# Hazard Mitigation of Critical Facilities

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*URS*

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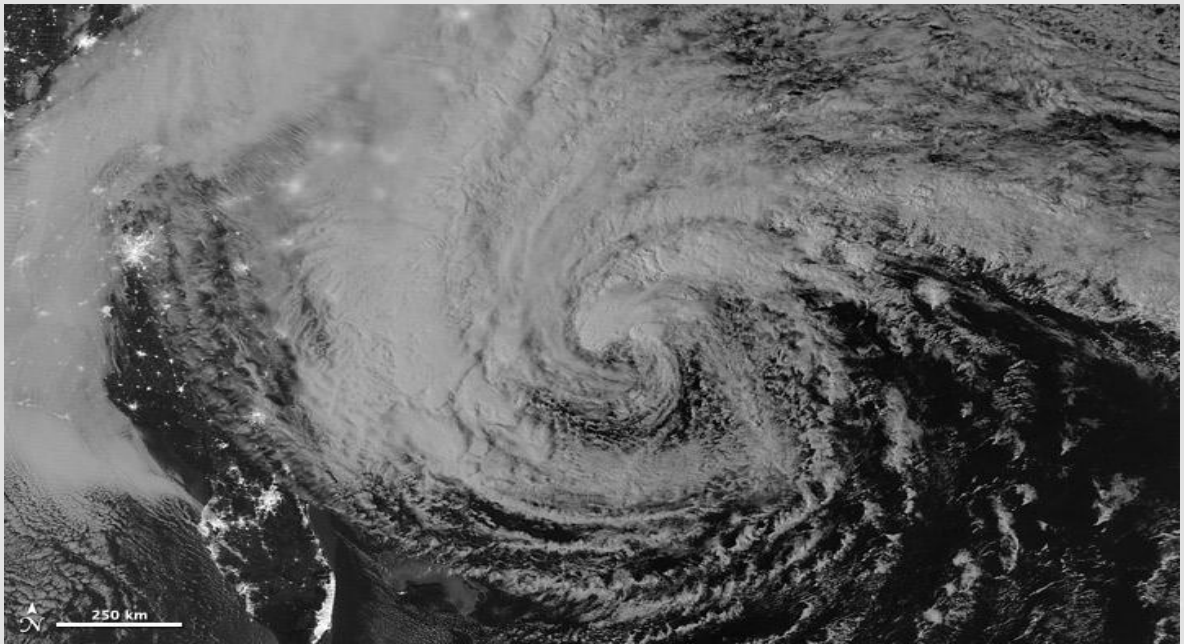
# Outline

- Definitions
- Case Studies
- Design Standards
- Building Performance Objectives
- Hazards
  - Flooding
  - High Winds
- Mitigation Recommendations

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# Critical Facility Definitions

- ASCE 7 Definition:
  - Category III
    - High occupancy buildings (e.g., schools)
  - Category IV
    - Essential facilities (e.g., hospitals, EOCs)

FEMA 543 definition of Critical Facilities:

- Buildings essential for delivery of vital services or protection of community

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*St. John's Medical Center, Joplin, MO*

**EF3**


NOT
EXIT
THIS IS
NOT
AN EXIT

# Design Standards - Prescriptive Requirements

Minimum requirements for materials, design, and construction:

- Allowable area
- Allowable height
- Fire resistance
- Loads
- Materials
- Strength
- Approved systems


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# Model Building Codes & Standards

ASCE 24

- Basic design requirements
- Specific foundation types
- Enclosures
- Materials
- Floodproofing

ASCE 7

- Structural design
- Means for determining dead, live, soil, flood, wind, snow, rain, atmospheric ice, and earthquake loads


