

**National Construction Safety Team (NCST)
Advisory Committee Meeting
National Institute of Standards and Technology (NIST)
Gaithersburg, Maryland
September 28, 2017**

Meeting Summary

Advisory Committee Members:

James (Jim) R. Quiter	Arup, Committee Chair
Ross Corotis	University of Colorado, Boulder
Jeremy Isenberg	AECOM (retired)
Reginald DesRoches	Rice University
Paul A. Croce	FM Global (retired)
James Harris	JR Harris and Company, Committee Vice Chair
Jeanette Sutton	University of Kentucky
Gary Klein	Wiss, Janney, Elster Associates, Inc.

NIST Representatives, Guests, and Contractor Support:

Kent Rochford	Acting Director, NIST
Howard Harary	Director, Engineering Laboratory, Designated Federal Officer, NIST
Judith Mitrani-Reiser	Director, Disaster and Failure Studies Program
Long Phan	Group Leader, Structures Group, NIST
Marc Levitan	Acting Director, National Windstorm Impact Reduction Program (NWIRP) R&D, NIST
Erica Kuligowski	Leader, WUI Fire Group, NIST
Jason Averill	Chief, Materials and Structural Systems Division, NIST
Therese McAllister	Leader, Community Resilience Group, NIST
Stephen Cauffman	Research Engineer, Community Resilience Group, NIST
Nelson Bryner	Chief, Fire Research Division, NIST
Michael Newman	Senior Communications Officer, Public Affairs Office, NIST
John van de Lindt	Professor, Colorado State University (NIST COE)
Walter Peacock	Professor, Texas A&M University (NIST COE)
Dan Cox	Professor, Oregon State University (NIST COE)
Frank Gayle	Deputy Director, Office of Advanced Manufacturing, NIST
Ben Davis	Management and Program Analyst, Community Resilience Group, NIST
Melissa Banner	Administrative Assistant, Community Resilience Group, NIST
Mat Heyman	Consultant, Applied Research Associates

Summary of Discussions

I. Opening Remarks, Introduction, and Agenda Review

Judith Mitrani-Reiser opened the meeting, and then Committee members and other attendees introduced themselves. Following a review of safety procedures, Mitrani-Reiser introduced Kent Rochford, who provided opening remarks.

Rochford thanked Committee members for their time, commitment and willingness to serve, noting that their contributions will make an important difference. Since the last Advisory Committee meeting, he said, NIST has worked to implement recommendations made by the Committee and Mitrani-Reiser had joined NIST as Director of the Disaster and Failure Studies Program. Rochford also told the Committee that NIST has conducted reconnaissance missions related to several recent hurricanes. NIST is now engaged in post-deployment reviews. Rochford thanked departing Committee members Isenberg, Croce, and Quiter for their commitment during their tenure.

Jim Quiter, Chair of the Committee, welcomed Committee members and meeting attendees and acknowledged Jeremy Isenberg's previous service as Chair. Quiter said that the main output, and an important part of the meeting, will be the work on the Committee's annual report with recommendations to NIST, which would be discussed later in the day. Quiter reviewed the agenda and asked Howard Harary to provide NIST's responses to the Committee recommendations, included in the Committee's 2016 report.

II. NIST Responses to NCST Advisory Committee's 2016 Report

Harary thanked the Committee for its 2016 report — both for its support for NIST's work as well as specific NCST-related recommendations. He briefly reviewed the NCST Act and the Advisory Committee's charter.

Harary then reviewed, at a high level, NIST's specific responses to the Advisory Committee's recommendations: [[See presentation slides.](#)]

1. Expertise at NIST

The Committee had noted the special expertise possessed by NIST staff and their building safety orientation, and strongly suggested that an ability to investigate tornado events other than Joplin (MO) and wildland-urban interface (WUI) fires would be highly beneficial.

Harary assured the Committee that the decision to deploy an NCST Team is not dependent on the expertise that already exists at NIST. The NCST Act requires that at least one member of the Team be a NIST employee. Other team members can be experts from the private sector, universities, representatives of professional organizations with appropriate expertise, and appropriate federal, state, or local officials. In addition, the NCST Act allows for the procurement of temporary or intermittent services by experts and consultants. In sum, he told members, NIST is

required to engage other parts of the government, private sector, and universities to provide necessary expertise.

2. Criteria for Deploying NCST Teams

The Committee had urged NIST to review the deployment criteria in the context of apparent climate change and to consider ways of stretching its resources, perhaps by reducing the length and complexity of reporting in order to conduct more investigations.

Harary said that the NCST Act is focused on the impact that hazards have on buildings and subsequent challenges in evacuation and emergency response procedures; the Act does not focus on the type of hazard that resulted in a building failure. The NCST Act specifies the two criteria the NIST Director must consider in determining whether to deploy a Team under the Act: building failure and substantial loss of life or significant potential for substantial loss of life.

He explained that NIST scores all events and uses a filter to help decide about potential employments. During his tenure, Harary said, NIST had not seen a situation where it had wanted to do an investigation. He acknowledged that while there are always financial limitations, NIST is committed to doing studies where there is something really important to learn.

3. Safety of Teams

The Committee had suggested that coordination with local fire departments before and during any NIST deployment is prudent. It also had recommended that in the longer term, safety training of the type undertaken quarterly by FEMA search and rescue teams be considered. Participation by NIST personnel in the safety training of other agencies may be feasible, according to the Committee.

Harary said that NIST agreed with these recommendations. He advised the Committee that NIST employees who deploy as part of an NCST preliminary reconnaissance or an NCST investigation must complete a set of safety training courses. Those courses are updated with guidance from the EL Safety Professional and NIST's Occupational Safety, Health, and Environment (OSHE) Office, borrowing material from other agencies whenever needed. NIST employees with NCST credentials, issued by the NIST Director, are expected to discuss the status of their safety training with their managers twice each year during regular reviews, he said. NIST has investigated Federal Emergency Management Agency (FEMA) online training, with search and rescue as an example. He said that NIST is considering incorporating several of those elements into its own training, and that procedures for teams' safety is coordinated with fire departments.

