

**National Construction Safety Team (NCST)  
Advisory Committee Meeting Summary**

**National Institute of Standards and Technology (NIST)  
Gaithersburg, Maryland  
May 16, 2018, at 1 pm EST  
(meeting conducted via teleconference)**

**Advisory Committee Members:**

James R. Harris	J. R. Harris and Company
Jeanette Sutton	University of Kentucky
Bill Holmes	Rutherford & Chekene
Gary Klein	Wiss, Janney, Elstner Associates, Inc.
Reginald DesRoches	Rice University
Ross Corotis	University of Colorado, Boulder

**NIST Representatives**

Howard Harary	Director, Engineering Laboratory, Designated Federal Officer
Jason Averill	Chief, Materials and Structural Systems Division
Judith Mitrani-Reiser	Director, Disaster and Failure Studies Program
Erica Kuligowski	Lead Investigator, Hurricane Maria NCST
Joe Main	Associate Lead Investigator, Hurricane Maria NCST
Melissa Lieberman	Deputy Chief Counsel
Marc Levitan	Structural Research Engineer, Structures Group
Scott Weaver	Director, National Windstorm Impact Reduction Program
Chris Currens	Senior Advisor, Materials and Structural Systems Division
Benjamin Davis	Management & Program Analyst, NCST
Carmen Martinez	Information Technology Specialist, Engineering Laboratory
Steve Potts	Management & Program Analyst, NWIRP

**Registered Public Attendees**

Oswaldo Urdapilleta	Salma Consulting
Jazmine McCallister	Summit Consulting
Heather Brotsos	Summit Consulting
Zoe Rodriguez	Office of the Senate of Puerto Rico
Carmen Feliciano	Office of the Senate of Puerto Rico
Chris Clavin	Science and Technology Policy Institute

## Summary of Discussions

### I. Welcome and Opening Remarks

Dr. Howard Harary welcomed and thanked the participants. He stated that the NCST Advisory Committee (NCSTAC) helps us plan an effective and impactful program to assess building performance, emergency response, and evacuation procedures, carry out investigations conducted under the authorities of the NCST Act, and determine the cause or causes of structural failures in structures. It is important to note that NCST investigations are not about finding fault, responsibility or negligence. The Act gives NIST the authority to access the site of a building disaster, access key pieces of evidence such as records and documents, and move, preserve, and if necessary, subpoena evidence. The statutory responsibilities of the NCSTAC include advising the NIST Director on carrying out the NCST Act, reviewing the procedures for the establishment and deployment of a team to conduct an investigation under the Act, and reviewing the reports produced by the NCST.

Committee Chair, Dr. Jim Harris, stated that the purpose of the meeting is to be briefed on what's been accomplished thus far, and review the planned future work for the Hurricane Maria NCST focused on Puerto Rico (PR). He also remarked that Committee members that have comments will be communicating as individuals today. If any items need to be communicated as an Advisory Committee recommendation, arrangements for that will be provided by NIST as we conclude the meeting.

### II. Presentations

#### Overview of Preliminary Observations and Investigation Goals – Dr. Judith Mitrani-Reiser

Dr. Mitrani-Reiser presented: an overview of NIST's history in studying and investigating disasters; the NCST scoring and process flow for recommending NIST field activities in response to disaster and failure events; and preliminary observations made by a NIST preliminary reconnaissance team sent to Puerto Rico after Hurricane Maria.

