

# Mitigation Assessment Team Report on **Hurricane Ike**

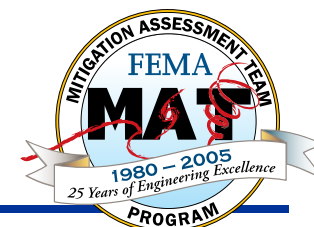
*NHC Presentation*



## Mitigation Assessment Team Report **Hurricane Ike in Texas and Louisiana**

Building Performance Observations, Recommendations,  
and Technical Guidance

FEMA P-757 / April 2009 / NHC 2009 Release



**NHC Presentation**

# MAT Mission

- Conduct *forensic engineering analyses*
- *Recommendations* to communities, states and organizations/agencies
- *Improve construction codes and standards, designs, methods, and materials*

# Hurricane Ike damage—Seen again and again



- We looked out of the window, and of all of the homes that were between our house and the beach, not one was left. It is just a clean sweep, nothing but desolation. . . . we could not see the water from our house before this storm.
- Following the 1900 Hurricane, Sarah Littlejohn
- 2000. Bixel and Turner. *Galveston and the 1900 Storm*. Univ. of Texas Press

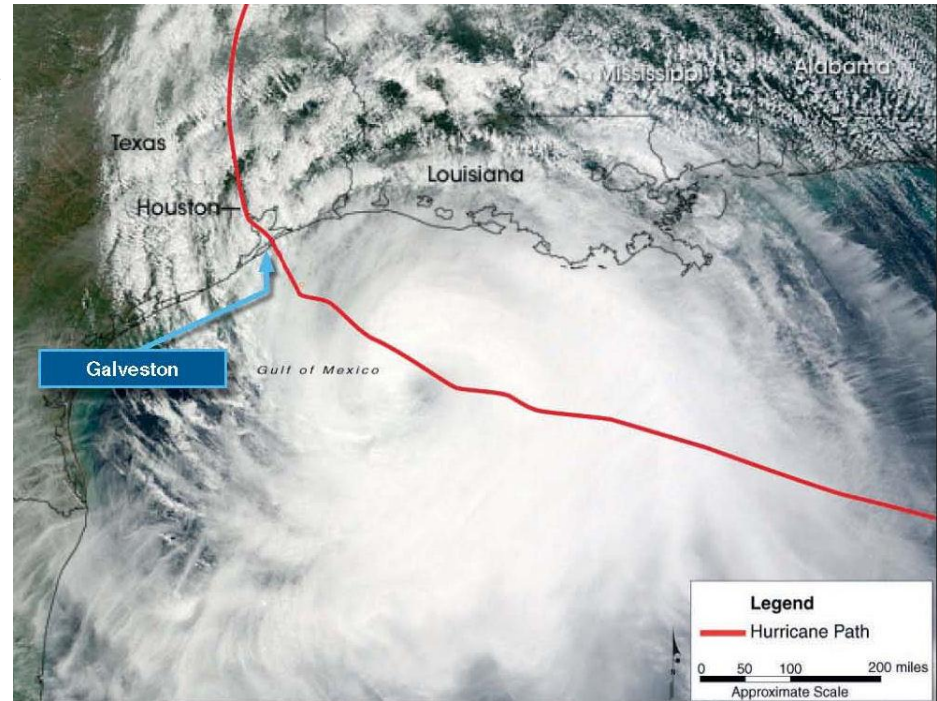
# Products

- Ike MAT Report (400+ pages)
- 46 Specific Recommendations
- 8 Recovery Advisories (3-9 pages w/specific target)
  - Example: Siding Installation in High-Wind Regions

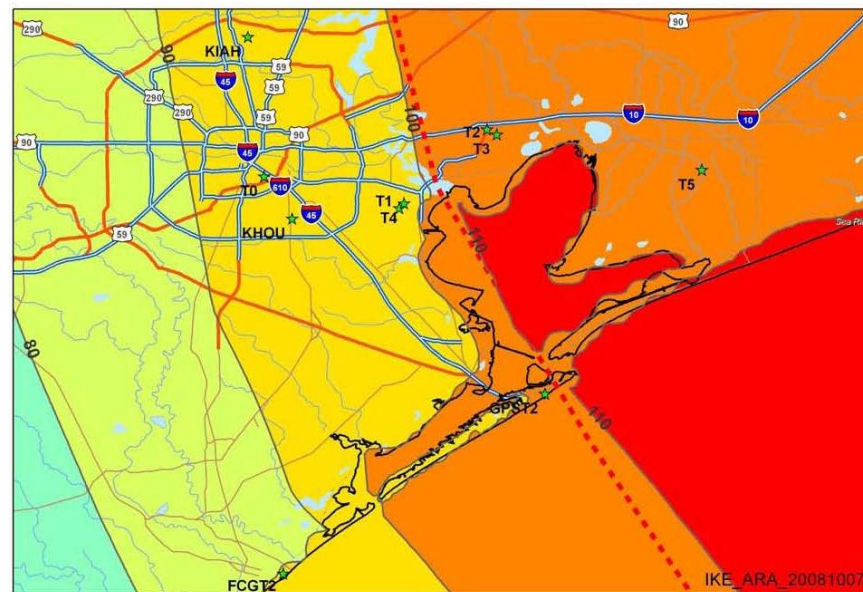
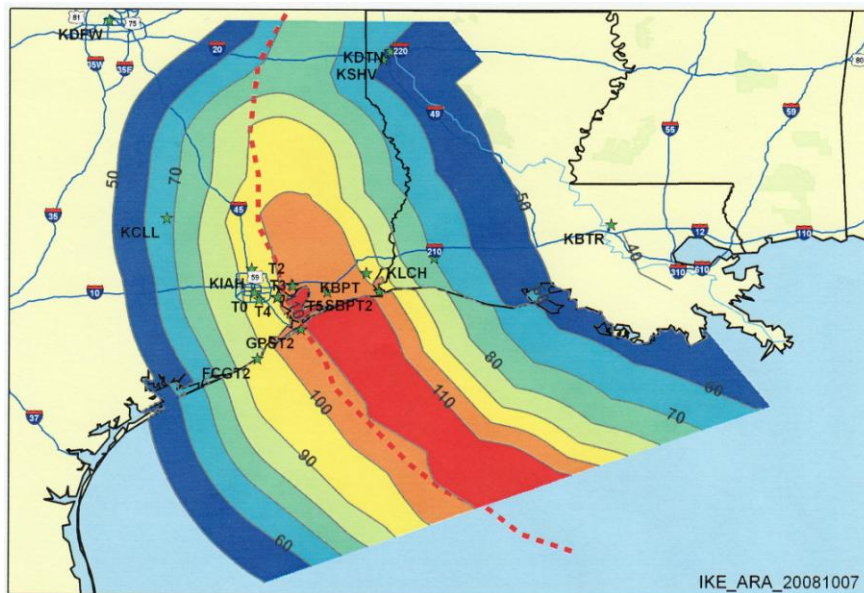


# Characterization of Hurricane Ike's Winds

- Hurricane Ike came ashore in Texas and Louisiana September 13, 2008
- Category 2 Hurricane on the Saffir-Simpson Scale
- Hurricane force winds extending from Freeport, TX to Cameron Parish, LA



# HAZUS-MH Wind Field Model



- 3 Second Gusts, Measured at 33' (10 m), Exposure C





## 3 Hours after Ike Landfall

- Chambers County experiences highest wind speeds
- Hurricane force winds continue to hammer the north and east sides of the Galveston West Bay
- Backside winds produced West Bay home damage



