hazard Areas, or shall be required to be approved by the authority having jurisdiction.

3. Amend Section BC G304.1.1 by adding a new Item 2.1 as follows:

   2.1 One- and two-family dwellings. In one- and two-family dwellings, enclosures with solid walls below the design flood elevation specified in Table 2-1 of ASCE-24 with a vertical clearance of five feet or more between the floor or ground surface and the underside of the structural ceiling above, shall be limited to 300 square feet. Any other spaces shall be enclosed only by open lattice or similarly open and permeable construction meeting the requirements of ASCE 24, Section 2.6.3.

4. Amend Section BC G501.1 by adding a new amendment to ASCE 24, Section 2.6.3, as follows:

**2.6.3** One- and two-family dwellings. In one- and two-family dwellings, enclosures below the design flood elevation specified in Table 2-1 and with a vertical clearance of five feet or more between the floor or ground surface and the underside of the structural ceiling above, shall comply with Sections 2.6.3.1 and 2.6.3.2.

**2.6.3.1** Maximum solid enclosure. Solid enclosures shall be limited to 300 square feet and shall be wet-floodproofed with openings complying with this standard.

**2.3.6.2** Other enclosures. Enclosures in excess of 300 square feet shall be enclosed only by open and permeable construction in accordance with Sections 2.3.6.2.1 through 2.3.6.2.4.

**2.6.3.2.1** The open and permeable construction shall have at least 50 percent openness when viewed horizontally in any 12-inch by 12-inch area, except that the following portions need not be included when calculating the 50% required openness:
1. Structural columns up to 12 inches in width and spaced no closer than six feet on center;
2. Curbs no higher than eight inches above the exterior grade;
3. Retaining walls where portions of the enclosed space are below grade; and
4. Walls, including party walls and fire walls, located at or within two feet of a side or rear lot line.

**2.6.3.2.2** Louvers, glazing, doors or other movable elements shall not reduce the required opening to less than the specified 50%.

**2.6.3.2.3** Enclosing materials below such design flood elevation shall be flood-damage resistant, including but not limited to metal pickets or wrought iron, fencing, concrete breeze blocks, screening or lattice.

**2.6.3.2.4** All spaces or portion thereof limited to enclosure by open and permeable construction shall be designed as unconditioned space in accordance with the New York City Energy Conservation Construction Code.

*Department of Buildings Bulletin:*

The Department of Buildings should issue a Buildings Bulletin that would clarify in detail the items that are covered by Appendix G of the New York City Building code and ASCE 24. Examples include but are not limited to:

**Materials**: Materials used must resist damage, deterioration, corrosion, or decay due to floods, including mold and corrosion resistance. This includes wall framing, insulation, and covering as well as structural members.

**Utilities**: Appendix G applies to all utilities, plumbing, HVAC, and related equipment. A provision for reasonable exception for de minimis items may assist in compliance with and enforcement of this code.
**Disconnect Switches**: Main feeders serving electrical distribution or panelboards below the Design Flood Elevation should have disconnects above the flood elevation.
**Design Flood Elevation**: Provide easy method for converting and using the three datums[1] used by the city into a form suitable for design flood elevation (DFE) calculations, and explain how the DFE should be calculated on different points within the flood hazard area.

*Future Updates to Appendix G:*

The Department should also incorporate any updates from ASCE 24-13 (to be released this summer) into the next triennial code cycle.

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## III. Supporting Information

**Expanded Issue and Benefits:**

Appendix G of the New York City Building code references ASCE 24-05, and together these govern construction in flood zones. In some cases the Appendix G references to ASCE 24-05 are vague. For example, Appendix G contains reference to “Utilities and attendant equipment”, but omits the definition of these items found in ASCE 24. In some cases ASCE 24 itself is vague; with requirements that sometimes contain terms such as “as appropriate” and “when necessary”. For design professionals and contractors to properly comply with these important documents, more clarity regarding their intent is required.

Since Appendix G makes references to the ASCE 24 standard, which is updated via a national consensus-based process, it would be cumbersome to develop patches for Appendix G. Therefore, it is more simple and direct for the Department of Buildings to issue, as it does regularly, a separate bulletin clarifying the application of the code documents. The material to be contained in the Bulletin can be developed in consultation with citywide experts on flood-resistant construction.

The Department of Buildings should consider exempting certain mechanical equipment from flood proofing, such as equipment that only serves spaces below the flood elevation, or items that are small, inexpensive or easily replaced. However, the city may be preempted from making modifications to certain code requirements that are based on national standards approved by Congress.

**Enclosure Design Options and Permitted Uses**
Homes in high-risk areas are required to have Open Foundations per the prescriptive measures within BC § G304.2.3. A performance-based standard allows designers to develop creative

[1] FEMA Region II Coastal Analysis and Mapping, “Vertical Datums and Advisory Base Flood Elevation (ABFE) Maps: Frequently Asked Questions”, http://www.region2coastal.com/sandy/abfe/vertical-datum.

solutions that protect communities during non-flood times as well as during flood times. Mitigating floodwaters should be balanced against safety, aesthetics, usability and accessibility factors associated with raised homes.

The changes in the Zoning Resolution currently being put forth by the Department of City Panning to make permanent and to expand aspects of Mayor's Executive Order 230 will allow one- and two-family houses in areas of special flood hazard to be built higher in order to increase resiliency – but the effect is the creation of additional space below the buildings that will be subject to floodwaters and damage.

The Mayor's Executive Order 230 currently prohibits solid enclosures below 1- and 2-family dwellings where the headroom is more than five feet, with an exception for a vestibule and stair. This proposal is to continue the spirit of that prohibition, but to relax it to allow wet floodproofed enclosures up to 300 square feet.

The continuation of restrictions on the use of spaces below one- and two-family dwellings will greatly reduce flood damage. Also, such restrictions will help ensure that the spaces are not used for living spaces. The cumulative effect of restricting the levels below the flood elevation to enclosures no greater than 300 square feet would mean fewer damaged homes and fewer displaced persons, thus allowing the city to devote its post-recovery efforts and funding to projects other than restoring enclosed flood-damaged ground floor levels and finding accommodations for person displaced from makeshift and substandard housing. The National Flood Insurance Program encourages but does not require communities to place restrictions on ground-floor enclosures in A-zones.

**Cost:**

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

The following analysis was provided by the authors of this proposal:

The cost of the foundation system and ground wall bearing supports will increase the cost of construction, but not significantly relative to the overall cost of constructing a new building. The savings will be to the owner in reduced post-storm losses and insurance premiums. The savings will also be to the city in being able to allocate post-disaster recovery resources where needed with less resources devoted to flood damage to newly constructed dwellings.

## NEW CONSTRUCTION

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **10** | **Clarify Construction Requirements in Flood Zones** | | | | | | | | | | | | | | | | |
| | NO CONSTRUCTION COST - CLARIFY | | | | | | | | | | | | | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | | | | | |
| | Contingency | | | | | | | | | | | | | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | | | | | |
| | GC Mark-ups | | | | | | | | | | | | | | | | |
| | **TOTAL** | | | | **$0** | | | | **$0** | | | | **$0** | | | | **$0** |

## EXISTING BUILDINGS

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **10** | **Clarify Construction Requirements in Flood Zones** | | | | | | | | | | | | | | | | |
| | NO CONSTRUCTION COST - CLARIFY | | | | | | | | | | | | | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | | | | | |
| | Contingency | | | | | | | | | | | | | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | | | | | |
| | GC Mark-ups | | | | | | | | | | | | | | | | |
| | **TOTAL** | | | | **$0** | | | | **$0** | | | | **$0** | | | | **$0** |

# **11** Prevent Wind Damage to Existing Buildings

## I. Summary

**Issue:**
High winds can cause walls, windows, doors, and building equipment to come loose. Loose stones on rooftops can become small missiles. While new buildings must meet strong wind standards, new installations on existing buildings do not.

**Recommendation:**
Require that equipment and structures added to existing buildings meet the same wind standards in effect for installations on new buildings. Require heavy pavers on rooftops and impact-resistant windows in high wind zones.

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## II. Proposed Legislation, Rule or Study

*Amendments to the New York City Building Code:*

1. Amend Section 1609.1 as follows:

   **1609.1 Applications.** Buildings, structures, and parts thereof, shall be designed to withstand the minimum wind loads prescribed herein. Decreases in wind loads shall not be made for the effect of shielding by other structures. Curtainwall elements, windows, doors, building mounted equipment such as cooling towers, fans, tanks, air conditioning units, hoods, louvers, antennae, plumbing fixtures, gas appliances, and equipment enclosures installed at any point in the life of any such building or structure, shall be designed to remain intact and firmly attached to such building structure or part thereof when subjected to such minimum wind loads. The design of the above described attachments shall be verified either by engineering calculations or by the manufacturer's certified design criteria. For any such attachments intended to withstand wind loads through gravity or friction, engineering calculations or manufacturer's certified design criteria shall demonstrate the ability of such attachments to withstand the minimum wind loads.

2. Add a new Section 1504.9 as follows:

   **1504.9 Aggregate.** Aggregate shall not be used as surfacing for roof coverings and neither aggregate, gravel nor stone shall be used as ballast on roofs of buildings.

   EXCEPTION: The use of a ballasted roof is permitted if it is justified by an engineering study that takes into consideration: the height and location of the building, the use of concrete or stone pavers at the perimeter, the parapet height, the Exposure Category, the topography of the neighborhood and the surrounding buildings and any other pertinent factor.

3. Amend Section 2402 by adding the following definition:

   **DESIGNATED SPACES**. Areas of assembly for 300 or more persons or areas of in-place shelter.

4. Add a new Section 2403.7 as follows:

   **2403.7 Wind-Borne Debris**. Glazing in buildings in Structural Occupancy Category IV, as defined in Table 1604.5, located in wind exposure C or D, as defined in Section 1609.4, and Glazing in Structural Occupancy Category III buildings located in exposure D enclosing the designated spaces shall be protected with an impact resistant covering or be impact-resistant glazing according to the requirements specified in ASTM E1886 and ASTM E1996 or other approved test methods and performance criteria. The levels of impact resistance shall be a function of Missile Levels and Wind Zones specified in ASTM E1886 and ASTM E1996.

   EXCEPTION: Glazing located shall be permitted to be unprotected if it is both:
   (1) Over 60 ft above the ground
   (2) Over 30 ft above aggregate-surfaced-roofs, including roofs with gravel or stone ballast, located within 1,500 ft of the building

   *[Modified Excerpt from ASCE 7-10, Chapter 26 Section 26.10.3]*

*Amendments to the New York City Mechanical Code:*

1. Add a new Section 401.5.4 as follows:

   **401.5.4 Wind-Driven Rain Rating.** All exterior louvers for building ventilation and exhaust systems shall comply with one of the following:

   1. Shall receive a Rating of A when tested under ACMA Standard 500L for wind-driven rain penetration for a 50 mile per hour wind velocity with a rainfall rate of eight inches per hour; or
   2. Shall be installed on a plenum configured to intercept any wind driven rain penetrating the louver and to prevent the rain from entering the building ductwork system. Such plenum shall be waterproofed and equipped with a drainage system to convey water penetrating the louver to storm or sanitary drains.

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## III. Supporting Information

**Expanded Issue and Benefits:**

The recommendations of this proposal apply to both new construction and renovations of existing buildings.

**Windows and Doors**
Pressure-related failures of windows and doors during high winds can greatly increase storm damage. By allowing wind-driven rain and other water infiltration to reach the interior, materials can be damaged or ruined. Wet materials often lead to mold growth and even materials that do not appear damaged can harbor enough moisture to contribute to mold growth later.

**Storm-Proof Attachments**
Items that are loosely attached to the building, like satellite dishes and window AC units, would benefit from engineered securement capable of resisting high winds. This proposal does not address furniture or other loose items, which should be secured as part of a building's Emergency Action Plan prior to a storm event.

**Roof Ballast**
During storm events, pea gravel and stone ballast on rooftops can be lifted by high winds and become dangerous projectiles capable of breaking windows, harming people and other damage. Eliminating these ballasts will reduce damage and injuries and shorten the recovery time of buildings.

For the construction of new roofs and the replacement of existing roof systems, this proposal recommends adoption of the IBC 2009 and 2012 Section 1504.8 requirements which outlaw gravel and stone ballast in hurricane prone areas such as New York City.

**Louvers**
Wind-driven rain can penetrate building louvers, entering ductwork or mechanical spaces. This issue may become more common with the expected increases in storm events and rainfall as a result of climate change. Water infiltration into these mechanical systems can lead to pervasive dampness and significant mold or microbial growth, primary drivers of poor indoor air quality and a threat to public health.

**Implementation:**

**Windows and Doors**
Windows and doors that satisfy the wind resistance requirements of this proposal are readily available, though some manufactures may have long lead times.

**Storm-Proof Attachments**
Methods to properly secure rooftop equipment or other items to buildings are readily available and widely used.

**Roof Ballast**
Roof cover assemblies that do not require pea gravel or stone ballast are commercially available and have been installed throughout New York City. Aesthetics may be a concern for roof

setbacks that can be viewed from upper floors, in which case a stone ballast is typically preferable for its appearance.

**Louvers**

Louvers that withstand wind-driven rain are typically a direct replacement, although they may have a slightly greater depth. The pressure drop across intake or exhaust systems may be increased slightly by the protected louvers so fans, fan motors and other equipment should be calibrated against this potential change.

The free area of louvers rated for wind-driven rain is generally less than that for standard louvers (40-50% versus 50-60%). To provide the same rated flow capacity as a standard louver, a rain-resistant one would be 10-20% larger. The pressure drop differential between the two types of louvers also varies, but the maximum difference is only about 0.06 inches of water column. The running cost differential due to this greater pressure drop for a 10,000 cfm ventilation fan running continuously all year long would be about $165, compared with its overall running cost of about $11,100 (about 1.5% increase).

The operating cost impact of raising the velocity through the louver by 10%, to provide the same flow without increasing the louver area would be in the range of 20%, so the cost differential would rise from about $165 to about $200. Depending upon the louver, the water rejection capability of the louver might be compromised by the higher face velocity.

**Cost:**

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

The following analysis was performed by the authors of this proposal:

**Windows and Doors**

Impact-resistant glazing systems are readily available but the additional costs are significant. If required in a market the size of New York City, costs would be expected to come down.

Impact-resistant window coverings are readily available and less expensive but have a significant aesthetic impact on the building. Coverings also have a shorter lifespan than integrated window systems.

In either case, the costs of damage to the building and interior finishes from a single storm likely outweighs the additional costs of robust window systems and greatly increases the likelihood that the building will remain habitable following a major storm event.

**Storm-Proof Attachments**
The cost premium for storm-proof attachments of equipment is very small, and almost insignificant relative to the overall cost of the equipment. The cost for engineering calculations of more robust attachments is minimal and, if required, would likely be borne by the manufacturers.

**Roof Ballast**
For new construction, the increased cost of non-ballasted roofing systems is modest, and includes the cost of removing the old ballast (which is typically used again in a like-for-like replacement). For existing buildings, in addition to the costs of replacing the ballast roof with a non-ballast roof, there may be additional costs for modifications to flashings, perimeter conditions or penetrations.

**Louvers**
The cost difference for wind-protected louvers is negligible.

## NEW CONSTRUCTION

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 11 | **Prevent Wind Damage to Existing Buildings** | | | | | | | | | | | | | | | | |
| | Premium to use wind resistant connections on rooftop equipment | | | | IN CODE | | | | IN CODE | | | | IN CODE | | | | IN CODE |
| | Premium to increase wind performance of curtain wall system | | | | IN CODE | | | | IN CODE | | | | IN CODE | | | | IN CODE |
| | Premium to include A-rated louver selection | 1 | LS | $5,000.00 | $5,000 | 1 | LS | $5,000.00 | $5,000 | 1 | LS | $5,000.00 | $5,000 | 1 | LS | $5,000.00 | $5,000 |
| | Premium to use roof pavers in lieu of ballast | 20,000 | SF | $20.00 | $400,000 | 2,000 | SF | $20.00 | $40,000 | 11,000 | SF | $20.00 | $220,000 | | | | $0 |
| | Premium to use impact resistant glazing in curtain wall system (100% exterior wall to elevation 60' above ground for high rise buildings) | 41,400 | SF | $15.00 | $621,000 | | | | $0 | 24,780 | SF | $15.00 | $371,700 | | | | $0 |
| | Premium to use impact resistant glazing in curtain wall system (40% exterior wall for low rise buildings) | | | | $0 | 2,412 | SF | $15.00 | $36,200 | | | | $0 | 5,500 | SF | $15.00 | $82,500 |
| | Premium for added louver water resistance requirements | | | Cost is minimal | | | | Cost is minimal | | | | Cost is minimal | | | | Cost is minimal | |
| | | | | | $0 | | | | $0 | | | | $0 | | | | $0 |
| | **SUBTOTAL DIRECT WORK** | | | | **$1,026,000** | | | | **$81,200** | | | | **$596,700** | | | | **$87,500** |
| | Contingency | | 10% | | $102,600 | | 10% | | $8,120 | | 10% | | $59,670 | | 10% | | $8,750 |
| | **SUBTOTAL** | | | | **$1,128,600** | | | | **$89,320** | | | | **$656,370** | | | | **$96,250** |
| | GC Mark-ups | | 20% | | $225,720 | | 20% | | $17,864 | | 20% | | $131,274 | | 20% | | $19,250 |
| | **TOTAL** | **620,000** | **GSF** | **$2.18** | **$1,354,320** | **4,000** | **GSF** | **$26.80** | **$107,184** | **231,000** | **GSF** | **$3.41** | **$787,644** | **15,000** | **GSF** | **$7.70** | **$115,500** |

## EXISTING BUILDINGS

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 11 | **Prevent Wind Damage to Existing Buildings** | | | | | | | | | | | | | | | | |
| | BEST PRACTICE | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | | | | | |
| | Contingency | | | | | | | | | | | | | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | | | | | |
| | GC Mark-ups | | | | | | | | | | | | | | | | |
| | **TOTAL** | | | | - | | | | - | | | | - | | | | - |

# **12** Analyze Wind Risks

## I. Summary

**Issue:**
New York City is in a hurricane-prone region and our building code incorporates modern standards for wind design. However, most NYC buildings were constructed under older codes that did not include the same level of protection. In addition, buildings under construction and climate change impacts are not fully addressed in the new codes.

**Recommendations:**
Analyze wind effects on existing buildings and those with particular wind vulnerability, such as homes raised on columns and buildings under construction. Study how climate change may affect wind speeds. Recommend changes to code and construction practices to address any vulnerabilities identified.

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## II. Proposed Legislation, Rule or Study

*Conduct the Following Wind Studies:*

1. **Buildings At Risk For Falling Debris**
   Study the types of buildings at risk for falling debris, utilizing factors such as age, construction classification, construction methods and materials, height, and occupancy. Based on these results, as necessary:

   a. Propose changes to Table 3 of Rule 1 RCNY 101-14, which lists exterior façade work exempt from filing and inspection.
   b. Propose additional periodic inspections for buildings not already subject to the Department of Building's Façade Safety Inspection Program (Section 28-302.1 of the Administrative Code).
   c. Produce design requirements, retrofit strategies, or requirements including standardized details.
   d. Produce standardized engineering inspection practices.

2. **Column-Supported Homes**
   Determine if additional standards are required for existing one- and two-family homes in coastal zones that become elevated on columns in order to comply with flood hazard area construction standards.

3. **Partially Completed Buildings**
   Study the effects of wind on buildings that are under construction, including buildings with incomplete façade assemblies and the storage of construction materials. Propose standard wind emergency action plans for the various partial completeness scenarios. Determine if additional wind analysis should be required for new tall buildings under construction.

4. **Temporary Structures & Equipment**
   Propose standard wind emergency action plans for each type of temporary structure or equipment, including cranes, derricks, scaffolds, concrete formwork, and sidewalk bridges.

5. **Future Wind Events & Weather Stations**
   Study forecasts for future changes in frequency, intensity, and paths of future storm events; predict how this climate change will affect wind speeds; and determine whether the Building Code's current design wind loads are sufficient for buildings constructed today to withstand future wind events. Study the benefits of installing and maintaining weather stations across the city, including on high-rise buildings, to improve our understanding of localized wind patterns in New York City's urban environment. Identify a mechanism to install such weather stations.

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## III. Supporting Information

**Expanded Issues and Benefits:**

**Buildings At Risk For Falling Debris**

Many New York City buildings constructed prior to 1968 were not required to consider wind as a factor in structural design calculations. Although the construction methods for these older buildings were prescriptive in nature, the performance gap between these older buildings and current wind load requirements for new construction during wind events should be evaluated. Studies of wind pressure and typical building response may help when formulating design requirements in the proposed Existing Building Code (Task Force Proposal #29: Adopt an Existing Building Code).

A category of typical New York City buildings that may be vulnerable to high winds, and should be the subject of the proposed studies, are high-rise buildings constructed under the requirements of the 1938 Code. Among these, there are roughly 60 high-rise commercial buildings built under the 1938 Code, the majority of which feature glass and metal curtain walls that would benefit from evaluation under current wind load standards. Similarly, there are many tall residential buildings from the 1960s that utilized cavity wall construction, when this technology was in its early stages of development. Wind load considerations were not required by code at the time and any analysis should be aware that the detailing, technology, and construction methods of cavity walls were all in flux as these systems were optimized.

Parapets are among the most sensitive elements of a building façade as they are exposed to the wind, rain, snow, and heat on both faces. While lower façade elements benefit from the stabilizing weight of the material above, there is no additional weight to help keep the parapet in place, which acts as a kind of vertical cantilever, and is vulnerable to wind and other forces. One of the most common façade incidents is the collapse of the parapet, typically due to a lack of maintenance and most frequent in those composed of lime-based mortar. Lime-based mortar is very common among older masonry buildings, but decomposes over time when exposed to air and water. As parapets age, even hairline cracks can provide an entry point for water, compromising the mortar throughout the parapet and often extending through the masonry to the line of the lintels of the highest windows.

Masonry parapets and cornices that were built before 1929 that are six stories high are of particular concern. Cornices of buildings for taller buildings are already inspected every five years pursuant to the Department of Building's Façade Safety Inspection Program. Also, consideration may be given to parapets that were reconstructed or substantially rebuilt in the last 10 years or that are adjacent to other buildings.

**Column-Supported Homes**

New flood regulations encourage the elevation of many one- and two-family homes on unenclosed columns. The vulnerability of this exposed column structure, and the underside of the elevated floors, to wind loads should be analyzed. Construction methods (such as screens) that mitigate any wind load impacts while allowing water passage during flooding should be identified.

**Partially Completed Buildings; Temporary Structures & Equipment**

Wind can affect buildings undergoing construction as well as the temporary installations used to construct buildings, such as cranes, derricks, and scaffolds. Being only partially complete, buildings under construction will respond differently to wind events than a completed and fully enclosed building and may introduce temporary irregularities, such as a partially completed façade, that may be vulnerable to high winds. The design of temporary structures should consider the height, location, and timeframe of installation at a given site. The study should propose typical emergency action plans to be followed prior to a forecasted wind event for a variety of possible scenarios of partial completeness, including how to address temporary structures that cannot be easily disassembled. The study should address additional wind protection that may be required for super high-rise buildings (and any required temporary structures) while under construction.

**Future Wind Events & Weather Stations**

The regional impacts of global climate change will almost certainly include greater frequency and ferocity of inclement weather events. This particular study should assess the probable impacts of these changes on wind speed and pressure, and hence any required modifications to wind load requirements in the building code.

Since New York City is a coastal, dense urban environment with building heights that vary from single-family homes to skyscrapers, wind patterns are not uniform across the five boroughs. The study should address the effectiveness of existing weather monitoring stations in providing data on these local variations.

The study should include a review of wind design parameters from other jurisdictions (including internationally) with similar wind patterns, density, and type of development, and an assessment of the applicability of these standards in New York City.

**Implementation:**

The city should retain a consultant to perform the studies.

**Cost:**

No cost estimation was performed for this proposal.

# **13** Capture Stormwater to Prevent Flooding

## I. Summary

**Issue:**
Storms can cause localized flash flooding of buildings and streets. The city applies rigorous stormwater standards to buildings that add new sewer connections, but stormwater from existing buildings must still be addressed.

**Recommendation:**
Design sidewalks to capture stormwater and continue supporting the NYC Green Infrastructure Plan.

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## II. Proposed Legislation, Rule or Study

*Proposed Sidewalk Standard:*

The Department of Transportation (DOT) and Department of Parks and Recreation (DPR) should revise their sidewalk rules, specifications, and details to conform to the standard below. In addition, information on agency websites should be coordinated and made consistent. (Note: this proposal references water detention provisions from the Green Codes Task Force Proposal UE3.)

Sidewalks shall include a continuous permeable strip at the curbside. The permeable strip shall conform to the following requirements:

1. Dimensions: The permeable strip shall have a width of at least 1/3 of the sidewalk width (the distance between the lot line and the curb) and be no less than three feet wide along the curbside length of the sidewalk from lot line to lot line. Strip shall be adjacent to the curb, unless existing trees occur elsewhere.
2. Tree Planting Zone: The permeable strip shall include a tree planting zone with a minimum length and depth as defined by DPR in the Tree Planting Standards: Sample Tree Pit Configurations, p. 20. The tree planting zone shall be backfilled with topsoil per the same reference standards, p. 9-11. Plantings may include single trees or grouped trees with or without shrubs or ground covers.
3. Existing Trees: Where existing trees are encountered in construction of a new permeable strip, the root mass shall be left undisturbed within the Critical Root Zone. Structural soil shall be placed outside of the Critical Root Zone.
4. Tree Planting Spacing: Trees shall be planted either individually or in groups with a minimum distance of 10 feet on center to a maximum of 25 feet on center. Other spacing requirements shall be as defined by DOT, DPR, FDNY and MTA, with the exception that

a pattern book shall be developed to determine tree spacing from intersections based on sight lines, traffic direction and traffic control.

5. Builder’s Pavement Plan: The builder's pavement plan shall show all existing and proposed trees on the block and indicate the species of the trees.
6. Requirements for Non-Planted Permeable Strips:
    a. Surface material shall be permeable based on DOT material options applicable to neighborhood classification that are in the process of development by DOT.
    b. Backfill Beyond Planting Zone: Between planting zones and within the full extent of the permeable strip, the backfill shall be Structural Soil as defined by DPR Tree Planting Standards: CU Structural Soil (p. 4-7) with a depth of no less than 24 inches from finished grade. The use of recycled concrete aggregate shall not be permitted due to its potential to alter the pH of the soil beyond the acceptable range for trees.
7. Requirements for Planted Permeable Strips:
    a. Within this planting strip, no turf grass shall be permitted. Plants shall consist of native meadow plantings and low herbaceous grasses or native ground covers, except that street trees within the planting strip shall have a 3-foot diameter/square mulch bed at their base.
    b. Meadow shall be mowed once per year or other grasses shall be trimmed in mid-winter.

**Exceptions**

1. Sidewalk zones where the distance between the curb and the lot line is less than 9'0" wide.
2. Areas within any sidewalk which contain sub-grade structures, including but not limited to subway vents or structures, critical utility infrastructure, sidewalk vaults, and electrical vaults.
3. Areas within curb cuts.
4. Historic sidewalks constructed of brick, granite, or bluestone slabs.
5. Locations where the groundwater level or impervious bedrock is within 5’ below sidewalk grade.
6. School sidewalks.

*Policy Recommendation:*

Continue the implementation of the NYC Green Infrastructure Plan.

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## III. Supporting Information

**Expanded Issue and Benefits:**

From NYC Natural Hazard Mitigation Plan (2009):

> *Intense rainfall, producing several inches of rain in a short period, is most likely to cause flash flooding and other problems, such as sewer back-ups*

> *into residences. These floods are unrelated to the 100-year floodplain designation. According to DEP's rain gauges, the July 18, 2007 storm produced 1.93 inches of rain in one hour in northern Queens. The August 8, 2007 storm, which resulted in levels of flooding throughout the City not seen for decades, produced more than three inches of rain in a two-hour period.* ***Based on historic probability, that level of rainfall has a chance of occurring about once every 25 years.*** *Over the last several years, storms of intense magnitude have been occurring somewhat more frequently than expected, and climatologists warn that the trend may continue as the effects of climate change are felt.*
> *Given the history of flooding in New York City, it is certain future floods will occur. Based on analysis of records from the National Climatic Data Center of NOAA, New York City has experienced flooding 60 times during the 15-year period between 1993 and 2007. Using simple historic frequency to indicate the future flooding potential, New York City will likely experience an average of four floods per year.*

1. Create a Green Sidewalk specification, maintained by the Departments of Transportation (DOT) and Parks and Recreation (DPR).

Since sidewalks comprise 8% of the city's land area, creating a single consistent sidewalk standard that includes permeable strips and water storage capacity can have an enormous cumulative effect on stormwater discharge. However, city rules and regulations for sidewalks are inconsistent and, in some cases, impede the development of green sidewalks.

DOT is responsible for regulating sidewalks, while the DPR is responsible for regulating the trees planted in those sidewalks. Their jurisdiction overlaps and is inconsistent on issues such as the location of street trees, the size of tree pits, materials within tree pits, and the extent of structural soil within tree pits. In addition, the Department of Design and Construction ("DDC") has two sets of specifications for tree pit soil and plantings, while School Construction Authority ("SCA") standards are relatively consistent with DOT tree pit specifications. All told, between the various city agencies and public authorities, there are at least 10 sets of inconsistent and sometimes conflicting specifications and drawings for sidewalk trees and tree pits.

This proposal would provide one standard sidewalk specification that would increase tree cover, reduce stormwater runoff, and decrease greenhouse gas emissions. It would require that the outer third of all sidewalks be permeable with at least 24" of structural soil below, referred to as a "linear tree pit." As structural soil is 30% void, it can serve as a repository for stormwater; almost all the rain in a 2" storm would be captured by a sidewalk designed to the proposed specification. By reducing stormwater runoff, the permeable strip will reduce flooding in sewers, subways, and roads, and reduce the pollution carried into waterways. It will also provide more root space for trees, ensuring a healthier tree canopy.

The proposed specification also directs that trees be planted closer together, increasing the number of trees in sidewalks. This will reduce urban heat island effect, increase natural shading and cooling through evapo-transpiration, and provide more pleasant sidewalks.

2. Continue the implementation of the NYC Green Infrastructure Plan.

This 2010 plan presents an alternative approach to improving water runoff quality that integrates "green infrastructure," such as swales and green roofs, with traditional, or "gray infrastructure." Appropriate deployment of green infrastructure assists in the retention and detention of stormwater to reduce surface flooding, can be easily integrated with existing systems, and can foster optimization of investments in targeted, cost-effective gray infrastructure.

**Cost:**

No cost estimation was performed for this proposal.

**Implementation:**

**Sidewalks**
There are no known implementation issues for this proposal regarding sidewalks. Multiple local suppliers carry structural soil and there are many manufacturers of permeable pavements.

**Green and Blue Roofs**
The following implementation-related considerations are quoted from the DEP Guidelines for the Design and Construction of Storm Water Management Systems (July 2012).

Advantages:

- Well suited for lot line to lot line buildings.
- Requires no additional land area.
- No excavation required.
- Easy to install.
- Extends the life of the roof by protecting roofing membranes from ultraviolet radiation.
- Commercially available products.
- Readily coupled with other storage techniques, such as subsurface storage or cisterns.
- Compatible with other rooftop uses.
- Green roofs add economic value to developments when used as passive recreational features or rooftop farms.
- Green roofs provide co-benefits, such as heat island reductions, energy conservation and climate change offsets, air quality improvements, and increased wildlife habitat value.

Limitations:

- Roofs with steep slopes (greater than 2% slopes for blue roofs and greater than 5% for green roofs) will provide limited storage.
- Regular inspection and maintenance of roof surface and roof drains are required.
- Limited benefit on sites where roof area makes up only a small portion of the total impervious area.
- Additional loading on roof may add to the cost of the building structure.

**Subsurface Detention Systems**
Subsurface systems are suitable in most urban environments. Subsurface systems can be installed below a variety of generally level areas, such as landscape areas, parking spaces, open lots, driveways, walkways, patios, and public plazas.

Limitations are associated with available space and subsurface conditions. Non-building areas are most suitable for subsurface systems. Permeable soil is required to adequately drain the stormwater.

**Limiting Impervious Area**

According to the DEP Guidelines for the Design and Construction of Storm Water Management Systems (July 2012), "Urban stormwater runoff results from rain, snow, sleet and other precipitation that lands on rooftops, parking lots, streets, sidewalks, and other surfaces. Of specific concern are impervious surfaces, as they do not allow water to infiltrate into the ground or be utilized by plants, both of which are key elements of the natural water cycle. Rather, impervious surfaces shed water, which then becomes runoff that eventually enters the city sewer system or is discharged directly to adjacent waterbodies. "Greening" a site with vegetation, as well as using pervious materials, reduces impervious surfaces. Non-paved areas reduce a site's weighted runoff coefficient and calculated developed flow."

Through the city Zoning Resolution, the Department of City Planning requires a minimum percentage of planting in front yards in residential areas. However, there are no requirements for planting or pervious area in backyards. According to a study by the Sustainable Yards project, conducted with CUNY assistance, residential yards make up 27% of the city's total area, not counting parks or street and sidewalk medians. Even in dense Manhattan, one fifth of the island's total area is yard space. Limiting the portion of impervious or paved area in backyards may significantly reduce stormwater runoff and the risk of surface flooding.

**Sources:**


1. NYC Green Infrastructure Plan
   http://www.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_plan.shtml
2. New York City Department of Parks and Recreation: Tree Planting Standards, April 2008.
   http://www.nycgovparks.org/permits/trees/standards.pdf
3. New York City Department of Design and Construction (NYCDDC). 2010. Water Matters: A Design Manual for Water Conservation
4. New York City Department of Environmental Protection (NYCDEP). 2010. NYC Green Infrastructure.
5. New York City Office of Long-Term Planning and Sustainability (OLTPS). 2008. PlaNYC Sustainable Storm Water Management Plan 2008
6. New York City School Construction Authority (NYCSCA). 2007.
7. New York City Department of Environmental Protection. July 2012. Guidelines for the Design and Construction of Storm Water Management Systems.
   http://www.nyc.gov/html/dep/pdf/green_infrastructure/stormwater_guidelines_2012_final.pdf
8. New York State Department of Health (NYSDOH). 1996. Individual Residential Wastewater Treatment Systems Design Handbook.
9. Newsweek, October 4, 2010. "How Green is the Big Apple?"
10. Wall Street Journal, October 6, 2010. "NYC Is Made of Asphalt, Concrete…and Yards?"

# **14** Use Cool Surfaces to Reduce Summer Heat

## I. Summary

**Issue:**
Light-colored roofs and surfaces reflect light and heat back into the atmosphere, cooling buildings and cities. City regulations mandate light-colored roof coatings, but only for flat roofs. These coatings also tend to darken over time, losing their effectiveness. Dark, non-compliant coatings are still sold in NYC, increasing unintentional violation of code.

**Recommendations:**
Expand existing cool roof requirements to include pitched roofs. Prohibit the sale of dark roofing materials and dark "crumb" rubber in synthetic playing fields. Encourage owners to use self-cleaning cool roof coatings and study the longevity of various cool roof options.

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## II. Proposed Legislation, Rule or Study

*Amendments to the NYC Building Code:*

1. Amend Section 1504.8 as follows:

   **1504.8 Reflectance.** Roof coverings on roofs or setbacks with slope equal to or less than two units vertical in 12 units horizontal (17 percent) shall have:
   1. a minimum initial solar reflectance of 0.7 in accordance with ASTM C1549 or ASTM E1918, and a minimum thermal emittance of 0.75 as determined in accordance with ASTM C1371 or ASTM E408; or
   2. a minimum SRI of 78 as determined in accordance with ASTM E1980.

   Roof coverings on roofs or setbacks with slope greater than two units vertical in 12 units horizontal (17 percent) shall have a minimum SRI of 25 as determined in accordance with ASTM E1980.

