

**National Institute of Standards and Technology
National Construction Safety Team Act
Annual Report
Fiscal Year (FY) 2017**

Summary

This annual report to Congress for Fiscal Year (FY) 2017 is required by the National Construction Safety Team (NCST) Act (Public Law 107-231). The National Institute of Standards and Technology (NIST) did not undertake any new NCST investigations, nor did it continue any NCST investigations in FY 2017.

In FY 2017, NIST deployed preliminary reconnaissance teams to Maryland, Texas, and Florida, in response to an apartment complex fire, and Hurricane Harvey and Irma, respectively. NIST is continuing to implement the recommendations to develop consensus standards and code provisions related to progressive collapse from the World Trade Center Investigation (September, 2005).¹ NIST is also implementing the 16 recommendations in the Joplin tornado investigation final report (March, 2014).² Highlights of FY 2017 activities include:

- Conducted preliminary field studies to collect data for the listed hazard events;
- Made significant progress on the development of tornado hazards maps;
- Contributed to building safety considerations and emergency communications to the new National Fire Protection Association (NFPA) Standard for Mass Evacuation and Sheltering (NFPA 1616);
- Contributed to an annex by NIST on community-wide public alerts and warnings in rapid-onset emergencies, which was approved for inclusion in the NFPA 1600 Standard on Disaster/Emergency Management and Business Continuity/Continuity of Operations Programs; and
- Published a new Commentary on the International Code Council's (ICC) Standard for the Design and Construction of Storm Shelters (ICC 500-2014), developed by NIST in collaboration with the Federal Emergency Management Agency (FEMA) and other members of the standard committee.

Additionally, NIST held one meeting of the NCST Advisory Committee (AC) during FY 2017. The meeting³ was held at NIST on September 28, 2017. In this meeting, NIST briefed the AC on:

- progress of NIST implementation of the Joplin tornado investigation recommendations;
- hazard and failure events scored using the preliminary reconnaissance screening criteria;
- updates on the readiness of its NCST team; and
- observations from preliminary deployments to Maryland, Texas, and Florida in response to an apartment complex fire, Hurricane Harvey, and Hurricane Irma, respectively.

A summary of the discussions at this meeting may be found in the FY 2017 Annual Report of the NCST AC to Congress.⁴

¹ Report available at: http://www.nist.gov/customcf/get_pdf.cfm?pub_id=909017

² Report available at: http://www.nist.gov/customcf/get_pdf.cfm?pub_id=915628

³ Meeting summary available at:

https://www.nist.gov/sites/default/files/documents/2017/10/17/ncstac_meeting_summary_9-28-17_1.pdf

⁴ FY 2017 NCST AC Report to Congress available at:

https://www.nist.gov/sites/default/files/documents/2018/01/02/ncst_advisory_committee_2017_report_to_congress_final.pdf

Introduction

In October 2002, the NCST Act was signed into law by President George W. Bush and authorized the Director of NIST to establish and deploy teams to investigate events leading to failure of a building or buildings that result in substantial loss of life or that pose significant potential for substantial loss of life.

The purpose of these investigations is to improve the safety and structural integrity of buildings in the United States. A team shall:

1. Establish the likely technical cause or causes of building failure;
2. Evaluate the technical aspects of evacuation and emergency response procedures;
3. Recommend as necessary, specific improvements to building standards, codes, and practices based on the findings made pursuant to (1) and (2); and,
4. Recommend any research and other appropriate actions needed to improve the structural safety of buildings, and improve the evacuation and emergency response procedures, based on the findings and recommendations of the investigation.

Under Section 10 of the NCST Act, NIST is to provide an annual report to the House Committee on Science, Space, and Technology and to the Senate Committee on Commerce, Science, and Transportation each year. This report is to include:

1. A summary of the investigations conducted by teams during the prior fiscal year;
2. A summary of recommendations made by the teams in reports issued under Section 8 of the NCST Act during the prior fiscal year and a description of the extent to which those recommendations have been implemented; and
3. A description of the actions taken to improve building safety and structural integrity by the NIST during the prior fiscal year in response to reports issued under Section 8 of the NCST Act.

This report summarizes NIST's activities under the NCST Act for FY 2017 as required by Section 10 of the Act.

1. Investigations Conducted Under the NCST Act during FY 2017

During FY 2017, NIST neither undertook nor continued any investigations under the NCST Act.

