National Construction Safety Team Act
Annual Report

Fiscal Year 2007

Introduction

In October 2002, the President signed into law the National Construction Safety Team (NCST) Act (P.L. 107-231), which authorized the Director of the National Institute of Standards and Technology (NIST) to establish National Construction Safety Teams for deployment after events causing the 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:

(A) establish the likely technical cause or causes of the building failure;
(B) evaluate the technical aspects of evacuation and emergency response procedures;
(C) recommend as necessary, specific improvements to building standards, codes, and practices based on the findings made pursuant to subparagraphs (A) and (B); and,
(D) 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 by February 15 of each year a report that includes:

(1) a summary of the investigations conducted by Teams during the prior fiscal year;
(2) a summary of recommendations made by Teams in reports issued under Section 8 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 National Institute of Standards and Technology during the prior fiscal year in response to reports issued under Section 8.

This report summarizes NIST's activities under the NCST Act for Fiscal Year 2007.

Investigations Conducted by Teams during Fiscal Year 2007

No new investigations were undertaken during Fiscal Year 2007. NIST issued the final report on World Trade Center 1 and 2 in October 2005. The final report and the 42 supporting project and technical topic reports are available on the NIST WTC web site, http://wtc.nist.gov. NIST's analysis of the collapse of World Trade Center 7 continued during 2007. The analysis of WTC 7 benefited from the acquisition of shop drawings in the spring of 2007; however, as a result of its review of the drawings, NIST and its contractors found it necessary to revise the connection details in the analytical models to accurately reflect the connections used in the building. This revision to the models combined with unanticipated long run times for the analytical models due to their complexity have delayed the expected completion date for the investigation. NIST anticipates releasing the draft final report on the investigation of WTC 7 in the summer of 2008.

Recommendations Made by Teams and the Extent of Implementation

NIST has conducted its building and fire safety investigation of the World Trade Center disaster of September 11, 2001, under the authority of the National Construction Safety Team Act (15 USC 7301 et seq.). The National Construction Safety Team's final report is required by the Act to include recommendations that address (1) specific improvements to building standards, codes, and practices, (2) changes to, or the establishment of, evacuation and emergency response procedures, and (3) research and other appropriate actions needed to help prevent future building failures.

As a part of its investigation of the World Trade Center disaster, NIST issued thirty recommendations that identified specific improvements in the way buildings are designed, constructed, maintained, and used in evacuation and emergency response procedures. Recommendations were made in eight areas:

(1) Increased Structural Integrity
(2) Enhanced Fire Endurance of Structures
(3) New Methods for Fire Resistant Design of Structures
(4) Improved Active Fire Protection
(5) Improved Building Evacuation
(6) Improved Emergency Response
(7) Improved Procedures and Practices
(8) Education and Training

These recommendations are documented in Chapter 9 of NIST's Final Report on the Collapse of the World Trade Center Towers (NIST NCSTAR 1, September 2005). In addition, NIST maintains a status of the implementation of these recommendations on the NIST WTC web site (http://wtc.nist.gov/recommendations/index.htm). The current status of the implementation of the recommendations from the World Trade Center investigation is shown in Appendix 1.

NIST conducted its investigation of the February 20, 2003 Station Nightclub Fire under the authorities of the NCST Act. The final report on the investigation was issued in June 2005 and included ten specific recommendations to improve building safety (http://www.nist.gov/public_affairs/ncst/Station_recommendations_2.html). NIST tracks the status of the implementation of recommendations resulting from it investigation of the Station Nightclub Fire. The current status of the implementation of these recommendations is shown in Appendix 2.

Actions Taken to Improve Building Safety and Structural Integrity

NIST has undertaken a number of actions to improve the safety and structural integrity of buildings in response to the recommendations resulting from the World Trade Center Investigation. NIST contracted with the National Institute of Building Sciences (NIBS) to assemble a group of code experts to review the recommendations resulting from the World Trade Center Investigation and develop proposals for code changes where appropriate. NIST technical experts provide technical support to the NIBS Code Experts Committee.

The members of the NIBS Code Experts Committee submitted nineteen proposals for change to the International Code Council (ICC) in March of 2006 for consideration at the September 2006 Code Hearings. At the Final Action Hearing in May 2007, eight of the proposed changes were adopted for inclusion in the Supplement to the 2006 International Building Code (IBC). These changes include the following:

- An additional exit stairway for buildings more than 420 feet in height.
- A minimum of one fire service access elevator for buildings more than 120 feet in height.
- Increased bond strength for fireproofing (nearly three times greater than currently required for buildings 75-420 feet in height and seven times greater for buildings more than 420 feet in height).
- Field installation requirements for fireproofing to ensure that:
    - installation complies with the manufacturer's instructions;
    - the substrates (surfaces being fireproofed) are clean and free of any condition that prevents adhesion;
    - testing is conducted to demonstrate that required adhesion is maintained for primed, painted or encapsulated steel surfaces; and
    - the finished condition of the installed fireproofing, upon complete drying or curing, does not exhibit cracks, voids, spalls, delamination or any exposure of the substrate.
- Special field inspections of fireproofing to ensure that its as-installed thickness, density and bond strength meet specified requirements, and that a bonding agent is applied when the bond strength is less than required due to the effect of a primed, painted or encapsulated steel surface. The inspections are to be performed after the rough installation of mechanical, electrical, plumbing, sprinkler and ceiling systems.

- Increasing by one hour the fire-resistance rating of structural components and assemblies in buildings 420 feet and higher. (This change was approved in a prior edition of the code.)
- Explicit adoption of the "structural frame" approach to fire resistance ratings that requires all members of the primary structural frame to have the higher fire resistance rating commonly required for columns. The primary structural frame includes the columns, other structural members including the girders, beams, trusses, and spandrels having direct connections to the columns, and bracing members designed to carry gravity loads.
- Luminous markings delineating the exit path (including vertical exit enclosures and passageways) in buildings more than 75 feet in height to facilitate rapid egress and full building evacuation.

In August 2007, a total of forty-seven proposals for changes were submitted to the ICC for consideration during the 2007/2008 code cycle. These proposals address the following areas:

- Structural Collapse
- Wind Tunnel Testing
- Fire Command Center
- Emergency Responder Communication
- Fire Service Elevator/Fire Service Elevator Lobby
- Exit Path Markings
- Fire Rated Wall Impact Resistance/Exit Enclosure Impact Resistance/Exit and Elevator Enclosure Impact Resistance
- Structural Frame
- Sprinkler Redundancy
- Burnout Without Collapse
- Stairway Communication
- Exit Remoteness
- Additional Exit Stair
- Sprayed Fire Resistive Materials
- Buildings Requiring Risk Assessment
- Evacuation Plans
- Occupant Evacuation Elevators
- Vertical Exit Continuity

Several of the proposals submitted seek to modify or improve on the new provisions that were adopted into the Supplement to the 2006 IBC. A number of proposals submitted by the ICC's Ad-Hoc Committee on Terrorism Resistant Buildings that were voted down in the last code cycle have been revised to address comments received and resubmitted for consideration during the current code cycle. The proposals for change submitted for consideration to the current code cycle also include a proposal on structural integrity developed by the Ad-Hoc Joint Industry Committee on Structural Integrity, a coalition of relevant industry groups. One proposal seeks to remove the provision for an additional exit stairway in buildings over 420 feet in height that was adopted into the Supplement to

the 2006 IBC, while another seeks to add specially protected occupant evacuation elevators. These proposals will be considered initially during the ICC Code Development Hearings scheduled for February 2008. The Final Action Hearing for the 07/08 code cycle is scheduled for September 2008. Proposals adopted during the 07/08 code cycle will appear in the 2009 editions. Appendix 1 includes updated information on the status of implementation of the WTC Investigation Recommendations and the code change proposals.

The NIBS Code Experts Committee is also working with the National Fire Protection Association (NFPA) to support proposals for change to the NFPA 5000 building code and the NFPA fire codes that respond to the recommendations of the WTC investigation.

NIST technical experts are also working closely with several standards and industry organizations including the American Society of Civil Engineers, ASTM International, the National Council of Structural Engineering Associations, American Society of Mechanical Engineers and others to provide technical support as these bodies consider actions that respond to the WTC Investigation recommendations.

