Disaster and Failure Studies Program Overview

NCST Advisory Committee
November 7, 2011

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National Institute of Standards and Technology
U.S. Department of Commerce

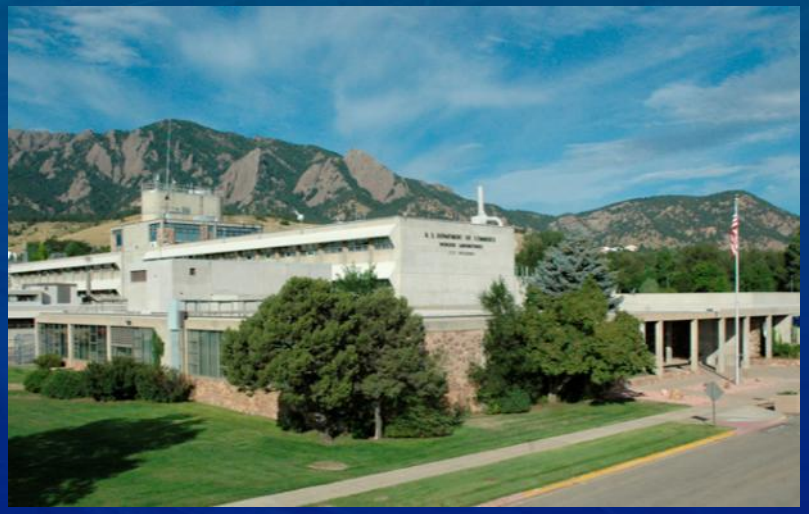
NIST
National Institute of Standards and Technology
U.S. Department of Commerce

NIST At A Glance

Gaithersburg, MD

- NIST Research Laboratories
- Manufacturing Extension Partnership
- Baldrige Performance Excellence Program
- Technology Innovation Program

Boulder, CO



~ 2,900 NIST employees

~ 2,600 associates and facility users

~ 1,600 field staff in partner organizations

~ 400 NIST staff serving on 1,000 national and international standards committees

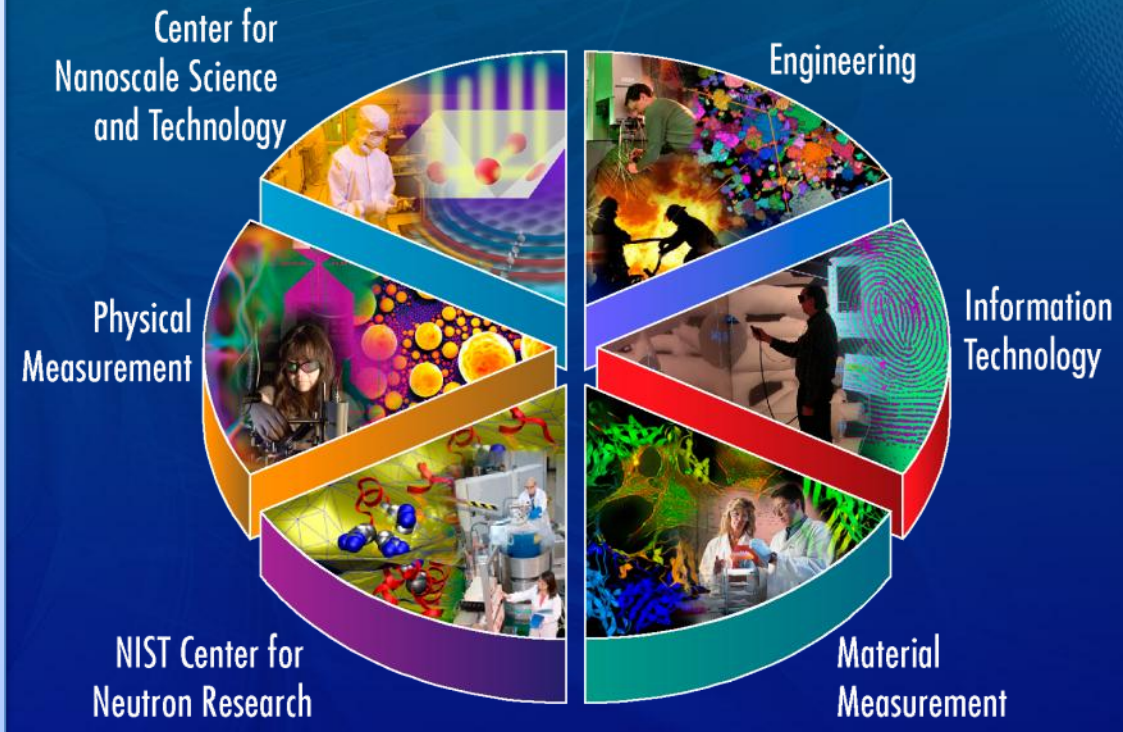
The NIST Laboratories

NIST's work enables

- Advancing manufacturing and services
- Helping ensure fair trade
- Improving public safety and security
- Improving quality of life

NIST works with

- Industry
- Academia
- Other federal agencies
- State and local government agencies
- Measurement laboratories
- Standards organizations



