# Public Comments on NIST Draft Final Report NCSTAR3

# "Technical Investigation of the May 22, 2011 Tornado in Joplin, Missouri – Draft Final Report for Public Comment"

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January 6, 2014

NIST NCSTAR 3 Technical Report on the May 22, 2011 Tornado in Joplin, Missouri

**COMMENTS OF:**
**THE INTERNATIONAL CODE COUNCIL (ICC)**
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The International Code Council (ICC) is a membership association dedicated to building safety, fire prevention, and energy efficiency. The International Codes, or I-Codes, published by ICC, provide minimum safeguards for people at home, at school and in the workplace. Building codes benefit public safety and support the industry's need for one set of codes without regional limitations.

Fifty states and the District of Columbia have adopted the I-Codes at the state or jurisdictional level. Federal agencies including the Architect of the Capitol, General Services Administration, National Park Service, Department of State, U.S. Forest Service and the Veterans Administration also enforce the I-Codes for the facilities that they own or manage. The Department of Defense references the International Building Code for constructing military facilities, including those that house U.S. troops, domestically and abroad.

ICC was established in 1994 as a non-profit organization dedicated to developing a single set of comprehensive and coordinated national model construction codes. The founders of the ICC are Building Officials and Code Administrators International, Inc. (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International, Inc. (SBCCI). Since the early part of the last century, these non-profit organizations developed three separate sets of model codes used throughout the United States. Although regional code development was effective and responsive to our country's needs, the time came for a single set of codes. The nation's three model code groups responded by creating the International Code Council and by developing codes without regional limitations; the International Codes.

The International Code Council (ICC) offers the following comments on the NIST NCSTAR 3 (Draft) Technical Report on the May 22, 2011 Tornado in Joplin, Missouri.

The International Code Council (ICC) appreciates the comprehensive and highly professional report on the Joplin Tornado, representing over 2 years of work by NIST professionals and other technical experts. The report explains and provides useful scientific data on the tornado event, the warnings that preceded and accompanied

the tornado, and an analysis of how various systems performed during the event. As the developer of model building codes that are widely adopted by most U.S state and local jurisdictions that adopt building codes to govern minimum standards of construction, ICC is concerned with how buildings, both commercial and residential, performed, and in many cases failed, during the tornado, and looks forward to working with NIST and other experts in the area of construction and standards to make sure that the information and recommendations developed by NIST can find their way into the model building safety codes that ICC publishes, and far more importantly, into the actual adopted building codes enforced in jurisdictions at risk from tornados and other high wind events.

Perhaps the most important lines in the report are the ones found just before NIST outlined the individual recommendations. It is a recommendation aimed squarely at state and local governments that ICC serves with its model codes: "NIST strongly urges State and local authorities having jurisdiction to adopt and enforce model building codes and standards. Enforcement is critical to ensuring expected levels of safety. Following good building practices also is critical to achieving better performance of structures during extreme events like tornadoes."

We note that of the 16 recommendations, NIST has listed ICC as an interested party on 10 of the 16 recommendations, and as the suggested lead, or co-lead, on 4 of the recommendations. We do agree that ICC should serve as the lead organization to move implementation of the recommendations forward on three of the recommendations: number 7, (model building codes for areas of refuge, storm shelters and requirements for shelter in certain building types); recommendation 10 (aggregate roofing materials); and recommendation 11 (strengthening building egress systems).

Regarding recommendation 7(a) that is already the requirement in the 2012 International Building Code (IBC) (Sec. 423) and 2012 International Residential Code (IRC) (Sec. 323)

Regarding recommendation 7(c), the next version of the ICC International Building Code, the 2015 edition, to be published in 2014, has already been amended to include requirements for storm shelters meeting the ICC 500 standard in the categories recommended in recommendation 7(c). Code change G94 requires that a storm shelter be incorporated into new buildings with a Group E occupancy, with occupant load of 50 or more, such as day care facilities and churches. Code Change G95 requires that emergency operations centers, fire, rescue, ambulance and police stations shall have a storm shelter in accordance with ICC 500.

Regarding recommendation 13, for a clear and accurate national emergency communication standard to provide advance and current warnings, ICC believes it is more appropriate for NFPA to take the lead, and we have so informed NFPA leadership.

For recommendations where ICC is designated as lead, ICC will assign the development of specific code change proposals for their 2018 editions of the IBC and IRC to the appropriate membership committees created for this purpose (Codes and Technology Committee [CTC] or Building Code Action Committee [BCAC]).

All code change proposals for the model I-Codes are developed, vetted and ultimately approved through the CC Governmental Consensus Process, and all such proposals must be made by members of ICC, other interested parties, or by the public. It should be understood that ICC staff is prohibited by ICC policies from making any code change proposals, or taking any position on proposals, to modify the codes developed by ICC.

## The I-Codes and the Process

Municipalities and states across America adopt and implement, and countries around the world adapt and use the International Codes® (I-Codes®). The I-Codes are the first and only set of coordinated, consistent, and comprehensive construction, fire, and energy codes.

Developed by the International Code Council® (ICC®) through the governmental consensus process, this single set of codes offers substantial advantages to all building professionals and the public.

Code officials, architects, engineers, designers, and contractors can work with a consistent set of requirements throughout the United States. Manufacturers can put their efforts into research and development rather than designing to different sets of standards and can focus on being more competitive in worldwide markets. Uniform education and certification programs can be used internationally. The code development process is key in gaining the trust and confidence of the global building and construction industry. This consensus process through which ICC develops and maintains the comprehensive and balanced codes is designed to protect the health, safety, and welfare of people around the world as well as protect our planet by encouraging sustainability, water, and energy conservation. Finally, the ICC process allows all jurisdictions, regardless of size, to benefit from the expertise of thousands of professionals in the development of the model codes, available for local adoption. The cost to include this expertise and manage this process would be prohibitive for any single jurisdiction.

Preliminary to our comments on individual recommendations, we believe it is useful to describe the process used by ICC in the development of our model codes.

Similar to the development of laws, the ICC code development follows a governmental consensus process that includes open forums of debate and refinement. It is an open, inclusive, and balanced consensus process with built-in safeguards designed to prevent domination by a single vested interest. The system ensures fairness in the process, controls against conflicts of interest, and prevents vested economic interests from determining the outcome of all code change proposals. This system of code development has provided the citizens of the U.S. the highest level of building safety in the world for more than 80 years. The ICC governmental consensus process meets the principles defined by the U.S. Standards Strategy of 2005; the OMB Circular A-119, Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities (1998), codified by Public Law 104-113, National Technology Transfer and Advancement Act of 1995. The key mechanisms that govern the ICC governmental consensus process include:

**Open Public Forums**

- All forums are open to the public at no cost
- Anyone can submit a code change proposal and testify at the hearings
- All views are considered by the code committees prior to a vote

**Decision Transparency**

- All testimony and committee recommendations are made in open public hearings
- All final code change proposal decisions are made by public safety officials in an open hearing

**Representation of Interests**

- Wide-ranging representation
- Full disclosure of conflicts of interest
- One-third of the committee's members must be governmental members with no financial vested interests
- Membership on a committee is not conditional on membership in ICC

**Due Process**

- Equal opportunities for rebuttal
- Committees consider all views, objections, and the cost impact of all code change proposals
- All who attend can testify

**Appeals Process**

- Open appeal process
- Appeals considered per due process

**Majority Consensus**

A simple majority from the committee decides the initial action of the proposed code change
ICC assembly action allows members to challenge the action of the committee
All final code change proposal decisions are made by public safety officials

Every ICC Code Development Committee is comprised of people who have specific knowledge and competence in the fields under discussion. They may include:

- Building, plumbing, electrical, mechanical, fire, energy officials
- Design professionals/consultants
- Trade association representatives
- Builders/contractors
- Manufacturers/suppliers
- Government agency representatives
- Any qualified individual with a vested interest

A minimum of 33.3% of a committee's members are required to be regulators who are experts in their fields. The final determination of code provisions is primarily in the hands of public safety officials who hold a public trust, have no vested interest, and can legitimately represent the public interest

Here is our initial summary of the recommendations that are related to ICC's role and competence.

***Recommendation 3—***

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.
ICC involvement: Existing standard ICC 500 contains a map at Figure 304.2(1) showing four zones of wind speeds for tornado shelter design. This map should be a starting point for the recommendation in the report. This hazard map could be incorporated into the IBC and IRC as are other hurricane wind maps; snow maps, etc.
Possible assignment to CTC or Building-CAC

***Recommendation 5—***

NIST recommends that nationally accepted performance–based standards for the tornado–resistant design of buildings and infrastructure be developed in model codes and adopted in local regulations to ensure 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 are designed so as to remain operational in the event of a tornado.

ASCE designated as lead. It may well be advisable for ASCE to propose any standards developed be referenced as recommended standards in the I-codes.

***Recommendation 6—***

NIST recommends the development of risk–consistent, performance–based tornado design methodologies to ensure that all building components and systems meet the same performance objectives when subjected to tornado hazards.

NIST/FEMA designated as lead. It may well be advisable for NIST/FEMA to propose any standards developed be referenced as recommended standards within the appropriate I-codes.

***Recommendation 7—***

NIST recommends that: (a) model building codes for new buildings require that tornado shelters be designed in accordance with the ICC 500 standard; (b) model building codes develop and adopt a tornado shelter standard specific for existing buildings; and (c) 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.

ICC designated as lead. Regarding recommendation 7(a) that is already the requirement in the 2012 IBC (Sec. 423) and 2012 IRC (Sec. 323)

Regarding recommendation 7(c), the next version of the ICC International Building Code, the 2015 edition, to be published in 2014, has already been amended to include requirements for storm shelters meeting the ICC 500 standard in the categories recommended in recommendation 7(c). Code change G94 requires that a storm shelter be incorporated into new buildings with a Group E occupancy, with occupant load of 50 or more, such as day care facilities and churches. Code Change G95 requires that emergency operations centers, fire, rescue, ambulance and police stations shall have a storm shelter in accordance with ICC 500. Possible assignment to CTC or Building-CAC.

***Recommendation 8—***

NIST recommends the development and implementation of uniform national guidelines that enable communities to create the safest and most effective public sheltering strategies. The guidelines should address planning for, siting, designing, installing, and operating public tornado shelters within the community.

This is a recommendation best addressed by other national organizations representing elected officials; city and county managers, emergency managers and fire chiefs. The organizations should consider referencing the I-Codes as resources for jurisdictional use.

***Recommendation 9—***

NIST recommends that uniform guidelines be developed and implemented nationwide for conducting tornado risk assessments 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.
This is a recommendation best addressed by other national organizations representing elected officials; city and county managers, emergency managers and fire chiefs. The organizations should consider referencing the I-Codes as resources for jurisdictional use.

***Recommendation 10—***

NIST recommends that aggregate, gravel, or stone be prohibited as roof surfacing material or roof ballast for buildings of any height in tornado–prone areas.
ICC designated as lead. Similar requirements already exist in 2012 IBC Sec. 1504.8 2012, prohibiting use of aggregate in hurricane–prone regions as designated in IBC Sec. 202. Possible assignment to Code Technology Committee (CTC) or Building-Code Action Committee (CAC).

***Recommendation 11—***

NIST recommends that enclosures of egress systems (elevators, exits) in critical facilities in tornado– prone areas be designed to maintain their functional integrity when subjected to tornado hazards.
ICC designated as lead. Possible assignment to CTC or Building-CAC.

***Recommendation 12—***

NIST recommends that owners and operators of existing critical facilities in tornado–prone areas perform tornado vulnerability assessments and take steps to ensure the functionality of (1) backup power supplies (harden the protection of emergency backup power, as region–wide losses of power due to damage to power transmission infrastructure occur frequently in tornadoes), (2) vertical movement within the building (elevator equipment and shaft enclosures), and (3) means of egress illumination (battery– powered lighting in addition to backup power), in a tornado event.
This is a recommendation best addressed by other national organizations representing building owners, managers or real estate (i.e. BOMA). Organizations are encouraged to reference I-code provisions to avoid duplication and conflicting requirements, where appropriate.

***Recommendation 13—***

NIST recommends the development of national codes and standards and uniform guidance for clear, consistent, and accurate emergency communications, encompassing alerts and warnings, to ensure safe, effective, and timely responses among individuals, organizations, and communities in the path of storms having the potential to create tornadoes.

