11. Recommendations

The recommendations in this report are based solely on the observations and conclusions of the MAT. They are intended to assist the States of Alabama, Louisiana, and Mississippi; communities; businesses; and individuals in the reconstruction process; and to help reduce future damage and impacts from flood and design level wind events similar to Hurricane Katrina. The recommendations will also help FEMA assess the adequacy of building performance standards as they relate to flood hazard mapping and floodplain management requirements and determine whether changes are needed or additional guidance required.

The general recommendations presented in Sections 11.1 (for flood) and 11.2 (for wind) relate to measures that are needed to ensure that designers, contractors, building officials, and coastal populations understand what is necessary for disaster-resistant construction in hurricane-prone regions.

11.1 Flood Related Recommendations

A few of the main recommendations are outlined in the following sections; details and additional recommendations are provided in Tables 11-1 through 11-4.

11.1.1 Codes and Standards

Adoption of modern building codes, such as the IBC, IRC, or NFPA 5000 are recommended. These codes include up-to-date design and construction provisions that are consistent with the NFIP. The 2006 editions of the IBC and NFPA 5000 incorporate flood load (ASCE 7-05) and flood-resistant construction (ASCE 24-05) standards (see Table 11-1). The IRC currently does not explicitly reference ASCE 7 and ASCE 24 for flood loads and flood-resistant construction. Thus, it is recommended that communities containing land within the estimated 100-year floodplain shown on the Katrina Flood Recovery Maps use ASCE 7-05 for flood load calculations and ASCE 24-05 for flood-resistant one- and two-family residential construction purposes. Adoption of any model code or standard should keep intact the minimum criteria established by the parent or expert document such as ASCE 7 or ASCE 24.

In the case of new and replacement manufactured home installations, adoption of the 2005 edition of NFPA 225 (*Model Manufactured Home Installation Standard*) is recommended. This edition of NFPA 225 contains the latest flood- and wind-resistant guidance for installation in hurricane- and flood-prone areas.

Table 11-1. Flood Hazard - Design and Construction Recommendations

Flood Hazard		
Building Component	**Recommendation***	
Design, Foundations, and Structures		
Code	1.	Adopt the 2006 IBC, IRC, or NFPA 5000 building codes for all jurisdictions in Alabama, Louisiana, and Mississippi.
Code	2.	Adopt the ASCE 24-05 for all jurisdictions in Alabama, Louisiana, and Mississippi.

* All recommendations are detailed in this report unless otherwise noted,

11.1.2 General Hazard Identification

Hurricane Katrina was a significant event that destroyed buildings well beyond the effective SFHA; in order to assess the adequacy of current flood mapping and hazard identification, a few of the key recommendations are provided below (additional recommendations are provided in Table 11-2):

- Evaluate existing storm surge modeling: Review the storm surge data and modeling procedures that served as the basis for the effective FIRMs. Conduct a revised tide frequency analysis,

update storm climatology for the area, and use modern storm surge models to estimate the BFEs throughout the Katrina impact area.

- Katrina Flood Recovery Maps: As an interim approach (pending completion of coastal flood restudies), adopt the ABFEs and flood hazard areas shown on the Katrina Flood Recovery Maps. This approach is preferable to adding freeboard within the SFHA on the pre-Katrina effective FIRM, because the latter approach does not address known flood hazards outside the mapped SFHA.
- Re-evaluate the hazard identification/mapping approaches in coastal flood hazard zones. Re-evaluate and revise the methodology used to determine flood zones and flood elevations in coastal areas.
- Revise flood hazard mapping procedures and maps for areas behind levees: Refer to Section 11.1.3 for recommendations.

11.1.3 Long-Duration Flooding Impact

In order to adequately portray the risk to buildings within levee-protected areas, the guidance and procedures for hazard mapping in areas protected by levees need to be re-evaluated. Recommendations are provided in Table 11-3 and a few of the key recommendations are described below:

Flood hazard mapping procedures and maps for areas behind leveesshould be revised. As guidance in carrying out the requirements of 44 CFR 65.10, FEMA issued an August 22, 2005, memo titled "Procedure Memorandum 34 – Interim Guidance for Studies Including Levees" (FEMA, David I. Maurstad, August 22, 2005) for immediate implementation. This memo provides guidance and standards in properly identifying flood hazards in areas possibly protected by levees. The procedure includes working with local entities responsible for levees to determine the accreditation of the levee providing flood protection. If a levee is not accredited, the area behind the levee will be identified as SFHA and will reflect the actual BFE. A copy of the memo is included in Appendix G.

The long-duration flooding of buildings in the New Orleans area resulted in deterioration of certain building materials, as well as contamination of building materials from biological vectors or agents and chemical contaminants.

The presence and concentration of the bacteria types and levels identified by the New Orleans Flood Team means that workers involved in the tear-out and cleanup of flooded structures are at risk of disease if not properly protected. Safety precautions (including the use of personal protective equipment) will need to be taken by building owners and restoration workers during repair and reconstruction work to minimize the health risks from biological and chemical contaminants (see the OSHA website <http://www.osha.gov>). Full face respirators would shield the eyes and respiratory tract. Any wounds, even small scratches, that result from such work should be disinfected promptly and covered to prevent infection. Similarly, the variety of fungal types and extensive levels of visible contamination in all of the examined structures support the use of extensive personal protective equipment during demolition and cleanup. The rampant fungal growth also reinforces the recommendation to remove and replace porous materials impacted by floodwaters.

Table 11-2. Flood Hazard - Hazard Identification and Regulations Recommendations for Government Agencies

Flood Hazard		
Parameter		Recommendation*
Hazard Identification and Regulation		
Storm Surge	1.	Review the storm surge data and modeling procedures that served as the basis for the effective FIRMs. Conduct a revised tide frequency analysis, update storm climatology for the area, and use modern storm surge model to estimate the BFEs throughout the Katrina impact area.
Katrina Flood Recovery Maps	2.	Adopt the Katrina Flood Recovery Maps as an interim approach (pending completion of coastal flood restudies). This approach is preferable to adding freeboard within the SFHA on the pre-Katrina effective FIRM, since the latter approach does not address known flood hazards outside the mapped SFHA. Post-event flood recovery maps should delineate the 100-year and 500-year flood limits and hazard zones, including the landward limits of anticipated V Zone, Coastal A Zone, and A Zone conditions. For future Recovery Maps, develop 500-year Advisory Flood Elevations.
Mapping	3.	Include 500-year elevation determinations for future ABFEs performed; this information is vital to reconstruction of critical and essential facilities.
Mapping Flood Hazards in Coastal Areas	4.	Re-evaluate the methodology to determine flood zones and flood elevations in coastal areas. Post-hurricane investigation revealed damage to A Zone-type structures exposed to less than 3-foot waves. Consider adoption of the 1.5-foot breaking wave height as the basis for mapping Coastal A Zones and requiring V Zone type building standards (the distinction currently is based on a 3-foot breaking wave height). Following a major coastal flood event that causes severe erosion and/or significant topographic changes to upland areas, evaluate whether updating the FIRMs is required and, if so, revise the FIRMs.
Future Conditions Mapping	5.	The effects of long-term erosion, wetland loss, sea level rise, and subsidence should be incorporated into flood hazard identification and mapping. Even if shown as optional data layers, the information will be available to communities, designers, lenders, and owners.
Flood Insurance Premiums	6.	Flood insurance provisions and premiums should reflect the actual risk during base flood conditions. For example, actual risk refers to those flood conditions that would potentially exist if the levees provided minimum, or no, protection.
Flood Insurance Premiums	7.	Flood insurance provisions and premiums should reward best practices for siting, design, and construction.
"What If" Mapping	8.	Maps should be developed that illustrate the effects of various disaster scenarios, such as floods that exceed design levels. These maps, to be developed by state and local agencies, can help educate local officials and the public, and can be used as a planning and decision-making tool. Coordination of "what if" mapping with local mitigation strategies and evacuation planning will be required.

* All recommendations are detailed in this report unless otherwise noted.