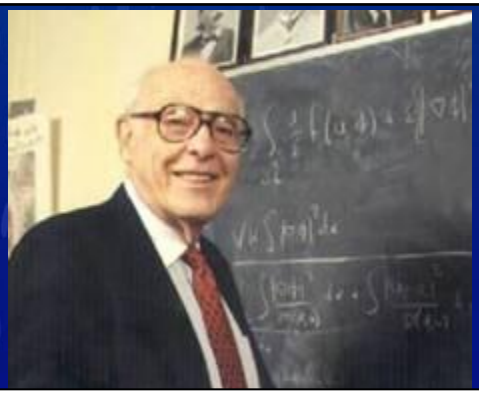
Providing measurement solutions for industry and the Nation

NIST has... ...world-class staff

Jan Hall
2005 Nobel Prize
in Physics

Eric Cornell
2001 Nobel Prize
in Physics

Bill Phillips
1997 Nobel Prize
in Physics



John Cahn
1998 National Medal of
Science

Anneke Sengers
2003 L'Oréal-UNESCO
Women in Science Award

Debbie Jin
2003 MacArthur
Fellowship

Engineering Laboratory Mission

To promote U.S. *innovation* and *industrial competitiveness* in areas of critical national priority **by anticipating and meeting the:**

- **measurement science and**
- **standards**

needs for technology-intensive manufacturing, construction, and cyber-physical systems in ways that enhance *economic prosperity* and improve the *quality of life.*

Engineering Laboratory Vision

To be *the* source for:

- creating **critical *solution-enabling* measurement science**, and
- critical technical contributions underpinning emerging **standards, codes, and regulations**

that are *used* by the U.S. manufacturing, construction, and infrastructure industries to strengthen leadership in domestic and international markets.

EL is the primary federal laboratory serving the manufacturing and construction industries.

EL Core Mission Functions[1]

- Fire prevention and control
- National earthquake hazards reduction
- National windstorm impact reduction
- National construction safety teams
- Building materials and structures
- Engineering and manufacturing materials, products, processes, equipment, technical data, and standards
- Green manufacturing and construction
- Manufacturing enterprise integration
- Collaborative manufacturing research pilot grants
- Manufacturing fellowships

[1]*Authorized by NIST Organic Act or by other statutes*

EL Goals and Programs

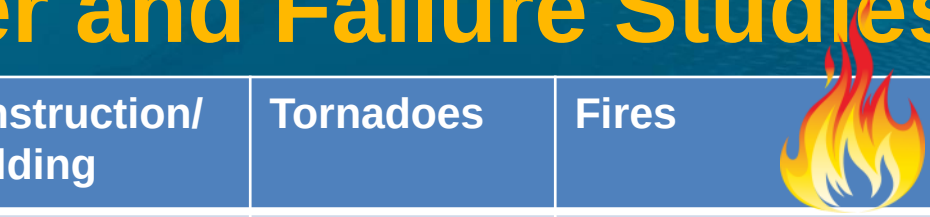
EL Goal/Program	FY 2012 Funding*
Goal: Smart Manufacturing, Construction, and Cyber-Physical Systems	
Smart Manufacturing Processes and Equipment	$3.0M
Next-Generation Robotics and Automation	$3.8M
Smart Manufacturing and Construction Systems	$3.3M
Systems Integration for Manufacturing and Construction Applications	$6.9M
Smart Grid Program	$8.0M
Goal: Sustainable and Energy-Efficient Manufacturing, Materials, and Infrastructure	
Sustainable Manufacturing	$5.3M
Sustainable, High-Performance Infrastructure Materials	$3.2M
Net-Zero Energy, High-Performance Buildings	$6.4M
Embedded Intelligence in Buildings	$3.2M
Goal: Disaster-Resilient Buildings, Infrastructure, and Communities	
Fire Risk Reduction in Communities	$4.7M
Fire Risk Reduction in Buildings	$5.6M
Earthquake Risk Reduction in Buildings and Infrastructure	$4.1M
Structural Performance Under Multi-Hazards	$3.5M
*** Pending FY 2012 Appropriations** **Total**	**$ 61.0M**

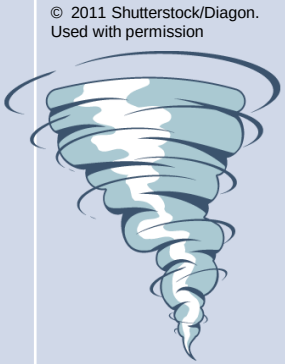
Goal: Disaster-Resilient Buildings, Infrastructure, and Communities

- **Fire Risk Reduction in Communities:** To develop and deploy advances in measurement science to improve the resilience of communities and structures to unwanted fires through innovative fire protection and response technologies and tactics
- **Fire Risk Reduction in Buildings:** To develop and deploy advances in measurement science to increase the safety of building occupants and the performance of structures and their contents by enabling innovative, cost-effective fire protection technologies
- **Earthquake Risk Reduction in Buildings and Infrastructure:** To develop and deploy advances in measurement science to resist earthquake effects, improve safety, and enhance resilience of buildings, infrastructure, and communities
- **Structural Performance Under Multi-Hazards:** To develop and deploy advances in measurement science to enhance the resilience of buildings and infrastructure to natural and manmade hazards