NIST has ten active research projects under the Research and Development for the Safety of Threatened Buildings program that support research needs identified in the WTC Investigation recommendations. A detailed description of the Safety of Threatened Buildings Program and the component projects is available on the NIST Building and Fire Research Laboratory web site, http://www2.bfrl.nist.gov/projects/goalslist.asp.

Appendix 1

NIST's Recommendations Following the Federal Building and Fire Investigation of the World Trade Center Disaster

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
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. ***Affected Standards:*** ASCE-7, AISC Specifications, and ACI 318. These standards and other relevant committees should draw on expertise from ASCE/SFPE 29 for issues concerning progressive collapse under fire conditions. *Model Building Codes:* The consensus standards	NIBS: The ICC Ad-Hoc Committee-Terrorism Resistant Buildings (AHC-TRB) submitted an IBC change proposal concerning Disproportionate Collapse (**S59-07/08**) for the 2007/2008 code cycle. ICC: The ICC received two proposals concerning Disproportionate Collapse for the 2007/2008 code cycle. ICC AHC-TRB submitted proposal **S59-07/08** and the Ad-Hoc Joint Industry Committee on Structural Integrity submitted proposal **S101-07/08** on Structural Integrity. The ICC has also received a proposal (**G108-07/08**) from the Ad-Hoc Joint Industry Committee on Structural Integrity for a new provision addressing buildings requiring risk assessment. The Ad-Hoc Joint Industry Committee on Structural Integrity: The Ad-Hoc Joint Industry Committee on Structural Integrity submitted a code change proposal on Structural Integrity **S101-07/08** for the 2007/2008 code	**Research Outcomes:** (NIST) Best Practices Guideline published February 2007 (NISTIR 7396).

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
should be adopted in model building codes (i.e., the *International Building Code* and NFPA 5000) by mandatory reference to, or incorporation of, the latest edition of the standard. State and local jurisdictions should adopt and enforce the improved model building codes and national standards based on all 30 WTC Investigation recommendations. The codes and standards may vary from the WTC Investigation recommendations, but satisfy their intent.	cycle. The Committee has also submitted a proposal (**G108-07/08**) for a new provision addressing buildings requiring risk assessment. ASCE: ASCE has formed a technical committee that has met twice (May 2006; May 2007); NIST staff members participate on the committee. NIST: Multi-year NIST project to support the development of performance criteria, prediction tools, and practical guidance for prevention of progressive collapse. NIST has conducted studies of the robustness of steel moment frame connections and composite floor systems. NIST has provided to AISC TC 3, Loads, Analysis, & Systems, the NIST report on Comparison of Existing Design Standards on Progressive Collapse for consideration. NFPA: NFPA is considering a proposal requiring risk assessment for certain events (terrorist attack) (5000-ROC-300). This is an annex note proposed to suggest risk assessment be prepared for buildings greater than 420 feet in height or that have more than 10,000 occupants. Assessment should be based on general principals and should evaluate anticipated performance of the building under some extreme load or extreme event. This proposal	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
	will be voted on during the NFPA Annual Meeting in June 2008.	
Recommendation 2. NIST recommends that nationally accepted performance standards be developed for: (1) conducting wind tunnel testing of prototype structures based on sound technical methods that result in repeatable and reproducible results among testing laboratories; and (2) estimating wind loads and their effects on tall buildings for use in design, based on wind tunnel testing data and directional wind speed data. ***Affected National Standard:*** ASCE-7. *Model Building Codes:* The standard should be adopted in model building codes by mandatory reference to, or incorporation of, the latest edition of the standard.	NIBS: The ICC Code Technology Committee (CTC) submitted an IBC change proposal, Determination of Wind Loads and Wind Tunnel Testing (**S81-07/08**), to reference the new ASCE standard, ASCE/SEI 49. ASCE: The ASCE Committee developing the new standard, ASCE/SEI 49, is working to resolve comments received during the second ballot of the new standard. NFPA: Recommended that expert groups such as ASCE, NCSEA or a combination of the two work towards development of a guideline document. Once available, NFPA 5000 would consider referencing such a guidance document. NFPA will consider making this a formal recommendation to ASCE or NCSEA via the NFPA High Rise Building Safety Advisory Committee (HRBSAC). NIST: Multi-year NIST project to support the development of prediction methodologies for wind loads estimation in next-generation standards. NIST has submitted three change proposals for consideration by the ASCE 7 wind committee. These proposals include: revisions to the peak gust wind speeds at 10 m over open	**Research Outcomes:** (NIST) NIST has made available on its website (www.nist.gov/wind) software for applying database assisted design techniques to high-rise buildings. NIST has also made available through the website a large aerodynamic database for rigid low rise buildings.

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
	terrain for hurricanes; interfacing correctly directional extreme wind climatological and directional aerodynamics information, and to account for uncertainties in dynamic parameters (damping, natural frequencies, modal shapes) to assure adequate safety margins for tall buildings; and, a change to address the risk of failure in regions prone to both extreme winds and seismic events.	
Recommendation 3. NIST recommends that an appropriate criterion be developed and implemented to enhance the performance of tall buildings by limiting how much they sway under lateral load design conditions (e.g., winds and earthquakes). ***Affected National Standards:*** ASCE-7, AISC Specifications, and ACI 318. *Model Building Codes:* The standards should be adopted in model building codes by mandatory reference to, or incorporation of, the latest edition of the standard.	NIBS: Not directly an IBC issue but rather an AISC, ACI, ASCE 7 issue. NIBS committee wrote to ASCE staff and ASCE 7 chair encouraging that the issue be addressed in the near-term and that the committee be involved in that process. NIST: Consulted with major design firms and reviewed designs of 36 buildings to tabulate range of drift ratios found in common practice. NIST is working with ASCE Committee on Design of Steel Building Structures to address Practices related to Design of Steel Buildings under Wind Loads. NFPA: Recommended that expert groups such as ASCE, NCSEA or a combination of the two work towards development of a guideline document. Once available,	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
	NFPA 5000 would consider referencing such a guidance document. Current drift limit criteria for seismic design as well as serviceability issues should be considered when any changes are suggested by ASCE/NCSEA. NFPA will consider making this a formal recommendation to ASCE or NCSEA via the NFPA High Rise Building Safety Advisory Committee (HRBSAC).	
Recommendation 4. NIST recommends evaluating, and where needed improving, the technical basis for determining appropriate construction classification and fire rating requirements (especially for tall buildings)—and making related code changes now as much as possible—by explicitly considering factors including: • timely access by emergency responders and full evacuation of occupants, or the time required for burnout without partial collapse;	NIBS: The ICC AHC-TRB submitted an IBC change proposal, Survival of a Building Contents Fire (**G51-07/08**). ICC: The ICC has received two proposals (**G51-07/08** and **G52-07/08**) that address survival of a building contents fire for consideration during the 2007/2008 code cycle. NFPA: The NFPA High Rise Building Safety Advisory Committee (HRBSAC) is considering a categorization process for high rise buildings. HRBSAC is also working to determine what enhanced or redundant features may be necessary based on this resultant categorization process. NFPA committees will also be closely reviewing the WTC	**Code Outcomes:** (IBC) Increased by one hour the fire-resistance rating of structural components and assemblies in buildings 420 feet and higher. This change was approved and included in the 2004 supplement to the IBC and later in the 2006 IBC (section 403.3.1, Item 1). National Electrical Code: Article 708 of the 2008 National Electrical Code addresses critical operations power supply. The article can

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• the extent to which redundancy in active fire protection (sprinkler and standpipe, fire alarm, and smoke management) systems should be credited for occupant life safety ; • the need for redundancy in fire protection systems that are critical to structural integrity; • the ability of the structure and local floor systems to withstand a maximum credible fire scenario without collapse, recognizing that sprinklers could be compromised, not operational, or non-existent; • compartmentation requirements (e.g., 12,000 ft2 (27)) to protect the structure, including fire rated doors and automatic enclosures, and limiting air supply (e.g., thermally resistant window	7 report as it relates to Bullet Item 6. Article 708 of the 2008 National Electrical Code addresses critical operations power supply. The article can be applied to any critical systems.	be applied to any critical systems.