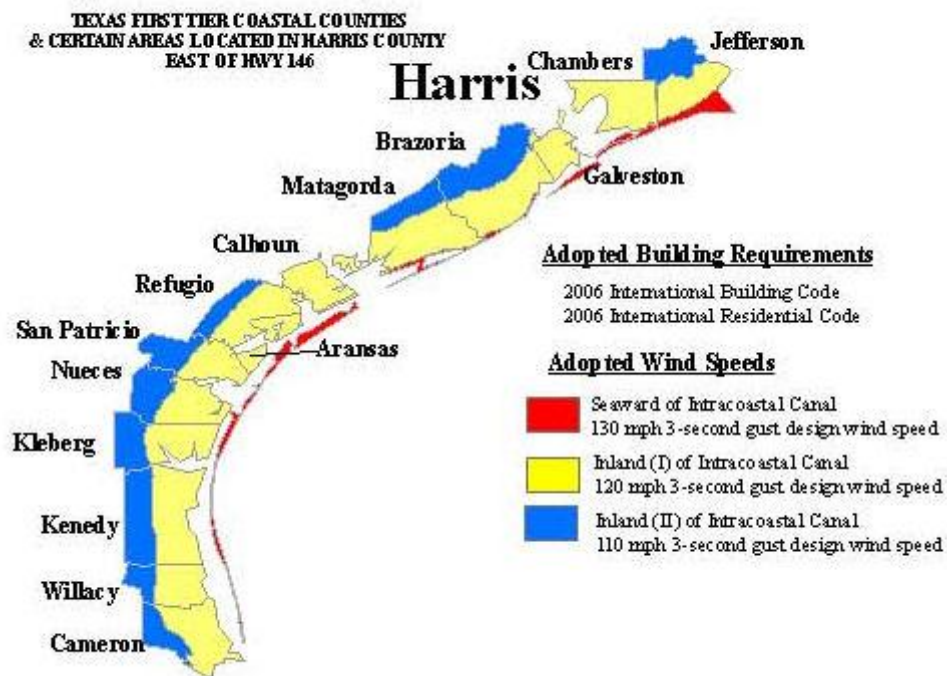
# Damage produce by Backside Winds



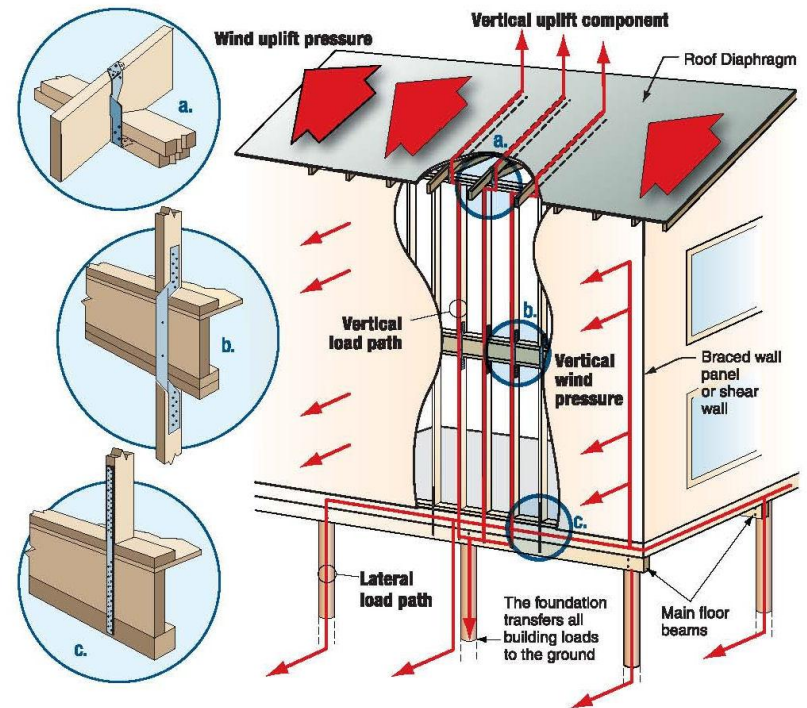
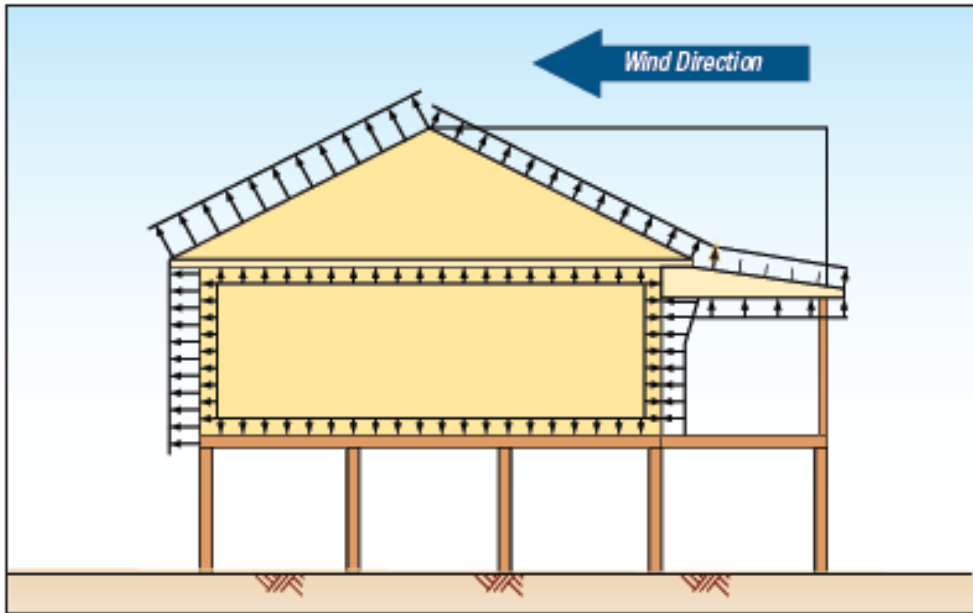
# Building Codes and Standards – TX & LA

- TX – Statewide
  - 2000 IBC/IRC
  - 1999 NEC
- TRCC – Building Standards for unincorporated areas
- TDI – Texas Windstorm Code
- LA – 2000 IBC/IRC (since 2005)

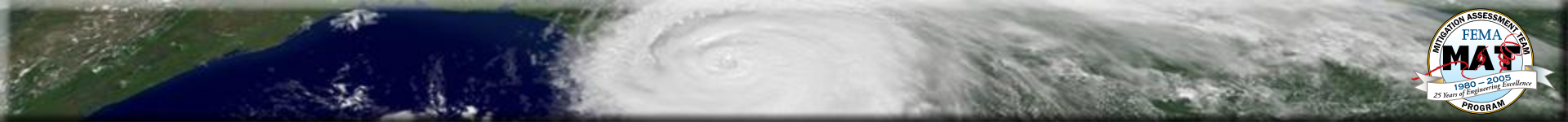
## Designated Catastrophe Areas



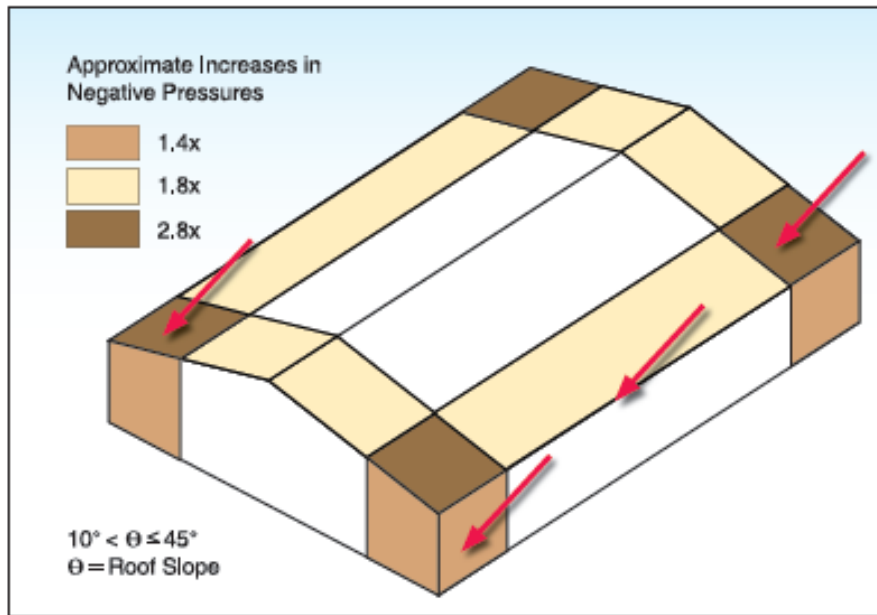
# Keeping the Building Connected - MWFRS