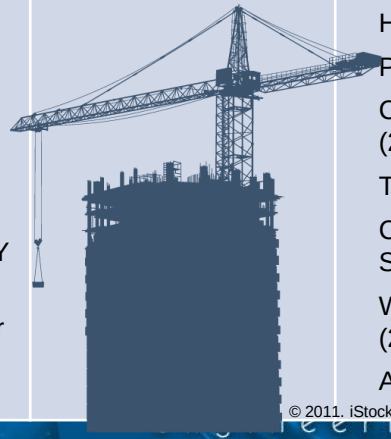
NIST Disaster and Failure Studies

Earthquakes	Hurricanes	Construction/ Building	Tornadoes	Fires
San Fernando, CA (1971)	Camille, MS/LA (1969)	Skyline Plaza Apartments, Bailey's Crossroads, VA (1973)	Jarrell, TX (1997)	DuPont Plaza Hotel, San Juan, PR (1986)
Mexico City, Mexico (1985)	Alicia, Galveston, TX (1983)	Willow Island Cooling Tower, WV (1978)	Spencer, SD (1998)	First Interstate Bank Building, Los Angeles, CA (1988)
Loma Prieta, CA (1989)	Hugo, SC (1989)	Kansas City Hyatt Regency, Kansas City, MO (1981)	Oklahoma City, OK (1999)	Loma Prieta Earthquake, CA (1989)
Northridge, CA (1994)	Andrew, FL (1992)	Riley Road Interchange, East Chicago, IN (1982)	Joplin, MO (2011)*	Hillhaven Nursing Home (1989)
Kobe, Japan (1995)	Hurricanes Mitch and Georges, LAC (1998)	Harbor Cay Condominium, Cocoa Beach, FL (1981)		Pulaski Building, Washington, DC (1990)
Kocaeli, Turkey (1999)	Hurricanes Katrina and Rita (2005)	L'Ambiance Plaza, Hartford, CT (1987)		Happyland Social Club, Bronx, NY (1990)
Maule, Chile (2010)*		Ashland Oil Tank Collapse, Floreffe, PA (1988)		Oakland Hills, CA (1991)
Christchurch, NZ (2011)*		U.S. Embassy, Moscow, USSR (1987)		Hokkaido, Japan (1993)
		Murrah Federal Building, Oklahoma City, OK (1995)		Watts St, New York City (1994)
		World Trade Center Disaster, New York, NY (2001)		Northridge Earthquake, CA (1994)
		Dallas Cowboys Indoor Practice Facility, May 2009		Kobe, Japan (1995)
				Vandalia St, New York City (1998)
				Cherry Road, Washington, DC (1999)
				Keokuk, IA (1999)
				Houston, TX (2000)
				Phoenix, AZ (2001)
				Cook County Administration Building Fire (2003)
				The Station Nightclub, RI (2003)
				Charleston, SC, Sofa Super Store Fire (2007)
				Witch Creek & Guejito, CA, WUI Fire (2007)
				Amarillo, TX, WUI Fire (2011)





* Ongoing



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, as amended):*** structural investigations; fire-resistive building materials; materials, mechanisms, structures, components, and systems)
- ***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

A 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)

Disaster and Failure Event Studies and Data Repository FY 2012 (+$1.8M)*

- NIST will develop a prototype disaster and failure database, i.e., a *National Disaster and Failure Events Database*.
- NIST will collect and analyze data and artifacts to improve the understanding of hazards, the real-world performance of buildings and infrastructure during disaster and failure events at both the component and the system levels, associated emergency response and evacuation procedures, and technical, social, and economic factors that affect pre-disaster mitigation activities and post-disaster response efforts.
- The results of disaster and failure studies will lead to recommendations to provide disaster-resilience at the structure and community levels through improvements to building codes, standards, and practices and identification of gaps in current knowledge about buildings, infrastructure, emergency response, and human behavior.
- NIST will create and maintain the database to facilitate disaster and failure studies and widely disseminate the data, findings, and recommendations from these studies.
- Other federal agencies, state and local governments, research institutions and industry organizations that are engaged in parallel efforts and can provide input for the database will be engaged in the development of the database. For example, developing the earthquake module of the database, NIST will engage with FEMA, NSF, and USGS.

*Pending FY 2012 Appropriations

Problem Statement

- Hazards are a continuing and significant threat to U.S. communities:
  - earthquakes
  - wind-related hazards (hurricanes, tornadoes, windstorms)
  - fire-related hazards (community-scale fires in the wildland-urban interface, structural fires)
  - water-related hazards (storm surge, tsunami)
  - human-made hazards (blast, impacts, failure during construction or in-service)

Why Conduct Post-Disaster Studies?

- Extreme events test buildings and infrastructure in ways and on a scale that cannot easily be replicated in a laboratory – buildings and infrastructure are built without being tested at full scale. The “real world” is the laboratory for buildings and infrastructure.

- The study of disaster and failure events is essential to improving the performance of buildings and infrastructure, the safety of building occupants, and the associated evacuation and emergency response procedures.

- The results of disaster and failure studies also help assess the adequacy of codes and standards, current practices, and the state-of-knowledge in these areas.

- Finally, the results of studies help minimize future risk and increase safety through improved codes, standards, and practices.