2. Amend Section 1507.2 as follows:

   **1507.2 Asphalt shingles.** The installation of asphalt shingles shall comply with the provisions of this section, [and] Table 1507.2 and section 1504.8.

3. Add a new section 1506.5 as follows:

**1506.5 Synthetic turf infill.** Any new synthetic turf playing field shall only utilize infill comprised of a material approved by the commissioner of parks and recreation. Dark crumb rubber shall be prohibited.

*Amendments to the Administrative Code of the City of New York:*

1. Add a new subchapter to Chapter 13 of Title 20 as follows:

   **Subchapter 13: Roof Coatings**

   **20-699.7 Roof coatings.** It shall be unlawful for any person to distribute, sell, offer for sale, or import any roof coating that does not meet the standards of Section 1504.8 of the New York City Building Code.

   **20-699.8 Civil penalty.** Any person who violates any of the provisions of this subchapter shall be liable for a civil penalty in the sum of not more than five hundred dollars for each violation.

*Study: Long-Term Cool Roof Performance*

The city should research the long-term solar reflectance and thermal emittance of various roof coatings, including bituminous roofs with acrylic and hydrophilic coatings, white rubber, and black rubber with a white coating.

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## III. Supporting Information

**Expanded Issue and Benefits:**

The urban heat island effect (UHI) is the increase in ambient air temperature in urban areas that results from the prevalence of materials, like dark pavement and roofing, that absorb solar thermal radiation and reduce the natural cooling that occurs in vegetated areas through evapotranspiration. In the hottest months of the year, the UHI leads to increases in heat-related mortality in the city and exacerbates ground-level ozone, which aggravates asthma and other respiratory conditions. Warmer air temperatures impact NYC's resiliency by increasing cooling demands in buildings and reducing comfort outdoors during hotter months of the year. Research suggests that UHI and waste heat from buildings may also alter the city's microclimate, intensifying summer storms. This Task Force proposal is designed to reduce UHI temperature impacts in order to minimize electricity use during times of peak demand that may cause blackouts, and to minimize health impacts and heat-related mortality during infrastructure outages in the summer.

Roofs with slopes greater than 17% make up a significant percentage of NYC's building stock and currently have no Building Code or regulation to monitor their UHI contribution. Optimally, these surfaces should be of white material or white coating because, as stated in Local Law 21-2011, a white roof reduces the UHI and "increases the durability of the roof membrane because it is subject to reduced thermal cycling amplitude and UV radiation." For situations where darker shingles or tiles are competitively priced, reflective shingle and tile technologies that have a minimum SRI of at least 25 are readily available. Alternatively, newer technologies utilizing a two-layer spray coating process can increase the solar reflectance significantly without sacrificing color options. The LEED® rating system has used an SRI benchmark of 29 for steep-sloped roofs since Version 2.2 was released in 2007.

Thermal maps and on-the-ground data collection have revealed that synthetic playing fields that use "crumb" rubber for infill are some of the hottest places in NYC on summer days, contributing to UHI in some of the city's hottest, poorest neighborhoods, which also tend to have low tree cover. In 2010, Local Law 123 created a Department of Parks Advisory Committee regarding synthetic turf to make recommendations that are non-binding and apply only to Parks Department turf fields. Since that time, data has confirmed that crumb rubber turf has very poor SRI and virtually no evapotranspiration capabilities, resulting in high heat conditions that pose acute risks to public health. Additionally, synthetic turf has little or no stormwater retention (which would help mitigate combined sewage overflow events), an important benefit of natural turf fields. Therefore, it is necessary that the Building Code contain requirements that apply to all synthetic playing fields.

Using alternative organic materials sourced from cork, coconut husks, or other nontoxic, high albedo (reflectiveness coefficient), and water absorptive materials will reduce thermal absorption, thereby reducing surface temperatures by as much as 35°F on a hot summer day. Initial costs are approximately 10% more than crumb rubber, but relative prices are expected to drop.

Painting dark roofs white significantly reduces their solar thermal retention and therefore leads to reduced ambient indoor and nearby outdoor temperatures (if implemented at scale). However, some studies have shown that roofs painted white with commonly used elastomeric acrylic exterior paints can lose up to 50% of their albedo capabilities in just several years, likely due to unavoidable dirt and particulate buildup. While a white roof performing at 50% of its cooling capability is still 50% better than a black roof, regular washing of white roofs would be beneficial. However, this is an onerous activity that building managers should not be required to conduct, nor could it be easily regulated. As an alternative, new self-cleaning (hydrophilic) paints like StoCoat®, Lotusan®, or HydroPhil™ should be considered.

More research is needed on the degradation of roof coatings. In particular, a study that monitors and compares the long-term solar reflectance and thermal emittance of various roof coatings is needed.

### General Background on Urban Heat Island Effect

By increasing the albedo of building surfaces, primarily the roof, walkways, and playing fields, along with increasing the amount of shading provided by trees and other landscaping, the city could reduce the ambient temperature impact of the Urban Heat Island Effect.

Increased temperatures result in higher peak electricity demands (which can lead to blackouts), contribute to heat-related mortality in vulnerable populations, and accelerate the production of ground-level ozone (which aggravates respiratory symptoms, especially among children and the elderly, and may lead to the development of asthma in children).

The Urban Heat Island Effect exacerbates warming trends resulting from global climate change. Studies have shown that the 31 counties of greater NYC experienced 2ºF warming of average annual temperatures from 1900-1997, and projections for the region in the 2050s range from 2.5º-7.6ºF warmer. There is a 13.05% increase in non-accidental causes of mortality for every 10ºF increase in temperature above the local threshold of 73.54ºF. In the 1990s, weather data showed that the average temperature in Central Park was 4.2ºF warmer than the 23 other weather stations in the region – a figure that is even higher in certain neighborhoods with less vegetation and higher concentrations of dark roofs. In addition, according to multiple research studies, elderly people and people carrying the sickle cell trait (almost exclusively African Americans) have a higher propensity for mortality due to heat-related exertion. According to NASA heat and vegetation maps overlaid with census tract maps, the hottest neighborhoods in the city with the least amount of green area (including Brownsville, the South Bronx, East Harlem, and others) are also predominantly minority neighborhoods.

The table below compares temperatures of different synthetic turf infill types, including “InfillPro Geo” – a coconut, cork, and sand mixture:

**Infill System Temperature Testing:**

**Hydra-Cone Infill Measurement · Infrared Thermometer · ACU-Rite Probe**

| Time/Day | Air Temp °F/ Sky | Humidity % | Wind MPH | Natural Grass °F | Raw Soil °F | Moisture % | InfillPro Geo °F | Rubber Infill °F | Sand/Rubber Infill °F |
|---|---|---|---|---|---|---|---|---|---|
| 11:00/ 1 | 63/ Sun | 44 | 12 | 80 | 89 | 2.0 | 84 | 104 | 103 |
| 2:00/ 1 | 71/ Sun | 32 | 15 | 89 | 110 | 2.0 | 107 | 144 | 149 |
| Moisture added after 2pm reading: | | | | | | | | | |
| 3:00/ 1 | 80/ Sun | 19 | 11 | 100 | 126 | 4.0 | 113 | 163 | 161 |
| 4:00/ 1 | 86/ Sun | 15 | 14 | 104 | 131 | 4.0 | 116 | 174 | 171 |
| Moisture added at 9am: (12 oz. per square foot) | | | | | | | | | |
| 11:00/ 2 | 83/ Sun | 21 | 21 | 88 | 117 | 5 | 109 | 121 | 119 |
| 2:00/ 2 | 88/ Sun | 33 | 3 | 99 | 124 | 5 | 111 | 126 | 123 |
| 3:00/ 2 | 93/ Sun | 26 | 10 | 101 | 126 | 4.5 | 115 | 164 | 163 |
| 4:00/ 2 | 97/ Sun | 15 | 16 | 97 | 131 | 4.5 | 103 | 171 | 173 |
| 5:00/ 2 | 98/ Sun | 11 | 20 | 92 | 126 | 4.3 | 101 | 147 | 144 |
| Moisture added at 9am: (12 oz. per square foot) | | | | | | | | | |
| 1:00/ 3 | 86/ Sun | 31 | 7 | 88 | 117 | 5.0 | 99 | 141 | 140 |
| 2:00/ 3 | 88/ Sun | 33 | 3 | 93 | 119 | 5.0 | 104 | 157 | 155 |
| 3:00/ 3 | 93/ Sun | 21 | 12 | 98 | 126 | 4.5 | 115 | 164 | 163 |
| 4:00/ 3 | 97/ Sun | 15 | 16 | 100 | 131 | 4.5 | 117 | 171 | 173 |
| 5:00/ 3 | 98/ Sun | 11 | 20 | 98 | 126 | 4.3 | 114 | 169 | 168 |

*Source: Limonta Sports Turf; ISA USA / DMA Sports Design Group (June 30, 2012)*

### Implementation:

There are no known implementation issues for this proposal.

Asphalt shingles meeting the SRI standards in this proposal are readily available. The top asphalt shingle manufactures, including Owens Corning, PABCO, CertainTeed, and GAF, all have product lines that meet the proposed SRI standard, and each line comes in an extensive variety of colors.[i] According to the Cool Roof Rating Council, there are at least 51 asphalt shingle product lines available in a variety of colors with an initial SRI of 25 or higher, and at least 14 with an SRI of 29 or higher.

Hydrophilic paints, on the other hand, are less readily available at this time. Once there is more competition in this specialty paint market, it may be plausible to add its use on low-slope roofs to the Building Code.

Numerous materials can substitute for dark crumb rubber in playing fields, including alternative rubber products and organic products such as coconut husks, walnut shells, cork, and sand. Rubber-type infills, such as EcoFill (TPE) by Mondo, have performance characteristics similar to natural turf, and also have significantly less heat absorption than black crumb rubber.[ii] According to Mondo, “On average, EcoFill produces 6% more heat than natural grass compared to 14% more heat for SBR/sand based fields.”

The School Construction Authority requires the use of synthetic turf materials that address both the performance of the field for sports and the heat and toxicity issues.

**Cost:**

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

The following analysis was provided by the authors of this proposal:

According to the Green Affordable Housing Coalition in 2007, asphalt composition shingles that are used on as many as 80% of existing U.S. homes are the least expensive option between the other two common steep-sloped roofing alternatives at approximately \$0.50-1.50/ft² (whereas metal = \$1.00-6.00/ft² and clay or concrete tiles = \$3.00-5.00+/ft²). The Department of Energy states that “[c]ool versions of some roofing materials, including thermoplastic membranes, coated metal products, and clay tiles are available at little or no additional cost. Cool asphalt shingles currently sell for up to \$0.50/ft² more than conventional asphalt shingles.” High-albedo asphalt shingles (SRI>25) are becoming more competitive in price, although metal and tile roofing is more flexible from a UHI-reducing perspective because metal can easily be painted and tiles come in a variety of colors.

Since properly installed asphalt shingle roofs often have a lifespan of 30 years or more, the energy savings realized from cool roofs can significantly offset or recoup the additional per-square-foot costs associated with improved cool roof products. According to the ENERGY STAR

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i. The Timberline® line by GAF, for instance, offers six color options and PABCO’s Premier Radiance® line offers grey, off-white, brown, and multicolor options. CertainTeed has asphalt shingles with an initial SRI of 26 in tan, black, brown, grey, orange, yellow, and multicolor.
ii. http://www.piedmont.k12.ca.us/forms/turf/mondoturf/Mondoturf_Temperature_Study.pdf

rating system (which compiles a list of hundreds of qualified cool roof products) the average homeowner spends nearly $1000 per year on heating and air conditioning costs. $40 billion is spent annually on air conditioning alone in America. They state: “ENERGY STAR qualified roof products… can lower roof surface temperatures by up to 100˚F, decreasing the amount of heat transferred into a building,” and “can reduce peak cooling demand by 10-15%.”

For low-slope roofs, self-cleaning coatings like StoCoat®, Lotusan®, or HydroPhil™ typically cost approximately $0.50/ft² (including installation) more than the popular elastomeric acrylic exterior paints (e.g., APOC® 247 Sun-Shield), but labor costs remain the same, long-term cleaning costs are mitigated, and the paint lasts longer.

**NEW CONSTRUCTION**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **14** | **Use Cool Surfaces to Reduce Summer Heat** | | | | | | | | | | | | | | | | |
| | Premium to use roof covering with high solar reflectance index and high thermal emittance in lieu of traditional materials - sloped roofs | | | | | 2,000 | SF | $1.00 | $2,000 | | | | | 3,000 | SF | $1.00 | $3,000 |
| | | | | | | | | | $0 | | | | | | | | $0 |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | **$2,000** | | | | | | | | **$3,000** |
| | Contingency | | | | | | 10% | | $200 | | | | | | 10% | | $300 |
| | **SUBTOTAL** | | | | | | | | **$2,200** | | | | | | | | **$3,300** |
| | GC Mark-ups | | | | | | 20% | | $440 | | | | | | 20% | | $660 |
| | **TOTAL** | | | | **N/A** | **4,000** | **GSF** | **$0.66** | **$2,640** | | | | **N/A** | **15,000** | **GSF** | **$0.26** | **$3,960** |

**EXISTING BUILDINGS**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **14** | **Use Cool Surfaces to Reduce Summer Heat** | | | | | | | | | | | | | | | | |
| | Premium to use roof covering with high solar reflectance index and high thermal emittance in lieu of traditional materials - sloped roofs | | | | | 2,000 | SF | $1.00 | $2,000 | | | | | 3,000 | SF | $1.00 | $3,000 |
| | | | | | | | | | $0 | | | | | | | | $0 |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | **$2,000** | | | | | | | | **$3,000** |
| | Contingency | | | | | | 10% | | $200 | | | | | | 10% | | $300 |
| | **SUBTOTAL** | | | | | | | | **$2,200** | | | | | | | | **$3,300** |
| | GC Mark-ups | | | | | | 20% | | $440 | | | | | | 20% | | $660 |
| | **TOTAL** | | | | **N/A** | **4,000** | **GSF** | **$0.66** | **$2,640** | | | | **N/A** | **15,000** | **GSF** | **$0.26** | **$3,960** |

# **15** Choose Reliable Backup Power & Prioritize Needs

## I. Summary

**Issue:**
Few backup power systems are large enough to serve a whole building, forcing most buildings to make difficult choices about what equipment to back up.

**Recommendation:**
Prioritize which electrical equipment will run on backup power so buildings can remain habitable during extended blackouts. Because cogeneration and solar power systems are always in use, they can be more reliable than generators that are only turned on during emergencies.

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## II. Proposed Legislation, Rule or Study

1. Where practical, the following loads should be evaluated for extended operation. Starting with Tier 1, the loads are organized by types of electrical equipment that should be given the highest priority for backup power use.

   **Tier 1: Egress**
   - Exit signs and egress illumination

   **Tier 2: Extended life safety**
   - Fire alarm and smoke/carbon dioxide detectors (battery backup instead of generator)
   - Common corridor and stairwell lighting
   - Essential security equipment such as electric locks
   - Fuel pump systems for generators

   **Tier 3: Water**
   - Sump and sewage ejector pumps
   - Domestic water booster pumps
   - Building Management System (for critical loads shown on this list)

   **Tier 4: Parking Egress**
   - Parking egress (lifts and lighting)

   **Tier 5: Convenience power for building occupants**
   - Charging stations equipped with current limiters
   - Community room

**Tier 6: Small critical heating loads**
- When possible, heating systems and all ancillary equipment required to generate and distribute heat for space conditioning. This may include control panels, burners, boilers, circulators, condensate pumps, vacuum pumps, gas boosters, fuel pumps, combustion air dampers and fans, and inducer fans.
- Domestic hot water equipment and all ancillary equipment required to generate and distribute domestic hot water. This may include control panels, burners, boilers, recirculation pumps, gas boosters, fuel pumps, and inducer fans.

**Tier 7: Improved habitability**
- Elevator car operation
- One convenience receptacle in living units, such as for refrigeration
- Air conditioning
- Main telecommunications room

2. When designing and evaluating the feasibility of backup power, buildings should consider the following options as alternatives to a traditional, standby generator:
   - Cogeneration
   - Solar photovoltaic (PV) systems
   - Central battery systems integrated with either cogeneration or PV systems

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## III. Supporting Information

**Expanded Issue and Benefits:**

During Superstorm Sandy, large portions of New York City were left without power for extended periods, leaving many residential buildings within the blackout zones uninhabitable. Some backup generators that were in place did not operate properly when turned on and others operated inefficiently. Greater backup or “standby” power in residential buildings could have mitigated many of the habitability challenges faced by these buildings during extended power outages.

This proposal recommends that buildings (i) prioritize which electrical systems should be on backup power and (ii) consider the use of cogeneration or solar photovoltaic systems as alternatives to generators, potentially in combination with large electric batteries.

Many of the electrical loads recommended for prioritization in this proposal are not addressed by life safety requirements and have very different power requirements. For example, determining instantaneous power supply requirements for an elevator operating continuously during an emergency egress condition is fundamentally different than designing a system including battery storage that can be used to meet elevator load requirements for a few minutes out of every hour during a multiday blackout.

For all but the largest residential buildings, a combination of relatively modest cogeneration systems with battery systems could meet a significant portion of the common area loads for an extended period. Cogeneration and/or PV systems dedicated to powering certain common area systems are potentially more reliable during power outages than backup generators since they are operating continuously, rather than only being turned on during emergencies. Solar photovoltaic PV systems with batteries also could supply critical loads for smaller buildings for an extended period of time.

**Implementation:**

CHP and PV are very mature technologies with widespread market penetration in NYC.

The integration of large batteries in buildings has been established to varying degrees in the following applications: (i) the use of lighting systems with central batteries; (ii) the use large scale batteries in off grid remote buildings; (iii) the use of large scale batteries in buildings with controls to optimize peak demand reduction and minimize utility costs; and (iv) the use of large scale batteries with a continuous back up power source (CHP unit, diesel generator, etc.) for the operation of critical building systems during extended blackouts.

A NYSERDA funded research study is being conducted by Steven Winter Associates to examine the application considerations and benefits of large battery systems in NYC residential and commercial buildings. A primary goal of this study is to provide the market with better data to support easier screening of these opportunities in buildings.

**Cost:**

This proposal does not mandate a building owner to perform any work. Therefore, cost is dependent on the building and the standby loads chosen by the building owner for extended operations.

Solar PV costs have dropped significantly in recent years and substantial government incentives are available. Many companies will also cover the full up front cost of solar PV (though not batteries) through leasing programs.

Owners should be aware that in some cases financing of CHP systems is available through 3rd parties and/or CHP equipment vendors. Because the electrical and thermal outputs of CHP systems are metered, the technology lends itself to “shared savings contracts” or “power purchase agreements” whereby a third party installs, maintains and purchases the gas used by a CHP system and charges the owner for the useful energy output of the CHP system. In such cases, the owner’s net operating costs will either stay constant or slightly decrease. From a resiliency standpoint, pursuing such a strategy allows for the primary component of an emergency generator system to be installed with no impact on capital or operating budgets. Note that the reconfiguration of existing site wiring to allow the CHP system to be connected to critical loads would likely still be a cost that the owner would have to bear.

There is no such financing alternative for traditional (non CHP) emergency generators because they do not result in a positive revenue stream.

Spurred in large part by the Electric Vehicle market, a drop in battery costs in recent years has opened up the potential to integrate banks of batteries in buildings in combination with smart load monitoring control systems to release energy at optimal times. There are two potential revenue streams that can result from the integration of such batteries in buildings: (1) reduced electric demand charges from Con Edison associated with the use of batteries to shave peak demand; and (2) participation in NYISO demand curtailment programs whereby batteries enable buildings to reduce load during critical 4-5 hour periods during peak summer conditions with no impact on comfort. This revenue stream is only applicable to larger buildings that can curtail at least 100 kW of demand for 4-5 hours. As a result of these relatively predictable revenue streams, there is also the potential to utilize 3rd parties to finance large electric batteries, although this market is not as mature as the one for CHP systems.

No cost estimation was provided for this proposal.

**Sources:**

1. http://aristapower.com/
2. http://demandenergynetworks.com/pressroom/latest/128-barclay-tower-becomes-world-s-first-intelligent-energy-storage-powered-high-rise

# **16** Use Cogeneration & Solar During Blackouts

## I. Summary

**Issue:**
Many cogeneration and solar power systems are not set up to run during a blackout. Because of this, they cannot provide heat and power to buildings during these emergencies.

**Recommendation:**
Cogeneration and solar power systems should be designed to run during blackouts.

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## II. Proposed Legislation, Rule or Study

As a "best practice", no legislation is included in this proposal.

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## III. Supporting Information

**Expanded Issue and Benefits:**

To provide useful, long-term supplemental power during an extended blackout, both cogeneration and PV solar electric power systems should be capable of operating in "island mode" in a manner acceptable to the electric utility and in compliance with the National Electric Code (NEC) and New York City Construction Code. "Island mode" means a generator capable of self-excitation and black start, supplying power to a distribution system that is electrically isolated from the local utility power supply.

**Safety**
Any such installation must include 1) an automatic inverter disconnect or shutdown that will prevent any power from being fed back into the grid in the event of an outage, and 2) an approved, break-before-make transfer switch to ensure that the generating equipment is only capable of independent operation when disconnected and only supplies specified and controlled loads during the outage. Automatic switching of cogeneration units from normal utility connections to standby connections/switchgear is preferred, but manual switching is acceptable. The isolation switching should include permissive relaying or other means of automatic notification to the cogeneration units so that isolation from normal utility connections is completed before the cogeneration units are capable of restart.

### Loads

It is unclear what loads, if any, such a cogeneration system would be required to supply. Emergency generators are now required for residential (R-2) buildings 125 feet in height or greater and for other high-rise commercial buildings by building code,[1] and must be sized to supply specified loads. However, these emergency generators are not required for existing buildings or new smaller buildings. A Department of Buildings (DOB) memo[2] (TPPN 1/07) describes the loads emergency generators that are installed in existing buildings must provide, and includes emergency lighting, fire alarm systems, and one elevator. However, TPPN 1/07 is not clear on which buildings are subject to its requirements; any building voluntarily installing a generator, or only buildings that would require an emergency generator if constructed today. The proposal "Remove Barriers to Backup and Natural Gas Generators" includes proposed improvements to TPPN 1/07.

Because of limited roof area and temporal variation of the solar resource, the ability of a PV system to service building loads will be limited and vary greatly from one building to another. In large buildings, in some cases the most a PV system could supply would be charging appliances like cell phones or manually controlled water pumping; in other cases, it could supply essential building services, such as limited elevator service. Only in a few cases would a PV system be capable of meeting all the loads specified for emergency generators, and thus, a PV-based system will likely need to be coupled with another system to fully provide "emergency power" in large buildings. It is more likely that solar PV in large buildings will act as supplemental power to provide limited relief during blackouts. In smaller residential buildings, such as detached homes and row houses, PV could support many or all key loads if equipped with battery storage, with a trade-off between the capacity of the batteries and the number of days without bright sun.

For systems in facilities that require emergency generation to meet certain loads by code, the cogeneration system could be used in island mode, in parallel with the emergency generation, to support additional building loads. For systems in larger, new residential, commercial and critical facilities that require emergency generation by code, the PV system would be used in island mode in parallel with the emergency generation to support additional building loads.

### Energy Source

Natural gas is the preferred fuel source for cogeneration systems and is a code acceptable fuel source for voluntary standby generator applications. Use of natural gas is recommended for cogeneration installations capable of providing standby power/island mode operation. Natural gas has almost always been available when electric power was lost due to hurricanes; liquid fuel, on the other hand, was often unavailable for some time until the infrastructure could be re-established, demonstrating that natural gas is often a better fuel than diesel during extended outages.

### Conversion

PV systems employ inverters (also known as static power converters, SPCs) to convert DC power to grid-compatible AC power. An inverter can be self-commutating, meaning it can operate by itself and provide 60 Hz power at some desired voltage. These systems are common in remote locations. Alternatively, the inverter can be grid-commutated, meaning that it requires

[1] BC 403.11, BC 2702.

[2] Technical Policy and Procedure Notice # 1/07, "Voluntarily Installed Emergency Generators"

connection to the grid and derives its phase and frequency from the grid. This second system is the norm in New York City, with the PV and inverter feeding AC power in the building's electrical system to lower demand on the utility or even feed excess power back when available. Hybrid systems are available that can operate normally in grid-commutated mode, then disconnect and switch to self-commutated operation once the grid connection is securely broken. All of these systems are readily available through reputable suppliers.

The services of a licensed electrical engineer experienced in interconnection with the Con Edison grid should be employed to facilitate the process of installing or upgrading PV systems.

Existing cogeneration and PV systems capable of operation in island mode but not currently employing this functionality should be upgraded to do so, and those systems not capable of operating in island mode should be upgraded to provide this capability. In either case, the building electrical distribution must be reconfigured to provide standby isolation and management of priority loads.

Currently NYSERDA requires new cogeneration units to be capable of stand-alone operation to receive NYSERDA funding.

**Implementation:**

Inverters are available for reciprocating engine-based cogen systems to enable them to function in island mode. Microturbine-based systems already have such capability.

A licensed electrical engineer experienced in cogen interconnection to the Con Edison grid should be retained to oversee the process of installing or upgrading cogen units to run in island mode. The effort must include defining procedures for transition to island mode operation and overseeing the testing of the transition from grid parallel to island mode operation. Some equipment, such as VFD's, may need to be installed to motors to prevent the starting in-rush current from exceeding the capabilities of the cogen system.

Educating residential property managers to fully understand the value and benefits of cogen in their buildings can be difficult; however, the opportunity for better living conditions during blackouts may help convince managers to implement the recommendations in this proposal.

**Cost:**

Turner Construction Company did not perform cost estimation for this proposal. The following analysis was provided by the authors of this proposal:

There are minimal ongoing maintenance costs associated with changing from induction cogen systems to synchronous, such as the need to maintain a starting battery. An initial investment will be needed for inverters and for switchgear to enable the separation of priority loads.

The cost of inaction is people living in high-rise buildings for the duration of a blackout without water to flush toilets or fire alarms, which was the experience of many after the widespread damage caused by Superstorm Sandy. In some cases elevators will be available, making shopping plausible for people on high floors. Since the costs of not being able to shop, for instance, are born individually and without recourse, they are hard to quantify.

# **17** Remove Barriers to Backup & Natural Gas Generators

## I. Summary

**Issue:**
Existing regulations require buildings that voluntarily provide backup, standby generators to supply backup power for at least one elevator in addition to whatever other loads the buildings may want to power. This increases generator size and costs, making backup generators too expensive for some buildings. Other regulations discourage natural gas generators, which are clean burning and can power buildings for extended periods without fuel deliveries.

**Recommendation:**
Only require buildings over 75 feet to power an elevator with the standby generator, and reduce the minimum requirements for generator size. For emergency generators, increase the allowed startup delay from 10 to 60 seconds, making more options available for generators operated by natural gas.

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## II. Proposed Legislation, Rule or Study

*Amendments to Department of Buildings Technical Policy and Procedure Notice # 1/07:*

1. Revise TPPN # 1/07 as follows:

   **Specifics:**

   Recognizing that the installation of emergency generators can be very beneficial to the building and in order to encourage [voluntary] standby installations, only the following life safety loads shall be required to be connected to such generators:

   1. Emergency lighting (unless supported by battery packs of adequate capacity), including stairway lighting. For systems whose start time exceeds 10 seconds, power to emergency lighting shall be powered by battery backup during the interim.
   2. Fire alarm system.
   3. For buildings greater than 75 feet in height, one elevator serving all floors of the building.

   Occupants' optional loads are permitted to be connected to the [voluntarily] standby installed generator. [Such generator shall be increased in capacity to supply the required equipment at full design load and occupants' optional loads.] If an elevator is a required life safety load, such generator shall have the minimum capacity to supply the elevator after shedding all other loads through the use of manual transfer switch.

Fuel supply may be one of the following:

1. Fuel oil in compliance with [Article 17 of Subchapter 14] Section 1301 of the NYC Mechanical [Building] Code with tank capacity sufficient to supply the total emergency power load for a period of at least three (3) hours.

2. Dedicated gas line in compliance with [Subchapter 16 and Reference Standard RS 16] Chapter 4 of the 2008 NYC Fuel Gas Code. The dedicated gas line can originate upstream of an existing outside gas service line valve where acceptable to the commissioner and utility. The outside gas cut-off required by [RS16 §P115.5] Section E.6 of Appendix E, of the NYC Fuel Gas Code shall be installed prior to gas authorization.

All other applicable code requirements for emergency power (generator) installation shall be complied with.

*Amendments to the New York City Building Code:*

1. Amend Section BC 2702.1 as follows:

**2702.1 Installation.** Emergency systems shall be installed in accordance with the New York City Electrical Code, NFPA 110 and NFPA 111.[, and] Systems relying on fuel oil shall have an on-premises fuel supply sufficient for not less than 6-hour full-demand operation of the system. [However, for R-2 occupancies required to provide emergency power systems pursuant to the provisions of Section 403.11.2, and for voluntarily installed emergency power systems, n] Natural gas from the public utility street main shall be permitted as fuel supply.

*Amendments to the New York City Electrical Code:*

1. Amend 2008 NEC Section 700.12 as follows:

**Section 700.12 General Requirements**: Current supply shall be such that, in the event of failure of the normal supply to, or within, the building or group of buildings concerned, emergency lighting, emergency power, or both shall be available within the time required for the application but not to exceed [10] 60 seconds. For systems whose start time exceeds 10 seconds, emergency lighting shall be powered by battery backup in the interim.

2. Add Section 702 of 2008 NEC on Optional Standby Generators.

## III. Supporting Information

**Expanded Issue and Benefits:**

During Superstorm Sandy large portions of New York City were left without power, making many residential buildings within the blackout zones uninhabitable. Greater backup or "standby" power in residential buildings could have mitigated the challenges of living in buildings without grid power.

Current NYC Building Code guidelines outlined in Technical Policy and Procedure Notice # 1/07 (TPPN #1/07) make the voluntary installation of backup power cost prohibitive for many building owners due to minimum load requirements that include egress lighting (where not powered by battery backup), the fire alarm system and one elevator serving all floors. The cost of the elevator requirement sometimes precludes building owners from installing generators, leaving all parties (owner, occupants, and emergency response personnel) at a disadvantage if grid power is lost, especially for extended periods of time. Eliminating the elevator requirement for buildings under 75 feet in height (about six floors) and giving building owners the option to isolate the elevator load from other loads during its use, increases the flexibility of system sizing and design without reducing the benefit of standby power to occupants and emergency response personnel.

Superstorm Sandy highlighted the limitations of diesel generators which require significant quantities of fuel delivered by truck, and which negatively impact local air quality. However, the majority of existing backup generators in NYC are powered by diesel fuel and the allowable capacity of onsite fuel is limited by code. Currently the Building Code requires emergency generators to be diesel fuel powered with an onsite storage capacity equivalent to 6 hours of operation at full load, while residential buildings are permitted to utilize natural gas as a fuel source. The city's natural gas supply, which has not been disrupted in decades, is an underutilized fuel source in times of greatest need. Natural gas does not face the onsite storage limitations and potential delivery issues of diesel and burns much cleaner than diesel. However, it is challenging for units above 1000 kW to energize within 10 seconds, the required start time for emergency generators in the Electrical Code. Increasing the maximum allowable start time will expand the market options available to building owners and ease the restrictions imposed on natural gas fired units.

This proposal will facilitate the development of a micro-grid system for use during periods of extended power outages. With the dense population of New York City, the low vacancy rate, the dependence of its habitants on their place of residence, and the year-round presence of huge numbers of visitors occupying hotels in all five boroughs, even small reductions in habitable space can place great strain on available resources. Standby power systems, supplied by a broad, existing distribution network of natural gas that can remain active during major storms and disasters, will greatly increase the resiliency of New York City.

**Implementation:**

All relevant technology is commercially available and is widely used in a variety of applications. The proposal will allow for an increase in available market products for building owners.

The proposed changes (once implemented) would have an immediate effect on the resiliency of a building.

Natural gas is not available throughout all areas of New York City.

**Cost:**

This proposal does not mandate building owners to perform any work. The cost for owners to voluntarily add backup generators is dependent on the characteristics of the building, the standby loads chosen by the building owner, and fuel choice (natural gas versus diesel). Owners that choose to install stand-by generators will see an increase in their annual operation and maintenance budget due to monthly testing and equipment maintenance.

No cost estimation was performed for this proposal.

**Sources:**

1. Technical Policy and Procedure Notice # 1/07 http://www.nyc.gov/html/dob/html/codes_and_reference_materials/tppn0107.shtml. Since TPPN #1/07 is an interpretation of the 1968 Building Code, the changes recommended in this proposal would modify the interpretation of a code that has been replaced. In the end, a new TPPN or modification of the 2008 building code should be prepared that will incorporate the changes proposed here.
2. 2008 NYC Building Code: Chapter 27 – Electrical http://publicecodes.cyberregs.com/st/ny/ci-nyc/b200v08/st_ny_ci-nyc_b200v08_27_sec002.htm?bu=YC-P-2008-000006
3. Administrative Code of the City of New York, Title 27 Construction and Maintenance, Chapter 3 Electrical Code, Section 27-3025 http://www.nyc.gov/html/dob/downloads/pdf/admin_sec_2007_elec_code.pdf
4. 2008 NEC – Article 700 (Section 700.12 attached)
5. Email communication with John Viserto of H.O. Penn – Local Caterpillar Sales Representative

## Supporting Documents:



section, panelboard enclosure, or individual disconnect enclosure as emergency circuits.

**(C) Wiring Design and Location.** Emergency wiring circuits shall be designed and located so as to minimize the hazards that might cause failure due to flooding, fire, icing, vandalism, and other adverse conditions.

**(D) Fire Protection.** Emergency systems shall meet the additional requirements in 700.9(D)(1) and (D)(2) in assembly occupancies for not less than 1000 persons or in buildings above 23 m (75 ft) in height with any of the following occupancy classes: assembly, educational, residential, detention and correctional, business, and mercantile.

**(1) Feeder-Circuit Wiring.** Feeder-circuit wiring shall meet one of the following conditions:

(1) Be installed in spaces or areas that are fully protected by an approved automatic fire suppression system
(2) Be a listed electrical circuit protective system with a minimum 1-hour fire rating

FPN: UL guide information for electrical circuit protection systems (FHIT) contains information on proper installation requirements to maintain the fire rating.

(3) Be protected by a listed thermal barrier system for electrical system components
(4) Be protected by a listed fire-rated assembly that has a minimum fire rating of 1-hour and contains only emergency wiring circuits.
(5) Be embedded in not less than 50 mm (2 in.) of concrete
(6) Be a cable listed to maintain circuit integrity for not less than 1 hour when installed in accordance with the listing requirements

**(2) Feeder-Circuit Equipment.** Equipment for feeder circuits (including transfer switches, transformers, and panelboards) shall be located either in spaces fully protected by approved automatic fire suppression systems (including sprinklers, carbon dioxide systems) or in spaces with a 1-hour fire resistance rating.

FPN: For the definition of *Occupancy Classification*, see Section 6.1 of NFPA *101*-2006, *Life Safety Code*.

**(3) Generator Control Wiring.** Control conductors installed between the transfer equipment and the emergency generator shall be kept entirely independent of all other wiring and shall meet the conditions of 700.9(D)(1).

### III. Sources of Power

**700.12 General Requirements.** Current supply shall be such that, in the event of failure of the normal supply to, or within, the building or group of buildings concerned, emergency lighting, emergency power, or both shall be available within the time required for the application but not to exceed 10 seconds. The supply system for emergency purposes, in addition to the normal services to the building and meeting the general requirements of this section, shall be one or more of the types of systems described in 700.12(A) through (E). Unit equipment in accordance with 700.12(F) shall satisfy the applicable requirements of this article.

In selecting an emergency source of power, consideration shall be given to the occupancy and the type of service to be rendered, whether of minimum duration, as for evacuation of a theater, or longer duration, as for supplying emergency power and lighting due to an indefinite period of current failure from trouble either inside or outside the building.