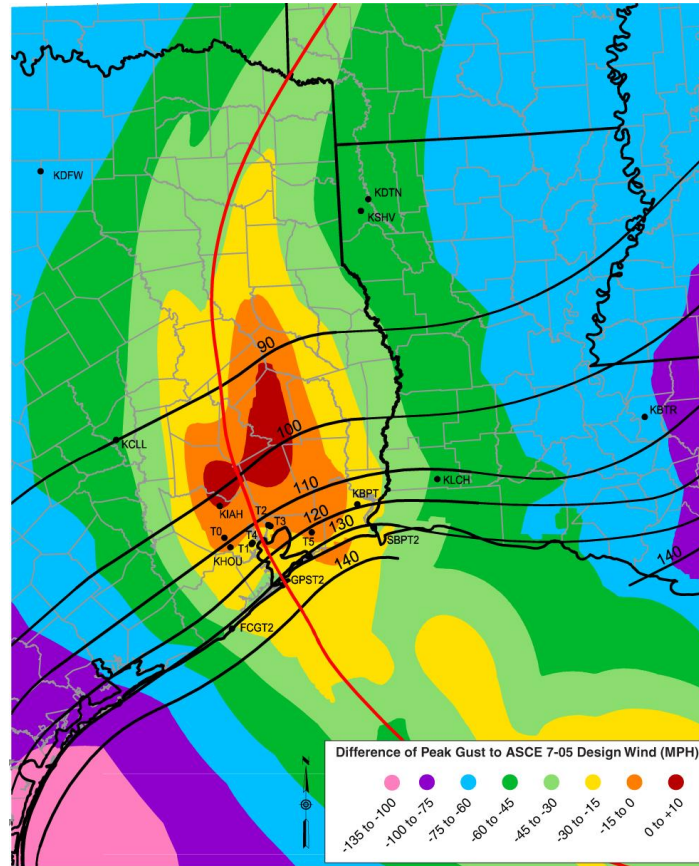


# Keeping the Building Components Connected – C&C



# MAT Observations of Residential Building Performance vs. Ike's Winds

- Ike's winds were less than IRC/ASCE 7 design levels.
- Expectations were that minimal damage to both structural elements and components would be seen.
- MAT observed good structural performance, but poor cladding performance.





# Asphalt Shingle Performance

- Shingle loss varied from a few shingles to whole roofs
- TDI currently allows Class F shingles (ASTM D 3161 rated at 110 mph) for all wind zones – 110, 120, & 130 mph.



# Asphalt Shingle Recommendations

- TDI should only allow ASTM D 7158 rated shingles:
  - Class D – 90 mph rating
  - Class G – 120 mph rating
  - Class H – 150 mph rating
- Manufacturers should provide Class labeling on the backside of shingles



# Roof Soffit and Fascia Performance

- Failures of aluminum fascia covers and vinyl and fiber cement soffits were frequently observed.
- TDI and Inspectors should ensure that high wind zone products and installation methods are used.





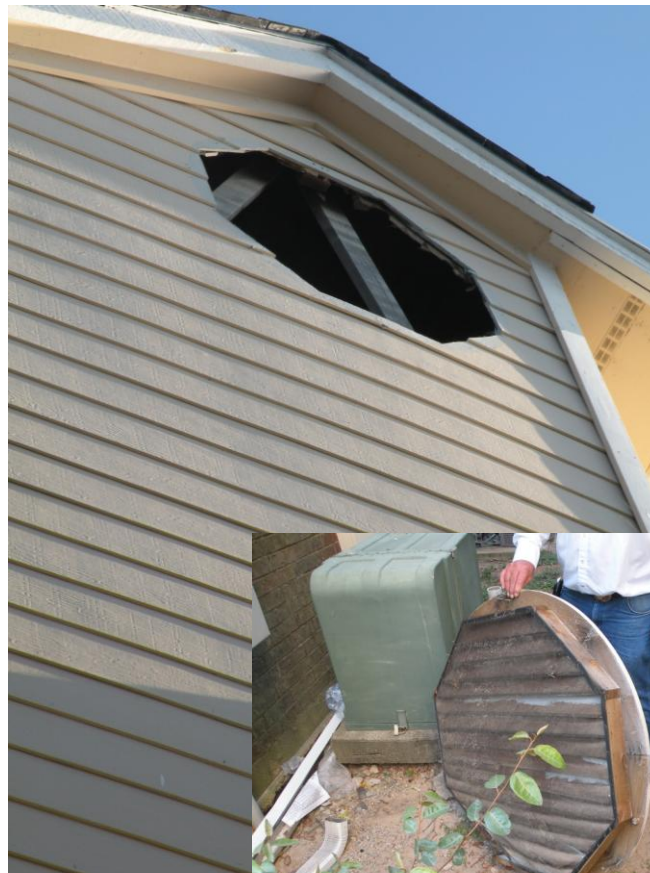
# Roof Venting Failures



- Observed failures included:
  - Continuous roof ridge vents.
  - Gable end vents.

# Roof Venting Failures

- Recommendations:
  - Continuous roof ridge vents frequently allows the infiltration of water into the attic and should not be allowed by TDI
  - Gable end vents should be properly connected to the structure and shuttered.



# Building Sheathing Failures

- Sheathing failures are routinely the result of :
  - Internal and external pressures
  - Installations not consistent for high wind zones
  - Poor connection to the building structure





# Building Sheathing Failures



- It is recommended that TDI require that exterior wall substrates be fully sheathed with plywood or OSB sheathing.

# Wind Induced Veneer & Cladding Issues

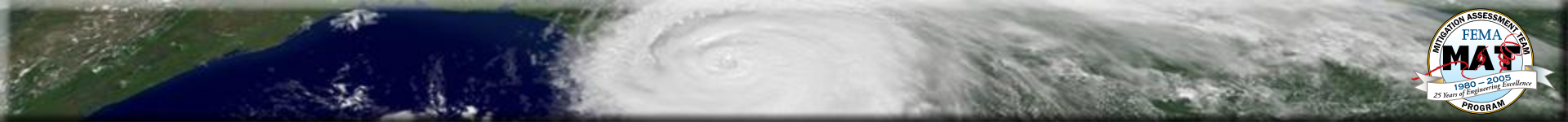
- Brick veneer failures were the result of:
  - Corroded brick ties.
  - Improper or no tie embedments.
  - Tie spacing non-compliant for high wind zone installations.



# Vinyl Siding & Fiber Cement Cladding Issues

- Vinyl siding and fiber cement cladding were the predominant cladding observed. Failures were the result of:
  - Materials were not high wind zone rated.
  - Installations were poor or non-compliant with high wind zone recommendations.
- Recommendations:
  - Code authorities and TDI and their inspection programs should ensure that products and installations meet manufacturers' high wind zone guidelines.





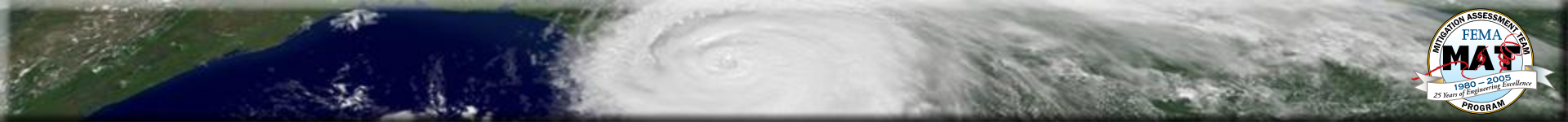
# Vinyl Siding



# Vinyl Siding







# Fiber Cement Siding





# Windborne Debris Protection

- ASCE 7-05/2003 IRC require opening protection within 1 mile of the coastal mean high water line where wind speeds are 110 mph or greater.
- TDI requires opening protection only in the Seaward (130 mph) and Inland I (120 mph) zones.
- It is recommended that TDI include the 1 mile portion of the Inland II wind zone (110 mph) in its windborne debris protection requirement.