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
assemblies) to retard fire spread in buildings with large, open floor plans; • the effect of spaces containing unusually large fuel concentrations for the expected occupancy of the building; and • the extent to which fire control systems, including suppression by automatic or manual means, should be credited as part of the prevention of fire spread. ***Model Building Codes:*** A comprehensive review of current construction classification and fire rating requirements and the establishment of a uniform set of revised thresholds with a firm technical basis that considers the factors identified above should be undertaken.		

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
Recommendation 5. NIST recommends that the technical basis for the century-old standard for fire resistance testing of components, assemblies, and systems be improved through a national effort. Necessary guidance also should be developed for extrapolating the results of tested assemblies to prototypical building systems. A key step in fulfilling this recommendation is to establish a capability for studying and testing the components, assemblies, and systems under realistic fire and load conditions. ***Affected National and International Standards:*** ASTM E 119, NFPA 251, UL 263, and ISO 834. *Model Building Codes:* The standards should be adopted in model building codes by mandatory reference to, or incorporation of, the latest edition of the standard.	NIBS: The NIBS Building Code Experts will support efforts to change ASTM E119 and related Underwriters Laboratories (UL) and National Fire Protection Association (NFPA) standards. NIST: Developed and submitted recommendations for changes to the E119 standard to ASTM E05. ASTM E05 is considering these changes. NIST plans to submit detailed proposals in pre-standard language for consideration by E05 before the committee's December 2008 meeting. ASTM: International Subcommittee E05.11 on Fire Resistance began addressing this recommendation concerning changes to ASTM standard E 119 in December 2005. Numerous revisions have been proposed, most significantly changes in the measurement of heat flux, which are in the balloting process. E05 has held a series of workshops on plate and directional flame thermometers as they relate to the NIST recommendations and balloting actions are anticipated in the near future. NFPA: The Fire Protection Research Foundation (FPRF) of the NFPA is working along side the ASTM E05 process	

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	to complete a literature review and to begin an evaluation process.	
Recommendation 6. NIST recommends the development of criteria, test methods, and standards: (1) for the in-service performance of sprayed fire-resistive materials (SFRM, also commonly referred to as fireproofing or insulation) used to protect structural components; and (2) to ensure that these materials, as-installed, conform to conditions in tests used to establish the fire resistance rating of components, assemblies, and systems. ***Affected Standards:*** AIA MasterSpec and AWCI Standard 12 for field inspection and conformance criteria; ASTM standards for SFRM performance criteria and test methods. *Model Building Codes:* The standards should be adopted in model building codes by mandatory reference to, or incorporation of, the	ICC: The ICC has received two proposals that address spray applied fire-resistive materials. **G68-07/08** seeks to clarify the language used in the provision adopted in the 2007 supplement that addresses the building heights at which higher bond strength material is required. The second proposal (**G69-07/08**) seeks to delete the provision adopted in the 2007 supplement requiring higher bond strength fireproofing in tall buildings. NFPA: Technical Committees are expected to review proposals that will mandate conformance with field inspection/quality control issues from groups like AWCI and FCIA. ASTM: Standard E2584-07 "Standard Practice for Thermal Conductivity of Materials Using a Thermal Capacitance (Slug) Calorimeter," was approved by ASTM Committee E37 in September 2007. International Committee E06 on Performance of Buildings is addressing this recommendation and other related SFRM recommendations.	**Code Outcomes:** (IBC) Increased bond strength for fireproofing (nearly three times greater than currently required for buildings 75-420 feet in height and seven times greater for buildings more than 420 feet in height). Field installation requirements for fireproofing to ensure that: • installation complies with the manufacturer's instructions; • the substrates (surfaces being fireproofed) are clean and free of any condition that prevents adhesion; • testing is conducted to demonstrate that required adhesion is

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
latest edition of the standard. (See Recommendation 10 for more on this issue.)	NIST: NIST, in partnership with private industry, is developing a new field test method to assess adhesion. Two standards are currently in development: one based on a peel test and the second based on a blister test. NIST has been in discussions with ASTM E06 regarding the development of these two proposals.	maintained for primed, painted or encapsulated steel surfaces; and • the finished condition of the installed fireproofing, upon complete drying or curing, does not exhibit cracks, voids, spalls, delamination or any exposure of the substrate. Special field inspections of fireproofing to ensure that its as-installed thickness, density and bond strength meet specified requirements, and that a bonding agent is applied when the bond strength is less than required due to the effect of a primed, painted or encapsulated steel surface. The inspections are to be performed after the rough installation of mechanical,

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		electrical, plumbing, sprinkler and ceiling systems. **Standards Outcome:** (ASTM) ASTM E2584-07 "Standard Practice for Thermal Conductivity of Materials Using a Thermal Capacitance (Slug) Calorimeter," was been approved by ASTM Committee E37 in September 2007.
Recommendation 7. NIST recommends the adoption and use of the "structural frame" approach to fire resistance ratings. ***Model Building Codes:*** This approach is currently required by the *International Building Code (IBC)*, one of the model codes, and was incorporated into the 2006 edition of NFPA 5000, Building Construction and Safety Code. This requirement ensures consistency in the fire	ICC: The ICC has received three proposals for modification to provisions that address the fire resistance of the structural frame. These proposals, **FS113-07/08**, **FS114-07/08** and **FS115-07/08** will be considered during the 2007/2008 code development cycle. These proposals seek to modify the provision that was adopted into the 2007 supplement to the IBC.	**Codes Outcome:** (IBC) Explicit adoption of the "structural frame" approach to fire resistance ratings that requires all members of the primary structural frame to have the higher fire resistance rating commonly required for columns. The primary structural frame includes the columns, other structural members including the girders, beams, trusses, and spandrels

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
protection provided to all of the structural elements that contribute to overall structural stability. State and local jurisdictions should adopt and enforce this requirement.		having direct connections to the columns, and bracing members designed to carry gravity loads. (NFPA): The structural frame approach is mandated in the 2006 edition of NFPA 5000.
Recommendation 8. NIST recommends that the fire resistance of structures be enhanced by requiring a performance objective that uncontrolled building fires result in burnout without partial or global (total) collapse. ***Model Building Codes:*** This recommendation should be included into the national model codes as an objective and adopted as an integral part of fire resistance design for structures. The issue of non-operational sprinklers could be addressed using the existing concept of Design Scenario 8 of NFPA 5000,	NIBS: The ICC AHC-TRB has submitted an IBC change proposal (**G51-07/08**) addressing burnout without collapse in buildings over 420 feet in height for consideration in the 2007/2008 code development cycle. ICC: The ICC has received two proposals addressing burnout without collapse in buildings over 420 feet in height (**G51-07/08** and **G52-07/08**). These proposals will be considered during the 2007/2008 development cycle. NFPA: NFPA is considering a proposed change to address design for local/global collapse due to fire (5000-ROC-68b). When the Performance Based Design (PBD) provisions are utilized, this change establishes a design scenario that requires high rise buildings to be evaluated for performance under a fully developed fire event and the ability of the structure withstand that design event.	