Equipment shall be designed and located so as to minimize the hazards that might cause complete failure due to flooding, fires, icing, and vandalism.

Equipment for sources of power as described in 700.12(A) through (E) where located within assembly occupancies for greater than 1000 persons or in buildings above 23 m (75 ft) in height with any of the following occupancy classes — assembly, educational, residential, detention and correctional, business, and mercantile — shall be installed either in spaces fully protected by approved automatic fire suppression systems (sprinklers, carbon dioxide systems, and so forth) or in spaces with a 1-hour fire rating.

FPN No. 1: For the definition of *Occupancy Classification*, see Section 6.1 of NFPA *101*-2006, *Life Safety Code*.

FPN No. 2: Assignment of degree of reliability of the recognized emergency supply system depends on the careful evaluation of the variables at each particular installation.

**(A) Storage Battery.** Storage batteries used as a source of power for emergency systems shall be of suitable rating and capacity to supply and maintain the total load for a minimum period of 1½ hours, without the voltage applied to the load falling below 87½ percent of normal.

Batteries, whether of the acid or alkali type, shall be designed and constructed to meet the requirements of emergency service and shall be compatible with the charger for that particular installation.

For a sealed battery, the container shall not be required to be transparent. However, for the lead acid battery that requires water additions, transparent or translucent jars shall be furnished. Automotive-type batteries shall not be used.

An automatic battery charging means shall be provided.

**(B) Generator Set.**

**(1) Prime Mover-Driven.** For a generator set driven by a prime mover acceptable to the authority having jurisdiction and sized in accordance with 700.5, means shall be provided for automatically starting the prime mover on failure of the normal service and for automatic transfer and

**701.17 Ground-Fault Protection of Equipment.** The alternate source for legally required standby systems shall not be required to have ground-fault protection of equipment.

**701.18 Coordination.** Legally required standby system(s) overcurrent devices shall be selectively coordinated with all supply side overcurrent protective devices.

*Exception: Selective coordination shall not be required in (1) or (2):*

*(1) Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exists on the transformer secondary,*

*(2) Between overcurrent protective devices of the same size (ampere rating) in series.*

## ARTICLE 702
## Optional Standby Systems

### I. General

**702.1 Scope.** The provisions of this article apply to the installation and operation of optional standby systems.

The systems covered by this article consist of those that are permanently installed in their entirety, including prime movers, and those that are arranged for a connection to a premises wiring system from a portable alternate power supply.

**702.2 Definition.**

**Optional Standby Systems.** Those systems intended to supply power to public or private facilities or property where life safety does not depend on the performance of the system. Optional standby systems are intended to supply on-site generated power to selected loads either automatically or manually.

FPN: Optional standby systems are typically installed to provide an alternate source of electric power for such facilities as industrial and commercial buildings, farms, and residences and to serve loads such as heating and refrigeration systems, data processing and communications systems, and industrial processes that, when stopped during any power outage, could cause discomfort, serious interruption of the process, damage to the product or process, or the like.

**702.3 Application of Other Articles.** Except as modified by this article, all applicable articles of this *Code* shall apply.

**702.4 Equipment Approval.** All equipment shall be approved for the intended use.

**702.5 Capacity and Rating.**

**(A) Available Short-Circuit Current.** Optional standby system equipment shall be suitable for the maximum available short-circuit current at its terminals.

**(B) System Capacity.** The calculations of load on the standby source shall be made in accordance with Article 220 or by another approved method.

**(1) Manual Transfer Equipment.** Where manual transfer equipment is used, an optional standby system shall have adequate capacity and rating for the supply of all equipment intended to be operated at one time. The user of the optional standby system shall be permitted to select the load connected to the system.

**(2) Automatic Transfer Equipment.** Where automatic transfer equipment is used, an optional standby system shall comply with (2)(a) or (2)(b).

(a) *Full Load.* The standby source shall be capable of supplying the full load that is transferred by the automatic transfer equipment.

(b) *Load Management.* Where a system is employed that will automatically manage the connected load, the standby source shall have a capacity sufficient to supply the maximum load that will be connected by the load management system.

**702.6 Transfer Equipment.** Transfer equipment shall be suitable for the intended use and designed and installed so as to prevent the inadvertent interconnection of normal and alternate sources of supply in any operation of the transfer equipment. Transfer equipment and electric power production systems installed to permit operation in parallel with the normal source shall meet the requirements of Article 705.

Transfer equipment, located on the load side of branch circuit protection, shall be permitted to contain supplemental overcurrent protection having an interrupting rating sufficient for the available fault current that the generator can deliver. The supplementary overcurrent protection devices shall be part of a listed transfer equipment.

Transfer equipment shall be required for all standby systems subject to the provisions of this article and for which an electric utility supply is either the normal or standby source.

*Exception: Temporary connection of a portable generator without transfer equipment shall be permitted where conditions of maintenance and supervision ensure that only qualified persons service the installation and where the normal supply is physically isolated by a lockable disconnecting means or by disconnection of the normal supply conductors.*

**702.7 Signals.** Audible and visual signal devices shall be provided, where practicable, for the following purposes.

**701.17 Ground-Fault Protection of Equipment.** The alternate source for legally required standby systems shall not be required to have ground-fault protection of equipment.

**701.18 Coordination.** Legally required standby system(s) overcurrent devices shall be selectively coordinated with all supply side overcurrent protective devices.

*Exception: Selective coordination shall not be required in (1) or (2):*

*(1) Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exists on the transformer secondary,*

*(2) Between overcurrent protective devices of the same size (ampere rating) in series.*

# ARTICLE 702
# Optional Standby Systems

## I. General

**702.1 Scope.** The provisions of this article apply to the installation and operation of optional standby systems.

The systems covered by this article consist of those that are permanently installed in their entirety, including prime movers, and those that are arranged for a connection to a premises wiring system from a portable alternate power supply.

**702.2 Definition.**

**Optional Standby Systems.** Those systems intended to supply power to public or private facilities or property where life safety does not depend on the performance of the system. Optional standby systems are intended to supply on-site generated power to selected loads either automatically or manually.

FPN: Optional standby systems are typically installed to provide an alternate source of electric power for such facilities as industrial and commercial buildings, farms, and residences and to serve loads such as heating and refrigeration systems, data processing and communications systems, and industrial processes that, when stopped during any power outage, could cause discomfort, serious interruption of the process, damage to the product or process, or the like.

**702.3 Application of Other Articles.** Except as modified by this article, all applicable articles of this *Code* shall apply.

**702.4 Equipment Approval.** All equipment shall be approved for the intended use.

**702.5 Capacity and Rating.**

**(A) Available Short-Circuit Current.** Optional standby system equipment shall be suitable for the maximum available short-circuit current at its terminals.

**(B) System Capacity.** The calculations of load on the standby source shall be made in accordance with Article 220 or by another approved method.

**(1) Manual Transfer Equipment.** Where manual transfer equipment is used, an optional standby system shall have adequate capacity and rating for the supply of all equipment intended to be operated at one time. The user of the optional standby system shall be permitted to select the load connected to the system.

**(2) Automatic Transfer Equipment.** Where automatic transfer equipment is used, an optional standby system shall comply with (2)(a) or (2)(b).

(a) *Full Load.* The standby source shall be capable of supplying the full load that is transferred by the automatic transfer equipment.

(b) *Load Management.* Where a system is employed that will automatically manage the connected load, the standby source shall have a capacity sufficient to supply the maximum load that will be connected by the load management system.

**702.6 Transfer Equipment.** Transfer equipment shall be suitable for the intended use and designed and installed so as to prevent the inadvertent interconnection of normal and alternate sources of supply in any operation of the transfer equipment. Transfer equipment and electric power production systems installed to permit operation in parallel with the normal source shall meet the requirements of Article 705.

Transfer equipment, located on the load side of branch circuit protection, shall be permitted to contain supplemental overcurrent protection having an interrupting rating sufficient for the available fault current that the generator can deliver. The supplementary overcurrent protection devices shall be part of a listed transfer equipment.

Transfer equipment shall be required for all standby systems subject to the provisions of this article and for which an electric utility supply is either the normal or standby source.

*Exception: Temporary connection of a portable generator without transfer equipment shall be permitted where conditions of maintenance and supervision ensure that only qualified persons service the installation and where the normal supply is physically isolated by a lockable disconnecting means or by disconnection of the normal supply conductors.*

**702.7 Signals.** Audible and visual signal devices shall be provided, where practicable, for the following purposes.

# **18** Remove Barriers to Cogeneration

## I. Summary

**Issue:**
Onsite cogeneration can be an efficient and cost effective source of heat and power to buildings, but technical and regulatory barriers inhibit its use.

**Recommendation:**
Con Edison should help facilitate the installation of larger systems by preparing guidelines similar to those for smaller systems, and implement a plan for significant expansion of cogeneration. Cogeneration should be properly sized to maximize economic benefit and energy efficiency.

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## II. Proposed Legislation, Rule or Study

This proposal on larger cogeneration or Combined Heat and Power (CHP) systems consists of four distinct parts:

*Item 1: Facilitate Large CHP Systems*
Con Edison should facilitate the implementation CHP systems by providing a clear set of design and installation procedures, comparable to those now available for smaller systems at (www.coned.com/dg/process_guide/processGuide.asp).

*Item 2: Permit Less Expensive Controls of Large CHP Systems*
To improve the cost-effectiveness of larger CHP systems, Con Edison should permit the use of substantially less costly communication systems that will still allow them to monitor operating distributed generators and shut them down rapidly if necessary.

*Item 3: Prepare for Greatly Increased Distributed Generation*
Over the next decade, Con Edison should modify its distribution system to prepare for substantially greater use of CHP and other forms of distributed generation than are now possible.

*Item 4: Design CHP Capacity to Meet Thermal Loads and Minimize Power Exports to the Grid*
As best practice for new construction and existing buildings, Combined Heat and Power systems (CHP) should be designed with systems sized to the thermal load of the facility, so that power to sell back to the utility will not normally be available. Less common cases of systems capable of or requiring sellback should be worked out individually.

## III. Supporting Information

*Item 1: Facilitate Large CHP Systems*

**Expanded Issue and Benefits:**
Con Edison must ensure that power produced by an independent generator (like a large CHP system) does not induce instability or exceed the capacity of the local network, and that the generator can be safely disconnected in the event of a grid failure. In many cases, existing network technology that is not designed to accept power flows associated with distributed generation (DG) limits the capacity of the generators. These constraints require Con Edison engineers to perform an evaluation of each application for new CHP facilities to determine compatibility with the existing network.

For CHP systems under 100 kW, which will be connected to the lower voltage secondary network, this is no longer an issue since Con Edison has prepared a clear set of guidelines[i]. In general, these smaller systems cannot feed power back onto the grid, since Con Edison does not regard the lower voltage secondary system as capable of accepting CHP power.

Larger CHP systems of 2 MW or more connect directly to the primary (high voltage) grid and that grid is capable of accepting CHP power. However, the application and connection process remains difficult for larger systems due to more complex rules, and the cost of delays is greater in proportion to the size of the system.

Con Edison should prepare and present a clear set of procedures for large CHP systems, comparable to those now available for smaller systems. The timesaving in design and review for both applicants and Con Edison will be significant and more than warrant Con Edison deploying the necessary resources.

**Cost:**
Turner Construction Company did not perform cost estimation for this proposal. The following analysis was provided by the authors of this proposal:

No cost to practitioners, cost to Con Edison may be repaid in reduced time reviewing applications.

**Implementation:**
There are no barriers to implementation.

**Sources:**
Interviews with practitioners and conversations with Con Edison staff.

i. www.coned.com/dg/process_guide/processGuide.asp

*Item 2: Permit Less Expensive Controls of Large CHP Systems*

**Expanded Issue and Benefits:**
Con Edison must be able to ensure that CHP systems are safely and rapidly disconnected in the event of a grid failure. For larger cogeneration systems (around 2 MW or more) that may be selling power back onto the grid "Transfer/Trip telemetry" facilitates direct communication between the cogeneration system and the utility. Con Edison's current requirement, that this system be capable of shutting down in a fraction of a second, can currently only be satisfied by telemetry systems that are extremely expensive. This expensive requirement seems excessive and hinders the cost-effectiveness of larger CHP systems.

Con Edison should work with CHP manufacturers to develop appropriate technical solutions so it can monitor and shut down distributed generation with adequate speed at a significantly lower price.

**Cost:**
Turner Construction Company did not perform cost estimation for this proposal. The following analysis was provided by the authors of this proposal:

Appropriate development should lower costs for all parties.

**Implementation:**
Developers are convinced acceptable systems are available; clearly dialog is necessary.

**Sources:**
Conversations with leading CHP engineers.

*Item 3: Prepare for Greatly Increased Distributed Generation*

**Expanded Issue and Benefits:**
Both CHP and solar electric power constitute what is called "distributed generation" (DG) because they produce electric power at many distributed points, rather than at large central stations. The Con Edison power grid was designed with central generation in mind, characterized by one-way flows out of the generation stations, through the network, and out to the customer. Today, Con Edison must ensure that power flows associated with DG do not exceed the capacity of the local distribution network. In many cases, existing network technology that is not designed to accept power flows associated with distributed generation (DG) prevent those systems from selling power back to the utility. Accordingly, integration of CHP or DG with the capacity to supply large amounts of power to the primary grid will require improvement or reconstruction of portions of that grid.

Network improvements are taking place, but this will take several years. Even with local network improvements, the capacity of DG that can be safely integrated into the network while preserving stability is limited and may prove to be a bottleneck in the future.

In the short term, Con Ed should give network improvement priority, and components should be selected that are capable of operating under conditions of two-way power flows that would permit sales into the secondary network as distributed generation grows in importance. On a longer time scale, Con Ed should develop a plan to modify its systems to make practical the installation of large DG systems into the primary grid without compromising system stability.

**Cost:**
Turner Construction Company did not perform cost estimation for this proposal. The following analysis was provided by the authors of this proposal:

The cost of grid improvements can be passed on to the ratepayers, but careful accounting must be used to ensure that the savings resulting from increased DG are also passed back to the ratepayers.

**Implementation**
The technical issues can be overcome, but they are not trivial, which is why planning should start now, if it is not already underway. Con Edison asserts that increased DG capacity is already part of their planning process, in which case this proposal should be read as encouragement to expand the effort.

**Sources:**
Conversations with DG professionals and review of Con Edison tariffs and literature.

*Item 4: Design CHP Capacity to Meet Thermal Loads and Minimize Power Exports to the Grid*

**Expanded Issue and Benefits:**
To be financially and environmentally successful, CHP must be sized so that all available thermal energy is used to produce domestic hot water or otherwise displace an alternative fuel. This limits the useful size of CHP systems in residential applications to electric capacities well below peak or even average electrical load, and ensures that the machine will run at capacity most of the time, especially if thermal storage tanks are available to level the demand for hot water over the course of a day. This is the ideal situation, since the price Con Edison pays for exported power is much lower than the price customers pay when they are purchasing electricity, making the economic value of these sales uncertain, and as a general matter, Con Edison does not accept power exported from CHP systems on the low-voltage grid to which most residential buildings are connected.

There are two circumstances where an owner or developer might wish to build a system large enough to require the sale of power to the utility. First, a system involving emergency or standby power and second, in the case of direct metering.

First, consider **emergency power**. It is tempting to consider use of CHP systems to meet the requirements for emergency power in new residential buildings over 125 feet high and most other buildings over 75 feet high, as specified in Sections BC 403.11 and BC 2702 of the NYC Building Code. These requirements have been in effect for new construction for about 5 years, and the equipment must provide adequate power for exit signs, egress illumination, fire alarms, at least one elevator, fire pumps and other listed loads. This power is designed to permit evacuation of buildings during fires or other emergencies, and buildings are only required to have a 6-hour fuel supply, normally diesel oil, on hand. Multifamily (R-2) buildings are permitted to use natural gas for these generators, and in such cases are well situated to handle extended blackouts. Buildings without natural gas and only a 6-hour supply of diesel fuel will shortly find themselves without sufficient power because the number of deliveries required for 24-hour operation will prove impractical.

The use of CHP generators to meet these emergency power requirements would seem attractive, and would lower barriers to the use of CHP. However, analysis by staff at a major developer of large residential building (390 units) revealed that a CHP unit sized to run at its most effective efficiency (and therefore sized by the amount of thermal load it can shed) would be too small to meet the demands of code-mandated emergency power. A problem exacerbated when the loads required in an extended outage are included. Their solution was to install a dedicated gas-fired emergency/standby generator to provide power during an outage, with a non-islanding CHP for use only during normal conditions. In another, somewhat smaller building (225 units), a pair of island-capable microturbines would have been able to meet the emergency loads, but could not meet the total load when the “convenience” loads needed for long-term habitability were added. For this building, they retained the microturbines and added a small gas-fired emergency generator to run in parallel and provide adequate total capacity during emergencies.

One could install a CHP system large enough to meet the required emergency loads, but then it would be discarding thermal energy. Sale of electric power to Con Edison would only be possible if the system was large enough to be connected to the high-voltage network, and would only garner the relatively low LBMP rates[ii] for power. Since the excess thermal energy would be wasted, it is very unlikely that this configuration would be cost-effective.

The optimal approach to buildings with both CHP and emergency power is a hybrid configuration: include CHP capacity in new construction whenever possible, capable of operating in island mode with transfer switches and other equipment as needed for safe operation as emergency generation. Size the CHP system to meet but not exceed thermal loads and to operate full time. Then add gas-fired emergency generator capacity, capable of running in parallel with the CHP system, sized to meet code-mandated emergency loads and desired standby loads. This will result in minimum cost systems, without any legal or regulatory barriers.

**Voluntary standby generation** is another case to consider. Existing buildings are not required to add emergency generation, but may wish to install CHP for economic reasons. Many CHP systems can operate in island mode without a grid connection, are gas-fired, and could provide power to a building during an emergency electrical outage. Use of CHP in this function would increase the financial viability of the CHP system by lowering the costs associated with pure emergency generation capacity. However, the modest CHP system size will limit the number of loads that can be carried. Any CHP system could easily provide power for common area lighting and fire alarm systems. Many could also power water and sewage pumps, making it possible to maintain sanitation. However, powering elevators or large pumps may exceed the capacity of smaller CHP systems, especially when inrush current is accounted for. The issue of which loads must be met by CHP systems during long electric service interruptions is dealt with in Building

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[ii] The “low” energy prices paid for cogenerated electric energy represent the wholesale price of generation (Location-Based Marginal Pricing or LBMP), established by competition among all available generators.

Resiliency Task Force Proposal "Remove Barriers to Backup & Natural Gas Generators," and if that proposal is successful, CHP systems sized to thermal loads will be able to meet many essential building loads during blackouts.

There is one circumstance, **direct metering**, where a building owner could reasonably approach Con Edison with a request for net metering, in which the building owner is paid the same rate for energy as he pays when purchasing it. (These are the rates paid for solar electric power, due to its low carbon footprint and lack of air pollution). The ideal case for residential CHP is one where the CHP system is sized to the thermal loads, and generates power at all times. However, this will normally work only in a building with a single, "master" electric meter, since the CHP's electric output will exceed the small nighttime demands of the building's common areas. Only if the CHP can also meet the resident's nighttime needs, such as refrigerator operation, can the electric power be put to good use. With a single master meter for the entire building's single Con Edison account, this is the case.

However, many buildings utilize direct metering, where each apartment has its own Con Edison account. In this case, since Con Edison will not accept sell-back, the CHP system must be downsized to follow the nighttime electric loads of the common area, at a considerable loss in efficiency. The building could qualify for a thermally sized CHP system by converting to master metering, but many owners are reluctant to do this, for a variety of reasons. Physically, if Con Edison were to offer net metering to such a directly metered building, the power fed back would in fact stay within the building and the resulting physical and economic impacts on the Con Edison system would be the same as if the building had converted to master metering. Because of the complexity of determining the "right-sized" CHP system, the impact of a building's transformer configuration, and many other details, it is unlikely that a simple tariff can be developed around this situation. However, it may be well worth a developer's time to bring a particular case like this to Con Edison's attention and see if any negotiations are possible.

Since CHP allows greater fuel utilization efficiency than standard utility generation, buy-back should be encouraged from installations where high thermal loads allow production of unneeded electric energy, but high connection charges and low LBMP-based buy-back energy prices discourage sales to the utility, which are only allowed at the high-tension level. For larger CHP, for instance one meeting a large thermal load, sellback may be attractive even at LBMP rates. For these cases it may be worth examining the associated demand and customer charges, which accrue for both purchases from the utility (SC-5, 8, 9, & 12) and sales to the utility (SC-11). (Duplicate customer charges are waived). However, these tariffs are the result of many cases and arguments before the New York State Public Service Commission (PSC) and will not be easy to modify, even if modification is justified. Owners and developers of larger, high-voltage systems should examine their demand tariffs to assess the value of requesting negotiated changes.

**Cost:**
Turner Construction Company did not perform cost estimation for this proposal. The following analysis was provided by the authors of this proposal:

These best practice suggestions do not involve costs, but may produce substantial life cycle savings.

**Implementation:**
All technologies are available off the shelf.

**Sources:**
Con Edison tariffs and regulations, discussions with developers and engineers.

# **19** Remove Barriers to Solar Energy

## I. Summary

**Issue:**
Onsite solar power can keep buildings habitable during blackouts, but technical, regulatory, and economic barriers inhibit its use.

**Recommendation:**
Con Edison, NYSERDA, and other government agencies should continue working together to streamline permitting processes, reduce barriers in project schedules, and increase the allowable roof area for solar power.

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## II. Proposed Legislation, Rule or Study

*Facilitate DOB Permitting:*

The issues addressed here do not require changes in building code, but can be rectified by improvements in the way permits for photovoltaic (PV) system installations are processed.

1. The Department of Buildings should prepare a manual that clearly identifies all requirements for PV installations. Examples of topics include: when an engineering study is required to prove the structural integrity of the roof, and when a simple statement of conditions will be acceptable instead of the study; when a licensed asbestos inspection is required as opposed to a visual inspection reported by the contractor; and what procedures are acceptable for sealing envelope penetrations. Con Edison's manual for Distributed Generation provides an example of the recommended coverage and depth. (www.coned.com/dg/process_guide/processGuide.asp).

2. The Department should train inspectors in the characteristics and requirements of PV systems, reducing the likelihood of unnecessary inspections or the requirement of unneeded construction measures due to uncertainty as to what is safe and reliable.

*Con Edison & NYSERDA Policies:*

1. Con Edison should work with NYSERDA to coordinate approvals, so that funding can be based on clear knowledge of project progress, and not be rigorously tied to meter installation, which can be delayed for internal reasons at Con Edison.

2. The future development of photovoltaic (PV) power in New York City will be limited by the ability of Con Edison's grid to accept distributed power. Con Edison should develop a long-term plan to strengthen and diversify the grid so that a substantial fraction of the system's energy can be supplied by distributed sources by 2025.

*Amendments to the New York City Fire Code:*

1. Amend Section 504.4.1, 504.4.2 and add a new section 504.4.5 to read as follows:

   **504.4.1 Rooftop access.** [Access] Except as otherwise provided in Section 504.4.5, access to building rooftops shall be provided as follows:

   1. For each 12 linear feet (3658 mm) of building perimeter accessible from the frontage space of the building and from any other exposure accessible to fire apparatus, a minimum clearance of 6 feet (1829 mm) in width and 6 feet (1829 mm) in depth from any obstruction shall be provided at the parapet wall or other perimeter of the rooftop. Where such building perimeter is 24 linear feet (7315 mm) or greater, but less than 36 linear feet (10 973 mm), the required clearance openings shall be separated by a distance of not less than 12 linear feet (3658 mm). Where such building perimeter is 36 linear feet (10 973 mm) or greater, the required clearance openings may be contiguous, provided, however, that such contiguous openings shall not exceed 12 linear feet (3658 mm) and shall be separated from other required clearance openings by a distance of not less than 12 linear feet (3658 mm). Each exposure accessible by fire apparatus may be treated separately for purposes of locating clearance openings and otherwise complying with the requirements of this provision.

   2. A minimum clearance of 6 feet (1829 mm) in all directions shall be provided from each door opening onto a rooftop from a dwelling unit, stairway, bulkhead, or other occupied space or means of egress, as measured from the door hinge.

   3. A minimum clearance of 3 feet (914 mm) in all directions shall be provided from any fire escape or rooftop access ladder, as measured from each side of the ladder or landing.

   **504.4.2 Rooftop obstructions.** [Unobstructed] Except as otherwise provided in Section 504.4.5, unobstructed space shall be provided on rooftops sufficient to allow firefighting operations, as follows:

   1. A clear path of not less than 6 feet (1829 mm) horizontal width and 9 feet (2743 mm) in height shall be provided from the front of the building to the rear of the building and from one side of the building to the other, except that a conduit or pipe in compliance with the requirements of this section may cross such path. Such clear path shall be accessible from each point of the rooftop access from which clearance is required pursuant to Section 504.4.1.

   2. To the maximum extent practicable, conduits, including cable trays, and piping, shall be installed on the rooftop side of the parapet wall. If such installation is not

practicable, conduits and piping shall be installed along the periphery of the rooftop, in order to minimize rooftop obstructions. Steps or ramps constructed of non-combustible material and equipped with railings shall be provided in the clear paths for any conduits or piping installations that exceed 1 foot (305 mm) in height above the rooftop. All conduits and piping installations shall be color-coded with continuous, durable and weatherproof reflective or luminescent markings as follows:

2.1. High voltage wiring – Red.

2.2. Low voltage wiring – Orange.

2.3. Natural gas piping – Yellow.

2.4. Other compressed gas piping – Yellow, labeled at regular intervals with the type of gas.

2.5. Fuel oil piping – Yellow with black stripes.

*   *   *

**504.4.5 Rooftop access on adjoining rooftops.** Two or more adjoining rooftops meeting the requirements of Section 504.4.5.1 may be consolidated for purposes of complying with the rooftop access requirements of Sections 504.4.1(1) and rooftop obstruction requirements of Section 504.4.2(1). Where adjoining rooftops are consolidated for these purposes, they may comply with the alternative requirements of Section 504.4.5.2.

**504.4.5.1 Eligible rooftops.** Rooftops may be consolidated for rooftop access purposes only in connection with the installation of solar panels and only where the rooftops:

1. are on buildings classified as Occupancy Group R-2 or R-3;

2. are at the same height and are physically adjoining, without any gap;

3. have no bulkheads; and

4. individually are not more than 25 feet in width.

**504.4.5.2 Alternative rooftop access and obstruction requirements.** All rooftops consolidated for purposes of this section may be provided with rooftop access in compliance with the following requirements:

1. The front portion of each adjoining roof shall be unobstructed for the full width of the adjoining roofs to a depth of 6 feet (1829 mm) and height of 9 feet (2743 mm), providing an unobstructed path along the front portion of the adjoining buildings. A similar unobstructed path shall be provided along the front portion of any other building exposure that is fire apparatus accessible (such as on a corner building fronting on two streets).

2. The rear portion of each adjoining roof shall be unobstructed for the full width of all of the adjoining roofs to a depth of 4 feet (1219 mm) and a height of 9 feet (2743 mm), providing an unobstructed path along the rear portion of the adjoining buildings.

3. Access to the rear of the adjoining buildings shall be provided by a clear path 6 feet (1829 mm) in width and 9 feet (2743 mm) in height, complying with the requirements of Section 504.4.1, on not less than every other building.

4. Rooftop obstructions shall not obstruct fire escapes or other means of rooftop access or egress; cover skylights, hatches or scuttles; or otherwise obstruct any building feature required by the Building Code to be operable or accessible.

**504.4.5.3 Application.** The application for the rooftop solar panel installation submitted to the Department of Buildings shall include a plan identifying the rooftops consolidated for purposes of this section. The application shall be signed or otherwise authorized by the owners of the respective buildings.

**504.4.5.4 Notification to department.** Notification of a solar panel installation on rooftops consolidated pursuant to this section shall be made to the department in an approved manner.

**504.4.5.5. Signage.** A durable sign shall be conspicuously posted on each rooftop upon which there is a solar panel installation indicating the location of the inverter shut off switch for the installation by reference to the building address and floor of the building.

**504.4.5.6 Discontinuance and restoration of adjoining rooftop access.** If, for any reason (including alteration of the rooftop or demolition of the building), the rooftop access required pursuant to Section 504.4.5.2 is no longer available on one or more adjoining rooftops consolidated for purposes of this section, any adjoining rooftop or rooftops lacking the required access from an adjoining building shall be restored or altered to comply with the rooftop access provisions of Section 504.4.1 and the rooftop obstruction provisions of Section 504.4.2.

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## III. Supporting Information

The details of the three separate components of this proposal are presented here.

*Item 1: Facilitate DOB Permitting*

**Expanded Issue and Benefits:**
Certain New York City Department of Buildings (DOB) practices and procedures have the effect of slowing the widespread installation of solar thermal and PV systems on the roofs of New York City buildings. These practices cause delays that are significantly greater than those found on

Long Island or in New Jersey, increasing costs and heightening the sense of risk when considering solar systems. Because these delays are largely independent of the size of the job, they are particularly damaging to the cost effectiveness of smaller projects. Improved procedures would result in more widespread implementation of PV systems throughout the five boroughs, improving air pollution, lowering greenhouse gas emissions, and increasing resilience. Interestingly, these delays do not appear to arise from the construction codes, but instead from the novelty of PV installations, the absence of well-defined procedures, and the consequent inexperience of building inspectors in this area. This inexperience has led, in the opinions of practitioners, to many instances of excessive caution, resulting in requirements for additional, largely unnecessary analyses or structural support.

To minimize these issues, the DOB should streamline procedures for PV system installations by creating a standard set of guidelines and training inspectors who are specialized to facilitate these projects.

**Cost:**
Turner Construction Company did not perform cost estimation for this proposal. The following analysis was provided by the authors of this proposal:

Although there would be some modest cost to the DOB, streamlining PV applications will trim the time spent by DOB in review and the overall benefits of increased adoption of PV systems will greatly outweigh these startup costs. Currently an expeditor costs $5,000 for a residential project, increasing overall cost by about 20%, and by a larger percentage for smaller projects. One practitioner estimates that he spends $3.50 per watt for parts and labor on a small residential system, and $2.50 per watt on permits and expediting. Another reported expense is spending $750 for an engineer’s statement that a roof capable of holding New York City snow loads can also hold a much lighter PV system.

**Implementation:**
These changes will be carried out within the DOB.

**Sources:**
Interviews with customers and practitioners.

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*Item 2: Con Edison & NYSERDA Policies:*

**Expanded Issue and Benefits:**
Currently, NYSERDA provides incentives that cover a significant portion of the cost of a PV system. NYSERDA’s payment schedule is tied to the installation of Con Edison meters, and delays in installation of these meters are reported to impede the advancement and funding of projects. Con Edison, NYSERDA, and interested PV installers should collaborate to clarify the details of this issue and develop a communication protocol to minimize delays or complications.

New York City faces a future in which a much greater portion of our power must come from carbon-free sources. Planning for greatly increased distributed PV production throughout the city should be a major component of Con Edison’s long-term planning.

**Cost:**
Turner Construction Company did not perform cost estimation for this proposal. The following analysis was provided by the authors of this proposal:

Implementing these proposals is likely to decrease the cost of PV installations, since time spent on scoping studies would be reduced, construction periods shortened, and a greatly increased scale of PV installation made possible.

**Implementation:**
There are no clear barriers to implementing this proposal.

**Sources:**
Interviews with practitioners and customers; review of Con Edison materials.

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*Item 3: Amendments to the NYC Fire Code*

**Expanded Issue and Benefits:**
One of the barriers to installing larger solar systems is the amount of rooftop space that must be allocated for unobstructed paths for firefighters. The Fire Code (Section 504.4.1) requires that the rooftop of every building have a 6 foot clear path running from the front to the back of the building, and another 6-foor clear path running from side to side. This requirement is the same for every building, so for smaller buildings the paths can preclude use of a substantial portion of the roof. (On a row house with a roof that is 20 feet wide and 40 feet deep, the required clear path would require 324 square feet, 40% of the rooftop area.) Other required clear areas, such as around rooftop ladders, add to the problem. Because solar energy systems include fixed costs that do not vary based on the size of the system, removing unnecessary barriers that constrain the size of rooftop solar systems will improve their cost-effectiveness.

There are situations in which the FDNY has allowed limited exceptions to their clear path requirements. Where a clear path running continuously from across the rooftops of multiple buildings, only one of those buildings must have a front to back clear path. This decreases the area that must be dedicated to fire lanes. Currently, the FDNY requires that these paths be established through an easement agreement between the building owners, which can be difficult to negotiate.

This proposal recommends an approach that would address the FDNY's needs while making it easier to obtain the consolidated roof exception. Under the proposal, owners of adjoining properties need only sign an application, rather than create an easement agreement. Consolidation would be available to adjoining residential buildings of the same height and without bulkheads. The front 6 feet and back 4 feet of the buildings must remain unobstructed, and only one rooftop must maintain a 6-foot wide clear path from front to back.

**Cost:**
Turner Construction Company did not perform cost estimation for this proposal. The following analysis was provided by the authors of this proposal:

This proposal will lower the cost of installing PV systems, dramatically in the case of smaller buildings.

**Implementation**

There are no significant barriers to implementing this approach, assuming the Fire Department makes the recommended rule changes.

**Sources:**

Current New York City Fire Code and informal discussion with Department representatives, who have provided information but have not supported or opposed this proposal.

# **20** Add Hookups for Temporary Generators & Boilers

## I. Summary

**Issue:**
Buildings with extended service disruptions can use electricity and heat from temporary emergency generators and boilers. It is much easier to connect this equipment if convenient hookup points are installed in advance.

**Recommendations:**
Require some existing health care facilities to install external electrical hookups. Recommend these installations as best practice for other buildings, and recommend external hookups for heating and cooling as well.

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## II. Proposed Legislation, Rule or Study

*Amendments to the New York City Building Code:*

1. Add a new section BC2702.4 as follows:

   **2702.4 Temporary Generators.** The provisions of this section for an external connection of secondary source of power shall be required for buildings that are:

   a. New construction or undergoing substantial alteration of the building electrical service;
   b. Served electrically by either a separate spot network for the building that allows the utility company to disconnect electric service to the building, or that have a single main disconnect switch; and
   c. In occupancy groups I-1 or I-2.

   **Exceptions:**
   1. Buildings with permanently installed generators in accordance with this chapter that additionally supply a secondary source of power sufficient to allow for the operation of space heating, vertical transportation, domestic water, and 50% of occupied spaces' lighting and power.
   2. Buildings with interior transformer vaults which are elevated within the building and have a distance in excess of 200 feet from the main distribution to the temporary generator.

**2702.4.1 Switchboard Modifications.** The main electrical distribution for a building shall allow for use of an externally located source of power, such as an portable generator, by means of a manual or automatic switch meeting the requirements of sections 2704.4.1.1 through 2704.4.1.8.

**2704.4.1.1** The switchboards shall be constructed to create a point of connection for temporary cables that connect to a temporary source of power, such as a generator.

**2704.4.1.2** First or second level distribution gear shall be considered permissible connection points for temporary cabling. Cabling extensions from the switchboard(s) are not required as part of the permanent installation.

**2704.4.1.3** Connection points can be established "ahead of the main" or as a secondary or tertiary level connection point, provided that the sum total of the connection points does not exceed the equivalent quantity of main ($1^{st}$ Level) devices.

**2704.4.1.4** Connection points that are "ahead of the main" require the utility company to disconnect the service prior to the manual connection of the temporary cabling and energization of roll-up generators. These "ahead of the main" connection points shall employ hinged, locking panel sections with warning labels that include the following information:

1. Contact information for the electrical utility serving the building;
2. Necessary safety procedures to implement a temporary connection; and
3. Maximum cabling and generator size.

**2704.4.1.5** Connection points shall either be established as additional over-current protective devices or as main or branch busway extensions, provided that the connection points permit the full service capacity to be made with temporary cabling.

**2704.4.1.6** A clear notice shall be posted near the connection points describing the specifications of the required generator to serve the building, including phases, voltage, capacity, and any other information required to correctly procure a temporary generator.