The presence of the chemical contaminants detected in flood-impacted building materials indicates the use of proper personal protective equipment during all restoration activities, including respirators with HEPA filters or masks rated N-95 or higher. Furthermore, based on the presence of contaminants such as DROs, heavy metals, and pesticides in porous building materials, it is recommended that all flood-impacted porous materials be removed from buildings during restoration.

For additional details on safety precautions and flood restoration techniques, refer to the FEMA Hurricane Recovery Advisories, *The ABCs of Returning to Flooded Buildings,* and *Initial Restoration for Flooded Buildings.* FEMA Recovery Advisories can be found at http://www.fema.gov/rebuild/mat/mat_katrina.shtm.

11.1.4 Design and Construction

Recommendations related to design and construction of buildings are presented in Table 11-4. Some of the main recommendations include:

It is highly recommended that buildings be constructed to survive flood levels that exceed the base flood design conditions. Flood conditions can exceed those shown on the FIRM for a variety of reasons, but the most common include: storms more severe than the 1 percent annual chance flood; and outdated flood maps, either because of changed site conditions, the availability of better topographic data, or improved modeling procedures. For these reasons, design for flood conditions more severe than the base flood is recommended.

Constructing buildings to survive flood levels can be done by elevating the lowest floor above the BFE (preferably to the ABFE), choosing a foundation that is more resistant to flood forces and erosion, and using flood damage-resistant materials above the BFE. Using these measures will make a building more "storm-resilient," reduce future flood damages, provide for easier repairs, and reduce flood insurance premiums.

- Although not mandated by the IRC, use the 2005 edition of ASCE 24 for flood-resistant design of one- and two-family structures in coastal areas, as well as for floodways. Moreover, use the 2005 edition of ASCE-24 and update, from the 1998 edition, referenced by the 2003 IBC and IRC.
- Use the *Home Builder's Guide to Coastal Construction Technical Fact Sheets* (FEMA 499) found at http://www.fema.gov/rebuild/mat/mat_fema499.shtm and the *Coastal Construction Manual* (FEMA 55) for additional guidance related to flood- and wind-resistant design and construction.
- Refer to the National Institute of Building Sciences (NIBS) *Whole Building Design Guide* for more flood recommendations for commercial and public buildings (http://www.wbdg.org/design/env_flood.php).

Table 11-3. Flood Hazard - Long-Duration Flooding Impact Recommendations

Flood Hazard			
Category		Recommendation*	Action Required By**
Flooding within Levee-Protected Areas	1.	Implement FEMA Procedure Memorandum - Interim Guidance for Studies Including Levees (FEMA, David I. Maurstad, August 22, 2005). This memo provides guidance and standards in properly identifying flood hazards in areas possibly protected by levees. The procedure includes working with local entities responsible for levees to determine the accreditation of the levee providing flood protection. If a levee is not accredited, the area behind the levee will be identified as a SFHA and will reflect the actual BFE.	G
	2.	Revise hazard identification and mapping procedures to consider predicted rates of sea level rise and subsidence.	G
	3.	Building owners should consider the savings in repair costs from damages that may occur in future events versus the initial cost in constructing the building to a higher elevation.	C, O
	4.	Develop "what if" maps for levee-protected areas to illustrate the effects of various disaster scenarios, such as floods that exceed design levels and levee failures. The maps, to be developed by state and local agencies, can help educate local officials and the public, and can be used as a planning and decision-making tool.	G
Biological and Chemical Contamination of Building Materials	5.	For details on safety precautions and flood restoration techniques, refer to the FEMA Hurricane Recovery Advisories: *The ABC's of Returning to Flooded Buildings* and *Initial Restoration for Flooded Buildings.* Recovery Advisories can be found at: www.fema.gov/rebuild/mat/mat_katrina.shtm	C, O
	6.	To facilitate restoration of flooded buildings, building owners should: ■ Open windows and doors to maximize air flow ■ Remove contents for restoration or disposal ■ Remove porous wall materials, fibrous wall insulation, carpeting, vinyl flooring, and electrical components that were impacted by floodwaters ■ Thoroughly clean and sanitize interior surfaces ■ Allow sufficient time for drying prior to initiating reconstruction activities	C, O
	7.	Take appropriate safety precautions (including the use of personal protective equipment) during repair and reconstruction work to minimize the health risks from biological and chemical contaminants.	C, O
	8.	Conduct a feasibility study to develop screening standards and action levels for building materials exposed to chemical contaminants.	G

* All recommendations are detailed in this report unless otherwise noted.

** Action required by: Contractor (C), Government Official (G), Building Owner (O).

Table 11-4. Flood Hazard - Design and Construction Recommendations

Flood Hazard			
Building Component		Recommendation*	Action Required By**
Design, Foundations, and Structures			
Design Guidance	1.	Use ASCE 7-05, Chapter 5 for the calculation of flood loads during the base flood, including floodborne debris loads.	D, C, G
Design Guidance	2.	Use ASCE 24-05 for the flood-resistant design of all structures in flood hazard areas, including one- and two-family structures.	D, C, G
Design Guidance	3.	Use the *Home Builder's Guide to Coastal Construction Technical Fact Sheets* (FEMA 499) and the *Coastal Construction Manual* (FEMA 55) for additional guidance related to flood and wind resistant design and construction.	D, C, G
Design Guidance	4.	Use the guide: *Recommended Residential Construction for the Gulf Coast: Building on Strong and Safe Foundations* (FEMA 550).	D, C, G
Installation Guidance, Manufactured Homes	5.	Where manufacturers' installation manuals don't prohibit placing homes in the floodplain, use NFPA 225 for installation of new and replacement manufactured homes in flood hazard areas.	D, C, G
Installation Guidance, Historic Buildings	6.	Refer to the recommendations in this section for those elements that apply and coordinate with the State Historic Preservation Officer. For the vacant buildings, it is necessary to take earlier precautionary measures to stabilize the building to prevent deterioration, which may be further exacerbated by a major storm.	D, C, G
Coastal A Zones	7.	Require V Zone standards for new construction, per ASCE 24-05, in Coastal A Zones subject to erosion, scour, velocity flow, and/or subject to wave heights greater than 1.5 feet.	D, C, G
Foundation Type	8.	Select the type of foundation based on the flood hazards depicted on the Katrina Flood Recovery Maps, not based on the flood hazard zones shown on the pre-Katrina FIRMs.	D, C, G

* All recommendations are detailed in this report unless otherwise noted.

** Action required by: Designer (D), Contractor (C), Government Official (G).

Table 11-4. Flood Hazard - Design and Construction Recommendations (continued)

Flood Hazard			
Building Component		Recommendation*	Action Required By**
Design, Foundations, and Structures			
Use of Fill	9.	In some V Zone areas shown on the Katrina Flood Recovery Maps, ABFEs are many feet above grade. This can result in lowest floor elevations of new and reconstructed buildings more than one story above grade. Design professionals, communities, and owners may wish to consider the feasibility of adding non-structural fill under and around new or reconstructed buildings. The use of fill may facilitate building access, improve the aesthetics of highly elevated buildings, and reduce local flood depths near buildings. An engineering evaluation can assess the stability and impact of non-structural fill, both from a damage-prevention standpoint and a damage inducing standpoint (i.e., potential wave runup and flood flow deflection). ASCE 24-05 provides some guidance on the technical evaluation of such fill. Other issues (e.g., economic and environmental) may also require evaluation.	D, C, G
Shear Wall Foundation	10.	Investigate the technical, policy and financial implications of allowing shore-perpendicular foundation walls beneath one- and two-family residential buildings in V Zones where the required lowest floor elevation above the ground is in excess of one story.	G
Lowest Floor Elevation	11.	Elevate all new construction (including substantially improved structures and replacement of substantially damaged structures) in coastal flood hazard zones with the bottom of the lowest horizontal supporting member above the BFE (preferably to the ABFE). Freeboard for all buildings in all special flood hazard zones is desirable; the amount will vary with building importance, but ASCE 24-05 can provide guidance.	D, C, G
Ground Level Slabs, Fully-Engineered, Multi-Story Construction (governed by the IBC)	12.	The ground level floor of a multi-story building (typically used for parking or building access) should either: 1) use a lowest floor slab or floor system that will not collapse and can support all anticipated design loads and conditions, including undermining, or 2) use a slab or floor system that will collapse into small pieces.	D, C, G
Ground Level Slabs, Buildings (governed by the IRC)	13.	Within the V Zone, the grade-level slab should collapse and break into small pieces if undermined. The same performance is recommended for elevated buildings in Coastal A Zones subject to erosion, scour, velocity flow, and/or subject to wave heights greater than 1.5 feet. Slabs under elevated buildings in non-Coastal A Zones need not break up.	D, C, G

* All recommendations are detailed in this report unless otherwise noted.
** Action required by: Designer (D), Contractor (C), Government Official (G).