2. Summary of Recommendations Made by Teams in Reports Issued Under Section 8 of the NCST Act during FY 2017

During FY 2017, NIST did not issue a report under Section 8 of the NCST Act.

3. Actions Taken to Improve Building Safety and Structural Integrity During FY 2017 in Response to Reports Issued Under Section 8 of the NCST Act

During FY 2017, NIST convened one meeting of the NCST Advisory Committee (AC). The meeting⁵ was held at NIST on September 28, 2017. In this meeting, NIST briefed the AC on:

- progress of NIST implementation of the Joplin tornado investigation recommendations;
- events scored using the preliminary reconnaissance screening criteria;
- updates on NIST efforts towards enhancing the readiness of teams; and
- observations from preliminary deployments to Maryland, Texas, and Florida in response to an apartment complex fire, Hurricane Harvey, and Hurricane Irma, respectively.

a. Actions Related to Report on the NIST World Trade Center Investigation:

In its *Final Report on the Collapse of the World Trade Center Towers*,¹ NIST recommended that “progressive collapse be prevented in buildings through the development and nationwide adoption of consensus standards and code provisions.” In FY 2012, based on a proposal from NIST, a new American Society of Civil Engineers (ASCE) Structural Engineering Institute (SEI) Standards Committee called the Disproportionate Collapse Mitigation Standard Committee was established. This voluntary standards committee is currently developing a standard, with substantial contributions from four NIST staff who are informing the standard with the results of NIST research. The draft standard was in the first round of balloting by the committee in March 2017, and is expected to move into the second round in FY 2018.

b. Actions Related to Report on the NIST Joplin Tornado Investigation:

NIST has taken the following actions during FY 2017 to implement the recommendations to improve building safety and structural integrity. The following recommendations in the Joplin tornado investigation final report² were addressed:

- NIST continued to lead the *Tornado Working Group* within the ad-hoc ASCE committee on *Performance-Based Design for Wind Hazards*, addressing NIST recommendation #5 and supporting NIST recommendation #6 (of Recommendations Group 2, *Performance of Buildings, Shelters, Designated Safe Areas, and Lifelines*, in the final report²). The Committee is creating a performance-based framework for wind hazards, intended for inclusion in ASCE 7-22, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*.
- NIST continued developing tornado hazard maps for use in tornado-resistant design of buildings, and entered into an Interagency Agreement with the Nuclear Regulatory Commission for NIST to provide high wind analysis to evaluate the epistemic modeling uncertainties associated with the main components of the tornado map development process. NIST also awarded a grant under the Disaster Resilience Research Grants Program that will inform development of wind load design methods. These efforts directly address NIST recommendation #3 (of Recommendations Group 1, *Tornado Hazard Characteristics and Associated Wind Field*) and provide prerequisite technical underpinning for recommendations #5 and #6 (of Recommendations Group 2, *Performance of Buildings, Shelters, Designated Safe Areas, and Lifelines*, in the final report²).

⁵ Meeting summary available at:

https://www.nist.gov/sites/default/files/documents/2017/10/17/ncstac_meeting_summary_9-28-17_1.pdf

