

collapse in infrequent fires that may occur when active fire protection systems are rendered ineffective, e.g., when sprinklers do not exist, are not functional, or are overwhelmed by the fire.

Fire scenarios for structural design based on single compartment or single floor fires are not appropriate representations of infrequent fire events. Such events have occurred in several tall buildings resulting in unexpected substantial losses. Instead, historical data suggests that infrequent fires which should be considered in structural design involve: ordinary combustibles and combustible load levels, local fire origin on any given floor, no widespread use of accelerants, consecutive fire spread from combustible to combustible, fire-induced window breakage providing ventilation for continued fire spread and accelerated fire growth, concurrent fires on multiple floors, and active fire protection systems rendered ineffective. The fires in WTC 7 involved all of these.

NIST believes the recommendations are realistic, appropriate, and achievable within a reasonable period of time. NIST strongly urges that immediate and serious consideration be given to these recommendations by the building and fire safety communities in order to achieve appropriate improvements in the way buildings are designed, constructed, maintained, and used—with the goal of making buildings safer in future emergencies. The scope of the WTC Investigation does not include supporting analyses of the recommendations, such as alternative factors or design options.

A complete listing of all 13 recommendations (Recommendations A through L) based on this Investigation follows. Under a few of the recommendations, the pertinent lesson from the reconstruction of the WTC 7 collapse is reflected in the form of a modification. For the 12 reiterated recommendations, the pertinent codes, standards, and organizations were listed in Table 9-1 and Tables 9-2a through 9-2c of NIST NCSTAR 1 and are not repeated here. For the one new recommendation, B, this information is provided in the text below.

## **5.2 NIST’S RECOMMENDATIONS FOR IMPROVING THE SAFETY OF BUILDINGS, OCCUPANTS, AND EMERGENCY RESPONDERS**

### **5.2.1 Group 1. Increased Structural Integrity**

**The standards for estimating the load effects of potential hazards (e.g., progressive collapse, wind) and the design of structural systems to mitigate the effects of those hazards should be improved to enhance structural integrity.**

**Recommendation A (NIST NCSTAR 1 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 guidance—to reliably predict the potential for complex failures in structural systems subjected to multiple hazards.**

*Relevance to WTC 7:* Had contemporaneous standards and practices been available to expressly design WTC 7 for prevention of fire-induced progressive collapse, it would have been sufficiently robust to withstand local failure due to the fires without suffering total collapse.