NIST also recommends that emergency managers, the NWS, and the media develop a joint plan and take steps to ensure that accurate and consistent emergency alert and warning information is communicated in a timely manner to enhance the situational awareness of community residents, visitors, and emergency responders affected by an event.
ICC and NFPA designated as lead. We believe this is an error, and that NFPA should be the designated lead. This is a recommendation appropriately addressed by FEMA in cooperation with other national organizations representing emergency managers and fire chiefs

***Recommendation 14—***

NIST recommends that the full range of current and next–generation emergency communication "push" technologies (e.g., GPS–based mobile alerts and warnings, reverse 9–1–1, outdoor siren systems with voice communication, NOAA weather radios) be widely deployed and utilized, to maximize each individual's opportunity to receive emergency information and respond safely, effectively, and in a timely fashion.
This is a recommendation best addressed by FEMA in cooperation with other national organizations representing emergency managers and fire chiefs

***Recommendation 15—***

NIST recommends research to identify the factors that will significantly enhance public perception of personal risk and how such knowledge can be better used to rapidly and effectively respond during tornadic events.
This is a recommendation best addressed by FEMA in cooperation with other national organizations representing emergency managers and fire chiefs
This could be incorporated into messaging ICC distributes for Building Safety Month

**National Fire Protection Association**

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January 6, 2014

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VIA EMAIL: *disaster@nist.gov*

Please find the comments of the National Fire Protection Association (NFPA) that have been developed in response to the December 3, 2013 Federal Register Notice [Docket No: 131113954-3954-01] concerning the Technical Investigation of the May 22, 2011 Tornado in Joplin, Missouri. Our comments have a primary focus on the findings and recommendations of the draft report. NFPA will work on integrating and addressing, to the extent possible, the essence and substance of the various recommendations that are applicable to our codes, standards and educational materials.

If you have any questions on our comments, please direct them to Robert Solomon by phone: 617.770.3000; or by email: rsolomon@nfpa.org.

Sincerely,

Robert E. Solomon

Robert Solomon, PE
Division Manager, Building Fire Protection and Life Safety
NFPA

C: G. Cade

# NFPA Comments to NIST on the Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri

## INTRODUCTION

NFPA is pleased to present comments to NIST on their comprehensive study of the May 22, 2011 tornado in Joplin, MO. As we noted in previous NCST reports from NIST (WTC 1 and 2, WTC-7, *The Station* nightclub) the level of effort, study, analysis and examination of this event is a complex endeavor due to the myriad circumstances involved as well as the breadth of subjects addressed in the report . The members of the National Construction Safety Team (NCST), the contributing NIST and NOAA staff, as well as the private contractors and consultants are to be applauded for their commitment to this project as well as the public members of the NCST Federal Advisory Committee for their oversight of the investigation.

NFPA will make a commitment to NIST to study, review and evaluate the recommendations in this study through the various means and resources we have at our disposal. This includes our technical committees, advisory committees, Fire Protection Research Foundation and other organization wide approaches to consider the recommendations. The comments contained within this document have been prepared by the staff of NFPA and have not been reviewed or endorsed by any of the NFPA Technical Committees or relevant NFPA advisory committees. While that process is ongoing in some cases, we will engage our resources in the near future to ensure we have considered and contributed to an outcome that vets the substance of the recommendations.

Our comments have been arranged so as to generally follow the major NCSTAR page, section and chapter headings of the report. When possible, our comments will refer to specific sections of the NIST study to make sure we have correlated our responses to the recommendations, findings or supplemental information contained within the report. In most cases, NFPA's comments may be as simple as agreeing with the recommendation or finding, agreeing with the recommendation or finding in principle or in some cases, disagreeing with the recommendation or finding.

Regardless of our comments on the report, NFPA plans to fully consider the depth and breadth of the recommendations in future revision cycles of the relevant NFPA codes and standards, research programs, advisory committee input, public education programs and instructional efforts.

# SUMMARY

The draft report by NIST from November, 2013 is what NFPA believes to be a very thorough, technical and scientific study of a loss investigation. The content of the report addressing not only the building damage assessments, but also the response, recovery and rebuilding efforts is not usually seen in such studies and investigations. Also of importance is the review of early warning systems, sheltering options, weather prediction and design models and the ideas as to how these concepts must be integrated into 21st centuty building design. Consistent with Presidential Policy Directive-8 (PPD-8) and NIST's own work in this area, this holistic approach to building design and construction is in lock step with ongoing efforts for resilient design initiatives as captured in the NIST Engineering Lab Strategic Goal: *Disaster-Resilient Buildings, Infrastructure, and Communities.* Resiliency is defined in PPD-8 as "...the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies." Many of the findings and the recommendations in the report point in the direction of these efforts.

The need to conduct more research in some areas such as public perception of personal risk is quite clear. Situation awareness of pending threats from weather (and other hazards) including real time updates on the hazard and when the threat has passed allows for better preparation, response and recovery.

While some of our comments will be specific in nature, others will be broader in scope and have application to multiple areas of the report or may be considered for future studies by NIST.

# NFPA COMMENTS

| PAGE | SECTION | COMMENT |
|---|---|---|
| Page xxii and various | | GENERAL: Some figures note what building is the subject of the figure (such as Figure 2-13 on Page xxii) while others do not (such as Figure 3-10 on Page xxiv). The final report should use a consistent format to identify the figure in both the table of contents and in the report. For example, Figure 3-49 identifies the photo as being the Home Depot but Figure 3-50 does not. While you can refer to the narrative to establish what the structure is, identifying the building in the caption would be helpful at each occurrence. |
| Various | | GENERAL-Photographs and Figures: While we are not questioning the caption, analysis or finding associated with any photograph, it may be beneficial to show multiple close in shots of the feature or configuration. Figure 3-12 shows roof damage at SJRMC. A close in photo of the EPDM damage and the roof vacated of the aggregate may help to reinforce the type of damage sustained in this case. (NOTE: Figure 3-18 shows this for the east tower.) In Figure 3-14, can you highlight the steel frame associated with the elevator shaft? In Figure 3-17, can you provide close up photo of how the curtain wall panels were attached? Figure 3-80 does not identify the area of interest on the larger photograph segment. Figure 3-109 shows a hurricane tie-down. Showing multiple close up views of the tie down connection to the truss and the wall can show if the connection was properly made or not. In Figure 3-113, are close up photos available of the connections that would point to a wind uplift failure? Figure 3-116 showing an elevated view looking down at the wall might give a better perspective. |
| xlv | E.2 Goals-First Bullet Point | Suggest that "lifelines" be defined. They are usually associated with electrical power, communication systems/networks, gas/liquid fuels pipelines and storage, water and wastewater systems, transportation systems/networks and ports. Some readers of the report may not be familiar with the term and the executive summary should indicate what lifeline features the report does and does not cover. |
| xlv | E.2 Goals-Second Bullet Point | The final report might say "...that can serve as the basis to include, but not be limited to:" SDO's and other groups may identify topics beyond what is listed as work is done to address the recommendations of the report.<br>In this same section, consider moving the *Potential improvements to public safety* as the first sub item as that should always be the top priority. |
| xlvi | E.2, Objectives Item 5 | Clarify in this section (or in other appropriate sections) of the report the ongoing need to continuously address the enforcement aspect of the adopted codes and standards. Resources, training, credentialing and continuing education need to be at the forefront of the code adoption process. |
| xlvii | E.4.1 Context, Third Bullet Point | Identify the code in use at the time. Also, were any modifications made to the code at the state or local level by the adopting authority? |
| xlvii | E.4.1 Context, Fifth Bullet Point | A mention of the protection afforded by basements in single family homes as well as other types of residential and non-residential properties should be included here. While not purpose built as a shelter per-se, these areas do offer a fair amount of protection. |

| PAGE | SECTION | COMMENT |
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| xlix | Finding 9 | Given the amount of damage to so many residential structures (7,400), it seems as though something offered some protection. Specifically, what role did basements offer in this scenario? |
| l | Finding 11 | As noted in our general comments concerning the photos, additional pictures (if available) might help to stress the failure modes being described. |
| l | Finding 12 | Is the parenthetical statement at the end a code based provision that is explicitly permitted or is a best practice? |
| l | Finding 14 | Rather than referring to a lack of robustness, shouldn't this be described as an area to be addressed in the future? The building design did not account for this level of hazard thus it seems this type of statement indicts the design criteria (code based) used. |
| l | Finding 16 | Is the water intrusion from wind driven rain, damaged plumbing/fire protection piping or other sources? Is the damage straight water damage or does it also include subsequent mold growth and development? |
| li | Finding 20 and 23 | Given the large number of homes that were severely damaged, is there any evidence to indicate what saved so many lives if so many homes lacked basements? Did the homes have some other inherent feature that helped to protect the occupants? Of the 18 percent of homes that did have basements, were some of the occupants interviewed to determine if they sheltered in the basement? |
| li | Finding 25 and 26 | NFPA 1600, *Standard on Disaster/Emergency Management/Business Continuity Programs* can be referenced here as model guidance for requiring preplanning to ensure sustainability of life line systems during emergency events. |
| lii | Finding 30 | Can the term false alarm be defined here? Are these malfunctions? Or are they conditions that indicate tornado formation was ideal, an alarm was initiated but an actual tornado never materialized? There may be some cross over to the NFPA "Unwanted Alarm Project" that addresses activation of fire alarm systems. |
| liii | Finding 36 | Are alternative messaging systems available such as ASL, CC, and texting for those who are hard of hearing or that may have a cognitive disability? |
| liv | Finding 44 | Should "visual cues" be listed here? Various sections of the draft report indicate residents did not observe anything that appeared to be threatening when they looked outside. |
| lv | Recommendation 4 | Applied Technology Council (ATC) would appear to be a good "interested party" for this effort. |
| lvi | Recommendation 5 | Add NFPA to the interested parties' column. Several NFPA documents including but not limited to NFPA 70, NFPA 76, NFPA 99, NFPA 101, NFPA 805, NFPA 820, NFPA 850 and NFPA 5000 contain various criteria that relate to critical buildings and infrastructure. |
| lvii | Recommendation 6 | Add NFPA to the interested parties column. Several NFPA documents including but not limited to NFPA 99, NFPA 101, NFPA 805, NFPA 1600 and NFPA 5000 integrate risk based evaluations, performance based design options or both directly in the document. |
| lvii | Recommendation 7 | Add NFPA to the interested parties column. Several NFPA documents including but not limited to NFPA 99, NFPA 101 and NFPA 5000 would be appropriate to make reference to ICC 500. |
| lvii | Recommendation 8 | NFPA will work with FEMA and other parties on this item. Broad utilization of ICC 500 integrated with proposed NFPA standard 1616 *Standard for Mass Evacuation and Sheltering* would be a good pairing for this recommendation. |
| lvii | Recommendation 9 | Add NFPA to the interested parties column. Several NFPA documents including but not limited to NFPA 99, NFPA 101 and NFPA 5000 would be appropriate to describe sheltering options for other hazards. |
| lvii | Recommendation 10 | Single Ply Roofing Industry (SPRI) would appear to be a good "interested party" for this effort. They develop and maintain ANSI/SPRI RP-4 2013 Wind Design Standard For Ballasted Single-ply Roofing Systems which is referenced in the IBC and NFPA 5000. Add NFPA to the interested parties column. NFPA |

| PAGE | SECTION | COMMENT |
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| | | documents including but not limited to NFPA 5000 would be appropriate to add any new provisions for ballasted roof systems. |
| lvii | Recommendation 11 | Add NFPA to the interested parties column. Also, make this a joint ICC/NFPA effort with regard to Lead Responsibility. The NFPA Technical Committee on Means of Egress (NFPA 101/NFPA 5000) is comprised of some of the most well-known and respected thought leaders in this areas and can make a significant contribution to this effort. |
| lviii | Recommendation 12 | Add NFPA to the interested parties column. NFPA 70, Article 708 Critical Operations Power Systems (COPS) was develop in the post 9-11 world to address this level of performance. The Article 708 criteria could be used in the assessment of the reliability/redundancy of the systems. In addition, NFPA 99 and NFPA 110 both address backup power supplies and the rooms housing those supplies for critical facilities and can address both existing and new facilities. NFPA 99 includes a Chapter on emergency management, which includes conducting a hazard vulnerability assessment that must be developed for a facility and updated on an annual basis. NFPA 1600 details risk assessments and business impact analysis as elements of a vulnerability analysis. Including this information along with that may be one means for dissemination of this recommendation. |
| lviii | Recommendation 13 | Revise Recommendation to read:<br>NIST recommends review of *existing national standards and continued* development of…….<br>Reason: NFPA 1600 is an existing National Standard for Preparedness for the private sector in accordance with Title IX of Public Law 11-53 Section 524.<br><br>NFPA will work with the other parties on this item. Broad utilization of the mass notification system (MNS) requirements in NFPA 72 may be adaptable to integrate with other hazard warning systems. NFPA 1600 and 1616 illustrate how emergency planners can develop and sustain communication systems for sharing and disseminating critical information. Also, NFPA Public Education programs such as *Get Ready!* can be used to expand the messaging for consumers. Community education to raise awareness of the risk of tornados and the appropriate behaviors to stay safe would be appropriate. |
| lviii | Recommendation 14 | Add NFPA to the interested parties column. Ongoing work with NFPA 950, *Standard for Data Exchange for the Fire Service*, NFPA 951, *Guide for Data Exchange for the Fire Service*, and NFPA 1221, *Standard on Installation, Maintenance and Use of Emergency Services Communications Systems* will have crossover to the elements of this recommendation. |
| lviii | Recommendation 15 | NFPA Public Education programs such as *Get Ready!* can be used to expand the messaging for consumers. Community education to raise awareness of the risk of tornados and the appropriate behaviors to stay safe would be appropriate. |
| lviii | Recommendation 16 | Add NFPA to the interested parties column. Ongoing work with NFPA 950, *Standard for Data Exchange for the Fire Service* has application to this type of information exchange. |
| 236 | 4.2 | Add a sixth key factor as follows:<br>Use pre scripted information or bulletins or templates. Pre scripted messages will help avoid delays in developing messages and getting appropriate instructions to residents<br>Source: NFPA 1600, *Standard on Disaster/Emergency Management and Business Continuity Programs*, Section 6.4. |
| 243 | 4.3.1, 2nd paragraph | Add to existing language: Emergency warning notification and communication protocols and procedures shall be developed, tested, and used to alert stakeholders potentially at risk from an actual or impending incident.<br>Source: NFPA 1600, *Standard on Disaster/Emergency Management and Business Continuity Programs*, Section 6.4. |

