

6.10 THERMAL ENVIRONMENT MODELING

6.10.1 Need for Simulation

Following the impact of the aircraft, the jet-fuel-ignited fires created the sustained and elevated temperatures that heated the remaining building structure to the point of collapse initiation. The photographic evidence provided some information regarding the locations and spreading of the fires. However, the cameras could only see the periphery of the building interior. The steep viewing angles of nearly all of the photographs and videos further limited the depth of the building interior for which fire information could be obtained. NIST could not locate any photographic evidence regarding the fire exposure of the building core or the floor assemblies.

The simulations of the fires were the second computational step in the identification of the probable sequences leading to the collapse of the towers. The required output of these simulations was a set of three-dimensional, time varying renditions of the thermal and radiative environment to which the structural members in the towers were subjected from the time of aircraft impact until the onset of building collapse. The rigor of the Investigation placed certain requirements on the computational tool (model) used to generate these renditions:

- Resolution of the varying thermal environment across key dimensions, e.g., the truss space;
- Representation of the complex combustibles;
- Computation of flame spread across the large expanses of the WTC floors; and
- Confidence in the accuracy of the predictions.

6.10.2 Modeling Approach

The time frame of the Investigation and the above requirements led to the use of the Fire Dynamics Simulator (FDS). Under development at NIST since 1978, FDS was first publicly released in February 2000 and had been used worldwide on a wide variety of applications, ranging from sprinkler activation to residential and industrial fire reconstructions. However, it had never before been applied to spreading fires in a building with such large floor areas.

Figure 6–30 shows how FDS represented the eight modeled floors (92 through 99) of the undamaged WTC 1. A similar rendition was prepared for floors 78 through 83 of WTC 2. The layout of each floor was developed from architectural drawings and from the information described in Section 5.8. There was a wide range of confidence in the accuracy of these floor plans, varying from high (for the floors occupied by Marsh & McLennan in WTC 1, for which recent and detailed plans were obtained) to low (for most of the space in WTC 2 occupied by Fuji Bank, for which floor plans were not available).

The effects of the aircraft impact were derived from the simulations described in Section 6.8. The portions of walls and floors that were “broken” in those simulations were simply removed from the FDS models of the towers. The furnishings outside the aircraft-damaged regions were assumed to be unmoved and undamaged. The treatment of furnishings within the impact zone is discussed later in this section.