- NIST developed provisions and annex material on building safety considerations for selection of shelters for tornadoes, hurricanes, and other hazards, in the new NFPA 1616-2017: Standard for Mass Evacuation, Sheltering, and Re-entry. This effort supports NIST recommendation #8 (of Recommendations Group 2, *Performance of Buildings, Shelters, Designated Safe Areas, and Lifelines*, in the final report²).
- NIST continued to work with the ASCE SEI committee that is developing the new *Tornado Wind Speed Estimation Standard*. The American Meteorological Society (AMS) is also engaged in this effort, and the standard will be a joint ASCE/SEI/AMS document when completed. The committee, co-chaired by the National Oceanic and Atmospheric Administration (NOAA) and NIST staff, is developing standardized methods for estimating the wind speeds in tornadoes and other severe wind storms, including significant improvements to the Enhanced Fujita Scale. This activity on standards development directly addresses NIST recommendations #2 and #4, and supports NIST recommendations #1 and #3 (of Recommendations Group 1, *Tornado Hazard Characteristics and Associated Wind Field*, in the final report²).
- NIST produced Technical Note 1950, *Outdoor Siren Systems: A review of technology, usage, and public response during emergencies*. NIST staff also conducted a workshop on public alerting using short message alerting systems (e.g., Wireless Emergency Alerts and Twitter). Workshop attendees were experts in the use of short message platforms for emergency alerting purposes, and included emergency managers, public information officers, press secretaries, and government affairs managers from state and local emergency management agencies and universities, as well as warning coordination meteorologists from the National Weather Service. The purpose of this workshop was to present the previously developed preliminary guidance on short message alerts, obtain feedback on guidance feasibility, and explore research gaps in public response to short message alerts. This effort supports NIST recommendations #13, #14, and #15 (of Recommendations Group 3, *Pattern, Location, and Cause of Fatalities and Injuries, and Associated Performance of Emergency Communications Systems and Public Response*, in the final report²).
- NIST continued working on an annex on community-wide public alerts and warnings in rapid-onset emergencies prior to the Second Draft Meeting of the Technical Committee for NFPA 1600 *Standard on Disaster/Emergency Management and Business Continuity/Continuity of Operations Programs*. This effort supports NIST recommendations #13, #14, and #15 (of Recommendations Group 3, *Pattern, Location, and Cause of Fatalities and Injuries, and Associated Performance of Emergency Communications Systems and Public Response*, in the final report²).

In addition to the above actions, NOAA's National Severe Storms Lab (NSSL) made significant progress developing a new hazardous weather forecasting platform called Forecasting a Continuum of Environmental Threats (FACETs). FACETs include a grid-based, all-hazard watch/warning paradigm for communicating probabilistic threats. This effort supports NIST recommendation #16 (of Recommendations Group 3, *Pattern, Location, and Cause of Fatalities and Injuries, and Associated Performance of Emergency Communications Systems and Public Response*, in the final report²).

4. Preliminary Investigations

NIST uses a screening tool to assess the need for NCST investigations of disasters and failures that

includes the following key decision criteria: event consequences (substantial loss of life or disabling injury, significant potential for loss of life; hazard intensity; consequences to resilience), major challenges in evacuation and/or emergency response, international factors (relevance to the United States), and study impacts (safety of team; new knowledge gains; and potential impact to existing standards, codes, and guidelines). Thirteen domestic and international events were scored in FY 2017, including five hurricanes, three wildland urban interface fires, three building fires, and two earthquakes. Three of the thirteen events scored met preliminary deployment criteria in FY17 and resulted in the deployment of teams to collect preliminary data and inform recommendations for an NCST investigation. NIST deployed teams to collect preliminary data in response to three events: (1) Fuse-47 apartment complex fire in Maryland, (2) Hurricane Harvey in Texas, and (3) Hurricane Irma in Florida.

The Fuse-47 apartment complex fire occurred at approximately 9:30 a.m. (EST) on Monday, April 24, 2017, in College Park, Maryland. The seven-story apartment complex was under construction and scheduled for occupancy in the summer of 2017. The building was constructed with concrete for the first two levels and wood construction for levels three to seven. The structure was planned to have 250 apartments, retail stores, and a parking garage. The fire was first observed at the sixth and seventh floors and rapidly extended to the attic space and roof. Part of the roof collapsed, and the roads near the fire scene were closed for much of the day. The smoke resulted in the evacuation of 68 residents of a senior living facility across the street and temporary closure of the nearby University of Maryland. Construction workers were on site at the time of the fire, and all the workers were safely evacuated. Since it was still under construction, the building complex reportedly had no fire protection systems in service. Reconnaissance teams were sent to the scene of the fire on April 26, May 9, June 2, and June 8 of 2017 to meet with the local fire department and building developers and to collect preliminary data from the room of origin, the pump room, and another apartment with the same floorplan as the apartment where the fire began. Despite its serious nature, after a preliminary investigation, NIST determined that this event did not meet the criteria for an NCST investigation.

