Mitigation Assessment Team (MAT) 
2011 Tornadoes

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AL, GA, MS, TN – April Tornadoes
Joplin, MO – May 22 Tornado
Objectives of the MAT Program

- Conduct forensic engineering analyses to determine causes of building failure and success
- Looking to answer two questions:
  - Can we be safer next time
  - If yes, then how?
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Mitigation Assessment Team

Mission

Immediate

Forensic Analysis

Long Term

Impact construction codes and standards

Inform Recovery

Short Term
Prior MAT activity

- **Hurricanes**
  - 10+ reports
  - Key observations and national impacts

- **Flooding**
  - Midwest floods of 2008

- **Tornadoes**
  - KS and OK, 1999
  - KS and OK, 2007

- **Terrorism**
  - Oklahoma City Bombing
  - World Trade Center

FLASH Annual Meeting – October 27, 2011
Who Studies the impacts?

- Experts include:
  - FEMA HQ and Regional Staff
  - Technical Assistance Contractor and SMEs
    - Architects
    - Engineers
    - Building Code Experts
    - Meteorologists
    - Emergency Managers
  - Research universities
    - University of Alabama
    - Texas Tech University
Other Teams in the Field

- Other national teams in the field
  - National Science Foundation (Tuscaloosa, AL)
    - Wood-framed houses
  - ASCE/SEI (Joplin)
    - Houses and critical facilities
  - National Institutes of Standards and Technology (Joplin)
    - Emergency Communications
    - Performance of Lifelines
    - Critical facilities, evacuation, sheltering
MAT Technical Focuses

- Evaluation of building performance for
  - Critical and essential facilities
  - Schools
  - Residential and non-residential buildings
- Evaluation of sheltering actions and shelter/safe room usage
- EF Scale rating and collaboration with NWS and NSF
Analysis and Action

- Recovery Advisories
- MAT Reports
- Design Guidance
- Training Delivery
Safe Rooms

- Safe room initiatives since the 1990s
- States and FEMA partnered on multiple programs for
  - Residential safe rooms
  - Community safe rooms
  - ICC-500 shelters in public schools
Refuge Areas in Residential Buildings

Refuge area in residential home in Pleasant Grove, AL
Refuge Areas in Residential Buildings

Refuge area in residential home in Tuscaloosa, AL

These individuals constructed shelters on their own that were nearly FEMA 320 compliant

Refuge area in residential home in Athens, AL
Residential Safe Rooms

Tuscaloosa, AL
Residential Safe Rooms

Crescent Ridge area of Tuscaloosa, AL
Compliant vs. Non-compliant Doors

Tested door assembly w/ multiple hinges and latches

Untested door assembly with multiple hinges, but only one latch
School Performance

- Impacted schools had significant damage
- Newer codes consider schools critical facilities, older codes did not – just designed for additional “hazard-resistance”
- Most of these buildings performed no better than “typical” commercial construction
- Most schools had a “tornado plan”, but
  - They did not have a safe room or shelter
  - Used a refuge area
  - The refuge area was never assessed for vulnerability to wind and windborne debris
The Need for Safe Rooms at Schools

- Tornado, March 2007
- Enterprise, Alabama
- 8 killed while taking refuge
- No shelter in the school

Enterprise, AL
Protecting Students from Tornadoes

- Most schools have plans
- Teachers and students know where to go and what to do
  - Plans are written down
  - Drills several times per year
- More work to do
  - Have the refuge areas been evaluated for vulnerabilities
  - Are the refuge areas hardened or are they safe rooms?
Alberta Elementary School
Refuge Areas at Schools

Alberta Elementary – Tuscaloosa, AL
Sheltering and Safe Rooms

- Most schools have tornado drills and move students to refuge areas.
- A number of businesses have tornado plans and move the public into “designated” spaces.
- However, the people taking shelter in “best available” spaces, refuge areas, and shelters are still very much at risk.
  - Most of these “spaces” were not hardened or designed for high winds.
  - The few that were did not have doors that provided protection.
  - Several FEMA-funded safe rooms did not have doors that were compliant with the FEMA 361/320 criteria.
Evaluating Refuge Areas

- FEMA P-361, *Design and Construction Guidance for Community Safe Rooms* (2008), Checklists in Appendix B
- East Joplin Middle School
This Is Not A New Lesson to Be Learned

Figure 6-34. Northmoor Elementary School, Moore, Oklahoma, place of refuge – corridor with clerestory windows. This corridor offers little protection from tornadoes as shown in a school of similar design in Figure 6-35.

Figure 6-35. Kelley Elementary School, Moore, Oklahoma, place of refuge – corridor with clerestory windows. These interior corridor walls had brick masonry up to a height of approximately 7 feet. Glass extended from the top of the brick masonry to the top of the wall.

Kelley Elementary School – Moore, OK (May 1999)
Community Shelters and Safe Rooms

FEMA-funded safe room in Brookside, AL

- Outside damage path
- 150+ occupants during event
Community Shelters and Safe Rooms

FEMA Safe Room – Brookwood, AL
Similar single “tube” used in Phil Campbell, AL
“Building Better” Makes a Difference

- Performance of buildings designed to recent codes (in most cases) verified that newer code requirements improve hazard resistance
- Code is a minimum set of requirements
- Exceeding code reduces vulnerability and may reduce damage to smaller events
  - We know this is true in hurricane-prone regions
Can we be safer next time? How?

- RA 1: Tornado Risks and Hazards in the Southeastern United States
- RA 2: Safe Rooms: Selecting Design Criteria
- RA 3: Residential Sheltering: In-Residence and Stand-Alone Safe Rooms
- RA 4: Safe Rooms and Refuge Areas in the Home
- RA 5: Critical Facilities Located in Tornado-Prone Regions: Recommendations for Facility Owners
- RA 6: Critical Facilities Located in Tornado-Prone Regions: Recommendations for Architects and Engineers
- RA 7: Rebuilding and Repairing Your Home After a Tornado
- RA 8: Reconstructing Non-Residential Buildings After a Tornado