Typical Study Objectives

- Establishing likely technical factors responsible for damage, failure/successful performance of buildings/infrastructure in aftermath of disaster/failure event.
- Evaluating technical aspects of evacuation and emergency response procedures that contributed to extent of survival and injuries and fatalities sustained.
- Determining procedures and practices that were used in design, construction, operation and maintenance of buildings/infrastructure.
- Recommending, as necessary, specific improvements to standards, codes, and practices as well as any research and other appropriate actions based on study findings.

NIST promotes, enables, and tracks adoption of recommendations through improved standards, codes, and practices as well as any research and other appropriate actions based on study findings.

Types of NIST Disaster and Failure Studies

- ***Preliminary Reconnaissance:*** a field study at a disaster or failure site to gather information and to help determine if a technical investigation is warranted.

- ***Technical Investigation:*** a fact-finding study that will likely result in recommendations for improvements to standards, codes, and practices and/or new knowledge. Studies may range anywhere from:
  - limited scope, i.e., *based on data collection and interpretation, modest analytical efforts, and judgment of technical experts*,

    to
  - extensive scope, i.e., *based on in-depth technical study—including extensive use of data, models, analytical and computational tools, laboratory and/or field experiments, and/or interviews*.

NIST's Role in Disaster and Failure Studies

- NIST may use any one or a combination of the study options below in conducting a preliminary reconnaissance or a technical investigation:
  - **NIST may lead post-event studies.** In many cases, these types of studies may involve a preliminary reconnaissance followed by a technical study that may include the characterization of the hazard, the safety and performance of buildings and structures, and the associated emergency response and evacuation procedures. Private sector and academic experts may be involved in these studies through contracts. Other public sector experts may also be involved in these studies.
  - **NIST may coordinate or participate in post-event studies.** These types of studies may involve significant participation and/or coordination by other federal agencies with mission responsibilities and expertise.
  - **NIST may sponsor or participate in private sector-led post-event studies.** In many cases, these types of studies may a involve preliminary reconnaissance followed by a technical study that is limited in scope. NIST participation may be limited to guidance, oversight, and/or serving as a technical expert. These types of studies may involve significant private sector leadership and participation augmented with public sector experts.
  - **NIST may provide technical assistance in the reconstruction process for international disaster and failure events** at the request of U.S. agencies, industry, private organizations, governments of other nations, or international organizations.

International Disaster and Failure Events

- NIST may conduct reconnaissance of international disaster or failure events when lessons can be learned for the U.S.
- NIST involvement in international disaster or failure studies generally are undertaken:
  - in cooperation with other U.S. agencies, industry or private organizations, governments of other nations, or international organizations
  - for the purpose of establishing or improving practices, codes, and standards in the U.S.
- The decision criteria and guidelines for conducting studies are not intended to preclude situations where NIST is requested by other U.S. agencies, industry, private organizations, governments of other nations, or international organizations to provide technical assistance, on a reimbursable basis, in the reconstruction process for international disaster and failure events.

NIST Plan for Partnering and Agreements

- Establish strategic partnerships and standing agreements with appropriate federal agencies, state and local governments, academic and industry organizations to ensure effective national coordination in disaster and failure studies
  - NIST coordinates with the National Earthquake Hazards Reduction Program (NEHRP) agencies on post-earthquake investigations which are led by U.S. Geological Survey (USGS circular 1242 (2003) which provides the Plan to Coordinate NEHRP Post-Earthquake Investigations).
  - An ongoing NEHRP activity funded by NIST will update the plan to coordinate NEHRP post-earthquake investigations. The plan will be consistent with any changes to statute resulting from pending reauthorization (S.646, House markup pending).
- Establish coordination mechanisms and protocols for technical activities and public communications with partnering program agencies
- Provide information to other agencies, stakeholders, technical bodies, Congress, and the public

Working Definitions

- Building – The term “building” includes the structural system, the building envelope, the fire protection (active or passive) system, the air-handling system, the building control system, and other non-structural systems within a building.

- Infrastructure - The term “infrastructure” includes the physical systems and networks other than in buildings, e.g., in infrastructure lifelines such as transportation (e.g., bridges, tunnels) and utility (e.g., power, water and wastewater, oil and gas, communication) systems.

Definition of Failure

- A building or structural failure is generally understood to involve a partial or total collapse of the building or at the very least a local failure involving one or more building components (e.g., beams, girders, floors, compartments, sprinklers, smoke alarms, doors).

- NIST may study the technical aspects of:
  - building (or infrastructure) failure
  - successful building (or infrastructure) performance
  - evacuation and emergency response procedures, including
    - occupant behavior
    - evacuation (egress or access) system
    - emergency response system
    - emergency communication system

NIST Decision Criteria and Guidelines

- NIST has developed Decision Criteria and Guidelines that provide a rational basis for evaluating the value of conducting a NIST study.
  - NIST considers staff availability, resource availability, staff safety, and the quality and adequacy of information and artifacts available to conduct a meaningful study.
  - To the extent practicable, NIST will deploy a team in a timely manner after a disaster or failure event.
- If the Congress or the Administration issues a directive to respond to an event, NIST will seriously consider conducting a technical Investigation with scope that ranges anywhere from limited to extensive as appropriate to the event.
- The decision criteria and procedures may be refined as NIST gains experience with their use.