Table 11-4. Flood Hazard - Design and Construction Recommendations (continued)

Flood Hazard			
Building Component		Recommendation*	Action Required By**
Design, Foundations, and Structures			
Debris Impacts	14.	Buildings should be designed, and constructed, to resist loads and conditions during the design flood. At a minimum, the design flood should be the base flood, but designing for more severe floods is recommended in accordance with ASCE 24-05. Floodborne debris characteristics and loads should be determined using Section C.5 of ASCE 7-05.	D, C, G
Foundations Near Bay and Bayou Shorelines	15.	For sites near bay or bayou shorelines, foundation selection should be based on factors as described in this chapter.	D, C, G

* All recommendations are detailed in this report unless otherwise noted.
** Action required by: Designer (D), Contractor (C), Government Official (G).

11.1.5 Foundations

Recommendations related to foundations are presented in Table 11-4 and a few of the key recommendations are shown below:

- Select and design foundations based on ABFEs shown on Katrina Flood Recovery Maps, not the pre-Katrina FIRMs, until such time that revised regulatory floodmaps become available for the Gulf Coast: The pre-Katrina effective FIRMs understate the lateral extent of the special flood hazard area and the area subject to damaging waves. Therefore, prudent reconstruction should be based on flood elevations and flood hazard zones depicted on the Katrina Flood Recovery Maps (with the caveat that the maps may overstate wave heights and wave crest elevations away from the Gulf of Mexico shoreline).
- Use the *Recommended Residential Construction for the Gulf Coast: Building on Strong and Safe Foundations* (FEMA 550) when building new homes in coastal areas. FEMA 550 contains schematic designs for several foundation styles to assist local engineers, builders, and code officials in designing and constructing flood- and wind-resistant residential foundations. FEMA 550 was developed with input from the Gulf Coast Homebuilding Industry.
- New and replacement manufactured homes should be elevated with their lowest floor in accordance with the requirements of NFPA 225 (2005 ed.), Chapter 12. This chapter requires that: 1) in existing manufactured home parks, new and replacement homes must be elevated with the bottom of the main chassis frame beam no less than 3 feet above grade, unless a home previously on a site was substantially damaged by flood, in which case the new or replacement home on the site must be elevated with the bottom of the main chassis frame beam no lower than the BFE (ABFE), and 2) outside of existing man-

ufactured home parks, all new and replacement homes must be elevated with the bottom of the main chassis frame beam no lower than the BFE (ABFE). See Figure 11-1 for exact requirements in V and A Zones.

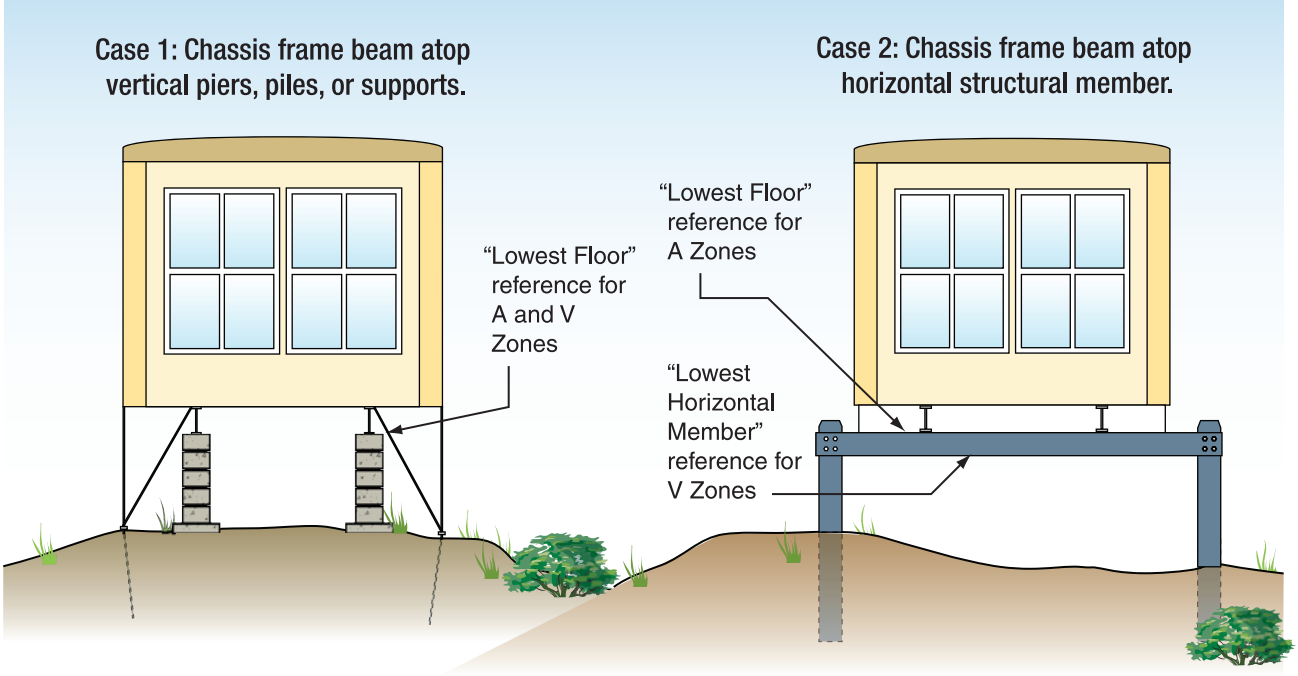

Figure 11-1.
Recommended elevation of new and replacement manufactured homes as recommended by NFPA 225. Specific anchorages shall be determined based on manufacturer's instructions.

SOURCE: NFPA 225

Note that this recommendation is consistent with current NFIP requirements with one exception, the change in A Zone lowest floor reference from the top of the floor to the bottom of the main chassis frame beam. This recommendation is not intended to eliminate the 3-foot pier exception allowed for new and replacement homes on sites in existing manufactured home parks that have not previously experienced substantial damage due to flooding. However, this report suggests that new and replacement homes in existing parks be elevated higher than the 3-foot pier exception allows, preferably with the bottom of the main chassis frame beam at the ABFE.

- Freeboard is a factor of safety typically expressed in feet above the flood level for purposes of floodplain management (see Figure 11-2). For flood insurance purposes, the freeboard is referenced from the top of the lowest floor to the BFE in A Zones and the bottom of the lowest horizontal structural member to the BFE in V Zones. Freeboard is recommended for all buildings in all special flood hazard zones. At a minimum, the freeboard specified in ASCE 24-05 should be considered (freeboard amounts in ASCE 24-05 depend on the building importance, flood hazard zone, and floor beam orientation). Consider using more freeboard than ASCE 24-05 specifies if ABFEs are not adopted by a community.

