



Recommendations From NCST Investigations

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NCST Act of 2002



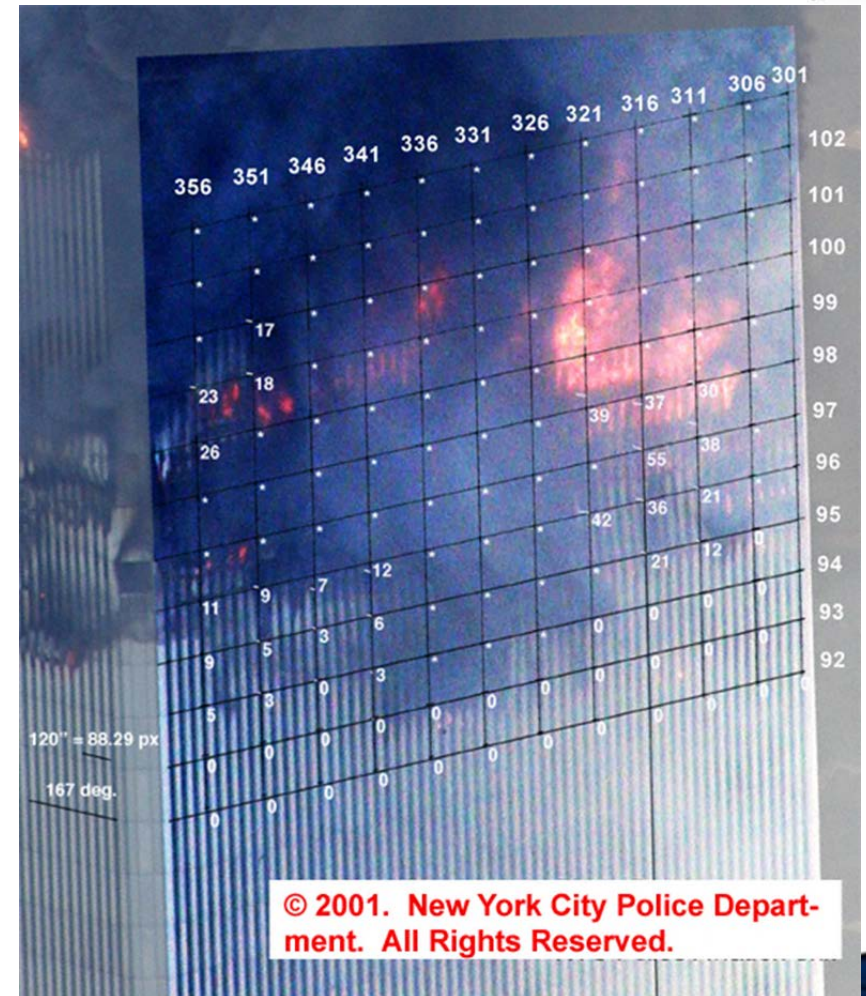
SEC. 9. NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY ACTIONS.

After the issuance of a public report under section 8, the National Institute of Standards and Technology shall comprehensively review the report and, working with the United States Fire Administration and other appropriate Federal and non-Federal agencies and organizations—

- (1) conduct, or enable or encourage the conducting of, appropriate research recommended by the Team; and
- (2) promote (consistent with existing procedures for the establishment of building standards, codes, and practices) the appropriate adoption by the Federal Government, and encourage the appropriate adoption by other agencies and organizations, of the recommendations of the Team with respect to—
 - (A) technical aspects of evacuation and emergency response procedures;
 - (B) specific improvements to building standards, codes, and practices; and
 - (C) other actions needed to help prevent future building failures.

World Trade Center, 2002

- Investigation Goals:
 - To investigate the building construction, the materials used, and the technical conditions that contributed to the outcome of the WTC disaster.
 - To serve as the basis for: improvements in the way buildings are designed, constructed, maintained, and used; improved tools and guidance for industry and safety officials; recommended revisions to current codes, standards, and practices; and improved public safety.



World Trade Center Recommendations (September 2005)

- 30 Recommendations in eight areas:
 - Increased structural integrity
 - Enhanced fire endurance of structures
 - New methods for fire resistant design of structures
 - Improved active fire protection
 - Improved building evacuation
 - Improved emergency response
 - Improved procedures and practices
 - Education and training

Over 40 Changes to codes, standards, and practices:

- International Building Code, International Fire code
- NFPA 1 (Fire Prevention), 13 (sprinklers), 72 (Fire Alarms), 101 (Life Safety Code)
- ASME A17 (Elevators)
- ASCE 7 (Structural Loads)
- ACI 318 (Concrete Design)

World Trade Center Improved Emergency Evacuation



- Recommendation 17. NIST recommends that tall buildings be designed to accommodate timely full building evacuation of occupants when required in building-specific or large-scale emergencies such as widespread power outages, major earthquakes, tornadoes, hurricanes without sufficient advanced warning, fires, explosions, and terrorist attack. Building size, population, function, and iconic status should be taken into account in designing the egress system. Stairwell capacity and stair discharge door width* should be adequate to accommodate counterflow due to emergency access by responders.

