



NIST Disaster and Failure Studies Program Update

ACEHR Meeting
November 9, 2011

William Grosshandler
Deputy Director for Building and Fire Research
Engineering Laboratory
National Institute of Standards and Technology
U.S. Department of Commerce

Presentation Outline

- Authorities, roles and decision criteria
- NCST study of Joplin, MO tornado
- NCST Advisory Committee
- Update on Disaster and Failure Events Data Repository



NIST Disaster and Failure Studies

Results

- Probable technical cause
- Lessons learned: successes and failures
- Improvements to standards, codes, practices, technologies
- Future research priorities

NIST Authorities & Roles:

- **NCST Act (2002):** building failures, evacuation and emergency response procedures
- **NIST Act (1950 and 1985):** structural investigations
- **Fire Prevention and Control Act (1974):** fire investigations
- **NEHRP Reauthorization Act (2004):** earthquakes
- **National Windstorm Impact Reduction Act (2004):** wind, storms and floods
- **National Response Framework:** structural and fire safety; disaster operations and situation assessment; urban and industrial hazard analysis; recovery

Program focus: Develop and maintain archival disaster and failure database of hazards, performance of buildings and infrastructure, evacuation and emergency response, and related factors (e.g., mitigation, response)



Categories of Decision Criteria

- Substantial Loss of Life or Disabling Injury
- Significant Potential for Loss of Life: Exposed Population
- Level of Hazard
- Consequences (Extent of Damage and Loss of Functionality)
- Need for NIST involvement
- Stakeholder Concern
- Evacuation / Emergency Response Challenges
- International Events (code enforcement; similarity of practices)



Recent Disasters		
Year	Event	Total Weighted Score
2010	Earthquake - Chile	3.8
2010	Warehouse Fire - Chicago	2.6
2011	Typhoon Yasi - Australia	2.7
2011	Metrodome Collapse	3.0
2011	Amarillo Wildfires	4.0
2011	Earthquake Christchurch, New Zealand	4.4
2011	Tsunami - Japan	4.2*
2011	Southeastern US Tornadoes	3.6
2011	Joplin, MO	4.3
2011	Eastern Turkey	3.6

* Did not deploy due to concerns with staff safety, coordination with The United States-Japan Cooperative Program in Natural Resources (UJNR) mechanism



Presentation Outline

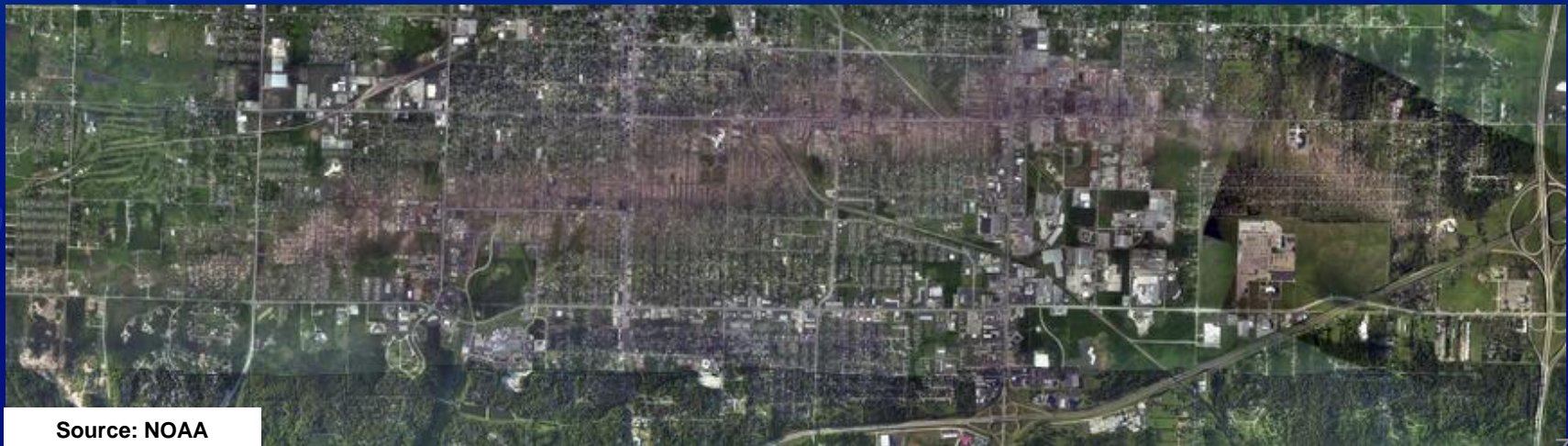
- Authorities, roles and decision criteria
- NCST study of Joplin, MO tornado