**2704.4.1.7** In new I-2 (non-hospital and non-acute care) facilities, the electrical system shall be designed with an electrical "quick-connect" to allow for an external generator to be easily connected and power all electrical services.

**2704.4.1.8** In existing and new hospital and/or acute care I-2 facilities, the electrical system shall be designed with an electrical "quick-connect" to allow for an external generator to be easily connected and power, as a minimum, emergency power services.

**2704.4.1.9** In existing and new I-1 and adult care facilities located within a Special or Moderate Flood Hazard Area, the electrical system shall be designed with an electrical "quick-connect" to allow for an external generator to be easily connected and power all electrical services.

**2704.4.2 Architectural Openings.** Architectural provisions, including but not limited to doors, hatches, framed openings, access panels, sleeves, and conduit, shall be established and sized to readily permit the installation of temporary cabling in accordance with the New York City Electrical Code.

**2704.4.3 Special Hazard Flood Areas.** External connection routes shall be either located above the design flood elevation, or wet floodproofed in accordance with ASCE 24.

2. Add a new subsection 7 to Section BC G304.1.1 of Appendix G as follows:

   7. Backup systems. New I-1 and adult care facilities shall have a backup generator above the Design Flood Elevation or shall be designed with an electrical quick-connect to allow for an external generator to be easily connected and power all electrical services.

3. Add a new subsection 3 to section G304.1.2:

   3. Backup systems. All new I-2 facilities shall be designed with an electrical quick-connect to allow for an external generator to be easily connected and power all electrical services, except that I-2 that are hospitals providing acute medical care shall be designed with an electrical quick-connect that can handle, as a minimum, emergency power services. All new I-2 that are hospitals providing acute medical care with heating or cooling equipment below the Design Flood Elevation shall be designed with a quick-connect that can allow temporary heating or cooling to be connected.

*Amendments to the New York City Construction Code:*

1. Add Article 315 as follows:

   315. RETROFIT OF BACKUP ELECTRIC SYSTEMS IN ACUTE CARE HOSPITALS AND ADULT CARE FACILITIES

   **315.1** The provisions of this article shall apply retroactively to I-2 buildings and structures that are hospitals or nursing homes and to I-1 buildings and structures that are adult care facilities. Compliance shall be required of the applicable facilities within 20 years of the effective release date of most recent FEMA FIRM maps.

   **315.1.1 Retroactive requirements for I-2 and are hospitals providing acute medical care.**

   All existing buildings and structures in designated areas of moderate and special flood hazard shall retrofit the following utilities and attendant equipment to comply with G304.1.2 Nonresidential 3. Backup systems.

   **315.1.2 Retroactive requirements for I-1 and adult care facilities.**

All existing buildings and structures in designated areas of special flood hazard shall retrofit the following utilities and attendant equipment to comply with G304.1.1 Residential (7) Backup systems.

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## III. Supporting Information

**Expanded Issue and Benefits:**

The intent is to require hookups in buildings that meet all of the following criteria:

1. New construction or substantial "total building gut" renovation
2. Occupancy I-1 and I-2
3. Electrical service with either a separate spot network for the building or a single main disconnect switch.

The Task Force recommends these installations as best practice for commercial office buildings in occupancy group B (especially if the building is in excess of 100,000 square feet of gross floor area) and hotels and residential buildings in group R-1 and R-2 (especially if the building has 40 or more units). The provisions of this recommendation may also be a good practice for smaller buildings or buildings that do not meet all the requirements shown above, and should be considered by building owners to allow for easy connection of portable generators during extended blackouts.

Individual homes are not required to provide generator connectivity but it is recommended as best practice to install quick connects of the twist-lock variety to avoid dangerous connections to small generators during blackouts.

It is recommended to limit the distance between the intended portable generator location and the electric service connection to no more than 200 feet. If the distance is greater, it is recommended to place a full rated connectivity interface, served by permanent fixed feeders, within 200 feet of the generator parking location.

This proposal places most of its text in the NYC Building Code but the Electrical Code may be another appropriate place for this new code language.

**Healthcare Facilities**

Hospitals need to quickly enable connectivity of a redundant source of power, should their backup generation be lost and utility power unavailable.

"Quick-connect" equipment allows hospitals, acute care facilities, and nursing homes to quickly establish an additional source of power by avoiding the time-consuming rewiring that is required of traditional connections. The speed of power deployment can play a major factor in avoiding forced evacuation of critical care facilities.

Adult care facilities aren't required to have any backup power today, but serve a medically frail community for whom even basic care depends on powered systems and whose safety is difficult to ensure in the absence of power.

**Electrical Choices**
There are two primary options available when providing external connections to a temporary generator:

1. **Bussing Only**
   The least expensive path is simply to add bus extensions for service switchboards, without the inclusion of an additional service switch. This allows for the installation of temporary cabling by authorized personnel, *but only after* disconnection of normal electrical service by the utility. This could present delays for buildings dependent on action by the utility company before the external generation can be energized.

   In these cases, both new and existing buildings should create temporary cabling access paths to readily allow for connection between an outdoor "roll-up" generator and the main switchboards.

2. **Connectivity "After the Main"**
   To temporarily eliminate dependence on the utility, switchboards with a single main disconnect can be provided with additional bussing, or with an additional secondary overcurrent protective device, to allow for connection of cabling to a temporary generator interface on the secondary side of the single main service switch. In this configuration, switchboards with a temporary generator connection on the secondary side of its single main overcurrent protective device "main" would not require the inclusion of the utility in the disconnect process. Buildings could utilize a manual or automatic transfer switch (or interlocking service switch) to allow for the connection of external generators; however, this would not be absolutely necessary, especially since the time to deliver and implement a temporary generator solution is not congruent with the speed of a transfer switch operation.

**Exceptions**
Under either path, buildings with sufficient backup generation would not need to add external connections. There is also an exception for buildings in which it is very difficult to connect external cabling (due to distance and location.) Exceptions in these instances require the approval of the Department of Buildings.

**Other MEP Systems**
Internal or utility systems failures during extreme weather events can easily impact a building's ability to run MEP systems. Often, the loss of one system can impact the ability to operate other systems.

To more easily allow for the temporary supply of heating and cooling in the event of an extended power (or other utility) outage, building owners should consider adding the following to their heating and/or cooling systems:

1. Appropriately sized steel piping from the physical plant to an external, accessible location for the supply and return of hot and/or chilled water, or low pressure steam and condensate return with valved and capped outlets; and,

2. Valving internal to the building to enable primary heating and cooling sources to be disconnected from the distribution system, and to allow the distribution system to be served by the temporary heating and cooling source; and,

3. External connections for a temporary heating and/or cooling source. In Special or Moderate Flood Hazard Areas, these connections are to be either located above the design flood elevation or floodproofed (not just waterproofed). These external connections can provide for safer and more efficient hook-ups to portable boilers or other units, without “snaking” piping or hoses through building apertures.

**Implementation:**

There are no known implementation issues for this proposal.

**Cost:**

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

**NEW CONSTRUCTION**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 20.1 | **Add Hookups for Temporary Generators & Boilers** | | | | | | | | | | | | | | | | |
| | ***Boiler (Hot Water)*** | | | | | | | | | | | | | | | | |
| | Acquisition of temporary equipment | | | | By Owner | | | | | | | | By Owner | | | | |
| | Fuel oil for temporary equipment | | | | By Owner | | | | | | | | By Owner | | | | |
| | Pipe main to system (permanent boiler in basement) | 350 | LF | $365.00 | $127,800 | | | | | 250 | LF | $200.00 | $50,000 | | | | |
| | Required valving for switchover to temp system | 1 | ALW | $50,000.00 | $50,000 | | | | | 1 | ALW | $50,000.00 | $50,000 | | | | |
| | Pipe main dedicated emergency riser | | | | Not Required | | | | | | | | Not Required | | | | |
| | External hot water temporary connections | 1 | ALW | $25,000.00 | $25,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | Connection to existing hot water loop | 1 | ALW | $25,000.00 | $25,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | Core drilling (supply and return piping) | | | | Not Required | | | | | | | | Not Required | | | | |
| | Added testing of temporary piping | 1 | ALW | $7,200.00 | $7,200 | | | | | 1 | ALW | $4,800.00 | $4,800 | | | | |
| | Cold water makeup pipe from first floor or below | 200 | LF | $200.00 | $40,000 | | | | | 200 | LF | $150.00 | $30,000 | | | | |
| | External temporary cold water connection | 1 | ALW | $10,000.00 | $10,000 | | | | | 1 | ALW | $10,000.00 | $10,000 | | | | |
| | Architectural feature on connections | 1 | ALW | $5,000.00 | $5,000 | | | | | 1 | ALW | $5,000.00 | $5,000 | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$290,000** | | | | | | | | **$199,800** | | | | |
| | Contingency | | 10% | | $29,000 | | | | | | 10% | | $19,980 | | | | |
| | **SUBTOTAL** | | | | **$319,000** | | | | | | | | **$219,780** | | | | |
| | GC Mark-ups | | 20% | | $63,800 | | | | | | 20% | | $43,956 | | | | |
| | **TOTAL** | 620,000 | GSF | $0.62 | **$382,800** | | | | **N/A** | 231,000 | GSF | $1.14 | **$263,736** | | | | **N/A** |

**EXISTING BUILDINGS**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 20.1 | **Add Hookups for Temporary Generators & Boilers** | | | | | | | | | | | | | | | | |
| | *Boiler (Hot Water)* | | | | | | | | | | | | | | | | |
| | Acquisition of temporary equipment | | | | By Owner | | | | | | | | By Owner | | | | |
| | Fuel oil for temporary equipment | | | | By Owner | | | | | | | | By Owner | | | | |
| | Pipe main to system (permanent boiler in basement) | 350 | LF | $365.00 | $127,800 | | | | | 250 | LF | $200.00 | $50,000 | | | | |
| | Required valving for switchover to temp system | 1 | ALW | $50,000.00 | $50,000 | | | | | 1 | ALW | $50,000.00 | $50,000 | | | | |
| | Pipe main dedicated emergency riser | | | | Not Required | | | | | | | | Not Required | | | | |
| | External hot water temporary connections | 1 | ALW | $25,000.00 | $25,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | Connection to existing hot water loop | 1 | ALW | $50,000.00 | $50,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | Core drilling | 4 | EA | $10,000.00 | $40,000 | | | | | 4 | EA | $1,000.00 | $4,000 | | | | |
| | Added testing of temporary piping | 1 | ALW | $7,200.00 | $7,200 | | | | | 1 | ALW | $4,800.00 | $4,800 | | | | |
| | Cold water makeup pipe from first floor or below | 200 | LF | $200.00 | $40,000 | | | | | 200 | LF | $150.00 | $30,000 | | | | |
| | *External temporary cold water connection* | 1 | ALW | $10,000.00 | $10,000 | | | | | 1 | ALW | $10,000.00 | $10,000 | | | | |
| | Architectural feature on connections | 1 | ALW | $10,000.00 | $10,000 | | | | | 1 | ALW | $10,000.00 | $10,000 | | | | |
| | Retrofit of existing conditions | 1 | ALW | $25,000.00 | $25,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$385,000** | | | | | | | | **$233,800** | | | | |
| | Contingency | | 10% | | $38,500 | | | | | | 10% | | $23,380 | | | | |
| | **SUBTOTAL** | | | | **$423,500** | | | | | | | | **$257,180** | | | | |
| | GC Mark-ups | | 20% | | $84,700 | | | | | | 20% | | $51,436 | | | | |
| | **TOTAL** | **620,000** | **GSF** | **$0.82** | **$508,200** | | | | **N/A** | **231,000** | **GSF** | **$1.34** | **$308,616** | | | | **N/A** |

## NEW CONSTRUCTION

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 20.2 | **Add Hookups for Temporary Generators & Boilers** | | | | | | | | | | | | | | | | |
| | ***Boiler (Steam)*** | | | | | | | | | | | | | | | | |
| | Acquisition of temporary equipment | | | | By Owner | | | | | | | | By Owner | | | | |
| | Fuel oil for temporary equipment | | | | By Owner | | | | | | | | By Owner | | | | |
| | Pipe main to system (permanent boiler in basement) | 350 | LF | $475.00 | $166,300 | | | | | 250 | LF | $275.00 | $68,800 | | | | |
| | Required valving for switchover to temp system | 1 | ALW | $50,000.00 | $50,000 | | | | | 1 | ALW | $50,000.00 | $50,000 | | | | |
| | Pipe main dedicated emergency riser | | | | Not Required | | | | | | | | Not Required | | | | |
| | External steam temporary connections | 1 | ALW | $35,000.00 | $35,000 | | | | | 1 | ALW | $35,000.00 | $35,000 | | | | |
| | Connection to existing steam and condenser water loop | 1 | ALW | $25,000.00 | $25,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | Core drilling (supply and return piping) | | | | Not Required | | | | | | | | Not Required | | | | |
| | Added testing of temporary piping | 1 | ALW | $7,200.00 | $7,200 | | | | | 1 | ALW | $4,800.00 | $4,800 | | | | |
| | Cold water makeup pipe from first floor or below | 200 | LF | $200.00 | $40,000 | | | | | 200 | LF | $150.00 | $30,000 | | | | |
| | External temporary cold water connection | 1 | ALW | $10,000.00 | $10,000 | | | | | 1 | ALW | $10,000.00 | $10,000 | | | | |
| | Architectural feature on connections | 1 | ALW | $8,000.00 | $8,000 | | | | | 1 | ALW | $8,000.00 | $8,000 | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$341,500** | | | | | | | | **$231,600** | | | | |
| | Contingency | | 10% | | $34,150 | | | | | | 10% | | $23,160 | | | | |
| | **SUBTOTAL** | | | | **$375,650** | | | | | | | | **$254,760** | | | | |
| | GC Mark-ups | | 20% | | $75,130 | | | | | | 20% | | $50,952 | | | | |
| | **TOTAL** | 620,000 | GSF | $0.73 | **$450,780** | | | | **N/A** | 231,000 | GSF | $1.32 | **$305,712** | | | | **N/A** |

## EXISTING BUILDINGS

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 20.2 | **Add Hookups for Temporary Generators & Boilers** | | | | | | | | | | | | | | | | |
| | **Boiler (Steam)** | | | | | | | | | | | | | | | | |
| | Acquisition of temporary equipment | | | | By Owner | | | | | | | | By Owner | | | | |
| | Fuel oil for temporary equipment | | | | By Owner | | | | | | | | By Owner | | | | |
| | Pipe main to system (permanent boiler in basement) | 350 | LF | $475.00 | $166,300 | | | | | 250 | LF | $275.00 | $68,800 | | | | |
| | Required valving for switchover to temporary system | 1 | ALW | $50,000.00 | $50,000 | | | | | 1 | ALW | $50,000.00 | $50,000 | | | | |
| | Pipe main dedicated emergency riser | | | | Not Required | | | | | | | | Not Required | | | | |
| | External steam temporary connections | 1 | ALW | $35,000.00 | $35,000 | | | | | 1 | ALW | $35,000.00 | $35,000 | | | | |
| | Connection to existing steam and condenser water loop | 1 | ALW | $25,000.00 | $25,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | Core drilling | 6 | EA | $1,000.00 | $6,000 | | | | | 6 | EA | $1,000.00 | $6,000 | | | | |
| | Added testing of temporary piping | 1 | ALW | $7,200.00 | $7,200 | | | | | 1 | ALW | $4,800.00 | $4,800 | | | | |
| | Cold water makeup pipe from first floor or below | 200 | LF | $200.00 | $40,000 | | | | | 200 | LF | $150.00 | $30,000 | | | | |
| | External temporary cold water connection | 1 | ALW | $10,000.00 | $10,000 | | | | | 1 | ALW | $10,000.00 | $10,000 | | | | |
| | *Architectural feature on connections* | 1 | ALW | $8,000.00 | $8,000 | | | | | 1 | ALW | $8,000.00 | $8,000 | | | | |
| | Retrofit allowance | 1 | ALW | $25,000.00 | $25,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$372,500** | | | | | | | | **$262,600** | | | | |
| | Contingency | | 10% | | $37,250 | | | | | | 10% | | $26,260 | | | | |
| | **SUBTOTAL** | | | | **$409,750** | | | | | | | | **$288,860** | | | | |
| | GC Mark-ups | | 20% | | $81,950 | | | | | | 20% | | $57,772 | | | | |
| | **TOTAL** | **620,000** | **GSF** | **$0.79** | **$491,700** | | | | **N/A** | **231,000** | **GSF** | **$1.50** | **$346,632** | | | | **N/A** |

**NEW CONSTRUCTION**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 20.3 | **Add Hookups for Temporary Generators & Boilers** | | | | | | | | | | | | | | | | |
| | ***Chiller*** | | | | | | | | | | | | | | | | |
| | Acquisition of temporary equipment | | | | By Owner | | | | | | | | By Owner | | | | |
| | Fuel oil for temporary equipment | | | | By Owner | | | | | | | | By Owner | | | | |
| | Pipe main to system (permanent chiller in basement) | 350 | LF | $475.00 | $166,300 | | | | | 250 | LF | $275.00 | $68,800 | | | | |
| | Required valving for switchover to temp system | 1 | ALW | $50,000.00 | $50,000 | | | | | 1 | ALW | $50,000.00 | $50,000 | | | | |
| | Pipe main dedicated emergency riser | | | | Not Required | | | | | | | | Not Required | | | | |
| | External temporary chiller connections | 1 | ALW | $25,000.00 | $25,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | Connection to existing chilled water loop | 1 | ALW | $25,000.00 | $25,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | Core drilling (supply and return piping) | | | | Not Required | | | | | | | | Not Required | | | | |
| | Added testing of temporary piping | 1 | ALW | $7,200.00 | $7,200 | | | | | 1 | ALW | $4,800.00 | $4,800 | | | | |
| | Cold water makeup pipe from first floor or below | 200 | LF | $200.00 | $40,000 | | | | | 200 | LF | $150.00 | $30,000 | | | | |
| | External temporary cold water connection | 1 | ALW | $10,000.00 | $10,000 | | | | | 1 | ALW | $10,000.00 | $10,000 | | | | |
| | Condenser water riser (not required for air cooled chiller) | | | | Not Required | | | | | | | | Not Required | | | | |
| | Architectural feature on connections | | | | Not Included | | | | | | | | Not Included | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$323,500** | | | | | | | | **$213,600** | | | | |
| | Contingency | | 10% | | $32,350 | | | | | | 10% | | $21,360 | | | | |
| | **SUBTOTAL** | | | | **$355,850** | | | | | | | | **$234,960** | | | | |
| | GC Mark-ups | | 20% | | $71,170 | | | | | | 20% | | $46,992 | | | | |
| | **TOTAL** | **620,000** | **GSF** | **$0.69** | **$427,020** | | | | **N/A** | **231,000** | **GSF** | **$1.22** | **$281,952** | | | | **N/A** |

**EXISTING BUILDINGS**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 20.3 | **Add Hookups for Temporary Generators & Boilers** | | | | | | | | | | | | | | | | |
| | **Chiller** | | | | | | | | | | | | | | | | |
| | Acquisition of temporary equipment | | | | By Owner | | | | | | | | By Owner | | | | |
| | Fuel oil for temporary equipment | | | | By Owner | | | | | | | | By Owner | | | | |
| | Pipe main to system (permanent chiller in basement) | 350 | LF | $475.00 | $166,300 | | | | | 250 | LF | $275.00 | $68,800 | | | | |
| | Required valving for switchover to temp system | 1 | ALW | $50,000.00 | $50,000 | | | | | 1 | ALW | $50,000.00 | $50,000 | | | | |
| | Pipe main dedicated emergency riser | | | | Not Required | | | | | | | | Not Required | | | | |
| | External temporary chiller connections | 1 | ALW | $25,000.00 | $25,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | Connection to existing chilled water loop | 1 | ALW | $25,000.00 | $25,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | Core drilling | 4 | EA | $1,000.00 | $4,000 | | | | | 4 | EA | $1,000.00 | $4,000 | | | | |
| | Added testing of temp piping | 1 | ALW | $7,200.00 | $7,200 | | | | | 1 | ALW | $4,800.00 | $4,800 | | | | |
| | Cold water makeup pipe from first floor or below | 200 | LF | $200.00 | $40,000 | | | | | 200 | LF | $150.00 | $30,000 | | | | |
| | External temporary cold water connection | 1 | ALW | $10,000.00 | $10,000 | | | | | 1 | ALW | $10,000.00 | $10,000 | | | | |
| | Condenser water riser (not required for air cooled chiller) | | | | Not Required | | | | | | | | Not Required | | | | |
| | Architectural feature on connections | 1 | ALW | $5,000.00 | $5,000 | | | | | 1 | ALW | $5,000.00 | $5,000 | | | | |
| | Retrofit allowance | 1 | ALW | $25,000.00 | $25,000 | | | | | 1 | ALW | $25,000.00 | $25,000 | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$357,500** | | | | | | | | **$247,600** | | | | |
| | Contingency | | 10% | | $35,750 | | | | | | 10% | | $24,760 | | | | |
| | **SUBTOTAL** | | | | **$393,250** | | | | | | | | **$272,360** | | | | |
| | GC Mark-ups | | 20% | | $78,650 | | | | | | 20% | | $54,472 | | | | |
| | **TOTAL** | **620,000** | **GSF** | **$0.76** | **$471,900** | | | | **N/A** | **231,000** | **GSF** | **$1.41** | **$326,832** | | | | **N/A** |

**NEW CONSTRUCTION**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 20.4 | **Add Hookups for Temporary Generators & Boilers** | | | | | | | | | | | | | | | | |
| | *Generator (Switchgear Room Adjacent to Access Panel; Extend Bus Only)* | | | | | | | | | | | | | | | | |
| | Option 1A: Extend bus only (within switchgear room) | 6 | EA | $4,000.00 | $24,000 | | | | | 1 | EA | $4,000.00 | $4,000 | | | | |
| | Option 1A: Access panel and signage at exterior (assume 24"x24" stainless steel) | 1 | EA | $2,000.00 | $2,000 | | | | | 1 | EA | $2,000.00 | $2,000 | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$26,000** | | | | | | | | **$6,000** | | | | |
| | Contingency | | 0.1 | | $2,600 | | | | | | 0.1 | | $600 | | | | |
| | **SUBTOTAL** | | | | **$28,600** | | | | | | | | **$6,600** | | | | |
| | GC Mark-ups | | 0.2 | | $5,720 | | | | | | 0.2 | | $1,320 | | | | |
| | **TOTAL** | **620,000** | **GSF** | **$0.06** | **$34,320** | | | | **N/A** | **231,000** | **GSF** | **$0.03** | **$7,920** | | | | **N/A** |
| 20.5 | **Add Hookups for Temporary Generators & Boilers** | | | | | | | | | | | | | | | | |
| | *Generator (Switchgear Room Adjacent to Access Panel; Tapbox with Kirkkey Interlock)* | | | | | | | | | | | | | | | | |
| | Option 1B: Tapbox with kirkkey interlock | 6 | EA | $27,500.00 | $165,000 | | | | | 1 | EA | $27,500.00 | $27,500 | | | | |
| | Option 1B: Conduit + wire (power + controls) from tap box to gear | 50 | LF | $13,500.00 | $675,000 | | | | | 50 | LF | $2,250.00 | $112,500 | | | | |
| | Option 1B: Access panel to exterior wall (not required, included in tap box) | | | | Not Required | | | | | | | | Not Required | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$840,000** | | | | | | | | **$140,000** | | | | |
| | Contingency | | 10% | | $84,000 | | | | | | 10% | | $14,000 | | | | |
| | **SUBTOTAL** | | | | **$924,000** | | | | | | | | **$154,000** | | | | |
| | GC Mark-ups | | 20% | | $184,800 | | | | | | 20% | | $30,800 | | | | |
| | **TOTAL** | **620,000** | **GSF** | **$1.79** | **$1,108,800** | | | | **N/A** | **231,000** | **GSF** | **$0.80** | **$184,800** | | | | **N/A** |

**EXISTING BUILDINGS**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 20.4 | **Add Hookups for Temporary Generators & Boilers** | | | | | | | | | | | | | | | | |
| | **Generator (Switchgear Room Adjacent to Access Panel; Extend Bus Only)** | | | | | | | | | | | | | | | | |
| | Option 1A: Extend bus only (within switchgear room) | 6 | EA | $4,000.00 | $24,000 | | | | | 1 | EA | $4,000.00 | $4,000 | | | | |
| | Option 1A: Access panel and signage at exterior (assume 24"x24" stainless steel) | 1 | EA | $2,000.00 | $2,000 | | | | | 1 | EA | $2,000.00 | $2,000 | | | | |
| | SUBTOTAL DIRECT WORK | | | | $26,000 | | | | | | | | $6,000 | | | | |
| | Contingency | | 10% | | $2,600 | | | | | | 10% | | $600 | | | | |
| | **SUBTOTAL** | | | | **$28,600** | | | | | | | | **$6,600** | | | | |
| | GC Mark-ups | | 20% | | $5,720 | | | | | | 20% | | $1,320 | | | | |
| | **TOTAL** | **620,000** | **GSF** | **$0.06** | **$34,320** | | | | **N/A** | **231,000** | **GSF** | **$0.03** | **$7,920** | | | | **N/A** |

**EXISTING BUILDINGS**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **20.5** | **Add Hookups for Temporary Generators & Boilers** | | | | | | | | | | | | | | | | |
| | **Generator (Switchgear Room Adjacent to Access Panel; Tapbox with Kirkkey Interlock)** | | | | | | | | | | | | | | | | |
| | Option 1B: Tapbox with kirkkey interlock | 6 | EA | $27,500.00 | $165,000 | | | | | 1 | EA | $27,500.00 | $27,500 | | | | |
| | Option 1B: Conduit + wire (power + controls) from tap box to gear | 50 | LF | $13,500.00 | $675,000 | | | | | 50 | LF | $2,250.00 | $112,500 | | | | |
| | Option 1B: Access panel to exterior wall (not required, included in tap box) | | | | Not Required | | | | | | | | Not Required | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$840,000** | | | | | | | | **$140,000** | | | | |
| | Contingency | | 10% | | $84,000 | | | | | | 10% | | $14,000 | | | | |
| | **SUBTOTAL** | | | | **$924,000** | | | | | | | | **$154,000** | | | | |
| | GC Mark-ups | | 20% | | $184,800 | | | | | | 20% | | $30,800 | | | | |
| | **TOTAL** | **620,000** | **GSF** | **$1.79** | **#######** | | | | **N/A** | **231,000** | **GSF** | **$0.80** | **$184,800** | | | | **N/A** |
| **20.6** | **Add Hookups for Temporary Generators & Boilers** | | | | | | | | | | | | | | | | |
| | **Generator (Switchgear Room ~200 LF from Access Panel; Extend Bus Only)** | | | | | | | | | | | | | | | | |
| | Option 2A: Extend bus only (within switchgear room) | 6 | EA | $4,000.00 | $24,000 | | | | | 1 | EA | $4,000.00 | $4,000 | | | | |
| | Option 2A: Conduit + wiring (from switchgear to access panel) | 200 | LF | $13,500.00 | $2,700,000 | | | | | 200 | LF | $2,250.00 | $450,000 | | | | |
| | Option 2A: Access panel to exterior wall (assume 24"x24" stainless steel) | 1 | EA | $2,000.00 | $2,000 | | | | | 1 | EA | $2,000.00 | $2,000 | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$2,726,000** | | | | | | | | **$456,000** | | | | |
| | Contingency | | 10% | | $272,600 | | | | | | 10% | | $45,600 | | | | |
| | **SUBTOTAL** | | | | **$2,998,600** | | | | | | | | **$501,600** | | | | |
| | GC Mark-ups | | 20% | | $599,720 | | | | | | 20% | | $100,320 | | | | |
| | **TOTAL** | **620,000** | **GSF** | **$5.80** | **$3,598,320** | | | | **N/A** | **231,000** | **GSF** | **$2.61** | **$601,920** | | | | **N/A** |
| 20.7 | **Add Hookups for Temporary Generators & Boilers** | | | | | | | | | | | | | | | | |
| | **Generator (Switchgear Room ~200 LF from Access Panel; Tapbox with Kirkkey Interlock)** | | | | | | | | | | | | | | | | |
| | Option 2B: Tapbox with kirkkey interlock | 6 | EA | $27,500.00 | $165,000 | | | | | 1 | EA | $27,500.00 | $27,500 | | | | |
| | Option 2B: Conduit + wire (power + controls) from tap box to gear | 200 | LF | $13,500.00 | $2,700,000 | | | | | 200 | LF | $2,250.00 | $450,000 | | | | |
| | Option 2B: Access panel to exterior wall (not required, included in tap box) | | | | Not Required | | | | | | | | Not Required | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | **$2,865,000** | | | | | | | | **$477,500** | | | | |
| | Contingency | | 10% | | $286,500 | | | | | | 10% | | $47,750 | | | | |
| | **SUBTOTAL** | | | | **$3,151,500** | | | | | | | | **$525,250** | | | | |
| | GC Mark-ups | | 20% | | $630,300 | | | | | | 20% | | $105,050 | | | | |
| | **TOTAL** | 620,000 | GSF | $6.10 | **$3,781,800** | | | | **N/A** | 231,000 | GSF | $2.73 | **$630,300** | | | | **N/A** |

# **21** Keep Residential Stairwells & Hallways Lit During Blackouts

## I. Summary

**Issue:**
All buildings are required to have 90 minutes of emergency lighting so they can be safely evacuated. However, during a prolonged blackout, residents in multifamily buildings need lighting in hallways and stairwells throughout the duration of the event.

**Recommendation:**
Require most new multifamily buildings to provide lighting in hallways and stairwells during extended blackouts; require the same of existing multifamily buildings within two years.

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## II. Proposed Legislation, Rule or Study

*Amendments to the New York City Building Code*:

1. Add a new Section 1006.4 as follows:

   **1006.4 Standby lighting system.** Exit access corridors, exit passageways, exit stairways, and interior exit discharge elements serving occupancies in Groups I-1, R-1, and R-2 shall be provided with a standby lighting system that meets the minimum performance criteria of Section 1006.4.2, utilizing a power source that complies with Section 1006.4.1.

   **Exceptions:**

   1. Buildings in Group R-2 occupancy that are four stories or less and do not contain more than three dwelling units per story.

   2. Where the emergency power source for the illumination required in Section 1006.3 is an on-site generator utilizing natural gas from the public utility street main as a fuel supply, as permitted by Section 2702.

   3. Any level of a stairwell that is provided with not less than 12 square feet of exterior glazed opening facing onto a public way, or onto a yard or court.

   4. Public corridors that are provided with exterior glazed openings facing onto a public way, or onto a yard or court. The net glazed area shall be not less than 6 percent of the floor area of the corridor.

**1006.4.1 Standby power source.** The standby lighting system shall receive power from storage batteries, photovoltaic solar cells, on-site generator, or some combination thereof starting automatically within one minute after failure of the premise's normal electrical supply, and lasting for not less than 120 hours, or until the premise's normal electrical supply is restored, whichever occurs first.

**1006.4.2 Performance of standby system.** Not less than 60 lumens of light output shall be provided at each stairway entrance and discharge. Not less than 60 lumens of light output shall be provided in every 30 feet of public corridor. Systems utilizing storage batteries shall provide the minimum required light output for the entire 120 hour duration.

*Within Two Years, Adopt New Requirements for Existing Buildings:*

Study options for adding extended backup lighting to existing buildings, and within two years, adopt legislation mandating this lighting. The study should consider: (1) various scenarios for lighting level and length of time backup lighting is provided; (2) commercially available lighting and batteries; and (3) installation and maintenance costs under various construction scenarios.

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## III. Supporting Information

**Expanded Issue and Benefits:**

After Hurricane Sandy, tens of thousands of New Yorkers were left stranded in high-rise apartment buildings with no electrical power for extended periods. After a few hours, when the batteries of their emergency lighting systems failed, many of these buildings had absolutely no light in their common corridors and stairwells, even in the middle of the day. This made it difficult and dangerous for people to leave their homes to obtain essentials like food and water. If an evacuation had been required, due to fire or other hazards, it would have been carried out in complete darkness.

Experience has shown that it is much easier to evacuate and close commercial buildings than residential buildings during a widespread blackout because people are unwilling or unable to leave their homes. This is especially true of a community like NYC with a low vacancy rate, a relative lack of mobility for many residents, and limited open space. Despite the city's best efforts, in a widespread and prolonged power failure, many thousands of people will continue to occupy their residential buildings.

Until recently, it would have been prohibitively expensive to provide standby lighting for 120 hours without utility power. However, the development of high-efficiency, low-wattage white light LED's (light emitting diodes) makes it possible to produce the required 60 lumens of light from a fixture that consumes only 0.75 watts of electricity. LEDs can also run directly from the 12V DC power that is produced by batteries and photovoltaics without any power conversion.

Additionally, the electrical code allows 12V power to be distributed by UL Class 2 wiring, which is much less expensive to install in existing buildings than conventional wiring.

Photovoltaic panels provide several additional benefits, including:

- Return free electricity to the building under normal operating conditions;
- Extend the operation of the lighting system indefinitely if a power outage lasts longer than 120 hours; and
- Allow the standby lights to operate during the day if batteries fail.

It is also recommended that standby lighting systems be required to comply with the same requirements for testing and maintenance as emergency egress lighting systems to ensure that they perform properly when needed.

The light level requirements in this proposal are framed in terms of output from a fixture (in lumens), rather than a light level for a given space (in footcandles), which is normally the case for egress requirements. This focus on fixture output rather than space illumination will reduce the burden of meeting the requirements. Lumen levels are printed on the packaging of light bulbs and are commonly used to describe the light output of flashlights and LED light fixtures. A lumen-based requirement is essentially a product requirement - a 60 lumen product will always comply regardless of how it is mounted or what type of space it is mounted in. An illuminance-based standard would require different products for different applications, a much higher standard of care than necessary when the goals are simple habitability and basic safety for temporary periods.

The recommended time period and illumination levels for standby lighting in this proposal require further consideration and discussion. It is important to add extended backup lighting to existing buildings, but further study is required before selecting the appropriate performance parameters and compliance options, as well as determining installation and materials costs.

**Implementation:**

The emergency lighting industry in New York City has been working with LED's and battery packs for over 20 years, and all of the technology needed to meet the proposed requirements already exists. Due to unique requirements in the New York City Building Code for emergency lighting, these products are still designed and manufactured in New York, making local manufacturers quick to develop products and systems designed to meet these new requirements, just as they did after passage of Local Law 41 of 1978, Local Law 16 of 1984, Local Law 59 of 1996, and Local Law 26 of 2004.

The major impediments to implementation within existing buildings by January 1, 2016 are building owner awareness of the new requirements and the limited capacity for enforcement by the Department of Buildings.

**Cost:**

Depending on the type of building, the following four strategies are options that could be pursued to meet the new standby lighting system requirements.

1. In new construction, connect emergency egress lighting already required by the Building Code to gas-fired generators. The incremental cost of adding generator capacity will be offset by the reduction in emergency battery packs required within light fixtures, resulting in no net cost increase.

2. In existing buildings where light fixtures exist in all locations where standby lighting is required, (i) install a new standby lighting unit next to the existing light fixture to run off the utility power that supplies the existing fixture and (ii) charge the batteries in the standby lighting unit by utility power until the power fails. An emergency lighting manufacturer has quoted the materials cost, including distributor markup, at $95 per standby lighting unit with integral 120-hour battery.

   In existing buildings where standby lights must be installed at new locations, install low voltage lights connected to a central battery. An emergency lighting manufacturer has quoted the materials cost, including distributor markup, as $45 per standby low voltage lighting unit (remote battery) and $2,000 per central battery to operate 60 fixtures for 120 hours.

3. Reduce the size of a building's battery by adding a photovoltaic panel on the roof to recharge the battery during the daytime. There would be only a slight cost to add a photovoltaic panel because the added cost of the photovoltaic would almost be offset by the reduction in battery cost.

