The May 22, 2011, Joplin Tornado Investigation

March 26-27, 2015
NCST Advisory
Committee Meeting

Progress on Implementation of Recommendations

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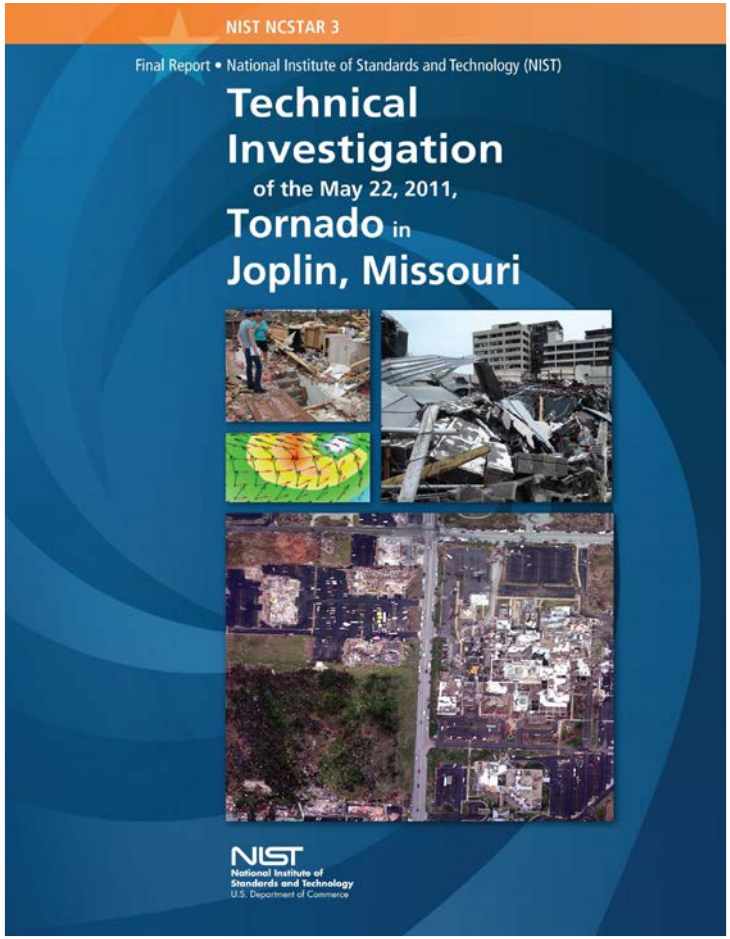
Outline

- Summary of Joplin Tornado Investigation activities since last Advisory Committee meeting
  - Final Report
  - Recommendations Implementation Plan
- Implementation Progress Update

Final Report

- Following the December 10-11, 2013 NCSTAC meeting, NIST began receiving and addressing public comments on Draft Final Joplin Tornado report
- Finalized and vetted recommendations with Lead organizations
- Published *Final Report* (March 2014)



Available at http://dx.doi.org/10.6028/NIST.NCSTAR.3

Final Report *(cont'd)*

Joplin tornado recommendations call for development and adoption of:

1. **Nationally accepted standards for tornado–resistant design and design methodologies for** tornado hazards
2. **Uniform national guidelines** that enable communities to create safe and effective public sheltering strategies, tornado shelter standard for existing buildings, and installation of tornado shelters in new and existing buildings
3. **National codes and standards and uniform guidance for clear, consistent, recognizable, and accurate emergency communications** and **joint plans** by emergency managers, the NWS, and the media to make sure that accurate and consistent emergency alert and warning information is communicated in a timely manner
4. **Research, technologies and strategies** to advance tornado wind measurements, strengthen emergency communications, increase warning time, derive more accurate tornado hazard maps and improve public response

Final Report *(cont'd)*

Positive responses from Lead organizations

- **International Code Council (ICC)**
  "…comprehensive and highly professional report...looks forward to working with NIST to make sure information and recommendations developed by NIST can find their way into the model building safety codes…"
- **American Society of Civil Engineers (ASCE)**
  "…firmly believes that national performance-based standards are needed…stands ready to work with the NIST on this and other activities which seek to protect the public health and safety…"
- **National Fire Protection Association (NFPA)**
  "…very thorough, technical and scientific study…addressing not only the building damage assessments, but also the response, recovery and rebuilding efforts"