| PAGE | SECTION | COMMENT |
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| 249 | 3.2.3.2 | The description of the Greenbriar Nursing Home does not belong in this section. Nursing homes are a subset within in the healthcare occupancy category –not multifamily residential. |
| 419 | Appendix L | See changes beginning with the second paragraph that suggests several corrections to the information contained in Appendix L.<br><br>The National Fire Protection Association's (NFPA) One national model code, NFPA 72, or the National Fire Protection Association's (NFPA) *National Fire Alarm and Signaling Code*[169], essentially an installation standard, includes requirements for specifically devoted to emergency communication systems, and can be applied to tornado siren systems. NFPA 72 contains a chapter (Chapter 24) specifically devoted to emergency communication systems (2013). This chapter establishes minimum requirements for the performance, reliability, and quality of installation for emergency communication systems. By definition, emergency communication systems are those that are intended to communicate information about emergencies, including (but not limited to) fires, accidents, and natural disasters. Chapter 24 provides requirements for in–building communication systems, namely one–way ~~and two–way~~ in–building fire emergency voice/alarm communication systems, in–building mass notification systems, two–way radio communications enhancement systems (in buildings), area of refuge emergency communication systems (in buildings), and elevator emergency communication systems (in buildings). For the category that is most applicable to a community–wide tornado siren system, namely wide–area mass notification systems, NFPA 72 specifies requirements for the wide–area systems' components, including the emergency command center ~~central control station~~, high–power speaker arrays, high–power speaker array enclosures and mounting, and speaker array structural loads for wind– and seismic–resistant design. These wide area mass notification systems are generally installed to provide real-time information to outdoor areas. ~~Additionally, this code specifically states that these systems should not be used to provide mass notification inside any structures. In other words, these systems are to be designed and used only for outdoor alert or warning dissemination. Whereas previous guidance was provided in the annex, the most recent revision of~~ NFPA 72 (2013) ~~begins to~~ provides guidance on how to create and disseminate an emergency message, if the alert or warning system has that capacity. ~~This revision~~ It suggests ways to improve intelligibility, the use of an alert tone in addition to a message, and the types of message content that will prompt a more efficient recipient response. This guidance is helpful for those communities with outdoor public address systems or visual signage; however, there is no mention ~~in this model code~~ about requirements for sound patterns, length of sounds, sound types, etc., or about the use of the siren system itself.<br>Update the reference for NFPA 1221 from 2010 to 2013. |

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January 6, 2014

NIST Technical Investigation Joplin
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Gaithersburg, Md. 20899-8611

The American Society of Civil Engineers (ASCE) is pleased to have the opportunity to provide comments on the "Final Report, National Institute of Standards and Technology (NIST) Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri (NIST NCSTAR 3)". Specifically, the attached comment addresses Recommendation 5 on the Performance of Buildings, Shelters, Designated Safe Areas, and Lifelines.

As the stewards of the nation's infrastructure civil engineers plan, design, construct, operate, maintain, reuse, and decommission buildings, bridges, roads, pipelines, towers, dams, and other projects, which are exposed to natural and man-made hazards such as tornadoes. ASCE recognizes its obligation to become fully involved mitigating disasters by working to make communities more resilient. ASCE firmly believes that national performance-based standards are needed to assure that appropriate and consistent design and construction methods are available worldwide for mitigating natural and man-made hazards.

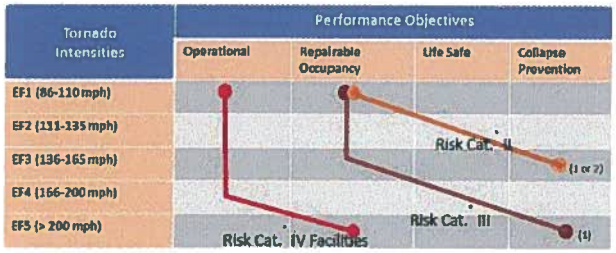
Once again, thank you for the opportunity to provide comments. ASCE stands ready to work with the National Institute of Standards and Technology (NIST) on this and other activities which seek to protect the public health and safety. Please contact Jennifer Goupil at jpoupil@asce.org or 703-295-6102 if we can be of further assistance.

Sincerely,

Brian T. Pallasch
Managing Director
Government Relations and Infrastructure Initiatives

# Public Comment response to the NIST Joplin Report

ASCE/SEI Response; drafted by Jennifer Goupil, P.E.; Director of the Structural Engineering Institute of ASCE; jgoupil@asce.org; 703-295-6102
Jan. 3, 2014

| Recommendation | Interested Parties | Organization with Lead Responsibility for Implementation |
|---|---|---|
| *Group 2: Performance of Buildings, Shelters, Designated Safe Areas, and Lifelines* | | |
| **Recommendation 5:** NIST recommends that nationally accepted performance–based standards for tornado–resistant design for buildings and infrastructure be developed in model codes and adopted in local regulations to ensure 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 are designed so as to remain operational in the event of a tornado.<br><br>An example of a tornado performance objectives matrix for buildings of different risk categories is shown below:<br>  <br><br>(1) Hardened area, shelter–in–place.<br>(2) Public shelter.<br>* Risk Categories based on ASCE 7–10. | Academia, ASCE, Design and construction industry (ACI, AISC, AWS, PCA, SDI, SJI, TMS), FEMA, ICC, NIST | ASCE |



## ASCE/SEI response to Recommendation #5 above:

ASCE/SEI is well qualified to lead the effort to develop performance-based design standards. In fact, ASCE/SEI is currently forming a technical committee to discuss and develop a performance based design provisions for wind design. This committee has already discussed the appropriateness of tornado-resistant design for buildings and other structures as well as how to incorporate the provisions into ASCE standards, which are adopted by reference into local regulations. The items described above are well within the many aspects to be considered while developing a performance standard.

Aside from this new effort, the current ASCE 7 Wind Loads Subcommittee is developing commentary to address some aspects of tornado design and includes some performance goals; these new provisions intend to be included in the 2016 edition of the standard. Additionally, the ASCE/SEI Moore, Okla., 2013 Post-Disaster Assessment Report, currently in draft, will contain

a specific chapter outlining performance-based design recommendations. Many of these efforts can coalesce around the recommended performance-based standard for tornado resistant design. The one aspect of the proposed standard development that must be addressed outside of ASCE/SEI is the development of tornado-specific hazard maps. ASCE/SEI is well qualified to lead the effort to develop the provisions per its ANSI process; however, development of the hazard maps on which the provisions will be based must be funded and developed in conjunction with the standard for it to be effective. NIST is currently funding development of revised wind maps, and further effort is required for tornado specific hazard maps if a performance based standard for tornado resistant design is to be effective.

National Association of Home Builders

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January 6, 2014

Dr. Marc L. Levitan
Lead Investigator
NIST Technical Investigation Joplin
National Institute of Standards and Technology
100 Bureau Dr., Stop 8611
Gaithersburg, Md. 20899-8611

RE: NAHB Comments on Draft NIST NCSTAR 3 *Technical Investigation of the May 22, 2011 Tornado in Joplin, Missouri*

Dear Dr. Levitan:

On behalf of the National Association of Home Builders (NAHB) and its more than 140,000 members, I submit the following comments on the draft NIST NCSTAR 3 *Technical Investigation of the May 22, 2011 Tornado in Joplin, Missouri* that was released for public comment on November 21, 2013. NAHB supports NIST's goals in identifying and assessing the impacts such disasters have on buildings and other structures and further supports NIST's goals in identifying methods for improving such structures to withstand future catastrophes.

NAHB is a Washington, D.C.-based trade association whose mission is to enhance the climate for housing and the building industry. NAHB promotes policies that will keep safe and affordable housing as a national priority. A federation of more than 800 state and local associations nationwide, NAHB's membership includes more than 140,000 members who will construct approximately 80 percent of the new homes built each year in the United States, as well as residential remodeling and light commercial construction. NAHB strives to ensure that housing remains a national priority when laws are made and policies are established.

NAHB agrees with NIST's recommendation urging states and local jurisdictions to adopt and enforce building codes and standards based on the International Code Council's family of model building codes. NAHB is a strategic partner with the ICC and a participant in ICC's code development process as well as those for the development of key standards such as ASCE 7 *Minimum Design Loads for Buildings and Other Structures*. NAHB is also a member of the ICC/NSSA Consensus Committee on Storm Shelters, which develops the ICC-500 *Standard for the Design and Construction of Storm Shelters*.

NAHB is interested in NIST's recommendations for the development of performance-based design standards and design methodologies for tornado-resistant design and incorporating those into model codes and standards. NAHB is also interested in the NIST recommendation to incorporate storm shelters into a variety of occupancies including multifamily residential buildings. NAHB would welcome an opportunity to

work with NIST, other federal agencies, and other interested parties that plan to move these recommendations forward.

NAHB supports amendments to national model building codes and industry standards for the purpose of mitigating property damage to residential construction from natural disasters that have sound technical justification and are cost-effective. To be considered cost-effective, more stringent requirements in national model building codes and industry standards must not jeopardize a potential homebuyer's ability to qualify for a mortgage to purchase their desired home. In addition, increased requirements must be offset by reduced property insurance rates, tax credits and/or other incentives such that the home buyer's total principal, interest, taxes and insurance payment will be no greater after the inclusion of the cost of the natural hazards mitigation features than before.

NAHB is particularly concerned with some of the proposed recommendations and the negative impact that they may have on housing affordability. For example, the recommendation to incorporate storm shelters in all new multifamily construction in tornado-prone areas, as well as to retrofit all existing multifamily buildings in such areas. Depending on the required occupancy, the cost to provide a shelter for new construction can range from $10,000 for a minimum size prefabricated shelter to over $100,000 for a large site-built shelter that can accommodate 100 or more users. The costs to retrofit a shelter into existing construction increase as foundations and exterior walls may need to be strengthened, additional sprinklers and ventilation systems may need to be installed, and additional plumbing fixtures may need to be provided.

NIST Recommendation #7 acknowledges this issue in recommending the development of a standard targeted specifically at storm shelter installation in existing buildings. NAHB suggests that a separate standard, or provisions within ICC-500, also needs to be developed specific to multifamily buildings. Under the *International Building Code*, multifamily buildings are typically classified as Residential Group R-2 occupancies, with specific requirements for fire separations, fire sprinklers, accessibility and means of egress. Storm shelters under ICC-500 are generally considered Assembly Group A-3 occupancies, which triggers more stringent requirements for those same categories. Thus, under ICC-500, providing a storm shelter in either a new or existing multifamily building changes the occupancy classification of part or all of the building, increasing design requirements and costs beyond those necessary to insure the structural integrity of the shelter under tornado wind loads.

In conclusion, NAHB welcomes the opportunity to work with NIST and all other interested stakeholders to examine in more depth the recommendations contained in the Technical Investigation, as well as other hazard-related building performance design recommendations.

If you have any questions or would like additional information, please do not hesitate to give me a call at 202.266.8545.

Sincerely,

Gary J. Ehrlich, P.E.
Senior Program Manager, Structural Codes & Standards

# S.A.V.E. COALITION

c/o Missouri State Emergency Management Agency
Attn: Steve Besemer - Earthquake Program Manager
P.O. Box 116
Jefferson City, MO 65102


SPONSORING ORGANIZATIONS

American Council of Engineering Companies/Missouri * American Institute of Architects/Missouri
American Society of Civil Engineers/St. Louis * Earthquake Engineering Research Institute/New Madrid
Missouri Association of Code Enforcement * Missouri Society of Professional Engineers
Society of American Military Engineers/St. Louis * Structural Engineers Association of Kansas & Missouri
Missouri Seismic Safety Commission

December 17, 2013

NIST Technical Investigation Joplin
100 Bureau Dr., Stop 8611
Gaithersburg, MD 20899-8611

RE: Public Comments
NIST NCSTAR 3 (Draft)
Tornado in Joplin, Missouri

Dear NIST Colleagues:

On behalf of the Missouri State Emergency Management Agency's Structural Assessment and Visual Evaluation (SAVE) Coalition board of directors, please accept these comments on the referenced report:

1) Page 12 "The Mercy Village Apartments building, a wood-framed structure … suffered only light damage to its envelope." Two separate SAVE Coalition building inspection teams evaluated this structure on May 26, 2011. The structure was evaluated using the Applied Technology Council's ATC-20/45 rapid visual evaluation criteria as implemented by SAVE. We observed load bearing walls out of plumb and partial collapse of two walls. See attached SAVE photos 1 – 5. A red Unsafe placard was posted on the building. We recommend changing your report to say "…suffered relatively light damage."