# Windborne Debris Protection

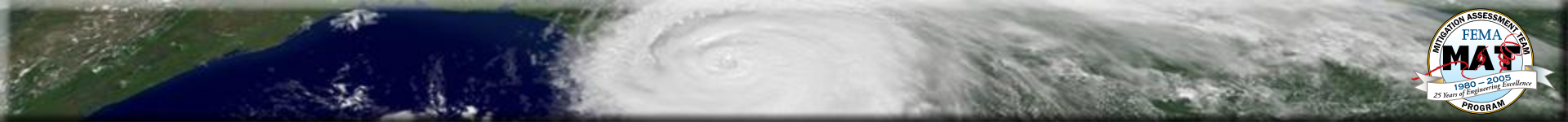
- Shutter performance varied from:
  - Excellent
  - Only installed on the windward face
  - Not attached to the building structure
  - Non-existent



# Windborne Debris Protection



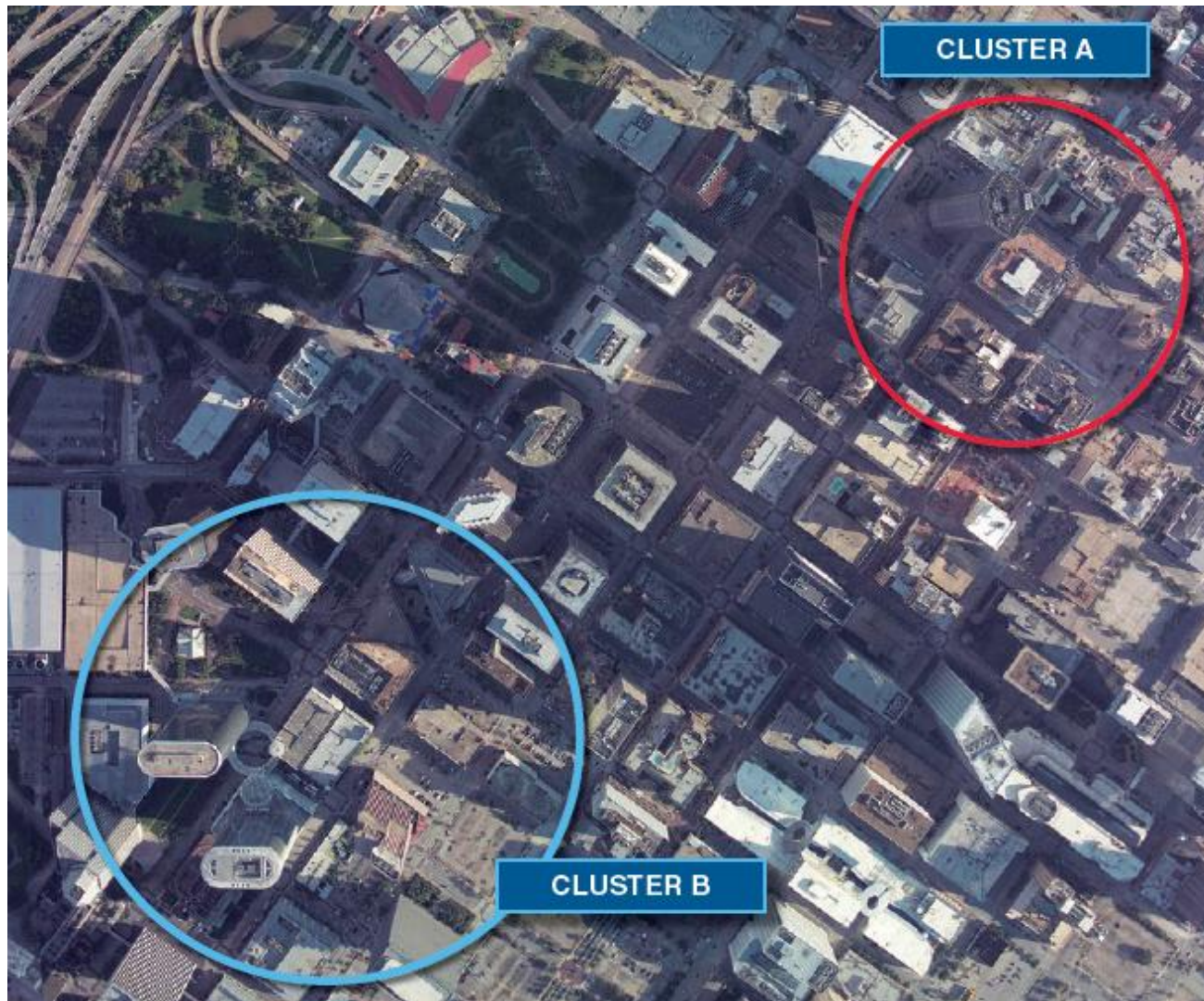




