National Institute of Standards and Technology (NIST)

National Construction Safety Team Advisory Committee (NCSTAC)

NIST NCSTAC 2023 Annual Report to Congress

December 18, 2023

The Honorable Frank Lucas
Chairman
Committee on Science, Space, and Technology
United States House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

We are pleased to submit the 2023 Annual Report of the National Construction Safety Team Advisory Committee (NCSTAC/the Committee) of the National Institute of Standards and Technology (NIST). The Committee serves as NIST's advisor on implementation of the National Construction Safety Team (NCST) Act (P.L. 107-231; the 'Act'), and the opinions and recommendations expressed in this letter reflect our views as an independent body composed of technical experts in engineering, public health, and the social sciences.

The Act directs the Committee to report to Congress annually on its findings and recommendations in two areas:

1. Evaluation of NCST activities, and
2. Assessment of the implementation of recommendations of NCST and the Committee.

The Act was passed in response to the coordinated attacks of September 11, 2001. Following the collapse of the World Trade Center towers, NIST conducted a groundbreaking study of building performance and issued transformative, evidence-based recommendations for improvements in building codes and standards. Prior to 9/11, NIST had already distinguished itself as a leading federal agency with a history of rigorously investigating disasters of various types, going back at least as far as the 1971 earthquake in the San Fernando Valley. The passage of the Act solidified and now facilitates NIST's ability to conduct such investigations and enhances cooperation with other federal agencies.

On August 9, 2022, a change in the Act was approved. The change requires NCST's cooperation with civil litigants provided such cooperation does not compromise NCST's investigation or preservation of evidence. This change is an important step toward timely and just resolution of civil suits arising from events that NCST chooses to investigate.

Under **H.R. 4143**, amendments to the Act are proposed to expand the safety team's authority to investigate failures of infrastructure and structures other than buildings. **NCSTAC applauds this proposed change, which is consistent with a 2022 recommendation from the NCST Advisory Committee.** The amendment would formalize NCST's authority to evaluate damage to infrastructure, in addition to buildings, from natural disasters. Investigation of natural disasters, including hurricanes and wildfires, has been the primary focus of the NCST over the last decade.

The frequency and severity of natural hazard events have increased, particularly those related to atmospheric conditions, therefore making the NCST's work even more urgent.

This year the committee met on June 14-15, 2023, and again on September 7, 2023. During these meetings, NIST staff briefed the Committee on activities performed under the Act and closely related activities performed by NIST under other authorities. The Committee also took this opportunity to ask NIST staff and research team members questions and to provide feedback on their many ongoing activities. These meetings, as well as our review of presentation slides and other available documents, helped to inform this annual report.

Throughout this report, we use bold typeface and indented text to highlight our recommendations.

NIST'S RESPONSE TO THE RECOMMENDATIONS IN THE COMMITTEE'S 2022 REPORT TO CONGRESS

General Comments

> **2022 Recommendation 1.** We recommend that NIST takes advantage of its agreement with the National Science Foundation (NSF)-funded Natural Hazard Engineering Research Infrastructure (NHERI) by exploring more specifically how these programs can cooperate.

The NCSTAC is pleased that NIST is using their recently established interagency agreement with the NSF. To date, NIST has issued two work orders, one to the NSF-sponsored NHERI experimental facility at the University of Texas-Austin, to utilize a shared-use mobile shaker and associated personnel, and one with the University of Washington to expand a NHERI RAPID project to use shared-use equipment to collect perishable data following the Champlain Towers South collapse. NIST has also issued a work order to organize a data synthesis workshop.

> **2022 Recommendation 2.** In addition to NIST's crucial work on tornado effects on high-impact buildings, we encourage additional efforts to broaden recommendations for design guidelines for tornado effects to include additional classes of buildings and other structures.

The NCSTAC is pleased that NIST collaborated with FEMA to develop and publish a 21-page FEMA/NIST fact sheet in early 2023, titled "Improving Windstorm and Tornado Resilience: Recommendations for One- and Two-Family Residential Structures." NIST has also begun a longer-term research and development effort to identify tornado resistant design options, evaluate associated benefit/cost ratios, and develop design guidance and code change proposals for Risk Category II buildings (common structures, such as the aforementioned residential structures, that are not considered essential facilities). We encourage NIST to continue in this direction, so that their guidance can encompass both high impact buildings such as schools and hospitals and these more common buildings.