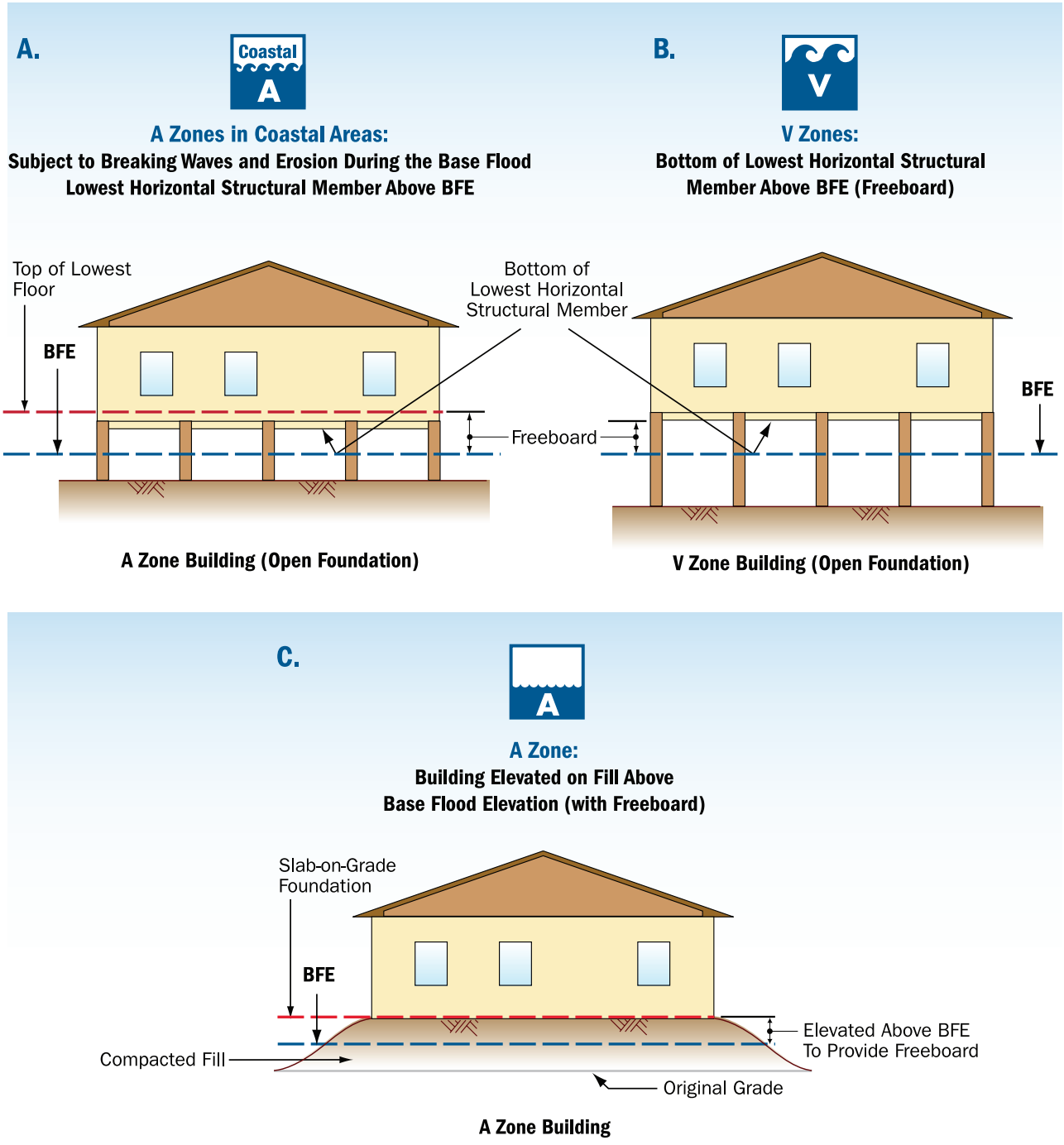

Figure 11-2.
Freeboard and open foundations are recommended for V Zones and Coastal A Zones. Illustration C shows an example of a building in an A Zone elevated on fill above the BFE with freeboard.

- Foundations along the shoreline: Pier foundation performance in coastal areas has been poor where erosion, waves, and/or debris impacts are present, especially during base flood events. Pier foundations should only be considered when these hazards are not present.
  - Use a deep pile and/or column foundation along the Gulf of Mexico shoreline if significant erosion is likely during the base flood. Use of other foundation types should be limited to those areas far from the shoreline and not subject to erosion.
  - Use a deep pile or column foundation along shorelines for bays and sounds if significant erosion is likely during a base flood event. For sites near bays or along bayous, foundation selection should be based on several factors: erodibility of the soil; exposure to "damaging" waves (greater than 1.5 feet high); potential for velocity flow; potential for floodborne debris; and required resistance to lateral flood and wind forces. Table 11-5 should be used to help select an appropriate foundation near bay/bayou shorelines.
  - Where limited erosion and scour allow the use of shallow foundations, construct footings using continuous concrete grade beams or mat foundations in lieu of discrete concrete footings.
  - Construct piers and columns with reinforced concrete in lieu of masonry and provide sufficient reinforcement to resist wind loads, flood forces, and debris impact.

Table 11-5. Recommended Foundations for Coastal Areas near Bay or Bayou Shorelines (but not mapped as a V Zone)

Foundation Type	Base Flood Condition Present			
	Erodible Soils, Base Flood Inundation Possible	Wave Heights between 1.5 and 3 Feet[1]	Velocity Flow	Large Debris[3]
Fill	no	no	no	no
Slab-on-Grade	no	no	no	no
Crawlspace, Shallow Footing	no	no	no	no
Foundation Walls, Shallow Footing	no	no	no	no
Stemwall, Shallow Footing	no	yes	no	yes
Stemwall, Deep Footing[2]	yes	yes	yes	yes

[1] Wave heights greater than 3 feet mapped as V Zone: fill, slab, crawlspace, wall foundations not permitted.

[2] Deep means sufficiently deep to withstand erosion and scour (including that induced by the presence of the foundation itself), and withstand all lateral flood loads and resist sliding.

[3] Building materials, dock pilings, vegetation.

Table 11-5. Recommended Foundations for Coastal Areas near Bay or Bayou Shorelines (but not mapped as a V Zone)

Foundation Type	Base Flood Condition Present			
	Erodible Soils, Base Flood Inundation Possible	Wave Heights between 1.5 and 3 Feet[1]	Velocity Flow	Large Debris[3]
Pier, Shallow Footing	no	no	no	no
Pier, Deep Footing[2]	yes	yes	yes	no
Post, Shallow Embedment	no	no	no	no
Pile/Column, Deep Embedment[2]	yes	yes	yes	yes

[1] Wave heights greater than 3 feet mapped as V Zone: fill, slab, crawlspace, wall foundations not permitted.

[2] Deep means sufficiently deep to withstand erosion and scour (including that induced by the presence of the foundation itself), and withstand all lateral flood loads and resist sliding.

[3] Building materials, dock pilings, vegetation.

Absent a detailed study for a site, exposure to damaging waves greater than 1.5 feet can be estimated based on three factors:

1. Evaluate the potential for generating waves during the base flood for bays and bayous, which will be dependent on the direction of the wind from varying directions across the water body: If the distance from one shoreline to the other is less than 1 mile, the potential for generation of damaging waves is low. If the distance is 1 mile or greater, assume damaging waves can be generated.
2. Stillwater depth at the site, after accounting for erosion: If the stillwater depth is 2 feet or greater, sufficient depth exists to allow passage of 1.5-foot waves. If the stillwater depth is less than 2 feet, waves may be present, but should be less than 1.5 feet high.
3. Obstructions between the site and the shoreline: If dense stands of trees or buildings/structures capable of withstanding the base flood forces stand between the site and the shoreline, it is reasonably safe to assume the height of any damaging waves will be reduced. If these obstructions do not exist (or if their future existence is questionable), assume the wave heights will not be reduced appreciably.

Pier foundations should be used only where soil characteristics and flood conditions permit, and where their design and construction are consistent with the details shown in Figure 11-3. Footings should consist of continuous reinforced grade beams or mats. Discrete piers should only be used where local soils data and analyses confirm that discrete pier foundations will resist all flood and debris loads without failure. Although this is a common foundation type, its performance in coastal areas has been poor where erosion, waves, and/or debris are present.

