

these floors during the morning; and, even at 2:00 p.m., the fire on the 7th floor was still in the southwest section of the building. The computations were continued for six hours, since the time in the structural simulations at which the building would become structurally unstable was not yet known.

The fire on the 9th floor was not observed until about 4:00 p.m., approximately one hour after fire was first observed on the 8th floor. Since there was no information about the history of the 9th floor fire prior to 4:00 p.m., and since there was limited knowledge of the layout of combustible materials on this floor, this fire was approximated by displacing the 8th floor fire one hour later.

The layouts of the 11th and 12th floors were essentially identical. The observation of fires on the 11th floor indicated that they were similar to those on the 12th floor, but lagged by about an hour in reaching equivalent positions along the building perimeter. The intense fires on the 13th floor appeared after about 2:30 p.m. on the east face and the east side of the north face. These fires also appeared similar to those on the 12th floor, but lagged behind them by about a half hour. Thus, these fires were simulated using the 12th floor fires, suitably offset in time.

On the 14th floor, a small fire was observed at the far east of the north face at about 5:03 p.m. It was not observed at 4:52 p.m., nor at 5:09 p.m. On September 11, 2001, the 14th floor was unoccupied and should have had a very small combustible fuel load. From this evidence, the Investigation Team deduced that it was unlikely that there had been a sustained fire of appreciable heat output. Thus, no fire simulation was performed for this floor.

The calculations were very similar to those conducted for WTC 1 and WTC 2 (NIST NCSTAR 1-5F) and, therefore, only a brief description of the major assumptions is included. It should be remembered that there were far fewer photographs of WTC 7 than of the towers. Thus, while the severity of the simulated WTC 7 fires (as established from the visual evidence) is reasonable, the details of these fires are not as precise as for the fires in the towers.

9.1.2 Fire Spread

Ventilation Effects

If each floor of WTC 7 had been airtight (i.e., no broken windows or breach in the exterior from debris impact damage), a fire starting on a particular floor would have been limited to a size that would not likely have threatened the building for the following reasons:

- The volume of a floor was approximately $1 \times 10^4 \text{ m}^3$ ($4 \times 10^5 \text{ ft}^3$). The mass of air contained in that volume was $1.7 \times 10^4 \text{ kg}$; the mass of oxygen was $3 \times 10^3 \text{ kg}$. The heat release from combustion of typical combustibles is 13.1 MJ per kg of oxygen consumed (Huggett 1980). Only about half the oxygen could have been consumed, since that would have resulted in an oxygen level below which flame spread would slow considerably and soon halt. Thus, a fire on this airtight floor would have generated about $2 \times 10^4 \text{ MJ}$.
- If the density of combustible materials able to burn were 20 kg/m^2 (4 lb/ft^2), there would have been approximately $6 \times 10^4 \text{ kg}$ of combustibles on a given floor. If they were wood-like in heat of combustion (heat of combustion approximately 20 kJ/g (Drysdale 2002)), they would have generated $1 \times 10^6 \text{ MJ}$, given sufficient oxygen. Since an airtight floor would have only