Hurricane Maria NCST Investigation

> **2022 Recommendation3**. We encourage NCST team members to continue their collaborative work in developing a standard protocol for conducting verbal autopsies.

NCST investigations, specifically, and mortality studies, in general, will greatly benefit from the verbal autopsies that NIST has been spearheading as part of their Hurricane Maria investigation. The Committee applauds NIST and their collaborators for their efforts, which we understand will contribute significantly to the development of standard protocols for conducting verbal autopsies.

> **2022 Recommendation 4.** Conclusions of the Hurricane Maria study should emphasize that loss of building function, a key measure of resilience, depends not only on structural damage, but also on other building systems and surrounding critical infrastructure.

The NCSTAC is pleased to learn that loss of function -of building systems and surrounding infrastructure (particularly those that are critical to recovery) are a major part of the ongoing NIST studies. We encourage the NCST to continue to develop and share these efforts.

> **2022 Recommendation 5.** It may be useful to consult Spanish language speakers who are native to Puerto Rico and can comment about potential language-related nuances for the Hurricane Maria study.

The NCSTAC is pleased to learn that, to ensure the best quality outcome, high quality translation by certified translators, along with independent review, has been a high priority in the development of Spanish language data collection instruments and in translation of Spanish language responses into English. We encourage the NCST to continue consulting with people who are Spanish speakers native to Puerto Rico, given the linguistic and cultural nuances that will need to be considered in the presentation of the research findings.

Champlain Tower South Partial Collapse NCST Investigation

> **2022 Recommendation 6.** The Committee recommends careful attention to the following highly challenging elements of this historic investigation:
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> - NCST is advised to pursue all potentially valuable information that may not be tied to physical evidence and that can only be gained through interviews. It is also important to consider that some memories may be quite perishable over time.

NCST has been collecting all information through interviews that may otherwise be lost if not tied to physical evidence. The Committee applauds NIST for expanding their number of social science investigators and accelerating the collection of qualitative interviews by using innovative strategies.

- Regarding the review of the Champlain Towers South structure, it would be very useful to find a set of calculations for a similar building in South Florida designed in the late 1970s or early 1980s; such a set would help establish probable design practices and the standard of care.

The NCST has searched for such calculations but has not yet found a set. They are continuing their efforts in this regard.

- With respect to the structural testing of replicas of critical elements of the structural system, we recommend that NCST recognize the uncertainty of pre-collapse conditions and conduct tests on specimens that represent a reasonable range of probable conditions.

The NCST has agreed that uncertainty is an important aspect of the investigation, and all analyses will include probabilistic considerations.

- The computational models and laboratory test results should be adjusted to reflect the effects of long-term sustained load, which are difficult to simulate in the laboratory tests.

The investigation includes long-term effects of sustained loads, such as concrete durability, aging, and reinforcement corrosion.

> **2022 Recommendation 7.** Considering the significance of the collapse and its potential impact on the U.S. and global construction industry, we urge NCST to expedite their investigation and issue interim summaries of critical lessons learned as the investigation progresses.

NIST has developed a communication plan and intends to share all data allowed within the limits of privacy laws. NIST has also been very sensitive to the needs of bereaved survivor communities in terms of their communications protocols. Recommendations can only be disclosed at the end of the study and release of the final report; however, NIST will share relevant pieces of information as allowed throughout the study.

With this balance among openness and the sensitivity and security of the data in mind, the Committee encourages the NCST—in accordance with recent guidance from the White House Office of Science and Technology Policy regarding open science and the public good—to make appropriate data and findings available without delay.

UPDATES TO THE DISASTER AND FAILURE STUDIES PROGRAM

Event scoring, to measure the significance of building failures to help determine the focus of disaster investigations, is an important function of the Disaster and Failure Studies Program (DFSP). In FY2023, NIST scored 19 domestic and international events, comprising five tornados, one hurricane, six earthquakes, one wildfire, and six structural failures. Two of these scored high

but occurred in other countries where the lessons to be learned for the United States were judged minimal (a small team traveled to Turkey after the February 2023 earthquake to conduct preliminary reconnaissance with a larger team from the American Concrete Institute). Three domestic events were considered seriously for potential deployment, and two were not selected for further investigation because they lacked broad implications for codes and standards. The third was the Hawaii wildfires, for which a NCST reconnaissance team went to Maui. This event is still being considered for a NCST designation, but now constrained by NCST's fiscal and personnel resources, since NIST currently has two NCST investigations ongoing.