Near bay and bayou shorelines, elevating the building on piles or another deeply embedded open foundation, and leaving the area below free of obstructions or enclose it with breakaway walls is recommended. Although stemwall foundations (backfilled with a concrete slab on top) performed better than many other A Zone type foundations near bay/bayou shorelines, their use should be contingent on having footings deep enough to withstand erosion and scour.

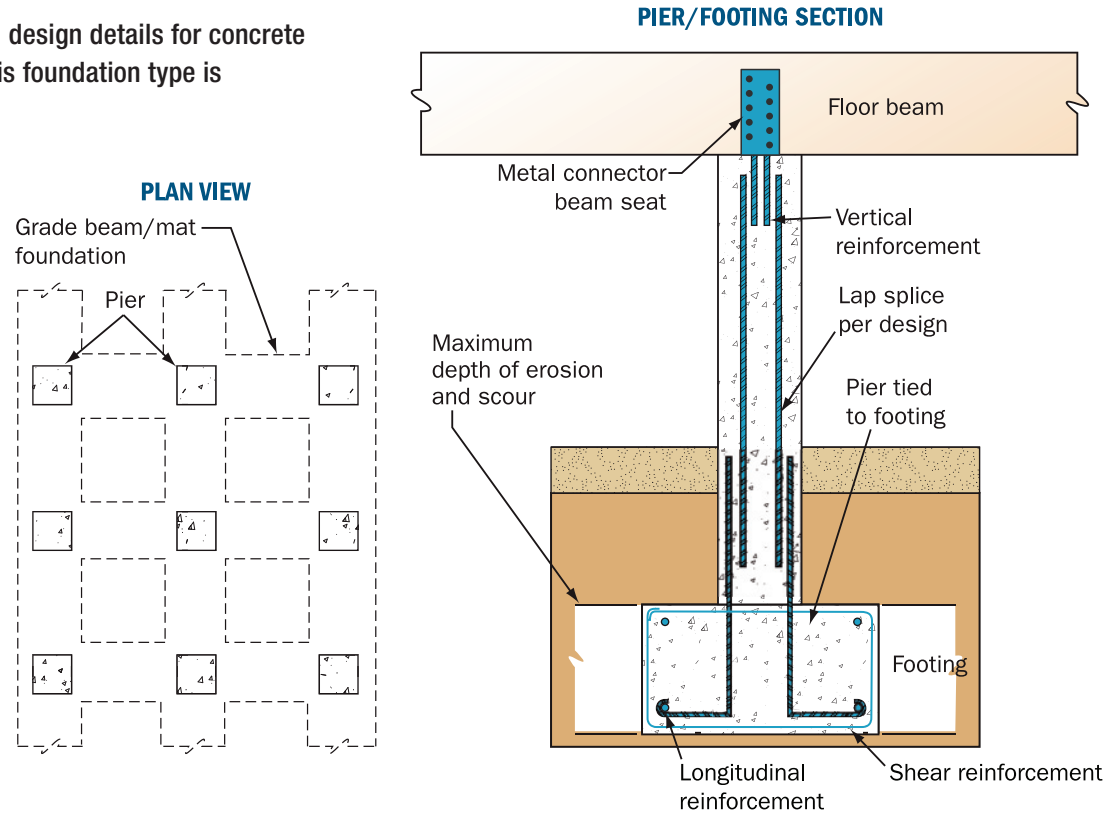

Figure 11-3.
Recommended design details for concrete piers where this foundation type is appropriate

11.1.6 Flood Insurance

Flood insurance provisions and premiums should reflect the actual risk during base flood conditions. Flood insurance provisions and premiums should reward best practices for siting, design, and construction (such as through the use of the V Zone Risk Factor Rating Form), and should not discourage or penalize those practices that result in improved flood resistance of buildings. For example, current NFIP provisions penalize some buildings where pilings extend to and support multiple stories above the BFE. This pole-type or structural frame construction is discussed in Chapter 4.

11.2 Wind Related Recommendations

The recommendations from the MAT report are intended to assist the States of Alabama, Louisiana, and Mississippi; communities; businesses; and individuals lessen the impact of wind damage from future events. The following recommendations address building code, design and construction, and mitigating existing buildings.

11.2.1 Building Codes

Buildings that had been designed or mitigated to resist high-wind loads in accordance with modern building codes were observed to perform substantially better than buildings constructed to earlier codes. Therefore, adoption and enforcement of a current building code like the 2006 editions of the IBC, IRC, or NFPA 5000 is key to improved wind performance. When adopted, current building codes should not be amended or modified in any fashion that reduces their criteria. For example, wind speeds should not be reduced and windborne debris provisions should not be exempted.

The study of buildings and their interaction with high winds associated with hurricanes is an evolving process. Incorporating many of the recommendations in this report into the next available code cycle is key to setting the new standard in hurricane-resistant construction in all hurricane-prone regions. For example, test method improvements are recommended to assess the performance of exterior systems like EIFS, vinyl siding, and soffit panels that historically have performed poorly during hurricanes.

Recommendations related to building codes and standards are shown in Table 11-6. Some of the recommended code changes in the table will require research before they can be incorporated.

11.2.2 Design and Construction

Roof covering and wall cladding failures were widespread during Hurricane Katrina, which was less than a design wind event in most areas. To ensure that components and cladding elements are being engineered and designed per the code requirements, additional focus should be given to the design and construction of the building envelope. Specific recommendations related to roof systems, soffits, exterior cladding, windows, doors, and rooftop equipment are provided in Table 11-7. The table also provides general recommendations regarding renovation and remodeling, inspecting for moisture intrusion following hurricanes, and protection of historic buildings.

11.2.3 Wind Mitigation for Existing Buildings

To avoid future damage of buildings that have vulnerable structural systems and/or building envelopes or rooftop equipment, the MAT recommends that owners of commercial and public buildings have a vulnerability assessment performed by qualified professionals. If vulnerabilities are discovered, they should be mitigated to avoid future losses. For buildings that are located in windborne debris regions and have unprotected glazing, installation of protection (e.g., shutters) is recommended.

Residential homeowners should consider mitigation measures such as installation of metal framing connectors (e.g., straps between rafters/trusses and bearing wall, connections between the roof deck and rafter/trusses), and upgrading the attachment of the roof covering to the roof deck.

Table 11-6. Wind Hazard - Recommendations for Building Codes/Standards and Adopting Agencies

Wind Hazard		
Building Component		Recommendation*
General		
Code	1.	Adopt the 2006 IBC, IRC, or NFPA 5000, for all affected jurisdictions in Alabama, Louisiana, and Mississippi.
Code	2.	Do not reduce the wind provisions of the IBC and IRC, ASCE 7, or NFPA 5000 with local amendments. Prior to Hurricane Katrina, some jurisdictions had reduced the design wind speed and/or the windborne debris region requirements prescribed in ASCE 7. Reductions such as these reduce the effectiveness of the building code.
Code	3.	If and until the recommendations below are adopted by the model codes, applicable recommendations should be considered best practices and incorporated in all new construction and mitigation projects.
Code	4.	Ensure code compliance through increased enforcement of construction inspection requirements such as the IBC, IRC, and NFPA 5000. Ensure enforcement of Special Inspections Provisions per the IBC and NFPA 5000.
Code	5.	The 2006 IRC does not require the use of high-wind provisions at speeds below 110 mph. However, the IRC Code development Committee has approved a code change proposal for the 2007 amendments to lower the threshold to 100 mph. Therefore, it is recommended that high-wind provisions for residential construction be used in wind zones of 100 mph and greater.
Building Envelope		
Soffit	6.	Develop and adopt wind resistance and wind-load criteria for soffits. Wind-driven rain resistance of ventilated soffit panels should also be added. Testing Application Standard (TAS) 110 may be a suitable test method, although it may require modification.[a]
EIFS	7.	Revise test method ASTM E 330: Use a 60-second load duration instead of a 10-second load duration. Incorporate deflection criteria specified in test method ASTM E 1592 into ASTM E 330.
Vinyl Siding	8.	Revise test method ASTM D 5206: Use a 60-second load duration instead of a 30-second load duration. Incorporate the deflection criteria specified in test method ASTM E 1592 into ASTM D 5206.
Vinyl Siding	9.	The ASTM task group responsible for ASTM D 5206 should give consideration to dynamic testing of vinyl siding in lieu of the static testing now prescribed in ASTM D 5206.
Vinyl Siding	10.	Revise ASTM D 3679 to require a minimum safety factor of 2 versus the 1.5 factor currently specified. Revise ASTM D 4756 to require installation of a water-shedding underlayment (e.g., asphalt-saturated felt or housewrap).

