

- While two documents from The Port Authority indicated that the safety of the WTC towers and their occupants in an aircraft collision was a consideration in the original design, it appears that the effect of the subsequent fires was not considered. NIST was unable to locate any documentary evidence on the aircraft impact analysis considered by The Port Authority.

8.5.2 Structural Safety

- At the time of the design and construction of the WTC towers, there were no explicit structural integrity provisions to mitigate progressive collapse. U.S. Federal agencies and the United Kingdom have since developed and implemented such guidelines. New York City adopted by rule in 1973 a requirement for buildings to resist progressive collapse under extreme local loads. The rules apply specifically to buildings that used precast concrete wall panels and not to other types of buildings.
- At the time of the design and construction of the WTC towers, there were no explicit minimum structural integrity provisions for the means of egress (stairwells and elevator shafts) in the building core that were critical to life safety. The building core, generally designed to be part of the vertical gravity load-carrying system of the structure, need not be part of the lateral load-carrying system of the structure. In this case, the structural designer may have preferred the use of partition walls rather than structural walls in the core area to reduce building weight. In the case of the WTC towers, the core had 2 hour fire-rated, gypsum partition walls with little structural integrity, and the core framing was required to carry only gravity loads. Had there been a minimum structural integrity requirement to satisfy normal building and fire safety considerations, it is conceivable that the damage to stairways, especially at the floors of impact, may have been less extensive.
- Wind loads were a major factor in the design of structural components that made up the frame-tube steel framing system. Building codes allow the determination of wind forces from wind tunnel tests for use in design, but there were not (and still are not) standards for conducting wind tunnel tests and for the methods used in practice to estimate design wind loads from test results. Results of two sets of wind tunnel tests conducted for the WTC towers in 2002 by independent commercial laboratories as part of insurance litigation, and voluntarily provided to NIST by the parties to the litigation, show up to 40 percent differences in resultant forces on the structures. There were also significant differences among various specified design wind speeds. Such disparities are indicative of the limitations associated with the current state of practice in wind engineering for tall buildings.
- The original design wind loads on the towers exceeded those established in the prescriptive provisions of the NYC Building Code from 1968 through 2001. These wind loads were also higher than those required by other selected building codes and the relevant model building code of the time. Note, however, that the approach in these codes was oversimplified, and as a result, these codes may not be applicable for super-tall building design.
- In the original design of the towers, the calculated drift (the maximum sway of the building) was significantly larger than what is currently used in practice. However, drift was not, and is not, a design factor prescribed in building codes.