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

August 8, 2011

Recommendation, Affected Standards and Codes	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 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 recommendations. The codes and standards may vary from the WTC recommendations, but satisfy their intent.	**Research Outcome:** (NIST) Best Practices Guideline published February 2007. **Code Outcomes:** (IBC) Provides minimum structural integrity for framed and bearing wall structures through continuity and tie-force requirements for buildings over 75 ft. in height that represent a substantial hazard to human life in the event of failure (e.g., buildings with occupant loads exceeding 5,000) and essential facilities, such as hospitals.) This code change is intended to enhance overall structural integrity but is not intended to prevent progressive collapse in structures. (IBC) Clarifies the definition of secondary structural members by including roof construction that does not have direct connections to the building columns.
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.	**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.

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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.	
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; • 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 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.	**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 be applied to any critical systems.

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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.	
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 latest edition of the standard. (See Recommendation 10 for more on this issue.)	**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). The increased fireproofing bond strength is required to be "installed throughout the building." 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 the 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. **Standards Outcome:** (ASTM) ASTM E2584-07 "Standard Practice for Thermal Conductivity of Materials Using a Thermal Capacitance (Slug) Calorimeter."

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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 protection provided to all of the structural elements that contribute to overall structural stability. State and local jurisdictions should adopt and enforce this requirement.	**Codes Outcomes:** (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 having direct connections to the columns, and bracing members designed to carry gravity loads. The definition of the primary structural frame was broadened to include bracing members essential to vertical stability (e.g., floor systems or cross bracing) whether or not they 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, 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.	**Practice Outcome:** (NIST) Published "Best Practice Guidelines for Structural Fire Resistance Design of Concrete and Steel Buildings," (NIST TN 1681)
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 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.	

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Recommendation 10. NIST recommends the development and evaluation of new fire-resistive 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.	**Standards Outcome:** (ASTM) ASTM E2584-07 "Standard Practice for Thermal Conductivity of Materials Using a Thermal Capacitance (Slug) Calorimeter." **Practice Outcome:** The slug calorimeter has been commercialized by Anter Corporation.
Recommendation 11. NIST recommends that the performance and suitability of advanced structural steel, reinforced and pre-stressed concrete, and other high-performance 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.	
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.	**Code Outcomes:** (IBC) Requires greater reliability of sprinklers with a minimum of two water supply risers for each sprinkler zone in buildings over 420 ft. in height. Each riser is required to supply sprinklers on alternate floors. The sprinkler risers are to be placed in stair enclosures which are remotely located. Clarifies the prohibition against locating sprinklers in elevator machine rooms, elevator machine spaces, and elevator hoistways of fire service elevators. Also clarify the prohibition against the installation of shunt trip devices in fire service elevators.

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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 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.	
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 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.	**Code Outcomes:** Requires an increase in the area of the Fire Command Center from 96 sq. ft. to 200 sq. ft. in buildings over 75 ft. in height. The minimum dimension of the Fire Command Center is increased from 8 ft. to 10 ft. Requires the inclusion of a Building Information Card to be located at the Fire Command Center. The Building Information Card will put critical response information for a building in a user-friendly format and medium.
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 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.	

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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 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.	**Practice Outcome:** (NFPA) Guidance document to address emergency procedures for persons with disabilities. This proposal will require fire safety and evacuation plans for all occupancies and buildings where required by the International Fire Code. This provision will provide consistent requirements for jurisdictions regarding 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 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.	**Code Outcomes:** (IBC) An additional exit stairway for buildings more than 420 feet in height. The total width of any combination of remaining stairways with one stairway removed cannot be less than the total width previously required. Scissor stairs are not considered to satisfy the additional stairway requirement. A horizontal exit is not an acceptable alternative to an additional exit stairway. Requires an increase of 50 percent in the width of exit stairways in new sprinklered buildings with floor areas exceeding about 15,000 sq. ft. This change eliminates the credit in width of exit stairways for sprinklered buildings (i.e., sprinkler trade-off). Permits use of elevators for occupant evacuation in fires and other emergencies for all buildings over 420 ft. in height. All passenger elevators for general public use and other elevators used for self-evacuation must meet additional requirements to be used as occupant evacuation elevators, including requirements for electric power, protection of wiring and cables, automatic sprinkler system, water protection, emergency voice/alarm communication system, elevator lobbies, emergency signage, two-way communication system, design and installation and elevator system monitoring. Provides requirements for the activation of occupant evacuation elevators in the event of activation of an automatic sprinkler system, activation of smoke detectors, or approved manual controls. Clarifies the multiple requirements related to egress width.