2) Page 94. Footnote 80 should say "Structural Assessment and Visual Evaluation, a Missouri State Emergency Management Agency volunteer organization of architects, engineers, and building inspectors that conducted building evaluations at the request of the City of Joplin following the May 22, 2011, tornado."

3) Page 185. There is a national inconsistency in the use of building damage classifications. Some agencies (FEMA) use 4 categories (red, orange, yellow, green) and other agencies (ATC, Missouri SAVE, California Emergency Management Agency, NCSEA SEERPlan) recommend using 3 categories (red, yellow, green). Consensus should be

developed on the number and criteria for damage categories to avoid duplication of effort and confusion for affected property owners. We recommend your report acknowledge this inconsistency and suggest a national dialogue to resolve it.

4) Page 195. The damage description should be revised to reflect the higher degree of damage that this structure actually suffered. The bullet points concerning the photos should include "loss of roof sheathing and sections of roof framing." See attached SAVE photos 1.

5) Page 196, Figure 3-11, see attached. The caption should include "roof framing and sheathing" to include the damaged roof dormer shown on the right side of the photo. See attached SAVE photo 1.

6) Page 196, Figure 3-12, see attached. This photo shows a POST event repair to the third floor roof and walls which misleads the reader as to the level of damage this building sustained. See attached SAVE photos 1-4. The entire third floor wall at the south end of the building was removed by the tornado. Load bearing walls at the south and east ends of the building were separated from the roof and pushed out of plumb. SAVE photo 3 should be used in your report instead of the photo showing the post event repairs.

7) Page 197. The bullet point should say "Loss of entire sections of wall as well as roof sheathing between the third floor and roof."

8) The report should recognize the limitations of damage assessments using aerial photography versus boots on the ground inspections by trained design and construction professionals. The Mercy Village Apartment is a prime example of a structure rated green by aerial photo analysis and red/unsafe by on the ground inspection.

Thank you for the opportunity to comment on your report. Please feel free to contact us if you have questions on our comments or if we can provide additional information.

Sincerely,

Benjamin A. Ross

Benjamin A. Ross, P.E.
Missouri SAVE Coalition Board Member

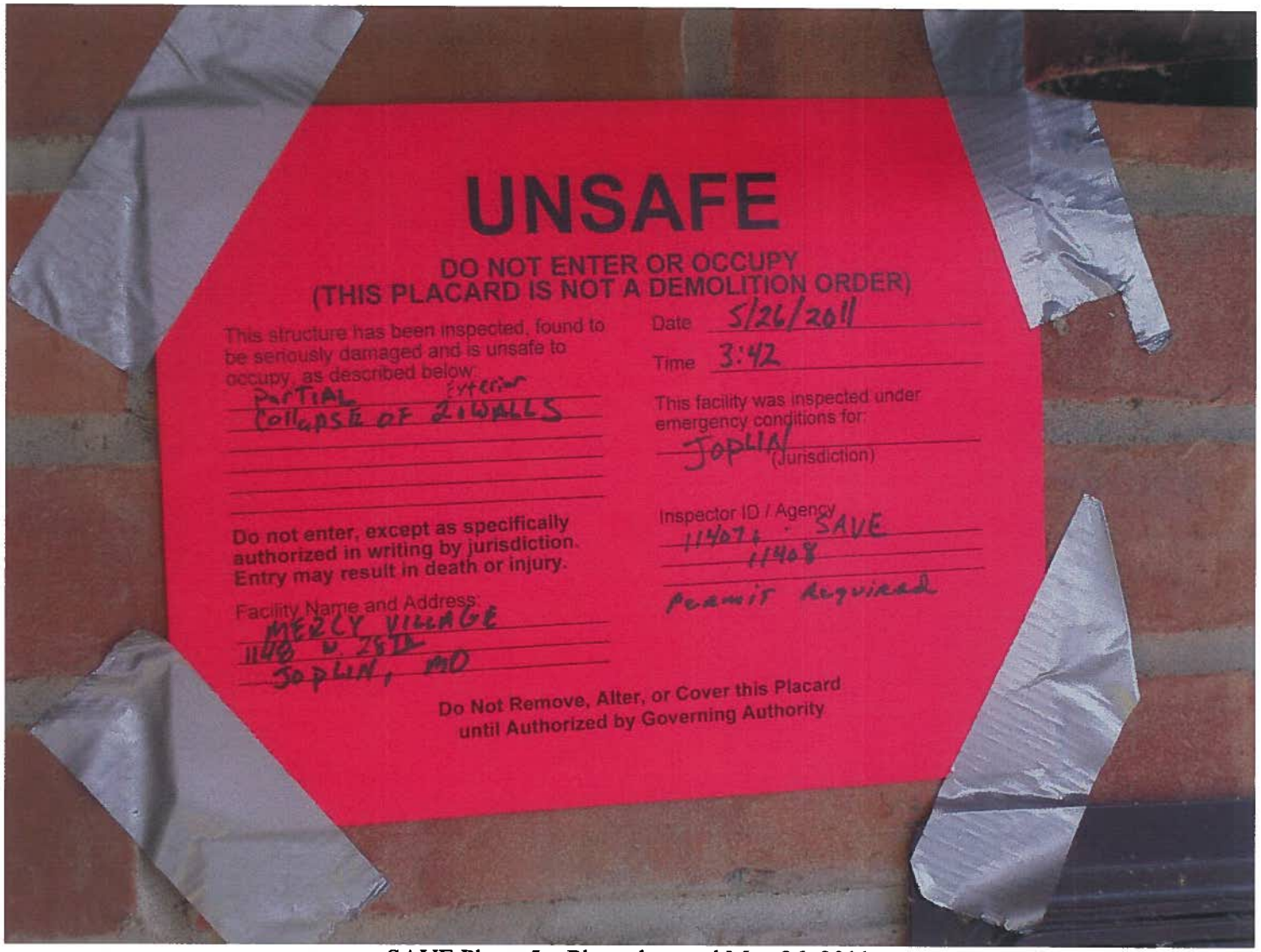
enclosures


SAVE Photo 1 – Northwest corner looking northeast


SAVE Photo 2 – West Wall, south end looking east


SAVE Photo 3 – South Wall, South Wing (looking north)


SAVE Photo 4 – East Wall, East Wing (looking northwest)




SAVE Photo 5 – Placard posted May 26, 2011

**Figure 3–111. Mercy Village Apartments, viewed from the north, with envelope damage (sidings, window glazing, roof covering).**

**Figure 3–112. Damage to the building envelope of the Mercy Village Apartments.**

**From:** David Anderson <davida@integdes.net>
**Sent:** Sunday, December 15, 2013 4:11 PM
**To:** disaster
**Cc:** Brad
**Subject:** Response Comment to Joplin MO Report - NCSTAR 3 (Draft)

Gentlemen,

Having read your subject NIST report and recommendations, I would like to suggest an addition to one of those recommendations:

On report page 366, Recommendation 10, you suggest prohibiting the use of aggregate and gravel as roof ballast material in tornado-prone areas. I suggest that you also consider the potential damage that could be caused by ballast stones used in rooftop PV panel installations, when these systems are installed as ballasted, surface-mount systems (as opposed to being structurally supported by the primary building structure). More and more of these systems are being installed every day, and to my knowledge, very little consideration has been given to their effect on public safety during a tornado.

Thanks,

Dave

David W. Anderson, PE SECB
Principal Engineer

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From: Davis, Richard [mailto:richard.davis@fmglobal.com]
Sent: Saturday, January 04, 2014 4:28 PM
To: Levitan, Marc
Cc: Harrington, John; Ali, Hosam; Nong, Shangyao; Doddipatla, Lakshmana
Subject: RE: NIST Draft Report on Joplin Tornado

Marc, I was not sure who I should address this to so I thought I would start with you. The report is very detailed and I appreciate all the effort that went into it. I am in general agreement with most of the findings and recommendations as I understand that at this phase they must remain general in nature. It seems that the estimated wind speeds causing major damage to large structures was 165-170 mph (+/- 20 mph). I do have the following comments:

1. On page 94 of the report, in talking about the SJRMC it states, "Given SJRMC's functionality as a critical facility that should remain operational, current building code would have designated its buildings as Risk Category IV structures for design purposes, meaning that they would have been designed for a basic wind speed of 120 mph based on today's design standards."
I believe it should say the facility should have "withstood" 120 mph, as opposed to "been designed for" 120 mph. The basic wind speed design is 90 mph (3 sec gusts) for that area. The importance factor and safety factors applied to pressure, would be 1.15 and 1.6, respectively. That would equate to a velocity at yield (not design) of 90 mph(1.15)^1/2(1.6)^1/2 = 122 mph. As written, the statement seems misleading, although I am sure there is additional robustness provided on the material side of the design.

2. I feel that Finding 19 on page 353 is subject to misinterpretation and should be re-worded as it tends to downplay the significance of the windborne roof aggregate and seemingly contradicts testimony on page 100 of the report. The roof aggregate broke windows which reportedly resulted in occupants receiving cuts.

From page 100 -"Most of us had abrasions and cuts and that sort of thing but no one expired and it's an absolute miracle. Mostly because the fourth wall in from the outside, from the south part of the hospital stayed up. So the exterior window walls came in, the inside patient room walls came in and another interior wall came down part way and the fourth wall stayed up and that sort of sheltered the interior hallway where we were". (NIST Interview 6) "And so that was really, really the most difficult thing about that was getting people out once we got them uncovered because there was debris on top of people, on top of us, walls in, doors in, door frames in, debris everywhere. You can't imagine the shattering that goes on when you have materials exposed to that kind of wind. Plus just the wires that were down from the ceiling, all the equipment that's inside a room,"

From page 353 - "Finding 19-
While there was no direct evidence that roof aggregate contributed to any injuries or fatalities in Joplin, there was evidence that roof aggregates contributed to envelope damage in SJRMC buildings and surrounding structures, thus adding to the tornado debris hazard and the potential for injuries or fatalities."

Hopefully I will see you next month at the WLSC meeting. Thanks and regards.
Dick

Richard J. Davis, P.E., FSFPE, M.ASCE
AVP, Senior Engineering Technical Specialist FM Global, Engineering Standards Division

**From:** McKeough, Lawrence <LMcKeoug@Joplinmo.org>
**Sent:** Monday, November 25, 2013 5:09 PM
**To:** disaster
**Subject:** NIST NCSTAR-3 Joplin Tornado Investigation report

To Whom it May Concern:

I began reviewing the NIST Report last week and noticed a few things which may or may not be of interest:

Page-12 & Page-13: St Mary's catholic Elementary School mentioned as being destroyed, but not the Church, Rectory or Community Center; the Church was right next to the school and the rectory was right next to the church; the Community Center was directly across the street from both.

Page-265: Again, St Mary's Church not mentioned under "Places of Worship" - all other churches damaged or destroyed were mentioned...

I stopped on Page 279 and haven't been able to get back into the NIST Report since...

Respectfully;

Mac McKeough

*Lawrence R. (Mac) McKeough*, MPA, CEM, MoCEM
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Neri G. Terry, Jr. terryme@cox.net; [redacted]

4 January 2014

[redacted]

terryme@cox.net; neri.terry@usmc.mil

[redacted]

To: NIST Technical Investigation Joplin

100 Bureau Drive, Stop 8611

Gaithersburg, MD 20899-8611

Ref: (a.) http://www.nist.gov/manuscript-publication-search.cfm?pub_id=914787

Dear Sir,

I write as part of the United States National Grid (USNG) Community of Interest to provide comments to Reference (a.), the *Draft Final Report, National Institute of Standards and Technology (NIST) Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri (NIST NCSTAR 3) ***Draft for Public Comments*** (http://www.nist.gov/manuscript-publication-search.cfm?pub_id=914787).*

In general these comments deal with: 1) The need to fully implement SI units in accordance with NIST and other Federal policies and; 2) more particularly the need to integrate the Federal Geographic Data Committee (FGDC)'s US National Grid (USNG), consensus standard and metric based system in this report on the Joplin events.

I regret that limited time and resources prevent me from providing complete instances where these two issues should be implemented in the report. Sufficient examples are provided to enable appreciation of the issues and full implementation throughout the final report. I offer to visit the NIST Gaithersburg campus for a more complete discussion on use of the USNG. As a Federal employee, my organization is agreeable to me visiting NIST as implementation of these recommendations are in the public's interest. The USNG Community of Interest can assist in implementing the recommended suggestions below.

Sincerely,

Neri G. Terry, Jr.