Turner Construction Company prepared cost estimates for each of the above options based upon several standardized building typologies. Cost examples were developed for both a residential building with two apartment units per floor (Figure 1), and one for a residential building with 11 apartment units per floor (Figure 2). For each floor layout, estimation was prepared for a high-rise residential building 20 stories tall and a low-rise residential building 5 stories tall.

Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

Labor rates provided by Turner Construction Company are based upon union labor. While labor rates for non-union crews may be lower, other cost factors such as premiums for small projects and buying power with vendors influence the total cost of a project. For this proposal, using RSMeans 2012 data to estimate a 20% reduction in per-hour rates for non-union labor, total costs might be reduced by 5% to 15%.

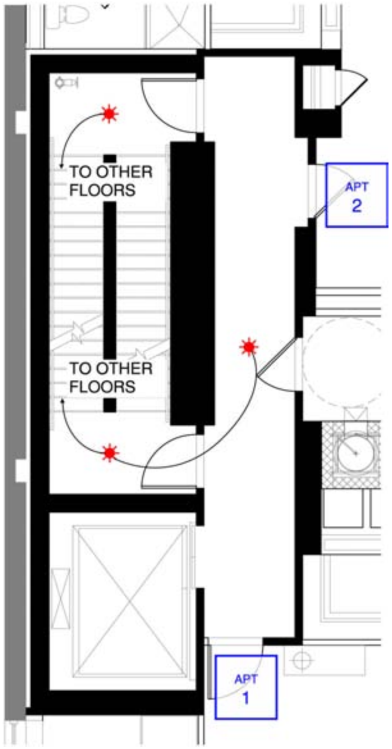


**Figure 1** 2 Units Per Floor

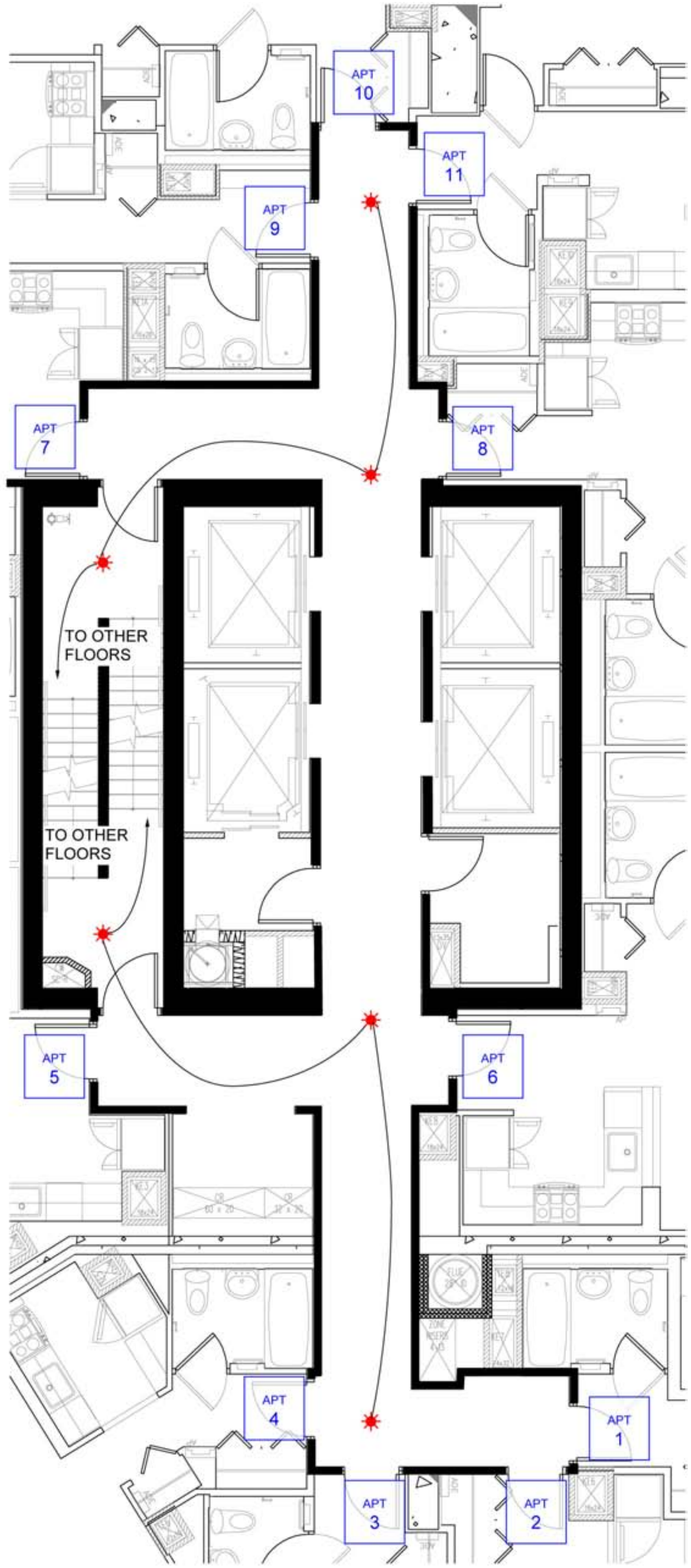


**Figure 2** 11 Units Per Floor

## NEW CONSTRUCTION

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| | | | | | | | | | | | | | | | | | |
| 21.1 | **Keep Residential Stairwells & Hallways Lit During Blackouts** | | | | | | | | | | | | | | | | |
| | **Building with 2 Units Per Floor (Connect Emergency Egress Lighting to Gas-Fired Generators)** | | | | | | | | | | | | | | | | |
| | Assumes egress lighting connected is connected to a gas generator in place per Building Code - NO COST IMPACT | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | | | | | |
| | Contingency | | | | | | | | | | | | | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | | | | | |
| | GC Mark-ups | | | | | | | | | | | | | | | | |
| | **TOTAL** | | | | N/A | | | | N/A | | | | N/A | | | | N/A |

## EXISTING BUILDINGS

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| | | | | | | | | | | | | | | | | | |
| 21.1 | **Keep Residential Stairwells & Hallways Lit During Blackouts** | | | | | | | | | | | | | | | | |
| | **Building with 2 Units Per Floor (Connect Emergency Egress Lighting to Gas-Fired Generators)** | | | | | | | | | | | | | | | | |
| | Assumes egress lighting connected is connected to a gas generator in place per Building Code - NO COST IMPACT | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | | | | | |
| | Contingency | | | | | | | | | | | | | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | | | | | |
| | GC Mark-ups | | | | | | | | | | | | | | | | |
| | **TOTAL** | | | | **N/A** | | | | **N/A** | | | | **$0** | | | | **$0** |

## NEW CONSTRUCTION

| | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **21.2 Keep Residential Stairwells & Hallways Lit During Blackouts** | | | | | | | | | | | | | | | | |
| **Building with 2 Units Per Floor (Integral Battery)** | | | | | | | | | | | | | | | | |
| Furnish 3 fixtures per floor *Pricing as noted in proposal | | | | | | | | | 60 | EA | $95.00 | $5,700 | 15 | EA | $95.00 | $1,500 |
| Install 3 fixtures per floor (assume 2 work-hours per fixture) | | | | | | | | | 120 | HRS | $130.00 | $15,600 | 30 | HRS | $130.00 | $3,900 |
| **Furnish wiring (in 3/4" electrical conduit) from panelboard to light fixtures** | | | | | | | | | **3,000** | **LF** | **$6.00** | **$18,000** | **750** | **LF** | **$6.00** | **$4,500** |
| Install wiring (in 3/4" electrical conduit) from panelboard to light fixtures | | | | | | | | | 3,000 | LF | $14.00 | $42,000 | 750 | LF | $14.00 | $10,500 |
| **Furnish 20 amp circuit breaker in a panelboard. Assume 1 circuit breaker per floor for lighting circuits. Panelboard not included in this cost** | | | | | | | | | **20** | **EA** | **$50.00** | **$1,000** | **15** | **EA** | **$50.00** | **$800** |
| Install 20 amp circuit breaker in a panelboard. Assume 1 circuit breaker per floor for lighting circuits. Assume 2 work-hours per circuit | | | | | | | | | 40 | HRS | $130.00 | $5,200 | 15 | HRS | $130.00 | $2,000 |
| **Furnish 120 hour central batteries for building **Not required** | | | | | | | | | - | EA | $2,000.00 | N/R | - | EA | $2,000.00 | N/R |
| Install 120 hour central batteries for building **Not required | | | | | | | | | **-** | **HRS** | **$130.00** | **N/R** | **-** | **HRS** | **$130.00** | **N/R** |
| **Furnish low-voltage, Class 2 wiring (in 3/4" electrical conduit) from battery pack to panelboard. **Not required** | | | | | | | | | - | LF | $6.00 | N/R | - | LF | $6.00 | N/R |
| Install low-voltage Class 2 wiring (in 3/4" electrical conduit) from battery pack to panelboard. **Not required | | | | | | | | | **-** | **LF** | **$14.00** | **N/R** | **-** | **LF** | **$14.00** | **N/R** |
| | | | | | | | | | | | | **$0** | | | | **$0** |
| **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | **$87,500** | | | | **$23,200** |
| Contingency | | | | | | | | | | 0.1 | | $8,750 | | 0.1 | | $2,320 |
| **SUBTOTAL** | | | | | | | | | | | | $96,250 | | | | **$25,520** |
| GC Mark-ups | | | | | | | | | | 0.2 | | $19,250 | | 0.2 | | $5,104 |
| **TOTAL** | | | | **N/A** | | | | **N/A** | 231,000 | **GSF** | **$0.50** | **$115,500** | **15,000** | **GSF** | **$2.04** | **$30,624** |

## EXISTING BUILDINGS

| | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **21.2 Keep Residential Stairwells & Hallways Lit During Blackouts** | | | | | | | | | | | | | | | | |
| **Building with 2 Units Per Floor (Integral Battery)** | | | | | | | | | | | | | | | | |
| Furnish 3 fixtures per floor *Pricing as noted in proposal | | | | | | | | | 60 | EA | $95.00 | $5,700 | 15 | EA | $95.00 | $1,500 |
| Install 3 fixtures per floor (assume 2 work-hours per fixture) | | | | | | | | | 120 | HRS | $130.00 | $15,600 | 30 | HRS | $130.00 | $3,900 |
| Furnish wiring (in 3/4" electrical conduit) from panelboard to light fixtures | | | | | | | | | 3,000 | LF | $6.00 | $18,000 | 750 | LF | $6.00 | $4,500 |
| Install wiring (in 3/4" electrical) from panelboard to light fixture | | | | | | | | | 3,000 | LF | $14.00 | $42,000 | 750 | LF | $14.00 | $10,500 |
| Patching of drywall | | | | | | | | | 1 | LS | $15,000.00 | $15,000 | 1 | LS | $3,750.00 | $3,800 |
| Furnish 20 amp breaker in existing panelboard. Assume one circuit breaker per floor for lighting load. Assume existing panelboards have sufficient capacity and space for additional circuit breaker | | | | | | | | | 20 | EA | $50.00 | $1,000 | 5 | EA | $50.00 | $300 |
| Install 20 amp circuit breaker in existing panelboard. Assume one circuit breaker per floor for lighting circuits. Assume 3 work-hours per circuit | | | | | | | | | 60 | HRS | $130.00 | $7,800 | 15 | HRS | $130.00 | $2,000 |
| Furnish 120 hour central batteries for building **Not required | | | | | | | | | - | EA | $2,000.00 | Required | - | EA | $2,000.00 | Required |
| Install 120 hour central batteries for building **Not required | | | | | | | | | - | HRS | $130.00 | Required | - | HRS | $130.00 | Required |
| Furnish low-voltage, Class 2 wiring (in 3/4" electrical conduit) from battery pack to panelboard. **Not required | | | | | | | | | - | LF | $6.00 | Required | - | LF | $6.00 | Required |
| Install low-voltage Class 2 wiring (in 3/4" electrical conduit) from battery pack to panelboard. **Not required | | | | | | | | | - | LF | $14.00 | Required | - | LF | $14.00 | Required |
| **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | **$105,100** | | | | **$26,500** |
| Contingency | | | | | | | | | | 10% | | $10,510 | | 10% | | $2,650 |
| **SUBTOTAL** | | | | | | | | | | | | **$115,610** | | | | **$29,150** |
| GC Mark-ups | | | | | | | | | | 20% | | $23,122 | | 20% | | $5,830 |
| **TOTAL** | | | | **N/A** | | | | **N/A** | 231,000 | **GSF** | **$0.60** | **$138,732** | **15,000** | **GSF** | **$2.33** | **$34,980** |

**NEW CONSTRUCTION**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 21.3 | **Keep Residential Stairwells & Hallways Lit During Blackouts** | | | | | | | | | | | | | | | | |
| | **Building with 2 Units Per Floor (Remote Battery)** | | | | | | | | | | | | | | | | |
| | Furnish 3 fixtures per floor *Pricing as noted in proposal | | | | | | | | | 60 | EA | $45.00 | $2,700 | 15 | EA | $45.00 | $700 |
| | Install 3 fixtures per floor (assume 2 work-hours per fixture) | | | | | | | | | 120 | HRS | $130.00 | $15,600 | 30 | HRS | $130.00 | $3,900 |
| | Furnish wiring (in 3/4" electrical conduit) from panelboard to battery packs | | | | | | | | | 100 | LF | $6.00 | $600 | 50 | LF | $6.00 | $300 |
| | Install Class 2 wiring (in 3/4" electrical conduit) from panelboard to battery packs | | | | | | | | | 100 | LF | $14.00 | $1,400 | 50 | LF | $14.00 | $700 |
| | Furnish Class 2 wiring (in 3/4" electrical conduit) from battery packs to light fixtures | | | | | | | | | 3,000 | LF | $6.00 | $18,000 | 750 | LF | $6.00 | $4,500 |
| | Install Class 2 wiring (in 3/4" electrical conduit) from battery packs to light fixtures | | | | | | | | | 3,000 | LF | $14.00 | $42,000 | 750 | LF | $14.00 | $10,500 |
| | Furnish 20A circuit breaker in a panelboard. Assume 1 circuit breaker per battery pack. Panelboard not included in this cost | | | | | | | | | 2 | EA | $50.00 | $100 | 1 | EA | $50.00 | $100 |
| | Install 20A circuit breaker in a panelboard. Assume 1 circuit breaker per battery pack. Assume 2 work-hours per circuit | | | | | | | | | 4 | HRS | $130.00 | $600 | 2 | HRS | $130.00 | $300 |
| | Furnish 120 hour central batteries for building *Pricing as noted in proposal | | | | | | | | | 2 | EA | $2,000.00 | $4,000 | 1 | EA | $2,000.00 | $2,000 |
| | Install 120 hour central batteries for building (assume 20 work-hours per battery set) | | | | | | | | | 40 | HRS | $130.00 | $5,200 | 20 | HRS | $130.00 | $2,600 |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | **$90,200** | | | | **$25,600** |
| | Contingency | | | | | | | | | | 0.1 | | $9,020 | | 0.1 | | $2,560 |
| | **SUBTOTAL** | | | | | | | | | | | | $99,220 | | | | **$28,160** |
| | GC Mark-ups | | | | | | | | | | 0.2 | | $19,844 | | 0.2 | | $5,632 |
| | **TOTAL** | | | | **N/A** | | | | **N/A** | 231,000 | **GSF** | **$0.52** | **$119,064** | **15,000** | **GSF** | **$2.25** | **$33,792** |

**EXISTING BUILDINGS**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 21.3 | **Keep Residential Stairwells & Hallways Lit During Blackouts** | | | | | | | | | | | | | | | | |
| | **Building with 2 Units Per Floor (Remote Battery)** | | | | | | | | | | | | | | | | |
| | Furnish 3 fixtures per floor *Pricing as noted in proposal | | | | | | | | | 60 | EA | $45.00 | $2,700 | 15 | EA | $45.00 | $700 |
| | Install 3 fixtures per floor (assume 2 work-hours per fixture) | | | | | | | | | 120 | HRS | $130.00 | $15,600 | 30 | HRS | $130.00 | $3,900 |
| | Furnish wiring (in 3/4" EC) from panelboard to battery packs | | | | | | | | | 100 | LF | $6.00 | $600 | 50 | LF | $6.00 | $300 |
| | Install Class 2 wiring (in 3/4" EC) from panelboard to battery packs | | | | | | | | | 100 | LF | $14.00 | $1,400 | 50 | LF | $14.00 | $700 |
| | Patching of drywall | | | | | | | | | 1 | LS | $500.00 | $500 | 1 | LS | $250.00 | $300 |
| | Furnish Class 2 wiring (in 3/4" EC) from battery packs to light fixtures | | | | | | | | | 3,000 | LF | $6.00 | $18,000 | 750 | LF | $6.00 | $4,500 |
| | Install Class 2 wiring (in 3/4" EC) from battery packs to light fixtures | | | | | | | | | 3,000 | LF | $14.00 | $42,000 | 750 | LF | $14.00 | $10,500 |
| | Patching of drywall | | | | | | | | | 1 | LS | $15,000.00 | $15,000 | 1 | LS | $3,750.00 | $3,800 |
| | Furnish 20 amp breaker in existing panelboard. Assume one circuit breaker per battery pack. Assume existing panelboards have sufficient capacity and space for additional circuit breaker | | | | | | | | | 2 | EA | $50.00 | $100 | 1 | EA | $50.00 | $100 |
| | Install 20 amp circuit breaker in existing panelboard. Assume one circuit breaker per battery pack. Assume 3 work-hours per circuit | | | | | | | | | 6 | HRS | $130.00 | $800 | 3 | HRS | $130.00 | $400 |
| | Furnish 120 hour central batteries for building *Pricing as noted in proposal | | | | | | | | | 2 | EA | $2,000.00 | $4,000 | 1 | EA | $2,000.00 | $2,000 |
| | Install 120 hour central batteries for building (assume 20 work-hours per battery set) | | | | | | | | | 40 | HRS | $130.00 | $5,200 | 20 | HRS | $130.00 | $2,600 |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | **$105,900** | | | | **$29,800** |
| | Contingency | | | | | | | | | | 10% | | $10,590 | | 10% | | $2,980 |
| | **SUBTOTAL** | | | | | | | | | | | | **$116,490** | | | | **$32,780** |
| | GC Mark-ups | | | | | | | | | | 20% | | $23,298 | | 20% | | $6,556 |
| | **TOTAL** | | | | N/A | | | | N/A | 231,000 | GSF | $0.61 | $139,788 | 15,000 | GSF | $2.62 | $39,336 |

## NEW CONSTRUCTION

| | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **21.4 Keep Residential Stairwells & Hallways Lit During Blackouts** | | | | | | | | | | | | | | | | |
| **Building with 11 Units Per Floor (Integral Battery)** | | | | | | | | | | | | | | | | |
| Furnish 6 fixtures per floor *Pricing as noted in proposal | | | | | | | | | 120 | EA | $95.00 | $11,400 | 30 | EA | $95.00 | $2,900 |
| Install 6 fixtures per floor (assume 2 work-hours per fixture) | | | | | | | | | 240 | HRS | $130.00 | $31,200 | 60 | HRS | $130.00 | $7,800 |
| Furnish wiring (in 3/4" electrical conduit) from panelboard to light fixtures | | | | | | | | | 6,000 | LF | $6.00 | $36,000 | 1,500 | LF | $6.00 | $9,000 |
| Install wiring (in 3/4" electrical conduit) from panelboard to light fixture | | | | | | | | | 6,000 | LF | $14.00 | $84,000 | 1,500 | LF | $14.00 | $21,000 |
| Furnish 20 amp circuit breaker in a panelboard. Assume 1 circuit breaker per floor for lighting circuits. Panelboard not included in this cost | | | | | | | | | 20 | EA | $50.00 | $1,000 | 5 | EA | $50.00 | $300 |
| Install 20 amp circuit breaker in a panelboard. Assume 1 circuit breaker per floor for lighting circuits. Assume 2 work-hours per circuit | | | | | | | | | 40 | HRS | $130.00 | $5,200 | 15 | HRS | $130.00 | $2,000 |
| Furnish 120 hour central batteries for building **Not required | | | | | | | | | - | EA | $2,000.00 | N/R | - | EA | $2,000.00 | N/R |
| Install 120 hour central batteries for building **Not required | | | | | | | | | - | HRS | $130.00 | N/R | - | HRS | $130.00 | N/R |
| Furnish low-voltage, Class 2 wiring (in 3/4" electrical conduit) from battery pack to panelboard. **Not required | | | | | | | | | - | LF | $6.00 | N/R | - | LF | $6.00 | N/R |
| Install low-voltage Class 2 wiring (in 3/4" electrical conduit) from battery pack to panelboard. **Not required | | | | | | | | | - | LF | $14.00 | N/R | - | LF | $14.00 | N/R |
| **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | **$168,800** | | | | **$43,000** |
| Contingency | | | | | | | | | | 10% | | $16,880 | | 10% | | $4,300 |
| **SUBTOTAL** | | | | | | | | | | | | $185,680 | | | | **$47,300** |
| GC Mark-ups | | | | | | | | | | 20% | | $37,136 | | 20% | | $9,460 |
| **TOTAL** | | | | **N/A** | | | | **N/A** | 231,000 | **GSF** | **$0.96** | **$222,816** | **15,000** | **GSF** | **$3.78** | **$56,760** |

## EXISTING BUILDINGS

| | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **21.4 Keep Residential Stairwells & Hallways Lit During Blackouts** | | | | | | | | | | | | | | | | |
| **Building with 11 Units Per Floor (Integral Battery)** | | | | | | | | | | | | | | | | |
| Furnish 6 fixtures per floor *Pricing as noted in proposal | | | | | | | | | 120 | EA | $95.00 | $11,400 | 30 | EA | $95.00 | $2,900 |
| Install 6 fixtures per floor (assume 2 work-hours per fixture) | | | | | | | | | 240 | HRS | $130.00 | $31,200 | 60 | HRS | $130.00 | $7,800 |
| Furnish wiring (in 3/4" electrical conduit) from panelboard to light fixtures | | | | | | | | | 6,000 | LF | $6.00 | $36,000 | 1,500 | LF | $6.00 | $9,000 |
| Install wiring (in 3/4" electrical conduit) from panelboard to light fixture | | | | | | | | | 6,000 | LF | $14.00 | $84,000 | 1,500 | LF | $14.00 | $21,000 |
| Patching of drywall | | | | | | | | | 1 | LS | $30,000.00 | $30,000 | 1 | LS | $7,500.00 | $7,500 |
| Furnish 20 amp breaker in existing panelboard. Assume one circuit breaker per floor for lighting load. Assume existing panelboards have sufficient capacity and space for additional circuit breaker | | | | | | | | | 20 | EA | $50.00 | $1,000 | 5 | EA | $50.00 | $300 |
| Install 20 amp circuit breaker in existing panelboard. Assume one circuit breaker per floor for lighting circuits. Assume 3 work-hours per circuit | | | | | | | | | 60 | HRS | $130.00 | $7,800 | 15 | HRS | $130.00 | $2,000 |
| Furnish 120 hour central batteries for building **Not required | | | | | | | | | - | EA | $2,000.00 | N/R | - | EA | $2,000.00 | N/R |
| Install 120 hour central batteries for building **Not required | | | | | | | | | - | HRS | $130.00 | N/R | - | HRS | $130.00 | N/R |
| Furnish low-voltage, Class 2 wiring (in 3/4" electrical conduit) from battery pack to panelboard. **Not required | | | | | | | | | - | LF | $6.00 | N/R | - | LF | $6.00 | N/R |
| Install low-voltage Class 2 wiring (in 3/4" electrical conduit) from battery pack to panelboard. **Not required | | | | | | | | | - | LF | $14.00 | N/R | - | LF | $14.00 | N/R |
| **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | **$201,400** | | | | **$50,500** |
| Contingency | | | | | | | | | | 10% | | $20,140 | | 10% | | $5,050 |
| **SUBTOTAL** | | | | | | | | | | | | **$221,540** | | | | **$55,550** |
| GC Mark-ups | | | | | | | | | | 20% | | $44,308 | | 20% | | $11,110 |
| **TOTAL** | | | | **N/A** | | | | **N/A** | 231,000 | **GSF** | **$1.15** | **$265,848** | **15,000** | **GSF** | **$4.44** | **$66,660** |

**NEW CONSTRUCTION**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 21.5 | **Keep Residential Stairwells & Hallways Lit During Blackouts** | | | | | | | | | | | | | | | | |
| | **Building with 11 Units Per Floor (Remote Battery)** | | | | | | | | | | | | | | | | |
| | Furnish 6 fixtures per floor *Pricing as noted in proposal | | | | | | | | | 120 | EA | $45.00 | $5,400 | 30 | EA | $45.00 | $1,400 |
| | Install 6 fixtures per floor (Assume 2 work-hours per fixture) | | | | | | | | | 240 | HRS | $130.00 | $31,200 | 60 | HRS | $130.00 | $7,800 |
| | Furnish wiring (in 3/4" electrical conduit) from panelboard to battery packs | | | | | | | | | 100 | LF | $6.00 | $600 | 50 | LF | $6.00 | $300 |
| | Install wiring (in 3/4" electrical conduit) from panelboard to battery packs | | | | | | | | | 100 | LF | $14.00 | $1,400 | 50 | LF | $14.00 | $700 |
| | Furnish Class 2 wiring (in 3/4" electrical conduit) from battery packs to light fixtures | | | | | | | | | 6,000 | LF | $6.00 | $36,000 | 1,500 | LF | $6.00 | $9,000 |
| | Install Class 2 wiring (in 3/4" electrical conduit) from battery packs to light fixtures | | | | | | | | | 6,000 | LF | $14.00 | $84,000 | 1,500 | LF | $14.00 | $21,000 |
| | Furnish 20A circuit breaker in a panelboard. Assume 1 circuit breaker per battery pack. Panelboard not included in this cost | | | | | | | | | 2 | EA | $50.00 | $100 | 1 | EA | $50.00 | $100 |
| | Install 20A circuit breaker in a panelboard. Assume 1 circuit breaker per battery pack. Assume 2 work-hours per circuit | | | | | | | | | 4 | HRS | $130.00 | $600 | 2 | HRS | $130.00 | $300 |
| | Furnish 120 hour central batteries for building *Pricing as noted in proposal | | | | | | | | | 2 | EA | $2,000.00 | $4,000 | 1 | EA | $2,000.00 | $2,000 |
| | Install 120 hour central batteries for building (assume 20 work-hours per battery set) | | | | | | | | | 40 | HRS | $130.00 | $5,200 | 20 | HRS | $130.00 | $2,600 |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | **$168,500** | | | | **$45,200** |
| | Contingency | | | | | | | | | | 10% | | $16,850 | | 10% | | $4,520 |
| | **SUBTOTAL** | | | | | | | | | | | | $185,350 | | | | **$49,720** |
| | GC Mark-ups | | | | | | | | | | 20% | | $37,070 | | 20% | | $9,944 |
| | **TOTAL** | | | | **N/A** | | | | **N/A** | 231,000 | **GSF** | **$0.96** | **$222,420** | **15,000** | **GSF** | **$3.98** | **$59,664** |

**EXISTING BUILDINGS**

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 21.5 | **Keep Residential Stairwells & Hallways Lit During Blackouts** | | | | | | | | | | | | | | | | |
| | **Building with 11 Units Per Floor (Remote Battery)** | | | | | | | | | | | | | | | | |
| | Furnish 6 fixtures per floor *Pricing as noted in proposal | | | | | | | | | 120 | EA | $45.00 | $5,400 | 30 | EA | $45.00 | $1,400 |
| | Install 6 fixtures per floor (assume 2 work-hours per fixture) | | | | | | | | | 240 | HRS | $130.00 | $31,200 | 60 | HRS | $130.00 | $7,800 |
| | Furnish low-voltage, Class 2 wiring (in 3/4" electrical conduit) from battery packs to light fixtures | | | | | | | | | 6,000 | LF | $6.00 | $36,000 | 1,500 | LF | $6.00 | $9,000 |
| | Install low-voltage, Class 2 wiring (in 3/4" electrical conduit) from battery packs to light fixtures | | | | | | | | | 6,000 | LF | $14.00 | $84,000 | 1,500 | LF | $14.00 | $21,000 |
| | Patching of drywall | | | | | | | | | 1 | LS | $30,000.00 | $30,000 | 1 | LS | $7,500.00 | $7,500 |
| | Furnish wiring (in 3/4" electrical conduit) from panelboard to battery pack | | | | | | | | | 100 | LF | $6.00 | $600 | 50 | LF | $6.00 | $300 |
| | Install low-voltage Class 2 wiring (in 3/4" electrical conduit) from panelboard to battery pack | | | | | | | | | 100 | LF | $14.00 | $1,400 | 50 | LF | $14.00 | $700 |
| | Patching of drywall | | | | | | | | | 1 | LS | $500.00 | $500 | 1 | LS | $250.00 | $300 |
| | Furnish 20 amp circuit breaker in existing panelboard. Assume one circuit breaker per battery pack. Assume existing panelboards have sufficient capacity and space for additional circuit breaker | | | | | | | | | 2 | EA | $50.00 | $100 | 1 | EA | $50.00 | $100 |
| | Install 20 amp circuit breaker in existing panelboard. Assume one circuit breaker per battery pack. Assume 3 work-hours per circuit | | | | | | | | | 6 | HRS | $130.00 | $800 | 3 | HRS | $130.00 | $400 |
| | Furnish 120 hour central batteries for building *Pricing as noted in proposal | | | | | | | | | 2 | EA | $2,000.00 | $4,000 | 1 | EA | $2,000.00 | $2,000 |
| | Install 120 hour central batteries for building (assume 20 work-hours per battery set) | | | | | | | | | 40 | HRS | $130.00 | $5,200 | 20 | HRS | $130.00 | $2,600 |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | **$199,200** | | | | **$53,100** |
| | Contingency | | | | | | | | | | 10% | | $19,920 | | 10% | | $5,310 |
| | **SUBTOTAL** | | | | | | | | | | | | **$219,120** | | | | **$58,410** |
| | GC Mark-ups | | | | | | | | | | 20% | | $43,824 | | 20% | | $11,682 |
| | **TOTAL** | | | | **N/A** | | | | **N/A** | 231,000 | **GSF** | **$1.14** | **$262,944** | **15,000** | **GSF** | **$4.67** | **$70,092** |

# 22 Keep Gas Stations Open During Blackouts

## I. Summary

**Issue:**
During blackouts, most service stations are unable to sell gas because the pumps rely on electricity. In the days following Superstorm Sandy, about half of NYC's service stations were not operational, delaying recovery efforts and disrupting work and life for hundreds of thousands of residents and businesses.

**Recommendation:**
Unless New York State passes an equivalent law, NYC should require all fuel stations to either have a backup generator or be "generator ready."

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## II. Proposed Legislation, Rule or Study

*Amendments to the New York City Building Code:*

1. Add a new section to Chapter 4 of Section 406.5 as follows:

   **406.5.4 Standby power systems.** A standby power system complying with Section 2702 shall be provided to power the following loads:

   1. All pumps used to deliver motor fuel from storage tanks;
   2. Sufficient lighting as to allow for normal operation of the facility at all times;
   3. All fire and safety systems required by law;
   4. All communication systems;
   5. Payment processing facilities sufficient for normal business processes.
      Where a generator is used as the standby power system, the fuel source shall be one of the motor fuels dispensed from storage tanks at the facility.

   **Exception:** Standby power systems are not required at facilities that provide for rapid connection to non-stationary standby generation complying with section 2702.4, provided that the facility is capable of powering all loads listed in section 406.5.4.

*Require Retroactive Application:*

Motor fuel-dispensing facilities shall retroactively comply with section 406.5.4 of the New York City Building Code according to the following schedule:
1. Facilities with more than twelve pumps, by January 1, 2015;
2. Facilities with six to twelve pumps, by January 1, 2017;
3. All facilities, by January 1, 2019.

## III. Supporting Information

**Expanded Issue and Benefits:**

In the days following Superstorm Sandy, roughly half of New York City's service stations were without power and were unable sell gasoline because fuel dispenser pumps require electricity. Even when gas was available, this contributed to fuel shortages and hours-long waits for gas. The issue is especially important in less dense areas of New York City where residents and businesses are dependent on automobiles for almost all transportation, because longer trips are required and there are relatively few public transportation options.

On February 20, 2013, New York State Governor Andrew Cuomo recommended the state adopt the following provisions:

1. All gas stations within a half-mile of highway exits and hurricane evacuation routes will be required to have a transfer switch installed by March 1, 2014, and to deploy and install a generator within 24 hours of losing power during a fuel supply or energy emergency. A transfer switch means a station is pre-wired to hook up a backup generator to power the pumps and other critical equipment. This requirement applies to approximately one-third of all gas stations in the state.
2. In addition, gas station chains with 10 or more stations under common ownership in any region of the state will be required to install a transfer switch for an additional 50% of their stations by March 1, 2016, and must deploy and install a generator to these stations within 48 hours of losing power during a fuel supply or energy emergency. This requirement applies to an additional approximately 15% of gas stations.
3. As of March 1, 2014, all newly constructed gas stations or gas stations that have major renovations will be required to have a transfer switch or backup generator installed.

If the state adopts the above, the recommendations of this proposal will not be required.

**Cost:**

Service stations would incur the cost installing the transfer switch. However, presumably the cost will be amortized over time because service stations will remain operational during blackouts. The state may choose to ameliorate costs by making a pool of backup generators available for use by service stations during blackouts.

No cost estimation was performed for this proposal.

**Implementation:**

This proposal references another Task Force proposal ("Add Hookups for Temporary Generators & Boilers") that details the required electrical wiring to allow for rapid connection to portable generation (proposed section 2702.4). Similar language should be incorporated into section 406.5.4.

The technology to add quick connections and a transfer switch to an electric service is widely available and implemented. Generators will have to be rented during blackouts unless they are made available by the state.

Note: On March 29, 2013, New York State Governor Andrew M. Cuomo signed a new law that requires approximately half of all downstate gas stations in New York City, Long Island and Westchester and Rockland counties to have back-up power in the event of an emergency.

1. Stations within a half-mile of a highway exit or hurricane evacuation route in these downstate areas will need to be wired with a transfer switch by April 1, 2014. They must deploy and install a generator within 24 hours of losing power in an emergency.
2. In addition, 30 percent of all retail outlets that are part of a chain further than half-mile from highway exits and evacuation routes in these downstate areas will be required to install a transfer switch by August 1, 2015. They must deploy and install a generator within 48 hours of losing power.
3. All newly constructed gas stations in New York City, Long Island, Westchester and Rockland counties for which a building permit is issued on or after April 1, 2014 will be required to have wiring to deploy a generator or have a back-up generator installed.
4. Gas stations selling less than 75,000 gallons of fuel per month are exempt.

Information for gas station owners and motorists is available at nysandyhelp.ny.gov/fuel-ny. The site also includes information about NYSERDA grants available to gas station owners to defray the costs of adding alternate power sources.

**Sources:**

1. "Gas Station Back-Up Power Program", NYSERDA. http://www.nyserda.ny.gov/About/Statewide-Initiatives/Gas-Station-Back-Up-Power-Program.aspx. Last visited June 7, 2013.
2. "Alternate generated power source at retail gasoline outlets", New York State, Section 192-h of Article 16 of the Agriculture and Markets Law, Weights and Measures. http://nysandyhelp.ny.gov/sites/default/files/documents/Article-16-192-h.pdf. Last visited June 7, 2013.

# **23** Supply Drinking Water Without Power

## I. Summary

**Issue:**
During a power failure, residential buildings using electric pumps lose their supply of potable water. Water may be present below the sixth floor, but in some cases remains unavailable if a nonoperating pump blocks the water supply.

**Recommendation:**
Require residential buildings to provide drinking water to a common area, supplied directly through pressure in the public water main.

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## II. Proposed Legislation, Rule or Study

*Amendments to the New York City Plumbing Code*:

1. Add new Section 614 as follows:

**SECTION PC 614**
**EMERGENCY POTABLE WATER ACCESS**

**614.1 Buildings required to provide alternative potable water access.** Buildings with residential occupancies where the water supply has been supplemented by an elevated water tank, a hydropneumatic pressure booster system, or a water pressure booster pump installed in accordance with Section 606.5 must provide an alternative potable water supply which is fed only by street pressure from the public water main. Such supply must be available at a freely accessible fixture.