Joplin Tornado Overview

- Touched down in Joplin beginning at 5:34 PM CDT, Sunday, May 22, 2011
- Enhanced Fujita Scale EF-5 tornado (highest category)
- Maximum estimated wind speeds: 200+ mph
- Path: up to 1 mile wide, 22.1 miles long (6 miles in Joplin)
- Track: generally West to East across Joplin (Newton and Jasper counties)
- \approx 8,000 structures damaged or destroyed (\approx 30% of Joplin)
- 162 fatalities, >1,000 injuries (Joplin Population: 49,024)

Sources: National Weather Service (NWS), Federal Emergency Management Agency (FEMA), City of Joplin



Source: NOAA



National Construction Safety Team

Based on analysis of the data collected and other criteria required by law and regulation, NIST Director Pat Gallagher established a team under the NCST Act on June 29, 2011, to proceed with a more comprehensive study of the impacts of the disaster

- Team Members

- Four NIST Engineering Laboratory employees

- Dr. Marc Levitan: Study Team Leader,
Wind Engineer, Leader of NIST NWIRP R&D
- Dr. Erica Kuligowski: Fire Protection Engineer and Sociologist
- Dr. Frank Lombardo: Wind Engineer and Meteorologist
- Dr. Long Phan: P.E., Structural Engineer,
Experienced in wind disaster studies

- One National Oceanic and Atmospheric Administration (NOAA) employee

- Dr. David Jorgensen: Research Meteorologist and Chief,
National Severe Storms Lab (NSSL)/Warning R&D Div.

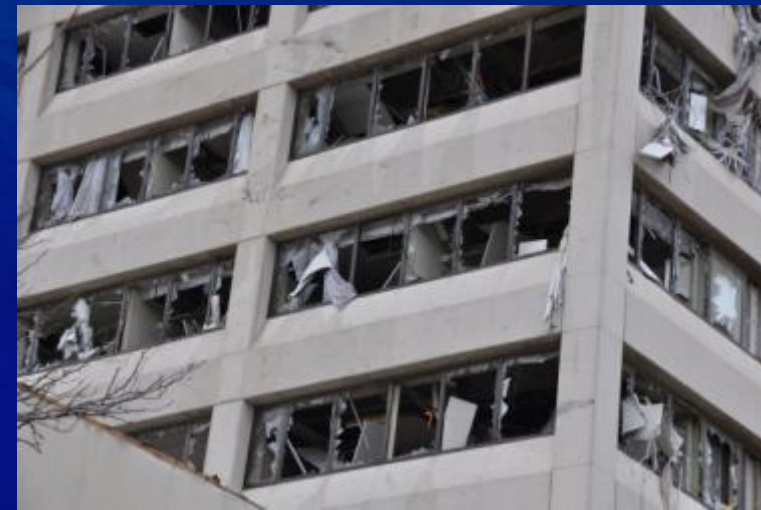
Draft Technical Study Plan - Objectives

1. Determine the tornado hazard characteristics and associated wind fields in the context of historical data
2. Determine the pattern, location, and cause of fatalities and injuries, and associated emergency communications and public response
3. Determine the response of residential, commercial, and critical buildings, including the performance of designated safe areas
4. Determine the performance of lifelines as it relates to the continuity of operations of residential, commercial, and critical buildings
5. Identify, as specifically as possible, areas in current building, fire, and emergency communications codes, standards, and practices that warrant revision