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where such compromise is assumed and the result is required to be acceptable to the Authority Having Jurisdiction. *Affected Standards:* ASCE-7, AISC Specifications, ACI 318, and ASCE/SFPE 29.	Building performance must resist both local and global collapse under the specified design fire. This proposal will be voted on during the NFPA Annual Meeting in June 2008. NIST: Multi-year NIST project to support the development of performance objectives, criteria, evaluation methods, prediction tools, and practical guidance for fire resistance design and retrofit of structures. NIST is working with AISC TC 8 Design for Fire Conditions to implement performance-based approach to steel design.	
Recommendation 9. NIST recommends the development of: (1) performance-based standards and code provisions, as an alternative to current prescriptive design methods, to enable the design and retrofit of structures to resist real building fire conditions, including their ability to achieve the performance objective of burnout without structural or local floor collapse: and (2) the tools, guidelines, and test methods necessary to evaluate the fire	NIBS: The NIBS Building Code Experts support the performance-based design concept and will bring together various interests to identify gaps with respect to evaluation tools and to develop a detailed action plan (with estimated costs) for filling those gaps. Three national standards (ASCE/SFPE 29, ACI 216, and AISC Specifications) have incorporated first-generation performance-based methods, as an alternative to current prescriptive methods, to enable the design and retrofit of structures to resist building fires. These methods are limited to standard (not real) fires. NFPA: Technical Committees are likely to parse this recommendation to distinguish between local collapse and	

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performance of the structure as a whole system. ***Affected National and International Standards:*** ASCE-7, AISC Specifications, ACI 318, and ASCE/SFPE 29 for fire resistance design and retrofit of structures; NFPA, SFPE, ASCE, and ISO TC92 SC4 for building-specific multi-compartment, multi-floor design basis fire scenarios; and ASTM, NFPA, UL, and ISO for new test methods. *Model Building Codes:* The performance standards should be adopted as an alternate method in model building codes by mandatory reference to, or incorporation of, the latest edition of the standard.	global collapse. PBD options already in NFPA 101 and NFPA 5000 address the possibility of non-functioning/available systems or features. NFPA supports the adoption of more formal guidance to establish performance criteria and relevant guidelines or information. ASTM: Various committees in ASTM International have been addressing the issue of performance-based methods. NIST: NIST is working with AISI, AISC, and other industry groups to support the development of performance-based standards for fire resistance design and retrofit of structures. Multi-year NIST project to support the development of performance objectives, criteria, evaluation methods, prediction tools, and practical guidance for fire resistance design and retrofit of structures. NIST anticipates releasing a draft best practices guideline for fire resistance design and retrofit of structures in April 2008.	
Recommendation 10. NIST recommends the development and evaluation of new fire-resistive	ASTM: Standard E2584-07 "Standard Practice for Thermal Conductivity of Materials Using a Thermal Capacitance (Slug) Calorimeter," was approved by ASTM	**Standards Outcome:** (ASTM) ASTM E2584-07 "Standard Practice for Thermal

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coating materials, systems, and technologies with significantly enhanced performance and durability to provide protection following major events. ***Affected Standards:*** Technical barriers, if any, to the introduction of new structural fire resistance materials, systems, and technologies should be identified and eliminated in the AIA MasterSpec, AWCI Standard 12 and ASTM standards for field inspection, conformance criteria, and test methods. *Model Building Codes:* Technical barriers, if any, to the introduction of new structural fire resistance materials, systems, and technologies should be eliminated from the model building codes.	Committee E37 in September 2007. NIST: NIST has formed an industry consortium to develop the test methods, measure performance, and determine in-service performance criteria for fire protective coating materials. NIST multi-year project to assess the performance of current spray-applied and intumescent fire protective materials and to support the development of new standards. NIST, in partnership with private industry, is developing a new field test method to assess adhesion. Two standards are currently in development: one based on a peel test and the second based on a blister test. NIST has been in discussions with ASTM E06 regarding the development of these two proposals.	Conductivity of Materials Using a Thermal Capacitance (Slug) Calorimeter," was been approved by ASTM Committee E37 in September 2007.
Recommendation 11. NIST recommends that the performance and suitability of advanced structural steel, reinforced and pre-stressed concrete, and other high-performance	NIBS: Not directly a code matter but NIBS Building Code Experts will develop a plan for looking at new materials and facilitating their testing and use. NIST: Project to determine the in-service performance	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
material systems be evaluated for use under conditions expected in building fires. ***Affected Standards:*** AISC Specifications and ACI 318. Technical barriers, if any, to the introduction of these advanced systems should be eliminated in ASTM E 119, NFPA 251, UL 263, ISO 834. *Model Building Codes:* Technical barriers, if any, to the introduction of these advanced systems should be eliminated from the model building codes.	properties of high temperature steels and compile property database. NIST is helping to develop standard test methods for evaluating the performance of structural steel in fire conditions by working through ASTM task group WK16928. NFPA: Will forward the relevant information to the NFPA Fire Test Committee for further consideration. ASTM: Has established a joint task group under subcommittees A01.13 (Mechanical and Chemical Testing and Processing Methods of Steel Products and Processes) and E28.10 (Mechanical Testing: Effect of Temperature and Stress Relaxation) to define fire resistant steels and develop a standard material test method for fire resistance of such steels. That task group (WK16928) is charged with developing a standard test method. Over the past two years it has examined two candidate methods in detail, by conducting pre-standards research to establish the limitations of both methods. It plans to select a single method to standardize within the next six months. The chairman of that committee is also a member of Committee E05 (Fire Standards), which ensures communication with many of the ultimate users of such a standard.	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
Recommendation 12. NIST recommends that the performance and possibly the redundancy of active fire protection systems (sprinklers, standpipes/hoses, fire alarms, and smoke management systems) in buildings be enhanced to accommodate the greater risks associated with increasing building height and population, increased use of open spaces, high-risk building activities, fire department response limits, transient fuel loads, and higher threat profile. ***Affected Standards:*** NFPA 13, NFPA 14, NFPA 20, NFPA 72, NFPA 90A, NFPA 92A, NFPA 92B, and NFPA 101. *Model Building Codes:* The performance standards should be adopted in model building codes by mandatory reference to, or incorporation of, the latest edition of the standard.	NIBS: The ICC AHC-TRB submitted an IBC change proposal addressing sprinkler system redundancy and isolation (**G46-07/08**) for consideration during the 2007/2008 code cycle. ICC: the ICC received proposal **G46-07/08** addressing redundancy of sprinkler system in buildings over 420 feet in height. This proposal will be considered during the 2007/2008 code development cycle. NFPA: The NFPA High Rise Building Safety Advisory Committee (HRBSAC) is considering a categorization process for high rise buildings. HRBSAC is working to determine what enhanced or redundant features may be necessary based on this any new high rise building categories. There is a project within the Fire Protection Research Foundation to develop the Leadership in Life Safety Design (LLSD) approach, included in this is development of categorization for high-rise buildings. This process will look at resource documents such as the CTBUH *Building Enhancement Guidelines* and apply a point scoring system for enhancements that go above minimum code mandated criteria. NIST: Has formed a consortium with NEMA 3SB to develop active surveillance technologies to enhance the	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
	reliability of sprinkler systems. The methods would form the basis for code change proposals. NIST is collaborating with the fire alarm industry, through a consortium with NEMA, to develop new technologies and features for fire alarm systems that provide active surveillance and automated testing of fire safety systems and components keyed to primary modes of failure in order to provide maximum operational reliability.	
Recommendation 13. NIST recommends that fire alarm and communications systems in buildings be developed to provide continuous, reliable, and accurate information on the status of life safety conditions at a level of detail sufficient to manage the evacuation process in building fire emergencies; all communication and control paths in buildings need to be designed and installed to have the same resistance to failure and increased survivability above that specified in present standards. ***Affected Standards:*** NFPA 1, NFPA 72, and NFPA 101. *Model Building*	NIBS: The ICC AHC-RB submitted proposal **F86-07/08** concerning emergency command centers. The ICC AHC-TRB also submitted proposal **G58-07/08** which addressed communications and video monitoring systems for stairways, elevator hoistways, lobbies, and machinery spaces. ICC: The ICC has received three proposals addressing emergency command centers (**F84-07/08**, **F85-07/08**, and **F86-07/08**) for consideration in the 2007/2008 code cycle. The ICC has also received proposal **G58-07/08** addressing stairway communications and video monitoring for stairways, elevator hoistways, lobbies, and machinery spaces. NFPA: The NFPA 72 Committee will work to incorporate	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
and Fire Codes: The performance standards should be adopted in model building and fire codes by mandatory reference to, or incorporation of, the latest edition of the standard.	appropriate technologies when they are further developed. The 2007 edition of NFPA 72 (available September 2006) has accepted proposals and comments to recognize exit marking audible notification appliances. NIST: The Department of Justice's National Institute of Justice has asked NIST to develop specifications and protocols that will enable fire/emergency command stations in buildings to accept and interpret a larger quantity of more reliable information from the active fire protection (e.g., sprinklers, fire alarm, smoke management) systems for purposes of providing tactical decision aids to fireground commanders (NIST WTC Investigation Recommendation #14) and for managing the evacuation process (NIST WTC Recommendation #13).	
Recommendation 14. NIST recommends that control panels at fire/emergency command stations in buildings be adapted to accept and interpret a larger quantity of more reliable information from the active fire protection systems that provide tactical decision aids to fireground commanders, including water flow rates from pressure and flow	NIBS: The ICC AHC-RB submitted proposal **F86-07/08** concerning emergency command centers. The ICC AHC-TRB also submitted proposal **G58-07/08** which addressed communications and video monitoring systems for stairways, elevator hoistways, lobbies, and machinery spaces. ICC: The ICC has received three proposals addressing emergency command centers (**F84-07/08**, **F85-07/08**, and	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
measurement devices, and that standards for their performance be developed. ***Affected Standards:*** NFPA 1, NFPA 72, and NFPA 101. *Model Building and Fire Codes:* The performance standards should be adopted in model building and fire codes by mandatory reference to, or incorporation of, the latest edition of the standard.	**F86-07/08**) for consideration in the 2007/2008 code cycle. The ICC has also received proposal **G58-07/08** addressing stairway communications and video monitoring for stairways, elevator hoistways, lobbies, and machinery spaces. NFPA: The NFPA 72 Committee will work to incorporate appropriate technologies when they are further developed. NIST: The Department of Justice's National Institute of Justice has asked NIST to develop specifications and protocols that will enable fire/emergency command stations in buildings to accept and interpret a larger quantity of more reliable information from the active fire protection (e.g., sprinklers, fire alarm, smoke management) systems for purposes of providing tactical decision aids to fireground commanders (NIST WTC Investigation Recommendation #14) and for managing the evacuation process (NIST WTC Investigation Recommendation #13). NIST has worked in partnership with NEMA SB30 to address these issues. NEMA: New SB30 document, currently in committee review, provides specifications to enable fire/emergency command centers to accept and interpret larger quantities of data from active fire protection systems. Document	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
	will be provided to NFPA 72 for consideration when approved by NEMA.	
Recommendation 15. NIST recommends that systems be developed and implemented for: (1) real-time off-site secure transmission of valuable information from fire alarm and other monitored building systems for use by emergency responders, at any location, to enhance situational awareness and response decisions and maintain safe and efficient operations; and (2) preservation of that information either off-site or in a black box that will survive a fire or other building failure for purposes of subsequent investigations and analysis. Standards for the performance of such systems should be developed, and their use should be required. ***Affected Standards:*** NFPA 1, NFPA	NIBS: The ICC AHC-RB submitted proposal **F86-07/08** concerning emergency command centers. The ICC AHC-TRB also submitted proposal **G58-07/08** which addressed communications and video monitoring systems for stairways, elevator hoistways, lobbies, and machinery spaces. ICC: The ICC has received three proposals addressing emergency command centers (**F84-07/08**, **F85-07/08**, and **F86-07/08**) for consideration in the 2007/2008 code cycle. The ICC has also received proposal **G58-07/08** addressing stairway communications and video monitoring for stairways, elevator hoistways, lobbies, and machinery spaces. NFPA: The NFPA 72 Committee will work to incorporate appropriate technologies when they are further developed. The NFPA High Rise Building Safety Advisory Committee (HRBSAC) is considering a process to have real time information from the emergency scene simulcast	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
72, and NFPA 101. *Model Building and Fire Codes:* The performance standards should be adopted in model building and fire codes by mandatory reference to, or incorporation of, the latest edition of the standard.	to a remote location. NIST: NIST has worked in partnership with NEMA SB30 to develop specifications and protocols for off-site data transmission for use by emergency responders. NEMA: New SB30 document, currently in committee review, includes specifications for secure, off-site transmission of data for use by first responders. The document will be provided to NFPA 72 for consideration once approved by NEMA.	
Recommendation 16. NIST recommends that public agencies, non-profit organizations concerned with building and fire safety, and building owners and managers develop and carry out public education and training campaigns, jointly and on a nationwide scale, to improve building occupants' preparedness for evacuation in case of	NIBS: A NIBS/MMC committee expert has prepared a white paper for the committee on a state-of-the-art summary of research knowledge regarding public information campaigns for large general populations. This paper also identifies three other areas in need of similar exploration to provide the basis for a concerted effort. (**see paper**) NFPA: At present, NFPA Public Education materials do address building evacuation issues. However, efforts are	Practice Outcome: (NFPA): Emergency Evacuation Guide for Persons with Disabilities (available at http://www.nfpa.org).