**614.2 Emergency potable water fixture.** An emergency potable water fixture shall be a plumbing fixture meeting the requirements of this Section 614.2, which is provided with cold water from a supply line fed only by street pressure from the public water main and shall include the fixtures in Sections 614.2.1 and 614.2.2.

**614.2.1** A sink meeting the requirements of Section PC 418 and fitted with a faucet or fitting suitable for supplying drinking water for human ingestion meeting the requirements of Section 424.

**614.2.2** A floor drain meeting the requirements of Section 412 in combination with a faucet or fitting suitable for supplying drinking water for human ingestion meeting the requirements of Section 424.

**614.3 Number of fixtures required.** A building required to provide alternative potable water pursuant to Section 614.1 shall maintain a number of emergency potable water fixtures meeting the requirements of Section 614.2 equivalent to one emergency potable water fixture for every 75 residents or fraction thereof residing in the building.

**614.4 Required Accessibility.** Emergency potable water fixtures shall be located indoors in an area which is freely accessible to the tenants of the building.

**614.5 Signage.** Required emergency potable water fixtures shall be designated by a legible sign stating: “EMERGENCY POTABLE WATER”. Signs shall be readily visible and located near the emergency potable water fixture, and on the door to any room/closet in which the fixture is installed.

**614.7 Prohibited location.** Emergency potable water fixtures shall not be located in a public or private restroom.

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## III. Supporting Information

**Expanded Issue and Benefits:**

The inherent pressure within the municipal water system elevates water to roughly the sixth floor of buildings without the need for pumps. In taller buildings, water pressure booster pumps or elevated tanks supplied by pumps ensure delivery of water above the sixth floor. During power failures, occupants above the sixth floor can rapidly lose access to potable water.

To ensure potable water is accessible to tenants in the event of a power outage, residential buildings should designate one or more common areas on lower floors for potable water distribution. As this distribution would primarily be utilized by residents above the sixth floor, it is recommended that this emergency potable water access point be on as high a floor below the sixth as is practical.

Some buildings have onsite power generation that can serve the building’s water system during utility outages. However, onsite generation (whether a renewable source like solar photovoltaic panels or fuel-based like a diesel generator) can fail or the supply of fuel can be interrupted, both of which were frequent occurrences following Superstorm Sandy. This proposal ensures some potable water supply within the building at all times.

In some cases the layout of potable water supply plumbing may include inline electric pumps or water storage tanks that create blockages to delivery of water during a power outage. In these instances a manual emergency bypass at each of these blockages may be required to allow water to reach the emergency potable water access point. This problem can also be alleviated by installation of a dedicated riser serving only the emergency potable water fixtures.

In larger buildings, multiple water access areas will be required to ensure adequate water supply for residents. The number of required emergency potable water fixtures can be determined using the following assumptions and formula:

1. A fixture can provide about 750 gallons per day, based upon:
   a) Use: 10 hours per day, 8am-6pm (typical staff hours);
   b) Flow: 2.5 gallons/minute (typical faucet);
   c) Setup factor: Actual water flow about 50% of time to allow for bucket set up and to avoid long waiting periods.
2. Equation: (10 hours/day) X (2.5 gpm) X (60 minutes/hour) X (50%) = 750 gallons/day.
3. For the purposes of this proposal, assume a need of 10 gal/day/person for water for sanitation and hydration.
4. Therefore, one fixture can serve 75 people (750/10).

Since the emergency fixture may receive only intermittent use, the water supply pipe serving it can become stagnant. This is known as a “dead leg”, and precautions should be taken to ensure that the potential dead leg does not harbor pathogens. Domestic cold water systems are ordinarily not a major problem for *Legionella* growth, and maintaining cold-water lines below 20°C (68°F) will limit the potential for growth of bacteria. However, if the cold water line is warmed by an external heat source, bacterial growth can become an issue.

The simplest means to prevent a dead leg is to ensure that a regularly used fixture is installed downstream on the same line feeding the emergency fixture. For example, the emergency fixture could be located in-line on a pipe that serves another fixture, such as a service sink in the lobby or the basement. Another possibility is to run the supply to the emergency fixture as a loop with a venturi tee or a small circulating pump to circulate water in the loop back to the riser or supply pipe. Finally, it might be possible to drain the supply line feeding the emergency fixture, so that it is kept dry in between uses. In this case, a valve would be installed so that the emergency fixture riser is only filled with water when in use during extended outages. Building staff would need to be aware of the location and trained in the use of this valve.

In the absence of one of these solutions, the supply line to the emergency fixture will need to be flushed regularly. An example of how this could be done is the specification for maintenance of emergency eyewash fixtures, ANSI Z358.1-2009, which requires that “Plumbed units should be activated long enough on a weekly basis to be sure flushing fluid is provided.” (Section 6.5.2) and also “Minimum flushing fluid of 3 GPM at 30 PSI for 15 minutes” (Section 6.1.6). However, a permanent plumbing method that ensures water safety without the need for ongoing attention and maintenance of building personnel is greatly preferred over a flushing regimen.

The Residential Buildings Committee recommends that this fixture by required in all R-1 and R-2 buildings, including retroactive application to existing buildings, within five years. The Critical Building Committee recommends extending this same timeline to I-1 buildings (adult care facilities).

**Cost:**

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

Labor rates provided by Turner Construction Company are based upon union labor. While labor rates for non-union crews may be lower, other cost factors such as premiums for small projects and buying power with vendors influence the total cost of a project. For this proposal, using RSMeans 2012 data to estimate a 12% reduction in per-hour rates for non-union labor, total costs might be reduced by 2% to 6%.

## NEW CONSTRUCTION

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| | | | | | | | | | | | | | | | | | |
| 23.1 | **Supply Drinking Water Without Power** | | | | | | | | | | | | | | | | |
| | **Added Water Fixtures in a Room Already with an Approved Sink (ex: Laundry Room)** | | | | | | | | | | | | | | | | |
| | Electrical - NO CONSTRUCTION COST IMPACT | | | | | | | | | | | | $0 | | | | |
| | 1/2" pipe to hosebibs (6' each) | | | | | | | | | 24 | FT | $50.00 | $1,200 | | | | |
| | Existing Approved Potable Water Fixture | | | | | | | | | 1 | EA | | In Plan Already | | | | |
| | Furnish and install one hosebib per 75 residents | | | | | | | | | 4 | EA | $300.00 | $1,200 | | | | |
| | Furnish and install utility sinks with signage to drains | | | | | | | | | 4 | EA | $1,500.00 | $6,000 | | | | |
| | 4" sanitary and vent piping for drainage | | | | | | | | | 24 | FT | $150.00 | $3,600 | | | | |
| | Pipe connections | | | | | | | | | 1 | ALW | $1,500.00 | $1,500 | | | | |
| | Architectural re-work | | | | | | | | | 1 | ALW | $2,500.00 | Required | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | **$13,500** | | | | |
| | Contingency | | | | | | | | | | 10% | | $1,350 | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | **$14,850** | | | | |
| | GC Mark-ups | | | | | | | | | | 20% | | $2,970 | | | | |
| | **TOTAL** | | | | **N/A** | | | | **N/A** | **231,000** | **GSF** | **$0.08** | **$17,820** | | | | **N/A** |

## EXISTING BUILDINGS

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| | | | | | | | | | | | | | | | | | |
| 23.1 | **Supply Drinking Water Without Power** | | | | | | | | | | | | | | | | |
| | **Tap off Existing Sink and Common Space Area** | | | | | | | | | | | | | | | | |
| | Electrical - NO CONSTRUCTION COST IMPACT | | | | | | | | | | | | $0 | | | | |
| | 1/2" pipe to hosebibs (6' each) | | | | | | | | | 24 | FT | $50.00 | $1,200 | | | | |
| | Furnish and install one hosebib per 75 residents | | | | | | | | | 4 | EA | $300.00 | $1,200 | | | | |
| | Furnish and install utility sinks with signage to drains | | | | | | | | | 4 | EA | $1,500.00 | $6,000 | | | | |
| | 4" sanitary and vent piping for drainage | | | | | | | | | 24 | FT | $150.00 | $3,600 | | | | |
| | Pipe connections | | | | | | | | | 1 | ALW | $1,500.00 | $1,500 | | | | |
| | Architectural re-work | | | | | | | | | 1 | ALW | $2,500.00 | $2,500 | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | **$16,000** | | | | |
| | Contingency | | | | | | | | | | 10% | | $1,600 | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | **$17,600** | | | | |
| | GC Mark-ups | | | | | | | | | | 20% | | $3,520 | | | | |
| | **TOTAL** | | | | **N/A** | | | | **N/A** | **231,000** | **GSF** | **$0.09** | **$21,120** | | | | **N/A** |

| NEW CONSTRUCTION | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **23.2** | **Supply Drinking Water Without Power** | | | | | | | | | | | | | | | | |
| | **Dedicated Emergency Potable Water Cabinets in Common Space** | | | | | | | | | | | | | | | | |
| | Electrical - NO CONSTRUCTION COST IMPACT | | | | | | | | | | | | $0 | | | | |
| | 2" pipe outlet off riser (assume 100' or less) | | | | | | | | | 100 | LF | $90.00 | $9,000 | | | | |
| | 1/2" pipe to hosebibs (6' each) | | | | | | | | | 30 | LF | $50.00 | $1,500 | | | | |
| | Furnish and install one hosebib per 75 residents | | | | | | | | | 5 | EA | $300.00 | $1,500 | | | | |
| | Furnish and install utility sinks with signage to drains | | | | | | | | | 5 | EA | $1,500.00 | $7,500 | | | | |
| | 4" sanitary and vent piping for drainage | | | | | | | | | 100 | LF | $150.00 | $15,000 | | | | |
| | Architectural hosebib cabinets and signage | | | | | | | | | 5 | EA | $500.00 | $2,500 | | | | |
| | Demolition of existing conditions | | | | | | | | | | | | Not Required | | | | |
| | Core drilling - 2" each supply and drain | | | | | | | | | | | | Not Required | | | | |
| | System draindown | | | | | | | | | | | | Not Required | | | | |
| | Connection to existing cold water supply | | | | | | | | | 1 | ALW | $1,000.00 | $1,000 | | | | |
| | 2" ball valve at tee connection | | | | | | | | | 1 | ALW | $1,000.00 | $1,000 | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | **$39,000** | | | | |
| | Contingency | | | | | | | | | | 10% | | $3,900 | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | **$42,900** | | | | |
| | GC Mark-ups | | | | | | | | | | 20% | | $8,580 | | | | |
| | **TOTAL** | | | | **N/A** | | | | **N/A** | 231,000 | **GSF** | **$0.22** | **$51,480** | | | | **N/A** |

## EXISTING BUILDINGS

| | | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| 23.2 | **Supply Drinking Water Without Power** | | | | | | | | | | | | | | | | |
| | **New Emergency Potable Water Cabinets** | | | | | | | | | | | | | | | | |
| | Electrical - NO CONSTRUCTION COST IMPACT | | | | | | | | | | | | $0 | | | | |
| | 2" pipe outlet off riser (assume 100' or less) | | | | | | | | | 100 | FT | $90.00 | $9,000 | | | | |
| | 1/2" pipe to hosebibs (6' each) | | | | | | | | | 30 | FT | $50.00 | $1,500 | | | | |
| | Furnish and install one hosebib per 75 residents | | | | | | | | | 5 | EA | $300.00 | $1,500 | | | | |
| | Furnish and install utility sinks with signage to drains | | | | | | | | | 5 | EA | $1,500.00 | $7,500 | | | | |
| | 4" sanitary and vent piping for drainage | | | | | | | | | 100 | FT | $150.00 | $15,000 | | | | |
| | Architectural hosebib cabinets and signage | | | | | | | | | 5 | EA | $500.00 | $2,500 | | | | |
| | Demolition of existing conditions | | | | | | | | | 1 | ALW | $15,000.00 | $15,000 | | | | |
| | Core drilling - 2" each supply and drain | | | | | | | | | 4 | EA | $1,000.00 | $4,000 | | | | |
| | System draindown | | | | | | | | | 1 | ALW | $1,500.00 | $1,500 | | | | |
| | Connection to existing cold water supply | | | | | | | | | 1 | ALW | $2,500.00 | $2,500 | | | | |
| | 2" ball valve at tee connection | | | | | | | | | 1 | ALW | $1,000.00 | $1,000 | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | **$0** | | | | |
| | **SUBTOTAL DIRECT WORK** | | | | | | | | | | | | **$61,000** | | | | |
| | Contingency | | | | | | | | | | 10% | | $6,100 | | | | |
| | **SUBTOTAL** | | | | | | | | | | | | **$67,100** | | | | |
| | GC Mark-ups | | | | | | | | | | 20% | | $13,420 | | | | |
| | **TOTAL** | | | | **N/A** | | | | **N/A** | 231,000 | **GSF** | **$0.35** | **$80,520** | | | | **N/A** |

# **24** Ensure Toilets & Sinks Work Without Power

## I. Summary

**Issue:**
Some toilets and faucets need electricity to function. This presents a sanitation risk during an extended power outage.

**Recommendation:**
Require that toilets and faucets be capable of operating without grid power.

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## II. Proposed Legislation, Rule or Study

***Amendments to the New York City Plumbing Code*:**

1. Add a new subsection 424.7 as follows:

   **424.7 Lavatory sensor control devices**. In each bathroom, one or more sensor control devices used for lavatory faucets shall be able to continue normal operation in the event of a loss of building electrical power for a period of at least two weeks, without connection to the building electrical power supply. Exception: This requirement shall not apply to a lavatory faucet that is designed to be operated manually and without electrical power.

2. Add a new subsection 425.5 as follows:

   **425.5 Water closet and urinal flushing sensor control devices.** In each bathroom, one or more sensor control devices used for flushing toilets or urinals shall be able to continue normal operation in the event of a loss of building electrical power for a period of at least two weeks, without connection to the building electrical power supply. Exception: This requirement shall not apply to a toilet or urinal that is designed to be operated manually and without electrical power.

---

## III. Supporting Information

## Expanded Issue and Benefits:

Automatic bathroom fixtures were created in part to reduce human contact with bathroom surfaces that might spread disease. However, the need of many such fixtures for electricity leaves them vulnerable to disruptions in the power grid, potentially crippling building sanitation during blackouts. The effect of losing sanitation in an occupied building was graphically demonstrated in the aftermath of Hurricane Sandy when lack of water pressure caused toilets to fail. This proposal is intended to promote sanitary conditions by ensuring the proper functioning of automatic bathroom fixtures during prolonged power disruptions.

This proposal does not recommend the elimination of power-activated bathroom fixtures because these fixtures provide important health and conservation benefits. The purpose is rather to ensure that these devices can function in the event of utility loss.

In order to minimize required expenses in existing buildings, this proposal does not suggest retroactive application. However, retrofitting at least one toilet and faucet per bathroom is considered a best practice in existing buildings to maintain the use of sanitary facilities during an extended power outage.

## Implementation:

Lavatory faucet sensors and toilet sensors with the required battery life are readily available. Some flushometer toilets with sensors also provide a manual override. There should not be any implementation problems with these devices as they are currently required to be installed by a licensed plumber and installation of these devices has been common for years. Devices must have a true manual override that allows the device to be operated in the complete absence of external power, not a button that still requires electricity supply to the device for it to function.

## Cost:

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

The following analysis was provided by the authors of this proposal:

The cost of using battery-powered devices rather than hard-wired ones is minimal. There is a potential maintenance cost associated with the changing of batteries in battery-powered devices. However, since true manual override devices are available, as well as battery-powered devices with batteries lasting up to 10 years, the maintenance expenses are very low or zero.

**NEW CONSTRUCTION**

| | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **24.1 Ensure Toilets & Sinks Work Without Power** | | | | | | | | | | | | | | | | |
| **Battery Powered** | | | | | | | | | | | | | | | | |
| Premium for 1 battery powered flushometer per unit | | | | | | | | | 175 | EA | $0.00 | $0 | | | | |
| Premium for 1 battery powered faucet per unit | | | | | | | | | 175 | EA | $200.00 | $35,000 | | | | |
| Premium for 1 battery powered flushometers per gang bathroom | 60 | EA | $0.00 | $0 | 4 | EA | $0.00 | $0 | | | | N/A | | | | |
| Premium for 1 battery powered urinal flushometers per gang bathroom | 30 | EA | $0.00 | $0 | 2 | EA | $0.00 | $0 | | | | N/A | | | | |
| Premium for 1 battery powered faucet per gang bathroom | 60 | EA | $200.00 | $12,000 | 4 | EA | $200.00 | $800 | | | | N/A | | | | |
| Remediation of old electric-only fixtures | | | | Not Required | | | | Not Required | | | | Not Required | | | | |
| **SUBTOTAL DIRECT WORK** | | | | $12,000 | | | | $800 | | | | $35,000 | | | | |
| Contingency | | **10%** | | **$1,200** | | **10%** | | **$80** | | **10%** | | **$3,500** | | | | |
| **SUBTOTAL** | | | | $13,200 | | | | $880 | | | | $38,500 | | | | |
| GC Mark-ups | | **0.2** | | **$2,640** | | **0.2** | | **$176** | | **0.2** | | **$7,700** | | | | |
| **TOTAL** | **620,000** | **GSF** | **$0.03** | **$15,840** | **4,000** | **GSF** | **$0.26** | **$1,056** | **231,000** | **GSF** | **$0.20** | **$46,200** | | | | **N/A** |

**EXISTING BUILDINGS**

| | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **24.1 Ensure Toilets & Sinks Work Without Power** | | | | | | | | | | | | | | | | |
| **Battery Powered** | | | | | | | | | | | | | | | | |
| Furnish and install 1 Zurn ZTR6200EV battery powered flushometer per unit | | | | | | | | | 175 | EA | $1,000.00 | $175,000 | | | | |
| Furnish and install 1 Zurn Z6914 battery powered faucet per unit | | | | | | | | | 175 | EA | $750.00 | $131,300 | | | | |
| Furnish and install 1 Zurn ZTR6200EV battery powered flushometer per gang bathroom | 60 | EA | $1,000.00 | $60,000 | | | | | | | | N/A | | | | |
| Furnish and install 1 Zurn ZTR6203 urinal flushometer per men's gang bathroom | 30 | EA | $1,000.00 | $30,000 | | | | | | | | N/A | | | | |
| Furnish and install 1 Zurn Z6914 battery powered faucet per gang bathroom | 60 | EA | $750.00 | $45,000 | | | | | | | | N/A | | | | |
| Remediation of old electric-only fixtures | 150 | ALW | $600.00 | $90,000 | | | | | 350 | ALW | $600.00 | $210,000 | | | | |
| Remediation labor | 1,200 | HRS | | Included | | | | | 2,800 | HRS | | Included | | | | |
| **SUBTOTAL DIRECT WORK** | | | | **$225,000** | | | | | | | | **$516,300** | | | | |
| Contingency | | 10% | | $22,500 | | | | | | 10% | | $51,630 | | | | |
| **SUBTOTAL** | | | | **$247,500** | | | | | | | | **$567,930** | | | | |
| GC Mark-ups | | 20% | | $49,500 | | | | | | 20% | | $113,586 | | | | |
| **TOTAL** | 620,000 | GSF | $0.48 | $297,000 | | | | B | 231,000 | GSF | $2.95 | $681,516 | | | | N/A |

## NEW CONSTRUCTION

| | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **24.2 Ensure Toilets & Sinks Work Without Power** | | | | | | | | | | | | | | | | |
| **Electrical With True Mechanical Override** | | | | | | | | | | | | | | | | |
| Premium for 1 battery flushometer with true mechanical override per unit | | | | | | | | | 175 | EA | $100.00 | $17,500 | | | | |
| Premium for 1 battery powered faucet per unit | | | | | | | | | 175 | EA | $200.00 | $35,000 | | | | |
| Premium for 5 flush valves with true mechanical override per gang bathroom | 60 | EA | $100.00 | $6,000 | 4 | EA | $100.00 | $400 | | | | | | | | |
| Premium for 4 urinals with true mechanical override per men's gang bathroom | 30 | EA | $0.00 | $0 | 2 | EA | $0.00 | $0 | | | | | | | | |
| Premium for 5 battery powered faucets per gang bathroom | 60 | EA | $200.00 | $12,000 | 4 | EA | $200.00 | $800 | | | | | | | | |
| Remediation of old electric-only fixtures | | | | Not Required | | | | Not Required | | | | Not Required | | | | |
| **SUBTOTAL DIRECT WORK** | | | | $18,000 | | | | $1,200 | | | | $52,500 | | | | |
| Contingency | | **10%** | | **$1,800** | | **10%** | | **$120** | | **10%** | | **$5,250** | | | | |
| **SUBTOTAL** | | | | $19,800 | | | | $1,320 | | | | $57,750 | | | | |
| GC Mark-ups | | **0.2** | | **$3,960** | | **0.2** | | **$264** | | **0.2** | | **$11,550** | | | | |
| **TOTAL** | **620,000** | **GSF** | **$0.04** | **$23,760** | **4,000** | **GSF** | **$0.40** | **$1,584** | **231,000** | **GSF** | **$0.30** | **$69,300** | | | | **N/A** |

## EXISTING BUILDINGS

| | Commercial High Rise | | | | Commercial Low Rise | | | | Residential High Rise | | | | Residential Low Rise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total | Quantity | Unit | Unit Cost | Total |
| **24.2 Ensure Toilets & Sinks Work Without Power** | | | | | | | | | | | | | | | | |
| **Electrical With True Mechanical Override** | | | | | | | | | | | | | | | | |
| Furnish and install 1 Sloan Royal 113-1-.28 ES-S TMO electrical flushometer with true mechanical override per unit (includes re-wire) | | | | | | | | | 175 | EA | $1,100.00 | $192,500 | | | | |
| Furnish and install 1 Zurn Z6914 battery powered faucet per unit | | | | | | | | | 175 | EA | $750.00 | $131,300 | | | | |
| Furnish and install 1 Sloan Royal 113-1-.28 ES-S TMO electrical flushometer with true mechanical override per gang bathroom (includes re-wire) | 60 | EA | $1,100.00 | $66,000 | | | | | | | | N/A | | | | |
| Furnish and install 1 Sloan Royal 186-1 ES-S TMO urinal flushometer with true mechanical override per men's gang bathroom | 30 | EA | $1,100.00 | $33,000 | | | | | | | | N/A | | | | |
| Furnish and install 1 Zurn Z6914 battery powered faucet per gang bathroom (no faucet with mechanical override available) | 60 | EA | $750.00 | $45,000 | | | | | | | | N/A | | | | |
| Remediation of old electric-only fixtures | 150 | ALW | $600.00 | $90,000 | | | | | 350 | ALW | $600.00 | $210,000 | | | | |
| Remediation labor | 1,200 | HRS | | Included | | | | | 1,400 | HRS | | Included | | | | |
| **SUBTOTAL DIRECT WORK** | | | | **$234,000** | | | | | | | | **$533,800** | | | | |
| Contingency | | 10% | | $23,400 | | | | | | 10% | | $53,380 | | | | |
| **SUBTOTAL** | | | | **$257,400** | | | | | | | | **$587,180** | | | | |
| GC Mark-ups | | 20% | | $51,480 | | | | | | 20% | | $117,436 | | | | |
| **TOTAL** | 620,000 | GSF | $0.50 | **$308,880** | | | | - | 231,000 | GSF | $3.05 | **$704,616** | | | | **N/A** |

# **25** Enhance Building Water Reserves

## I. Summary

**Issue:**
Water towers can provide potable water during power losses. City regulations no longer require water towers for new construction and they allow towers to be removed from existing buildings.

**Recommendation:**
Encourage building owners to maintain existing water towers and consider using water towers in new construction.

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## II. Proposed Legislation, Rule or Study

This is a best practice recommendation using existing technology and techniques only. Part of this proposal is adopted from the Green Codes Task Force Proposal BR 8, “Enhance Building Water Supply During Blackouts.”

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## III. Supporting Information

**Expanded Issue and Benefits:**

The wooden water towers of New York City rooftops are not just a nostalgic feature of the City’s skyline, but are an important component of community resiliency in times of power outage. In many older buildings more than six floors in height, municipal water is pumped up to these rooftop water tanks, where it is then distributed back down through the building via gravity. In lieu of rooftop gravity tanks, newer systems often utilize one or more water pressure tanks, which store very little water and continuously supply water at the necessary pressure by pumping.

Rooftop storage units offer several advantages. If electrical or water systems are disrupted, the water stored in the tank is available and can be distributed using gravity, not power. Additionally, gravity tanks generally use less energy than water pressure tanks. In the former, pumping is only required intermittently when the water level dips below a threshold and the tank is refilled, whereas with the latter, more frequent pumping is needed to maintain the availability of water at the required pressure.

Nonetheless, many building owners are abandoning their old water tanks, often because of perceived maintenance issues. In addition, new buildings often opt for water pressure tanks because they don't impact the building silhouette and do not require the robust structural supports required for gravity fed tanks.

This proposal discourages the removal of existing tanks and encourages new buildings to either install water tanks or comply with the emergency water supply standards developed by the Department of Buildings.

While this proposal is focused on residential buildings, which are more likely to be occupied continuously during extended power outages, commercial buildings would benefit from even a limited water supply during an emergency.

If buildings retain or install water tanks, the following details are provided as best practice:

**Maintain Existing Water Tanks**
An existing gravity tank serving the domestic water requirements of a building should not be removed unless it is replaced by a gravity tank of greater or equal capacity.

**New Construction**

1. New buildings in occupancy groups I-1, R-1, and R-2 under 300 feet in height should include a gravity tank as part of the domestic water supply system. Such tank should have a minimum capacity of 25 gallons per dwelling unit in addition to any tank capacity reserved for fire protection.
2. New buildings in occupancy groups I-1, R-1, and R-2 over 300 feet in height should include a gravity tank as part of the domestic water supply system. Such tank should have a minimum capacity of 7,500 gallons in addition to the capacity required for fire protection under fire code regulations.
3. New buildings in occupancy groups I-1, R-1, and R-2 may not need the above if either:
   a. The domestic water system for the building is designed to not make use of electric pumps, or
   b. Pressure or water distribution pumps serving the domestic water supply of the building are connected to an approved standby generation source capable of operation during an extended power outage.

**Rationing**
If water is to be "rationed" with an independent emergency downfeed water line with a communal "tap" on each floor, it should follow the following guidelines:

1. **Emergency water rationing line.** An independent emergency water rationing line should be connected to the domestic outlet piping from the elevated water tank, upstream of the main downfeed shut-off valve. The line should extend to the lowest occupied floor. On each occupied floor, in an area which is freely accessible to the tenants of the building, the emergency water line should be fitted with a faucet or fitting suitable for supplying drinking water for human ingestion meeting the requirements of Section PC 424 of the NYC Plumbing Code.

2. **Valves.** A full port control valve should be installed at the top of the independent emergency water rationing line in close proximity to the main downfeed shut-off valve

from the elevated water tank. Downstream from the last faucet, the line should terminate at a blow off/cleanout hose bib or valve for maintenance.

3. **Water pressure reducing valve or regulator.** Where water pressure on the emergency water rationing line will exceed 85 psi (586 kPa) static, a water pressure reducer should be utilized in accordance with Section 604.8 of the NYC Plumbing Code.

4. **Signage.** Faucets, valves, or fittings connected to the emergency water rationing line, and the rooms in which these items are installed, should be designated by a sign that reads: "EMERGENCY POTABLE WATER." Signs should be readily visible and clearly identify the equipment in question.

5. **Prohibited location.** Faucets or fittings connected to the emergency water rationing line should not be located in a public or private restroom.

**Implementation:**

There are no known implementation issues for this proposal. Many companies in New York City provide installation and maintenance services for water tanks.

**Cost:**

Because gravity water tank systems use pumps less frequently, they typically allow for downsizing of the building generator powering the water pump. No cost estimation was performed for this proposal.

# **26** Ensure Operable Windows in Residential Buildings

## I. Summary

**Issue:**
Operable windows permit cooling without power, which allows buildings to remain habitable during power outages and saves energy. New windows are often installed with stops that prevent them from opening more than 4.5 inches, reducing their cooling potential.

**Recommendation:**
Extend the mandate of the Task Force through Fall 2013 to recommend options for regulating windows that address both child safety and the overheating during blackouts.

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## II. Proposed Legislation, Rule or Study

*Extend the Mandate of the Building Resiliency Task Force:*

Extend the mandate of the Task Force through Fall 2013 to examine the impact of window size openings on cooling without power, and recommend options to simultaneous address concerns for child safety and overheating during blackouts that may include the following:

- Eliminating requirements for window stops on windows over a certain height
- Requiring double-hung windows with stops on the lower sash to have an openable upper sash
- Alternative window hardware that allows window sections to “pop out,” opening along all four sides
- Providing tenants without children the option of removing window stops as part of the annual window guard notice, while addressing landlord liability concerns
- Creating parameters for internal temperatures during blackout that could be met through prescriptive or performance means

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## III. Supporting Information

**Expanded Issue and Benefits:**

From 1997-2010, 152 New Yorkers died from heat stroke,[i] often associated with power outages. During heat waves, mortality from other diseases also increases, as the extreme heat exacerbates existing conditions. The Department of Health and Mental Hygiene estimates that deaths from existing conditions, such as cardiovascular and pulmonary disease, increased by 6.5% during 12 prolonged heat waves over that period, representing approximately 1,090 additional deaths.

Extreme heat, defined as a heat index greater than 100ºF for one day or greater than 95ºF for two or more days, occurs roughly four times a year in NYC. According to a recent study, temperature-related deaths in Manhattan could rise 20% by the 2020s and, under worst-case scenarios, 90% by the 2080s.[ii] While heat-related deaths may not be directly related to the size of window openings, if the power fails during a heat event – and extreme heat is a common cause of power failures – the only way to cool an apartment is to open the windows. This is of particular concern for older residents, who are more vulnerable to overheating and whose limited mobility means they may be unable to leave buildings when elevators fail during a blackout.

Before mechanical ventilation existed, natural ventilation via windows and skylights was the only way to flush stale, hot or dirty air out of an interior space. New York City's ground-breaking Tenement House Act of 1901 ensured that all apartments would have access to fresh air and natural light. Operable windows are still an efficient way to provide fresh air and can substantially reduce energy use, especially during spring and fall when the temperature and humidity match human comfort levels. In homes where air conditioning is not used, operable windows function as the main source of temperature control.

For many years the New York City Building Code has required naturally ventilated residential buildings to provide a minimum openable area to the outdoors that is equivalent to 5 percent of floor area. Buildings that mechanically supply fresh air into habitable spaces must also provide openable windows (though the minimum operable area required is reduced to 2½ percent of the floor area[iii] if a minimum of 40 cubic feet per minute of fresh air is supplied).

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[i] New York City Department of Health and Mental Hygiene, *Health Advisory #11 Heat-Related Morbidity and Mortality in New York City*, May 26, 2011.

[ii] Freeman Klopott, *Manhattan Heat Deaths Seen Rising 20% in 2020s as Climate Warm*, BLOOMBERG, May 19, 2013, http://www.bloomberg.com/news/2013-05-19/manhattan-heat-deaths-seen-rising-20-in-2020s-as-climate-warms.html.

[iii] CITY OF NEW YORK, NY, HOUSING MAINTENANCE CODE §1203.4.1.2 (2009) available at http://www.nyc.gov/html/dob/downloads/pdf/cc_chapter12.pdf. (The minimum operable area to the outdoors shall be 5 percent of the floor area of the habitable space to be ventilated. Every opening providing required natural ventilation shall be at least 12 square feet, providing a minimum of six square feet of openable space. Exceptions: 1. Where fresh air is furnished in any habitable room or space by mechanical means supplying a minimum of 40 cubic feet per minute, the free openable area of the openings may be reduced to 2½ percent of the flow area but each such opening shall provide not less than 5½ square feet of openable area. 2. The minimum free openable area of a mullioned casement window shall be 5½ square feet provided that the minimum ratio of floor area to openable area is met); CITY OF NEW YORK, NY, HOUSING MAINTENANCE CODE § 27-2058(c) (2009) available at http://www.nyc.gov/html/dob/downloads/pdf/cc_chapter12.pdf. (1. The total area of all windows in the room shall be at least one- tenth the floor area of such room... 3. At least one-half of every required window shall open, except that for a mullioned casement window a minimum of five and one-half square feet is sufficient. In a room where a centralized mechanical ventilating system provides forty cubic feet of air per minute, twenty-five percent of the window area or five and one-half square feet of such area, whichever is greater, shall be openable).

In 1976, in response to children accidently falling out of apartment windows, the New York City Department of Health and Mental Hygiene enacted Window Guard Regulations to require landlords, building managers or owners (in condominium units) to install window guards and/or stops. They are required in all windows of apartments where children 10 years or younger reside, except at fire escapes, and must reject the passage of a solid 5 inch sphere.[iv] This is straightforward for some windows as guards on double hung windows are now common in the city. Depending on the configuration, some pivot windows present particular complications for using guards, in which case window stops must be installed to prevent the window opening beyond 5 inches.[v]

Window stops are inexpensive, simple to install and not as unsightly as guards. For these reasons, many building owners install all windows with stops in order to comply with the Department of Health, whether or not children reside in the apartment. Manufacturers of double hung windows even include them as an option in the window assembly.

Once windows have stops, however, ventilation is reduced. While tenants or owners of apartments without children 10 years or younger can request the removal of window stops, those with children 10 years or younger cannot, many tenants do not know they have this option, and some building owners are unwilling to allow the removal of stops due to concern about legal liability. Moreover, the use of stops has grown more widespread as recent residential construction has incorporated large fixed expanses of glass with minimal openings, increasingly turning to pivot-style windows.

There are several potential options, which require further consideration, to both ensure child safety and protect against overheating:

1. The location of an opening should be considered along with its size. For example, balcony railings typically have a height of 42", above which opening sizes are not limited. It would be consistent to not limit opening sizes on windows starting more than 42" from the floor, or some higher level to take into account the ability to crawl onto furniture. In addition, double-hung windows with stops on the lower sash could be required to have an openable upper sash.

2. In new buildings, openings might be provided in the form of: hardware that allows window sections to "pop out," opening along all four sides; an additional window; operable spandrel or louver sections; or different window designs.

3. Tenants without children could be annually presented with the option of removing window stops, while also providing landlords protection from any associated liability. Tenants could be given the opportunity to "opt out" when they return the annual window guard notice.

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[iv] CITY OF NEW YORK, NY, HOUSING MAINTENANCE CODE § 12, (2009). (Requires the installation of window guards "on all windows except fire escape access windows and secondary egress windows in first floor apartments, where the fire escapes are on the upper floors. Choice of unguarded window is optional in latter cases." Section 12-10 specifies that window guards must be at least 15 inches high and capable of rejecting "the passage of a solid five (5) inch sphere at every space and interval." That section also requires the installation of stops to prevent "the lower window from being raised more than 4½ inches above the lowest section of the top horizontal bar of the window guard.")

[v] CITY OF NEW YORK, NY, HOUSING MAINTENANCE CODE § 12-11 (2009), available at http://www.nyc.gov/html/doh/html/win/wincha.shtml#12-11.

4. The city could develop parameters for internal temperatures during blackouts such as limiting them to no more than 3 degrees F above external temperatures, and provide prescriptive and performance-based compliance options. These measures might include limiting glazing area, providing blinds or external shutters, providing additional ventilation openings, providing higher performance glazing, carrying out natural ventilation calculations to determine ventilation area, or requiring standby power to internal ventilation systems (which usually have relatively small power requirements).

**Implementation:**

Marvin Windows manufactures all of its sashes with optional limiters that are installed in the field. They can be removed with normal tools.[vi] Pella Windows produces vent stops for their double hung windows only.[vii] The vent stops can be popped out and are not tamper proof. Their double hung windows require guards or stops as per the requirements of the Department of Health.

**Cost:**

No cost estimation was performed for this proposal.