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)

Preliminary Reconnaissance Criteria

Preliminary Reconnaissance Criteria	Low (1)	Med (3)	High (5)
1. Substantial Loss of Life or Disabling Injury			
Single or adjacent structures	0	1 to 2	>2
Community (city, county, metropolitan area)	0 to 3	4 to 9	>10
Region (state to multi-state)	0 to 5	6 to 19	>20
2. Significant Potential for Loss of Life: Exposed Population			
Single structure (occupancy)	<100	100 to 499	≥500
Community (city, county, metropolitan area)	<1 000	1 000 to 9 999	≥10 000
Region (state to multi-state)	<100 000	100 000 to 999 999	≥1 000 000
3. Actual Hazard			
Earthquake	≤ MMI IV	MMI V to VII	≥MMI VIII
Hurricane at Landfall	≤Cat 3	Cat 4	Cat 5
Tornado	≤EF3	EF4	EF5
Coastal Inundation	< 3 ft	3 to 9 ft	≥ 10 ft
Fire Spread in a Structure	Fire spread not beyond area of origin	Fire spread throughout a structure	Fire spread beyond structure of origin
Wildland Urban Interface (WUI)	High Forest Service Fire Danger Rating	Very High Forest Service Fire Danger Rating	Extreme Forest Service Fire Danger Rating
Blast	< 99 lbs. TNT-equivalent	100 - 999 lbs. TNT-equivalent	>1000 lbs. TNT-equivalent
Impact	< 1 x 10^6 ft lb/sec	1 x 10^6 to 1 x 10^7 ft lb/sec	> 1 x 10^7 ft lb/sec
4. Consequences (damage and functionality)			
Failure during Construction	Local structural failure	Partial structural collapse	Total structural collapse
Engineered Building Structures	Minimal nonstructural damage	Significant nonstructural damage Minimal structural damage	Significant structural damage or collapse
Transportation & Utility Structures	Minimal nonstructural damage	Minimal structural damage Partial loss of function	Significant structural damage or collapse Complete loss of function
Non-Engineered Building Structures	Minimal nonstructural damage	Minimal structural damage	Significant structural damage or collapse
5. Need for NIST Involvement			
NIST Authority	Addressed by other authorities – and their mission responsibility and agency expertise	Collaboration with other agencies where NIST provides complementary expertise	NIST has primary authority and/or expertise
Score Sum	**__ x 1**	**__ x 3**	**__ x 5**

Preliminary Reconnaissance Criteria (2)

Preliminary Reconnaissance Criteria	Low (1)	Med (3)	High (5)
6. Stakeholder Concern			
Federal disaster declaration	N/A	Declaration; Minimal structural damage	Declaration; Significant structural damage
Request by other Authorities (local, state, federal)	None	NIST provides complementary expertise	NIST has primary expertise
Public Interest.	Local news	State or regional news	National news
Unique event with potential broad implications for similar or other types of structures	Minimal impact	Moderate impact	Significant impact
Score Sum	**__x 1**	**__ x 3**	**__ x 5**
Total Score Total Sum	**__ x 1**	**__x 3**	**__x 5**
7. Evacuation and Emergency Response			
Evacuation	Normal evacuation	Moderate evacuation challenges	Significant evacuation challenges
Emergency Response	Normal operations	Moderate operational challenges	Significant operational challenges
Score Sum	**__ x 1**	**__x 3**	**__ x 5**
8. International Events*			
Codes, standards and enforcement	No building codes, standards, or enforcement	Building codes and standards, but no enforcement	Building codes and standards, with enforcement
Construction practices similar to the U.S.	Minimally similar	Moderately similar	Significantly similar
Total Score: (From 1-6) __x__ = __ Sum	$(0.7)^n$	$(0.9)^n$	$(1.0)^n$

* n is 0,1, or 2, depending on the number of selected items under each ranking category (i.e., Low, Med, or High) for Criteria 8. The factor applied to the Total Score is the product of all three factors.

Examples of Decision Criteria

Year	Event	Criteria 1 to 5 Weighted Score	Total Weighted Score	Evacuation and/ or Emergency Response Score
Blasts and Impacts				
1993	***WTC 1 Truck Bombing***	4.2	N/A	N/A
2001	WTC 1 and WTC 2 Collapse	5.0	N/A	5.0
2001	WTC 7 Collapse	3.8	4.1	N/A
Fire Events				
2003	Rhode Island Nightclub Fire	4.2	N/A	5.0
2007	Charleston Sofa Super Store Fire	3.8	4.25	3.0
2007	California WUI Fire	4.2	N/A	5.0
Earthquake				
1994	Northridge Earthquake, Los Angeles	4.4	N/A	N/A
2001	Nisqually Earthquake, Seattle	2.7	N/A	N/A
Hurricane				
2005	Hurricane Katrina (Sun, 28 Aug)	3.0	3.5	5.0
2005	Hurricane Katrina (Tues, 30 Aug)	4.7	N/A	5.0
Structural Failures				
1981	Hyatt Regency Walkway Collapse	4.5	N/A	N/A
1981	L'Ambience Plaza	3.5	4.1	N/A
1988	Ashland Tank Failure	2.5	3.6	N/A
2006	***Elks Lodge Collapse, Missouri***	2.6	N/A	N/A
2009	Dallas Cowboys Collapse	3.5	3.6	N/A

