

Industry should partner with the research community to fill critical gaps in knowledge about how structures perform in real fires, particularly considering: the effects of fire on the entire structural system; the interactions between subsystems, elements, and connections; and scaling of fire test results to full-scale structures, especially for structures with long span floor systems.

Affected Standards: ASCE 7, ASCE/SFPE 29, AISC Specifications, ACI 318. Development of performance objectives, design criteria, evaluation methods, design guidance, and computational tools should begin promptly, leading to new standards.

Model Building Codes: The new standard should be adopted in model building codes (IBC, NFPA 5000) by mandatory reference to, or incorporation of, the latest edition of the standard.

Relevance to WTC 7: The effects of restraint of free thermal expansion on the steel framing systems, especially for the long spans on the east side of WTC 7, were not considered in the structural design and led to the initiation of the building collapse.

Recommendation C (NIST NCSTAR 1 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:³

- **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;⁴**
- **the need for redundancy in fire protection systems that are critical to structural integrity;⁵**
- **the ability of the structure and local floor systems to withstand a maximum credible fire scenario⁶ without collapse, recognizing that sprinklers could be compromised, not operational, or non-existent;**

³ The construction classification and fire rating requirements should be *risk-consistent* with respect to the *design-basis hazards* and the *consequences* of those hazards. The fire rating requirements, which were originally developed based on experience with buildings fewer than 20 stories in height, have generally decreased over the past 80 years since historical fire data for buildings suggests considerable conservatism in those requirements. For tall buildings, the likely consequences of a given threat to an occupant on the upper floors are more severe than the consequences to an occupant on the first floor or the lower floors. For example, with non-functioning elevators, both the time requirements are much greater for full building evacuation from upper floors and emergency responder access to those floors. The current height and area tables in building codes do not provide the technical basis for the progressively increasing risk to an occupant on the upper floors of tall buildings that are much greater than 20 stories in height.

⁴ Occupant life safety, prevention of fire spread, and structural integrity are considered separate safety objectives.

⁵ The passive fire protection system (including the application of SFRM, compartmentation, and firestopping) and the active sprinkler system each provide redundancy for maintaining structural integrity in a building fire, should one of the systems fail to perform its intended function.