

Chapter 8

PRINCIPAL FINDINGS

8.1 INTRODUCTION

This chapter presents the findings of the National Institute of Standards and Technology (NIST), organized according to the first three of the Investigation objectives for the World Trade Center (WTC) towers. The fourth objective is the subject of Chapter 9. WTC 7 is the subject of a companion report. The findings were derived from the extensive documentation summarized in the preceding chapters and described in detail in the accompanying reports. While NIST was not able to compile a complete documentation of the history of the towers, due to the loss of records over time and due to the collapses, the Investigators were able to acquire information adequate to support the findings and recommendations compiled in this chapter and the next. The chapter begins with summary statements and continues with the listing of the full set of principal findings.

8.2 SUMMARY

Objective 1: Determine why and how WTC 1 and WTC 2 collapsed following the initial impacts of the aircraft.

- The two aircraft hit the towers at high speed and did considerable damage to principal structural components (core columns, perimeter columns, and floors) that were directly impacted by the aircraft or associated debris. However, the towers withstood the impacts and would have remained standing were it not for the dislodged insulation and the subsequent multi-floor fires. The robustness of the perimeter frame-tube system and the large size of the buildings helped the towers withstand the impact. The structural system redistributed loads in places of aircraft impact, avoiding larger scale damage upon impact. The hat truss, which was intended to support a television antenna atop each tower, prevented earlier collapse of the building core. In each tower, a different combination of impact damage and heat-weakened structural components contributed to the abrupt structural collapse.
- In WTC 1, the fires weakened the core columns and caused the floors on the south side of the building to sag. The floors pulled the heated south perimeter columns inward, reducing their capacity to support the building above. Their neighboring columns quickly became overloaded as the south wall buckled. The top section of the building tilted to the south and began its descent. The time from aircraft impact to collapse initiation was largely determined by how long it took for the fires to weaken the building core and to reach the south side of the building and weaken the perimeter columns and floors.
- In WTC 2, the core was damaged severely at the southeast corner and was restrained by the east and south walls via the hat truss and the floors. The steady burning fires on the east side of the building caused the floors there to sag. The floors pulled the heated east perimeter columns inward, reducing their capacity to support the building above. Their neighboring