Recent Deployments

- 2010 Maule, Chile, earthquake
- 2011 Christchurch, New Zealand, earthquake
- 2011 Amarillo, TX, wildland-urban interface fire
- 2011 Joplin, MO, tornado


Chile Earthquake


New Zealand Earthquake


Amarillo WUI fire
© 2011 Karen Slagle, Used with permission


The Home Depot, Joplin Tornado


St. John's Hospital
Joplin Tornado

Amarillo Wildfire			
Preliminary Reconnaissance Criteria	Low (1)	Med (3)	High (5)
1. Substantial Loss of Life or Disabling Injury			
A. Single or adjacent structures	0	1 to 2	>2
B. Community (city, county, metropolitan area)	0 to 3	4 to 9	>10
C. Region (state to multi-state)	0 to 5	6 to 19	>20
2. Significant Potential for Loss of Life: Exposed Population			
A. Single structure (occupancy)	<100	100 to 499	≥500
B. Community (city, county, metropolitan area)	<1 000	1 000 to 9 999	≥10 000
C. Region (state to multi-state)	<100 000	100 000 to 999 999	≥1 000 000
3. Actual Hazard			
A. Earthquake	≤ MMI IV	MMI V to VII	≥MMI VIII
B. Hurricane at Landfall	≤Cat 3	Cat 4	Cat 5
C. Tornado	≤EF3	EF4	EF5
D. Coastal Inundation	< 3 ft	3 to 9 ft	≥ 10 ft
E. Fire Spread in a Structure	Fire spread not beyond area of origin	Fire spread throughout a structure	Fire spread beyond structure of origin
F. Wildland Urban Interface (WUI)	High Forest Service Fire Danger Rating	Very High Forest Service Fire Danger Rating	Extreme Forest Service Fire Danger Rating
G. Blast	< 99 lbs. TNT-equivalent	100 - 999 lbs. TNT-equivalent	> 1000 TNT-equivalent
H. Impact	< 1 x 10^6 ft lb/sec	1 x 10^6 to 1 x 10^7 ft lb/sec	> 1 x 10^7 ft lb/sec
4. Consequences (damage and functionality)			
A. Failure during Construction	Local structural failure	Partial structural collapse	Total structural collapse
B. Engineered Building Structures	Minimal nonstructural damage	Significant nonstructural damage Minimal structural damage	Significant structural damage or collapse
C. Transportation & Utility Structures	Minimal nonstructural damage	Minimal structural damage Partial loss of function	Significant structural damage or collapse Complete loss of function
D. Non-Engineered Building Structures	Minimal nonstructural damage	Minimal structural damage	Significant structural damage or collapse
5. Need for NIST Involvement			
A. NIST Authority	Addressed by other authorities – federal, state, local – and their mission responsibility and agency expertise	Collaboration with other agencies where NIST provides complementary expertise	NIST has primary authority and/or expertise
Score: 19 / 5 = 3.8 **Sum**	1 x 1	1 x 3	3 x 5

Preliminary Reconnaissance Criteria	Low	Med	High
6. Stakeholder Concern			
A. Federal disaster declaration	N/A	Declaration; Minimal structural damage	Declaration; Significant structural damage
B. Request by other Authorities (local, state, federal)	None	NIST provides complementary expertise	NIST has primary expertise
C. Public Interest.	Local news	State or regional news	National news
D. Unique event with potential broad implications for similar or other types of structures	Minimal impact	Moderate impact	Significant impact
Score: _13_/_3_ = _4.3_ Sum	_0_ x 1	_1_ x 3	_2_ x 5
Total Score: _32_/_8_ = _4.0 Total Sum	_1_ x 1	_2_ x 3	_5_ x 5
7. Evacuation and Emergency Response			
A. Evacuation	Normal evacuation	Moderate evacuation challenges	Significant evacuation challenges
B. Emergency Response	Normal operations	Moderate operational challenges	Significant operational challenges
Score: __/__ = __ Sum	__ x 1	__ x 3	__ x 5
8. International Events*			
A. Codes, standards and enforcement	No building codes, standards, or enforcement	Building codes and standards, but no enforcement	Building codes and standards, with enforcement
B. Construction practices similar to the	Minimally similar	Moderately similar	Significantly similar
Total Score: (From 1-6) __x__ = __ Sum	$(0.7)^n$	$(0.9)^n$	$(1.0)^n$

Minneapolis Metrodome Roof 12/12/2010			
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C. Tornado	≤EF3	EF4	EF5
D. Coastal Inundation	< 3 ft	3 to 9 ft	≥ 10 ft
E. Fire Spread in a Structure	Fire spread not beyond area of origin	Fire spread throughout a structure	Fire spread beyond structure of origin
F. Wildland Urban Interface (WUI)	Service Fire Danger Rating	Very High Service Fire Danger Rating	Service Fire Danger Rating
G. Blast	< 99 lbs. TNT-equivalent	100 - 999 lbs. TNT-equivalent	> 1000 TNT-equivalent
H. Impact	< 1 x 10^6 ft lb/sec	1 x 10^6 to 1 x 10^7 ft lb/sec	> 1 x 10^7 ft lb/sec
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Score: _14_/_4_ = _3.5_ Sum	_1_ x 1	_1_ x 3	_2_ x 5