* All recommendations are detailed in this report unless otherwise noted.

[a] TAS is a Florida document: http://infosolutions.com/icce/gateway.dll?f=templates$fn=default.htm$vid=icc:florida_hurricane

[b] ASTM D 7158 was published in 2006 as a replacement for UL 2390.

Table 11-6. Wind Hazard - Recommendations for Building Codes/Standards and Adopting Agencies (continued)

Wind Hazard		
Building Component		Recommendation*
Building Envelope (continued)		
Gutters and Downspouts	11.	Develop and add criteria for uplift resistance of gutters and downspouts.
Reroofing	12.	Except for minor repairs, require removal of existing roof covering down to the deck and replacement of deteriorated decking in areas where basic wind speed is 110 mph or greater. If existing decking attachment does not comply with loads derived from Chapter 16 of the IBC, require installation of additional fasteners to meet loads.
Asphalt Shingles	13.	Require compliance with ASTM D 7158.[b] Also require six nails per shingle and require use of asphalt roof cement at eaves, rakes, hips, and ridges where basic wind speed is 110 mph or greater (refer to FEMA 499, Fact Sheet 20).
Windows and Shutters		
Shutters	14.	Add requirement to label shutters (other than wood) to indicate compliance with ASTM E 1886. Without labels, building owner does not know if shutters are suitable.

* All recommendations are detailed in this report unless otherwise noted.

a TAS is a Florida document: http://infosolutions.com/icce/gateway.dll?f=templates$fn=default.htm$vid=icc:florida_hurricane

b ASTM D 7158 was published in 2006 as a replacement for UL 2390.

The Institute of Building and Home Safety (IBHS) (http://www.ibhs.org) and the Federal Alliance for Safe Homes (FLASH) (http://www.flash.org) have comprehensive guidelines and plans for retrofitting existing homes for wind resistance. The mission of both organizations is to reduce the loss of life and property damage from natural disasters by promoting construction techniques that typically exceed those of the minimum adopted building code. Their guidelines are strongly recommended and highly relevant for mitigating damage from events such as hurricanes.

Building owners should consider covering windows with impact-resistant shutters or replace them with impact-resistant windows.

Mitigation can be expensive because it often requires partial demolition and replacement of interior building finishes, and it may require displacement of occupants while mitigation is performed. However, even though mitigation measures may not be required by the building code or local ordinance, proactively implementing needed mitigation will ensure that future damages and interrupted use of buildings are lessened or avoided entirely.

Renovation work and roof covering replacement projects offer opportunities to perform mitigation retrofits to improve a building's continuous load path. For instance, installing additional fasteners to secure decking to rafters is relatively inexpensive when they are installed in conjunction with a planned reroofing project. Also, the connections between the walls and roof structure can often be made economically accessible during these projects, thus allowing the installation of metal framing connectors to help create a continuous load path. (Note that additional anchorage of the bottom of the wall may still be required to develop a complete load path.) Such mitigation measures would have avoided much of the roof decking and roof structure failures observed after Hurricane Katrina. Refer to FEMA Fact Sheet 30: "*Repairs, Remodeling, Additions and Retrofitting.*"

For buildings with aggregate surfaced roofs, mitigation is recommended to avoid aggregate blow off.

Table 11-7. Wind Hazard - Design and Construction Recommendations

Wind Hazard			
Building Component		Recommendation*	Action Required By**
General	1.	Increase inspections during construction by designers or third-party inspectors. This recommendation pertains to residential as well as non-residential construction. In addition to inspecting structural elements, it is recommended that building envelopes and rooftop equipment also be inspected to verify that various components are being properly installed and attached.	D, C, G, O
General	2.	Involve a structural design engineer, architect, or professional-licensed contractor in designing and planning renovation or remodeling of structural or building envelope improvements.	O
General	3.	Perform followup inspections after a hurricane to look for moisture or wind-related damage that may affect the structure or building envelope.	C, O
General, Historic Buildings	4.	Refer to the recommendations in this section for those elements that apply and coordinate with the State Historic Preservation Office. For vacant buildings, it is necessary to take earlier precautionary measures to stabilize the building to prevent deterioration, which may be further exacerbated by a major storm.	D, C, G
Building Envelope			
All	5.	For commercial and public buildings, refer to NIBS *Whole Building Design Guide* at http://www.wbdg.org/design/env_wind.php	
Asphalt Shingles	6.	Ensure manufacturers' installation instructions are followed (i.e., starter strips and nail locations) and use Fact Sheets 19 and 20 (FEMA 499).	D, C
Metal Panel Roof System	7.	Specify close spacing of fasteners at eaves, and hip and ridge flashings (e.g., spacings in the range of 3 to 6 inches on center, commensurate with the design wind loads.)	D
Tile Roof System	8.	Use Fact Sheet 21 (FEMA 499).	D, C
Edge Flashings and Copings	9.	Comply with American National Standards Institute (ANSI)/ SPRI ES-1 (2003). Use safety factor of 2 for Category II buildings and a safety factor of 3 for Category III and IV buildings.	D
Edge Flashings and Copings	10.	Place a bar over roof membrane near edge of flashing and coping to provide secondary protection (see FEMA 424, *Design Guide for Improving School Safety in Earthquakes, Floods, and High Winds*).	D, C
Gutters and Downspouts	11.	Develop design guide for wind-resistant gutters; include attachment of downspouts.	M, C
Brick Veneer	12.	Use Hurricane Katrina Recovery Advisory (in Appendix E): *Attachment of Brick Veneer in High-Wind Regions*.†	M, G

* All recommendations are detailed in this report unless otherwise noted.

** Action required by: Designer (D), Contractor (C), Manufacturer (M), Government Official (G), Building Owner (O).

† The Hurricane Katrina Recovery Advisories can be accessed on-line at: http://www.fema.gov/rebuild/mat/mat_katrina.shtm

Table 11-7. Wind Hazard - Design and Construction Recommendations (continued)

Wind Hazard			
Building Component		Recommendation*	Action Required By**
EIFS	13.	Manufacturers should re-evaluate their training programs to ensure that EIFS assemblies are installed properly by adequately-trained workers.	M
EIFS	14.	EIFS Industry Members Association (EIMA) should consider all elements of the EIFS assembly. Although EIMA members may not manufacture or supply assembly components such as metal framing, sheathing, or sheathing fasteners, these elements are also critical in achieving suitable wind performance.	M
EIFS	15.	When EIFS is installed over sheathing, designers should specify attachment requirements for all elements of the assembly, including framing and sheathing attachment.	D
EIFS	16.	Designers should specify special inspections to ensure proper application of all elements of the assembly.	D
EIFS	17.	Develop design guidance for EIFS attachment.	M, G
Vinyl Siding	18.	Develop design guidance for vinyl siding attachment.	M, G
Soffits	19.	Design guidance: Develop design guidance for attaching soffits, including design of baffles or filter media to prevent wind-driven rain from entering attics.	M, G
Doors			
Exterior Doors	20.	Specify wind-driven rain-resistant weather stripping at exterior doors (see FEMA 424).	D
Entrance Vestibules	21.	Design entrance vestibules for areas where basic wind speed exceeds 120 mph (see FEMA 424). When design conditions of 120 mph or greater are experienced, it is very difficult to avoid water infiltration around doors; therefore, vestibules are recommended.	D
Rolling and Sectional Doors	22.	Consider type, size, and spacing of door, frame, and frame fasteners to loads. If frame is attached to wood blocking, attention should also be given to the blocking attachment. Maintain adequate edge distances for frame fasteners placed in concrete or masonry.	D, C
Exterior Equipment			
General	23.	For all rooftop equipment, see Hurricane Katrina Recovery Advisory (in Appendix E): *Attachment of Rooftop Equipment in High-Wind Regions*.†	D
Lightning Protection Systems	24.	See Hurricane Katrina Recovery Advisory (in Appendix E): *Rooftop Attachment of Lightning Protection Systems in High-Wind Regions*.†	M, D, G

* All recommendations are detailed in this report unless otherwise noted.

