

The 30 recommendations contained in the National Institute of Standards and Technology report on the collapse of the World Trade Center:

#### Increased Structural Integrity

- No. 1: Prevent progressive collapse and perform failure analysis of complex systems
- No. 2: Estimate wind loads and their effects on tall buildings
- No. 3: Limit tall building sway under lateral loads

#### Enhanced Fire Resistance

- No. 4: Review existing construction classifications and fire rating requirements and make appropriate changes
- No. 5: Test fire resistance of building components and extrapolate data to qualify untested building components
- No. 6: Develop criteria, test methods and standards for performance of sprayed fire-resistive materials
- No. 7: Use of "structural frame" approach to fire resistance ratings

#### Methods of Fire Resistant Design

- No. 8: Implement performance objectives that would allow uncontrolled fires to burnout and not result in building collapse
- No. 9: Use performance-based design in structures to resist real building fire conditions
- No. 10: Develop and evaluate new fire resistive coatings
- No. 11: Evaluate use of advanced structural steel, concrete and other high-performance materials

#### Active Fire Protection

- No. 12: Enhance performance and redundancy of active fire protection systems
- No. 13: Develop fire alarm and communications systems that provide information on life safety conditions to aid in an evacuation process
- No. 14: Adapt fire control panels to relay more reliable information from fire protection systems to aid in tactical decisions
- No. 15: Improve transmission of information to emergency responders and require information to be stored off site or in a "black box"

#### Improved evacuation procedures

- No. 16: Develop public education campaigns to improve preparedness for building evacuations
- No. 17: Design building to accommodate timely full-building evacuation
- No. 18: Design egress paths to maximize remoteness and to maintain their functional integrity during building emergencies
- No. 19: Request facility executives and emergency responders develop joint plans and make sure information is transmitted accurately to enhance occupants' situational awareness during emergencies
- No. 20: Evaluate alternative evacuation methods, including elevators and exterior escape devices

#### Improved Emergency Response

- No. 21: Install fire-protected and structurally hardened elevators to improve emergency response activities
- No. 22: Install, inspect and test communications systems to be sure they can be used in buildings with challenging propagation environments and to locate and track emergency responders
- No. 23: Enhance data gathering, processing and delivery of critical information to emergency responders
- No. 24: Ensure uninterrupted operation of the command and control system for large-scale emergencies

#### Improved Procedures and Practices

- No. 25: Ensure nongovernmental and quasi-governmental agencies not subject to codes obtain code-equivalent level of safety
- No. 26: Adopt and enforce codes to be sure egress and sprinkler requirements are met
- No. 27: Require building owners to retain documents related to building design, construction, maintenance and modifications at an off-site location and make documents available to emergency responders in hard copy or electronic format
- No. 28: Clarify the phrase "design professional in responsible charge" to be sure that fire protection and structural engineers provide the standard of care when employing innovative or unusual methods

#### Continuing Education and Training

- No. 29: Cross-train architects, fire protection engineers and structural engineers
- No. 30: Develop educational tools in computational fire dynamics and thermostructural analysis

### Structural Integrity

- New types of steel and reinforced and prestressed concrete to withstand a fire burnout
- Structural design to prevent progressive collapse

### Evacuation Procedures

- Fire-protected, structurally hardened elevators for occupant evacuation
- Fire-protected, structurally hardened elevators dedicated for use by emergency responders

- Wider, hardened stairwells located on the building's perimeter
- Photoluminescent markers along egress paths

# FUTURE HIGH-RISE?

**NIST recommendations and security industry guidelines could reshape design and operation of high-rises**

### Fire Protection

Redundant sprinklers, fire alarms, smoke management systems, and standpipes and hoses

Improved control panels in fire command center for tactical planning during an emergency

- Fire alarm and communications systems to manage full building evacuations
- "Black boxes" to store information from fire alarms

### Safety & Security

Low-deck parking and occupant parking near building. High-deck and visitor parking located farther away

- Visitor management area for expedited visitor registration
- Optical turnstiles in multitenant buildings
- Access control systems at entry points and elevators

Bollards, tiered landscaping and Jersey barriers to prevent vehicles from getting near building

Blast-resistant window film

Dedicated delivery entrance

- HVAC air intakes located 75 feet above grade or high enough to make tampering difficult
- Cameras on air intakes to detect potential threats

SOURCES: NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, NATIONAL FIRE PROTECTION ASSOCIATION, ASIS INTERNATIONAL

For more information on the NIST investigation, reports and recommendations, go to [wtc.nist.gov](http://wtc.nist.gov).