

reach this temperature for an insulated lighter column. These times are both far longer than the time over which post-flashover gas temperatures were sustained in the computed WTC 7 fires. For comparison, this steel temperature would have been reached in under one-half hour if the insulation were not applied.

- It is unlikely that the collapse of WTC 7 would have been prevented had the insulation thickness on the floor beams been increased by 50 percent, from 13 mm (1/2 in.) to 19 mm (3/4 in.). NIST calculations indicated that the time to reach the steel temperature of 649 °C (1200 °F) would have increased by about 10 min to 20 min.
- The ASTM E119 test does not capture critical behavior of structural systems, e.g., the effect of thermal expansion or sagging of floor beams on girders, connections, and/or columns. The thermal expansion of the WTC 7 floor beams that initiated the probable collapse sequence occurred primarily at temperatures below approximately 400 °C (750 °F). Thus, to the extent that thermal expansion, rather than loss of structural strength, precipitates an unsafe condition, thermal expansion effects need to be evaluated. The current fire resistance rating system, which does not include thermal expansion effects, is not conservative.

#### **14.5.4 Fire Safety and Fire Protection Systems**

- WTC 7 had the following active fire protection systems: fire alarms, smoke and heat detectors, manual pull stations, smoke control systems, and automatic sprinklers. Each was designed, constructed, and apparently maintained consistent with applicable building codes and standards.
- The standpipe and automatic sprinkler systems were divided into three zones. As prescribed by the NYCBC, each zone had a primary and secondary water supply.
  - The primary water supply for fire protection for the high zone (Floors 40 through 47) and mid-level zone (Floors 21 through 39) was from two water storage tanks on the 46<sup>th</sup> floor. The secondary supply was pumped from the city water main.
  - The primary water supply for fire protection for the low zone, floors 1 through 20, was a direct connection to the city water mains. The secondary supply was from an automatic fire pump, which was connected to the city water main as well.
- Since the city water main had been compromised as a result of the collapses of the two towers, there was no water supply to control the fires on the 7<sup>th</sup> through 13<sup>th</sup> floors. By contrast, the early fires on the 22<sup>nd</sup>, 29<sup>th</sup>, and 30<sup>th</sup> floors may have been assisted by the sprinkler system on the upper floors, whose primary water supply was from the storage tanks on the 46<sup>th</sup> floor.
- The architectural drawings indicated that there were fire-rated walls between tenant spaces on the same floor and between tenant spaces and the building core. Spaces housing mechanical equipment, power transformers, emergency power generators, and other such equipment were enclosed in fire-rated partitions. While the partitions between offices, conferences rooms,