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	Clarifies the requirement for enclosed fire service elevator access lobbies to state that they are not required at the level of exit discharge (defined term) rather than at street level. Reinstates the width requirements for stairs and other egress components in buildings with sprinklers and add a requirement for an emergency voice/alarm communication system in these buildings. (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 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-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.	**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. Requires the addition of luminescent markings for obstacles, exit doors, exit signs, and floor numbers in the exit path for buildings over 75 ft. in height. Requires luminescent exit path markings in existing buildings greater than 75 ft. in height, with the exception of open, unenclosed stairs in historic buildings. Requires exit stairway enclosures to be separated by a distance not less than 30 ft. or not less than on-fourth of the maximum building diagonal, whichever is less. The distance shall be measured in a straight line (not along the walking path) between the nearest portions of the stairway enclosure. Requires hardening of exit stairway and passageway enclosures and elevators shaft enclosures in buildings. This requirement applies to all buildings over 420 ft. in height. It also applies to buildings between 75 ft. and 420 ft. in height that represent a substantial hazard to human life in the event of failure (e.g., buildings with occupant loads exceeding 5,000 and essential facilities, such as hospitals.) The hardening requirement is based on ASTM Standard 61629/C1629M-06 for gypsum and fiber-reinforced cement wall enclosures. Concrete and masonry enclosures are deemed to satisfy this requirement. Require an approved method of preventing water from entering the elevator hoistway

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	due to operation of the automatic sprinkler system outside the fire service access elevator lobby. Requires an approved method of preventing water from entering the elevator hoistway due to operation of the automatic sprinkler system outside the occupant evacuation elevator lobby. (NFPA) The 2007 edition of NFPA 72 includes provisions to recognize exit marking audible notification appliances.
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 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.	**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 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. ***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.	**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) 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.

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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. ***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.	**Code Outcomes:** (IBC) A minimum of one fire service access elevator for buildings over 120 feet in height. Requires the entire height of the elevator hoistway to be illuminated not less than 1 foot-candle at the top of the car of each fire service access elevator. Requires each enclosed fire service access elevator lobby to be a minimum of 150 sq. ft. in area with a minimum dimension of 8 ft. Requires a standardized pictorial symbol designating which elevators are fire service access elevators and specifies size and location of the symbols. Requires an independent, key-operated three-position "Fire Recall" switch at the designated level for each occupant elevator. Requires an independent key-operated "Fire Recall" switch and the designated level for each fire service elevator or group of fire service elevators. Also require that an activation of any building fire alarm also initiates Phase I emergency recall of all fire service elevators. All other elevators will remain in normal service unless a Phase I emergency recall is manually initiated. If the building also employs occupant evacuation elevators, an independent, three-position key-operated "fire recall" switch shall be provided at the designated level for each fire service access elevator. Clarifies the prohibition against locating sprinklers in elevator machine rooms, elevator machine spaces, and elevator hoistways of fire service elevators. Also clarify the prohibition against the installation of shunt trip devices in fire service elevators. Requires each doorway to a fire service access elevator lobby or an occupant evacuation elevator lobby, other than the hoistway door, to have a ¾ hour fire door assembly. Requires that the exit enclosure containing the standpipe shall have access to the floor without passing through the fire service access lobby. This will prevent smoke from entering the fire service access elevator lobby possibly causing a recall of the elevators. Clarifies that wiring and cables that provide control signals to fire service access elevators are not required to be protected provided that the wiring or cables do not serve Phase II emergency in-car operation. (IFC) Requires fire service access elevator lobbies to be maintained free of storage.

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	(City of San Francisco Building Code) The City of San Francisco adopted a requirement for a fire service access elevator. The provision applies to buildings over 200 ft. in height and includes requirements for hoistway lighting, pressurization, standby power, lobby monitoring, direct access to a stair, and not placing sprinklers in the elevator machine room.
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 codes by mandatory reference to, or incorporation of, the latest edition of the standard.	**Code Outcomes:** (IBC) Requires approved radio coverage in all buildings for emergency responders within the building based upon the exiting coverage level of public safety communication systems at the exterior of the building. Existing buildings that do not have approved radio coverage within the building shall be equipped with such coverage within a time frame established by the adopting authority. The code change specifies requirements for signal strength, system design (including signal booster requirements), installation requirements (including acceptance test procedure), and maintenance (including field testing and compliance.) Requires an emergency responder radio communications system to be installed in buildings, replacing the typical hardwired communication system, to provide the required level of radio coverage throughout a building. Amplifiers are required to handle the frequencies in operation by the local emergency responder agencies. Completes the necessary modifications to the code to ensure that emergency responder radios have coverage throughout new and existing buildings.
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 building codes by mandatory reference to, or incorporation of, the latest edition of the standard.	

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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.	**Code Outcome:** Requires an increase in the area of the Fire Command Center from 96 sq. ft. to 200 sq. ft. in buildings over 75 ft. in height. The minimum dimension of the Fire Command Center is increased from 8 ft. to 10 ft.
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 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 as the *International Existing Building Code (IEBC)*, International Fire Code, NFPA 1, NFPA 101, and ASME A 17.3.	**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. Requires the addition of luminescent markings for obstacles, exit doors, exit signs, and floor numbers in the exit path for buildings over 75 ft. in height. Requires luminescent exit path markings in existing buildings greater than 75 ft. in height, with the exception of open, unenclosed stairs in historic buildings.

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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 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 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 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	

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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. ***Affected Organizations:*** AIA, SFPE, ASCE, ASME, AISC, and ACI, ICC, NFPA.	