[https://www.nist.gov/sites/default/files/documents/2018/05/17/01\\_ncstac\\_preliminary\\_observations\\_and\\_investigation\\_goals.pdf](https://www.nist.gov/sites/default/files/documents/2018/05/17/01_ncstac_preliminary_observations_and_investigation_goals.pdf)

#### Key Points of the Presentation:

- NIST cannot deploy to every disaster and building failure event. NIST uses scoring criteria and prescribed process flow to inform decisions on deployments to disasters and failure events. The process flow includes a quantitative and qualitative assessment of the event to determine if deployment thresholds are met and if resources (personnel and financial) are available to deploy.
- If deployment thresholds are not met, or NIST does not have authority to investigate, the scoring is filed for record keeping purposes. If the scoring criteria indicate that an investigation is warranted, a preliminary reconnaissance deployment is recommended to the EL Director.
- Once the preliminary reconnaissance is complete, the NCST scoring criteria are re-evaluated based upon initial observations. If the updated evaluation indicates that an NCST deployment is warranted, then the EL Director makes a recommendation to the NIST Director to invoke the NCST Act. The NIST Director determines if it is appropriate to invoke the NCST Act.

- If an NCST technical investigation is not warranted, NIST either creates an archive of the observations made by the preliminary reconnaissance team or may follow up by conducting a research study (under the Organic Act or other authority) of the event.
- The Disaster and Failure Studies program currently has multiple active studies, but Hurricane Maria is the only NCST event.
- Hurricane Maria was not just a wind event, there was also extensive rainfall (max of 38") and several landslides. Maria was the most severe hurricane to hit Puerto Rico in decades.
- The entire island (total population is approximately 3.3 million) was exposed to Hurricane Maria's hazards, and as of Dec. 9, 2017, 64 deaths have been officially attributed to Hurricane Maria. The New York Times and other news organizations estimate the actual death toll could be over 1,000.
- Four NIST researchers were deployed to Puerto Rico, including one (Dr. Levitan) formally embedded with FEMA. The team's activities were prioritized based on statutory requirements (NCST and NWIRP) and current research goals (e.g., community resilience) of the Materials and Structural Systems Division in the Engineering Laboratory.
- Multiple social dimensions of communities, including the economy, health, emergency management, education, and other sectors were prioritized in the field. The goal was to interview stakeholders in Puerto Rico that cover the breadth of the scales relevant to communities impacted by disasters: local (municipal), state (commonwealth), and federal.
- The team deployed to the most eastern third of the island, where the hurricane made landfall and where the most significant damage was expected.
- The NIST Director established a Team under the National Construction Safety Team (NCST) Act on February 21, 2018, to conduct a technical investigation of the effects of Hurricane Maria on the U.S. territory of Puerto Rico. The objectives of the investigation are to characterize the following:
  - (1) the wind environment and technical conditions associated with deaths and injuries;
  - (2) the performance of representative critical buildings, and designated safe areas in those buildings, including their dependencies on lifelines; and
  - (3) the performance of emergency communications systems and the public's response to those communications.

Dr. Mitrani-Reiser noted that the overall breadth of NIST activities is quite wide. There are other authorities that NIST can act under, including the National Earthquake Hazards Reduction Program (NEHRP), and the National Windstorm Impact Reduction Program (NWIRP). This was mentioned because NIST may be engaged in other activities that do not exclusively fall under the NCST Act, but still related to Hurricane Maria. The team proposes to study impacts to critical social functions, including education, healthcare, and business recovery. The team will also focus on power loss, road closures, and supply chain obstacles that were encountered as a result of Hurricane Maria.

## Questions:

Q. Dr. Harris stated that this investigation is an opportunity to look at topographic factors in ASCE-7 (American Society for Civil Engineers' *Minimum Design Loads For Buildings and Other Structures*) concerning hurricanes and islands with rough topography. He asked if NIST has planned to accomplish any of this.

A. Dr. Mitrani-Reiser responded that the Committee will see a presentation on this topic by the Associate Lead Investigator shortly.

Q. Dr. Harris asked if NIST is considering potential problems and failures of power distribution systems when looking at the performance of the overall power electric network.

A. Dr. Mitrani-Reiser responded that NIST would like to characterize the power network failures and better understand the timeline for power restoration, especially as it related to building system failures and continuity of building operations, respectively. The performance of distributed lifelines is underpinning all of our investigation goals.