Recommendations Implementation Plan

- **Developed and funded new project for implementation of Joplin recommendations (April, 2014)**

  Strategy: implement all 16 recommendations at the earliest possible date, based on code and standard development cycles, by

  - Developing, or coordinating the development of, guidelines, national standards, and code change proposals
  - Coordinating/championing their adoption in the national model codes
  - Conducting/coordinating research to enable development/deployment of technology for improved emergency communication, tornado hazard characterization, and public perception of risk and response in emergencies

  Milestones planned through FY2020, with actions already under way.

Implementation Plan *(cont'd)*

- **Convened strategy meetings with leadership of Lead organizations** to (1) affirm their commitment, (2) develop implementation strategies, and (3) coordinate activities

- **Highlights of some of the major interactions**
  - **American Society of Civil Engineers (ASCE)**
    - Began discussions in December 2013
    - Formed new ASCE/SEI *Wind Speed Estimation in Tornadoes Standard* Committee. NIST staff co-chairs
    - This addresses Joplin recommendations #2 and #4, and supports #1 and #3
    - NIST staff also formed and led a *Tornado Working Group* within an ASCE committee on *Performance-Based Design for Extreme Wind* to address recommendation #5 and to support #6

Implementation Plan *(cont'd)*

- **Highlights of some of the major interactions (cont'd)**
  - **International Code Council (ICC)**
    - Met in April 2014. Developed joint ICC-NIST action plan for implementing recommendations #7, #10, and #11 (July 2014)
    - Worked with ICC Building Code Action Committee (BCAC), developed and submitted code change proposals for shelter requirements (rec #7, January 2015) for 2018 IBC and IEBC
  - **Nuclear Regulatory Commission (NRC)**
    - Met in July 2014
    - Briefed NRC on NIST effort to develop tornado risk maps for building design (recommendation #3)
    - Discussed NRC interest in tornado risk maps development and potential collaboration

Implementation Plan *(cont'd)*

- **Highlights of some of the major interactions (cont'd)**
  - **Federal Emergency Management Agency (FEMA)**
    - First met in August 2014, in regular communications since
    - Discussed specific IBC and IEBC code change proposals related to tornado shelters that NIST jointly developed with ICC BCAC (recommendation #7)
    - Discussed public sheltering strategies and working with FEMA to update FEMA P-361 (Guidance for Community Safe Rooms) as part of the implementation of recommendation #8
    - Working with FEMA to update FEMA P-431 (Tornado Protection: Selecting Refuge Area in Buildings) as part of the implementation of recommendation #9

Implementation Plan *(cont'd)*

- **Highlights of some of the major interactions (cont'd)**
  - **National Fire Protection Association (NFPA)**
    - Met in August 2014
    - Developed a joint NIST-NFPA action plan for recommendations #3, #11, and #13
  - **National Science Foundation (NSF)**
    - Met in July 2014
    - Discussed strategy for implementing recommendation #15

Implementation Plan *(cont'd)*

- **Initiated work on NIST-led Recommendation #3, Tornado Risk Maps**
  - Drafted technical requirements for *Tornado Risk Maps for Building Design: Development of Framework for Tornado Hazard Risk Assessment* (June 2014)
  - Awarded contract to Applied Research Associates, Inc.(Sept. 2014)
  - Three years effort. Year One focuses on (1) review of tornado data and risk estimation methods and (2) quantification of tornado risk metrics for a pilot Midwestern municipality, to develop R&D plan for map completion
  - Kickoff meeting with participation of key stakeholders (Dec. 2014)
  - Stakeholder inputs workshop on pilot tornado risk metrics (Sept. 2015)
  - Provides the technical underpinning for recommendations #5 and #6

Implementation Progress Update

Efforts currently under way on implementation of 9 recommendations, which will have impacts on

