

Following the aircraft impact into the building, the structure was able to successfully redistribute the building weight to the remaining elements and to maintain a stable condition. This return to a stable condition is suggested by the preliminary analyses and also evidenced by the fact that the structure remained standing for 1 hour and 43 minutes following the impact. However, the structure's global strength was severely degraded. Although the structure may have been able to remain standing in this weakened condition for an indefinite period, it had limited ability to resist additional loading and could potentially have collapsed as a result of any severe loading event, such as that produced by high winds or earthquakes. WTC 1 probably experienced some additional loading and damage due to the collapse of the adjacent WTC 2. The extent of such damage is not known but likely included broken window and façade elements along the south face. This additional damage was not sufficient to cause collapse. The first event of sufficient severity to cause collapse was the fires that followed the aircraft impact.

2.2.1.2 Fire Development

It is estimated, based on information compiled from Government sources, that each aircraft contained about 10,000 gallons of jet fuel upon impact into the buildings. A review of photographic and video records show that the aircraft fully entered the buildings prior to any visual evidence of flames at the exteriors of the buildings. This suggests that, as the aircraft crashed into and plowed across the buildings, they distributed jet fuel throughout the impact area to form a flammable "cloud." Ignition of this cloud resulted in a rapid pressure rise, expelling a fuel rich mixture from the impact area into shafts and through other openings caused by the crashes, resulting in dramatic fireballs.

Although only limited video footage is available that shows the crash of American Airlines Flight 11 into WTC 1 and the ensuing fireballs, extensive video records of the impact of United Airlines Flight 175 into WTC 2 are available. These videos show that three fireballs emanated from WTC 2 on the south, east, and west faces. The fireballs grew slowly, reaching their full size after about 2 seconds. The diameters of the fireballs were greater than 200 feet, exceeding the width of the building. Such fireballs were formed when the expelled jet fuel dispersed and flames traveled through the resulting fuel/air mixture. Experimentally based correlations for similar fireballs (Zalosh 1995) were used to estimate the amount of fuel consumed. The precise size of the fireballs and their exact shapes are not well defined; therefore, there is some uncertainty associated with estimates of the amount of fuel consumed by these effects. Calculations indicate that between 1,000 and 3,000 gallons of jet fuel were likely consumed in this manner. Barring additional information, it is reasonable to assume that an approximately similar amount of jet fuel was consumed by fireballs as the aircraft struck WTC 1.

Although dramatic, these fireballs did not explode or generate a shock wave. If an explosion or detonation had occurred, the expansion of the burning gasses would have taken place in microseconds, not the 2 seconds observed. Therefore, although there were some overpressures, it is unlikely that the fireballs, being external to the buildings, would have resulted in significant structural damage. It is not known whether the windows that were broken shortly after impact were broken by these external overpressures, overpressures internal to the building, the heat of the fire, or flying debris.

The first arriving firefighters observed that the windows of WTC 1 were broken out at the Concourse level. This breakage was most likely caused by overpressure in the elevator shafts. Damage to the walls of the elevator shafts was also observed as low as the 23rd floor, presumably as a result of the overpressures developed by the burning of the vapor cloud on the impact floors.

If one assumes that approximately 3,000 gallons of fuel were consumed in the initial fireballs, then the remainder either escaped the impact floors in the manners described above or was consumed by the fire on the impact floors. If half flowed away, then approximately 4,000 gallons remained on the impact floors to be