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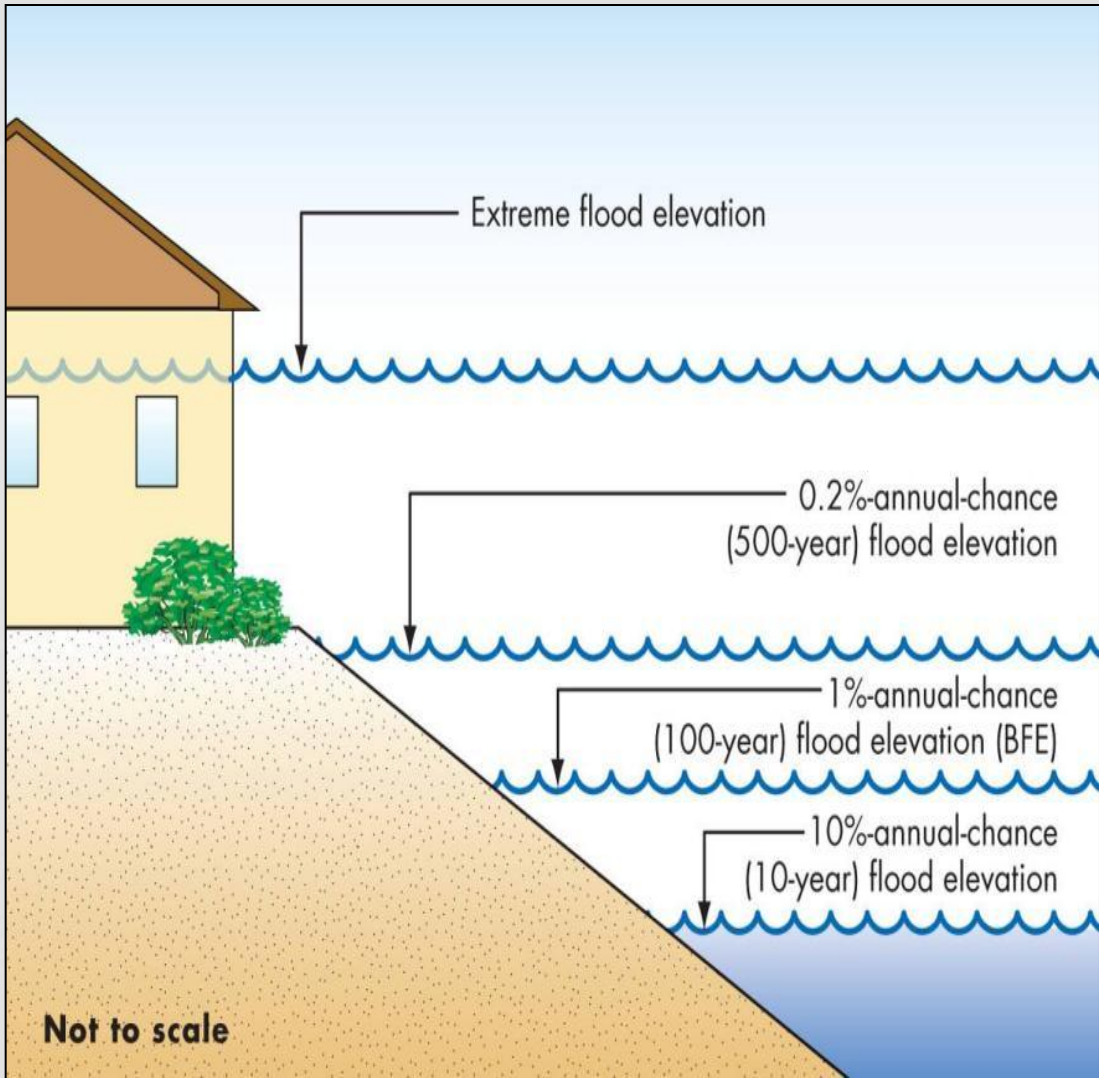
# Flooding in the United States

Flooding is the most common natural hazard:

- 7-10% of U.S. land area mapped as floodplain
- 70% of Presidential Disaster Declarations
- 2014: over 40 major disaster declarations for flooding

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# Flood – Key Design Concerns

- Depth
- Duration
- Velocity
- Wave action
- Impacts from debris and ice
- Erosion and scour