Preliminary Reconnaissance Criteria	Low	Med	High
6. Stakeholder Concern			
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C. Public Interest.	Local news	State or regional news	National news
D. Unique event with potential broad implications for similar or other types of structures	Minimal impact	Moderate impact	Significant impact
Score: _7_/_3_ = _2.3_ **Sum**	_2_ x 1	_0_ x 3	_1_ x 5
Total Score: _21_/_7_ = _3.0_ **Total Sum**	_3_ x 1	_1_ x 3	_3_ x 5

7. Evacuation and Emergency Response			
A. Evacuation	Normal evacuation	Moderate evacuation challenges	Significant evacuation challenges
B. Emergency Response	Normal operations	Moderate operational challenges	Significant operational challenges
Score: __/__ = __ **Sum**	__ x 1	__ x 3	__ x 5

8. International Events*			
A. Codes, standards and enforcement	No building codes, standards, or enforcement	Building codes and standards, but no enforcement	Building codes and standards, with enforcement
B. Construction practices similar to the	Minimally similar	Moderately similar	Significantly similar
Total Score: (From 1-6) __x__ = __ **Sum**	$(0.7)^n$	$(0.9)^n$	$(1.0)^n$

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 Panel on Wind and Seismic Effects of The United States-Japan Cooperative Program in Natural Resources (UJNR)**

Purpose and Scope of NCST Authorities

- The purpose of NCST studies is to improve the safety and structural integrity of buildings *("and infrastructure"* in pending NCST Act reauthorization, S.646*)* in the United States, and the focus is on fact finding.
- NCST Teams are authorized to assess building performance and emergency response and evacuation procedures in the wake of any building failure that has resulted in substantial loss of life or that posed significant potential for substantial loss of life.
- NIST does not have the statutory authority to make findings of fault by individuals or organizations.
- Further, no part of any report resulting from a NIST investigation into a building failure or from an investigation under the National Construction Safety Team Act may be used in a suit or action for damages arising out of any matter mentioned in such report (15 U.S.C 281a, as amended by Public Law 107-231).

National Construction Safety Team Act - PL 107-231

- Authorizes Director of NIST to establish and deploy Teams, to the maximum extent practicable, within 48 hours of an event (pending NCST Act reauthorization in Congress, S.646, authorizes NIST Director to make a decision to deploy within 72 hours of an event).
- Tailored to events involving substantial loss of life or that pose significant potential for substantial loss of life.
- Modeled by Congress after the National Transportation Safety Board (NTSB)
    - NIST is the designated lead agency to assess:
        - Building performance
        - Emergency response
        - Evacuation procedures
    - Investigation priority (except for NTSB and criminal acts)
    - Prohibits interference with search and rescue efforts

NCST Coordination and Priorities

- "NIST shall enter into a memorandum of understanding with each Federal agency that may conduct or sponsor a related investigation, providing for coordination of investigations"
  - Criminal Acts— "If the Attorney General, in consultation with the [NIST] Director, determines and notifies the Director, that circumstances reasonably indicate that the building failure being investigated by a Team may have been caused by a criminal act, the team shall relinquish investigative priority to the appropriate law enforcement agency. The relinquishment of investigative priority by the Team shall not otherwise affect the authority of the Team to continue its investigation under this Act."
  - NTSB —"If the NTSB is conducting an investigation related to an investigation of a Team, the NTSB investigation shall have priority over the Team investigation. Such priority shall not otherwise affect the authority of the Team to continue its investigation under this Act."
- "A Team shall cooperate with State and local authorities carrying out any activities related to a Team's investigation"

Post-Investigation Actions Required by NCST

- After the issuance of a Team report, NIST…shall, working with USFA and other appropriate Federal and non-Federal agencies and organizations to:
  - Conduct, or enable or encourage the conducting of, appropriate research recommended by the Team
  - 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
    - Technical aspects of evacuation and emergency response procedures
    - Specific improvements to building standards, codes, and practices
    - Other actions needed to help prevent future building failures

NCST Advisory Committee

Objectives and Duties:

- Advise the Director of the National Institute of Standards and Technology on carrying out the Act by:
  - Providing advice on the functions of National Construction Safety Teams, hereinafter referred to as Teams, as described in section 2(b)(2) of the Act
  - Providing advice on the composition of Teams under section 3 of the Act
  - Providing advice on the exercise of authorities enumerated in sections 4 and 5 of the Act
  - Providing such other advice as necessary to enable the Director to carry out the Act
- Review and provide advice on the procedures developed under section 2(c)(1) of the Act
- Review and provide advice on the reports issued under section 8 of the Act
- Function solely as an advisory body, in accordance with the provisions of the Federal Advisory Committee Act

Annual Report:

- An evaluation of Team activities, along with recommendations to improve the operation and effectiveness of Teams
- An assessment of the implementation of the recommendations of Teams and of the advisory committee

NCST Advisory Committee

- Members are selected on the basis of established records of distinguished service in their professional community and their knowledge of issues affecting Teams.
- Members reflect the wide diversity of technical disciplines and competencies involved in NCST studies.
- Members are drawn from industry and other communities having an interest in NCST studies, such as, but not limited to, universities, state and local government bodies, non-profit research institutions, and other Federal agencies and laboratories.
- The types of disciplines include: structural engineering (buildings and infrastructure), fire protection, firefighting and emergency response, and human behavior and evacuation. Other disciplines that may be represented include: codes and standards (buildings, infrastructure and fire), architecture, insurance and risk, and materials science and engineering.

