

ES.3. PRINCIPAL FINDINGS OF THE INVESTIGATION

The fires in WTC 7 were ignited as a result of the impact of debris from the collapse of WTC 1, which was approximately 110 m (350 ft) to the south. The debris also caused structural damage to the southwest exterior of WTC 7, primarily between Floors 7 to 17. The fires were ignited on at least 10 floors; however, only the fires on Floors 7 through 9 and 11 through 13 grew and lasted until the time of the building collapse. These uncontrolled fires had characteristics similar to those that have occurred previously in tall buildings. Their growth and spread were consistent with ordinary building contents fires. Had a water supply for the automatic sprinkler system been available and had the sprinkler system operated as designed, it is likely that fires in WTC 7 would have been controlled and the collapse prevented. However, the collapse of WTC 7 highlights the importance of designing fire-resistant structures for situations where sprinklers are not present, do not function (e.g., due to disconnected or impaired water supply), or are overwhelmed.

Eventually, the fires reached the northeast region of the building. The probable collapse sequence that caused the global collapse of WTC 7 involved the initiation of the buckling of a critical interior column in that vicinity. This column had become unsupported over nine stories after initial local fire-induced damage led to a cascade of local floor failures. The buckling of this column led to a vertical progression of floor failures up to the roof, and led to the buckling of adjacent interior columns to the south of the critical column. An east-to-west horizontal progression of interior column buckling followed, due to loss of lateral support to adjacent columns, forces exerted by falling debris, and load redistribution from other buckled columns. The exterior columns then buckled as the failed building core moved downward, redistributing its loads to the exterior columns. Global collapse occurred as the entire building above the buckled region moved downward as a single unit. This was a fire-induced progressive collapse, also known as disproportionate collapse, which is defined as the spread of local damage, from an initiating event, from element to element, eventually resulting in the collapse of an entire structure, or a disproportionately large part of it.

Factors contributing to the building failure were: thermal expansion occurring at temperatures hundreds of degrees below those typically considered in design practice for establishing structural fire resistance ratings; significant magnification of thermal expansion effects due to the long-span floors, which are common in office buildings in widespread use; connections that were designed to resist gravity loads, but not thermally induced lateral loads; and a structural system that was not designed to prevent fire-induced progressive collapse.

Within the building were emergency electric power generators, whose fuel supply tanks lay in and under the building. However, fuel oil fires did not play a role in the collapse of WTC 7. The worst-case scenarios associated with fires being fed by the ruptured fuel lines (a) could not have been sustained long enough, or could not have generated sufficient heat, to raise the temperature of the critical interior column to the point of significant loss of strength or stiffness, or (b) would have produced large amounts of visible smoke that would have emanated from the exhaust louvers. No such smoke discharge was observed.

Simulations of hypothetical blast events show that no blast event played a role in the collapse of WTC 7. NIST concluded that blast events did not occur, and found no evidence whose explanation required invocation of a blast event. Blast from the smallest charge capable of failing a single critical column would have resulted in a sound level of 130 dB to 140 dB at a distance of at least half a mile. There were