

## **WTC Collapse Initiation Floors: What They Were And How Much Damage They Suffered**

by Kevin Fenton

Although much has been written about the collapses of the World Trade Center towers on September 11, 2001, one important aspect – the floors on which the collapses initiated – has received little attention. However, the floors on which the collapse began must be a key factor, as it would appear to be the events on these floors, rather than those of the other floors impacted by the airliners, that determined the buildings' fate.

It is interesting to compare the collapse initiation floor in WTC1 to the central impact floors in terms of three of the main aspects thought to have influenced the collapse: impact damage, jet fuel spilled, and debris available to remove fire insulation.

### *Comparison of Impact Damage on Collapse Initiation Floor and Central Impact Floors*

According to the final reports of the National Institute of Standards and Technology (NIST), the collapse of the North Tower, began on floor 98.[1] NIST also reproduces photographs said to be taken at the time of the collapse showing fire and debris being expelled from floor 98, and showing the section of the building above this floor tilting.[2] Although some aspects of NIST's work on the WTC have been questioned, the author is not aware of any reliable claims giving the collapse initiation floor for WTC1 as anything other than 98. In addition, a review of video sequences appeared to confirm NIST's view.[3]

Floor 98 was not in the centre of the impact area, but was struck by a portion of the aircraft. The fuselage and the engines hit floors 95 and 96, whereas floor 98 was only hit by the outer section of the plane's starboard wing. Five of the perimeter columns on floor 98 were severed. If 50% of the building's gravity load is assumed to be carried by the columns in the building's core and 50% by the 236 perimeter columns, the five severed perimeter columns would have degraded floor 98's ability to bear the gravity load it supported by slightly more than 1%. The central impact floors, where 15-18 perimeter columns were severed, suffered more damage. The damage suffered by the central impact floors was therefore at least three times worse than that suffered by floor 98.

While possible damage to the core is not known definitively, despite attempts at using computer simulations to predict it, it would be reasonable to assume that the greater volume of heavier debris on the central impact floors would be more likely to sever columns in the building's core. The NIST computer simulations did not predict any damage to the core columns on floor 98, but, for example, NIST's severe case scenario predicted that on floor 95 six core columns would be severed and another seven damaged, possibly reducing the ability of that floor's columns to bear their gravity loads

by around 10%. However, the presumed damage to core columns on lower floors may have had some effect on the ability of the core on floor 98 to carry its gravity load due to load redistribution to columns not damaged at a lower point.

The fact that a floor that suffered comparatively little damage collapsed before a floor that suffered comparatively heavy damage indicates that the impact damage did not play a defining role in the collapse.

#### *Comparison of Jet Fuel Spilled on Collapse Initiation Floor and Central Impact Floors*

Although the role of the jet fuel, which is said to have burned up within a few minutes of the initial impact, is not thought to have been large, the amount of fuel spilled on floor 98 and that on the central impact floors can also be compared. According to NIST's severe case scenario, only 454 gallons of jet fuel were spilled on floor 98, which had an area of over 40,000 ft<sup>2</sup>, whereas over 1,905 gallons – over four times more – were spilled on each of floors 94, 95 and 96.[5] This indicates that the jet fuel could not have been the major cause of the collapse.

#### *Comparison of Debris Available to Remove Fire Insulation on Collapse Initiation Floor and Central Impact Floors*

The loss of fireproofing resulting from flying aircraft debris following the impacts is said to have been a major factor in the towers' collapses. Although NIST's simulations in this area have been disputed, it is clear that the more debris by weight there was on a floor, the more likely it was that fireproofing on that floor suffered some damage. A comparison of the different floors again highlights the relatively undamaged nature of floor 98 after the impacts. According to NIST's severe case scenario, only 7,300 lb of debris remained on floor 98 after the aircraft impact, whereas each of the central impact floors received over 21,000 lb, and floor 94 almost 59,900 lb without collapsing.[6]

According to NIST's severe case simulation, on floor 96, "The insulation was knocked off nearly all the core columns and over a 40 ft width of floor trusses from the south end of the core to the south face of the tower." [7] On the contrary, the alleged damage to the fireproofing on floor 98 was much less, "The debris cut a shallow path through the west and center array of trusses, damaging the insulation up to the north wall of the building core." [8] Even if NIST's simulations can be successfully challenged, it is logical to assume that the potential for damage to the fireproofing was greater on the central impact floors than on floor 98.