4. Longitudinal Studies

The Committee reiterated its recommendation that NIST consider following up on past investigations. One reason is to assess and update amendments to the deployment criteria, which include consequences to resilience. According to the Committee's report, revisiting a damaged site, possibly six months after an event,

permits exploring changes in building safety that have been implemented and whether damage models are reliable for resilience planning.

Harary said that NIST agreed with this recommendation. He noted that longitudinal studies for NCST investigations would allow better tracking of the impact of recommendations on improvements of building standards, codes, and practices. A follow-up of NCST investigations, even not at the original site, could prove beneficial to promote best practices across multiple hazards. Harary informed the Committee that the DFS program and the WUI group have and will study the effectiveness of public messaging in the context of the Joplin NCST investigation and the evacuation in the Gatlinburg (TN) WUI fire. He said that NIST is interested in doing this follow up regardless of whether it happens under the NCST or NIST's Organic Act.

Harary assured that Committee that NIST is very interested in taking each of its recommendations to heart in going forward. He and the NIST team believe that many of the suggested changes are possible, including those that address the criteria for undertaking an investigation. Harary noted that NIST would like to engage the Committee in greater detail in reviewing those criteria and being an essential part of the process, which could require the group to meet more than annually.

Committee Discussion of the NIST Response to the 2016 Report

Committee members and NIST representatives discussed other issues in a question-and-answer format. These topics were responded to briefly by NIST staff and in more detail in subsequent presentations and discussions, as described below.

Q. Paul Croce asked whether NCST investigations were restricted to buildings rather than any other type of structure.

A. Harary and Mitrani-Reiser confirmed that the NCST statute restricted NIST to investigating building-related failures under that authority. Harary told Committee members that they could recommend that Congress broaden the scope of NCST investigations if they believed that to be appropriate.

Q. Ross Corotis asked whether NIST had other units that could support non-building related investigations.

A. Harary and Mitrani-Reiser confirmed that there were other authorities NIST could use for non-building structures. NCST, however, offers certain authorities — such as subpoena power — that were not otherwise available as an investigatory tool.

Q. Reginald DesRoches asked whether NIST could investigate a building failure outside the United States.

A. Mitrani-Reiser responded that NIST's decision criteria for the NCST allowed the agency to consider investigations outside the United States if those countries have similar standards and practices. Harary added that NIST would take into account the ability of the other country to conduct an investigation.

Q. Isenberg remarked that he was uncertain as to the effectiveness of recommendations sent to Congress, and asked whether there is a chance of any real impact.

A. Harary agreed that the likelihood of recommendations being reviewed and acted upon depended on individual staff and members of Congress. As an positive example, he pointed to the Advisory Committee on Earthquake Hazards Reduction (ACEHR) as having successfully influenced Congressional interest and actions. Harary noted that there are several key members of Congress who especially care about earthquakes and federal agency activities. He told the Committee that ACEHR recommendations had translated into legislative proposals calling for improvements, expansions, and requirements to the underlying statute. Harary also cited the much-talked about window of outrage after a tragic event as being a time when recommendations tended to receive greater attention; he noted that this may be such a time with the recent hurricanes and fires.

Q. Quiter asked Mitrani-Reiser to explain the criteria for undertaking an investigation.

A. Mitrani-Reiser previewed a portion of her later presentation and described the two major considerations: quantitative and qualitative.

The quantitative aspect is divided into two sections. The first addresses the event consequence and physical impact:

- substantial loss of life or disabling injury
- significant potential for loss of life (exposed population)
- magnitude of the hazard
- consequences to resilience (physical damage)

The second part of the quantitative score takes into account evacuation and emergency response challenges:

- evacuation/emergency response challenges
- applicability of international events (code enforcement, similarity of practices)

Mitrani-Reiser also described the six qualitative considerations:

- unique new knowledge that may potentially be gained
- potential impact on standards, codes, and practices
- availability of sufficient resources
- how site conditions would affect the safety of field personnel
- whether NIST had been requested by others (federal, state, local) to undertake a study
- whether NIST would have primary authority and would NIST collaborate with other agencies or assume primary authority and expertise

Mitrani-Reiser informed the Committee that the quantitative answers and the sum of the qualitative scores are used to determine whether a threshold has been reached for reconnaissance. That threshold has been exceeded twice recently, and

as a result NIST sent out reconnaissance teams in response to Hurricanes Harvey and Irma. Croce said that he was heartened by those actions.

III. Progress on Implementation of Joplin Tornado Investigation Recommendations and Discussion

Summary of Progress on Joplin Recommendations

Mitrani-Reiser briefly reviewed NIST's Joplin Tornado investigation and its 16 recommendations [[See presentation slides.](#)] calling for:

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

She highlighted specific implementation recommendations and progress to date:

- Significant progress on development of tornado hazards maps.
- ASCE/SEI/AMS Tornado Wind Speed Estimation Standard Committee has begun subcommittee balloting of draft chapters (R2 and R4)
- New NFPA 1616 Standard on Mass Evacuation, Sheltering, and Reentry Programs published in 2017, including major contributions from NIST on building safety considerations and emergency communications (R8)
- Report demonstrating minimal economic impact of proposed restrictions on aggregate-surfaced roofing in tornado prone regions (R10)
- Workshop on Outdoor Siren Policies, in collaboration with the Fire Protection Research Foundation (FPRF) and the National Oceanic and Atmospheric Administration (NOAA) (R13)
- Continued progress and operational pilot testing on Forecasting a Continuum of Environmental Threats (FACETS)

Quiter noted that there appeared to be a lot more progress since last year's update, which Mitrani-Reiser confirmed.

Tornado Hazard Characteristics and Associated Wind Field Performance of Buildings, Shelters, Designated Safe Areas, and Lifelines

Long Phan reviewed performance-based design for tornadoes and three specific recommendations (R3, R5, R6). For context, he noted that national model building codes, standards, and practices seek to achieve life safety for the hazards considered in design. He added that tornado hazards are not currently considered in the design of buildings, except for safety-related structures in nuclear power plants, storm shelters, and safe rooms.

