

- compartmentation requirements (e.g., 12,000 ft² ⁽⁷⁾) 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.

Relevance to WTC 7: The floor systems in WTC 7 failed because thermal effects within the structural system, especially thermal expansion, were not considered in setting the fire rating requirements in the construction classification, which are determined using the ASTM E 119 or equivalent testing standard. Such evaluation is not required under current codes and standards.

Recommendation D (NIST NCSTAR 1 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.

Of particular concern is that the Standard Fire Resistance Test does not adequately capture important thermally-induced interactions between structural subsystems, elements, and connections that are critical to structural integrity. System-level interactions, especially due to thermal expansion, are not considered in the standard test method since columns, girders, and floor subassemblies are tested separately. Also, the performance of connections under both gravity and thermal effects is not considered. The United States currently does not have the capability for studying and testing these important fire-induced phenomena critical to structural safety.

Relevance to WTC 7: The floor systems failed in WTC 7 at shorter fire exposure times than the specified fire rating (two hours) and at temperatures lower than the endpoint temperature (593 °C, 1100 °F) because thermal effects within the structural system, especially thermal expansion, were not considered in setting the endpoint criteria when using the ASTM E 119 or equivalent testing standard. The structural breakdowns that led to the initiating event and the eventual collapse of WTC 7 occurred at temperatures that were hundreds of degrees below the criteria that determine structural fire resistance ratings.

Recommendation E (NIST NCSTAR 1 Recommendation 7). NIST recommends the adoption and use of the “structural frame” approach to fire resistance ratings. This approach requires all members that comprise the primary structural frame (such as columns, girders, beams, trusses, and

⁶ A maximum credible fire scenario includes conditions that are severe, but reasonable to anticipate, conditions related to building construction, occupancy, fire loads, ignition sources, compartment geometry, fire control methods, etc., as well as adverse, but reasonable to anticipate operating conditions.

⁷ Or a more appropriate limit, which represents a reasonable area for active firefighting operations.