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
building emergencies. ***Affected Standard:*** ICC/ANSI A117-1. *Model Building and Fire Codes:* The standard should be adopted in model building and fire codes by mandatory reference to, or incorporation of, the latest edition of the standard. *Affected Organizations:* NFPA, NIBS, NCSBCS, BOMA, and CTBUH.	underway to establish an occupant response protocol that works to address other than 'traditional' building emergencies. The NFPA Disability Access Review and Advisory Committee (DARAC) recommended that a guidance document for persons with disabilities be developed to address emergency procedures for persons with disabilities. The guide is available on the NFPA website. The guide provides a list of systems, resources and options for employers and occupants to assist those with disabilities. ICC: The ICC received two proposals (**E3-07/08** and **E4-07/08**) that address fire safety and evacuation plans.	
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	ICC: The ICC has received two proposals addressing an additional stairway in buildings over 420 feet in height. **G66-07/08** recommends a revision to the current provision. Proposal **G67-07/08** seeks to remove the provision requiring an additional egress stair in buildings over 420 feet in height. The ICC has received a proposal (**E14-07/08**) addressing the use of elevators as a means of egress during fires and other emergencies. NFPA: NFPA is considering a proposal on occupant	**Code Outcomes: (IBC)** An additional exit stairway for buildings more than 420 feet in height. (NFPA) The 2006 editions of NFPA 101 and NFPA 5000 include requirements for 56 inch wide (minimum) stairs when an aggregate of 2000 occupants are expected to use a stair.

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
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. ***Affected Standards:*** NFPA 101, ASME A 17. *Model Building and Fire Codes:* The standards should be adopted in model building and fire codes by mandatory reference to, or incorporation of, the latest edition of the standard.	evacuation elevators (101-ROC-400a, 5000-ROC-306a). The proposal would permit elevators to remain in service (prior to Phase 1 emergency recall) and to function as another system to assist with building evacuations or occupant relocation. The proposal requires a package of various protection measures that are largely derived from the ASME A17 Task Group on the use of elevators for occupant egress. The provision has been provided as a total package in new Annex Section E that is available for adoption by a government jurisdiction. The requirement governs occupant information features; detection; alarm and communication; sprinklers; elevator installation; elevator machine room; power and control wiring; and the occupant evacuation shaft system. Another proposal being considered by NFPA addresses elevator lobby access door locking (101-ROP-85a, 5000-ROP-102g). This proposal would establish criteria for the release of electronically locked elevator lobby exit access doors to prevent occupants from being stranded in an elevator lobby after elevators have been recalled. A proposal on elevator inspection frequencies (101-ROP-193) is also being considered. This proposal would require elevator inspection frequencies per ASTM A17.1.	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
	NFPA is also considering a proposal on minimum width of exit passageways serving for horizontal transfers within an exit stair system (101-ROP-123, 5000-ROP-114. This proposal would establish minimum width for exit passageways serving for horizontal transfer with an exit stair as two-thirds the width of the exit stair. These proposals will be voted on during the NFPA Annual Meeting in June 2008. NIST: Multi-year NIST project to produce new data, on occupant evacuation in stairwells, including the counterflow of emergency responders, as input to evacuation prediction models and code provisions. NIST has conducted evacuation modeling to support AHC-TRB's re-submittal of code change proposal.	
Recommendation 18. NIST recommends that egress systems be designed: (1) to maximize remoteness of egress components (i.e., stairs, elevators, exits) without negatively impacting the average travel distance; (2) to maintain their functional integrity and survivability under foreseeable building-specific or large-	NIBS: The ICC AHC-TRB submitted a proposal (**E84-07/08**) to make exit path markings required in existing buildings having occupied floors over 75 feet above the lowest level of fire department access. The ICC AHC-TRB has also submitted proposal **G61-07/08** to address remoteness of exit stair enclosures. ICC: The ICC received four proposals addressing the	**Code Outcomes:** **(**IBC) Luminous markings delineating the exit path (including vertical exit enclosures and passageways) in buildings over 75 feet in height to facilitate rapid egress and full building evacuation.