Neri G. Terry, Jr. terryme@cox.net; [redacted]

Comments on *Draft Final Report, National Institute of Standards and Technology (NIST) Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri (NIST NCSTAR 3) ***Draft for Public Comments*** (http://www.nist.gov/manuscript-publication-search.cfm?pub_id=914787).*

1. Please note, that to facilitate a more rapid response, I have directly lifted and used text from the report where applicable in my recommendations. Based on past experience, I recommend the authors of the NIST report first become comfortable in using the USNG before attempting to appreciate the recommendations below. To this end, I offer to drive up to NIST in Gaithersburg, MD to discuss the issues herein, provide practical training on using the USNG, enlist the aid of others, and assist where possible in implementation of the recommendations. The Federal Geographic Data Committee also has training material available at www.fgdc.gov/usng.

2. References that apply and are relevant to this report:
   a. Presidential Executive Order 12770 – July 25, 1991, FR 56 35801-35803.
   b. Metric Conversion Act of 1975
   c. NIST SP 814 – Interpretation of the SI for the United States and Federal Government Metric Conversion Policy
   d. NIST SP 811 – The NIST Guide for the use of the International System of Units
   e. Federal Geographic Data Committee, FGDC-STD-011-2001, United States National Grid
   f. US Geological Survey (USGS), Associate Director for Geography Memorandum of Sept 23, 2003; Subj: Support and Promotion of the US National Grid
   g. USGS USTopo 1:24,000-scale, 7.5-minute map sheets: JOPLIN WEST, MO Edition 2010; JOPLIN EAST, MO Edition 2011
   h. National Search and Rescue Committee (NSARC) Letter of Promulgation of Nov 10, 2009 for the Catastrophic Incident Search and Rescue Addendum to the National Search and Rescue Supplement to the International Aeronautical and Maritime Search and Rescue Manual
   i. FEMA Memorandum for the Administrator of May 28, 2009; Subj: Near Term Priorities for Disaster Operations Directorate
   j. Chairman Joint Chiefs of Staff Instruction (CJCSI) 3900.01C of June 30, 2007; Position Reference Procedures
   k. U.S. Fire Administration Firefighter Fatalities in the United States in 2005; FA-306/July 2006; p. 44

3. Scope of provided comments. In general these comments apply to: 1) The need to fully implement SI units in accordance with NIST and other Federal policies and to; 2) fully integrate the United States National Grid (USNG) standard in the report and outcomes. Generally these comments do not apply to improved codes for resilient design and construction of buildings. They do support integration of SI units and the USNG in analyses of the wind environment and technical conditions that may have contributed to the fatalities and injuries, the performance of emergency communications systems, and the public's response to emergency communications.

As the primary outcomes (findings and recommendations) of the NIST technical investigation provide a technical basis for improved codes, standards, and practices related to tornado hazard characterization, emergency communications systems, and emergency response, it is important that NIST implement SI based recommendations in accordance with US Government policies. (p.xiv)

4. Global application of comments. The draft report is nearly four hundred pages in length. It contains many excellent points of information, text, figures, and tables, most of which would be improved upon by adhering to NIST policy that specifies SI units as the preferred system, and by incorporating the US National Grid. The size of this report and this author's time and resources do not allow for detailed comment at this time on each and every instance related to issues regarding SI units and the US National Grid. Sufficient samples of recommended changes though are provided for different types of information such that the report authors can incorporate the changes on a global basis throughout the final report.

5. Background: Why the US National Grid and what is its relevance to this report? The USNG is a well-established Federal standard based on SI units. It is highly relevant to this draft NIST report. The USNG can and should be woven throughout the report so it provides a fully integrated and cross relational means of conducting analysis; improves presentation of information and reader understanding; offers proven methods for improving public pre-event warning and situational awareness; and as a historical resource.

   The USNG provides quantifiable, repeatable means based on SI units, in a consensus based standard, referenced to the figure of the Earth, for spatially describing the Joplin events as they occurred; the outcomes; for contributing to the wind effects analysis without resorting to developing a one-off grid based on imperial units; as a standard means for providing warning and situational awareness in future such events; and supporting future emergency response operations. Street names used to provide spatial relevance in the draft report change over time – USNG values will not.

   The USNG is a Federal standard now being implemented across the country, particularly in the emergency services. The USNG is fifth grade simple, composed of two perpendicular number lines based on linear values (meters). It is so simple in design that a fifth grader can accurately and precisely plot and scale USNG values on a map. It is far simpler and more intuitive than the complexities of angular units of latitude and longitude. The natural deficiencies of the nominal data that street addresses are composed of have caused the USNG to expand to beyond the emergency services to the general public and commercial activities. Operational economies drive it to supplement street addresses in commercial and private activities. The US Postal Service has patented its ZipGrid based on the USNG, and is giving consideration to its future applications.

   An example of the USNG's current use is how it is currently being taught to students from around the US as a standards based solution at the US Fire Administration's National Fire Academy in Maryland, near NIST. Students learn how to read and use the USNG and that the USNG is fully integrated into low-cost consumer GPS receivers such as Garmin's and Geographic Information System (GIS) software packages such as ESRI's ArcGIS software.

Not unlike how NIST developed its own one-off grid for use in this draft report, during the response to Hurricane KATRINA in 2005, each different search and rescue organization from around the country used their own arbitrary grid. This interoperability failure caused great difficulty in command and control; non-compatibility with low-cost consumer GPS receivers; and greatly complicated the mass replication of properly gridded maps. The National Search and Rescue Committee responded by reviewing Federal policy and adopting the USNG with guidance on its use as part of its Catastrophic Incident Search and Rescue Addendum. The Federal Emergency Management Administration's (FEMA) Urban Search and Rescue Teams (USAR) from around the country responding to the Joplin event were all trained and used the USNG in many of their activities. The Army National Guard units and their responding Soldiers to the Joplin event were all trained in the USNG (as the MGRS) and it is integrated into their maps, GPS receivers, and digital command and controls systems. The Missouri National Guard prior to the Joplin event had commissioned the production of a state wide set of 1:25,000-scale digital map files that print on letter size paper. These maps are organized on the USNG grid lines, and each sheet identifying number is based on the lower left corner grid coordinate. Thus a Soldier who has been informed of an area of interest with a USNG coordinate can intuitively determine the map sheet number they require. As small digital files in the GeoPDF format sheets can be easily transmitted over the web and formed into special atlases of an area. They can be viewed either digitally or printed in hard copy on readily available letter-size printers. At the time of the event, the US Geological Survey had published 1:24,000-scale USTopo maps over west Joplin that depict a full fine line USNG grid. In fact the entire US conterminous area and Hawaii (Alaska is in production now at 1:25,000-scale) is covered by these maps depicting a full fine line USNG grid. They are readily available through the web at store.usgs.gov. When plotters are not available for sheet map production, users with a letter size printer can print screen-shots of these for anywhere over the country at scales as large as 1:6,000, with a USNG grid for spatial reference. Applications for smart phones now provide USNG locations and low-cost consumer GPS receivers have had USNG functionality for years.

In recent years, the USNG has been adopted for various GIS analytical efforts such as the health of biological species that are similar to how NIST used its grid in this draft report.

With these issues in mind, the following recommendations are provided.

6. Improving recommendations from Table E-1 Summary of NIST recommendations.

**Recommendation 2:** 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.

Comment: Such information gathered and generated from tornado events (such as the Joplin tornado) should be stored in SI values in publicly available and easily accessible databases to

aid in the improvement of tornado hazard characterization. As this report envisions research on tornados such as this report, being stored for future research, it is important that SI and standards based protocols be used. The arbitrary grid that is neither based on an accepted standard, nor based on SI units should be replaced with the standards and SI based US National Grid.

**Recommendation 3:** 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.

Comment: The USNG should be integrated into this report and should be used with such tornado hazard maps.

**Recommendation 15:** NIST recommends research studies to identify the factors that will significantly enhance public perception of personal risk and how such knowledge can be better used to rapidly and effectively respond during tornadic events.

Comment: The USNG provides a means to readily assess how near a tornado is to the general public's present position through simple addition and subtraction of a reported tornado's location and the recipient's location. If you know through routine use your own approximate USNG location, such as that for your house, it is simple addition or subtraction for someone to determine how far away a tornado is through a media or NOAA report giving the tornado's initial location, such as "UB6202." This location is unique out of a thousand mile radius.

For example, NOAA, the media, and other communications could announce, *"Tornado now on the ground near Joplin, MO. Take cover NOW! Tornado is near UB 62 02, repeat UB 62 02."*

In this example, we will use the approximate center of the main built up area (BUA) of Joplin, MO: grid UB6505, as a recipient's location. The casual listener near the Joplin downtown area, experienced in routine use of the grid, would subtract 62 from 65, or 02 from 05, and immediately appreciate a tornado was within three-kilometers of them.

7. Improving Figures and illustrations with the USNG and SI units in the NIST report.

Figure 1-4 "Initial damage in the Joplin tornado..." located on p. 8

Comments on Figure 1-4. Using Figure 1-4 as an example, it is very difficult to identify from the draft NIST report where the tornado first touched down relative to the greater Joplin area. Figure 1-4 uses the road names Newton Road and S. County Club Dr. Newton Road is also known as West 32nd Street, or it turns into West 32nd Street. I never could locate S. Country Club Dr. on a map. In any event, the spatial descriptors used in the NIST report make it very difficult to appreciate what was taking place and where. The use of street names ***and*** USNG values would greatly simplify this and provide quantifiable information.

This quantifiable location information can also be easily used in other GIS systems, properly gridded maps, and later analysis against other storms.

Figure 1-4 should provide much greater information by depicting a full fine line USNG grid and grid line labels, a metric bar scale, and a ratio scale (such as 1:10,000). The North arrow currently depicted can be significantly reduced in size and line weight as it adds unnecessary visual clutter. Note that the USNG grid provides visual sense of scale, direction (to include north), and precise, quantifiable location information in a standards based format referenced to the figure of the Earth.

With few exceptions, such as the weather maps at Figures 2-1, 2-2, and 2-4; the line and image maps in this NIST report should depict a full fine line USNG grid and appropriate grid line labels. Scale should be provided by both ratio scales (such as 1:10,000) and bar scales. Bar scales should be metric based and if a bar scale depicting imperial units is required it should be secondary. This includes maps such as Figures 1-1, and 1-2 as well as the many very large scale image maps and diagrams, such as Figure 2-18. "*Observed tree fall pattern...* " throughout the report.

Figure 4–40. *Graphic showing the location of all 154 impact–related fatalities in relation to the EF wind speed zones (red = EF–4, orange = EF–3, yellow = EF–2, green = EF–1, and blue = EF–0).* (page 326)

Comments: Figure 4-40 is an excellent example of a graphic that will be greatly improved through depiction of a full fine line USNG grid and grid line labels. The grid will enable users to better correlate information in this graphic, other sources throughout the report, and elsewhere.

8. Improving textual information.

The USNG can supplement street addresses provided in the text using its very compact format (see FGDC-011-2001). It can be explained in the beginning of the report that features will be identified where appropriate with abbreviated USNG values. In this case, the area of extent is small enough (less than 100 x 100 kilometers) that all abbreviated grid coordinates are in relation to Joplin, MO [center located In Vicinity Of (IVO) 15SUB6505].

For example, on page 10, line 5, states, "*Centered around the intersection of 26th Street and Maiden Lane, this area included several small commercial office buildings, such as...* "

This can be improved significantly by adding the USNG location thus:
"*Centered around the intersection of 26th Street and Maiden Lane (grid 638 029), this area included several small commercial office buildings, such as...* "

Note how in this example the USNG's abbreviation and truncation convention (grid 638 029) allows for only six digits to provides a very clear and quantifiable means of graphing the location while consuming little space. These six-digits represent a 100-m posting, or resolution and are often quite good enough.

Alternatively, it may be necessary to use a 10-m posting or resolution. On page 12, second paragraph, third line, the text reads, "... *The Mercy Village Apartments building, a wood-framed structure located approximately one-fourth mile south of the tornado center and directly east of SJRMC suffered only light damage to its envelope.*"

This information can be improved thus,
"... *The Mercy Village Apartments building (grid 6428 0256), a wood-framed structure located approximately 400-m (one-fourth mile) south of the tornado center and directly east of SJRMC suffered only light damage to its envelope.*"

Also note how the distance (one-fourth mile) has been changed to conform to NIST SP 811 [i.e. *400-m (one-fourth mile)].*

9. Proper and routine use of SI units and USNG in Chapter 2 examples. Chapter 2 *Tornado Hazard Characteristics* is focused on meteorology issues. The lack of uniformity and discontinuity of unit formats throughout the report – SI for much of Chapter 2, but imperial units elsewhere – causes abrupt shifts for the reader in trying to assimilate the detailed information in this report. All chapters should conform to the NIST policy of preferring SI units and supplementing with imperial units in parentheses.

   Chapter 2 has several areas where the USNG can be implemented to better integrate the information throughout the report.