#### *Office Fires*

The office fires are the only aspects of the catastrophe that are comparable for the collapse initiation floor and the central impact floors, all of which were occupied by

Marsh and McLennan and can provisionally be assumed to have had similar amounts of combustibles.

## *WTC2*

The situation is similar for WTC2 – the collapse initiation floor suffered less damage than the central impact floor – although the contrast is not so marked. According to NIST, the collapse initiation floor was 82,[9] whereas the central impact floors were 80 and 81.[10] For example, NIST’s severe case scenario predicts ten severed core columns on floor 80, but only 5 on floor 82. According to the severe case, more fuel – 1,495 gallons – was deposited on floor 82 than on either of the central impact floors, although the floor that received the largest amount of fuel was 79 (note: the numbers are similar for the base cases for both towers). However, floor 82 only received a total of 1,400 lb of aircraft debris in this case, whereas floor 80 received over 40,000 lb, making it likely that any damage to fireproofing would have been significantly more severe on floor 80.[11]

## **Conclusion**

The results of the comparison are startling. The central impact floors in both towers held until more lightly damaged floors above fell on them. In the case of WTC1, direct impact by the aircraft’s fuselage and engines was not sufficient to cause floors 95 and 96 to collapse, whereas the impact of the outer section of the aircraft’s wing appears to have caused floor 98 to fail. This is the exact opposite of what one would have expected to find. Obviously, further research is required to determine the precise failure mechanism.

## **References**

[1] NIST repeatedly gives the collapse initiation floor for WTC1 as 98. For example in Table 6-2 on page 87 of NCSTAR 1 it states, “First exterior sign of downward movement of building at floor 98.” See also NCSTAR 1-6, Structural Fire Response and Probable Collapse Sequence of the World Trade Center Towers.

[2] NCSTAR 1-6, Structural Fire Response and Probable Collapse Sequence of the World Trade Center Towers, p. 305.

[3] Please see the collection of video images archived at the website 911research, which can be found here:  
<http://911research.wtc7.net/wtc/evidence/videos/index.html#northtower>. Perhaps the best sequence for determining the collapse initiation floor is here:  
[http://911research.wtc7.net/wtc/evidence/videos/wtc1\\_close\\_frames.html](http://911research.wtc7.net/wtc/evidence/videos/wtc1_close_frames.html). Watch for downward movement at the northeast corner of WTC1 (on the right of the picture) between frames 7 and 8. The downward movement appears to begin at the floor from which smoke and debris is being ejected - floor 98.

[4] See NCSTAR 1-2, p. 210, for severe case damage to floor 95.

[5] See NCSTAR 1-2, Table 7-5, p. 212. NIST gives the amount of jet fuel spilled on floor 98 as 3,100 lbs. Assuming the jet fuel weighed 6.825 lbs. per gallon, the quantity in gallons is 454. The weights of jet fuel spilled on the other floors were converted to gallons using the same ratio.

[6] See NCSTAR 1-2, Table 7-5, p. 212. In the base case scenario 2,200 lb of aircraft fuel was located on floor 98 after the impact, see NCSTAR 1-2, Table 7-2, p. 196.

[7] See NCSTAR 1, p. 21.

[8] See NCSTAR 1, p. 21.

[9] See Table 6-2 on page 87 of NCSTAR 1

[10] See NCSTAR 1, p. 40-41.

[11] See NCSTAR 1-2, Table 7-10, p. 258.