Q. Mr. Holmes remarked on the difference between 64 deaths and the 1,000 deaths mentioned in the presentation, and asked if the 64 deaths were from crushing and other injuries?

A. Dr. Mitrani-Reiser responded that the team is trying to understand how fatalities are characterized in disasters, and specifically identify those directly caused by building and/or building system failures. It is very challenging to attribute a death in a disaster event, especially indirect deaths. NIST will present to the Committee on these challenges shortly during the meeting.

Q. Dr. Sutton referred to the NIST Community Resilience Planning Guide slide of the presentation and asked how the communications infrastructure and the resilience of the community are being studied? She asked how the immediate response and the ongoing recovery phases of the disaster relate to the social and infrastructure aspects of resilience.

A. Dr. Mitrani-Reiser responded that the Lead Investigator would provide an answer and a detailed presentation to the Committee shortly after.

Dr. Kuligowski noted some ways that NIST will address this general topic:

- 1) review emergency communications received before and during the event, and assessing the interactions between emergency responders and the public following the event;
- 2) identify the instances and sources of any lack of communication between the public and emergency responders;
- 3) Identify the technical causes of failures in the physical communication infrastructure.

Dr. Levitan added that NIST will be focusing on the physical damage of wireless communications to determine what was responsible for the loss of widespread communications across the island. There are more issues that need to be identified than just the loss of power, and NIST is trying to discern all the issues involved and how best to address them.

Dr. Main presented: an overview of hazards associated with Hurricane Maria, effects of topography on wind speed, and plans to characterize the wind environment using measurements, modeling, and experiments.

[https://www.nist.gov/sites/default/files/documents/2018/05/17/02\\_ncstac\\_preliminary\\_project\\_plan\\_for\\_characterization\\_of\\_hazards.pdf](https://www.nist.gov/sites/default/files/documents/2018/05/17/02_ncstac_preliminary_project_plan_for_characterization_of_hazards.pdf)

Key Points of the Presentation:

- The primary focus of this project will be to characterize the wind environment, including topographic effects, and to document other hazards associated with the hurricane including, storm surge, rainfall, flooding, and landslides.
- Characterizing the hazard will help identify what may have led to the deaths and injuries, the loads on and subsequent performance of critical buildings and designated safe areas, and the dependence of critical buildings on distributed lifelines.
- An initial model will be developed, and a more detailed model will follow to address topographical effects.
- NIST will reach out to and coordinate with other agencies such as NOAA, NASA, and USGS to document other hazards associated with the hurricane. Puerto Rico has a significant mountainous topography, which can result in a significant speedup of winds.
- ASCE 7-16 applies only to isolated topographic features. Extensive wind tunnel studies have been conducted in Hawaii to quantify these effects.
- Both spatial and temporal variability of hazards will be considered. Specific questions that will be explored include: "How long was a building subjected to wind-driven rain?"; "What buildings experienced heavy rain and strong winds at the same time?"; "Did the interaction of storm surge and rain-induced flooding of rivers result in loss of life?"
- Other agencies with relevant data sources and modeling capabilities for hazard characterization will be identified.
- Plans will be developed for in-house modeling of topographic effects using computational fluid dynamics (CFD).

**Questions/Comments:**

No questions were asked about this portion of the presentation.

**Preliminary Project Plan for Mortality Study – Dr. Judith Mitrani-Reiser**

Dr. Mitrani-Reiser presented: the challenges with attributing deaths (directly or indirectly) to disasters, an overview of current mortality assessments, and a preliminary project plan for characterizing deaths and injuries associated with building and/or building system failures.