> **DFSP Recommendation 1.** Due to the important implications of wildfires for the entire nation, especially considering the recent increases in climate-impacted atmospheric natural disasters, we highly recommend that NIST remain involved in the study of the Hawaii wildfire disaster and coordinate with the other federal, state, and local authorities that are investigating the event. This involvement with authorities, viewed as a potential next step by the NCST, is fully encouraged by the Committee.

We are pleased to see NIST's progress on staff safety training and other activities to encourage a culture of "team readiness" to facilitate a quick deployment into the field for reconnaissance activities.

> **DFSP Recommendation 2.** We encourage the team to continue the emotional and mental health support to investigatory team members, especially those who rotate in and out of lengthy shifts in the field.

NIST's NCST received a $40M disaster supplemental for "Scientific and Technical Research and Services" to enhance its work on the impacts of hurricanes, typhoons, and wildfires. This supplemental funding to NCST allows it to continue important investigations such as the Champlain Towers South study, coordinating a study of Hurricane Fiona with the Hurricane Maria study, and a new study on Hurricane Ian.

HURRICANE MARIA NCST INVESTIGATION

Overview of the Hurricane Maria Investigation

The investigation has two major components, the NCST investigation and the National Windstorm Impact Reduction Program (NWIRP) investigation. These two investigations generated seven technical projects: (1) Hazard Characterization, (2) Performance of Critical Buildings, (3) Public Response to Emergency Communications, (4) Morbidity and Mortality, (5) Impacts to and Recovery of Infrastructure Systems, (6) Recovery of Business and Supply Chains, and (7) Recovery of Social Functions. These technical projects have been developed with the support of several federal, state, local, and territorial agencies. At this point, all the data collection for the NCST portion of the investigation has been completed, and most of the data collection has been completed for the NWIRP portion.

According to the Hurricane Maria NCST investigators, the draft of the final report should be available for review by fall of 2024, with the final report to be ready for release in 2025. We

applaud the monumental efforts of this team. Considering the importance of the results generated by these studies, we encourage the research team to continue meeting their deadlines to ensure that these important data and findings are broadly shared with the public.

CHAMPLAIN TOWERS SOUTH PARTIAL COLLAPSE NCST INVESTIGATION

Overview of the Champlain Towers South Investigation

In the two years since Chaplain Towers South (CTS) collapsed, the NCST has substantially progressed with its comprehensive study of potential causes of this tragic failure. Based on our discussions with NCST, we believe the effort is well organized, focused, and extremely comprehensive. This establishes high expectations that the NCST will identify the salient causes and propose fundamental changes in practice, if any are needed, to reduce the chances that another catastrophic collapse like this will occur in the future.

NIST and NCST should be commended for designing a rigorous technical approach, which includes a process for the engineers to request assistance from the social scientists on the team to gather information that augments the story being told by the building debris.

> **CTS Recommendation 1:** The internal NIST investigation process should encourage bi-directional exchange so that information gleaned by the social science team might also spur additional evidence gathering by the engineers. This model shows great promise for future investigations.

NCSTAC admires how NIST and NCST have established a plan to communicate findings to impacted family members prior to releasing information publicly. We commend the NCST's diligence and efficiency in the wide and extended-duration range of research activities, but we also applaud their dedication to ethical communication as a vital component for establishing and keeping public trust in the process.

With the above in mind, we also acknowledge that intense interest—particularly from family members and other members of the public directly impacted by the collapse—in the ultimate findings of this thorough investigation is generating frustration over its duration. With the expectation that the final report might not be released until 2025, this frustration is likely to grow.

> **CTS Recommendation 2:** NIST should maintain its public communication practice so that interested parties learn about the NCST's progress and findings at the earliest appropriate time.

Obstacles Faced by the NCST

NCSTAC acknowledges the efforts that the NCST investigation team has made in collecting, preserving, and managing the evidence necessary to evaluate multiple hypotheses for the collapse mechanism at Champlain Towers South. Indeed, NCST reports that investigators worked 18-hour

days, overlapping the two 12-hour response operational periods for 7 days/week for 2 months to preserve perishable data. This has been an extraordinary demand on them.