Performance of Facilities

Buildings

- **Main Buildings (RC, Steel Frame):** Extensive damage to envelope (glazing; roof blow-off) and interior; No observed damage to Main Wind Force Resisting System (MWFRS); Loss of function
- **Ancillary Buildings (CMU):** Collapsed or substantially damaged
- **Performance Issues:**
 - Building envelope/Loss of function
 - Collapse/damage of ancillary buildings
 - Life safety, continuity of vital service not achieved



Generator Plant



Chiller Plant



Draft Technical Study Plan - Anticipated Impacts

- Improved resilience of buildings, infrastructure, and communities to tornadoes
 - specifically focused on life safety objectives and enhanced performance of buildings during tornadoes to better protect building occupants and property
- Enhanced emergency communications systems and lifeline performance in future disasters
- Inform future research for the development and dissemination of guidance and tools for
 - assessing and reducing vulnerabilities related to tornadoes
 - producing the technical basis for cost-effective changes in national codes, standards, and practices

Presentation Outline

- Authorities, roles and decision criteria
- NCST study of Joplin, MO tornado
- NCST Advisory Committee



National Construction Safety Team – Advisory Committee

- Request for nominees – February 2011
- 10 members appointed by NIST Director – October 2011
- Areas of expertise reflect the broad range of activities associated with the Disaster and Failure Studies Program
 - Structural Design, Failure Analysis, Firefighting, Fire Engineering, Fire analysis, Insurance / Safety, Human Behavior/Evacuation, Building Codes, Probability and Risk
- Committee meeting – November 7, 2011



Advisory Committee Members

- Jeremy Isenberg, senior principal, Specialty Practices Group, AECOM (Oakland, Calif.) - Chair
- Carlos Fernandez-Pello, professor, Department of Mechanical Engineering, University of California Berkeley (Berkeley, Calif.)
- Susan Cutter, distinguished professor and director, Hazards and Vulnerability Research Institute, University of South Carolina (Columbia, S.C.)
- Jeffrey Garrett, president and CEO, CTL Group (Skokie, Ill.)
- Ron Coleman, chairman, Board of Trustees, Commission on Fire Accreditation International (Elk Grove, Calif.)
- Anne Kiremidjian, professor, Department of Civil and Environmental Engineering, Stanford University (Stanford, Calif.)
- Sarah A. Rice, project manager, Preview Group Inc. (Cincinnati, Ohio)
- Paul A Croce, retired VP and manager of research, FM Global (Middletown, R.I.)
- R. Shankar Nair, principal and senior VP, Teng & Associates Inc. (Chicago, Ill.)



Presentation Outline

- Authorities, roles and decision criteria
- NCST study of Joplin, MO tornado
- NCST Advisory Committee
- Update on Disaster and Failure Events Data Repository



Repository Purpose

- The repository will serve as a national archival database where NIST and other organizations can store the results of the study and analysis of disaster and failure events.
- The results of these studies and analyses will lead to recommended improvements to codes, standards, practices and/or new knowledge.
- By making these data available, NIST hopes to enable the efficient dissemination of data on disaster and failure events.



