

- The wind loads used for the WTC towers, which governed the design of the external columns, significantly exceeded the requirements of the NYC Building Code and other building codes of the day that were reviewed by NIST. Two sets of wind load estimates for the towers obtained by independent commercial consultants in 2002, however, differed by as much as 40 percent. These estimates were based on wind tunnel tests conducted as part of insurance litigation unrelated to the Investigation.

The tragic consequences of the September 11, 2001, attacks were largely a result of the fact that terrorists flew large jet-fuel laden commercial airliners into the WTC towers. Buildings for use by the general population are not designed to withstand attacks of such severity; building regulations do not require building designs to consider aircraft impact. In our cities, there has been no experience with a disaster of such magnitude, nor has there been any in which the total collapse of a high-rise building occurred so rapidly and with little warning.

While there were unique aspects to the design of the WTC towers and the terrorist attacks of September 11, 2001, there are several possibilities to improve the safety of tall buildings, occupants, and emergency responders that result from this investigation of commonly used procedures and practices that were used in the design, construction, operation, and maintenance of the WTC towers. There also are possible improvements for selected buildings that owners may determine to be at higher risk due to their iconic status, critical function, or design. The recommendations in Chapter 9 suggest a variety of ways in which to achieve these safety improvements.

8.3 FINDINGS ON THE MECHANISMS OF BUILDING COLLAPSE

8.3.1 Summary of Probable Collapse Sequences

WTC 1 was struck by a hijacked aircraft at 8:46:30 a.m. and began to collapse at 10:28:22 a.m. WTC 2 was struck by a hijacked aircraft at 9:02:59 a.m. and began to collapse at 9:58:59 a.m. The specific factors in the collapse sequences relevant to both towers (the sequences vary in detail for WTC 1 and WTC 2) are:

- Each aircraft severed exterior columns, damaged interior core columns and knocked off insulation from steel as the planes penetrated the buildings. The weight carried by the severed columns was distributed to other columns.
- Subsequently, fires began to grow and spread. They were initiated by the aircraft's jet fuel, but were fed for the most part by the building contents and the air supply resulting from breached walls and fire-induced window breakage.
- These fires, in combination with the dislodged insulation, were responsible for a chain of events in which the building core weakened and began losing its ability to carry loads.
- The floors weakened and sagged from the fires, pulling inward on the exterior columns.
- Floor sagging and exposure to high temperatures caused the exterior columns to bow inward and buckle—a process that spread across the faces of the buildings.