Regarding R5, NIST recommended 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. Phan noted that NIST had not recommended that every building be designed to be tornado proof. Standards should take into account tornado hazard characterization, performance objectives, and evaluation tools. He presented an example of a tornado performance objectives matrix now under consideration by ASCE and reported that NIST is continually working with the ASCE Technical Committee on Performance Based Design. Phan reviewed the Committee's progress and priorities. He also reviewed the ASCE 7-22 Development Cycle, including membership status and organizations with representatives on the Wind Load Subcommittee. NIST will lead the working group that will develop a proposed new chapter on tornado loads. Committee meetings will begin work in late 2017 or early 2018.

Phan noted that new tornado hazard maps under development were critical, and he reviewed an ongoing research and development project on tornado hazard mapping. NIST has made a new award to ARA, Inc., under the NIST Disaster Resilience Research Grants Program, that will inform development of wind load design methods. He described that project, pointing out that existing tornado hazard maps do not account for biases and increased risk of strike on large spatial systems, such as communities, rather than individual buildings. Phan said that the contractor is three years into a four-plus year effort that is scheduled to be completed in 2019.

Phan reviewed the process for developing tornado maps, and singled out some of the difficulties. He noted that the research team had found inaccurate data in previously available tornado databases. A particular problem is that tornadoes in sparsely populated areas caused the data to be inaccurate. An EF-5 could be listed as EF-0 if there were no or few structures subject to damage.

Phan also informed the Committee that before 1976, there was no F-scale, and subsequent changes in the characterization of tornadoes corrupted the database for design purposes. He said that an augmented tornado database for the years 1950-2016 had been produced, and data were augmented and made consistent with the newer database. NIST has also produced an initial set of tornado hazard classification zones in the U.S., using an advanced algorithm developed previously

for nuclear power plant site tornado hazard analysis. The Nuclear Regulatory Commission (NRC) will be co-funding modeling work with NIST.

Phan referred to this mapping work as Version 1.0. He noted that it was difficult to get ASCE approval for proposals unless there are reference reports, journals, and conference papers. Accordingly, NIST will publish the analysis and data underlying the maps.

Q. Gary Klein asked what kinds of economic and risk analyses are anticipated to make sure that while we *can* do these things, we *should* do these things.

A. Phan said that ASCE-7 might or might not require a critical facility to be designed to a particular level. NIST can do an economic study to see if the life safety improvements help factor in costs and benefits additional costs, and he said that the agency will monitor that going forward.

Q. Klein remarked that this seems like a topic that is broader than ASCE-7 is equipped to deal with.

A. Averill said that the NIST Office of Applied Economics (OAE) has been included on some of the recent deployment teams to get their additional insights on what they see in the field and economic considerations that might be included in future conclusions and recommendations from deployments. He pointed to a second dimension: even if NIST is successful in advancing the standards process, there is the additional step of actual local adoption, and good economic analyses could persuade municipality decision-making. He cited an economic study that was completed in time for Memphis' deliberation whether to adopt national seismic standards; that analysis helped persuade opinion, and the standards were adopted.

Q. Isenberg asked whether NIST could envision a time when hospitals will be required to upgrade to meet tornado standards, similar to the situation in California with earthquakes.

A. Phan responded that this could well be a future outcome, citing the results of the Joplin investigation's examination of how hospitals performed. Mitrani-Reiser added that there will always be risk choices that the public will have to make. She cited the experience with Hurricane Sandy and issues regarding the safe evacuation of health care facilities. Phan reminded the Committee that NIST is recommending strengthened tornado resistance for structures in high hazard zones rather than for the entire country.

Update on Performance of Buildings, Shelters, Designated Safe Areas, and Lifelines

Marc Levitan updated the Committee on standards, codes, and guidance development work as a result of the Joplin Tornado investigation recommendations, highlighting completed progress [[See presentation slides.](#)] He addressed both existing and new standards and reported on completed work that will bring significant changes to the 2018 International Existing Building Code and the 2018 International Building Code regarding tornado shelters.

Among other things, he noted that advancing FEMA P-431 regarding the selection of refuge areas in buildings required additional research and development. He also reported that after a nearly three-year effort, NIST had fostered a Memorandum of Understanding between ASCE and the American Meteorological Society (AMS). Levitan said involving AMS was considered critical for adoption and implementation of this standard even though it is not a standards developing organization (SDO). He told the Committee that for the EF-Scale, there is a whole new set of damage indicators based in science and engineering that will be taken into account. This includes new damage indicators (DI) for vehicles and structures. Levitan emphasized, however, that there are still huge uncertainties associated with estimates. Among other things, tornadoes often do not hit larger buildings, so experts have to rely on damage to residences, which is where most damage occurs. There are more than 100 committee members working on the ASCE standard on wind speed estimation in tornadoes; NIST and the NWS proposed and co-chair the committee whose scope includes multiple methods of wind speed estimation.

One recommended code change stemming from NIST's Joplin investigation was not successful in 2016: a proposed prohibition of aggregate used as surfacing for roof covering and aggregate, gravel, or stone used as ballast on buildings in a tornado-prone region. Developed in coordination with the Building Code Advisory Committee (BCAC) and with input from FEMA, the proposed ICC change was defeated in October 2016. NIST had completed research and produced a publication on the economic impact of the proposed code change showing a negligible cost impact. Levitan reviewed the results of that study and said that NIST intended, through the code process, to build support for the proposed change in the future.

Regarding the Joplin report's recommendation (R8) (guidelines to enable communities to create safe and effective public sheltering strategies), Levitan pointed to previous successes with FEMA's incorporation of NIST-developed guidance and singled out the new NFPA 161-2017 Standard for Mass Evacuation, Sheltering, and Re-entry.