- **Existing Standards**
  - ASCE/SEI 7-22, Minimum Design Loads for Buildings and Structures
  - ICC 500-2018, Standard for Design and Construction of Storm Shelters
- **New Standards**
  - ASCE Standard for Estimation of Wind Speeds in Tornadoes
  - NFPA 1616, Standard for Mass Evacuation and Sheltering
- **Building Codes**
  - 2018 International Building Code (IBC)
  - 2018 International Existing Building Code (IEBC)
- **Guidelines**
  - FEMA P-361, Safe Rooms for tornadoes and Hurricanes: Guidance for Community and Residential Safe Rooms
  - FEMA P-431, Tornado Protection: Selection Refuge Areas in Buildings
  - ICC 500-2014, Commentary on the Standard for Design and Construction of Storm Shelters

Implementation of the remaining 7 recommendations still in planning stages

R #	JOPLIN TORNADO INVESTIGATION RECOMMENDATION SUMMARY	LEAD
1	Development and deployment of technology to measure tornado wind fields	NOAA
2	Archival of tornado event data	NWS
3	Development of tornado hazard maps	NIST
4	Improvement of EF Scale; means for continued improvement; adoption by NWS	NWS
5	Development of performance-based standards for tornado-resistant design	ASCE
6	Development of performance-based tornado design methodologies	NIST, FEMA
7	a) Development of tornado shelter standard for existing buildings; b) Installation of tornado shelters in more buildings in tornado-prone regions	ICC
8	Development of guidelines for public tornado sheltering strategies	FEMA
9	Development of guidelines for selection of best available refuge areas	FEMA
10	Prohibition of aggregate coverings or ballast in tornado-prone regions	ICC
11	Development of requirements for enclosures of egress systems in critical facilities	ICC, NFPA
12	a) Development of tornado vulnerability assessment guidelines for critical facilities; b) Performance of vulnerability assessments by critical facilities in tornado-prone	FEMA
13	Development of codes, standards, and guidance for emergency communications; Development of joint plan by emergency mgrs/media/NWS for consistent alerts	NFPA
14	Deployment of “push” technologies for transmission of emergency information	FEMA
15	Research to identify factors to enhance public perception of personal risk	NSF, NIST
16	Develop technology for real-time, spatially-resolved tornado threat information	NOAA

R #	RECOMMENDATION IMPLEMENTATION (red – in progress, black – in planning)	LEAD
1	Development and deployment of technology to measure tornado wind fields	NOAA
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15	Research to identify factors to enhance public perception of personal risk	NSF, NIST
16	Develop technology for real-time, spatially-resolved tornado threat information	NOAA

Progress Update *(cont'd)*

Recommendation 4 (NWS): NIST recommends that new damage indicators (DIs) be developed for the Enhanced Fujita tornado intensity scale to better distinguish between the most intense tornado events. Methodologies used in the development of new DIs and associated degrees of damage (DODs) should be, to the extent possible, scientific in nature and quantifiable. As new information becomes available, a committee comprised of public and private entities should be formed with the ability to propose, accept, and implement changes to the EF Scale. The improved EF Scale should be adopted by NWS.

Developing a new ASCE/SEI Standard on *Wind Speed Estimation in Tornadoes*

- Committee co-chaired by NWS and NIST
- Scope of the new standard includes wind speed estimation by
  - EF Scale, Radar and In-situ Measurements, Forensic Engineering, Treefall Patterns, and Remote Sensing
- Kickoff meeting held at ASCE Headquarters, March 12-13, 2015
- Intended for adoption by NWS
- The new standard will also address recommendation #2 and support implementation of recommendations #1 and #3

Progress Update *(cont'd)*

Recommendation 2 (NWS): NIST recommends that information gathered and generated from tornado events (such as the Joplin tornado) should be stored in publicly available and easily accessible databases to aid in the improvement of tornado hazard characterization.