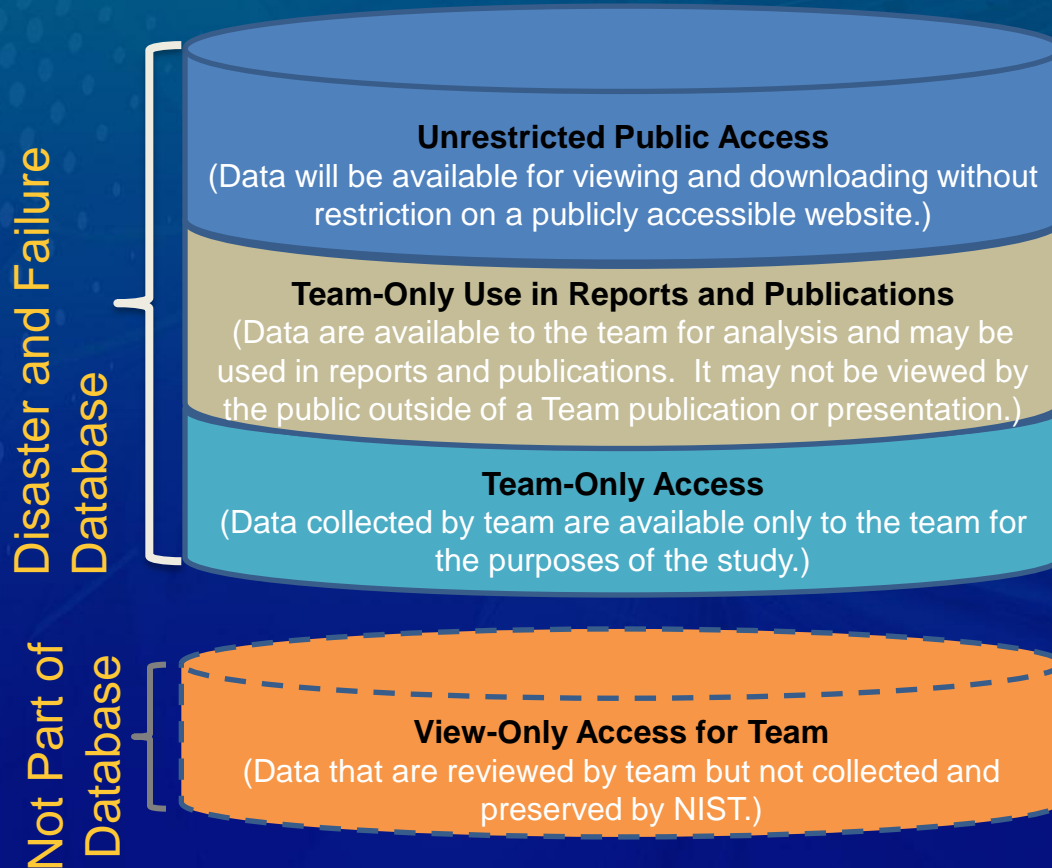
Repository Scope

- As the database grows, it will include data on significant hazard events; how buildings and other structures performed during those events; associated emergency response and evacuation procedures; and the technical, social and economic factors that affect pre-disaster mitigation activities and post-disaster response efforts.

Data Types
Site Documentation and Collection of Artifacts
Hazard or Threat Event Data
Safety and Performance Data
Design, Construction, Operation and Maintenance Information
Evacuation and Emergency Response Information
Findings, Conclusions and Recommendations
Changes to Standards, Codes and Practices Based on Recommendations



Levels of Access



NIST Repository Workplan

- Phase 1 – World Trade Center database
 - High level of interest in data collected
 - Goal of releasing before 10-year anniversary
- Phase 2 – Chile earthquake pilot
- Phase 3 – Full scale implementation



Phase 1 – World Trade Center

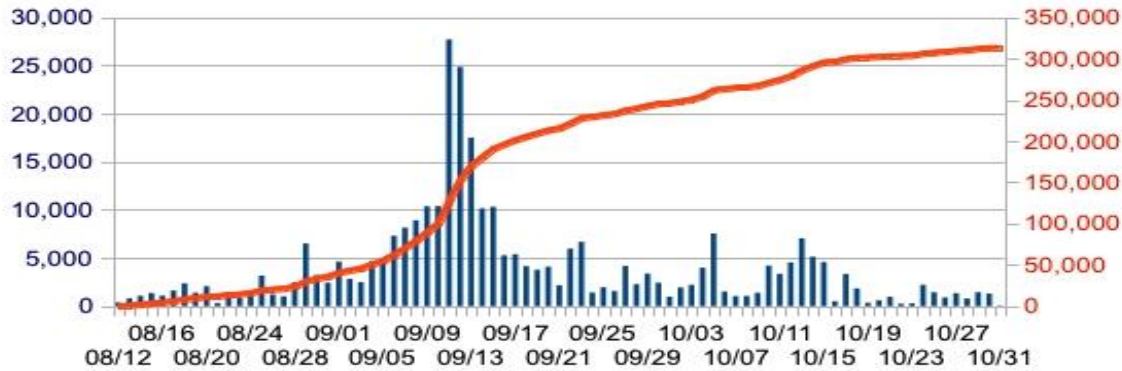
- Data previously released from NIST's 7-year investigation on the collapses of three buildings at New York City's World Trade Center
- Over 94,000 photos and videos
- Computer simulations
- Complete set of technical reports
- Repository created and managed by NIST
- Website publically released in August 2011