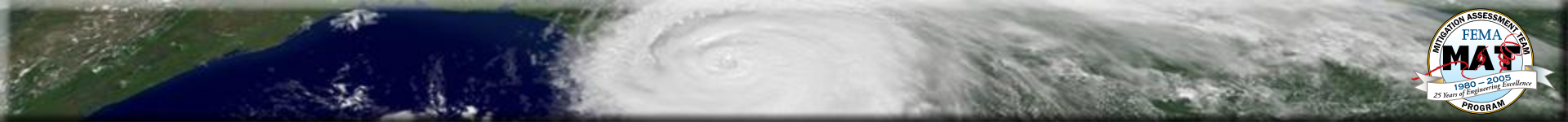
# Windborne Debris Protection



# Wind -- Downtown Houston



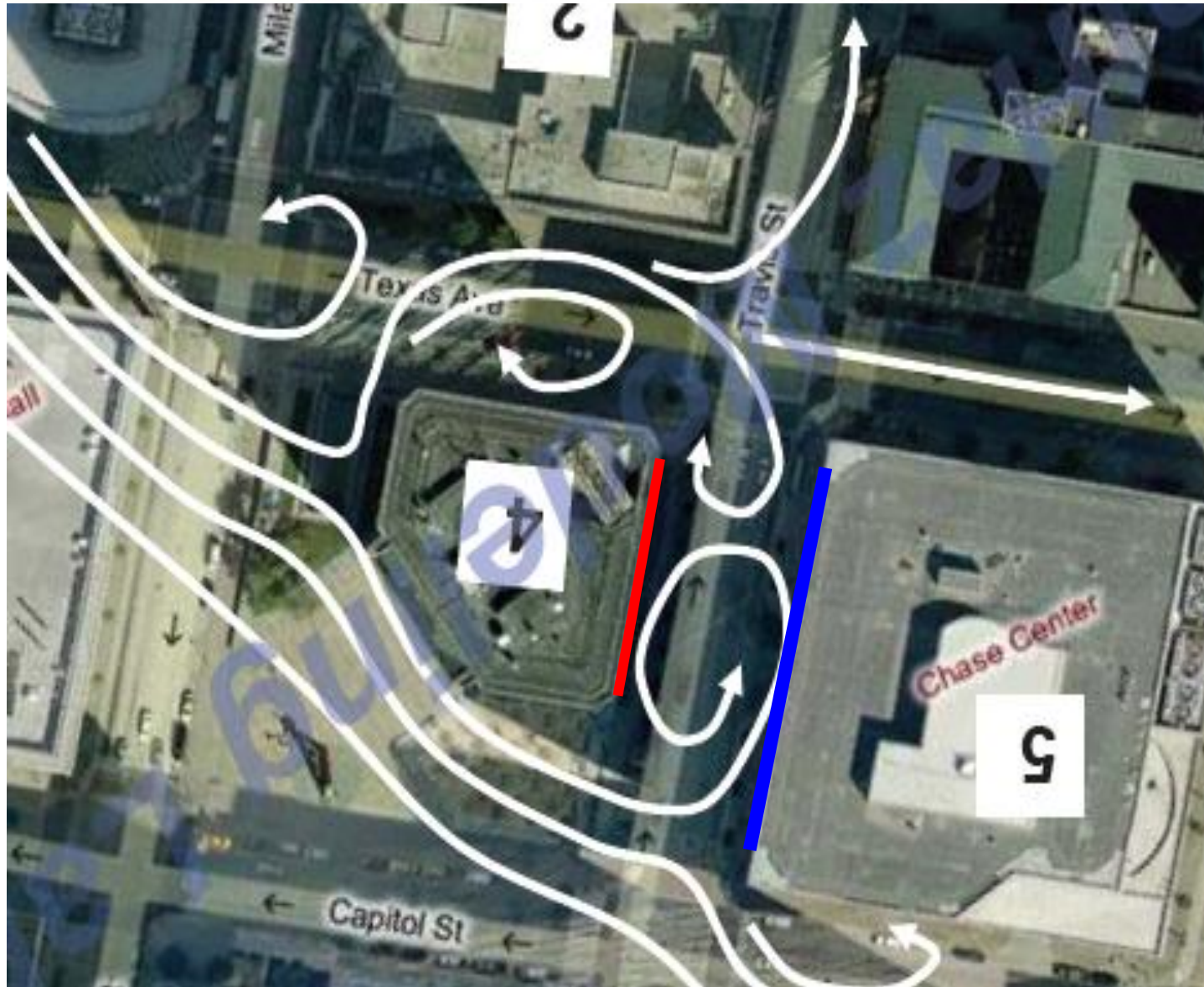




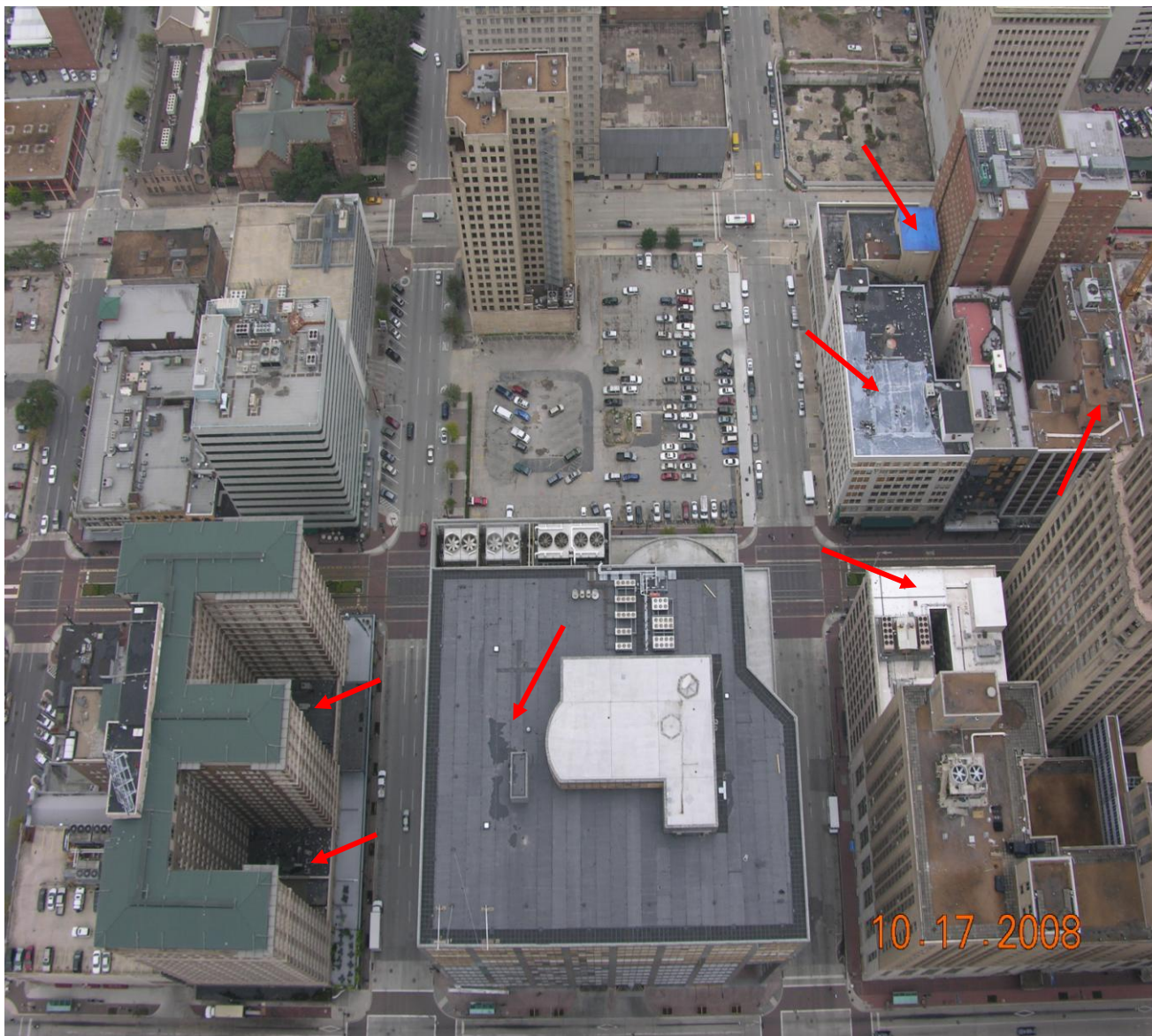
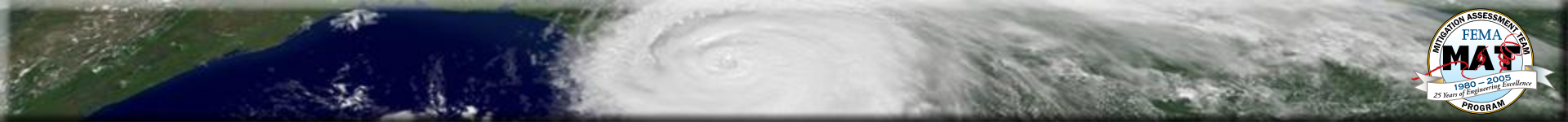