Levitan also highlighted recent progress in implementing the recommendation (R16) regarding NOAA's grid-based threat communication related to forecasting a continuum of environmental threats (FACETS). That new grid-based threat communication paradigm has been redesigned and infused with social and behavioral science considerations. This multi-year exploration/development effort tackles the limitations of the current tornado warning system based on polygons. He said that even with polygons, forecasters still notify many areas without a real threat. Now NOAA is aiming for more probabilistic guidance, and Levitan compared it to what the public sees in hurricane guidance. There is still a human element in these estimations, but in the future these warnings are expected to be based more on numerical models and continuous updates in an automated fashion. Levitan reviewed expected benefits of the more sophisticated, specific, and actionable system.

Discussion:

Q. Jim Harris noted the recent advances in recognizing flaws in the tornado database and suggested that we can make better judgments regarding classifying events in a particular EF category. He asked Levitan for his assessment of whether improvements in our knowledge would have come about if the Joplin tornado had not happened and if NIST had not conducted its investigation.

A. Levitan said that the Joplin event and NIST's subsequent investigation were the catalysts that jumpstarted the recent improvement-oriented activities and had truly gotten this issue onto the radar screen of the NWS — especially the need to better understand the wind field structure, not just the obvious forecasting aspects.

Q. Croce said that NIST made a lot of progress in this work resulting from the Joplin tornado. He noted that NIST's presentations are oriented around the recommendations and questioned whether it might be better to present material in terms of new versus existing construction. He also suggested focusing on single and two-family structures since larger buildings apparently are not affected as often — perhaps splitting recommendations and actions into residential buildings and everything else.

A. Levitan clarified that the focus on residential structures is used to determine damage indicators and to help grade the tornadoes simply as a practical matter since it is those structures where damage occurs most frequently considering their preponderance — not that other structures are not at risk. Regarding the suggestion that NIST focus on new versus existing construction, he noted that many of the tools and information being developed for new construction are also important in retrofit solutions. He cited a storm shelter standard that addresses new buildings, which ICC now has agreed to include in standards relating to retrofits.

Q. Croce said that there clearly were issues about feasibility and that communities needed better guidance to be able to properly protect people.

A. Levitan responded that NIST wanted to help develop overall guidance, information, and a range of options so that communities can make more informed choices. Levitan also stated that ARA is doing explicit modeling of different kinds of construction connections. The intention is to develop a front-end application to pull information that can be used to assess damage that will indicate the severity of weather conditions. That would enable NWS personnel on the ground to select a few key building features and enter the data, including photos, thereby enabling them to develop more refined wind estimates based on damage indicators (DI).

Q. Jeanette Sutton said that she was encouraged to hear about the work with NOAA and map development. She asked how this is being worked within NOAA to communicate key information to the end user.

A. Levitan said that there is a real challenge with constructing maps that can be understood and properly used by the public to make decisions. For example, even if the building has been maintained, a homeowner may want to know whether their house is built to withstand a category 4 hurricane. That is a huge challenge. NOAA/NWS is heavily involved with NIST in this work.

Q. Sutton expressed concern about changing the EF scale and the difficulty of educating the public based on preconceived notions. Being able to visualize the risk (e.g., cars being lifted up if the event is at a particular point on the scale) may help people to better understand the risk.

A. Levitan said that NIST probably will not recommend changing the EF scale and that the team's aim is to improve the estimation of the actual wind speeds; perhaps an event that was classified an EF-2 now will be slotted as an EF-3. More information and more and better tools will help to better classify these events. Erica Kuligowski endorsed Sutton's comment about the importance of actually showing the public what is meant by these higher winds and these categories.

Pattern, Location, and Cause of Fatalities and Injuries, and Associated Performance of Emergency Communications Systems and Public Response

Kuligowski updated the Committee on a NIST project to develop guidance for community-wide public alerts in emergencies. She said that NIST was focusing on NFPA1600 and NFPA 1616 as a basis for annexes for codes. [[See presentation slides.](#)]

The goal of this work is to minimize the confusion and improve the response to outdoor siren systems and short message alerts. In the Joplin investigation, NIST observed different communities using varied siren protocols and documented reports of confusion among the public as to what was happening and how it affected them, individually. Development of a guidance document would be a successful outcome for this work.

Kuligowski explained the purpose of alerts (capture attention) versus warnings (provide details of the emergency). NIST has found that the alerting systems seem to be doing a little of both. Those studying these issues are trying to improve alerting systems in an effort to make sure that both alerts and warnings are provided to the public.

The Fire Protection Research Foundation (FPRF) Project Panel is key to this work, with broad membership including federal departments and agencies as well as local and state emergency managers, siren and alarm manufacturers, and sociology and communications researchers, among others. NIST's role is to contribute relevant research.

Kuligowski reviewed the technical approach and project objectives, and the considerable progress that has been made in the first two years of the effort.

In Year 1, NIST had reviewed 53 different outdoor siren warning systems, FEMA guidance for sirens, and current siren policies. NIST also produced a key technical report and worked with FPRF and NOAA on a workshop for emergency managers and NWS representatives from 13 jurisdictions; participants discussed education efforts and all-clear communications (e.g., protocols like testing all-clear tests on the same day in all communities) and began developing guidance on usage of outdoor silent systems for the 2019 edition of NFPA 1600. NIST also developed guidance on

public alerts and warnings and the use of social media to support emergency communications; some of that guidance was successfully proposed for incorporation into the new NFPA 1616.

NIST is now completing its second year of work on this subject. Kuligowski highlighted the agency's review of human response to emergency-based short message alerts and its development of preliminary findings and guidance. She noted that most research to date has focused on Wireless Emergency Alerts and Twitter. The key to moving forward, Kuligowski told the Committee, is to identify ways to expand the restrictions on character length so that important information can be accessed in one place. Kuligowski said that as of September 2016, the FCC had put out a mandate to expand messaging to 360 characters — which will make this work even more important. The relevant research must be available to provide guidance regarding these longer messages.

NIST, NOAA, and FPRF joined in organizing a workshop earlier in the month with 16 participants across the U.S., including emergency managers, public information/communications experts, and NWS warning coordination meteorologists. The goal in assembling this collection of short-message super users was to get feedback on research findings and translating these into real-world applications. The session gathered information on lessons learned and the possibilities of standardized messages (templates).