The National Hurricane Center reported that Hurricane Harvey made landfall near Rockport, Texas, at approximately 10:00 p.m. (CDT) on Friday, August 25, 2017, as a Category 4 storm, with peak wind gusts of 225 kph and a minimum pressure of 938 mb. The storm produced 0.6 to 1.2 m of storm surge between Port O'Connor and Galveston Bay, with a maximum recorded water level of 1.8 m observed in Port Lavaca. More than 1.3 m of rain fell east of Houston, which is the greatest amount on record for a single storm. A large regional area and population was exposed to multiple hazards (wind, storm surge, and inland flooding) associated with Hurricane Harvey, causing physical damage to engineered buildings, non-engineered building systems, and infrastructure networks. Houston faced emergency response challenges in flooded areas. Hurricane Harvey presented a unique opportunity to collect perishable data of buildings subject to extreme rainfall amounts over a large geographical area, and multiple hazards (wind, storm surge, and inland flooding). NIST sent two teams, totaling eight NIST staff, to collect perishable data along the coastline (where the highest wind speeds were recorded), and in Houston (where severe inland flooding occurred). The teams collected data on: (1) the performance of building envelopes subject to sustained 145 to 225 kph winds for a variety of structure types; (2) the performance of structural systems and materials; (3) the performance of photovoltaic systems attached to structures; and (4) the availability of public hazard information and the effectiveness of emergency communications in producing protective actions by citizens. Although outside the time scope of this report, despite its serious nature, after preliminary investigation, NIST determined that this

event did not meet the criteria for an NCST investigation.

Hurricane Irma made first landfall on Cudjoe Key, Florida, at approximately 9:00 a.m. (EDT) on Sunday, September 10, 2017, as a Category 4 storm, with max peak wind gusts of 209 kph and a minimum central pressure of 929 mb. The second landfall occurred at about 3:00 p.m. on the same day as a Category 3 storm near Marco Island, Florida. The storm generated the most Accumulated Cyclone Energy (ACE) by a tropical cyclone on record in the tropical Atlantic. The storm produced 1.2 to 1.8 m of surge in some areas of the Keys and in parts of Fort Myers and Naples; the surge was less than expected because the storm moved inland before hitting the west coast of Florida. The storm diameter for tropical storm winds was 483 km, nearly twice the width of the State of Florida. The storm caused minimal physical damage to engineered buildings, moderate damage to non-engineered building systems, and severe physical damage to some infrastructure networks (two thirds of customers in the State of Florida lost power) in both the East and West coast of South Florida, as well as evacuation and emergency response challenges. In all, 72 deaths in Florida were attributed to Hurricane Irma. NIST sent two teams of four staff members to collect perishable data in the Florida Keys (where the highest wind speeds were recorded), and in South Florida (where damage was identified in areas with recorded wind speeds below design levels). The teams focused on collecting data on: (1) the physical damage to buildings, including dependencies on failed infrastructure; (2) challenges in the emergency response due to loss of function of critical facilities, including public safety facilities (fire, police, and emergency response) and long-term care facilities; (3) evacuation prior to storm landfall (in Florida, alone, officials issued a mix of mandatory and voluntary evacuation orders to 6.5 million residents); and (4) heterogeneity in building stock and in adoption of codes, standards, and practices. Although outside the time scope of this report, despite its serious nature, after preliminary investigation, NIST determined that this event did not meet the criteria for an NCST investigation.

The remaining events did not meet the criteria for a preliminary deployment for one or more of the following reasons: no clear study objectives that would impact standards, codes, and practices; unsafe conditions for NIST investigators; no primary authority or in-house expertise of hazard type; construction practice and codes for international events are not similar to those used in the U.S.; no new lessons would be gained; or minimal impact to building occupants.

One international event—a fire of a 24-story building that resulted in 71 fatalities—scored above the necessary threshold required to consider a preliminary NCST deployment, but NIST did not have primary authority to investigate the event and no request was made of NIST to conduct a study.

5. Conclusion

The NCST Act authorizes NIST to establish and deploy teams to investigate building failures that result in a substantial loss of life or pose significant potential for loss of life. In FY 2017, NIST assessed thirteen events (fires, earthquakes, hurricanes) using a screening tool that considers: event consequences (substantial loss of life or disabling injury; potential for loss of life; hazard intensity; physical damage) and evacuation and/or emergency response, international factors (relevance to the US), and study impacts (safety of team; new knowledge gains; and potential impact to existing standards, codes, and guidelines). NIST completed three preliminary deployments in FY 2017 and is analyzing the hurricane data from Florida and Texas and has

decided not to establish a team under the NCST Act to further investigate the fire in Maryland. NIST continues to pursue actions related to improving building safety and structural integrity that were recommended by previous NCST investigations. NIST presented these FY 2017 activities to the NCST Advisory Committee during an in-person meeting at the Gaithersburg campus on September 28, 2017.