[https://www.nist.gov/sites/default/files/documents/2018/05/17/03\\_ncstac\\_preliminary\\_project\\_plan\\_for\\_mortality\\_study.pdf](https://www.nist.gov/sites/default/files/documents/2018/05/17/03_ncstac_preliminary_project_plan_for_mortality_study.pdf)

Key Points of the Presentation:

- The objective of this project is to complete a quantitative morbidity and mortality assessment in Puerto Rico, and to better understand how damaged buildings and supporting infrastructure played a role in the injuries and deaths associated with Hurricane Maria.
- It has been challenging to develop guidance or policy to prevent disaster attributed mortality due to the lack of standards, consistent data collection, and reporting.
- Directly related deaths are defined as a death directly attributable to the forces of the disaster or by the direct consequences of these forces, such as structure collapse, flying debris or radiation exposure.
- Indirectly related disaster deaths occur when the unsafe or unhealthy conditions present during any phase of the disaster contribute to the death.
- Death certificates are the primary source of official mortality. Death certificates are also public records. National statistics of fatalities are collected by the International Classification of Disease (ICD).
- Unfortunately, what is written on the death certificate as the cause of death can be ambiguous. There is a lack of awareness among medical professionals regarding how to appropriately attribute deaths in the wake of a disaster.
- As of December 9, 2017, the Puerto Rico Department of Public Safety certified 64 deaths. However, record keeping was challenging in the days and weeks after the storm due to loss of power.
- The New York Times and other news organizations estimate that the actual death toll could be over 1,000. Additional instances and circumstances not directly associated with the hurricane likely had impacts on deaths that occurred.
- To make recommendations for changes to, or the establishment of, evacuation and emergency response, NIST will be investigating the following:
  - determine whether a death is attributed to a direct or indirect association with Hurricane Maria;
  - determine whether a death or injury was impacted by building, or building system, failures in windstorms; and
  - develop a process to integrate epidemiology and engineering methodologies, and identify tools that better determine risk factors and predict life loss due to failures in the built environment.
- NIST plans to develop partnerships with other agencies, and establish contracts and memorandums of understanding (MOUs), as necessary, for this multidisciplinary project.
- It is expected that at least two survey tools will be used for in-depth analysis of risk factors for direct and indirect deaths and injuries.
  - 1) a building assessment tool to inform the mortality studies;
  - 2) a survey instrument for a verbal autopsy from interactions with the families of people who were directly or indirectly killed by the hurricane.
- These surveys may be conducted with sampled households. Specific questions of interests include:
  - Did the deaths occur during any of the hazard events (e.g., downed trees) associated with Hurricane Maria?

- Did the deaths occur due to unsafe conditions caused by any of the hazard events?
- Were the deaths caused by direct physical forces?
- Were the deaths caused by unsafe or unhealthy conditions?

#### **Questions/Comments:**

Q. Dr. Sutton asked if NIST could link deaths to the loss of telecommunications along with the messages that were sent before Hurricane Maria hit.

A. Dr. Mitrani-Reiser responded that yes, there is an opportunity to create these links across the investigation. We will be working with the hazard characterization, the building performance team, and the emergency communications team to inform the mortality study. We are very interested in that component of the study.

Dr. Kuligowski stated that we may not be able to make direct links, but we could identify potential contributing factors for death in cases that are not specifically linked to infrastructure failure and messaging issues.

#### **Preliminary Project Plan for Evaluation of Critical Building Performance – Dr. Joseph Main**

Dr. Main presented: an overview of building damage observed by the NIST preliminary team; a plan for characterizing the performance of critical buildings; identifying dependencies on lifelines; and a preliminary project plan.

[https://www.nist.gov/sites/default/files/documents/2018/05/17/04\\_ncstac\\_preliminary\\_project\\_plan\\_for\\_evaluation\\_of\\_critical\\_building\\_performance.pdf](https://www.nist.gov/sites/default/files/documents/2018/05/17/04_ncstac_preliminary_project_plan_for_evaluation_of_critical_building_performance.pdf)