- Discussions held with NWS Storm Data program managers in conjunction with establishment of the new ASCE/SEI *Wind Speed Estimation in Tornadoes* standards committee
- NWS is in the process of upgrading its server capacity to include the ability to archive geospatial data
- Minimum data archival requirements included in the scope of the *ASCE/SEI Standard for Wind Speed Estimation in Tornadoes* (see Recommendation #4)
- The standard is intended for adoption by the NWS
  - Participation by NOAA staff on the standards committee should ease the path for NWS adoption

Progress Update *(cont'd)*

Recommendation 3 (NIST): NIST recommends that tornado hazard maps for use in the engineering design of buildings and infrastructure be developed considering spatially based estimates of the tornado hazard instead of point–based estimates.

Contracted with ARA for *Tornado Hazard Maps for Building Design: Development of Framework for Tornado Risk Assessment*

- Year One Objectives
  1. Review the state-of-knowledge on tornado climatology and tornado risk assessment
  2. Conduct preliminary analysis and sensitivity studies to inform R&D plan
  3. Develop R&D plan for completion of new tornado hazard maps, including consideration of stakeholder input
- Year One Tasks:
  1. Develop Project Plan (completed)
  2. Literature review to assess factors affecting tornado data and risk methodologies (in progress)
  3. Quantification of tornado risk metrics for pilot municipality (Joplin) and sensitivity analysis to guide prioritization of R&D (in progress)
  4. Develop R&D plan for map completion and document results (summer 2015)
  5. Stakeholder inputs workshop (late summer 2015)

Progress Update *(cont'd)*

Recommendation 5 (ASCE): NIST recommends that nationally accepted performance–based standards for the tornado–resistant design of buildings and infrastructure be developed and adopted in model codes and local regulations to enhance the resiliency of communities to tornado hazards. The standards should encompass tornado hazard characterization, performance objectives, and evaluation tools. The standards shall require that critical buildings and infrastructure such as hospitals and emergency operations centers be designed to remain operational in the event of a tornado.

Worked with ASCE in forming the new *Technical Committee on Performance-Based Design for Extreme Winds* (currently Ad hoc)

- This committee is developing framework for PBD for extreme winds, including tornadoes, intended for inclusion in ASCE 7-22.
- Committee has met four times, most recently in San Diego (February 2015)
- Two NIST staff are committee members. NIST staff formed and lead a *Tornado Working Group* within the committee
- The work of this committee also supports Recommendation #6

Progress Update *(cont'd)*

Recommendation 7 (ICC): NIST recommends that: (a) a tornado shelter standard specific for existing buildings be developed and referenced in model building codes; and (b) tornado shelters be installed in new and existing multi–family residential buildings, mercantile buildings, schools and buildings with assembly occupancies located in tornado hazard areas identified in the performance–based standards required by Recommendation 5.

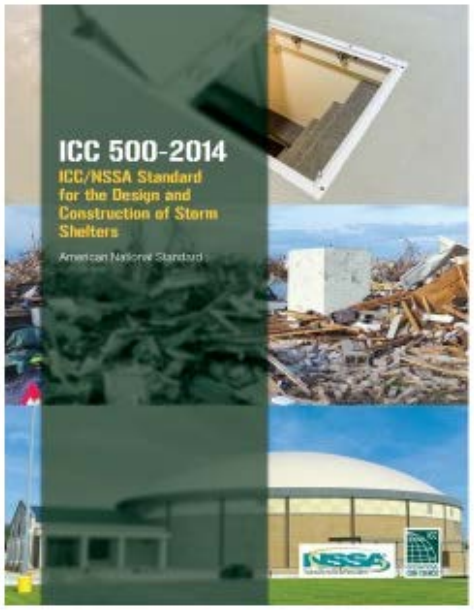
Developed specific ICC-NIST joint action plan (July 2014)

7(a): Planned expansion of scope of

ICC 500: ICC/NSSA Standard for the Design and Construction of Storm Shelters

to specifically include applications for existing buildings in the 2018 edition

- **ICC 500-2014** incorporated new provisions for installation of shelters on existing slabs
- Leading development of ICC 500 Commentary Chapter 3, Structural Design Criteria



Progress Update *(cont'd)*

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7(b): Developed and submitted code change proposals for 2018 IBC and IEBC