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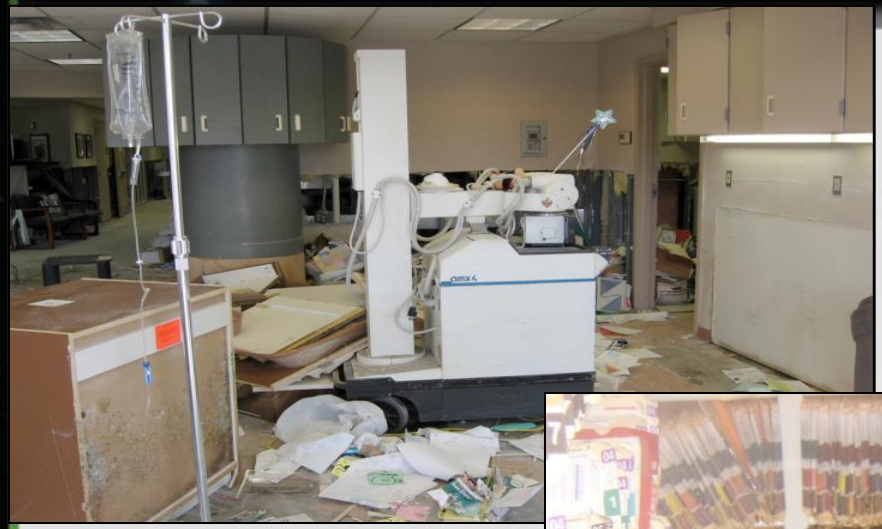
# Flood - Structural

# Flood – Nonstructural Damage



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# Mitigation Recommendations

- Dry Floodproofing
- Protection of Utility Systems
- Protection of key assets

# Flood Protection – Lourdes Hospital


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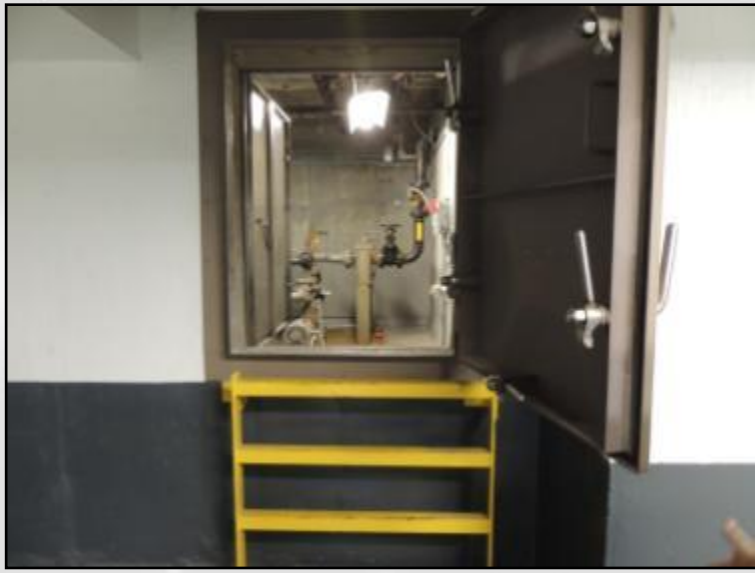
# Emergency Power Systems

Holistic Approach:

- Fuel supplies for emergency power systems
- Electrical system for emergency power
- Electrical system for normal power

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# Dry Floodproofing Selection

Dry floodproofing mitigation measures:

- Watertight shields for doors and windows
- Reinforced walls
- Membranes and sealants
- Drainage collection and sump pumps
- Check valves
- Anchoring


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# Utility Systems

## Utility Systems

- Location, location, location…
  - Elevation or dryfloodproofing
  - Redundancies
  - Quick Connects

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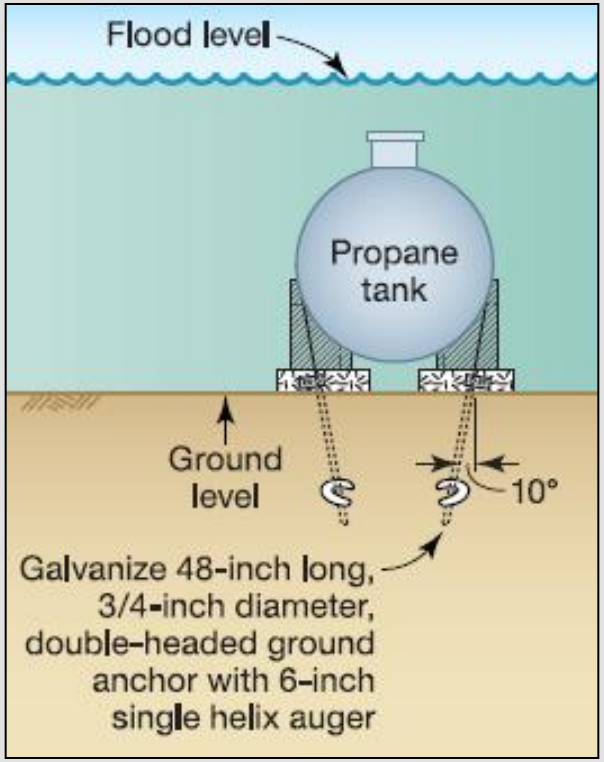
# Protection of Utility Systems