#### **Key Points of the Presentation:**

- The objective of this project is to characterize the performance of critical buildings in Hurricane Maria:
  - (1) documenting failures of structural systems, building envelopes, and rooftop equipment, along with the resulting intrusion of wind-driven rain, interior damage, and loss of function for a representative sample of hospitals and schools;
  - (2) identifying dependencies in loss of function on lifelines;
  - (3) characterizing wind loads on building envelopes and rooftop equipment through wind tunnel testing for a subset of these hospitals and schools to correlate with observed damage; and
  - (4) evaluating the adequacy of existing selection criteria and design requirements for storm shelters.
- During NIST's preliminary reconnaissance, limited structural damage was observed in concrete-block buildings with concrete roofs, but there was wind-induced damage to non-concrete roofs on reinforced concrete and concrete-block buildings.
- Even in buildings with limited structural damage, there was extensive nonstructural damage and loss of function as a result of water intrusion through multiple mechanisms such as building

envelopes being compromised due to failures of rooftop equipment (i.e., air conditioning units blown off, leaving openings on roofs).

- Extensive damage observed in rooftop equipment and roof coverings. Rainfall formed ponds on roofs, and damage was observed to windows and doors. Wind-driven rain penetration occurred even through undamaged cladding.
- NIST will identify available data on the performance of critical buildings (e.g., hospitals and schools) during Hurricane Maria in coordination with other federal agencies.
- Other agencies have already collected a lot of data on building damage, which can be leveraged. NIST has been working with the Building Science Branch at FEMA, by deploying a NIST researcher with FEMA's Mitigation Assessment Team (MAT).
- NIST will be conducting forensic wind tunnel testing of selected critical buildings to better understand wind loads on the building equipment and the building during the storm.
- NIST will also be evaluating storm shelter criteria and design requirements. This will be a broader study to assess shelter performance and existing selection criteria.
- It should also be noted that Puerto Rico is in a seismically active zone, and any recommendations resulting from the Hurricane Maria NCST Investigation related to building performance will take this into consideration.
- For a representative sample of hospitals and schools in Puerto Rico, NIST will be identifying dependencies on lifelines. This may include characterizing critical paths in cascading failures and recovery to determine what components of the infrastructure systems are critical to the return of overall functionality of buildings.
- NIST will also document the physical performance of wireless communication systems with respect to hazard levels and applicable requirements for design and construction.
- Wind tunnel testing is planned for a subset of the sample of critical buildings, where detailed characterization of the wind loads would be warranted for evaluation of building performance.
- Building models will be instrumented to test pressures on the building envelope and wind loads on rooftop equipment; surrounding buildings and terrain will be included in area models.
- Selected tests may be repeated with varying conditions such as different configurations of rooftop equipment and with and without surrounding buildings to quantify their effect on the wind loads.
- The wind tunnel testing findings will be combined with the wind-field model to estimate wind load histories during Hurricane Maria which will be used to document the history of wind loads on the building envelope which will help evaluate building performance.
- Relevant storm shelter information will be collected and documented including:
  - the shelter selection criteria and process,
  - shelter facilities used during Hurricane Maria,
  - storm impact on the facilities including damage and any injuries or fatalities that occurred in the shelters
- This study will evaluate the performance of the shelter system as a whole. Information on the varying hazard levels experienced at the shelters will be compared to the existing code and standard requirements to make recommendations to codes and standards for shelters.

#### **Questions/Comments:**

No questions.

**Performance of emergency Communication Systems and Public Response – Dr. Erica Kuligowski**

Dr. Kuligowski presented: observation related to emergency communications from the preliminary deployment; preliminary plans for the emergency communications project, and initial overall plans for scoping and sampling for the entire investigation.