Kuligowski reviewed next steps, including: finalizing NIST technical reports and a guidance document on public alerts (outdoor siren systems and short message alerts), providing biannual updates to the FPRF project panel and NFPA 1600 and 1616 committees, and beginning an extended project examining the use of social media for disaster response and recovery. She stressed that use of social media for *recovery* was especially significant. Focusing initially on Facebook and Twitter, NIST has a college intern working on this project using information and experiences from Hurricanes Harvey and Irma.

Kuligowski then reviewed FY 2018 project objectives regarding WUI fires that also involved the DFS program based on the (non-NCST) initial reconnaissance to Gatlinburg:

- 1) situational awareness and decision-making surrounding the need to evacuate affected communities,
- 2) emergency communications between fire incident managers and public, and
- 3) public response (including causes of deaths)

Discussion

Q. Harris inquired about plans to study events in Puerto Rico.

A. Kuligowski confirmed that NIST is interested in studying this event in the context of emergency communications.

Q. Croce suggested that NIST might want to add Mexico City into its scope.

A. Kuligowski acknowledged that NIST was interested in that disaster, as well.

Q. Klein noted that Kuligowski had not mentioned radio communications and said that if the grid is down, people can still operate radios; that is important in Puerto Rico right now. He asked about how public safety and communications officials can assure that the information provided via radio is accurate and reliable.

A. Kuligowski advised that there is already guidance regarding radio communications in NFPA's emergency communications chapter, although there is room to provide more information regarding radio for community alert purposes. NIST has focused on short communications because adequate information was not already available.

General Discussion of Progress on Joplin Recommendations

Mitrani-Reiser invited the Committee to engage NIST in an active discussion to help members digest the information presented and to allow the Committee to develop and refine content for its upcoming report.

Q. Isenberg asked about other types of hazards and how NIST addressed risks.

A. Mitrani-Reiser said that the NIST Community Resilience program is taking a hazard-agnostic approach. That program focuses on the community's social and economic needs and the physical infrastructure systems that contribute to resiliency on a community scale. She cited the *NIST Community Resilience Planning Guide for Buildings and Physical Infrastructure Systems* as a good way to put a wrapper around that. The Guide recognizes that each community is different and that some communities face multiple hazards while others face one prevailing hazard, which is an appropriate way to address the issue.

Q. Isenberg inquired whether NIST is empowered to address lifelines.

A. Mitrani-Reiser responded that lifelines were not explicitly covered under NCST, but that NIST can address them under other authorities. For example, in the reconnaissance in Florida recently, lifelines were key. Averill added that NIST could address certain aspects of lifelines from a broader perspective of building failures.

Q. Following up, Isenberg said that he did not believe that HAZUS included lifelines for flood events, which he termed a glaring omission; it struck him that NIST may be able to influence a change.

A. Levitan said that he was on the steering committee for the hurricane HAZUS model, which addressed coastal-based flooding. He noted that there were separate flood and earthquake models. To Isenberg's further question about whether there were specific provisions in HAZUS related to flooding damage to lifelines, Averill said that the CoE is specifically addressing this issue.

Q. Klein noted that there had been much discussion about government responses to disaster events, but there also had been a tremendous public and private organization response. Some efforts are very helpful, others are misguided. He asked whether NIST has a plan to study this in the context of proper mobilization of private industry.

A. Kuligowski said that NIST speaks with emergency managers regularly because they can collect information about all response activities; Klein remarked that the problem is broader. Terri McAllister informed the Committee that the event response is handled directly by FEMA, so NIST has not focused a lot on that aspect, other than studying communications and how that affects the recovery process. The research by the CoE and NIST focuses on the decisions and actions before the hazard event, and how that affects and promotes recovery (including the social and economic functions, rather than just the physical recovery of buildings). Mitrani-Reiser cited NIST's interactions with the Voluntary Organizations Active in Disasters (VOADs) in the field.

Q. Sutton asked about coordination with the National Science Foundation (NSF) especially since one of the criteria for deployments and investigations is whether something new could be learned.

A. Mitrani-Reiser said that she and NIST more broadly are very well plugged into related NSF's activities and that there is a huge amount of coordination among government agencies on these efforts; NIST plays a very active role.

IV. Federal Advisory Committee Act (FACA) Ethics Guidance

Jeffrey Harrington, Senior Attorney, Ethics Law and Programs Division, U.S. Department of Commerce, briefed members on their responsibilities and limitations as members of a federal advisory committee.

Harrington answered a number of procedural questions from Committee members. He also fielded a question from Klein regarding the use of information learned as a result of his NCST Advisory Committee work. Harary added that members were entitled to use any information that was available to the public; that included information presented during this and other NCST Advisory Committee meetings that were not closed—and such meetings would rarely, if ever, be closed.

V. Public Comment Period

There were no advance requests from the public to speak, nor were there any members of the public in attendance who asked to speak.

VI. Disaster and Failure Studies Program Updates

Mitrani-Reiser provided an overview and vision of the program, dividing its responsibilities and objectives into three parts: Statutory, Procedures, and Research. She remarked that one high-priority activity has been to establish strategic relationships in advance of any events so that NIST can be well prepared and make the best use of time in the field. [See presentation slides.]

The collection of procedures relating to disaster investigations is large; she has reviewed and revised details, including study objectives, field and safety protocols, human subject protocols, and Paperwork Reduction Act requirements.

After her first year in the position, Mitrani-Reiser said that she is now current on all steps required to be well-prepared for a deployment and investigation. She plans to

update procedures at least annually and expects to continuously improve and to inform NCST protocols by best practices at NIST and elsewhere.

Regarding equipment for data collection, she noted that when a disaster happens the NCST team needs to make very quick decisions. Even the basic matter of sharing data and how to manage that data (e.g., including rights to use photos taken inside homes) requires advance planning. She also agreed with the Committee's prior comments that being in the field allows NIST to test and evaluate these data collection procedures and then to incorporate those findings into the set of procedures used for future investigations.