Fuel Supply/Storage Systems:

- Use flexible connections
- Design tanks to resist flotation forces and implosion for the design flood level
- Move fuel tank with relocated equipment
- Use automatic cut-off valves
- Full tanks are less buoyant, better resist uplift, and are less susceptible to crushing

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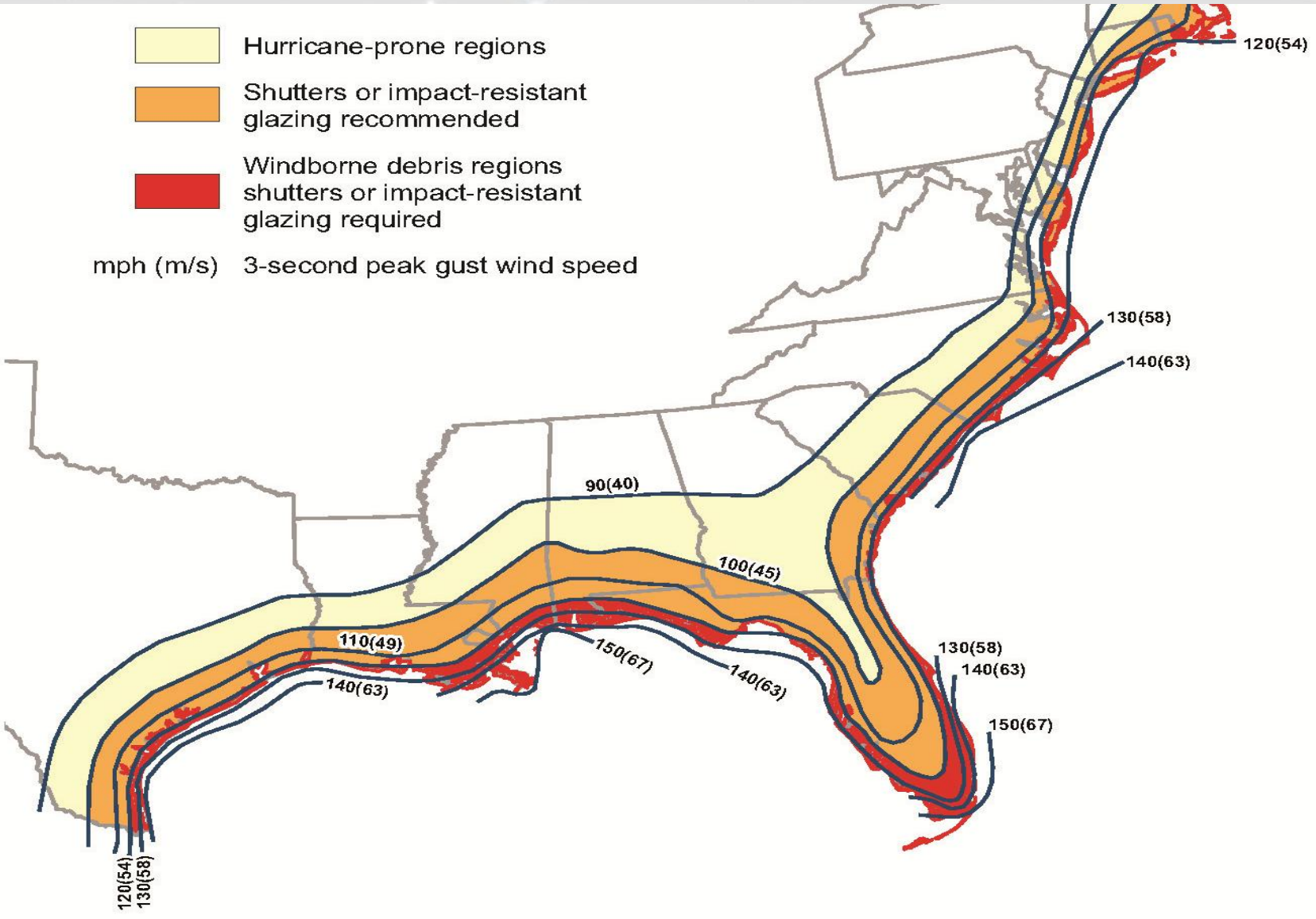
# Wind