* Egress capacity should be based on an all-hazards approach that considers the number and width of stairs (and doors) as well as the possible use of scissor stairs credited as a single stair.

World Trade Center Improved Emergency Evacuation



- Issue: Emergencies high in tall structures
 - How to get (all) people quickly and safely out of tall buildings
 - How to get responders to the emergency quickly and safely
- Process: Convene stakeholders to consider elevator usage during building fires
 - NIST/ASME/IAFF/ICC/NFPA/US Access Board Workshop in March 2004
 - Quarterly meetings (one week each) in Boston from 2004-2010 (24 meetings total)
 - Develop ISO Hazard Analysis (over 600 pages) to design engineered system
 - Hazard – Effect – Corrective Action – Residual Hazard(s)
 - Repeat until all hazards are mitigated
 - Parallel analyses for Occupant and Firefighter Usage

World Trade Center Improved Emergency Evacuation



- Outcome:
 - Changes to ASME A17.1 (Elevator Code)
 - Changes to International Building Code:
 - Fire Service Access Elevator. requires two fire service elevators with a minimum 3500 lb capacity serving every floor of the building with an occupied floor more than 120 ft. above the lowest level of fire department access.
 - An additional (third) exit stairway for buildings more than 420 feet high **OR** use of elevators for occupant evacuation in fires and other emergencies as an alternative to the required additional exit stairway for buildings more than 420 feet high.

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World Trade Center Recommendations



Research-oriented recommendations

Recommendation 1. NIST recommends that: (1) progressive collapse be prevented in buildings through the development and nationwide adoption of consensus standards and code provisions, along with the tools and guidelines needed for their use in practice; and (2) a standard methodology be developed—supported by analytical design tools and practical design guidance - to reliably predict the potential for complex failures in structural systems subjected to multiple hazards.

Process: Analytical research, followed by experimental validation, & guideline development
(*Alternative Load Path Analysis Guidelines*)

Outcome: ASCE/SEI committee established (*Disproportionate Collapse Mitigation of Building Structures*), draft standard developed, currently in ballot review

Lesson from WTC: While some recommendations achieve impact quickly, others may involve years of sustained effort

2011 Joplin Tornado Recommendations



- Event – May 2011
- Final Report and 16 Recommendations – March 2014
 - Tornado hazard characteristics and associated wind field (4 recommendations)
 - Performance of buildings, shelters, and lifelines (8 recommendations)
 - Fatalities, injuries, and performance of emergency communications (4 recommendations)
- Update: See presentations from Sep 2017 & Feb 2018 NCSTAC meetings
 - <https://www.nist.gov/topics/disaster-failure-studies/national-construction-safety-team-advisory-committee-ncstac-meeting>
 - https://www.nist.gov/sites/default/files/documents/2018/02/20/04_update_on_implementation_of_recommendations_from_the_joplin_investigation.pdf

2011 Joplin Tornado Recommendations



- Implementation of recommendations is not the exclusive responsibility of NIST
 - Joplin was a great example of partnerships; we identified a lead for each recommendation
 - For 16 Joplin recommendations:
 - NIST was Lead/Co-Lead on 3 recommendations
 - FEMA (5)
 - NOAA/NWS (4)
 - ICC (3)
 - NFPA (2)
 - ASCE (1)
 - NSF (1)

Lesson from Joplin: Partners will be strategically identified as we progress with the Hurricane Maria Investigation.

Hurricane Maria

Areas of investigation that may result in recommendations



Important context:

- NIST does not pre-judge the outcome of any technical investigation
- We use preliminary information to identify areas where adverse outcomes may produce recommendations
- Remain open to investigative findings that suggest new investigative directions

Hurricane Maria

Areas of investigation that may result in recommendations

- Assessment of hazards (wind, rain, landslides, etc)
 - Wind topographic effects
 - Relationship between hazards and building failure modes and deaths/injuries
- Damages to structural systems, building envelopes, & building (rooftop) equipment
 - Schools, particularly ones used as shelters
 - Hospitals
- Extensive and extended loss of critical infrastructure, including communications, power, transportation, and water
 - Schools, particularly ones used as shelters
 - Hospitals
- Widely varying accounts of injuries and fatalities resulting from the storm