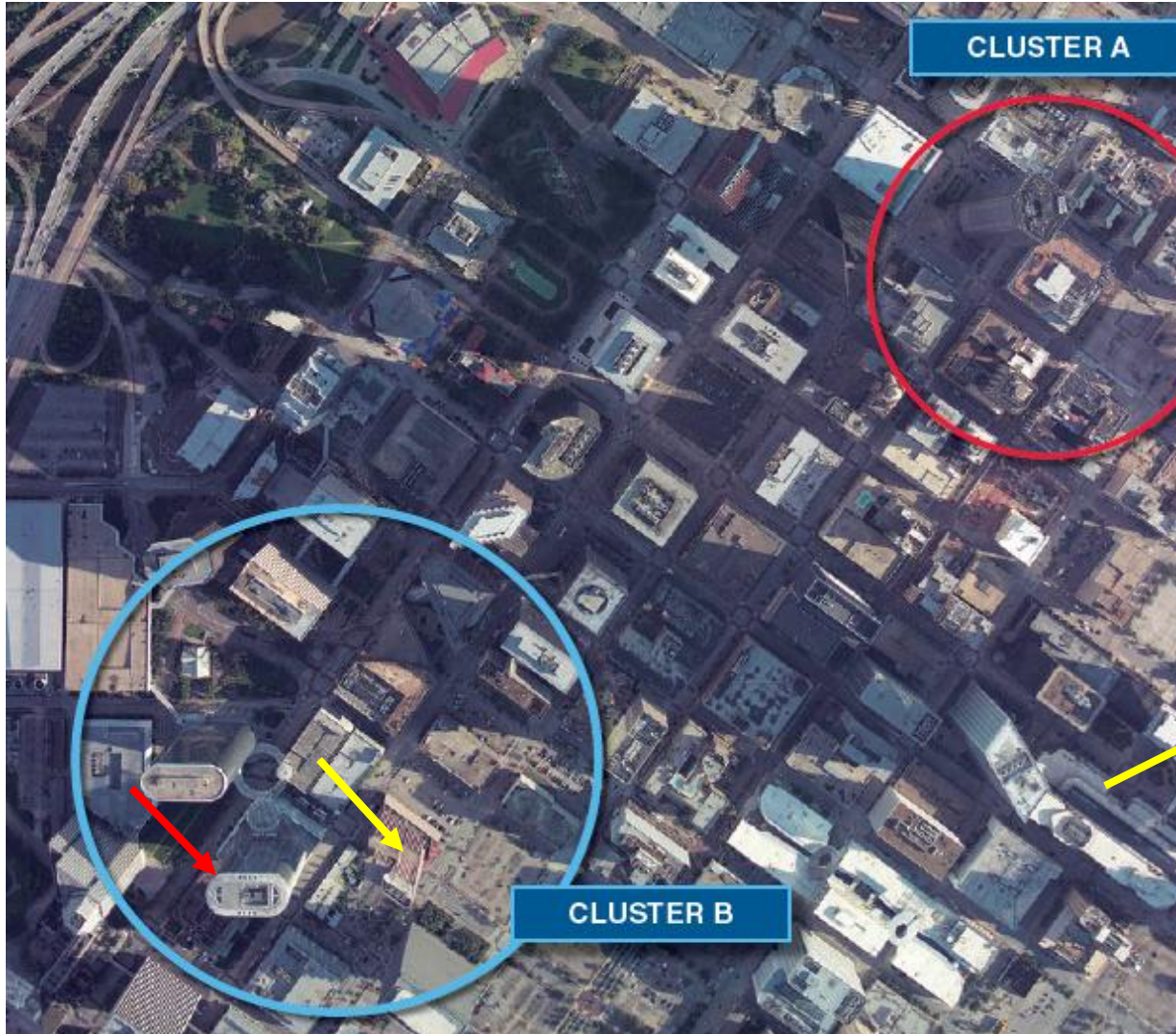




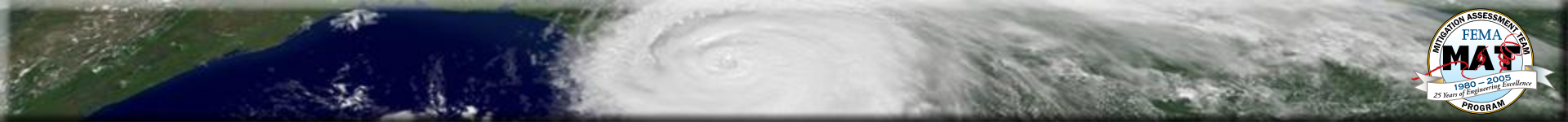




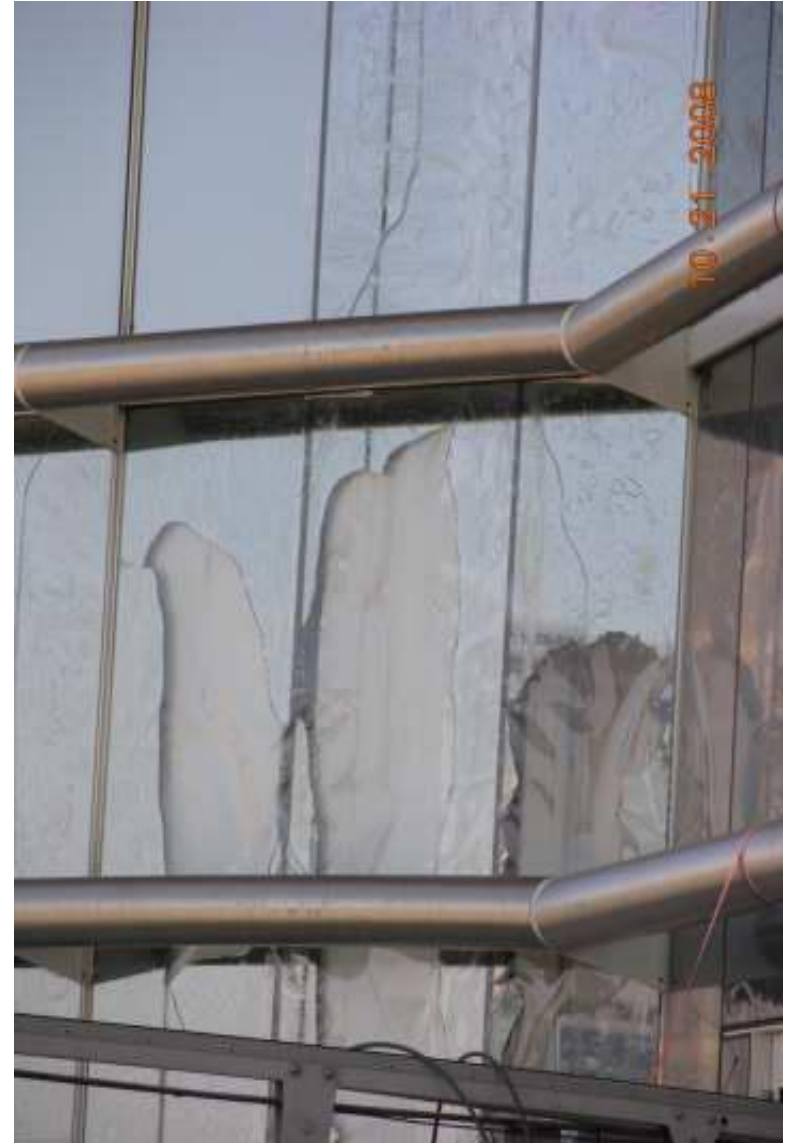
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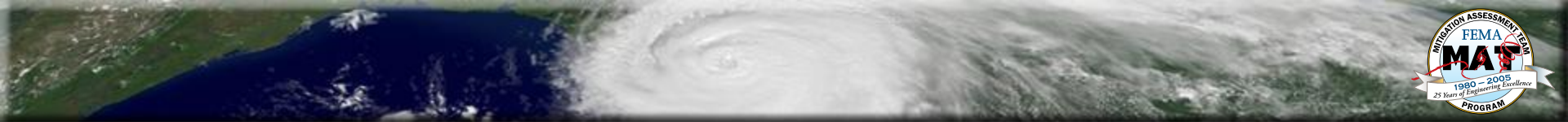




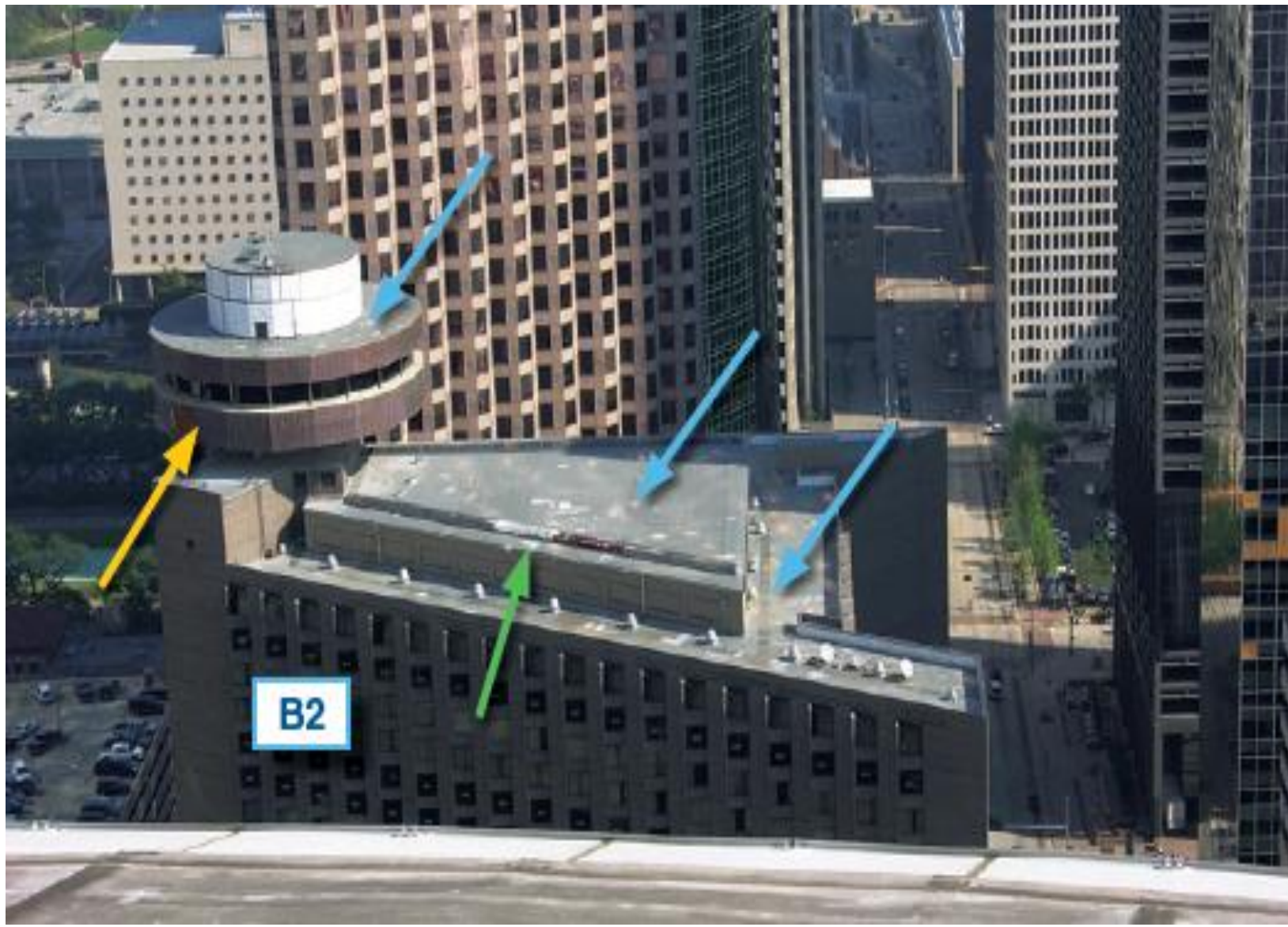
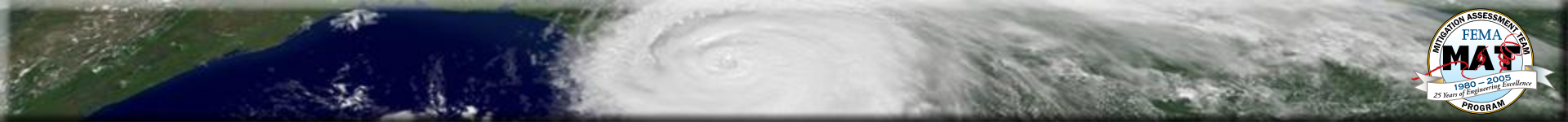