   9.a. Figure 2-5 should depict a full fine line USNG grid and line labels. The figure should depict a metric grid in both ratio and bar formats. The associated text should recommend that Tornado Warning (TO.W) corner vertices should be given in text as USNG values along with latitude and longitude coordinates. Again, readers of NOAA reports provided by text messages or other web appliances, could more readily sense the To.W. locations relatively to their positions.

   9.b. Figure 2-7 "*Radar reflectivity sequence from the Springfield radar...*"

   Comments on Figure 2-7: This Figure contains a very powerful set of images with a great deal of spatially relevant graphical information. It would be worth enlarging these powerful images to a spread of two full pages. Each of these radar images should have a full USNG grid over laid over them. This would allow the reader to better appreciate and correlate the time and location of weather phenomena with other detailed images and maps throughout the report.

   9.c. Figure 2-8 "*Center of Joplin tornado track as estimated by NIST.*"

   Comments on Figure 2-8: This figure and others similar formatted figures should depict a full fine line USNG grid and grid line labels, metric bar scale, and ratio-scale. The north arrow should be reduced in size to reduce unnecessary clutter.

9.d. Figure 2-12 would be improved if a Closest Point of Approach (CPA) distance in meters or kilometers was provided for the tornado and the Joplin Airport Automated Surface Observing System (ASOS) station. The location of the Joplin Airport ASOS should be provided in the text of paragraph 2.3.3.1 with a USNG value, such as, "*The Joplin Airport Automated Surface Observing System (ASOS) station (call letters KJLN) was located 5 miles to 6 miles north of the tornado as the storm passed through Joplin, well outside the damaged area.*"

This information would be improved in format and value thus: "*The Joplin Airport Automated Surface Observing System (ASOS) station (grid: 666 122, call letters KJLN) was located 8 – 10-kilometers (5 miles to 6 miles) north of the tornado as the storm passed through Joplin, well outside the damaged area.*"

(Author's comment: The grid coordinates given in this example are only estimated.)

9.e. Figure 2-14. *Elevation view of southwest-facing wall of Walmart Store #59.*

Comment: The Figure 2-14 caption should contain an 8-digit grid coordinate for the location of the camera.

9.f. Figure 2–16. *Grid system for tree fall analysis in Joplin. Each dot denotes a tree/wind–field point spaced at every 0.05 miles. The grid extends 6.2 miles west to east and 2.0 miles north to south.*

Comment: Figure 2-16 and other similar figures throughout the report should be revised with the USNG as the basis for analysis rather than a non-standard grid. In this case, 1,000-m grid line labels could be depicted with the dots spaced 100-m apart. Doing so would readily change the caption to read:
*Figure 2-16. Grid system for tree fall analysis in Joplin. Each dot denotes a tree/wind–field point spaced at every 100-m. The grid extends 10-kilometers west to east and 3.2-kilometers miles north to south.*

Alternatively, because the grid lines are labeled with kilometer values, Figure 2-16 could be captioned simply:
*Figure 2-16. Grid system for tree fall analysis in Joplin. Each dot denotes a tree/wind–field point spaced at every 100-m.*

9.g. Figure 2–24. *Estimated maximum wind speed polygons from tornado wind field model grouped by EF Scale. The solid black line represents the estimated tornado center. The area in the figure is approximately 6.2 miles west to east and 2.0 miles north to south.*

Comment: Figure 2-24 is an excellent example of how figures included in this NIST report are simply pretty pictures that should be enhanced with quantifiable spatial relevance. A full fine line USNG and grid line labels would enable someone to associate

the estimated wind speed more precisely with events on the ground and elsewhere in the report.

9.h. Table 2-2. *Estimated wind speeds for NIST-surveyed structures using EF Scale.*

Tables such as 2-2 benefit from including spatial relevance and context of each structure discussed by including USNG grid coordinates as depicted below:

| NIST-Surveyed Structure |
|---|
| Walmart (690 039) |
| Home Depot (689 035) |
| Franklin Technology Center (659 034) |
| SJRMC (East/West Towers) (639 027) |
| Joplin East Middle School (710 034) |
| Joplin High School (661 034) |

9.i. Figure 2-15. *Building footprints in part of Joplin showing damage classes. St. Mary's Catholic Elementary School (red box) shown for reference. Area shown is approximately 1.0 miles west to east and 0.8 miles north to south.*

Comments on Figure 2-15. This figure and others like it such as Figure 2-18 are excellent examples of drawings that would benefit from a full USNG fine line grid and line labels. The grid would give the line drawing and its contents an intuitive sense of scale, area of extent, and location. This enables the reader to better integrate the information into the context of the whole event in Joplin. The caption should be changed to read:

Figure 2-15. *Building footprints in part of Joplin showing damage classes. St. Mary's Catholic Elementary School (red box) shown for reference. Area shown is approximately 1.6-kilometers (1.0 mile) west to east and 1.3-kilometers (0.8 miles) north to south.*

Better yet, with the grid depicted, the area of extent is well illustrated and intuitively obvious so the caption can be shortened to simply read:

Figure 2-15. *Building footprints in part of Joplin showing damage classes.*

10. Use of a non-standard, non-SI based arbitrary grid for wind effects analysis by NIST.

10.a. Paragraph 2.3.4.2 Tornado Wind Field Model, page 42, Grid development

Comment: The unique, one-off, and non-standards based grid described on page 42 under Grid Development and in Appendix C Model Grid Coordinates should be eliminated from the study and replaced with the well-established consensus standard and SI based USNG. The imperial units grid developed by NIST for this study does not comply with NIST policy. It is an inefficient and unnecessary waste of manpower and analytical resources. It sets a dysfunctional precedent for future tornado analysis and gives poor guidance to future researchers. The USNG provides the basis for such analysis and is readily generated with standard commercial software packages such as ESRI's ArcGIS. Being standards based, the USNG will be used in similar tornado effects studies in the future in other locations without the need for redundant reinventing of the wheel. The USNG is currently used in other, similar spatial analysis efforts. Delta State University, Cleveland, MS has conducted tornado research using the USNG and Talbot Brooks (tbrooks@deltastate.edu) can provide detailed insight on the issue.

10.b. Appendix B *EF-Scale Rating for Random Residential Structures*

Comment: Appendix B is another excellent example of how the USNG can fully integrate information and enables efficient and better correlation of the Appendix to other information throughout the report and with other external data. Appendix B should be rewritten to incorporate the USNG.

Building ID Number: The USNG location should be used as the Building ID Number, giving the unique identifier spatial relevance also. See comment 9.h. above. As depicted below and in the Draft Report, this Building ID Number is based on a Pictometry assigned value. An 8-digit USNG grid coordinate will usually suffice for even modest size homes. 10-digit, 1-meter resolution can be used where needed.

NIST Wind Field Model; Closest Grid Point Number: When the Building ID Number is based on a USNG value, the "Closest Grid Point Number" column can be eliminated, as the Building ID Number is also the Closest Grid Point Number. As is, the Grid Point Number is from a practical perspective relatively useless to any readers of this report.

| Appendix B *EF-Scale Rating for Random Residential Structures* | | | | | | |
|---|---|---|---|---|---|---|
| Building ID Number | Pictometry Analysis Damage Level | NIST EF Analysis | | | NIST Wind Field Model | |
| | | Damage Indicator (DI) | Degree of Damage (DOD) | Estimated Wind Speed (mph) | Estimated Wind Speed (mph) | Closest Grid Point Number |
| 1387 | Light | 2 | 1 | 65 | 75 | 2691 |

Closing comment. The NIST report on the Joplin event contains much valuable information. We of the USNG Community of Interest stand ready to assist NIST where possible with implementing the USNG standard throughout the report's analysis and outcomes with the objective being to ensure the best report to the public possible.

Talbot J. Brooks
[redacted]
tbrooks@deltastate.edu
[redacted]

NIST Technical Investigation Joplin
100 Bureau Dr., Stop 8611
Gaithersburg, MD 20899-8611

Ref: http://www.nist.gov/manuscript-publication-search.cfm?pub_id=914787
Ref: Letter of 4 January 2014 from Neri G. Terry re: Joplin report

4 January 2014

Dear Sir;

I am writing in support of the comments offered by Mr. Tom (Neri) Terry with respect to the use of SI units and the US National Grid. As a member of the National Geospatial Advisory Committee, a FACA body responsible for providing advice to the Executive regarding spatial technologies and systems, the use of common standards across the Federal enterprise is critical. Further, the emergency response community at-large understands that it lacks a common language of location and, as this need is increasingly recognized through events such as the tragedy in Joplin, is gradually accepting USNG. Any recommendations forthcoming from the Joplin investigation would thus support not only NGAC and efforts from the Executive, but create additional awareness and speed of adoption and use by the emergency responder community.

Sincerely,

Talbot J. Brooks

| | |
|---|---|
| **From:** | Whitney, Mark <Mark.Whitney@fema.dhs.gov> |
| **Sent:** | Wednesday, December 11, 2013 2:07 PM |
| **To:** | disaster |
| **Subject:** | NIST Investigation of Joplin, Mo., Tornado - Comment |
| **Attachments:** | fa-240.pdf; RRL_240_Grid Coords Policy Req.pdf; USGSmemo.national.grid030923.pdf; SuperBowl2007LR_USNG.jpg |

Good morning disaster@nist.gov,

This input is my own as a many year disaster worker and while my agency, FEMA, does very much support the USNG standard/implementation, my views here do not necessarily represent the views of my agency.

If pursuit of "uniform guidance for clear, consistent and accurate emergency communications" (NIST press release re. Joplin report) is one of the primary reasons for NIST doing such a report, the USA's "U.S. National Grid (USNG) **standard** provides a nationally consistent *language of location* that has been optimized for local applications" (www.fgdc.gov/usng) and once fully implemented/trained goes a further distance towards the goal of "clear, consistent and accurate emergency communications" then any other measure imaginable (at a negligible cost when upgraded/planned properly).

The previous Administration's Science Advisor identified "USNG as one of the three most important immediate steps that the Government could take to improve homeland security." I couldn't agree more. On a tornado the size of that hitting Joplin, first responders probably came from 15 or more surrounding counties and likely more than one state. None of them operated using a common operating grid (USNG) for easily communicating locations as they coordinated among themselves and their citizen/customers in an area now largely without street signs and mostly unfamiliar to the largest portion of the response assets. While USNG won't cure all the ills and operational friction encounter on such jobs, it goes much further down that path than anything else the government has done since 09/11/2001. Speaking of 9/11, FDNY is now creating map books with USNG overlays. So is the State of New York, Florida, Minnesota, Missouri.... Here (attached) is one map (Miami-Dade) Florida made in support of the Super Bowl a few years ago.

Fed.gov responders? Of course the military, including the ever important for such events National Guard assets, all use MGRS and it (MGRS) is the interoperable with (same as) USNG. Urban Search and Rescue among many others who observed and learned the lessons from Katrina have now also implemented USNG for their response efforts.

This is a NPR story that focused on Katrina mapping issues:
http://www.npr.org/templates/story/story.php?storyId=5233408

Hundreds of reasons why this is important, many of which should be self-evident (especially for moderate size events such as the Joplin tornado). "The lack of a similar, standardized procedure by state, local, and many Federal Agencies is a critical deficiency in U.S. consequence management." (See attached RRL-240 from the USMC CBIRF).

We've proven many times over the weaknesses of the different versions lat/long or a newly created with each event local grid, "bingo grid," to go along with the many dozens of other bingo grids used for such responses (in the Katrina DFO, at least a dozen different grids being used...the NOPD and NOFD each had their own different map grid). Here was the result: "Holding an oversized grid map of New Orleans, Capt. Bob Norton of

the NOPD Criminal Intelligence Bureau plotted various points and discussed the difficulty in getting rescuers organized before Katrina. Despite the heroic work of individual rescue teams, the lack of coordination caused duplication of efforts, wasting time and costing lives, he said. Moreover, different agencies used different maps, making communication that much harder. The NOPD used its own zone map. The Fire Department used a map with different zones, and Wildlife and Fisheries used a state map. "'There was no unification,' he said. 'Those were hard lessons learned.'" (Trymaine Lee, Times-Picayune News).

Interoperability plans/systems/voice commo…, "rendered impossible". Search the attached report re. the needs of the US Fire Service on the word "interoperability."

One last item of note:
DHS is receiving encouragement from Congress this year in its 2014 Appropriations Bill:
S. Rept. 113-77 - DEPARTMENT OF HOMELAND SECURITY APPROPRIATIONS BILL, 2014

FYI:

http://beta.congress.gov/113/crpt/srpt77/CRPT-113srpt77.pdf

EMERGENCY RESPONSE AND RESCUE LOCATION INFORMATION

The United States National Grid [USNG] was developed in cooperation with the United States Geological Survey and National Geospatial Intelligence Agency, and it has since been adopted by a number of States. The Committee encourages the Department to continue to support awareness, adoption, implementation, and tactical use of the USNG for emergency response and rescue scenarios in cooperation with appropriate outside partners, including those in academia. Further, the Committee directs the Department to submit a report no later than 180 days after the date of enactment of this act on what training is currently available, what challenges there are in disseminating the USNG, and what partners have collaborated in training.