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
scale emergencies; and (3) with consistent layouts, standard signage, and guidance so that systems become intuitive and obvious to building occupants during evacuations. ***Affected Standard:*** NFPA 101. *Model Building and Fire Codes:* The standard should be adopted in model building and fire codes by mandatory reference to, or incorporation of, the latest edition of the standard.	impact resistance of fire-resistance rated wall assemblies (**FS7-07/08**, **G56-07/08**, **G57-07/08**, and **G65-07/08**). The ICC has also received proposal **E135-07/08** addressing the use of horizontal transfer corridors between vertical exit enclosures. These proposals will be considered during the 2007/2008 code development cycle. The ICC has received six proposals (**F211-07/08, E145-07/08, E146-07/08, E147-07/08, E148-07/08, and E149-07/08**) addressing exit path markings. The ICC AHC-TRB has submitted a proposal (**E135-07/08**) to reduce occupant confusion created by the use of horizontal transfer corridors between vertical exit enclosures. NFPA: The NFPA is considering a proposal on exit stair path marking (101-ROC-84). This proposal establishes a menu of provisions that can be mandated by the occupancy chapters to standardize on the installation of marking stripes for exit stair treads, landings, and handrails; perimeter demarcation; marking of obstacles, door frames, and door hardware; and placement of emergency exit symbols at exit doors. NFPA is also considering a proposal for pictograms in	(NFPA) The 2007 edition of NFPA 72 includes provisions to recognize exit marking audible notification appliances.

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
	accordance with NFPA 170 (101-ROP-160, 5000-ROP-132c). This proposal would permit the use of pictograms in accordance with NFPA 170 in lieu of exit signs where approved by the authority having jurisdiction. A proposal to prohibit remoteness measurement along corridor for high-rise buildings is also being considered (101-ROP-143a, 5000-ROP-128). This proposal would prohibit determining exit remoteness in high-buildings by measuring along 1-hour rated corridors. Instead, distance must be measured in a straight line between exits. NFPA is also considering a proposal on remoteness applied to exit discharge (101-ROP-141a, 5000-ROP-126a). This proposal would require that remoteness criteria be applied to exit discharges, and not only to exit accesses and exits. NFPA is also considering a proposal for directional exit signs in horizontal components of exits (101-ROP-155, 5000-ROP-132). The proposal would require directional exit signage within horizontal components of exit enclosures (such as “transfer corridors”) where continuation of egress path is not obvious. These proposals will be voted on during the NFPA Annual	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
	Meeting in June 2008. NIST: Provided AHC-TRB with pressure-impulse data representative of a gas explosion to support resubmittal of the Structural Integrity Criteria for Stair Enclosures proposal.	
Recommendation 19. NIST recommends that building owners, managers, and emergency responders develop a joint plan and take steps to ensure that accurate emergency information is communicated in a timely manner to enhance the situational awareness of building occupants and emergency responders affected by an event. This should be accomplished through better coordination of information among different emergency responder groups, efficient sharing of that information among building occupants and emergency responders, more robust design of emergency public address systems, improved emergency responder communication	NIBS: One of the NIBS/MMC building code experts has prepared a white paper for the committee on a state-of-the-art summary of research knowledge regarding public information campaigns for large general populations. This paper also identifies three other areas in need of similar exploration to provide the basis for a concerted effort. (**see paper**) NFPA: NFPA is considering a proposal on situation awareness (101-ROC-22, 5000-ROC-66). This proposal would add a provision that establishes situation awareness as a fundamental requirement. It introduces the terminology to codify and correlate situation awareness as a concept that encompasses elements like fire alarm systems, communication systems, signs, and responses and information dissemination by trained staff. NFPA is also considering a proposal on evacuation diagrams (101-ROP-164). This proposal would establish a	**Code Outcome:** (NFPA) The 2007 edition of NFPA 72 recognizes exit marking audible notification appliances. In addition, the new version recognizes criteria for mass notification systems that will formalize notification criteria for large building, campus and even urban areas.

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
systems, and use of the Emergency Broadcast System (now known as the Integrated Public Alert and Warning System) and Community Emergency Alert Networks. ***Affected Standard:*** NFPA 101 and/or a new standard. *Model Building and Fire Codes:* The standard should be adopted in model building and fire codes by mandatory reference to, or incorporation of, the latest edition of the standard to the extent it is within the scope of building and fire codes.	menu of provisions that can be mandated by the occupancy chapters to require evacuation diagrams that reflect the actual floor arrangement and exit location. Another proposal addresses evacuation strategy (101-ROP-448a, 101-ROC-390). This proposal would provide detailed advisory text on occupant evacuation strategies, extent of evacuation (none, partial, total) and extent of management with descriptions of managed and unmanaged sequences. These proposals will be voted on during the NFPA Annual Meeting in June 2008.	
Recommendation 20. NIST recommends that the full range of current and next generation evacuation technologies should be evaluated for future use, including protected/hardened elevators, exterior escape devices, and stairwell descent devices, which may allow all occupants an equal opportunity for evacuation and facilitate emergency response access.	NFPA: NFPA is considering a proposal for supplemental evacuation equipment (101-ROC-401b, 5000-ROC-308b). This proposal establishes a series of performance requirements to recognize (but does not mandate, nor give credit for) the use of certain devices that can be used as a last resort escape device. These include controlled descent devices and platform rescue systems. The provision has been provided as a total package in new Annex Section F that is available for adoption by a government jurisdiction. Many of the regulations added to address this type of equipment relate to specific approval by the authority	**Standards Outcomes:** (ASTM) ASTM E-2484-06 Standard Specification for High-Rise External Evacuation Controlled Descent Devices. ASTM E-2513-07 Standard Specification for Multi-Story Building External Evacuation Platform Rescue Systems. **Code Outcome:** (NFPA)

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
Affected Standards: NFPA 101, ASME A 17, ASTM E 06, ANSI A117.1. *Model Building and Fire Codes:* The standards should be adopted in model building and fire codes by mandatory reference to, or incorporation of, the latest edition of the standard.	having jurisdiction and dictate extensive use of occupant instruction and direction cues. Mechanical and installation specific details refer to ASTM E2513 and ASTM E2484. This proposal will be voted on during the NFPA Annual Meeting in June 2008. ASTM: International Committee E06 on Building Performance has recently approved two standards on High-Rise Building External Evacuation Devices: E-2484-06 Standard Specification for High-Rise External Evacuation Controlled Descent Devices. E-2513-07 Standard Specification for Multi-Story Building External Evacuation Platform Rescue Systems.	The 2006 editions of NFPA 101 and NFPA 5000 include requirements for the installation of stair descent devices for use by mobility impaired occupants in certain circumstances.
Recommendation 21. NIST recommends the installation of fire-protected and structurally hardened elevators to improve emergency response activities in tall buildings by providing timely emergency access to responders and allowing evacuation of mobility-impaired building occupants.	ICC: The ICC has received eight proposals that address fire service elevators: **F95-07/08** Maintain fire service elevator lobbies free of storage and furnishings **G60-07/08** Pressurization of hoistways, lobbies, and exit enclosures **G193-07/08** Robust fire service elevators **G194-07/08** Hoistway enclosure protection **G195-07/08** Hoistway lighting **G196-07/08** Lobby doorways	**Code Outcome:** (IBC) A minimum of one fire service access elevator for buildings over 120 feet in height.