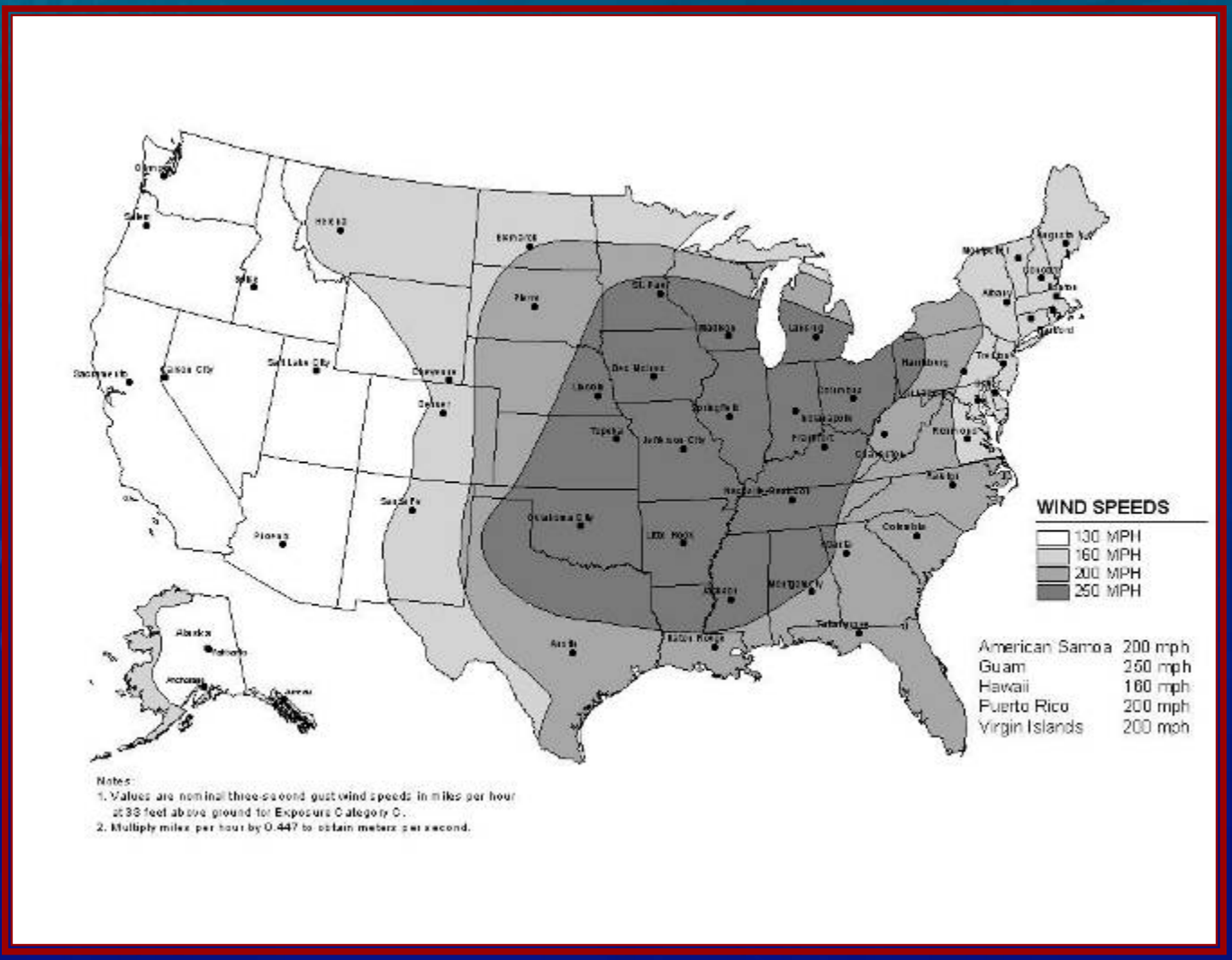
- In coordination with the Building Code Advisory Committee (BCAC) and FEMA
- Parallel proposals, requiring in the IBC that new buildings* on school campuses (Group E occupancies) and in the IEBC that additions to buildings* on school campuses (IEBC) in the 250 mph tornado region, include ICC 500 shelters large enough to protect the population of the school, provided the new construction is of sufficient size