[https://www.nist.gov/sites/default/files/documents/2018/05/17/05\\_ncstac\\_preliminary\\_project\\_plan\\_to\\_study\\_emergency\\_communications\\_during\\_hurricane\\_maria.pdf](https://www.nist.gov/sites/default/files/documents/2018/05/17/05_ncstac_preliminary_project_plan_to_study_emergency_communications_during_hurricane_maria.pdf)

#### Key Points of the Presentation:

- The objective of this project is to investigate the role of emergency communications in public response for those under imminent threat from Hurricane Maria. This project also aims to investigate the use of communications in disaster response during and immediately after the hurricane event.
- NIST's preliminary reconnaissance of Hurricane Maria in Puerto Rico highlighted severe evacuation and emergency response challenges.
- NIST observed a societal preference for sheltering in place as opposed to sheltering in other locations.
- NIST will be conducting interviews and surveys in ~3-4 selected areas/locations throughout the Commonwealth. The areas/locations for these surveys should be chosen based on factors associated with public response during hurricanes such as geographical location on the island, pre-hurricane household characteristics, number of deaths and injuries that occurred, and the level of exposure to Hurricane Maria.
- Structured surveys with sampled households within each of the 3-4 areas will be conducted to collect the following information:
  - Pre-hurricane preparedness activities
  - Types of emergency information sought/received before/during the hurricane
  - Perceptions of this emergency information
  - Subsequent responses to this information (over time)
  - Information needs during/after the event
  - Challenges encountered in obtaining information during and for days after the event
- Other agencies with information on emergency communication provided to the public will be identified, and plans will be made on the best ways to reach out for more information.
- For the remainder of the fiscal year 2018 NIST will be developing sampling strategies among selected areas, creating survey and interview protocols, and obtaining Paperwork Reduction Act (PRA) and Independent Review Board (IRB) approvals required to survey the public.
- Puerto Rico contains ~3.3 million people across 78 municipalities, NIST will need to select areas of study that allow for best sampling to inform the research being conducted.
- It will be important to focus on areas that provide heterogeneity in terrain (coastal, inland, mountainous) as well as population density.
- Impact of Hurricane Maria on communities will also be considered, including areas where significant damage occurred to critical buildings such as hospitals, schools, and supporting lifelines, as well as areas where little damage occurred, and high deaths and injuries occurred.
- NIST will also consider mean income when determining regions to conduct interviews.
- There are twelve emergency management regions in Puerto Rico, and four regions have been identified that may be conducive to the study due to their heterogeneity: socioeconomic

distribution, number and types of buildings, damage to power and communication infrastructure, exposure to hazards, and the number of deaths and injuries.

#### **Questions/Comments:**

Q. Mr. Klein stated that given the large number of variables (structural damage, wind, emergency response, etc.), a quantitative study may be challenging. He asked, “How NIST will approach the analysis of the data collected?”

A. Dr. Mitrani-Reiser explained that this event is unlike any other we’ve investigated at NIST because it covers such a large geographic area. Thus, careful sampling is needed to ensure the quantitative pieces we analyze are a representative sample of what was experienced across the island. All of those aspects are taken into account during scoping and sampling of this large geographic region.

Q. Dr. Sutton asked if NIST will also collect all messages sent to the public over different channels, and if NIST will consider including National Weather Service meteorologists as well as broadcasters in their interviews?

A. Dr. Kuligowski responded that the NIST investigation will include some of the social media messages disseminated before the landfall, and that NIST will seek to collect all of the different messages sent and then create a database of that information. In reference to Sutton’s second question, the answer is yes. Dr. Kuligowski will reach out to emergency managers, the Governor, the National Weather Service, media broadcasters, and others for the information they provided to the public.

Q. Dr. DesRoches asked if crowdsourcing was used to gather damage information and data?

A. Dr. Kuligowski responded that NIST will follow up on this. At this point, NIST has not used crowd-sourced data, but maybe other agencies have done that. FEMA has a platform known as OpenFEMA, where the public can submit pictures and explain what they witnessed. It is one example of a crowdsourcing platform that would allow that kind of collaboration. Dr. Kuligowski also commented that NIST can reach out to FEMA to determine if this information was collected.

Q. Mr. Holmes commented that hospitals and schools should be kept separate. Schools are not automatically set as Risk Category IV and should not all be considered shelters.