For current and future work in Florida, NIST has retained local consultants to work with members of the NCST, thereby alleviating some of the pressure going forward. The NCSTAC thanks the NCST for their efforts, while acknowledging that such a grueling work schedule is not personally or professionally sustainable and could become counterproductive to the overall effort if members of the team are not able to continue at this pace.

> **CTS Recommendation 3:** NCSTAC suggests that NIST continue to explore options to reduce the demand on investigators during future deployments, including retaining consultants based close to the event site, as appropriate, as NIST has done recently for the ongoing CTS investigation.

NCSTAC recognizes that the NCST has faced challenges in procurement of contracts and resources, due to Federal acquisition regulations. These regulations have remained an impediment to quick and efficient progress across all the NCST investigations, even though NIST was granted some expanded purchasing authorities to address this obstacle and accelerate some of the activities. Given the perishability of data necessary for understanding the built and social environment in a disaster context, such restrictive regulations inhibit timely data acquisition, preservation, and analysis, and consequently hinder and delay the reporting of findings.

Nevertheless, NIST and NCST leadership have been exceptional in their ability to proceed with investigations given the challenges of contracting and acquisitions per federal regulations. While the expanded authorities given to NIST have been helpful to the investigation and have allowed the preservation of perishable evidence necessary to the investigation, the NCSTAC was disheartened to learn that these expanded authorities ended on September 30, 2023, and that an extension has not been granted.

> **CTS Recommendation 4:** We recommend that NIST Disaster and Failure Studies Program continue to investigate strategies to partner with organizations that have quick access to resources necessary for success and to consider opportunities to amend the Act so that the temporary purchasing authorities provided in an emergency can be maintained as part of the common operations. This is vital to ensure that the collection of perishable data moves forward.

Progress on Finding the Cause of the CTS Collapse

An essential goal of the NCST is to identify the causes of the collapse. Knowing the failure mechanism quite specifically gives solace and understanding to survivors and the families of victims. It also could reveal potential risks in other existing buildings and methods to mitigate those risks going forward. Several failure hypotheses have been identified and are being carefully investigated and documented. As of our last meeting in September 2023, none had been eliminated.

During our meetings, the NCST described a prominent hypothesis related to the pool deck, to demonstrate progress toward identifying the cause of the failure and to show how the results of all the tasks underway, in combination, reveal evidence to support or eliminate hypotheses. For example, significant conditions under study in the pool deck adjacent to the high-rise portions of the building that collapsed include design understrength based on applicable original building code; misplaced top slab reinforcement reducing flexural strength capacity of the slab; heavier and more extensive planters on top of deck, various layers of fill and paving; and corrosion of slab reinforcement in different areas.

Significant investigation tasks remain, including sampling and testing of specimens from the evidence facility as well as laboratory tests of replicas of building elements involved in the collapse.

> **CTS Recommendation 5:** When the NCST identifies hypotheses that are of sufficiently low probability of explaining the failure, it should substantially curtail additional study of those hypotheses, to preserve resources for the testing of more prominent ones.

NCSTAC Conclusions Regarding the Champlain Towers South Investigation

NCST is conducting a comprehensive and competent investigation of a highly complex and tragic building failure that killed 98 people and now stands as one of the deadliest building failures in our national history. They have engaged top experts in the disciplines that are essential to the collection and assessment of the available evidence from the debris, witnesses, and other sources. NIST and NCST are executing a thorough study that should yield incontrovertible findings.

In meetings in June and September 2023, NCST outlined the timeline for future work, with the expectation that technical work likely will be completed in late June 2024 and the final report issued a year after that. The schedule has been extended slightly due to conditions out of NIST's control.

SUMMARY

NCSTAC met with NIST twice to review progress on initiatives over the past year and to provide feedback to NIST. Based on our discussions with NIST, we make the following observations:

The NCST program is highly valuable to the safety and resilience of the built environment—and the people who occupy it—in the United States.

We commend NIST for diligently administering the NCST program and developing and maintaining an extraordinary technical workforce.

The NCST teams investigating Hurricane Maria and the Champlain Towers South collapse are making appropriate progress toward completion of their assignments, using comprehensive state-of-the-art investigative tools and techniques.

NIST and the NCST teams have been responsive to feedback from the NCSTAC.

Sincerely yours,

José M. Izquierdo-Encarnación
Chair, National Construction Safety Advisory Committee

Ross Corotis
Past Chair (2022-2023), National Construction Safety Advisory Committee