  * includes indoor assembly spaces associated with the Group E occupancy, such as theaters, auditoriums, and gymnasiums with bleachers

- Next step – Committee Action Hearings (Group A), April 2015, Memphis

Progress Update *(cont'd)*

ICC 500-2014 Shelter Design Wind Speed Map for Tornadoes

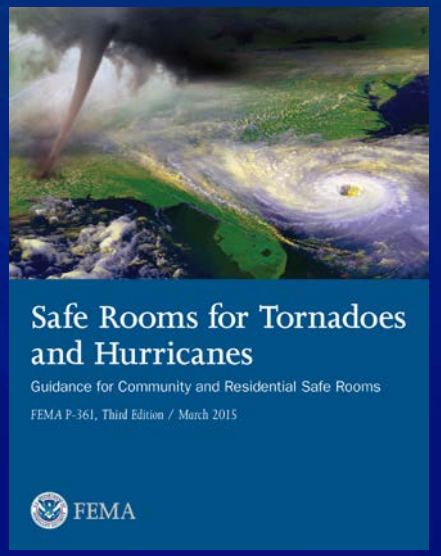


Progress Update *(cont'd)*

Recommendation 8 (FEMA): NIST recommends the development and implementation of uniform national guidelines that enable communities to create safe and effective public sheltering strategies. The guidelines should address planning for siting, designing, installing, and operating public tornado shelters within the community.

Worked with FEMA on update of *FEMA P-361, Safe Rooms for Tornadoes and Hurricanes: Guidance for Community and Residential Safe Rooms*

- New and expanded coverage of: identification of neighborhood populations to be sheltered; travel time to the safe room; signage; 24/7 accessibility; remote and automated unlocking of safe room doors on tornado watch issuance or tornado siren activation; access; entry; lockdown; and drills
- Includes examples (some from Joplin) of leveraging school safe rooms for dual use as public shelters
- New edition of FEMA P-361 to be published in March 2015



Source: FEMA.

Progress Update *(cont'd)*

Recommendation 8 (FEMA): NIST recommends the development and implementation of uniform national guidelines that enable communities to create safe and effective public sheltering strategies. The guidelines should address planning for siting, designing, installing, and operating public tornado shelters within the community.

Contributing to new NFPA standard under development,

NFPA 1616: Standard on Mass Evacuation and Sheltering

which addresses multiple hazards, including tornadoes

- NIST serving on Mass Sheltering Task Force of the NFPA 1616 committee
- NIST developed (in coordination with FEMA) and submitted draft provisions to require safety considerations as part of the shelter selection process
- Public comment draft scheduled for publication in fall 2015
- First edition of NFPA 1616 scheduled for publication in 2017