**Sources:**

All projects pursuing LEED certification must meet minimum indoor air quality performance (AE Prerequisite 1), in conformance with ASHRAE Standard 62.1-2004. Buildings that are not mechanically ventilated are required in Section 5.1 to have all naturally ventilated spaces permanently open to and within 25 feet of operable wall or roof openings and that the opening area be at least 4% of the net occupiable floor area.

[vi] Telephone Interview with Doug Andersen, Technical Staff, Marvin Windows (June 10, 2009).
[vii] Telephone Interview with Mr. Cricket, Technical Staff, Pella Windows (June 10, 2009).

# **27** Maintain Habitable Temperatures Without Power

## I. Summary

**Issue:**
Utility failures often disable heating and cooling systems, leaving interior building temperatures dependent on whatever protection is provided by the insulation and air sealing of a building's walls, windows, and roof.

**Recommendation:**
Extend the mandate of the Task Force through Fall 2013 to develop a multi-year strategy for ensuring that new and existing buildings maintain habitable temperatures during utility failures. Clarify requirements for tightly sealing new windows and doors and upgrading roof insulation during roof replacement.

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## II. Proposed Legislation, Rule or Study

*Extend the Mandate of the Building Resiliency Task Force:*

Extend the mandate of the Building Resiliency Task Force through Fall 2013 to develop a five-year strategy for our codes, construction practices, and building materials to achieve or surpass current international best practice standards on envelope performance. Explore options for improving upgrades to existing buildings, including requiring contractor education and expanding inspections to include window replacements. Eventually, building envelopes on all new construction should achieve the following minimum R-values and air tightness based on international best practice:

- Wall R-values of R-25
- Roof R-values of R-50
- Window assembly R-values of R-4.3
- Air tightness of less than 1.5 ACH at 50 Pa.

*Amendments to Department of Buildings Bulletin 2011-15:*

1. Amend paragraph 3(a)(ii) as follows:

   ii. Sheathing or decking exposed. Where alterations, renovations or repairs performed on a roof or roof setback expose the sheathing or decking, <u>air sealing shall be required that conforms to the requirements in Section 402 of the NYCECC and</u> insulation shall be required either above or below the sheathing or decking in accordance with Section 101.4.3, Exception 5 of the NYCECC. This may require construction at the parapet, bulkhead, etc., to meet New York City Building Code ("NYCBC") requirements. However, if provisions of the New York City Zoning Resolution preclude insulating above the sheathing or decking and there is a practical difficulty with insulating below the sheathing or deck, insulation of such roof plane shall not be required; in such a case, the applicant shall provide other measures to mitigate the calculated thermal loss of the noncompliant roof repair, in either site energy or the calculated energy cost.

2. Amend paragraph 7 as follows:

   **7. Sealing.** All envelope work, including work performed on the exterior wall of interior renovations, shall be sealed in accordance with Section 402.4 and/or 502.4 of the NYCECC. Any replacement window, door, or skylight must be sealed to limit infiltration in accordance with Section 402.4.1 of the NYCECC

*Best Practices for Existing Buildings:*

Building owners that are planning extensive renovations should consider advanced performance targets for envelope performance, such as the standards set by Passive House or the Army Corps of Engineers. If renovations are not planned, buildings should undergo an energy audit or be evaluated by an air sealing specialist to develop a targeted plan for phasing building envelope improvements into their building operations plan. Particular attention should be given to vents above elevator shafts.

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## III. Supporting Information

**Expanded Issue and Benefits:**

Twenty percent of New York City experienced a blackout during the two days following Superstorm Sandy, leading most to lose heating. Heating systems generally require some electricity to function, whether to run pumps or power fans to blow warm air. Fortunately, temperatures did not drop below 40 degrees in the week following Sandy because it was during a shoulder season. However, temperatures in the city can be extreme: the week of January 21, 2013 experienced five days with lows of 11-15 degrees, while temperatures were 92 degrees or higher during the week of July 4, 2012. Widespread blackouts have a long history in the city, with major blackouts occurring in 1965, 1977, 2003, and 2012.

Widespread power failures affect far more residents than the city can be expected to shelter and many will choose to remain in their homes. According to an analysis conducted for the Building Resiliency Task Force, there is a direct connection between the level of insulation and air sealing in a building's facade and the internal temperature of the building. The thermal performance of the building envelope is particularly critical in the depth of winter or height of summer as it determines how long a residence is habitable without active heating or cooling. The analysis showed that when outdoor temperatures are below freezing, the internal temperature in a poorly insulated building with high infiltration rates and no functioning heating will plummet by 15 degrees within hours, to near freezing in a number of days.

In order to improve the ability of buildings to maintain habitable temperatures in the event of a utility failure, this proposal recommends approaches for improving building envelopes in both new construction and existing buildings. For new buildings (and upgrades to major façade elements), the proposal is to extend the mandate of the Building Resiliency Task Force to develop a strategy for New York City's façades to achieve or surpass current international best practices. For existing buildings, the proposal clarifies existing requirements under the energy code. The proposal also recommends best practices for existing building retrofits.

**New Buildings**

New buildings that meet the standards of the current New York City or New York State energy codes perform much better than older buildings whose construction followed less stringent requirements. Nonetheless, there is still significant room for improvement of the standards for new building construction. Numerous buildings in the U.S. have demonstrated that more progressive façade design and construction leads to far better performance than currently typical, and in Europe voluntary standards like Passive House have demonstrated the substantial benefits of high performance envelopes for decades.

In the US, many larger buildings comply with the energy code using a "whole building performance" approach that allows the buildings to "trade off" lower performance façade systems against improvements to other building systems. While this relative performance approach can meet short-term objectives of reduced energy consumption, it does not address resiliency concerns and is much less stringent than standards elsewhere. As a result, most new building envelopes in the city perform well short of their potential. More progressive jurisdictions (such as Finland, Germany, Switzerland, and Japan) improve on this relative performance approach by setting energy intensity targets for each building. These standards also commonly include minimum requirements for individual building components that are higher than US standards. Among of the most relevant examples of this discrepancy are the thermal performance requirements for various building elements, some of which are outlined in the following tables:

| **Jurisdiction** | **Wall R-values** |
|---|---|
| Finland | R-22 |
| Germany | R-23 |
| Switzerland | R-28 |
| Passive House (Typical Performance) | R-28-56 |
| US | R-20 |

| **Jurisdiction** | **Roof R-values** |
|---|---|
| Finland | R-35 |
| Germany | R-35 |
| US | R-49 |

| **Jurisdiction** | **Window Assembly R-values** |
|---|---|
| Germany | R-4.3 |
| Switzerland | R-4.3 |
| US | R-2.8 |

These more progressive standards also address the air tightness of building envelopes, a significant contributor to the relatively poor performance of US buildings. In Germany, for instance, buildings with ventilations systems must have no more than 1.5 air changes per hour (ACH), while in Finland the threshold is even lower at 1.0 ACH, and 0.6 ACH for Passive House certified buildings. (In each case the building is tested under an air pressure of 50 Pa.)

Within the next year, New York State and New York City are expected to adopt the 2012 International Energy Conservation Code (IECC 2012), which will significantly improve building envelope requirements but still falls short of the best practice standards listed above. Moreover, trade-offs between building systems will still be permitted.

Within 5 years, NYC should improve the standards for building envelopes to ensure both energy efficiency and resiliency for all new buildings. Learning from existing national and international standards and voluntary rating systems, the city should develop improved standards that have a proven benefit and are appropriate for the building stock and climate conditions of New York City. The resulting improvements will include changes to existing codes, construction practices, and materials. Such measures should move towards increased levels of insulation and air tightness, including higher performing windows and frames. Significant improvement to curtain walls will be possible with new mullion designs that include composite materials or other means to reduce heat transfer. Energy recovery ventilation should be considered to ensure high indoor air quality and control moisture in buildings with improved air tightness. Building envelopes should be required to meet minimum standards, regardless of other energy trade-offs. These measures will require integrated, well-balanced evaluation to ensure an approach that optimizes performance while meeting economic, construction and operational objectives.

**Existing Buildings**

Most existing buildings have poorly insulated envelopes. Research conducted by Urban Green Council for their "90 by 50" study reveals that the walls of existing residential buildings have an average R-value of well below R-10. Experts estimate that typical curtain walls have an R-value of only 2 to 3. The problems with existing façades are legion, including: air leakage via old caulking and window frames; single-pane glazing; improperly and sporadically applied insulation, including thermal bridging in the insulation layer (through materials like metal studs); exposed concrete slab edges; aluminum window frames and curtain walls without thermal breaks; and large areas of glass without insulating coatings.

Under Local Law 85 of 2009, which created the NYCECC, any alterations to existing buildings must meet the relevant portions of the code for new construction. The Department of Buildings (the “DOB”) issued Bulletin 2011-015 to clarify how these code provisions apply to building envelopes. The bulletin specifies that roofs must be insulated when the roof sheathing decking is exposed during construction and states generally that envelope work must meet Energy Code air sealing requirements. However, anecdotal reports suggest that proper air sealing practices are often not followed during window, door, and roof replacements. As a result, this proposal recommends clarifications to the DOB bulletin.

Proper window installation requires sealing of the rough opening, a component of the building envelope that is only accessible during such window replacement. It is also important that windows and doors are installed in a manner that will ensure that factory-installed weatherstripping is effective and durable to seal against infiltration. Doors are often installed in a manner that allows continued infiltration owing to poor installation practices or inadequate weatherstripping (i.e. the weatherstripping still allows a gap to exist where there should be a full seal).

Roofs are the biggest source of air leakage and heat loss in most buildings. This is because the upper portions of the building are normally subject to the greatest natural pressure differentials, owing to stack effect (hot air rising through the building) and wind loading, both of which increase in magnitude with height. Roof replacement represents a unique upgrade opportunity because the construction process exposes the roof cavity, which is often otherwise inaccessible.

**Enforcement & Education**

Improving compliance with our building and energy codes is a critical component of achieving New York City's sustainability goals as well as ensuring health and safety and the overall resiliency of our community. After all, codes are merely words on paper if no one complies with them. The U.S. Department of Energy regards energy code compliance so highly that receipt of their energy stimulus grants is contingent on jurisdictions demonstrating a 90% compliance rate.

There are two primary aspects to increasing compliance rates. First, one can improve the level of knowledge within the design and construction community through education. California has taken this approach to energy code compliance for decades by providing training and resource centers, and it has achieved generally positive results. Second, a robust system of review and enforcement is required to ensure that the codes are taken seriously.

The Department of Buildings began robust enforcement of the Energy Code in 2011, including the creation of a detailed inspection checklist. It is in the midst of adding many staff to its Energy Code enforcement unit. Meanwhile, with NYSERDA funding, Urban Green Council developed energy code training for architects and engineers, which was delivered to thousands of design professionals in cooperation with AIA NY.

Not all energy-related construction requires a permit from DOB. Of particular interest to this Task Force proposal are window and door replacements, which require no permits or inspections. Sophisticated owners have the staff and internal processes to ensure such replacements are installed properly. However, many other building owners, such as coops and homeowners, do not have the expertise to review and assess the quality of such installations. As a result, this proposal recommends the study of these types of façade upgrades to determine how best to ensure quality work, such as using technologies like thermal imaging.

Given the rapid strengthening of the Energy Code, it is likely that the gap between construction practices and code requirements will grow without a significant investment in contractor education. In particular, standards for air tightness and insulation will require contractors to use improved wall assemblies and follow new practices to prevent air leakage. These techniques are not necessarily more complicated than past practice, but require education of a significant number of tradespeople. Also, unlike systems like lighting that can easily be improved at a later date, building façades are rarely upgraded so it is essential that upgrades or new construction are performed to a high standard. For this reason, the proposal recommends requiring contractor education as part of a multi-year plan to improve New York City building envelopes.

## Implementation:

### Best Practice Retrofit

There are many opportunities to improve air sealing and insulation in existing buildings, listed here and explained in more detail in following sections. The most effective strategies for multifamily residential buildings include:

- Seal open elevator shaft vents.
- Seal passive stairwell vents.
- Seal accessible side wall penetrations through the building envelope, particularly window/sleeve AC units, PTAC penetrations, plumbing penetrations, electrical service penetrations, electrical junction boxes, outlets, and switches.
- Seal interior partitions, chases, penetrations, and vertical and horizontal air leakage pathways to promote compartmentalization of the building, which will reduce heat loss and make the building habitable for longer periods.
- Weather seal loading docks to restrict infiltration when vehicles are parked in the doorway of the loading dock, in accordance with NYCEEC Section 502.4.5.
- Require vestibules at all entrance doors, including lobby doors, and require such a vestibule to be added during any lobby renovation or repair or alteration to an entrance door. Revolving doors are also an option where space is limited.
- Seal all air leakage pathways between garages and adjacent occupiable spaces, and insulate these partitions like an exterior wall.
- Seal all air leakage pathways between adjacent occupiable spaces and untempered mechanical rooms such as boiler rooms, MEP equipment rooms, meter rooms, and any other system or service rooms.

### Elevator Shaft Vents

Elevator buildings typically have enormous holes in the form of open vents at the top of elevator shafts. These open vents are substantial causes of air infiltration and drivers of the stack effect; indeed, it is often difficult to open the front doors of elevator buildings because substantial volumes of air continuously exit the building through these vents, creating “suction” at the lobby doors.

These holes are due to building code requirements that elevator shafts be capable of venting smoke and hot gases through open vents, mechanical ventilation, air pressurization, or alternate means.[i] The NYCECC now limits these options for new construction by requiring the vents to be entirely covered with smoke-actuated motorized dampers.[ii] However, all but the newest buildings have generally opted for open vents because of lower first costs. Under the building code, each elevator shaft is required to have a vent that is at least three sq. ft. per elevator car. A building with five elevator cars will have a hole the equivalent of approximately 15 sq. ft. open year round, typically located at the roof level. Two-thirds of the opening can be closed by a smoke-activated mechanical damper or breakable glass, greatly reducing the size of the hole and minimizing the impact of air infiltration.

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i. NYC Building Code: 3004.6

ii. Section 502.4.4 of the NYCECC holds that “[O]utdoor intakes and exhaust openings…stair and elevator shaft vents and other outdoor air intakes and exhaust openings integral to the building envelope shall be equipped with not less than a Class I motorized, leakage-rated damper with a maximum leakage rate of 4 cfm per square foot (6.8 L/s *m2) at 1.0 inch water gauge (w.g.) (1250 Pa) when tested in accordance with AMCA 500D.”

During an average NYC winter an elevator shaft with a three square-foot hole will leak $5,300 in heat.[iii] Reducing the vent opening by two-thirds would save approximately $3,500 annually in heating costs. It is estimated that this condition affects over 4,000 buildings in NYC – retrofitting every building with this condition could generate substantial energy savings.

NYC Building Code Section 3004.6 provides prescriptive methods for minimizing the open vent area at elevator hoistway enclosures. The least expensive and most cost-effective option is to cover two-thirds of the vent area with annealed glass, leaving the remaining one-third area open or on an openable, hinged damper. The more expensive option is to install smoke-actuated mechanical dampers that remain fully closed unless there is a smoke event.

**Window & Door Sealing**

Per section 402.4.1 of the NYCECC, all components of the building thermal envelope must be durably sealed to limit infiltration. Prescriptive language in the code section notes that the building component should be "caulked, gasketed, weatherstripped, or otherwise sealed with an air barrier material, suitable film, or solid material." Best practice examples include:

- Sealing the rough openings around a window with foam backer rod gasketing, caulk, and/or low expansion urethane foam;
- Caulking around the interior and exterior of a replacement window to ensure that moisture and air cannot enter the wall assembly;
- Verifying appropriate installation of all installed weatherstripping to ensure that a durable seal has been formed.

**Roof Air Sealing & Insulation**

Many residential buildings (especially smaller ones) include an attic space between the highest occupied rooms and the roof structure. At the time of roof deck replacement, this attic cavity below becomes accessible and upgrades to the building thermal envelope can performed. Some of these spaces are vented; others are not.

*Vented Roof Assemblies*

In these cases, the floor of the attic space (or alternatively, the ceiling of the highest occupied space in the building) typically marks the boundary plane separating conditioned and unconditioned spaces; when this space is accessible because of the removed roof deck, the attic plane should be thoroughly sealed with durable air impermeable materials (i.e. spray foam, rigid foam insulation board, silicone caulk, etc.) to eliminate the movement of conditioned air into the attic space. The objective is the creation of a continuous air barrier between conditioned spaces and the attic. Critical areas that require air sealing in this configuration are open wall cavities, mechanical service chases, and any other electrical, plumbing, or service penetrations that may allow conditioned air to escape into the attic space. Only after this air barrier is in place should code compliant levels of insulation be installed. The current NYCEEC calls for R-37 assembly in an attic space.

Code compliant attic ventilation should remain intact following this retrofit.

*Unvented Roof Assemblies*

With an unvented roof assembly, the building thermal envelope is considered to extend from the perimeter walls of the attic cavity to the level of the roof deck (with the insulation layer being rigid foam board type laid on top of the decking).

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iii. Steven Winter Associates estimates that a 3 square foot open hole across the top of the building drives approximately 255 mmBTU of heat loss. Energy loss estimates are based on current fuel rates, using a weighted average of fuel, gas, and steam based on actual consumption.

In many unvented attic situations the perimeter wall of the cavity is not properly insulated. This exterior wall should be insulated to NYCEEC requirements (R-11). Spray foam would be the most common application for insulating the exposed interior face of these exterior walls.

The roof should then be insulated to NYCEEC compliant levels (R-21 for continuous above deck insulation; R-37 for other applications). Typical options include the installation of above deck rigid foam, and the installation of spray foam at the underside of the roof deck and rafters from the inside of the attic cavity.

**Passively Vented Stairwells**
This proposal recommends that, by 2023, buildings with passively vented stairwells minimize infiltration by fully closing the net free area of all stairwell vents, in accordance with NYC Building Code Section 910.5.2. Similar in nature to the elevator hoistway enclosure vents discussed above, many buildings have passive vents at the top of stairwells intended to discharge smoke in the event of a fire. The Building Code allows for the retrofit of a damper that fully closes, provided that it will open when subjected to a temperature of 160F or to a rapid rise in temperature of 15F-20F per minute. As a best practice, stairwell vents should be retrofitted with a damper that fully closes and is either connected to a fusible link or controlled mechanically to open as required.

**Sidewall Penetrations**
All accessible sidewall penetrations through the building envelope should be durably sealed to limit infiltration. Particular attention should be paid to sealing room air conditioners, packaged terminal AC systems (PTACs), plumbing and electrical penetrations, and electrical boxes (receptacles, switches, etc.). These penetrations are subject to less differential pressure than those at the top and bottom of a building, but the interaction of wind, ventilation system performance, and stack effect can still drive significant volumes of air through even small sidewall leakage pathways. Sealing these gaps will allow for enhanced interior comfort and improved energy efficiency.

**Compartmentalizations**
Air sealing a building for compartmentalization is recognized by the high performance building design community as a particularly effective method of minimizing infiltration. Compartmentalization is the complete pressure isolation of an interior zone from spaces adjacent to that zone, with the intention of preventing the transfer of air or smoke between zones. Functionally, this means that all vertical and horizontal penetrations between apartments or between a unit and common spaces — even if they are interior to the building —be sealed to prevent the uncontrolled flow of air between these zones. The sealing and weatherstripping of other building interior components, such as stairway doors and vertical and horizontal chases, should also be encouraged, as should the installation of elevator vestibules at each floor and the implementation of zoned ventilation systems. Compartmentalizing a building is also considered a best practice because it reduces total air change rates by minimizing the impact of the stack effect and it effectively allows a building to remain habitable for a longer period of time during a service outage.

**Loading Docks**
Many buildings have loading docks as the central access point for deliveries. The use of loading docks is unavoidable during the winter months, and the loading dock doors often remain open for extended periods of time as deliveries are made. The top and bottom of buildings are the physical locations subject to the greatest stack effect pressures, and an

open loading dock door represents a massive hole in the envelope. It is not uncommon for over 50,000 cubic-feet-per-minute (CFM) of outside air to infiltrate the loading dock of a tall building on a cold day. NYCEEC Section 502.4.5 requires that "cargo doors and loading dock doors shall be equipped with weatherseals to restrict infiltration when vehicles are parked in the doorway." The availability of new products make this a measure that should be widely pursued to minimize the impact of uncontrolled infiltration.

**Exterior Entrance Doors**
All entrance doors should either be of the revolving type or should have an effective air lock vestibule installed. In accordance with NYCEEC Section 502.4.6, vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to be open at the same time. It is not uncommon for 50,000 CFM of outside air to infiltrate the building while entrance doors are open.

**Parking Garages**
Parking garages are typically open to the outdoors and are often adjacent to occupied areas of a building, representing myriad opportunities for air leakage. As such, the garage is a critical building component to seal and compartmentalize. Sealing a garage prevents carbon monoxide and other car exhaust fumes from entering a building and can substantially reduce levels of air infiltration, yielding improved efficiency and comfort.

**Cost:**

Turner Construction Company did not perform cost estimation for this proposal. The following analysis was provided by the authors of this proposal:

There are no cost impacts to extending the mandate of the Task Force. For other strategies already required under the energy code or recommended in this proposal:

*Windows:* There should be no measurable difference in cost to properly seal a window at the time of installation. Window manufacturers specify how and where to seal a window or door in their installation instructions. Window replacements should follow manufacturers' specifications, and thus the caulk/foam/sealants should be included within the cost of the project.

*Roof air sealing and insulation:* Effectively air sealing and insulating a vented roof assembly using common air sealing materials and cellulose insulation typically costs between $5-$7/sq. ft. of attic area, although the price will vary. The unvented option is more likely to cost $10-$15/sq. ft. of attic area, with more variables at play.

*Elevator dampers:* Building owners may expect to pay approximately $6,000 per vent for the motorized damper option, assuming electrical service is available at the roof level, and approximately $1,000 per vent for the annealed glass option. Each measure also yields cost benefits through reductions in heat loss to the exterior.

**Sources:**

1. NYCECC 402.4.1
2. NYS IECC2010 101.4.3

# **28** Create Emergency Plans

## I. Summary

**Issue:**
The multiday loss of power and extreme flooding from Superstorm Sandy exceeded most planning scenarios. As a result, few buildings or residents had plans to manage such emergencies.

**Recommendation:**
The city should work with industry experts to develop emergency preparedness information and instructions for apartment residents and homeowners including model emergency operating procedures and a building contact directory.

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## II. Proposed Legislation, Rule or Study

*Amendments to the Rules of the City of New York:*

1. The Office of Emergency Management and Fire Department should work with building owners to amend the Fire Safety Guide in Appendix 1 of Rule 408-02 of Title 3 to include instructions for preparedness for extreme weather events and extended utility outages. This information should include:

    a. The nearest Evacuation Center and list of resources from the Office of Emergency Management.
    b. When to contact 911 and when to contact 311.
    c. Whether, in the event of an extended utility outage, the building will provide any of the following: potable water; corridor, egress, and common area lighting; fire safety and fire protection; elevators; charging locations for cellular telephones; domestic hot water; or heating and cooling.
    d. For buildings within a special flood hazard area:

        i. Precautions the building has taken against flood risk including: sandbags and sandbag deployment training; installation of flood barriers; moving equipment above the design flood elevation; and floodproofing of areas below the design flood elevation.
        ii. Precautions tenants should take in case of flooding, including moving cars from basement garages to above the design flood elevation, unplugging electrical equipment that may come into contact with rising water, and moving valuables and important documents to areas above the design flood elevation.
        iii. Circumstances when tap water might become unsafe.

e. How to contact building staff for information during emergencies, including email addresses, phone numbers, and other means of communication (such as any common area notice board) when traditional means of communication are impaired.
f. Activities that would help the building and the city in cases of emergency, including:

    i. During floods and extreme rainfall, clearing the sewers of leaves and debris;
    ii. During high winds, removing furniture from rooftops and balconies;
    iii. During power outages, reducing water consumption for buildings that require pumps for water, reducing emergency power consumption in certain circumstances, and not using personal generators indoors; and
    iv. During water outages, only using water for essential sanitation functions.

2. Amend Section c(3)(C) of Rule 408-02 of Title 3 as follows:

    (C) The number of floors in the building, above and below ground level, and number of units.

3. Amend Section c(3) of Rule 408-02 of Title 3 to add new paragraphs J-L as follows:

    (J) The location of utility shut offs;

    (K) For buildings located in a special flood hazard area, the location and quantity of any item on the hazardous substance list, as defined by the department of environmental protection under Section 24-703 of the Administrative Code;

    (L) A list of building contact personnel;

*Recommendations for the Office of Emergency Management:*

1. The Office of Emergency Management (OEM), Fire Department, Department of Environmental Protection, Department of Health and Mental Hygiene, and Department of Buildings should work with building owners, operators, residents, and homeowners to develop standard emergency operating procedures for commercial and residential buildings as needed to supplement existing OEM resources. The plans should be general enough for application to a range of extreme weather events and extended power failures. The city should actively reach out to buildings located within flood zones for training. Depending on building type, key points could include:

    a. Protection

        i. Informing buildings and homeowners if they are located within the 100-year flood zone.
        ii. Determining if the building owner will furnish and/or install sandbags, jersey barriers and other protection around specific points around a building.
        iii. Securing loose items, such as window A/Cs, patio furniture, and flower boxes.
        iv. Securing windows and doors.
        v. Proactively shutting down elevators after moving them above the flood line.

   vi. Options to rent equipment to support the building after an event, such as pumps or generators.
   vii. Instructions for securing construction sites.

b. Communication

   i. Distributing building specific updates before, during and after an event through email, text, phone and/or written postings in a predetermined location.
   ii. Determine who would send these communications.
   iii. Posting citywide events that train individuals on resources, communication, and procedures provided by New York City.
   iv. Direct occupants to the Office of Emergency Management's website, which provides guidance on preparing for different hazards and how to stay informed.

c. Shelter in Place

   i. Direct occupants to the Office of Emergency Management's website for guidelines on sheltering in place.
   ii. Refer to the Office of Emergency Management for guidelines on care of seniors or people with special needs. Identifying residents who would like additional help could be included in the standard operating procedures.
   iii. Create guidelines for occupants and building staff on operating the building during power failures, including the use of shades and operable windows and activation of any backup systems that may exist like common area drinking water, generators, or battery lighting.

d. Recovery

   i. Direct occupants to the Office of Emergency Management, nyc.gov, local utility provider, and Department of Health and Mental Hygiene for the most current guidelines on recovering from an event, including use of alternate power sources and mold remediation.

e. Community Response Teams

   i. Encourage building occupants to become members of New York City's Community Emergency Response Team (CERT), which trains volunteers to support first responders in a variety of emergency events.

2. The city should also develop an annually updated registry of building contacts for use during emergencies.

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## III. Supporting Information

**Expanded Issue and Benefits:**

During and after Superstorm Sandy, many buildings suffered damage that could have been prevented, or from which they could have recovered more quickly, with the benefit of advanced planning. Few residential buildings or residents had plans to manage a multiday utility failure, and most lacked an understanding of the roles of various parties in the prevention or mitigation of problems.

The residents of multifamily buildings should be made aware of those building resources that will be available during extended emergencies so they can plan accordingly. For instance, residents should be informed whether drinking water will be available during a power failure, such as from a common area faucet on a low floor. Residents should be made aware of applicable evacuation routes and of local community resources like shelters. This information should be updated and provided to residents alongside their annual Fire Safety Plans.

Residents and building staff should be educated regarding the use of applicable building systems during utility failures. These operations could include the use of shades and operable windows to reduce heat build up during summer and the use of curtains to keep heat in during winter. In particular, building staff should be trained to operate any backup systems in the building – whether generators, battery lighting in stairwells, or common area drinking water. These systems should be clearly labeled as to their operation, and residents should be made aware of their potential use during an emergency period.

Residents and building staff should be educated about remediation that might, or must, be performed during the recovery period following an emergency. For example, homeowners and multifamily building residents should be educated about the hazards of leaving mold in place, where it is most likely to occur, and how it might be removed safely.

Clear operating procedures for emergency events will allow owners, managers, residents, and homeowners to prepare effectively. For instance, advanced planning will enable protective materials to be gathered before an event and clearly outline the roles and responsibilities of the team that is mobilizing protection. The emergency preparedness team in a residential building will typically consist of ownership, management, and residents. In a commercial building, or a critical building, the team might consist of management, operating staff, and tenant representatives. In hospitals, the Joint Commission, which accredits and certifies health care organizations, requires emergency preparedness plans that outline response and recovery strategies.[1]

An additional challenge during recent storms involved communication. Many residents of multi-family buildings received media broadcasts for citywide information, but not building-, or neighborhood-specific information. As a result some occupants were not aware of available resources within their own building or community. In other facilities basic planning like removing cars from below grade parking areas threatened by flooding was not undertaken, with grave financial and environmental consequences.

To improve communication, the standard procedures of multifamily buildings should outline how information will be shared in the event of an emergency. The communication system could be

[1] Joint Commission, Standard EM.02.01.01.

as complex as the Building Link management tool or as simple as a bulletin board posting. Any communications plan should include multiple forms of communication because access to power or cell phone towers will vary during emergencies.

Communications challenges also extend to the city's communication with building owners and managers, who play a critical role during extended emergencies. While many owners can be reached through professional associations and contact lists, the city does not have a way to directly contact all owners. The Department of Housing Preservation and Development requires residential building owners (except owner-occupied 1-2 family) to register annually, but the department only requests a single telephone number. It does not collect cellular telephone numbers, email addresses, or contact information for building managers and superintendents. The proposal thus recommends the city develop a citywide building contact list.

Careful planning, effective communication and targeted training will improve the level of building and occupant protection while minimizing panic and confusion.

**Implementation:**

The market presents no major hurdles to the implementation of these recommendations.

The only anticipated challenges relate to the voluntary organization of people and building owners to create these procedures and resources that dispense information. It is hoped that the experience of previous storms and the likelihood of future events will motivate the responsible parties to outline these plans in a timely manner. Education regarding this recommendation and the available resources would need to be communicated through media and relevant professional associations to ensure that as many city residents as possible are aware of the advanced planning that should be undertaken.

**Cost:**

Model emergency operating procedures and preparedness information should continue to be developed by OEM and made available online to owners and tenants. Building owners, managers, and occupants should utilize these available resources to develop their own building specific standard operating procedures. In the event of an emergency, the cost of protective provisions would vary by building and event.

If a building chooses to hire someone to prepare the building's standard operating procedures, consultants are available and costs will vary based on the robustness of the plan and the size of the facility.

No cost estimation was performed for this proposal.

# **29** Adopt an Existing Building Code

## I. Summary

**Issue:**
Existing building renovations are governed by a complex mix of new and old codes. This complexity discourages upgrades that would improve resiliency, particularly during time-sensitive recovery periods.

**Recommendation:**
The Task Force supports the Department of Buildings plans to adopt an Existing Building Code, which will simplify regulation of building upgrades and streamline permitting for resiliency improvements. The new code or other regulations should include specific provisions for post-disaster reconstruction.

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## II. Proposed Legislation, Rule or Study

The Task Force supports the Department of Buildings' plans to develop a code for existing buildings based on the International Existing Building Code. This code would be reviewed and updated every three years as is the case with the review of the city's other construction codes.

In addition to the current content of these model codes, the NYC Existing Building Code or other regulations should include streamlined permitting for resiliency improvements and specific provisions for post-disaster reconstruction.

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## III. Supporting Information

**Expanded Issue and Benefits:**

Existing buildings in New York City are governed by a confusing hybrid of modern and older, largely outdated building codes. With the adoption of the 2008 NYC Building Code, new buildings must conform to a relatively straightforward set of modern standards. An existing building, on the other hand, follows the new code for certain provisions, but has the option of following older codes (from 1968 or 1938) for other provisions. Even when an owner may prefer to primarily follow the new code, the complexity and time required to navigate the permitting and regulation process can discourage upgrades that would improve the safety and resiliency of existing buildings. This is especially true in the wake of a crisis when there is a need to complete rehabilitation work or other upgrades as quickly as possible.

The development of an Existing Building Code would bridge the significant gap between current and past codes and provide clearer guidelines for alterations to existing buildings. For new buildings, the 2008 code addresses modern requirements for seismic, snow, flood, and wind loads. An Existing Building Code could incorporate appropriate elements of these design loads and outline procedures to follow when altering existing buildings. New York State has joined many other states in adopting the International Existing Building Code (IEBC) and as a result virtually all jurisdictions except New York City utilize the IEBC to provide standards for alterations to existing buildings.

New Jersey provides an example of the benefits of adopting an existing building code. In 1998, the State created the Rehabilitation Subcode, which aimed to make repairs and alterations to existing buildings easier and to ensure that the cost of such repairs was relatively predictable. Prior to the establishment of this code, the lack of clear guidelines led to uncertainty about the time and cost of building improvements and discouraged upgrades.[1] The creation of the Rehabilitation Subcode has led to many improvements in the building stock of New Jersey.

The Department of Buildings has already begun to study how best to adopt an existing building code for New York City. It has researched various models including the New Jersey Rehabilitation Subcode and the International Existing Building Code. The Task Force supports these efforts and recommends that the department continue its planning and then begin the process of stakeholder involvement to develop a New York City Existing Building Code.

In addition, the city's code could be amended to facilitate rebuilding after natural disasters. Under the current system, building owners in New York that need to rebuild their properties after an event like Superstorm Sandy only have two options: they can either rebuild their property under the original code of construction or they can rebuild under the current code. The quicker option is to rebuild their property under the original code, but by doing this many of the building deficiencies that contributed to the building's failure during the disaster are unlikely to be addressed. Alternatively, if owners elect to rebuild their property under the current code, they are exposed to increased expenses and prolonged delays in reconstruction due to stringent design requirements and permitting issues.

The adoption of an Existing Building Code, or the introduction of other DOB regulations, could include reconstruction provisions specifically for post-disaster recovery efforts. These provisions would focus on the types of damage that buildings face during high winds, heat waves, heavy rain and snow events, and flooding, specifically addressing roof replacement, basement flood damage, and electrical or heating systems damage. In addition, the Code could outline a streamlined permitting process for reconstruction improvements, saving owners time and money. Reducing the complexity of permitting requirements would not only encourage smarter upgrades by owners, but also free up building department personnel and other resources that are likely to be stretched thin following a natural disaster.

The City of Los Angeles has similar recovery provisions in place for certain aspects of construction. For example, there is a specific code provision relating to the replacement of chimneys after an earthquake. By replacing damaged chimneys with pre-selected city-approved methods, building owners are allowed to skip portions of the permitting process that would otherwise bog down the rebuilding effort. New York should consider implementing similar provisions but on a wider array of issues. By making these decisions before a disaster, reducing the time required for the building permit process, and providing property owners with clear guidelines to improve their building's resilience, these reconstruction provisions will ensure that New York recovers faster from disasters and is better prepared for future events.

In summary, establishing an Existing Building Code would accomplish two important policy goals. First, such a code would incentivize building owners to upgrade building systems and improve building resiliency. Second, this code or other regulations would be a proactive means of responding to building damage following future natural disasters. Over time an existing building code will enable safer, more resilient buildings.

**Implementation:**

This effort would be two to three years in duration and should involve all the stakeholders in a consensus-based process. This proposal recommends developing an Existing Buildings Code within three years.

**Cost:**

The development of an Existing Building Code would be managed by the Department of Buildings with the voluntary collaboration of professional organizations like the AIA, SEAoNY, ACEC, and other stakeholders. The actual cost of implementing the new Code for existing buildings will depend on the provisions of the code, and will be determined as the code is being written. In general, building owners will benefit from the reductions in time and resources that will result from a streamlined process and clearer code requirements.

Investing in preventative measures and upgrades has been documented to be more economical than conducting repairs after a catastrophic event. In 2005, the Multihazard Mitigation Council conducted a congressionally mandated independent study which found that every dollar spent on mitigation saves society an average of four dollars on the cost of repairs.

# **30** Don't Discourage Buildings From Operating During Emergencies

## I. Summary

**Issue:**
Buildings need to remain open during many emergencies, but makeshift services that don't meet code standards during normal operations can be a liability risk. Buildings also need clarity about enforcement of various regulations during an emergency, such as those governing heat and stairwell lighting.