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 Kiremidijian, 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.)

Examples of Past Studies

Earthquakes

- San Fernando (1971)
- Mexico City (1985)
- Loma Prieta (1989)
- Northridge (1994)
- Kobe (1995)
- Turkey (1999)
- Chile (2010)
- Christchurch (2011)

Hurricanes

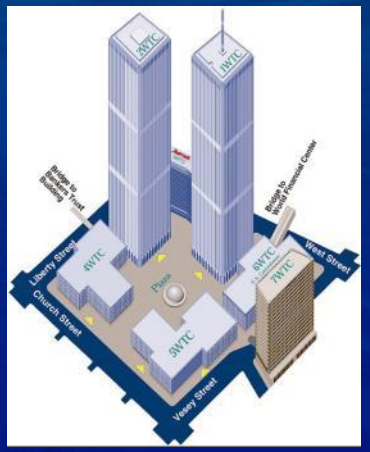
- Camille (1969)
- Hugo (1989)
- Andrew (1992)
- Mitch (1998)
- Katrina (2005)

Tornadoes

- Jarrell, TX (1997)
- Spencer, SD (1998)
- Oklahoma City (1999)
- Joplin, MO (2011)

Construction/Building

- Bailey's Crossroads (1973)
- Hyatt Regency (1981)
- L'Ambiance Plaza (1987)
- U.S. Embassy, Moscow (1987)
- Murrah Fed. Building (1995)
- World Trade Center (2001)
- Dallas Cowboys (2009)



Fires

- DuPont Plaza Hotel (1986)
- 1st Interstate Bank (1988)
- Happyland Club (1990)
- Oakland Hills (1991)
- Hokkaido, Japan (1993)
- Vandalia St, NYC (1998)
- Cherry Road, DC (1999)
- Cook County Admin.(2003)
- Station Nightclub (2003)
- Sofa Super Store (2007)
- Amarillo WUI Fire (2011)

Typical NIST Post-Study Actions

- Conduct, or enable or encourage the conducting of, appropriate research recommended by studies
- 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 study recommendations with respect to
  - Technical aspects of evacuation and emergency response procedures
  - Specific improvements to building standards, codes, and practices
  - Other actions needed to help improve safety

Stakeholders and Contributors

NIST Role in Building, Infrastructure, and Fire Safety Regulations

- NIST is a non-regulatory agency of the U.S. Department of Commerce
- NIST does not set building, infrastructure, or fire codes and standards
- NIST provides technical support to the private sector and to other government agencies in the development of U.S. building, infrastructure, and fire practice, standards, and codes by:
  - Conducting research which provides the measurement science and technical basis for such practice, standards, and codes
  - Disseminating research results to practicing professionals
  - Having staff participate on technical and standards committees
  - Providing technical assistance to the building, infrastructure, and fire safety communities

How NIST Products and Services come to be used in Engineering Practices, Standards and Codes

- NIST ***listens*** to major national bodies to identify priority issues.
- NIST ***organizes*** workshops to define problem, approach and desired products.
- NIST, working with its partners, develops ***technical basis*** for potential change to practices, standards, and/or codes in the form of critical solution-enabling tools through measurement science research and services.
- NIST generally seeks solutions that foster ***open systems and processes***, thus facilitating innovation and competitiveness.
- NIST participates in ***international standardization*** activities and works closely with overseas counterparts to maintain awareness, promote open systems, spot barriers to trade.
- NIST works with intended users to ***demonstrate value in use*** of emerging products, processes, and systems.
- NIST participates in technical standards and codes committees, makes ***critical technical contributions*** to development of standards, codes, and regulations, and publicly disseminates NIST products and services.
- National technical, professional, standards and/or code developing organizations, and regulatory agencies ***adopt*** changes; state and local officials develop and ***enforce*** regulations; and industry ***uses*** new practices, standards, and codes.

Total cycle times vary from months to decades

Sample Impacts of Disaster and Failure Studies

- World Trade Center (2001)
  - U.S. model building code changes adopted for fireproofing strength, installation, and inspection; fire-resistance rating; structural integrity
  - U.S. model building code changes adopted for occupant evacuation; fire service access; active fire protection systems; emergency responder communications
- The Station Nightclub Fire (2003)
  - Sprinklers, restricted festival seating, crowd manager, and egress inspection recordkeeping requirements for new and existing facilities adopted in NFPA 101 (Life Safety Code)
- Jarrell, TX, Tornado (1997)
  - Enhanced Fujita (EF) Tornado Intensity Scale adopted by NOAA's National Weather Service
- Northridge Earthquake (1994)
  - Design guidelines for seismic rehabilitation of existing welded steel frame buildings adopted by American Institute of Steel Construction
- Hurricane Andrew (1992)
  - Upgraded wind load provisions adopted in HUD's Manufactured Home Construction and Safety Standards
- DuPont Plaza Hotel Fire, San Juan PR (1986)
  - Passage of the Hotel-Motel Sprinkler Act
- L' Ambiance Plaza, Hartford CT (1982)
  - Improvements in OSHA's safety and inspection requirements for lift-slab construction

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