

- These computational models comprise a set of research tools that can take months (eight months in this case) for a complete simulation. Their adaptation for engineering practice would forestall future disasters, while reducing the potential for structural overdesign.

14.4 LIFE SAFETY FACTORS

14.4.1 Evacuation of WTC 7

- By the conventional measure of life safety, the evacuation of WTC 7 was successful, as NIST identified no life-threatening injuries or fatalities among the estimated 4,000 building occupants on September 11, 2001.
- Most of the occupants initiated their own evacuation shortly after WTC 1 was attacked.
- Evacuation of the building took just over an hour to complete, which was about 30 min longer than the estimated minimum time if the elevators and stairs had been used to maximum advantage. Nonetheless, the building was safely evacuated prior to the collapse of WTC 2. Some of the additional evacuation time was due to the considerable crowding in the lobby. Occupants arrived in the lobby from both stairwells, from the elevators, and from other WTC buildings, and were held in the lobby until a safe exterior exit was identified by emergency management officials.
- The calculated stairwell capacity was insufficient to meet the requirements of the NYCBC in effect during the design and construction period, if the building were occupied at the calculated maximum level ($\approx 14,000$ people).² The capacity was sufficient for the normal occupancy of the building ($\approx 8,000$ workers plus visitors), estimated by NIST, and was more than sufficient for the occupancy on September 11, 2001 ($\approx 4,000$ people), also estimated by NIST. The stairwell capacity met the requirement of the (subsequent) 2000 edition of the IBC, but not the 2003 edition of NFPA 5000.
- The separation of the stairwell doors met the requirement of the 1968 NYCBC. On some floors, the separation of the stairwell doors was below the remoteness requirements in the (current) 2000 IBC and the 2003 NFPA 5000.
- Evacuation management at every level did not provide prompt evacuation instructions to building occupants during the event. NIST was not able to determine whether specific guidance was delivered to the occupants via the public address system.
- In addition to the length of time that WTC 7 withstood the internal fires, some specific human actions likely contributed to the speed and overall success of the evacuation.

² When WTC 7 was being designed, many details of tenant spaces were unknown. Therefore, NIST used a conservative calculation of net floor area which does not account for tenant spaces which are normally unoccupied. While the NYCBC in effect at the time of design allowed for these reductions to net floor area calculations (spaces such as columns, fixed cabinets, furred-in spaces, equipment and accessory spaces would be subtracted from gross area), this calculation would require specific knowledge of tenant layout details and would preclude future changes to the floor layouts after stairwell construction.