Hazard Mitigation of Critical Facilities

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2014 INTERNATIONAL WORKSHOP ON ENVIRONMENT AND ALTERNATIVE ENERGY

October 21-24, 2014
Kennedy Space Center, FL
Outline

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

2011 Spring Tornadoes MAT Report Release

EF3

St. John’s Medical Center, Joplin, MO
Design Standards - Prescriptive Requirements

Minimum requirements for materials, design, and construction:

- Allowable area
- Allowable height
- Fire resistance
- Loads
- Materials
- Strength
- Approved systems
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
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
Flood – Key Design Concerns

- Depth
- Duration
- Velocity
- Wave action
- Impacts from debris and ice
- Erosion and scour
Flood – Nonstructural Damage
Mitigation Recommendations

- Dry Floodproofing
- Protection of Utility Systems
- Protection of key assets
Flood Protection – Lourdes Hospital
Emergency Power Systems

Holistic Approach:
- Fuel supplies for emergency power systems
- Electrical system for emergency power
- Electrical system for normal power
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
Utility Systems

- Location, location, location...
  - Elevation or dryfloodproofing
  - Redundancies
  - Quick Connects
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
Wind

- Hurricane-prone regions
- Shutters or impact-resistant glazing recommended
- Windborne debris regions
  - Shutters or impact-resistant glazing required

mph (m/s) 3-second peak gust wind speed
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.
Wind/Building Interactions

Designed as a Shelter – Completed in 2002

Florida  2004  1400 Occupants
Wind – Key Design Considerations

- Exposure
- Basic wind speed
- Topography
- Building height
- Internal pressure
- Building shape
## Wind Protection - Shelters

### FEMA 543 Recommendations

<table>
<thead>
<tr>
<th>Provide shelter within facility</th>
<th>Design per FEMA 361</th>
</tr>
</thead>
<tbody>
<tr>
<td>For small facilities, such as fire stations</td>
<td>Design per FEMA 320</td>
</tr>
<tr>
<td>Large Critical Facilities (Hospitals, Data Centers, Etc.)</td>
<td>Harden envelope to minimize disruption from nearby weak tornadoes/hurricanes and from strong, violent winds on periphery</td>
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# Wind Protection - Glazing

## FEMA 543 Recommendations

<table>
<thead>
<tr>
<th>Condition</th>
<th>Recommendation</th>
</tr>
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<tbody>
<tr>
<td>Basic wind speed ≥ 100 mph, glazing within 60 ft of grade designed to resist E missile</td>
<td>Laminated glass, polycarbonate or shutters</td>
</tr>
<tr>
<td>Aggregate roofs within 1,500 ft, glazing above 60 ft designed to resist A missile</td>
<td>Extend protection to 30 ft minimum above source roof</td>
</tr>
<tr>
<td>Large momentum threat within few hundred feet (EIFS, tile, rooftop equipment)</td>
<td>Use E missile for upper-level glazing</td>
</tr>
</tbody>
</table>
ASCE 7 requires use of impact-resistant glazing or shutters in wind-borne debris regions.

104 mph (gust, Exp C), Flight Path > 245’
Pre-Event Planning

Pre-Event Planning and Flood Protection Measures

- multiple hazard events
- Holistic approach
- Elevation is key
Questions?

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