# Temporary Plastic Film

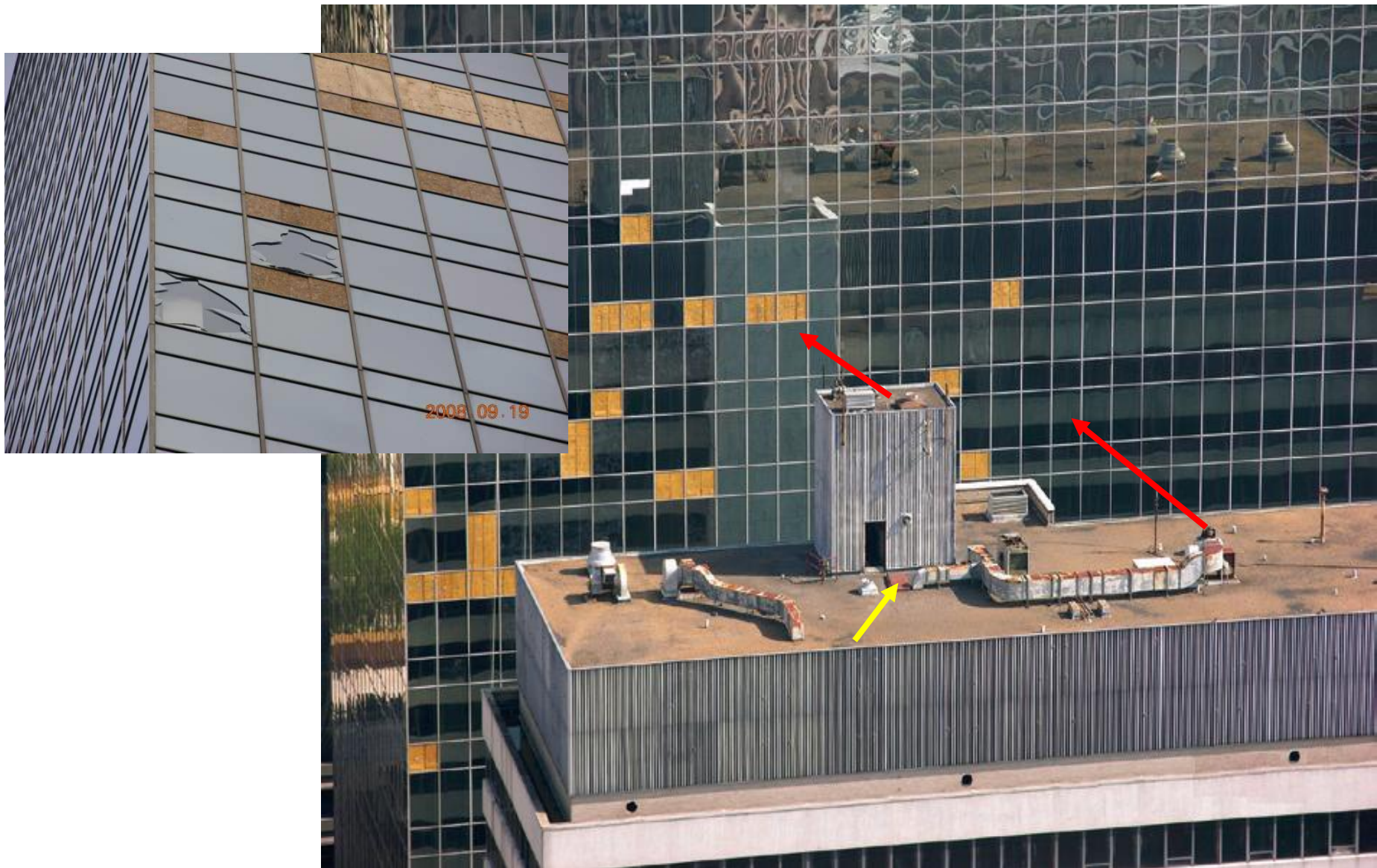












# Wind Recommendations -- Central Business Districts

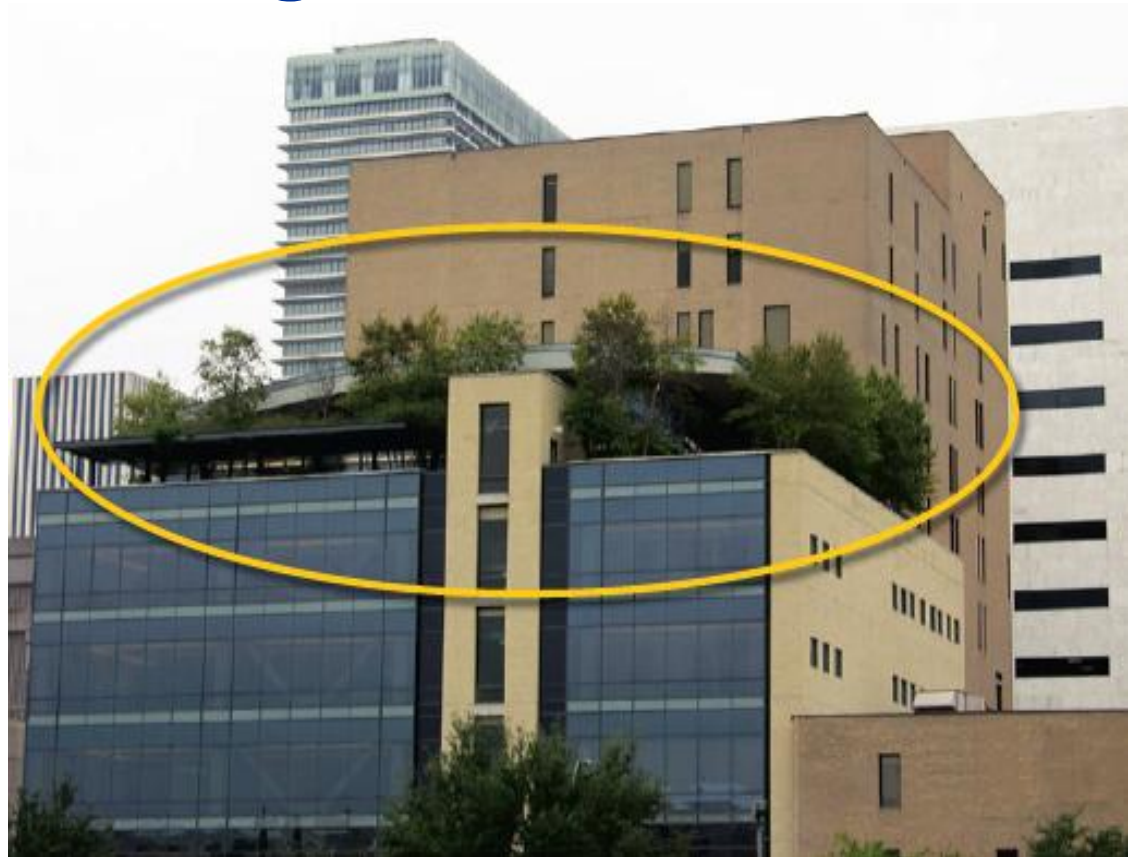
- In urban areas in hurricane-prone regions, existing aggregate surface roofs should be removed to avoid damage to other buildings
- Add aggregate abatement criteria to the ICC International Existing Building Code





# Wind Recommendations -- Central Business Districts, Vegetative Roofs

- Develop consensus design guide and building code requirements
- Interim guidance: Limit trees and shrubs to about 30'