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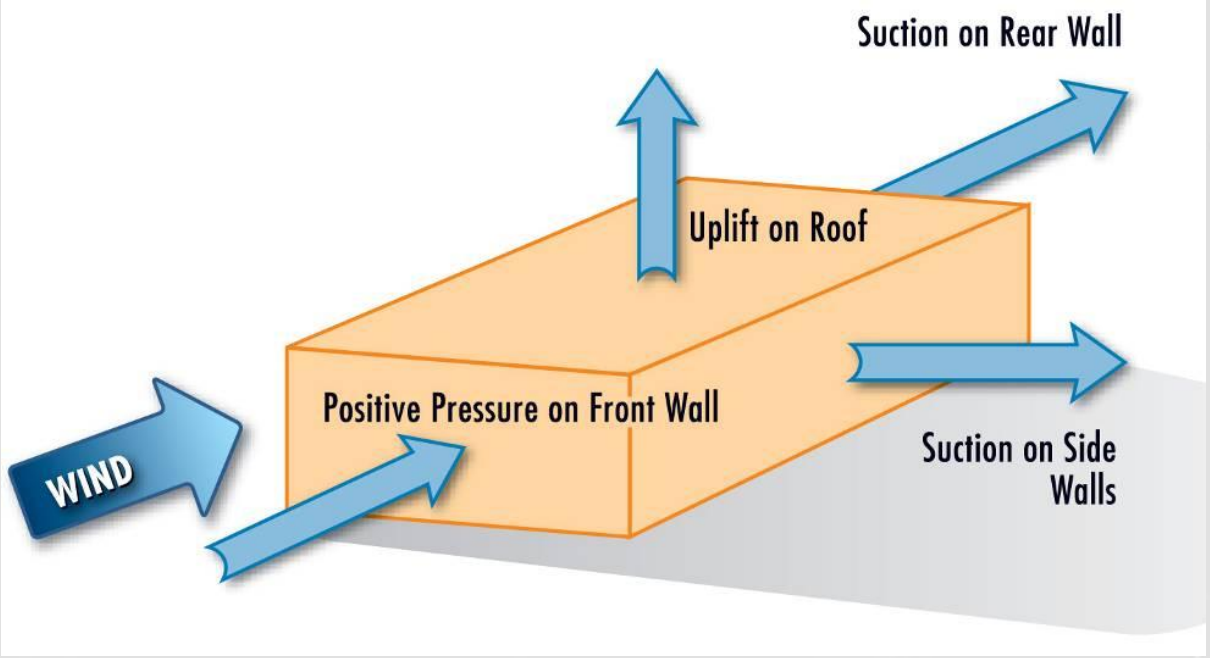
# Wind/Building Interactions

- Wind forces interact with buildings as both positive and negative (suction) pressures
- Loads exerted on building envelope are transferred to structural system, foundation, and ground

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# Wind/Building Interactions


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# Wind – Key Design Considerations

- Exposure
- Basic wind speed
- Topography
- Building height
- Internal pressure
- Building shape

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# Wind Protection - Shelters

- FEMA 543 Recommendations

| | |
|---|---|
| Provide shelter within facility | Design per FEMA 361 |
| For small facilities, such as fire stations | Design per FEMA 320 |
| Large Critical Facilities (Hospitals, Data Centers, Etc.) | Harden envelope to minimize disruption from nearby weak tornadoes/hurricanes and from strong, violent winds on periphery |

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# Wind Protection - Glazing

- FEMA 543 Recommendations

| Condition | Recommendation |
|---|---|
| Basic wind speed ≥ 100 mph, glazing within 60 ft of grade designed to resist E missile | Laminated glass, polycarbonate or shutters |
| Aggregate roofs within 1,500 ft, glazing above 60 ft designed to resist A missile | Extend protection to 30 ft minimum above source roof |
| Large momentum threat within few hundred feet (EIFS, tile, rooftop equipment) | Use E missile for upper-level glazing |

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# Wind Protection - Glazing

- ASCE 7 requires use of impact-resistant glazing or shutters in wind-borne debris regions

104 mph (gust, Exp C), Flight Path > 245’

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# Pre-Event Planning

**Pre-Event Planning and Flood Protection Measures**

- multiple hazard events
- Holistic approach
- Elevation is key

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# Questions?

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