WTC Repository Statistics

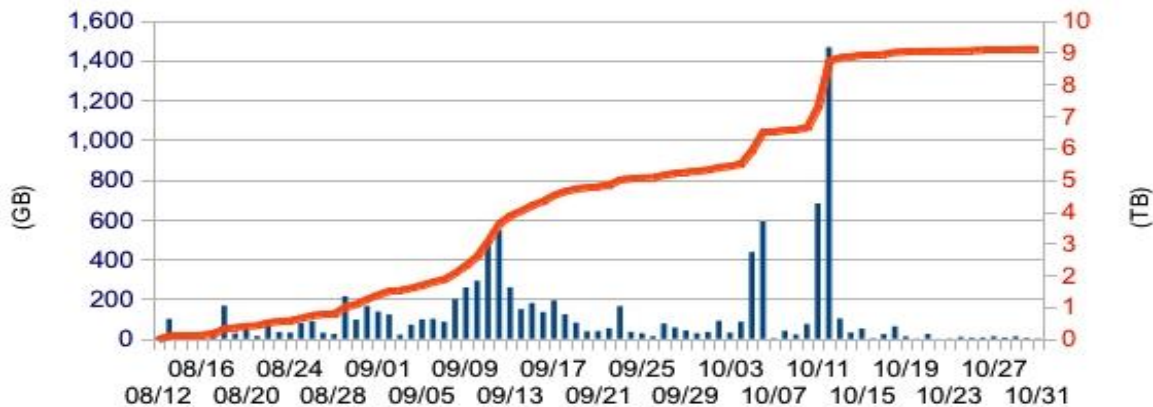
Daily Total Page Views

Aug 12, 2011 - Oct 31, 2011



Daily Total Volume

Aug 12, 2011 - Oct 31, 2011



Phase 2 – Chile Earthquake Pilot

- Develop event-specific, web-based repository
- Data-rich event that will also support the National Earthquake Hazards Reduction Program (NEHRP)
- Opportunity to leverage with the Network for Earthquake Engineering Simulation (NEES)
- NIST retained a contractor to assist with obtaining data previously collected by others (American Society of Civil Engineers - ASCE, Earthquake Engineering Research Institute - EERI, and Los Angeles Tall Buildings Council study teams)
- Beta system test – June 2012



Chile Earthquake

Database Functional Requirements

- Ground motion (both directly recorded and derived)
- Building inventory (geospatial info, age, story height, occupancy, etc.)
- Structural drawings
- Photos, accompanied by appropriate descriptive details
- Mapped structural damage from damaged buildings
- Instrumented building response data
- Geotechnical information (soils reports, liquefaction study reports, etc.)
- Publically available literature
- Bibliographic information
- Links to other relevant websites

NIST is in the process of obtaining permission for inclusion of copyrighted data in the repository



Phase 3 – Full-Scale Implementation

- Develop cost estimate to maintain, update, operate and improve accessibility of the repository
- Finalize user requirements and expand repository
- Populate with selected high-impact historical and future events
- Disseminate information to stakeholder / user community
- Maintain ongoing communication with stakeholder / user community



Contact Info

Eric Letvin

301 975 5412
eric.letvin@nist.gov

The NIST Engineering Laboratory
100 Bureau Drive Stop 8600
Gaithersburg, MD 20899-8600

www.nist.gov/el