Mitrani-Reiser noted that it was very important to determine and agree on the kinds of things NIST should be measuring in deployments. Before deployment, team members critically review whether they are collecting the right measurements in the field to answer the right question. Working with everyone at NIST who is conducting research in specific areas (e.g., wind, fire, structures, community resilience), Mitrani-Reiser said that she would like to do more research specifically on disaster-related measurements. She is involved in coordinating throughout the agency and with the NIST Center of Excellence (CoE) at the Center for Risk-Based Community Planning. Each time there is an event, she told Committee members, she reaches out to NIST's partners to be sure that they know what NIST is doing and vice-versa.

Mitrani-Reiser summarized the distinctions between NCST statutory requirements and the DFS research program, reiterated where NCST falls within the broader DFS effort.

Regarding DFS research, Mitrani-Reiser described work being led by the NIST. Part of the CoE's activities involves doing field investigations to validate their modeling. When Hurricane Matthew hit the east coast in October 2016, DFS and CoE agreed that there was a significant resilience element. NIST/DFS and CoE co-deployed to test existing protocols (safety, data management in the field) and to prepare for the next deployment. In addition, a structured survey was used for damage assessment and population displacement. Mitrani-Reiser reviewed a heat map indicating damage and contours indicating dislocation and showing graphically that the disaster affected people differently in terms of demographics. This was not an NCST investigation, but it improved NIST's preparedness for the next deployment.

She also noted that NIST is funding researchers at the University of California at San Diego on the use of UAV swarms for post-event damage data collection. This has created another cooperative agreement with an academic partner and supplements and complements NIST resources in the field. In addition, summer students explored best practices in sampling protocols, looking back 40 years.

Mitrani-Reiser expanded on her earlier presentation and reviewed criteria and the components for quantitative scoring as well as the qualitative considerations. She

followed with a review of the disasters that had taken place since the last Advisory Committee meeting and how each scored using those criteria.

Mitrani-Reiser reported that there had been three deployments since the Committee last met:

- Texas: Hurricane Harvey (multiple locations)
- Florida: Hurricane Irma (multiple locations)
- College Park, MD, for the Fuse-47 Apartment fire

She noted that the Fuse-47 fire had not scored very high using the NCST decision criteria, but the issue of fires in wood-framed in buildings while still under construction appears to be a chronic issue. Taken together as a family of events, this event merited greater attention and a pilot study.

Mitrani-Reiser told the Committee that NIST was still monitoring hurricane damage in the U.S. Virgin Islands and Puerto Rico, but that access issues would not permit a NIST deployment at this time even if a decision to deploy were made. FEMA and other response agencies are having difficulty gaining access due to the infrastructural deficiencies and safety challenges that remain. Similarly, NIST is still monitoring reports from the Puebla Earthquake (Mexico).

Committee members were told that key NIST staff had just returned from deployments and that the agency soon would be gathering those involved to review and evaluate preliminary data. NIST then will decide whether to conduct any investigations.

Mitrani-Reiser said that there were two anomalies among the incidents reviewed and rated by NIST using the design criteria, and she used them to explain the qualitative criteria. First, in London, the Grenfell Tower scored high but NIST does not have the authority to conduct an investigation on its own. The United Kingdom has not asked NIST to investigate. Answers to the qualitative questions contributed to NIST's decision not to deploy there. For example, the cladding used in this construction would not be allowed in current construction in the United States. (See below for a related update and Committee discussion of NIST's related fire activities.)

The Gatlinburg WUI fire in Tennessee attracted NIST's interest, especially since the number of fatalities for a WUI fire was relatively high. Most deaths appeared to be related to improper evacuations.

Review of recent deployments:

Florida/Hurricane Irma Preliminary Reconnaissance

In the case of Hurricane Irma in Florida, which followed on the heels of Harvey in Texas, Mitrani-Reiser said that NIST had to evaluate deployments to Harvey knowing that IRMA deployments also might happen in the near future. That played an import role in the decision making. In addition, FEMA gave NIST Mission

Assignments to provide wind field maps (provided by ARA under contract) for Hurricanes Harvey, Irma, and Maria. These maps allowed for comparisons of actual and design wind speeds: the actual wind speeds were near the design wind speed in US Virgin Islands (USVI), but were lower than the design wind speeds in Florida.

Mitrani-Reiser reported that approximately 7-8 months earlier, she had restarted the Disaster Working Group (DWG) at NIST with representation from nearly every group in the Engineering Laboratory (EL) as well as safety, legal affairs, public affairs, congressional affairs, and contracting representatives. Consequently, all key parties at NIST already were well engaged and understood the issues. When Harvey and Irma happened, it was easy to get feedback by calling a DWG meeting. That provided ideas about what NIST could learn from Irma, in the context of the investigation as well as the staff's other ongoing and planned work. The Advisory Committee already had recommended that NIST consider ways to focus its investigations more tightly, and Mitrani-Reiser told members that the agency did that through the DWG. She gave as an example a decision to consider solar panel connections as well as infrastructure systems in the deployments.

NIST sent two teams of four staff each to Florida (lower Keys and southern Florida). These were multidisciplinary. For example, NIST recognized that economists have a very different perspective on disasters, so they were incorporated into the teams.

In addition, 40 people were at NIST supporting the teams; they became a virtual team. Where it is sometimes especially challenging to conduct some of the data gathering and work while in the field (e.g., providing a map), the home team can do that easily.

Mitrani-Reiser stressed that there are many opportunities for cross-pollination and support across NIST. Moreover, due to advance relationship building, there has been a lot of cooperative work with other agencies. Aerial photography provided by NOAA is an example of the benefit of those relationships.

Texas/Hurricane Harvey Preliminary Reconnaissance

Averill reviewed the Hurricane Harvey storm track and intensities and the on-the-ground damage (including structures and autos). There are widely variable loss projections, he said, but it will be one of the highest dollar loss events in U.S. history. NIST's deployment was coordinated and conducted with the FEMA Pre-MAT team.

