

- Temperature-dependent mechanical properties of the steels, welds, and bolts used in the construction of WTC 7, including elastic, plastic, and creep properties.
- Column loads due to design loads shown in the design drawings, which were used to verify the structural models.

The fire dynamics and thermal analyses were similar to the analyses described in detail in the WTC towers reports. However, there were some differences in the analyses, which are briefly described here.

The major fires in WTC 7 were simulated using the Fire Dynamics Simulator (FDS). The FDS calculations were similar to those conducted for WTC 1 and WTC 2 (NIST NCSTAR 1-5F). There were fewer photographs and videos of WTC 7 than of the towers. Thus, the details of the WTC 7 fires were not as precise as for the fires in the towers. However, the imagery was sufficient to guide the WTC 7 fire simulations. Unlike the fire simulations for WTC 1 and WTC 2, the fire simulations for WTC 7 were conducted for each floor individually as there were no obvious pathways for the flames and heat to pass from one floor to another, aside from the debris-damaged area in the southwest corner of the building. As described in Section 5.6, sustained and/or late fires were observed on Floors 7 through 9 and 11 through 13. While use was made of the appearance of flames and window breakage in photographs and videos in formulating the simulations, the Investigation Team realized that the timing of the simulations might not align exactly with the timing of the fires on September 11, 2001. In addition, there might have been concealed, yet major fires in the mechanical space on Floors 5 and 6. Thus, a variety of possible fires on Floors 5 and 6 were studied to determine whether each would have produced a visible telltale and whether they would have been severe enough to weaken key structural elements on those floors.

The Fire Structure Interface (FSI) used the gas temperatures from the FDS simulations (Chapter 10) to heat on the structural components of WTC 7 (Chapter 2) and to predict the evolving thermal state of the building. The FSI created thermal loading data for use by the structural models that simulated the collapse of the building (Chapters 11 and 12). The structural response of WTC 7, simulated to understand the collapse initiation mechanism, was performed using the thermal data. The thermal analysis approach was similar to that used to simulate the fire induced thermal loads on WTC 1 and WTC 2, as described in NCSTAR 1-5G. The temperature data used in the structural analysis of WTC 7 contained thermal data sampled at 30 min intervals for a 6 hour period. For each time step, a set of thermal data was generated that specified the thermal state of the lower 16 stories of the building. Three different thermal response computations were used, which together represented a realistic and reasonable range of fire scenarios for WTC 7 on September 11, 2001. Case A used the temperature data as obtained from the FDS simulation. Case B increased the FDS gas temperatures by 10 percent and Case C decreased the FDS gas temperatures by 10 percent. Given the limited visual evidence, the Investigation Team estimated, using engineering judgment, that a 10 percent change was within the range of uncertainty in the extent and intensity of the fires.

WTC 7 was a large, complex structural system. To include all of the structural components and connections and their associated behavior and failure mechanisms using refined finite element meshes was not possible. The analysis approach used was a variant of the well-established sub-structuring approach, adapted for the analysis of structures with highly nonlinear behavior that progressed from individual components to major subsystems to global systems, as shown in Figure 1-2.