** Action required by: Designer (D), Contractor (C), Manufacturer (M), Government Official (G), Building Owner (O).

† The Hurricane Katrina Recovery Advisories can be accessed on-line at: http://www.fema.gov/rebuild/mat/mat_katrina.shtm

11.3 Critical and Essential Facilities Recommendations

Based on the poor flood and wind performance experienced by many of the critical and essential facilities impacted by Hurricane Katrina as well as other previous storms, and lack of needed criteria in model building codes for these important buildings, it is clear that much greater attention is needed in the design, construction, maintenance, and operation of critical and essential facilities. FEMA 543, *Design Guide for Improving Critical Facility Safety from Flooding and High Winds,* will be available in the summer of 2006. It will address new and existing facilities. Until it becomes available, please refer to the recommendations presented in Tables 11-8 and 11-9.

Table 11-8. Flood Hazard - Recommendations Specific to Critical and Essential Facilities

Flood Hazard			
Parameter		Recommendation*	Action Required By**
Critical/Essential Facilities			
Public Shelters	1.	Do not open shelters located in potential storm-surge inundation zones until after the hurricane has moved inland sufficiently to allow safe travel.	G, CFO
New Critical and Essential Facilities (reconstruction of existing facilities)	2.	At a minimum, elevate or protect new facilities in flood hazard areas to the 500-year (0.2% annual exceedance) flood level, or based on ASCE 24-05, whichever is higher. This is a current requirement per 44 CFR Section 9.11 for reconstructing existing facilities. Areas below this elevation can be used for vehicle and equipment storage, but plans should be made to relocate vehicles and equipment in the event of a severe storm. Floodproofing of vehicle and equipment storage areas may be an alternate approach for facilities located outside the V Zone and Coastal A Zone.	D, G, CFO
Existing Critical and Essential Facilities	3.	For facilities located within a SFHA, develop emergency operation plans that allow building occupants and operations to be relocated to sites outside SFHA before onset of storm. Do not occupy vulnerable facilities during an event.	G, CFO
Existing Critical and Essential Facilities	4.	Evacuate emergency supplies and equipment to the extent possible if an existing facility is to be evacuated before hurricane landfall.	G, CFO
Existing Critical and Essential Facilities	5.	Evaluate vulnerability of existing facilities in light of recent damage to similar facilities; strengthen and floodproof structures where feasible.	D, G, CFO

* All recommendations are detailed in this report unless otherwise noted.

** Action required by: Designer (D), Government Official (G), Critical Facilities Operator (CFO).

Table 11-9 . Wind Hazard - Recommendations Specific to Critical and Essential Facilities

Wind Hazard			
Building Component		Recommendation*	Action Required By**
New Construction			
General	1.	Emphasize best practices for schools and shelters described in FEMA 424 and FEMA 361, respectively, and in the latest codes and standards for wind resistance (ASCE 7).	D, CFO
General	2.	Develop additional criteria to help ensure continuity of function. See FEMA 424 and FEMA 361. Occupant needs for utilities should be provided through multiple sources.	D, CFO
General	3.	Contract drawings and specifications for new construction and remedial work on existing building envelopes and rooftop equipment should undergo rigorous peer review. During construction, perform detailed submittal reviews, field observation (inspection), and testing of building envelopes and rooftop equipment.	D, CFO, G
General	4.	Incorporate hazard mitigation peer review into the design approval process to ensure that critical and essential facilities are adequately designed to resist wind.	D, CFO
General	5.	Conduct special inspections for key structural items and connections to ensure performance of critical and essential facilities.	D, C, CFO
Design Loads	6.	Use a Directionality Factor of 1.0 for the building envelope and rooftop equipment, and 0.85 for the main wind force resisting system (MWFRS).[1]	D, CFO
Material Selection	7.	Reinforced concrete roof deck and reinforced concrete and/or reinforced and fully-grouted CMU exterior walls are recommended. FEMA 424 and FEMA 361 provide detailed guidance on material selection for structural and building envelope systems.	D, C, CFO
Detailing and Notations on the Building Plans	8.	Facility plans should delineate the facility area designed to function as a shelter or hardened area. Details of the shelter or hardened area and the envelope elements should be provided to ensure that the construction requirements are clearly understood by the builder and building official. Provide facility design criteria and maximum design pressures for the MWFRS and for components and cladding.	D, C, CFO
Roof System	9.	Design a roof system that will prevent or reduce water infiltration if roof is hit by windborne debris.	D
Gutters and Downspouts	10.	Secure gutters to resist wind uplift and to avoid membrane blow-off.	D, C, CFO

* All recommendations are detailed in this report unless otherwise noted.

** Action required by: Designer (D), Contractor (C), Government Official (G), Critical Facilities Operator (CFO).

*** See applicable items under New Construction

[1] Wind directionality factor: The ASCE 7 wind load calculation procedure incorporates a wind directionality factor (k_d). The directionality factor accounts for the reduced probability of maximum winds coming from any given direction. By applying the prescribed value of 0.85, the loads are reduced by 15 percent. Because hurricane winds can come from any direction, and because of the historically poor performance of building envelopes and rooftop equipment, a more conservative approach for critical facilities is recommended. A directionality factor of 1.0 is recommended for the building envelope and rooftop equipment (this results in a 15 percent load increase on these elements). For the MWFRS, a directionality factor of 0.85 is recommended (hence, no change for MWFRS).

Table 11-9 . Wind Hazard - Recommendations Specific to Critical and Essential Facilities (continued)

Wind Hazard			
Building Component		Recommendation*	Action Required By**
New Construction (continued)			
Rolling and Sectional Doors	11.	Install high-wind-rated, sectional, or rolling doors to protect against high wind.	D, C, CFO
Windows	12.	Implement window protection systems to protect critical facilities from windborne debris.	D
Existing Facilities***			
General	13.	American Red Cross 4496 provides a baseline for a shelter's integrity and performance, but meeting this criterion does not guarantee that the building will resist wind and windborne debris associated with hurricanes. Emphasize best practices for shelters described in FEMA 361.	D, CFO
General	14.	Implement mitigation measures or structurally retrofit critical and essential facilities to design levels other than minimum code requirements for general use buildings. Do not house critical and essential facilities in buildings that have not received thorough architectural and engineering attention.	D, CFO
General	15.	Conduct special inspections for key building envelope components to ensure performance of critical and essential facilities. Inspect rooftop equipment twice a year. Inspect windows, doors, and wall coverings at 5-year intervals. Conduct special inspections of the entire facility (both structural and building envelope systems) after major storms.	D, CFO
Vulnerability Assessment	16.	Perform vulnerability assessment to ensure continuity of operations. The assessment should evaluate the building performance and utilities that service critical and essential facilities, so that the building owner understands potential impacts to the facility during a storm, and operational impacts resulting from limited utility services.	D, C, CFO
Older Buildings	17.	Do not house critical and essential facilities in older buildings unless they are investigated by qualified engineers and architects to ensure survival in design level storms. If weaknesses are identified, the building should not be occupied during the event.	
Roof Structure	18.	Install hurricane clips or straps on inadequately connected roof beams and joists in those buildings that will be occupied during a hurricane.	D, C, CFO
Roofing	19.	Replace aggregate-surfaced roof systems with non-aggregate systems.	D, C, CFO
Edge Flashings and Copings	20.	Install exposed fasteners on the vertical face of weak metal edge flashings and copings (see FEMA 424).	D, C, CFO
Rolling and Sectional Doors	21.	Ensure sectional and rolling doors are properly installed and reinforced to prevent catastrophic door failure and building pressurization. Replace or retrofit existing doors that lack adequate resistance.	D, C, CFO

* All recommendations are detailed in the this report unless otherwise noted.