A. Dr. Main responded that NIST agrees, and has been keeping one sample for hospitals, and another for schools. Dr. Main noted that many schools were used as shelters, and so will have another sample for schools used as shelters.

#### **Projected Impacts on Codes and Standards – Jason Averill**

Mr. Averill presented: a brief overview of the NCST Act, a summary of previous NCST investigations and recommendations, and identified areas of the current NCST investigation that may result in impactful recommendations.

[https://www.nist.gov/sites/default/files/documents/2018/05/17/06\\_ncstac\\_recommendations\\_from\\_ncst\\_investigations.pdf](https://www.nist.gov/sites/default/files/documents/2018/05/17/06_ncstac_recommendations_from_ncst_investigations.pdf)

Key Points of the Presentation:

- The purpose of this presentation is to:
  - review the statutory basis for making recommendations;
  - review prior recommendations that resulted from investigations; and
  - preview the study areas that are currently being focused on and may lead to the development of future recommendations.
- NIST is a mission-based organization, and we measure success by the level of impact.
- When a disaster occurs changes in the buildings and codes usually follows.
- The previous World Trade Center Investigation report included 30 recommendations in 8 strategic areas, which resulted in over 40 changes to codes, standards, and practices.
- NIST convened a workshop of stakeholders to consider elevator usage during building fires. It resulted in a consensus that there needed to be a community of stakeholders to develop a revised system to allow elevators to be used to get emergency responders to the site of the emergency and get people out of tall buildings more quickly. It also recognized that requirements for people with disabilities did not have equal access to building exits as they did to building entries. It resulted in changes to ASME A17.1 (the elevator code) and to the International Building Code requiring fire service access elevators, and/or occupant evacuation elevators, depending on building height.
- NIST also made a recommendation on preventing progressive collapse. NIST has worked with ASCE-Structural Engineering Institute (SEI) since 2005 to develop a draft standard which is currently in ballot review;
- NIST can have a tremendous impact from these efforts. While some recommendations achieve impact quickly, others may involve years of sustained effort.
- NIST also conducted an NCST investigation into the May 2011 Joplin Tornado event.
- The final NCST report was released in March of 2014 and included 16 recommendations.
- An important lesson learned from developing the Joplin tornado recommendations was how necessary it is to develop partnerships. Therefore, partners will be strategically identified as we progress with the Hurricane Maria Investigation.
- The implementation of recommendations is not the exclusive responsibility of NIST.
- The Committee was tasked to think about whom NIST could strategically partner with to maximize the work that will be done during the investigation and achieve the most impact.
- NIST does not pre-determine which areas will result in outcomes and will not know until the technical investigation is complete. We use the preliminary information to identify areas where adverse outcomes may produce recommendations but remain open to findings that suggest new investigative directions.
- There are currently four areas that may result in recommendations
  - Wind hazard (wind, rain, landslides, etc.) specifically wind topographic effects and the relationship between hazards and building failure modes and deaths/injuries.
  - Damage to structural systems, buildings (specifically schools and hospitals), envelopes, & building (rooftop) equipment in schools, particularly ones used as shelters and hospitals.
  - Extended loss of critical infrastructure, including communications, power, transportation, and water with a focus on schools, particularly ones used as shelters and hospitals.

- Widely varying accounts of injuries and fatalities resulting from the storm to understand the source of the variance and provide recommendations for deaths and injuries as a result of natural hazards.

### **Questions/Comments:**

Q. Dr. Sutton asked if there is a timeline for all the research being proposed?

A. Dr. Mitrani-Reiser responded that the previous investigation took 3-4 years, so that is what we are assuming at for this investigation.

[end of formal presentations]

### **Open Discussion Period**

Q. Dr. Corotis commented that these are all excellent directions, and asked how NIST will decide on the priorities and resources to do these things?