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
Affected Standards: ASME A 17, ANSI 117.1, NFPA 70, NFPA 101, NFPA 1221, NFPA 1500, NFPA 1561, NFPA 1620, and NFPA 1710. *Model Building and Fire Codes:* The standards should be adopted in model building and fire codes by mandatory reference to, or incorporation of, the latest edition of the standard.	**G197-07/08** Lobby size **G198-07/08** Alternative machine room ventilation **G199-07/08** Protection of wiring and cables **G200-07/08** Protection from water ASME: A 17.1 task group, in partnership with the U.S. elevator industry and NIST, are working to develop specifications and operational protocols for protected elevators for fire service access and occupant egress. This work is being widely followed adoption in model building codes. GSA: Has agreed to install a prototype system in a federal building as a demonstration project. NFPA: NFPA is considering a proposal on first responder use of elevators (5000-ROC-246). This proposal provides criteria for first responder elevators in buildings greater than 120 feet in height. Requires a package of various protection measures that are largely derived from the ASME A17 Task Group on *Fire Fighter Use Elevators*. The provision has been provided as a total package in Chapter 54. The requirements govern design of the special first responder use elevator lobby; requires standpipe hose connection; two-way communication system; system to monitor the elevator status; requires	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
	standby power; and mandates protection for the control and power wiring that serve the elevator. The proposal will be voted on during the NFPA Annual Meeting in June 2008.	
Recommendation 22. NIST recommends the installation, inspection, and testing of emergency communications systems, radio communications, and associated operating protocols to ensure that the systems and protocols: (1) are effective for large-scale emergencies in buildings with challenging radio frequency propagation environments; and (2) can be used to identify, locate, and track emergency responders within indoor building environments and in the field. ***Affected Standards:*** FCC, SAFECOM, NFPA Standards on Electronic Safety Equipment, NFPA 70, NFPA 297, and NFPA 1221. *Model Building Codes:* The standards should be adopted in model building	NIBS: The ICC Code Technology Committee submitted a proposal concerning fire department communications systems (**F171-07/08**). ICC: The ICC received four proposals for change concerning emergency communications: Emergency Responder Radio Coverage (**F87-07/08**); fire Department Communication System (**F171-07/08**); Public Safety Radio Amplification Systems (**F204-07/08**); and Emergency Responder Radio (**G53-07/08**). NFPA: The NFPA High Rise Building Safety Advisory Committee (HRBSAC) is considering that broader use of supplemental antennas and/or repeaters for tall building environments to improve the communication ability of the radio equipment be integrated into building design. Such supplemental equipment may become a mandate via NFPA 72, NFPA 101, NFPA 5000 or some combination there-of. In addition, NFPA would recommend that NIST joint project with IEEE be explored to embark on a research program to look into more robust emergency	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
codes by mandatory reference to, or incorporation of, the latest edition of the standard.	responder communication hardware and relevant software.	
Recommendation 23. NIST recommends the establishment and implementation of detailed procedures and methods for gathering, processing, and delivering critical information through integration of relevant voice, video, graphical, and written data to enhance the situational awareness of all emergency responders. An information intelligence sector should be established to coordinate the effort for each incident. ***Affected Standards:*** National Incident Management System (NIMS), NRP, SAFECOM, FCC, NFPA Standards on Electronic Safety Equipment, NFPA 1500, NFPA 1561, NFPA 1620, NFPA 1710, and NFPA 1221. *Model Building Codes:* The standards should be adopted in model	NIBS: The ICC AHC-RB submitted proposal **F86-07/08** concerning emergency command centers. The ICC AHC-TRB also submitted proposal **G58-07/08** which addressed communications and video monitoring systems for stairways, elevator hoistways, lobbies, and machinery spaces. ICC: The ICC has received three proposals addressing emergency command centers (**F84-07/08**, **F85-07/08**, and **F86-07/08**) for consideration in the 2007/2008 code cycle. The ICC has also received proposal **G58-07/08** addressing stairway communications and video monitoring for stairways, elevator hoistways, lobbies, and machinery spaces. NFPA: The NFPA 72 Committee will work to incorporate appropriate technologies when they are further developed.	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
building codes by mandatory reference to, or incorporation of, the latest edition of the standard.		
Recommendation 24. NIST recommends the establishment and implementation of codes and protocols for ensuring effective and uninterrupted operation of the command and control system for large-scale building emergencies. ***Affected Standards:*** NIMS, NRP, SAFECOM, FCC, NFPA Standards on Electronic Safety Equipment, NFPA 1221, NFPA 1500, NFPA 1561, NFPA 1620, and NFPA 1710. *Model Building Codes:* The standards should be adopted in model building codes by mandatory reference to, or incorporation of, the latest edition of the standard.	NIBS: The ICC AHC-RB submitted proposal **F86-07/08** concerning emergency command centers. The ICC AHC-TRB also submitted proposal **G58-07/08** which addressed communications and video monitoring systems for stairways, elevator hoistways, lobbies, and machinery spaces. ICC: The ICC has received three proposals addressing emergency command centers (**F84-07/08**, **F85-07/08**, and **F86-07/08**) for consideration in the 2007/2008 code cycle. The ICC has also received proposal **G58-07/08** addressing stairway communications and video monitoring for stairways, elevator hoistways, lobbies, and machinery spaces. NFPA: The NFPA High Rise Building Safety Advisory Committee (HRBSAC) is considering recommending expansion of the available frequencies that could be used by emergency responders be explored to reduce over use	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
	of limited spectrum by emergency responders. In addition, exploratory research with related groups like IEEE should be work with NIST to address this subject.	
Recommendation 25. Nongovernmental and quasi-governmental entities that own or lease buildings and are not subject to building and fire safety code requirements of any governmental jurisdiction are nevertheless concerned about the safety of the building occupants and the responding emergency personnel. NIST recommends that such entities be encouraged to provide a level of safety that equals or exceeds the level of safety that would be provided by strict compliance with the code requirements of an appropriate governmental jurisdiction. To gain broad public confidence in the safety of such buildings, NIST further recommends that as designed and as-built safety be certified by a qualified third party, independent of the	NIBS: Jurisdictional standards of practice issue. The potential for writing to the relevant groups developing model legislation for special authorities will be explored. NIST: Has provided the NIBS Building Code Experts the statute (U.S. Code Title 40, Section 3312) containing the policy of the federal government with regard to code compliance.	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
building owner(s). The process should not use self-approval for code enforcement in areas including interpretation of code provisions, design approval, product acceptance, certification of the final construction, and post-occupancy inspections over the life of the buildings.		
Recommendation 26. NIST recommends that state and local jurisdictions adopt and aggressively enforce available provisions in building codes to ensure that egress and sprinkler requirements are met by existing buildings. Further, occupancy requirements should be modified where needed (such as when there are assembly use spaces within an office building) to meet the requirements in model building codes. ***Codes:*** Provisions related to egress and sprinkler requirements in existing buildings are available in such codes	NIBS: The ICC AHC-TRB submitted a proposal (**E84-07/08**) to make exit path markings required in existing buildings having occupied floors over 75 feet above the lowest level of fire department access. NFPA: NFPA 101 has always contained building safety requirements that are retroactive for myriad existing building types. It requires improvements to the level of safety provided to the occupants by ignoring grandfathering concepts that are the hallmarks of other model codes. An expansion of the NFPA 101 scope to cover other than fire type hazards or development of a separate document will be considered by NFPA.	