Averill told the Committee that two NIST teams deployed because the hurricane had become two different kinds of events. Winds in the Rockport area were a great concern, and they were accompanied by 14-16 in. of rainfall and storm surges. NIST needed to get a team there quickly before repairs were made. Their focus was on understanding why certain structures failed.

Houston was mostly a flood rather than a wind event; it experienced 30-52 in. of rainfall over a 5-6 day period. In that area, the NIST team needed to wait until the storm waters moved out. West Houston was selected for the team's focus, and it

joined up with universities and a private contractor (ARUP). That area was selected in part because it included two reservoirs that were intended to protect Houston from flooding. In West Houston, where the cause of building failures was clear, the NIST team was interested primarily in better understanding the resilience aspects and community recovery.

Mitrani-Reiser led the home team for the staff deployed in Texas, Averill reported. He provided details about the teams' activities and its initial observations about damage. [[See presentation slides.](#)]

Decisions about potential subsequent deployment to Texas will be made once observations from Irma — and possibly Maria, which did damage in the USVI and Puerto Rico — also are available. In each deployment, Averill noted, NIST has an opportunity for team members to evaluate field protocols.

Q. Isenberg asked whether NIST had collected any data that would shed light on the impact and wisdom of the mayor's non-evacuation orders.

A. Averill reported that simply by walking around and doing observations, team members gathered anecdotal local perspectives — but they did not gather enough data to provide any systematic assessments of this issue. He said that this issue is on the table for a possible systematic study if NIST re-deploys.

Center of Excellence (CoE) for Risk-Based Community Resilience Planning

John van de Lindt and Walter Peacock provided an overview of the NIST-funded CoE's field study in Lumberton, NC. The CoE's field studies are community resilience-oriented versus disaster-driven. Van de Lindt reviewed CoE's three thrusts and then focused on the Center's field studies and how they supported the center's larger work. The CoE looks at key metrics that require field study data, as well as metrics that do not require field study data. In all cases, these data support the validation of CoE models. [[See presentation slides.](#)]

Peacock reported that more than two dozen individuals from CoE-affiliated institutions and NIST participated in the field study of Lumberton, which suffered extensive damage in October 2016 from flooding caused by Hurricane Matthew. He provided additional details. The CoE field study leads wanted to combine both social science and engineering components in a field study, and they were able to achieve that goal. The study team looked at both heavily and lightly/non-flooded areas. Van de Lindt and Peacock also reviewed other aims of CoE/NIST collaborative field studies.

Q. Croce asked about the long-range goal of the CoE.

A. Van de Lindt explained that for the CoE, the underlying objective is to develop the science that explains community resilience. At the same time, the Center is developing the IN-CORE model to improve future studies as the science develops.

Q. Croce followed up and asked whether the CoE expects to become involved with a potential model resilience code.

A. Van de Lindt said that right now, codes and standards addressed single buildings and structures. At some point the CoE expected to draft something more expansive and on a community scale with a resilience focus. The exact timing remains to be determined. Also, the Center might choose to address this either by sector or at the community level.

Q. DesRoches asked whether the CoE was leveraging others' efforts in developing IN-CORE.

A. Van de Lindt confirmed that the Center had taken that approach and was trying not to reinvent the wheel. He said, however, that if the CoE incorporated work by others, it will want to validate and potentially update that work.

VII. Fire Research Program Updates

Bryner reviewed recent fires in buildings under construction as well as the Grenfell Tower fire in London. [\[See presentation slides.\]](#)

Bryner remarked on the number of structural fires under construction that resulted in extensive property damage but relatively few civilian deaths. He reviewed the series of large (block-sized) urban fires. He told the Committee that it was difficult to do investigations of these fires because there is not much left to study. Bryner noted that building and fire codes are designed to protect life, not property. Protections in buildings under construction are not activated until the property is occupied.

Bryner then provided detailed information about the Fuse 47 apartment fire in College Park, MD. There were many unresolved issues, including how the fire spread to the attic space and speculation about whether fire barriers in the attic would have limited spread. Fire sprinklers were installed but not yet operating at the time of the fire. Bryner reported that townhouses have fire barriers in place during construction, but apartment units have few barriers in place while they are being built.

Bryner summarized the fire at the Grenfell Tower in the North Kensington area of West London. NIST had not investigated this fire, and Bryner noted that the type of fascia materials used there are not permitted under current U.S. codes. Moreover, no UK authorities requested NIST's assistance. He reported that the building's window frames had been replaced using vinyl, which may have contributed to the aggressive fire spread. There are at least 400 similar structures in London. The building relied on a single stairwell, another design feature not permitted under U.S. codes.

VIII. Appreciation for Departing Members

Harary expressed NIST's special appreciation for three members of the Advisory Committee whose terms conclude after several years of service: Isenberg, Croce, and Quiter. He presented each with a certificate of appreciation to note their work while members of the Committee.

IX. NCSTAC Discussion: Information Requested By the Committee

Mitrani-Rieser reviewed the Committee's previous requests and provided additional details of how NIST addressed the issues. In several instances she reiterated Harary's earlier responses to the Committee report and the ensuing discussion. [[See presentation slides.](#)]

Criteria for deployment teams and potential growth

Committee Members earlier had several questions and initial observations regarding recommending criteria for deployment teams: What are the difficulties in getting people on the team now, and are there gaps in expertise? Does NIST see areas where investigations could grow and where they could make a greater impact?

She stressed the value of the Disaster Working Group (DWG) at NIST, which she has re-energized. She described the virtual team approach when deploying for a disaster event; among other things, virtual teams provide an opportunity to train junior staff in field deployments and to tackle multidisciplinary questions across NIST, bringing greater impact.

Mitrani-Reiser also pointed to the Fuse-47 fire deployment as an example of a pilot study for a potential NCST area of growth: chronic events. This is something that NIST will be paying greater attention to in the future.

Looking back at previous NIST deployments

The Committee had asked whether the deployment process could be improved by studying past investigations before NCST was in place and suggested that reviewing about a dozen investigations might be appropriate in terms of assessing scope and expertise. The Committee requested a listing of the principal investigator of each prior investigation of the type that would qualify for an NCST investigations if those incidents were to occur in the future.

