The Towers Lost and Beyond

A collection of essays on the WTC by researchers at the
Massachusetts Institute of Technology

Edited by

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Preface

This book contains eight articles that deal with the September 11, 2001 World Trade Center (WTC) disaster and its consequences, written by researchers at the Massachusetts Institute of Technology. For the most part, these articles were prepared between September 2001 and February 2002, and were revised in part in the spring of 2002. Indeed, some of these essays were largely written in their present form in the days following the disaster, which saw the first light in September of 2001 as opinion pieces in one of MIT's internet sites, and as internal research reports.

At about the time that the rough draft for this book was finished, an important study on the WTC came to light, namely the FEMA-NIST-ASCE report, which contained a wealth of new factual data. While this report could have provided additional material for the preparation of a revised version of this book, it was felt that the essays herein were not superseded by the FEMA report, but continued instead to be relevant and worthy of publication in their own right. Indeed, the FEMA report substantiated most of the writers' earlier views as to how the towers were wounded, how the fire affected the structures, and how they ultimately collapsed.

The book begins with a brief history of the Twin Towers, then continues with several technical analyses of the collision, the fire and the collapse of the towers, and concludes with two forward looking articles, one on possible future emergency escape systems from high rise buildings, and another on the consequences of terrorism on industrial supply chains —in brief, the timely and adequate supply of raw materials and parts to factories and business.

Fernandez commences by reviewing some historical facts about the design and construction of the towers. Thereafter, Kausel reminisces about the crash of the towers and expounds his early theories as to the reasons for their collapse. He then proceeds with an analysis of the speed of the aircraft immediately prior to collision in an article that led to a cover page story in the *New York Times* last February, which was carried around the world by the major news media.

Wierzbicki follows with a detailed analysis of the collision of the aircraft, and the heavy damage that they caused to the structures. From his exacting mechanical analysis, he concludes that the North Tower must have lost between 4 and 12 core columns —out of 44— while the South Tower lost between 7 and 20 such columns, and that both were brought to the verge of collapse by the collisions. Ghoniem examines carefully the fire conditions inside the towers, and determines that the temperature within the buildings must have been close to 1000°C, hot enough to significantly lower the stiffness and strength of the steel columns and girders. He also demonstrates that the chemical power of the aircraft fuel together with the combustible materials in the building, when released as heat over the course of one hour, was a staggering one gigawatt, which is comparable to the power of a large electrical power plant. This provides substantiation to the notion that the fires played a critical role in the collapse of the towers. Buyukozturk and Ulm proceed with a materials and structures analysis of the towers, their interaction with the fires, the effects of these on the structural materials, and the

mechanics of collapse. They also discuss how the vulnerability of future high rise buildings could be ameliorated by the widespread application of the concept of “redundancies”.

Fernandez elaborates on a series of new escape systems for high rise buildings under fire (or damaged by explosions) whose aim is to bypass impassable floors or blocked stairways. These would allow people trapped in higher elevations to escape safely to the street. He considers various types of devices, including those that can be deployed inside or on the exterior walls of the building. Finally, Sheffi discusses the effects that terrorist acts can have on the timely supply of raw materials and parts to industry, and on the need for a new strategy that blends on-time supplies with adequate strategic reserves, or as he succinctly puts it, “just in time and just in case”.

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