**Recommendations:**
New York State should adopt legislation that limits the liability of building owners and their staff during emergency conditions. The city should inform owners and tenants how enforcement of regulations may be relaxed during emergencies.

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## II. Proposed Legislation, Rule or Study

*Enact NYS Legislation Limiting Building Owner Liability During Emergencies:*

The New York State legislature should enact legislation that shields building owners, their employees and agents from claims for personal injury, wrongful death, property damage or other loss when they:

1. shelter persons during an actual or impending emergency or following an emergency for some period of time
2. render assistance during a declared national, state, or local disaster or emergency
3. unless such services were provided in a wanton, willful or grossly negligent manner or with intentional misconduct.

*Publish Relaxed Rules During Emergencies:*

City agencies should provide information in one central location, such as nyc.gov and 311, identifying any rules and regulations that may be relaxed during and immediately following emergencies.

## III. Supporting Information

## Expanded Issue and Benefits:

During and following an emergency, private property owners, their employees and agents, must make myriad life-safety decisions and should be encouraged to use their best judgment to secure the safety of residents and minimize property damage without fear of legal repercussions. For instance, building owners may not be able to provide essential services required by the building code or other city regulations, like heating, electricity, or running water. At the same time, it may be the most prudent or safest option for building residents to remain in the building during these periods of limited functionality. The priority during these events should be occupant safety and not prescriptive compliance; city agencies and DHCR should communicate and make accessible in obvious places a list of those rules and regulations that will be suspended in the aftermath of an emergency and the timeframe(s) for such suspensions.

Illinois provides a model for such an effort, having enacted legislation that shields certain private property owners from liability for reasonable actions taken during an actual or impending disaster.[i] We recommend New York State adopt similar legislation that would apply once the city has declared a disaster. Additionally, we recommend New York State enact legislation shielding private persons and volunteers acting during an emergency from tort liability, as the State of Michigan has done.[ii]

Existing buildings are regulated by numerous NYC agencies, including the Department of Buildings (DOB), the Fire Department of New York, the Department of Housing Preservation & Development (HPD) and the Department of Environmental Protection (DEP). For example, the Housing Maintenance Code regulates delivery of services to tenants including maintenance, service and utilities, (e.g., waste collection, water supply, sewers and drainage, heat and hot water, gas appliances, artificial lighting and protective devices and fire protection) and physical and occupancy standards for dwelling units (e.g., lighting and ventilation, sanitary facilities). [iii]

The following are examples of how the city might modify certain prescriptive existing building standards during disasters:

- The city issues violation notices and, when necessary, Orders to Vacate. Given that we cannot know in advance the specific consequences of any emergency, the agencies listed above should develop and publicize those rules and regulations for which enforcement may be reduced during and for a period after an emergency has been declared. In particular, we recommend that the city use a rule of reason and relax enforcement rules when specific violations are a direct result of a particular disaster or emergency.

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[i] Illinois Compiled Statutes ILCS 3305, Emergency Management Agency Act.
[ii] Michigan Emergency Management Act, Act 390 of 1976, Section 30.411. The following is sample language the State could utilize:

> An individual or entity engaged in disaster relief activity is not liable for the death of or injury to a person or persons, or for damage to property, as a result of that activity. An individual or an employee, agent, and volunteer of this entity that is engaged in disaster relief activity are immune from tort liability. As used in this section, "disaster relief activity" includes training for or responding to an actual, impending, mock, or practice disaster or emergency.

[iii] New York City Administrative Code, Chapter 2 Housing Maintenance Code, Section 27-2001 – 27-2153.

- The city evaluates decreased service complaints and can, among other things, order a rent reduction for affected tenants.[iv] Similar to the temporary suspension of certain housing rules and regulations described above, the city could temporarily suspend the rent reduction process for a defined period of time in connection with service reductions that have been directly caused by an emergency event.

- After Sandy, the DOB developed processes to streamline permit applications. Their solutions, which were intended to solve specific problems following Sandy, should be adopted as city practice for use following future events.

- The city should inform owners if regulation limiting their ability to pump out basements has been relaxed in the aftermath of a flood.

- The city suspends parking rules before and during events. This can allow vehicles, normally parked below grade or in flood zones, to be moved to higher ground before storms. The city should continue to disseminate information about parking rule suspension, with particular emphasis on flood zones. Additionally, the city should continue to ensure parking permits for temporary generators and boilers are quickly available when needed following emergencies or storm events.

**Implementation:**

Limitations of liability would need to be enacted as New York State law. We also recommend that city agencies issue policy and procedural updates after a state of emergency has been declared and its implications are understood.

**Cost:**

The cost of implementing this rule is negligible. No cost estimation was performed for this proposal.

[iv] See http://www.nyshcr.org/Rent/FactSheets/orafac14.htm.

# 31 Support Good Samaritan Legislation

## I. Summary

**Issue:**
Architects and engineers often hesitate to volunteer with emergency recovery efforts due to liability concerns.

**Recommendations:**
Enact New York State "Good Samaritan" legislation protecting architects and engineers from liability for emergency volunteer work.

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## II. Proposed Legislation, Rule or Study

*Enact New York State Good Samaritan Legislation:*

The New York State legislature should enact legislation that shields licensed engineers, architects, landscape architects and land surveyors from any claim of personal injury, wrongful death, property damage or other loss when they provide their professional services:

- on a voluntary basis;
- in response to or recovery from a declared national, state or local disaster or emergency;
- at the request of national, state or local governmental officials acting in an official capacity;
- unless such services were provided in a wanton, willful or grossly negligent manner or with intentional misconduct.

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## III. Supporting Information

**Expanded Issues and Benefits:**

During the 9/11 emergency recovery, architects and engineers rushed to Ground Zero to provide advice regarding structural, safety and other construction-related issues. Many of the design professionals who furnished services in the wake of and in connection with the cleanup and recovery efforts at and around the World Trade Center site have been named in lawsuits (many of which remain pending more than a decade later) alleging that they were somehow negligent and that such negligence caused workers and first responders at the site to incur injuries. Many architectural and engineering firms have now concluded that the liability risks are too high to volunteer during similar disasters. A legal shield to protect design professionals against liability in very specific circumstances would ensure that the City is able to draw upon the resources of the private sector to improve life safety conditions and mitigate additional damage following disasters or emergencies.

Currently, approximately 25 states have Good Samaritan legislation protecting architects and/or engineers responding to catastrophic situations and there is no federal legislation in place.[i] New York has not yet adopted such legislation, although there are bills pending in the State Senate and Assembly.[ii] Numerous professional societies, including the National Society of Professional Engineers and the American Institute of Architects, have advocated in favor of such legislation.

All 50 states have Good Samaritan legislation in place for volunteer licensed and/or certified medical personnel and other first responders acting in emergency situations.

In the aftermath of Superstorm Sandy, architects and engineers ready and willing to help assess storm damage were deterred by the threat of lawsuits like those faced by their colleagues in the wake of 9/11.[iii] Enactment of a Good Samaritan law will ensure that volunteer resources are available to the Department of Buildings and other city, state and federal agencies during future disasters by providing these volunteer professionals with appropriate legal protection.

**Cost:**

Passage of Good Samaritan legislation may reduce governmental costs for providing emergency design professional services by increasing the availability of volunteer resources. The legislation would put a supplemental voluntary workforce at the disposal of the Department of Buildings and any other agency requiring such services.

No cost estimation was performed for this proposal.

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i. See http://www.aia.org/aiaucmp/groups/aia/documents/pdf/aiab083366.pdf.
ii. New York State Senate Bill No. S03492 and New York State Assembly Bill No. A04380A, both introduced February 4, 2013.
iii. http://www.crainsnewyork.com/article/20130222/REAL_ESTATE/130229950.

# **32** Preapprove Emergency Inspectors

## I. Summary

**Issue:**
The Department of Buildings has procedures to mobilize large numbers of public and private sector inspectors trained for post-disaster building assessments. There are opportunities to speed implementation and enhance capabilities by formalizing this program.

**Recommendation:**
The Department of Buildings should formalize its practices by creating a Preapproved Emergency Inspector Program through its "special inspector" program to assist the city during emergencies.

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## II. Proposed Legislation, Rule or Study

The Department of Buildings should preapprove and establish a list of Special Inspectors trained in post-disaster building assessment who will form the core of a Preapproved Emergency Inspector Program.

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## III. Supporting Information

**Expanded Issue and Benefits:**

Following Superstorm Sandy, the Department of Buildings (DOB) retained eight private consulting firms that supplied over 200 engineers who were teamed with department inspectors to perform over 80,000 structural building assessments for storm-related damage. This follows a longstanding practice of pairing city and private sector resources to enable critical inspections to occur quickly.

Firms are selected using the department's contacts at many of the city's large engineering firms, based on their expertise, staff availability, and severity of the event. Many of these private sector staff are already trained under the same programs as city inspectors, which is ATC 45 "Safety Evaluation of Buildings after Wind Storms and Floods."

While the city already taps into private sector resources, a quality control process to prequalify these individuals would speed implementation of post-disaster assessments and could increase capabilities. This proposal recommends that DOB formalize its existing post-disaster process by prequalifying post-disaster inspectors through its Special Inspector Program. Under the Special Inspector program, private consultants are responsible for confirming that certain construction work is being done in accordance with approved plans and specifications.[i]

Similar programs are in place in San Francisco and the State of California. San Francisco's Department of Building Inspection has a Building Occupancy Resumption Program (BORP), which it describes as a "precertified emergency inspection program to allow a quick and thorough evaluation of possible damage to a structure by qualified persons familiar with the structural design and life-safety systems of the building."[ii] In the BORP program, inspectors are pre-assigned to inspect specific buildings. Importantly, San Francisco has established criteria for these inspectors, which can be adapted by New York City (The San Francisco program is based upon ATC-20 "Post-Earthquake Safety Evaluation of Buildings").[iii]

The State of California also has a Safety Assessment Program (SAP) managed by the California Emergency Management Agency. This program "utilizes volunteers and mutual aid resources to provide professional engineers and architects and certified building inspectors to assist local governments in safety evaluation of their built environment in an aftermath of a disaster." The SAP program requires design professionals to undergo specific training that is approved by the Department of Homeland Security and provides professional education credits to attendees.[iv]

**Implementation:**

An amendment to the New York City Building Code typically requires input from all stakeholders, including the NYC Department of Buildings, the City Council and representatives of the real estate, design and construction industries.

The Task Force is advocating separately for the passage of a Good Samaritan law that would protect voluntary post-emergency architects and engineers from liability. If these Special Inspectors are compensated, the city will need to consider how their liability will be covered.

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i. See http://www.nyc.gov/html/dob/html/development/special_insp_overview.shtml.
ii. The entire BORP emergency operations plan can be found at http://www.sfdbi.org/Modules/ShowDocument.aspx?documentid=772.
iii. These criteria are:
1. Structural Inspectors
   a. Current California license as a professional civil or structural engineer or architect
   b. Relevant experience in the structural design and/or inspection of similar buildings
   c. Proficiency in ATC-20 Detailed Evaluation Procedures
2. Elevator Inspectors
   a. Employment by a firm engaged in elevator maintenance and installation as their primary business.
   b. Familiarity with the building elevator installation
3. Life-safety System Inspectors (required for high-rise buildings)
   a. Familiarity with building life-safety system

iv. For more information on the SAP program, see http://www.calema.ca.gov/recovery/Pages/Safety-Assessment.aspx.

**Cost:**

Turner Construction Company did not perform cost estimation for this proposal. The following analysis was provided by the authors of this proposal:

Given that DOB already has in place the administrative framework for registering Special Inspectors, and the city already hires consultants to participate in post-disaster assessments, the cost would amount to processing and validating additional applications from those design professionals desiring to participate in a post-disaster response program. The DOB could charge a *de minimis* processing fee for such applications, if necessary, to cover any additional costs but should be mindful that these inspectors would most likely be voluntary.

# **33** Prenegotiate Emergency Recovery Agreements

## I. Summary

**Issue:**
Finding service providers and negotiating agreements can delay recovery for damaged buildings.

**Recommendation:**
As part of emergency planning, building owners and managers should identify service providers and prenegotiate emergency recovery agreements, reducing the economic and human impact of an emergency.

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## II. Proposed Legislation, Rule, or Study

The intent is to develop a pre-negotiated Master Agreement that is put into effect in advance of an emergency event to allow both the city as well as private owners and managers to engage contractors on an emergency basis.

As a best practice, the Master Agreement for each contractor or service should include:

1. Indemnification for all types of third-party claims.
2. Mutual limitations of liability.
3. Proper insurance coverage for builder's risk and hazardous materials.
4. Definition of payment terms.
5. The establishment of different delivery methods typically associated with emergency work, such as cost plus fee, unit pricing, etc.
6. Redefinition of procurement requirements to allow for sole source procurement, non-Wicks Law contracting, and the elimination of MWLBE requirements. In the types of extreme events where this type of an agreement would be put into effect, time is of the essence; therefore, circumstances may not permit a traditional bid/award process, because prequalified contractors may have to be engaged immediately to have their work force on-site in a matter of hours.
7. Deletion of damages clauses and notification of damages for delay.
8. Introduction of a mutual waiver of subrogation.
9. Defined reimbursable expenses, markups, and defined non-reimbursable costs.

As time is of the essence after severe weather events, any draft standard agreement must build in as much flexibility as possible to allow the fastest and most direct response, preferably within a day or two.

## III. Supporting Information

**Expanded Issue and Benefits:**

After a severe weather event, there is an urgent need for repair and remediation services to limit damage to buildings and to begin recovery. Electrical, mechanical, structural, and other elements of the building may need service, and mold and toxic materials may require cleanup before the building can be reoccupied. Despite the urgent need for these and other services, providers often cannot begin work until an agreement is negotiated due to indemnification, liability, insurance, and other issues. If these issues are resolved in advance of an emergency, work can be performed immediately on an “on-call” basis when needed. By using this standard draft agreement, buildings can prequalify vendors to perform work after an event (in terms of their specialties, capacity, business history, and other relevant factors) and then negotiate an agreement.

**Implementation:**

There are no anticipated difficulties in implementing this proposal.

**Cost:**

There is no additional cost to negotiating agreements before, instead of after, an extreme weather event. No cost estimation was performed for this proposal.

# Cost Methodology

## I. Introduction

Estimating the costs of complying with proposals developed by the Building Resiliency Task Force (BRTF) presented an interesting challenge, especially considering the diverse building types and construction projects in New York City. In order to create meaningful data associated with costing this wide range of building types, Turner Construction Company developed the following methodology.

## II. Building Types

The study focused on commercial (high and low rise) and residential (high and low rise) construction. Critical facilities (including hospitals and nursing homes) and single family homes were addressed separately and were not included in this study, although some of the data presented here may also be applicable to those building types.

There are many factors that may impact pricing. Turner worked with the BRTF to develop building typologies, as identified in Table 1. BRTF committees indicated how proposals applied to specific sectors. For each of the four building types, the study estimated costs to implement proposals in ground-up new construction and retrofit of existing buildings, where applicable, using the parameters described in Table 1. This allows a general high-level comparison of costs between new construction and retrofitting of existing building stock. New construction proved fairly straightforward to price; work in existing buildings was more problematic to price. Individual estimates list quantities and assumptions used to develop pricing of work in new in existing buildings as described by the adopted typologies.

It should be stressed that the models in shown in the table below do not represent any specific building in New York City in either new or existing conditions. Rather, taken together, they are representative of the range of commercial and residential high and low rise buildings that make up the city's building stock. Pricing per square foot will vary for buildings with a different floor area or number of stories, and this information should be kept in mind when interpreting the costs. For example, the total cost shown of $44,484 is the same for the voluntarily retrofit of a single sewage backflow preventer (proposal #8) for a high rise building, whether commercial or residential. For the commercial high rise building modeled, this is equivalent to a cost of $0.07/gross square foot. Since the fixed cost was the same but the residential building used in the model has less floor area, the cost would be almost three times higher on a per area basis for the residential high rise, at $0.19/gross square foot. Other buildings' results vary accordingly.

| Parameter | Unit | Commercial High Rise | Commercial Low Rise | Residential High Rise | Residential Low Rise |
|---|---|---|---|---|---|
| Footprint | Square feet | 20,000 | 2,000 | 11,000 | 3,000 |
| Stories | Number | 30 | 2 | 20 | 5 |
| Basement | Number | 1 | - | 1 | - |
| Total Area | Gross square feet | 620,000 | 4,000 | 231,000 | 15,000 |
| Electrical Service | Amps | 24,000 | 8,000 | 4,000 | - |

## III. Assumptions

Cost estimates to implement BRTF proposals were based on the following assumptions:

1. Pricing is rough-order-of-magnitude, with a goal of providing a general sense of the expense of each proposal. The cost is shown as price per gross square foot as well as in total dollars to facilitate comparison between building types for a particular estimate.
2. The cost estimate for each proposal includes direct subcontractor costs of labor, material, and equipment. In addition, cost estimates include general contractor mark-ups of 20% and a contingency of 10%. Design fees, permits and other “soft” costs are not included in the study.
3. In some cases, multiple compliance paths are shown, based upon different options to meet proposal requirements or different initial circumstances that might be encountered. In general, the lowest reasonable cost option to comply with a proposal was selected, but since Turner examined the typical case for a given proposal, prices shown do not necessarily represent the best, worst, or median cost that might be experienced during actual construction of a specific project.
4. Proposals that impacted operational and administrative changes for buildings, such as the creation of emergency plans, were not evaluated. Turner also did not evaluate proposals that were best practice recommendations, proposals that aimed only to remove regulatory or other barriers, or recommendations that clarify requirements already in the building code.
5. The analysis included ancillary hard construction costs that would be required to complete the scope of work for a proposal. For example, the cost to install conduit to feed emergency lights in hallways of an existing building includes the cost to patch and paint drywall.
6. Costs are based on the Turner database and recent subcontractor bids as of the first half of 2013. Future market trends were not considered.
7. Labor rates are based upon union labor. While labor rates for non-union crews may be lower, other cost factors such as premiums for small projects and buying power with vendors influence the total cost of a project. The cost to implement any proposal on a given building will vary from the cost listed in this study due to complexities inherent in specific projects that may not be addressed in the building typologies used in the study. The variance between

costs in the boroughs within New York City is within the level of accuracy of the rough-order-of-magnitude numbers.

8. The study found that costs were naturally absorbed in some instances if proposals were implemented during the design phase for new construction. With prior planning, the cost impact to relocate building systems, for example, is negligible. In these instances, the study indicates a zero dollar cost.
9. Each proposal was costed as a stand-alone design package. The study does not address and possible savings or additional costs that might result from grouping multiple proposals in one project.
10. The cost impact on operations and maintenance, such as fuel costs and labor to maintain an emergency generator, was not included in this analysis.
11. The cost impact on owners' revenue streams, such as rental income adjustments, was not included in this analysis.

## IV. Abbreviations in Cost Details

ALW = allowance
EA = each
CY = cubic yards
GC = general contractor
GSF = gross square feet
HRS = work-hours
LF = linear feet
LS = lump sum

## Building Typologies - Summary

| Parameter | Unit | Commercial High Rise | Commercial Low Rise | Residential High Rise | Residential Low Rise |
|---|---|---|---|---|---|
| | | | | | |
| Footprint | sf | 20,000 | 2,000 | 11,000 | 3,000 |
| Stories | no. | 30 | 2 | 20 | 5 |
| Basement | no. | 1 | - | 1 | - |
| Total Area | gsf | 620,000 | 4,000 | 231,000 | 15,000 |
| Exterior Wall Area | sf | 247,500 | 6,030 | 111,750 | 13,750 |
| Electrical Service | amps | 24,000 | 8,000 | 4,000 | - |
| | | | | | |

**Cost Model - Commercial High-rise**

| Level | TOTAL GSF | Floor Height (FT) | Bldg Length (FT) | Bldg Width (FT) | Perimeter (FT) | Exterior Wall Area (SF) | Roof (SF) |
|---|---|---|---|---|---|---|---|
| Parapet Wall | | 4 | 100 | 200 | 600 | 2,100 | |
| Roof | | | | | | | 2,000 |
| 30 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 29 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 28 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 27 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 26 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 25 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 24 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 23 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 22 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 21 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 20 | 20,000 | 13 | 100 | 200 | 1,320 | 7,800 | |
| 19 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 18 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 17 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 16 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 15 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 14 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 13 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 12 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 11 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 10 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 9 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 8 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 7 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 6 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 5 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 4 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 3 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| 2 | 20,000 | 13 | 100 | 200 | 600 | 7,800 | |
| Ground Floor | 20,000 | 17 | 100 | 200 | 600 | 10,200 | |
| Cellar Level | 20,000 | 15 | 100 | 200 | 600 | 9,000 | |
| Totals | 620,000 | 413 | | | 19,200 | 247,500 | 20,000 |

**Cost Model - Commercial Low-rise**

| Level | TOTAL GSF | Floor Height (FT) | Bldg Length (FT) | Bldg Width (FT) | Perimeter (FT) | Exterior Wall Area (SF) | Roof (SF) |
|---|---|---|---|---|---|---|---|
| Parapet Wall | | 4 | 40 | 50 | 180 | 630 | |
| Roof | | | | | | | 2,000 |
| 2 | 2,000 | 13 | 40 | 50 | 180 | 2,340 | |
| Ground Floor | 2,000 | 17 | 40 | 50 | 180 | 3,060 | |
| Cellar Level | - | - | | | | | |
| Totals | 4,000 | 34 | | | 540 | 6,030 | 2,000 |

**Cost Model - Residential Low-rise Attached**

| Level | TOTAL GSF | Floor Height (FT) | Bldg Length (FT) | Bldg Width (FT) | Perimeter (FT) | Exterior Wall Area (SF) | Roof (SF) |
|---|---|---|---|---|---|---|---|
| Parapet Wall | | 4 | 50 | 60 | 220 | 770 | |
| Roof | | | | | | | 3,000 |
| 5 | 3,000 | 11 | 50 | 60 | 220 | 2,420 | |
| 4 | 3,000 | 11 | 50 | 60 | 220 | 2,420 | |
| 3 | 3,000 | 11 | 50 | 60 | 220 | 2,420 | |
| 2 | 3,000 | 11 | 50 | 60 | 220 | 2,420 | |
| Ground Floor | 3,000 | 15 | 50 | 60 | 220 | 3,300 | |
| Cellar Level | - | - | - | - | - | - | |
| Totals | 15,000 | 63 | | | 1,320 | 13,750 | 3,000 |

**Cost Model - Residential High-rise**

| Level | TOTAL GSF | Floor Height (FT) | Bldg Length (FT) | Bldg Width (FT) | Perimeter (FT) | Exterior Wall Area (SF) | Roof (SF) |
|---|---|---|---|---|---|---|---|
| Parapet Wall | | 4 | 100 | 110 | 420 | 1,470 | |
| Roof | | | | | | | 11,000 |
| MER -screen | - | - | - | - | - | - | |
| MER -screen | - | - | - | - | - | - | |
| 20 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 19 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 18 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 17 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 16 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 15 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 14 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 13 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 12 | 11,000 | 11 | 100 | 110 | 1,320 | 14,520 | |
| 11 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 10 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 9 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 8 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 7 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 6 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 5 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 4 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 3 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| 2 | 11,000 | 11 | 100 | 110 | 420 | 4,620 | |
| Ground Floor | 11,000 | 15 | 100 | 110 | 420 | 6,300 | |
| Cellar Level | 11,000 | 15 | 100 | 110 | 420 | 6,300 | |
| Sub Cellar | - | - | - | - | - | - | |
| Totals | 231,000 | 243 | | | 9,240 | 111,750 | 11,000 |

## NEW CONSTRUCTION

ESTIMATE SUMMARY - CONSTRUCTION COSTS PER SQUARE FOOT

| | | Description | Commercial High Rise 620,000 GSF $/GSF | Commercial Low Rise 4,000 GSF $/GSF | Residential High Rise 231,000 GSF $/GSF | Residential Low Rise 15,000 GSF $/GSF |
|---|---|---|---|---|---|---|
| A. Stonger Buildings | 1 | Prevent Storm Damage to Homes | See Proposal | See Proposal | See Proposal | See Proposal |
| | 2 | Launch a Design Competition for Raised Homes | Recommended | Recommended | Recommended | Recommended |
| | 3 | Relocate & Protect Building Systems | $0 | $0 | $0 | $0 |
| | 4 | Remove Barriers to Elevating Buildings & Building Systems | Remove Barrier | Remove Barrier | Remove Barrier | Remove Barrier |
| | 5 | Remove Barriers to Sidewalk Flood Protection | Remove Barrier | Remove Barrier | Remove Barrier | Remove Barrier |
| | 6 | Add Backup Fire Safety Communication | $0.18 | N/A | $0.24 | N/A |
| | 7 | Safeguard Toxic Materials Stored in Flood Zones | $0 | $0 | $0 | $0 |
| | 8 | Prevent Sewage Backflow | $0.06 | $7.10 | $0.15 | $1.89 |
| | 9 | Plant Wind & Flood Resistant Trees | $0.04 | $4.03 | $0.07 | $0.84 |
| | 10 | Clarify Construction Requirements in Flood Zones | $0 | $0 | $0 | $0 |
| | 11 | Prevent Wind Damage to Existing Buildings | $2.18 | $26.80 | $3.41 | $7.70 |
| | 12 | Analyze Wind Risks | Further Action | Further Action | Further Action | Further Action |
| | 13 | Capture Stormwater to Prevent Flooding | Recommended | Recommended | Recommended | Recommended |
| | 14 | Use Cool Surfaces to Reduce Summer Heat | N/A | $0.66 | N/A | $0.26 |
| B. Backup Power | 15 | Choose Reliable Backup Power & Prioritize Needs | Recommended | Recommended | Recommended | Recommended |
| | 16 | Use Cogeneration & Solar During Blackouts | Recommended | Recommended | Recommended | Recommended |
| | 17 | Remove Barriers to Backup & Natural Gas Generators | Remove Barrier | Remove Barrier | Remove Barrier | Remove Barrier |
| | 18 | Remove Barriers to Cogeneration | Remove Barrier | Remove Barrier | Remove Barrier | Remove Barrier |
| | 19 | Remove Barrier to Solar Energy | Remove Barrier | Remove Barrier | Remove Barrier | Remove Barrier |
| | 20 | Add Hookups for Temporary Generators & Boilers | | | | |
| | 20.1 | *Boiler (Hot Water)* | $0.62 | N/A | $1.14 | N/A |
| | 20.2 | *Boiler (Steam)* | $0.73 | N/A | $1.32 | N/A |
| | 20.3 | *Chiller* | $0.69 | N/A | $1.22 | N/A |
| | 20.4 | *Generator (Switchgear Room Adjacent to Access Panel; Extend Bus Only)* | $0.06 | N/A | $0.03 | N/A |
| | 20.5 | *Generator (Switchgear Room Adjacent to Access Panel; Tapbox with Kirkkey Interlock)* | $1.79 | N/A | $0.80 | N/A |
| | 20.6 | *Generator (Switchgear Room ~200 LF from Access Panel; Extend Bus Only)* | $5.80 | N/A | $2.61 | N/A |
| | 20.7 | *Generator (Switchgear Room ~200 LF from Access Panel; Tapbox with Kirkkey Interlock)* | $6.10 | N/A | $2.73 | N/A |
| | 21 | Keep Residential Stairwells & Hallways Lit During Blackouts | | | | |
| | 21.1 | *Building with 2 Units Per Floor (Connect Emergency Egress Lighting to Gas-Fired Generators)* | N/A | N/A | $0 | $0 |
| | 21.2 | *Building with 2 Units Per Floor (Integral Battery)* | N/A | N/A | $0.50 | $2.04 |
| | 21.3 | *Building with 2 Units Per Floor (Remote Battery)* | N/A | N/A | $0.52 | $2.25 |
| | 21.4 | *Building with 11 Units Per Floor (Integral Battery)* | N/A | N/A | $0.96 | $3.78 |
| | 21.5 | *Building with 11 Units Per Floor (Remote Battery)* | N/A | N/A | $0.96 | $3.98 |
| | 22 | Keep Gas Stations Open During Blackouts | Currently in Code | Currently in Code | Currently in Code | Currently in Code |
| C. Essential Safety | 23 | Supply Drinking Water Without Power | | | | |
| | 23.1 | *Added Water Fixtures in a Room Already with an Approved Sink (ex: Laundry Room)* | N/A | N/A | $0.08 | N/A |
| | 23.2 | *Dedicated Emergency Potable Water Cabinets in Common Space* | N/A | N/A | $0.22 | N/A |
| | 24 | Ensure Toilets & Sinks Work Without Power | | | | |
| | 24.1 | *Battery Powered* | $0.03 | $0.26 | $0.20 | N/A |
| | 24.2 | *Electrical With True Mechanical Override* | $0.04 | $0.40 | $0.30 | N/A |
| | 25 | Enhance Building Water Reserves | Recommended | Recommended | Recommended | Recommended |
| | 26 | Ensure Operable Windows in Residential Buildings | Further Action | Further Action | Further Action | Further Action |
| | 27 | Maintain Habitable Temperatures Without Power | Further Action | Further Action | Further Action | Further Action |
| D. Better Planning | 28 | Create Emergency Plans | Not Costed | Not Costed | Not Costed | Not Costed |
| | 29 | Adopt An Existing Building Code | Further Action | Further Action | Further Action | Further Action |
| | 30 | Don't Discourage Buildings From Operating During Emergencies | Further Action | Further Action | Further Action | Further Action |
| | 31 | Support Good Samaritan Legislation | Further Action | Further Action | Further Action | Further Action |
| | 32 | Preapprove Emergency Inspectors | Further Action | Further Action | Further Action | Further Action |
| | 33 | Prenegotiate Emergency Recovery Agreements | Remove Barrier | Remove Barrier | Remove Barrier | Remove Barrier |

## EXISTING BUILDINGS

ESTIMATE SUMMARY - CONSTRUCTION COSTS PER SQUARE FOOT

| Section | # | Description | Commercial High Rise 620,000 GSF $/GSF | Commercial Low Rise 4,000 GSF $/GSF | Residential High Rise 231,000 GSF $/GSF | Residential Low Rise 15,000 GSF $/GSF |
|---|---|---|---|---|---|---|
| A. Stronger Buildings | 1 | Prevent Storm Damage to Homes | See Proposal | See Proposal | See Proposal | See Proposal |
| | 2 | Launch a Design Competition for Raised Homes | Recommended | Recommended | Recommended | Recommended |
| | 3 | Relocate & Protect Building Systems | Recommended | Recommended | Recommended | Recommended |
| | 4 | Remove Barriers to Elevating Buildings & Building Systems | Remove Barrier | Remove Barrier | Remove Barrier | Remove Barrier |
| | 5 | Remove Barriers to Sidewalk Flood Protection | Remove Barrier | Remove Barrier | Remove Barrier | Remove Barrier |
| | 6 | Add Backup Fire Safety Communication | $0.18 | N/A | $0.24 | N/A |
| | 7 | Safeguard Toxic Materials Stored in Flood Zones | $0 | $0 | $0 | $0 |
| | 8 | Prevent Sewage Backflow | $0.07 | $8.09 | $0.19 | $2.16 |
| | 9 | Plant Wind & Flood Resistant Trees | $0.04 | $4.03 | $0.07 | $0.84 |
| | 10 | Clarify Construction Requirements in Flood Zones | $0 | $0 | $0 | $0 |
| | 11 | Prevent Wind Damage to Existing Buildings | Recommended | Recommended | Recommended | Recommended |
| | 12 | Analyze Wind Risks | Further Action | Further Action | Further Action | Further Action |
| | 13 | Capture Stormwater to Prevent Flooding | Recommended | Recommended | Recommended | Recommended |
| | 14 | Use Cool Surfaces to Reduce Summer Heat | N/A | $0.66 | N/A | $0.26 |
| B. Backup Power | 15 | Choose Reliable Backup Power & Prioritize Needs | Recommended | Recommended | Recommended | Recommended |
| | 16 | Use Cogeneration & Solar During Blackouts | Recommended | Recommended | Recommended | Recommended |
| | 17 | Remove Barriers to Backup & Natural Gas Generators | Remove Barrier | Remove Barrier | Remove Barrier | Remove Barrier |
| | 18 | Remove Barriers to Cogeneration | Remove Barrier | Remove Barrier | Remove Barrier | Remove Barrier |
| | 19 | Remove Barrier to Solar Energy | Remove Barrier | Remove Barrier | Remove Barrier | Remove Barrier |
| | 20 | Add Hookups for Temporary Generators & Boilers | | | | |
| | 20.1 | *Boiler (Hot Water)* | $0.82 | N/A | $1.34 | N/A |
| | 20.2 | *Boiler (Steam)* | $0.79 | N/A | $1.50 | N/A |
| | 20.3 | *Chiller* | $0.76 | N/A | $1.41 | N/A |
| | 20.4 | *Generator (Switchgear Room Adjacent to Access Panel; Extend Bus Only)* | $0.06 | N/A | $0.03 | N/A |
| | 20.5 | *Generator (Switchgear Room Adjacent to Access Panel; Tapbox with Kirkkey Interlock)* | $1.79 | N/A | $0.80 | N/A |
| | 20.6 | *Generator (Switchgear Room ~200 LF from Access Panel; Extend Bus Only)* | $5.80 | N/A | $2.61 | N/A |
| | 20.7 | *Generator (Switchgear Room ~200 LF from Access Panel; Tapbox with Kirkkey Interlock)* | $6.10 | N/A | $2.73 | N/A |
| | 21 | Keep Residential Stairwells & Hallways Lit During Blackouts | | | | |
| | 21.1 | *Building with 2 Units Per Floor (Connect Emergency Egress Lighting to Gas-Fired Generators)* | N/A | N/A | $0 | $0 |
| | 21.2 | *Building with 2 Units Per Floor (Integral Battery)* | N/A | N/A | $0.60 | $2.33 |
| | 21.3 | *Building with 2 Units Per Floor (Remote Battery)* | N/A | N/A | $0.61 | $6.79 |
| | 21.4 | *Building with 11 Units Per Floor (Integral Battery)* | N/A | N/A | $1.15 | $11.51 |
| | 21.5 | *Building with 11 Units Per Floor (Remote Battery)* | N/A | N/A | $1.14 | $12.11 |
| | 22 | Keep Gas Stations Open During Blackouts | Currently in Code | Currently in Code | Currently in Code | Currently in Code |
| C. Essential Safety | 23 | Supply Drinking Water Without Power | | | | |
| | 23.1 | *Tap off Existing Sink and Common Space Area* | N/A | N/A | $0.09 | N/A |
| | 23.2 | *New Emergency Potable Water Cabinets* | N/A | N/A | $0.35 | N/A |
| | 24 | Ensure Toilets & Sinks Work Without Power | | | | |
| | 24.1 | *Battery Powered* | $0.48 | Recommended | $2.95 | N/A |
| | 24.2 | *Electrical With True Mechanical Override* | $0.50 | Recommended | $3.05 | N/A |
| | 25 | Enhance Building Water Reserves | N/A | N/A | Recommended | Recommended |
| | 26 | Ensure Operable Windows in Residential Buildings | Further Action | Further Action | Further Action | Further Action |
| | 27 | Maintain Habitable Temperatures Without Power | Further Action | Further Action | Further Action | Further Action |
| D. Better Planning | 28 | Create Emergency Plans | Not Costed | Not Costed | Not Costed | Not Costed |
| | 29 | Adopt An Existing Building Code | Further Action | Further Action | Further Action | Further Action |
| | 30 | Don't Discourage Buildings From Operating During Emergencies | Further Action | Further Action | Further Action | Further Action |
| | 31 | Support Good Samaritan Legislation | Further Action | Further Action | Further Action | Further Action |
| | 32 | Preapprove Emergency Inspectors | Further Action | Further Action | Further Action | Further Action |
| | 33 | Prenegotiate Emergency Recovery Agreements | Remove Barrier | Remove Barrier | Remove Barrier | Remove Barrier |