Mitrani-Reiser reviewed a selection of past NIST failure investigations, ranging from the 9/11 airliner crash into the Pentagon and two major tornadoes, a hurricane, two earthquakes, a nightclub building fire, and the collapse of an apartment building under construction. She noted the NIST leads for these projects and their backgrounds and said that the agency has a broad range of expertise — but reiterated that in-house expertise will not be the deciding factor.

Safety procedures

The Committee had asked for a copy of the First Level Hazard Review (FLHR) for failure study deployments in order to review and comment on the current NIST safety procedures for National Construction Safety Teams. This should include the DFS SOP as it is a part of the FLHR.

Mitrani-Reiser reviewed safety procedures, citing the extensive manual of procedures, and advised the Committee that NIST has in place a Hot Team with

NCST credentials that is always on stand-by for deployment. Members of this team are expected to be current on safety training at all times. She emphasized the value of making sure that staff regularly check-in with their supervisors regarding the status of their safety training and preparedness. One current procedure is to provide deploying team members with a one-page description of safety-related threats and issues that they may encounter in the field.

Q. Referencing the recent reconnaissance deployments to Texas and Florida, and some of the early information shared with the Committee, DesRoches said that it would be very helpful to document how lessons learned during any deployment had made an impact on mitigating certain types of problem issues.

A. Averill said that this was a very good observation that would apply primarily for actual investigations. He said that NIST needed to be sure that conclusions were based on information gathered from valid sampling. If NIST decides to return to Houston to conduct a more in-depth deployment, the agency would want to take that approach so that NIST could document what appeared to work in terms of building performance and what did not work well. Mitrani-Reiser added that FEMA looks at these sorts of things in the field and that NIST's ability to collaborate with them will help in assessments made during reconnaissance deployments as well as from longer term studies.

Q. Sutton asked whether NIST had included a focus on emergency communications, alerts, and warnings in its review of fires in buildings under construction or the Grenfell fire.

A. Bryner responded that since the Fuse-47 building was not yet occupied, there were no alerts. He suggested that it might be more useful to examine the evacuation of a senior citizen home across the street from Fuse-47 in light of issues regarding pros and cons of such evacuations of difficult-to-move occupants.

Q. Klein raised the issue of whether NIST might recommend that codes and standards be strengthened to cover buildings prior to occupancy.

A. Nelson pointed out that NFPA has a standard for buildings under construction, although it might not always be implemented. He suggested that there may be opportunities for improvement there — and that the ICC might well be receptive if the science can be done, and its effectiveness can be demonstrated.

Q. Croce said that he was stunned by the devastation in Joplin. He congratulated NIST for making significant progress but remained concerned about the pace of that progress; he urged that NIST do what it could to move things along more quickly. He requested NIST to look at the whole process from the start of its investigation to the time when it made recommendations. Croce suggested issuing interim reports or perhaps just findings before recommendations were proposed if that would speed the process.

A. Mitrani-Reiser noted NIST's close collaboration with FEMA and its Mitigation Assessment Team (MAT) program was designed to issue reports very quickly. Co-deploying and participating as part of their MAT activities, NIST has an opportunity to quickly issue information based on its work in the field. She said that it is

important to leverage the work of others and to manage expectations. Mitrani-Reiser also referred to the Advisory Committee's recommendation regarding more targeted investigations and agreed that if the scope of NIST's work was more tightly focused, the agency could work more quickly. She said that NIST was focusing on that approach now. Averill added that there is precedent for issuing interim reports to keep the public updated. That includes several reports issued to the Committee and subsequently made public. At the same time, he said, NIST does not want to lose something that NCST investigations have contributed; all NCST investigation reports have advanced the state of the art and laid the foundation to effect important changes. Levitan noted that in the Joplin investigation, NIST published its investigation plan and then an observation report. Phan said that in terms of time to achieve implementation of recommendations, NIST needs to work with the appropriate standards developing organization (SDO), and that was out of the agency's control. He gave as an example the 10-year time for the NWS to adopt changes in the tornado F and EF scale.

Q. Corotis suggested that there appeared to be a potential conflict for the agency's officials regarding their decisions about whether or not to launch an investigation since there were no resources specifically set aside for these deployments and all of the involved staff would have other projects to carry out. He asked about ways to address this issue that would relieve that natural tension.

A. Harary said that he, Mitrani-Reiser, and others had discussed this issue recently, and he assured members that resource availability would never interfere with his decisions about whether or not to launch an investigation; he pledged to make necessary funds available. Mitrani-Reiser noted that part of reinvigorating the DWG at NIST is engaging everyone before deployment so that she, as Director of the DFS program, can understand their research interests. She said that the goal is to reinforce individuals' responsibilities rather than distract them from their areas of research interest.

Q. Corotis agreed with this approach and stated that it would not be wise to wait until Congress acts.

A. Harary said that NIST had the IDIQ contract tools available. He noted that in case of a national emergency, FEMA can reach out to any federal agency and direct that organization to do something specific. This is exactly what happened during Hurricane Irma when NIST was asked to generate wind field maps within a matter of days. NIST mobilized its DWG and was able to push through a procurement action quickly to get those maps drawn so that FEMA could allocate resources for the mitigation assessment.

Q. Isenberg asked whether Congress had provided NIST funding explicitly for any particular investigations.

A. Averill reported that Congress appropriated \$16 million to FEMA with the direction to transfer those funds to NIST for the World Trade Center investigation.

Q. Corotis asked for assistance in accessing previous Commission-related NCST reports and other documents.

A. Mitrani-Reiser reported that all documents are online, and provided Committee members with an orientation to the relevant website.

X. NCST Advisory Committee Preparation of Annual Report and Adjournment

The Committee reviewed the day's presentations and discussions and produced a near-final draft with final text on the key issues and recommendations. The Chair was charged by the Committee with final formatting of the report.

Quiter thanked members for their participation and closed the meeting at 5:00 p.m.