Take good care and have the best of holidays,

Mark A. Whitney
Fire Programs Specialist
National Fire Data Center
United States Fire Administration
Federal Emergency Management Agency
Department of Homeland Security
16825 S. Seton Ave.
Emmitsburg, MD 21727
(301) 447-1836
USNG: 18SUJ00539637

**From:** Plisich, John
**Sent:** Tuesday, December 31, 2013 3:18 PM
**To:** 'disaster@nist.gov'
**Subject:** Plisich comments; Draft NIST NCSTAR 3 Joplin tornado technical investigation

To NIST,

Please find attached, comments to your draft report: NIST NCSTAR 3 (Draft) For Public Comment; Draft Final Report Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri.

Per your website, http://www.nist.gov/el/disasterstudies/weather/joplinpubliccomments.cfm , I have included the relevant information you requested for your deadline of 6 Jan 14.

Please call with any questions you may have on these comments.

Thanks for the opportunity to review and comment.

Have a Happy and healthy New Year to you and your loved ones.

Bud

FEMA Region IV
ATTN: John "Bud" G. Plisich (Mitigation)
3003 Chamblee Tucker Rd (Hollins Bldg)
Atlanta, GA 30341

Civil Engineer
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**NIST NCSTAR 3 (Draft) For Public Comment; Draft Final Report, National Institute of Standards and Technology (NIST) Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri Review**
**John Plisich Contact info; john.plisich@fema.dhs.gov; 770-220-5380**

| Item No. | Reviewer / Org | Para / Sentence | Page No. | Comments / Reason for Comment / Suggestion for Revision |
|---|---|---|---|---|
| 1 | Plisich / FEMA Reg IV | last sent / finding 3 | xlviii | Revise for clarity as existing sentence is unneccesarily complex. .... "While existing indirect methods cannot be used to unambiguously determine wind speeds that can be used in structural design, the remaining findings in this study are not sensitive to the level of uncertainty in this methodology." One suggestion attempting to keep the intent might be ... "While existing indirect methods cannot be used to determine wind speeds for structural design with exacting clarity, the remaining findings in this study can still be used, with the realization there are many uncertanties, leading to limitations, for this methodology. |
| 2 | Plisich / FEMA Reg IV | First sent / Finding 6 | xlix | Revise run on sentence for clarity as shown or similar … "Tornadoes rated EF–3 or lower have accounted for: a) approximately 96 percent of all U.S. tornadoes between 1950 and 2011, b) over one–third (36 percent) of the approximately 5,600 tornado–related fatalities over the same period, and c) about 80 percent of the $25 billion in estimated property losses incurred due to tornadoes between 1996 and 2011." |
| 3 | Plisich / FEMA Reg IV | Findings 8,9, 11 & 17 | xlix & l | Findings 8, 9, 11, 17 all have run on sentences. Suggest slightly revising those sentences to keep the intent, but shorten the lengthy sentences. The findings and recommendations section will most likely be read the most. |
| 4 | Plisich / FEMA Reg IV | Finding 21; last sent | li | Currently the finding states: "There are currently no design standards, requirements, or best–practice guidelines for designating refuge areas within existing commercial or critical buildings." …. FEMA 431 (Tornado Protection: Selecting Refuge Areas in Buildings - Oct 09) states on page v, "This booklet presents information that will aid qualified architects and engineers in the identification of the best available refuge areas in existing buildings." I'd recommend modifying this finding accordingly. One option might be to state ... "Other than FEMA 431, a best practice guidance document, there are currently no design standards or requirements for designating refuge areas within existing commercial or critical buildings." Then provide a footnote with "FEMA 431 Tornado Protection Selecting Refuge Areas in Buildings (2nd Ed; Oct 2009). Although this document is primarly written for schools, the concepts can be used for other types of buldings as well, when applicable". |
| 5 | Plisich / FEMA Reg IV | Finding 6 and Finding 41 | In exec Summary & chap 5 | Finding 6 states "In the case of the Joplin tornado, approximately 40 percent of the fatalities and as much as 90 percent of the tornado area were associated with EF–3 or lower wind speeds." … Finding 41 states: "Virtually all of the buildings in which the 135 impact–related fatalities occurred experienced maximum estimated winds associated with tornadoes rated EF–3 or higher." On page 19 in section 1.3, it mentions most of the fatalities were related to EF-3 and above (with some exceptions) type winds. Recommend revising verbiage in these two findings to better summarize, clarify, coordinate these internal findings for the reader and what your analysis found. Currently, it is a little confusing. |

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| Item No. | Reviewer / Org | Para / Sentence | Page No. | Comments / Reason for Comment / Suggestion for Revision |
|---|---|---|---|---|
| 6 | Plisich / FEMA Reg IV | Recommendations 8 & 9 | lvii & pages 365 & 366 | Recommend deleting "FEMA" from the interested parties column (and sections), since they are well represented in the lead responsibility column |
| 7 | Plisich / FEMA Reg IV | Recommendations 8 & 9 | exec summary & chap 5 | Delete "and implemented" from both recommendation 8 and 9 as FEMA is in no position to implement it nation wide. We are in a position to develop guidelines, from which OFA's, state and locals, non-profits, businesses and private owners and operators can utilize the guidance in implementing it as they deem most apprpropriate. There is a critical separation of powers between the federal govt and the state and local governments. This report should reflect that vital separation. |
| 8 | Plisich / FEMA Reg IV | Recommendation 10 | exec summary & chap 5 | Did you mean for critical facilities only? As written, Rec 10 seems excessive in that 2/3rds of the US is in a tornado prone region if you use the FEMA 361 / ICC 500 hazard maps. It also puts all of the burden of the problem on the aggregate business community, which is not exactly fair. Recommend putting a scalpel to the subset desired for this recommendation. …. "Recommendation 10: NIST recommends that aggregate, gravel, or stone be prohibited as roof surfacing material or roof ballast for buildings of any height in tornado – prone areas." .... Another option might be to recommend for community planners, building owners, designers to not use aggregate for their given building or a given area in the community they plan to be more tornado resistant. This helps broaden the burden to appropriate parties, such as communities, planners, developers, building owners, decision makers for proper area / facility / community planning, design, funding for a given protection level they want and are willing to fund, for that given area. |
| 9 | Plisich / FEMA Reg IV | Recommendations 13 | exec summary & chap 5 | Recommendation 13 should be broken up into atleast two different recommendations. This would enable the codes and standards part to be led by the ICC / NFPA and maybe the unifrom guidance part on alerts and other weather related issues led by NWS. As written it is not easily actionable as it is all muddied up together and the lead agency can only address certain parts, but not others. Some of the interested parties should be the lead org for parts of the recommendation. Guidance and standards are entirely different concepts and should be addressed as such, for their different roles, purposes and implentation. Federal agencies can probably move out quicker, with funding, to provide guidance, from which standards groups can use that guidance as the basis for helping them develop the codes and standards. |
| 10 | Plisich / FEMA Reg IV | Recommendation 14 | exec summary & chap 5 | Might want to add HUD in the interested parties column, through their multi billions of dollars in CDBG (Community Development Block Grant) funds. They might be able to write this option for consideration by communities who receive these types of grants. |
| 11 | Plisich / FEMA Reg IV | Recommendation 16 | exec summary & chap 5 | Delete NOAA from interested parties as they are well represented as the lead agency. Add FEMA, state and local EMA's to the interested parties list as they should be involved in coordination with NOAA to provide inputs in what products and the type of information and formats that might be best for more effective and efficient operations. |

**NIST NCSTAR 3 (Draft) For Public Comment; Draft Final Report, National Institute of Standards and Technology (NIST) Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri Review**
**John Plisich Contact info; john.plisich@fema.dhs.gov; 770-220-5380**

| Item No. | Reviewer / Org | Para / Sentence | Page No. | Comments / Reason for Comment / Suggestion for Revision |
|---|---|---|---|---|
| 12 | Plisich / FEMA Reg IV | E.6 References | lx | See comment on FEMA 431. If you add it, then add FEMA 431 to this references section. |
| 13 | Plisich / FEMA Reg IV | 2nd full para; 1st sent | 3 | Revise as shown or similar .... "Joplin is home to two ~~three~~ airports: and a heliport; Joplin Regional Airport (shown at the far north of Fig. 1–2); Five Mile Airport; and a heliport at SJRMC. .... I wouldn't and most other people wouldn't consider a heliport as an airport. |
| 14 | Plisich / FEMA Reg IV | 2.3.4.1; Table 2-1, Table 2-2 and Table 2-3 | multiple | Clarify by adding "3 sec peak gust" in multiple areas, to include in section 2.3.4.1 (EF Scale Process), as well as clarifying in table 2-1 (EF Scale), Table 2-2 and Table 2-3. As written, a less informed reader might not appreciate which wind speeds you are talking about and come to the wrong conclusions. |
| 15 | Plisich / FEMA Reg IV | Finding 3 | 350 | Revise for clarity as existing sentence is unneccesarily complex. .... "While existing indirect methods cannot be used to unambiguously determine wind speeds that can be used in structural design, the remaining findings in this study are not sensitive to the level of uncertainty in this methodology." One suggestion attempting to keep the intent might be ... "While existing indirect methods cannot be used to determine wind speeds for structural design with exacting clarity, the remaining findings in this study can still be used, with the realization there are many uncertanties, leading to limitations, for this methodology. |
| 16 | Plisich / FEMA Reg IV | Finding 20 | 353 | Recommend revising as shown or similar as lacking implies something that is wrong, which is not the case. ... "~~Also, 82 percent of the homes in Joplin lacked basements.~~" Revise to "82 percent of the homes in Joplin did not have basements. |
| 17 | Plisich / FEMA Reg IV | Finding 34 | 355 | Should this be walked back a bit? Did they believe they had a low probability of being struck, vs being immune? .... "Prior to the May 22, 2011, Joplin tornado, scientifically unfounded beliefs about tornado movements and the effects of regional topography contributed to a common public perception that the City of Joplin was immune to a direct tornado strike." Finding 44 also has the word immune it it. If they thought they were immune, then keep it. If this goes too far, then walk it back a bit. |
| 18 | Plisich / FEMA Reg IV | Recommendation 1 | 359 | Add "FEMA" to the list of interested parties. Adding FEMA can also potentially help in FEMA prioritizing such research referenicng this NIST report and the FEMA MAT 2011 tornado report, and working with DHS S&T to help get it accomplished. |

**NIST NCSTAR 3 (Draft) For Public Comment; Draft Final Report, National Institute of Standards and Technology (NIST) Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri Review**
**John Plisich Contact info; john.plisich@fema.dhs.gov; 770-220-5380**

| Item No. | Reviewer / Org | Para / Sentence | Page No. | Comments / Reason for Comment / Suggestion for Revision |
|---|---|---|---|---|
| 19 | Plisich / FEMA Reg IV | Recommendation 12 | 367 | Move DHS IP/FEMA to the interested parties area and move the bulding owners / operators to the lead responsibility area. FEMA and DHS have no authority or responsbility to carry out Vulnerability assessments for critical facilities owned by others. Owners and operators of their own facilities have that responsiblity and authority. Delete DHS S&T from interested parties as this is not a research issue. Add planners and key decision makers to interested parties. Delete AHJ's as this is not a code enforcement issue and add local government officials to interested parties. AHJ is more the term used in the code enforcement area, not necessarily local governments in general. |
| 20 | Plisich / FEMA Reg IV | Recommendation 15 | 369-370 | Add FEMA and modify DHS to DHS S&T to to the interested parties section. This is behavioral science research and S&T can also get invovled with that. Since it is related to preparedness and messaging for the public for EM related issues, FEMA would be an interested party. |
| 21 | Plisich / FEMA Reg IV | 1st sent at top in first bullet | 91 | Did you mean every 4 feet? Currently, it says every 4 inches…. "Required every masonry foundation wall to have at least one #4 reinforcing bar, spaced no more than 4 in. on center" |
| | | | | **End of review comments** |
| | | | | |
| | | | | **End of Comments on FEMA Sandy MAT 50% draft report & Appendices** |

| REVIEW COMMENTS | 1. DATE 11-29-2013 |
|---|---|

2. PROJECT:

**NIST Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri**

| 3. REVIEW PHASE: | 4. REVIEWER: | 5. MAIL ADDRESS: |
|---|---|---|
| **Draft Final** | **Al Studt, CFPS**<br>EMAIL: **USNG08@GMAIL.COM** | **6240 Corsica Blvd**<br>**Cocoa, FL 32927**<br>PHONE NUMBER: **321.591.3308** |