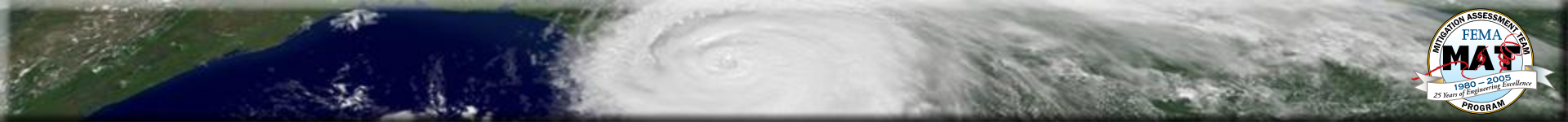


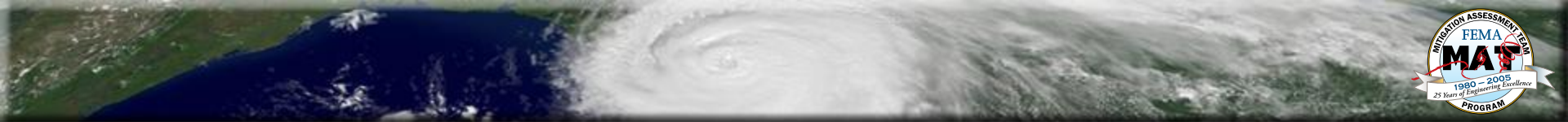
# Wind – Critical Facilities

- Observation: Most critical facilities had wind vulnerabilities -- some were significant



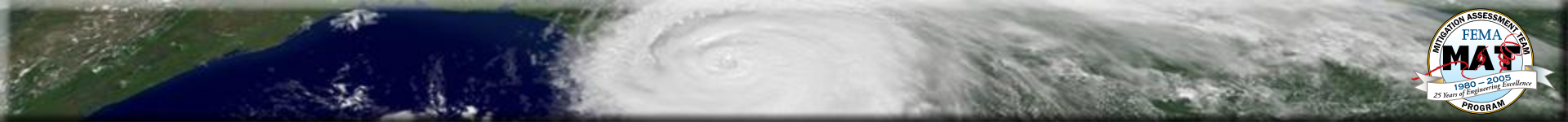






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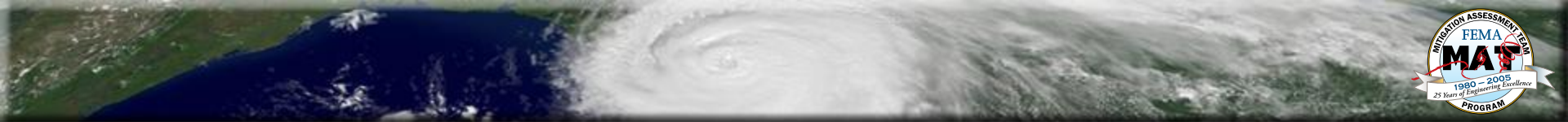




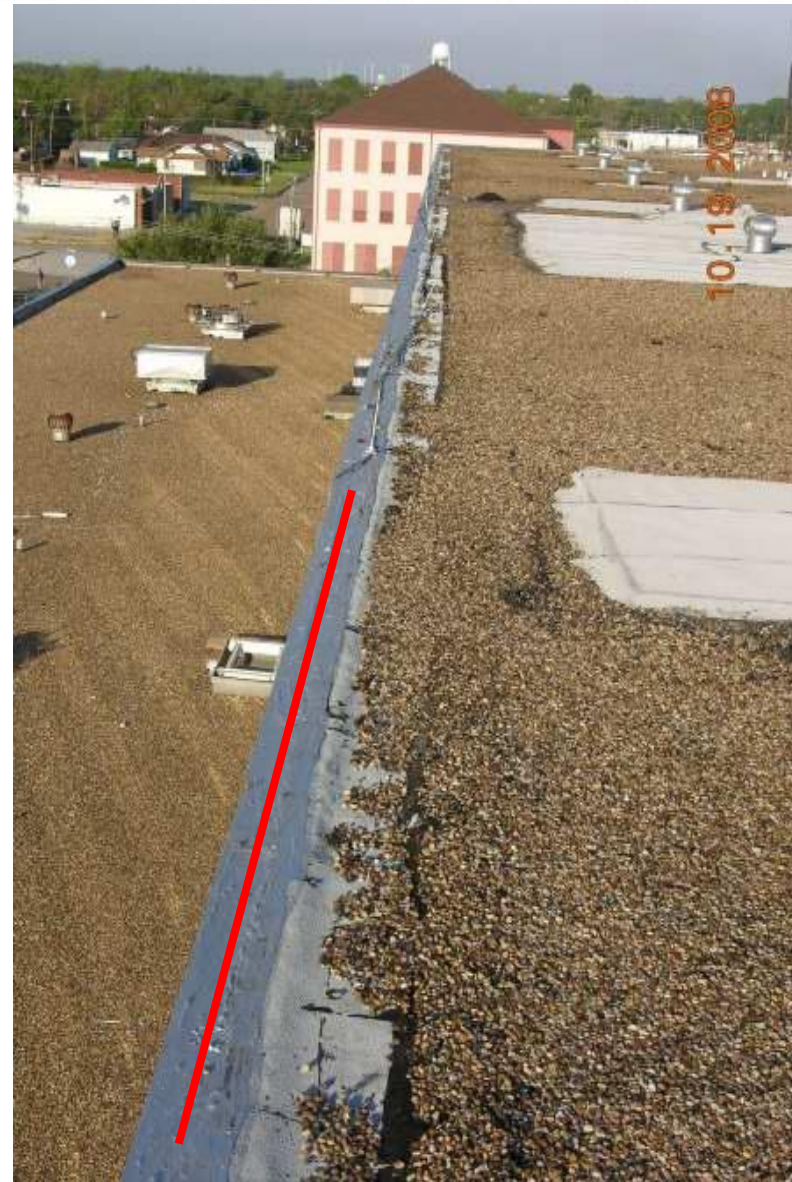
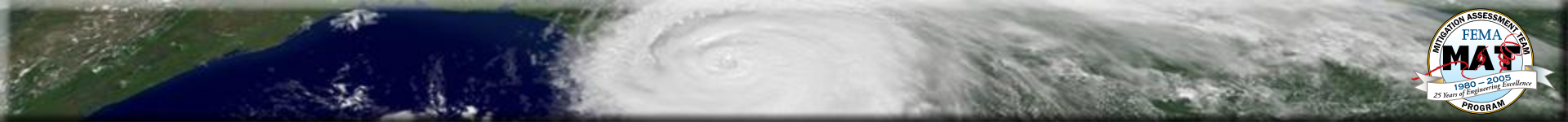
**105 mph**

**108 mph**







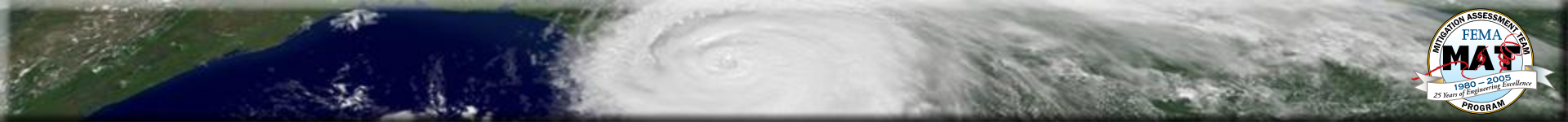


# Mitigation Project Performance

- Observation: Mitigated projects not sufficiently robust and/or not sufficiently comprehensive







# Critical Facilities

- FEMA 543 Critical Facilities
- FEMA 577 Hospitals



Risk Management Series

## Design Guide

for Improving Critical Facility Safety  
from Flooding and High Winds

FEMA 543 / March 2006

FEMA Region IV





# Critical Facilities Recommendations

- Existing facilities: perform comprehensive vulnerability assessment of wind-force resisting system and building envelope
- Mitigation: Consider Guidance in FEMA 543 and 577. If recommendations not implemented, base decision on deliberation and consideration of residual risks
- Mitigation projects: 2-stage peer review

# Critical Facilities Recommendations

- Update FEMA 424, 543 and 577
  - Roof drainage
  - Emergency power