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as the *International Existing Building Code (IEBC)*, International Fire Code, NFPA 1, NFPA 101, and ASME A 17.3.		
Recommendation 27. NIST recommends that building codes incorporate a provision that requires building owners to retain documents, including supporting calculations and test data, related to building design, construction, maintenance and modifications over the entire life of the building. Means should be developed for offsite storage and maintenance of the documents. In addition, NIST recommends that relevant building information be made available in suitably designed hard copy or electronic format for use by emergency responders. Such information should be easily accessible by responders during emergencies. ***Model Building Codes:*** Model	NIBS: The NIBS/MMC committee concluded that problems exist because of ownership changes, the proprietary nature of some documents, determining what medium to use to save documentation, unreimbursable expense of maintaining information. It also was noted that only threat assessment documents need to be out of the public domain. The AHC-TRB submitted a code change proposal (**F86-07/08**) that includes provisions for giving responders needed information by requiring that it be available in the command centers. NFPA: The NFPA High Rise Building Safety Advisory Committee (HRBSAC) is considering a recommendation that building inventory plans be provided to or readily available to the first responders.	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
building codes should incorporate this recommendation. State and local jurisdictions should adopt and enforce these requirements.		
Recommendation 28. NIST recommends that the role of the "Design Professional in Responsible Charge" be clarified to ensure that: (1) all appropriate design professionals (including, e.g., the fire protection engineer) are part of the design team providing the standard of care when designing buildings employing innovative or unusual fire safety systems, and (2) all appropriate design professionals (including, e.g., the structural engineer and the fire protection engineer) are part of the design team providing the standard of care when designing the structure to resist fires, in buildings that employ innovative or unusual structural and fire safety systems. ***Affected Standards:*** AIA Practice	NIBS: Selected NIBS Building Code Experts have been assigned to review the issue with AIA and NIST. The committee plans to examine whether working with the National Council of Architectural Registration Boards and the National Council of Examiners for Engineering and Surveying would be helpful in implementing this recommendation. NFPA: NFPA 5000 utilizes the term Registered Design Professional -RDP. Pending any clarifications that come out of the AIA-NIST effort, NFPA committees would be amenable to revisiting the use and description of this entity.	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
Guidelines. Model Building Codes: The IBC, which already defines the "Design Professional in Responsible Charge," be clarified to address this recommendation. The NFPA 5000 should incorporate the "Design Professional in Responsible Charge" concept and address this recommendation.		
Recommendation 29. NIST recommends that continuing education curricula be developed and programs be implemented for (1) training fire protection engineers and architects in structural engineering principles and design, and (2) training structural engineers, architects, fire protection engineers, and code enforcement officials in modern fire protection principles and technologies, including fire-resistance design of structures, and (3) training building regulatory and fire service	NIST: NIST has worked with the National Fire Academy to develop training courses on "Introduction to Fire Dynamics and Fire Modeling" and "Performance Based Design". Both these courses have been presented to classes, including fire service officers, building inspectors, fire marshals, and fire inspectors. BFRL staff have also made presentations on "Fire Modeling for Fire Investigators" an Fire Modeling Tools for Engineers" for SFPE, Florida Fire Marshals, Texas Fire Marshals, NY Fire Marshals, and West Texas Fire Marshals. In addition, NIST is working with the National Fire Academy to update a training module for Fire Prevention and a second training module for Fire Marshals.	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
personnel to upgrade their understanding and skills to conduct the review, inspection, and approval tasks for which they are responsible. ***Affected Organizations:*** AIA, SFPE, ASCE, ASME, AISC, ACI, and state licensing boards. *Model Building Codes:* Detailed criteria and requirements should be incorporated into the model building codes under the topic "Design Professional in Responsible Charge."		
Recommendation 30. NIST recommends that academic, professional short-course, and web-based training materials in the use of computational fire dynamics and thermostructural analysis tools be developed and delivered to strengthen the base of available technical capabilities and human resources.	NIST: NIST initiated a Fire Dynamics and Fire Modeling Course for the New York City Fire Department which is taught at the FDNY Fire Training Academy and does utilize WTC Investigation model outputs. This was so successful the first year, that it has been expanded to being offered to each new incoming training class for all NYC fire marshal trainees.	

Recommendation, Affected Standards and Codes	Status as of (February 6, 2008)	Outcomes
Affected Organizations: AIA, SFPE, ASCE, ASME, AISC, and ACI, ICC, NFPA.		

Appendix 2

Summary of actions needed and/or taken regarding the recommendations from the NCST investigation of The Station nightclub fire
Updated 1/25/2008

NIST Recommendation	Participating Parties	Comments
1. Adopt and enforce model codes	• state and local jurisdictions • ICC and NFPA	• Continuous education and training effort required to raise awareness of the benefits and importance of embracing recommendation. • NFPA TIA #742R required owner to maintain records of egress inspection (NFPA 101:12.7.1 and 101:13.7.1); adopted in 2006 edition. • RI adopted NFPA 1 and NFPA 101, and strengthened fire marshal's enforcement power.

NIST Recommendation	Participating Parties	Comments
2. Strengthen requirement for sprinklers	• state and local jurisdictions • NFPA and ICC	• NFPA TIA #739R required existing nightclub facilities and festival seating venues with occupant loads greater than 100 to be sprinklered (NFPA 101:13.3.5.1); adopted in 2006 edition. • NFPA TIA #743R required all new nightclub facilities and festival seating venues to be sprinklered (NFPA 101:12.3.5.1); adopted in 2006 edition. • Continuous effort required to raise awareness of the benefits and importance of embracing recommendation. • RI strengthened regulation requiring sprinklers based upon occupant load of 150 rather than 100, some exemptions. • Change to Section 903.2.1.2 of the 2006 IFC (F58-03/04 [Approved as Modified]) to tighten threshold for sprinklers in Group A-2 assembly occupancies, such as nightclubs, restaurants and banquet halls. ICC membership voted to require such occupancies to be sprinklered where the occupant load exceeds 100 (rather than 300).

NIST Recommendation	Participating Parties	Comments
3. Strengthen restrictions on foam plastic finish materials	• state and local jurisdictions • NFPA, ICC, ASTM, Underwriters Laboratories (UL) • North American Fire Testing Laboratory Consortium (NAFTL) • building materials industry • NIST	• ICC FS108-03/04 dealt with one small aspect of foam plastic finish materials; additional revisions needed to be developed using established procedures. • NIST will work with standards committees (UL 94, ASTM E84, NFPA 255, and NFPA 286) to develop ways to address recommendation. This will be a long term effort due to the research needed to support changes to building and fire codes and standards. • State and local jurisdictions can have immediate impact by adopting and enforcing existing model codes.
4. Strengthen restrictions on use of pyrotechnics	• state and local jurisdictions • NFPA, ICC	• NIST needs plans to work with NFPA 1126 to develop technical support for recommendation. This activity has not yet started. • RI strengthened restrictions to prohibit use of pyrotechnics in places of assembly such as nightclubs and to strictly regulate their use in large venues that can accommodate them safely. • State and local jurisdictions can have immediate impact by adopting and enforcing existing model codes.

NIST Recommendation	Participating Parties	Comments
5. Increase factor of safety on egress	• state and local jurisdictions • NFPA, ICC • NIST	• NFPA TIA #737R and NFPA TIA #740 restricted festival seating in new and existing facilities if occupant load is greater than 250 unless life-safety evaluation in conducted (NFPA 101:12.2.5.4.1 and 101:13.2.5.4.1); adopted in 2006 edition. • NFPA TIA# 738 required trained crowd managers for existing and new assembly occupancies (NFPA 101:12.7.5 and 101:13.7.5); adopted in 2006 edition. • NIST will work with NFPA 101, NFPA 5000, and IBC; substantial research effort required, which NIST is pursuing. • State and local jurisdictions can have immediate impact by adopting and enforcing existing model codes.
6. Conduct portable fire extinguisher study	• fire protection equipment manufacturers • NFPA • NIST	• Workshop held at NIST with equipment manufacturers, building owners, fire service, NFPA, ICC, and testing organizations to develop outline of study, and identify participants, to feed technical information into NFPA 10 committee. • Initiated NIST research project to develop performance metrics for portable fire extinguishers in fast growing nightclub fires. • RI now requires two 20 pound extinguishers in stage areas.
7. Adopt and practice communication, response, command structures, and staffing guidelines already established	• state and local jurisdictions • NFPA, ICC	• Continuous education and training effort required to raise awareness of the benefits and importance of embracing recommendation and practicing established guidelines for communication, response, command structures, and staffing. • No research nor code changes are required.

NIST Recommendation	Participating Parties	Comments
8. Conduct research to understand human behavior better in emergency situations	• NIST and other federal agencies • universities	• NIST has established research program. • Energized multi-agency effort is needed. • NIST-sponsored workshop titled *Rethinking Egress*, to deal with building design for safe egress and access, is scheduled for April, 2008.
9. Conduct research to understand fire spread and suppression better	• NIST and other federal agencies • building materials industry	• Research is ongoing at NIST and elsewhere. • NIST projects underway on fire growth and spread on melting plastics, polyurethane foam flammability, and nanoadditive fire retardants.
10. Conduct research to refine computer-aided decision tools	• NIST and other federal agencies • universities	• Research is ongoing at NIST and elsewhere.