| 6. ITEM NUMBER | 7. DRAWING OR PARAGRAPH NUMBER | 8. COMMENTS | 9. ACTION BY REVIEW CONFERENCE |
|---|---|---|---|
| 1 | Sheet 4 | In Disclaimer 3, the policy of NIST regarding SI units is stated. This policy was not considered when the 0.05 mile grid was created. SI unit grids for the USA and worldwide exist, USNG & MGRS, respectively. See Item 15. | |
| 2 | Page xxxix | Add US National Grid (assumes report will be changed, noted) | |
| 3 | Page lv | In Recommendation 2: location data shall be common to all users & reports and shall be by US National Grid. | |
| 4. | Page lviii | Recommendation 13: NIST shall specify that weather warnings shall be specific to 1 Km grids. The character count of this information for local users is six(6). In just six(6) characters, TV & radio broadcasters, Emergency Managers, etc. can advise details of exactly where the worst problem is and where it is going. Example: **PE 23 31** for Bethany, Oklahoma. There is no reason that Emergency Managers cannot teach their residents over time what the grid is for their home. Further, commonly available smart phone apps exist to place USNG/MGRS location information in the user's hand 24/7, wherever they are. How important is that when they are not in familiar territory? US National Grid is the solution for warning specificity needed; NIST should state so. Note: the NWS is already working on forecasting by USNG; check with them. | |
| 5. | Page lviii | Recommendation 15: knowledge is power. If the citizen knew where they were in an easy way, their 1 Km grid, and if hazard warnings were by 1 Km grid; the two could be correlated. Weather maps on TV and online need to display USNG grids routinely so viewers can read the location of the tornado cells themselves, in addition to being told, to see where they are and act. Also, for radio listeners, over time situation awareness will occur and hearing the grid and direction of travel, or the next expected grid, will give them proper reaction time. The recommendation here is to 'add' USNG references, not replace any exiting descriptions used. | |
| 6. | Page lix | Recommendation 16: NIST needs to come out and state: ".. by US National Grid". It is the SI standard grid and is already a national standard. Recommend its wider use, please. | |
| 7. | Page lx | E.6: Add the US National Grid standard (assumes report will be changed, noted) [L1] | |
| 8. | Page 1, & globally, all figures | Figure 1-1: A map without a grid is just a picture. Add USNG,grid lines and labels at proper scale, even if in fine, grey lines to most, if not all maps in this report. It provides scale, specificity, orientation, etc. Multiple free web tools exist that could have done this during the report creation and on the day of the event. See Mission Manager by Radishworks, or Florida Incident Mapper by Florida Division of Emergency Management. Overlays of weather radar and USNG, at the same time are more than possible. It has already been done for warnings in Florida and Oklahoma. [L2, L3, L4 L5] | |

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| 9. | Figure 1-11 | As example, a 100 meter grid map that includes the middle school is provided. [L6] | |
| 10. | Page 42 | Grid Development: the creation of a non-interoperable, non-SI unit, grid is an obvious error for correction. NIST shall use the national standard **US National Grid**. Standard grid sizes are 10 Km, 1 Km, 100 meters and even 10 meters. Check with the Minnesota I-35 Bridge collapse investigation team; they may have used 1 meter grids, as example of USNG use in a mishap type report. However, for this report, 10 or 100 meter grids are likely more than adequate. The 0.05 mile grid is 80 meters, but is not a standard size. Convert the data, maps, etc. | |
| 11. | Page 55 & all structures referenced | Table 2-6: Building reference by name only is obviously devoid of specific location information. Add simple and succinct USNG references to all structures throughout the report: Ex: Wal-Mart, 15S UB 6902 0398 or just 6902 0398, if a note is made in the report that all coordinates are in 15S UB. | |
| 12 | Page 96, & all photos, final & during investigation | Some, but not all photos may benefit from having the location of the photographer and the compass bearing in the photo or in the description of the photo. These may be more useful by the team on the ground doing investigations and trying to keep track of location. While the geo-tag function of photos is known; having the data on the photo is of extreme value. Examples are shown at USNGFlorida Twitter site routinely. Apps Theodolite and GeoCam. [L7] | |
| 13. | Page 101 & facility descriptions | Add a geo-location field and data for all structures. US National Grid 10 meter or in some cases 100 meter coordinate. Locations are best specified by the primary entrance, referred to by the Fire Service as Side A, See linked document for additional about how to specify a coordinate for use in reports. [L8] | |
| 14. | Page 242 | 4.2.3: This was an opportunity to ask responders how they operated when all typical navigational aids are gone. How do they report position, mark & transmit to others the locations of requests for help, hazards and victims. The lessons are long ago learned in the hurricane realm, the answer of course is supposed to be US National Grid. Did they use it? Were they aware of it? The report should be expanded in this area. | |
| 15. | General | Every county in the state of Missouri has USNG gridded maps. MO is the only such state. Maps were created 30 Aug 2010. What was their distribution prior to 05 May 2011? Who knew of them? Were they utilized by Emergency Managers and field responders? Relates to Item 14. Example supplied. [L9] | |
| 16. | General | In November 2011, US National Grid was designated as the Land Search & Rescue coordinate system by the National Search & Rescue Committee. Surely, response to a tornado fits this requirement; it is a prior lesson learned that needs expanded awareness and implementation. This Joplin report needs to mention it. Agencies responding to wide area disasters need to be made aware of standards; certainly a NIST related function. Use of US National Grid crosses all jurisdiction boundaries as well as full interoperability with US Military, National Guard, FEMA & state asset USAR teams, etc. A responder from California can operate, navigate and report position succinctly in New York and vice-versa when both are trained in a provided with US National Grid maps and coordinates. Relates to Item 14. [L10] | |
| 17. | General | Provided for NIST awareness: presentations from Florida Governor's Hurricane Conference, 2013, course # TS 37, '*The US National Grid for First Responders in Natural Disasters*' Part 1, Part 2 [L11, L12, L13] | |

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| | Link List | In order referenced | |
| | [L1] | http://www.fgdc.gov/usng | |
| | [L2] | http://www.radishworks.com/MissionManager/Maps.php | |
| | [L3] | http://map.floridadisaster.org/mapper/ | |
| | [L4] | https://twitter.com/usngflorida/status/329378904949288960 | |
| | [L5] | https://twitter.com/usngflorida/status/340618109771722753 | |
| | [L6] | http://www.radishworks.com/MissionManager/Maps.php?mark=USNG%3A%2015S%20UB%2071043%2003329&zoom=17&layer=Google%20Hybrid&coords=2&grid=true | |
| | [L7] | https://twitter.com/usngflorida/status/401394838454542336 | |
| | [L8] | http://usngcenter.org/wp-content/uploads/2013/08/USNG_Which_Coordinate_Specifies_a_Structure_2012_0301.pdf | |
| | [L9] | http://usngcenter.org/portfolio-item/mapbooks/ | |
| | [L10] | http://www.epcupdates.org/2012/03/nsarc-designates-usng-as-land-sar.html | |
| | [L11] | http://flghc.org/flghc2013/ | |
| | [L12] | http://www.flghc.org/docs/2013TS/TS-37-1.pdf | |
| | [L13] | http://www.flghc.org/docs/2013TS/TS-37-2.pdf | |
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Comments include example US National Grid map atlas file for Joplin: **016-15S UB 6405.pdf** available from: ftp://msdis.missouri.edu/pub/mapbooks/Jasper_MO_Atlas.zip

End of comments.

**From:** Jules G. McNeff <jmcneff@overlooksys.com>
**Sent:** Friday, November 22, 2013 3:41 PM
**To:** disaster
**Cc:** Fugate, Craig
**Subject:** After-action Technical Report on the 2011 Joplin Tornado

I note that on pp 42-43 the report discusses creation of a grid structure to convert to Lat/Long and use in tracking the tornado progress. Also, a number of recommendations highlight the need for accurate and useful spatial reference infor ation

You did not have to take the separate step of creating a unique, Joplin-specific grid structure as one already exists within the National Spatial Data Infrastructure, under the management of the Federal Geographic Data Committee (FGDC), chaired by US Geological Survey. That grid structure is the U.S. National Grid (USNG) standard, which provides geospatial reference values at 100 meter – 10 meter – 1 meter fidelity, depending on the spatial definition requirements you have. It is also not necessary to convert the USNG values to latitude/longitude for dynamic calculations, as USNG enables uniform metric spatial relationships to be directly calculated based on the grid location values alone, and already referenced to the locality involved. The standard and related information are available at the FGDC web site: htt ://www.f dc. ov/usn

FEMA Urban Search and Rescue Teams have used the USNG for several years in conducting rescue and recovery operations, and the FEMA Administrator (copied) has advocated the adoption of the USNG more widely throughout his organization. It is also being adopted incrementally in several States for use in providing uniform and easy-to-understand spatial references to aid emergency response and for general public use, such as spatial designations on trail markers in Minnesota.

With regard to Recommendations 3, 14, and 16 in your report, acknowledging for the future the need for education in awareness and use of the already available USNG will enable more coherent spatial estimates in advance of and real-time spatial reporting during such life-threatening weather events.

Please let me know if I can provide any additional information.

Best regards,

Jules McNeff

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**From:** Jean SmilingCoyote <maiinganikan@yahoo.com>
**To:** "disaster@nist.gov" <disaster@nist.gov>
**Sent:** Monday, November 25, 2013 9:02 PM
**Subject:** "Technical Investigation of the May 22, 2011 Tornado in Joplin, Missouri"

Re:
"Technical Investigation of the May 22, 2011 Tornado in Joplin, Missouri"
NIST Draft Final Report NCSTAR3 for Public Comment

I majored in Geography as the scientific foundation for my career goals in the full spectrum from regional land-use zoning, community planning and design, to house design including building codes. One section of building codes is zoning for natural hazards, which vary in kind and risk level across the USA.
I have given special attention to the tornado hazard because the need is great. To have a zoned building code section for tornadoes, the risk must be mapped in suitable zones. Many ways to map tornado incidence have been created.
With regard to the request for Page Numbers, Paragraphs & Sentences the Comments are referring to: there are too many to list. I would make the same Comments about any tornado-struck town in FEMA 320's "high risk zone for extreme winds." My reasons for my Recommendations are in the text of each.
Recommendation 1:
Over 30 years ago, I thought Voronoi diagrams would be the best way to create an isoline map of tornado density. I still do. Voronoi diagrams let the data create the "net" used to draw isolines. I have not been able to create this map, because I lack the math & computer skills; and have never had the money to pay anyone to help me. I appeal for help from any qualified person reading this; please contact me. At this time, I have to rely on FEMA maps – and actual tornadoes. Nothing speaks so strongly as the tornado that just hit you.
Recommendation 2:
FEMA P-320, "Taking Shelter From the Storm: Building a Safe Room For Your Home or Small Business," has always put Joplin in the "high risk zone for extreme winds" and says that here, a "safe room is the preferred method of protection from extreme winds." I agree, and think this should be required by law in all new and rebuilt construction of these buildings. Many times, people have no time to go someplace else for shelter.
Recommendation 3:
Building codes in this zone should require the building envelope be able to withstand EF3 tornadoes. This includes horizontal as well as vertical members. Modern construction of homes and small-business buildings can achieve this with several kinds of reinforced concrete. Along with rectangular types, the streamlined Monolithic Dome is thought to offer "near-absolute protection" from many natural hazards, including EF5 tornadoes. I know of no construction based on wood products, including wood frame with "hurricane clips," which will assure protection against tornadoes stronger than EF2, the debris being the greater problem than wind speed. I know that financially conservative design, including simple rectangular footprints and hip roofs, will offset the higher cost of reinforced concrete and make it feasible. I have a variety of resources listed on my website at http://EFTornadoSafeHome.com. Political resistance to reinforced concrete is based on both ignorance of these design solutions, and strong

pressure from the lumber industry. EF3 resistance of building envelopes will handle most tornadoes, and vastly reduce human and property losses even from stronger tornadoes.

Recommendation 4:

The website description of the 2nd Edition of FEMA P-361, "Design and Construction Guidance for Community Safe Rooms," says: "This latest edition meets and exceeds the design criteria set for in the ICC-500, Standard for the Design and Construction of Storm Shelters." For this reason, Community Safe Rooms should be based on FEMA P-361, 2nd Edition, instead of ICC-500.

Recommendation 5:

All safe rooms for homes, small businesses, and communities must be handicapped-accessible.

Recommendation 6:

I also propose this law for residential "safe rooms" per FEMA P-320: "In a residence with the usual bedrooms for all, a 'safe room' big enough for all the inhabitants to sleep in when they wish, need not have any windows for emergency egress, as long as it has at least 2 doors not on the same side of the room." When watches and warnings of severe thunderstorms or tornadoes apply to the hours of twilight and darkness, people in such a home can go to bed in a comfortable safe room, close the doors, go to sleep, and not have to get a warning to be safe overnight.

Recommendation 7:

Critical facilities such as (but not necessarily limited to) fire stations, police stations, emergency management centers, local government headquarters, hospitals, and emergency rooms, should be sheltered by Monolithic Dome construction, so that they *and their equipment* will be available to do their jobs after a strong tornado. Backup electric generators for these must be protected in some kind of "safe room," allowing for their need for ventilation.

Recommendation 8:

Mobile homes, as we know from experience, are poor places to be during a tornado. Therefore, every mobile home park must have individual and/or community "safe rooms" per FEMA P-320/FEMA P-361 for all residents.

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