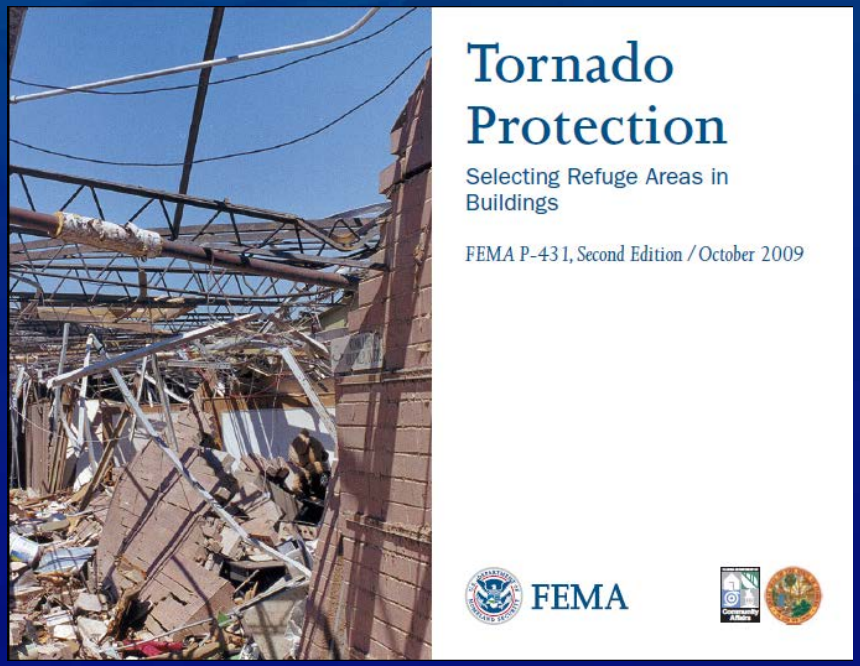
Progress Update *(cont'd)*

Recommendation 9 (FEMA): NIST recommends that uniform guidelines be developed and implemented nationwide for conducting assessment of tornado risk to buildings and designating best available tornado refuge areas as an interim measure within buildings until permanent measures fully consistent with Recommendations 5 and 7 are implemented.

Working with FEMA to update

FEMA P-431 Tornado Protection: Selecting Refuge Area in Buildings

- Current version of FEMA 431 deals almost exclusively with identifying ***best available refuge areas*** in schools. The revised version will be expanded to cover a much broader array of building types and functions.



Source: FEMA.

Progress Update *(cont'd)*

Recommendation 13 (NFPA), Part 1: NIST recommends the development of national codes and standards and uniform guidance for clear, consistent, recognizable, and accurate emergency communications, encompassing alerts and warnings, to enable safe, effective, and timely responses among individuals, organizations, and communities in the path of storms having the potential to create tornadoes.

- Met and discussed strategy with NFPA in August 2014
- Attended a follow-up phone call with NFPA on **NFPA 1616, Standard for Mass Evacuation and Sheltering** in December 2014
- Submitted revisions to NFPA 1616 during Public Input (closed 1/5/15)
- Attended First Draft Meeting, March 4, 2015 and presented on NIST's Technical Investigation of the Joplin, MO tornado and previously developed NIST guidance on emergency communications
- NPFA 1616 Technical Committee decided to create a task group and an annex on Emergency Communication: Public Alerts and Warning (NIST is a member); accompanying task group and annex on Social Media (NIST is a member)

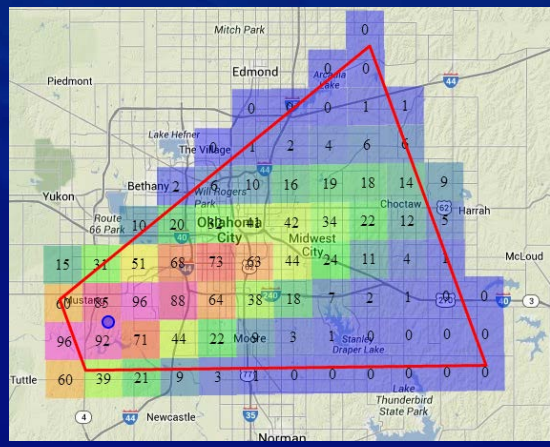
Progress Update *(cont'd)*

Recommendation 16 (NOAA): NIST recommends that technology be developed to provide tornado threat information to emergency managers, policy officials, and the media on a spatially resolved real–time basis to supplement the currently deployed official binary warn/no warn system.

NOAA's National Severe Storms Lab (NSSL) is actively exploring and developing a new grid-based threat communication paradigm, called

Forecasting a Continuum of Environmental Threats (FACETs)

- FACETs is a new, all-hazard watch/warning paradigm (grid-based, probabilistic threats) redesigned with social/behavioral science infused
- Multi-year exploration/development effort. FY 15 tasks:
  - Complete first iteration of probabilistic hazard grids and tools
  - Limited tests with NWS forecasters in Hazardous Weather Testbed
- NWS has not officially accepted or adopted these plans, NWS is partnering in research and exploration
- See http://www.nssl.noaa.gov/projects/facets/



engineering laboratory

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Questions?

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