** Action required by: Designer (D), Contractor (C), Government Official (G), Critical Facilities Operator (CFO).

*** See applicable items under New Construction

Table 11-9 . Wind Hazard - Recommendations Specific to Critical and Essential Facilities (continued)

Wind Hazard			
Building Component		Recommendation*	Action Required By**
Existing Facilities*** (continued)			
Shutters	22.	In windborne-debris regions (as defined in ASCE 7), install shuttering system on all exterior glazing that is not windborne-debris-resistant. Install power-operated shutters, laminated glass, or engineered film systems, to the glazing and frame on upper-level floors.	D, C, CFO
Design Guidance	23.	Develop a comprehensive design guide to complement FEMA 424 for mitigating existing facilities.	D, G

* All recommendations are detailed in the this report unless otherwise noted.
** Action required by: Designer (D), Contractor (C), Government Official (G), Critical Facilities Operator (CFO).
*** See applicable items under New Construction

11.4 Public Outreach Recommendations

Reconstruction of the Alabama, Louisiana, and Mississippi communities affected by Hurricane Katrina will require adherence to the codes and best practices for building design and construction. Before that can occur, however, flood and wind hazards must be communicated to interested parties, reconstruction options must be determined and discussed, and the best option(s) must be identified. Public outreach and education on codes will be essential to this process, particularly with regard to identifying hazards and reconstruction options. A variety of audiences must be involved and engaged, including building owners and homeowners, designers, contractors, building officials, floodplain managers, and elected officials.

Key topics to be part of any effective outreach and education program should include:

- Mapping flood hazards: ongoing restudies and interim Katrina Flood Recovery Maps.
- Design and construction guidance as to how to resist future hurricanes, including consideration for storm impacts above design conditions.
- The costs, benefits, and consequences of employing (or not employing) best practices for design and construction.
- Provide training to local designers, contractors, and building officials on *Recommended Residential Construction for the Gulf Coast: Building on Strong and Safe Foundations* (FEMA 550, publication available July 2006).
- Provide training to local designers, contractors, and building officials, on requirements of the latest adopted codes.

In addition to the adoption and enforcement of a current model building code, the other key element needed to significantly increase the wind performance of buildings is greater education for building owners and homeowners, designers, building officials, and contractors.

Educational efforts need to be multi-faceted and ongoing. Specific recommendations related to flood and wind hazards are given in Table 11-10.

Table 11-10. Flood and Wind Hazard - Public Outreach Recommendations

Education Topic		Outreach Method
Building Owners and Homeowners		
Mapping flood hazards: ongoing restudies and interim Katrina Flood Recovery Maps.	1.	✓ Conduct public meetings to educate building owners on Katrina Flood Recovery Maps and rebuilding information.
Design and construction guidance as to how to resist future hurricanes, including consideration for storm impacts above design conditions.	2.	✓ Provide outreach, via local newspapers and pamphlets, to describe advisory elevations and what they mean to building owners.
The costs, benefits, and consequences of employing (or not employing) best practices for design and construction.	3.	✓ Provide the FEMA web site address where the Katrina Flood Recovery Maps can be viewed.
Plan and budget construction projects that incorporate natural hazard mitigation measures.	4.	✓ Provide information to public and building owners regarding reconstruction guidance and best practices.
Select design and construction teams knowledgeable in effective construction methods in hurricane-prone areas.	5.	✓ Tailor informational pamphlets to homeowners and building owners.
Prepare and protect building prior to hurricane landfall.	6.	✓ Develop strategy to distribute information (e.g., standardized information sheets during sale of building).
Educate building owners on what to do after hurricane passes (inspecting for building damage, performing emergency repairs, and drying out building interiors).	7.	✓ Enlist assistance of real-estate companies and organizations such as the Building Owners and Managers Association.
Rebuild damaged structure in manner that protects against future damage.	8.	✓ Provide public service notices at start of each hurricane season.
Inspect exterior connections and fasteners for wear, corrosion, and other deterioration.	9.	✓ Develop informational materials on how wind-driven rainwater enters buildings, the resulting damage, and prevention methods.
Educate building owners on how wind-driven rainwater enters buildings, the resulting implications (loss of electricity, mold), and prevention methods.	10.	

Table 11-10. Flood and Wind Hazard - Public Outreach Recommendations (continued)

Education Topic		Outreach Method
Architects, Engineers, Consultants		
Improve the technical proficiency of building envelope design.	11.	✓ Prepare monographs for trade-wide distribution. ✓ Prepare Web-based tutorials and seminars. ✓ Encourage colleges and universities to augment existing curriculum with hurricane-resistant design instruction.
Provide adequate level of design details for connecting rooftop equipment, including mechanical, electrical, and lightning protection.	12.	
Share post-disaster building performance information to maximize the value of lessons learned. Broaden understanding of multihazard mitigation, disaster preparedness, risk analysis, and vulnerability assessment.	13.	
Provide training to local designers, contractors, and building officials on *Recommended Residential Construction for the Gulf Coast: Building Strong and Safe Foundations* (FEMA 550, publication available July 2006).	14.	
Provide training to local designers, contractors, builders, and building officials on requirements of the latest adopted codes.	15.	
Building Officials		
Share post-disaster building performance information to maximize the value of lessons learned.	16.	✓ Conduct annual seminars for building officials and plan reviewers in coastal areas to share lessons learned.
Train building officials to identify structural weaknesses that may cause structural or building component failure during a hurricane (e.g., unbraced gable end walls, missing truss bracing, truss anchorage, window/door anchorage).	17.	✓ Implement hurricane disaster building inspection training program and "train the trainer" program. ✓ Encourage building officials and inspectors to become Certified Coastal Construction and Floodplain Inspectors.
Implement effective enforcement techniques to maintain a high construction quality.	18.	
Provide training to local designers, contractors, and building officials on *Recommended Residential Construction for the Gulf Coast: Building Strong and Safe Foundations* (FEMA 550, publication available July 2006).	19.	
Provide training to local designers, contractors, builders, and building officials on requirements of the latest adopted codes.	20.	

Table 11-10. Flood and Wind Hazard - Public Outreach Recommendations (continued)

Education Topic		Outreach Method
Contractors		
Educate contractors who construct building envelopes and install rooftop equipment about hurricane-resistant fastening and anchoring systems.	21.	✓ Develop and distribute visual tools such as instructional videos or DVDs. ✓ Conduct on-the-job training to highlight failures that occur when simple anchoring techniques are not applied. ✓ Encourage trade schools in hurricane-prone areas to augment their curriculum with courses on state-of-the-art, hurricane-resistant construction.
Educate contractors on how wind-driven water enters buildings, the resulting implications (loss of electricity, mold), and prevention methods.	22.	
Provide training to local designers, contractors, and building officials on *Recommended Residential Construction for the Gulf Coast: Building Strong and Safe Foundations* (FEMA 550).	23.	
Provide training to local designers, contractors, builders, and building officials on requirements of the latest adopted codes.	24.	
Manufacturers		
Educate manufacturers of building envelope materials and rooftop equipment on the performance of their products during hurricanes.	25.	✓ Develop and distribute informational notices to manufacturers. ✓ Need to tie this with increased sales or profitability. Suggest possibility of a national testing system to replicate/replace Miami-Dade standards. This would make it easier to recommend products.
Encourage manufacturers to provide special guidance for use of their products in hurricane-prone areas.	26.	
Develop improved products and systems for hurricane-prone areas.	27.	
Manufacturers should educate designers and contractors on their products.	28.	
Associations, Institutes, and Professional Societies		
Advocate hurricane-resistant design and construction to their membership	29.	✓ Develop educational materials for distribution to their members and industry.