A. Dr. Mitrani-Reiser responded that everything that has been presented are things we already have resources to tackle. We have not presented anything beyond our capabilities. We may be limited in the number of buildings, so the sample may be limited. But regarding goals and scope – we have the resources.

Dr. Harary commented that this is an “all-hands-on-deck” effort. Due to the importance of this investigation, NIST leadership decided to provide a substantial amount of money for the investigation.

Q. Dr. Corotis followed up, asking if there were any results from the full-scale building test on wind that was conducted several years ago, and could that guide this investigation?

A. Dr. Levitan responded that as part of the NWIRP program and our role in post-windstorm coordination, NIST reached out to FEMA and HUD who focused on the performance of manufactured homes in multiple hurricanes this past Fall, but there are very few of these structures in Puerto Rico.

Q. Mr. Holmes stated in connection with the last comment, there is a National Science Foundation program called the Natural Hazards Engineering Research Infrastructure (NHERI) with impressive experimental wind facilities, and asked if the NIST investigation will coordinate with them.

A. Dr. Main replied yes, we are aware of the experimental facilities at the University of Florida (UF), including their wind tunnel, which has unique capabilities controlling terrain and high-resolution measurement. We are also coordinating closely with FEMA since they have similar interests in understanding the wind environment for immediate recovery.

Q. Mr. Holmes added that it is widely reported that the infrastructure in Puerto Rico was in very poor condition and it is unclear how much of that contributed to ongoing issues. It is clear that the U.S. cannot immediately make everything new again. It seems like NIST will have to prioritize recommendations so that communities can move forward gradually.

A. Dr. Main responded that part of the reason NIST is looking at hospitals and schools is to focus on engineered buildings, which have similar design criteria across the U.S.

Dr. Mitrani-Reiser added that NIST is in preliminary planning stages, and feedback from the Committee is very important.

Dr. Harary commented that we wanted to have this meeting in the early phases of the investigation to get your feedback.

Q. Dr. Sutton asked if there would ever be an interest or need for Advisory Committee members to travel to Puerto Rico to observe part of the investigation?

A. Dr. Mitrani-Reiser responded that there may be a conflict, and this practice was not used in previous investigations. She offered to follow up with the Ethics Officer of the Department of Commerce to more fully answer the question.

Q. Dr. Harris asked if NIST could provide a brief document that summarized the slides, or send the slides out?

A. Dr. Harary responded that the slides will be posted by COB. He suggested that if the Committee wants to develop any consensus comments based on that, we would need another meeting, and would have to announce it in the Federal Register to be transparent.

Dr. Harris encouraged Committee members to speak out if they disagree with what any of us are saying. He clarified that these should be considered individual comments, and that what he heard is that most comments are already being incorporated into the investigation.

Dr. Harary responded that what he heard were clarification questions, which do not need to be considered individual comments.

Q. Dr. Harris asked if any of the Committee wanted to make a Committee consensus comment?

A. Hearing no response, Dr. Mitrani-Reiser added that there will be an in-person meeting on August 30, 2018, so there will be another opportunity for the Committee to have meaningful conversations and provide feedback for us to incorporate into the investigation process.

[end of the open discussion period]

Dr. Harris commented that he appreciates the planning NIST is putting into this investigation. It appears that NIST is going after the things that will benefit the U.S. as a whole. NIST is identifying topics of interest that have similarities between construction and emergency response in Puerto Rico and the rest of the country. He commended NIST for focusing on those areas.

Dr. Harary thanked Dr. Harris for those comments and noted there had been a lot of hard work by the people here around the table.

### **III. Public Input period**

No comments were offered, and this portion of the meeting was closed.

### **IV. Closing Remarks and Adjournment**

Dr. Harris asked if there were any other comments from the Committee? None were offered.

Dr. Harary thanked everyone again for advising NIST. He reiterated that this Program includes every level of NIST, up to Director Walter Copan, who has provided the resources to make this happen. We are all aligned and committed to producing a high-impact investigation.

The meeting adjourned at 3:35 pm.