

Therese McAllister

Jonathan Barnett

John Gross

Ronald Hamburger

Jon Magnusson

1 *Introduction*

1.1 Purpose and Scope of Study

The events in New York City (NYC) on September 11, 2001, were among the worst building disasters and loss of life from any single building event in the United States. A total of 2,830 people lost their lives that day at the World Trade Center (WTC) site, including 403 emergency responders. The nation was shocked by the attacks and resulting collapse of office buildings that had been in use every day.

This report presents observations, findings, and recommendations regarding the performance of buildings affected by the September 11 attacks on the WTC towers in New York City. This report also describes the structural and fire protection features of the affected buildings and their performance in response to the terrorist attacks. Due to the unprecedented nature, magnitude, and visibility of the terrorist attacks, this event is among the most well-documented in the media, particularly in terms of photographic images, lives affected, and the immediate responses and ensuing sequence of events. An understanding of these events must include the performance of the buildings under extreme conditions beyond building code requirements. This includes determining the probable causes of collapse and identifying lessons to be learned. Recommendations are presented for more detailed engineering studies, to complete the assessments and to produce improved guidance for building design and performance evaluation tools.

During the September 11 attacks, a large number of buildings were extensively damaged by impact and fire events. To study the response of the affected buildings, a diverse group of experts in tall building design, steel structure behavior, fire protection engineering, blast effects, and structural investigations was empaneled into a Building Performance Study (BPS) Team. The study was sponsored by the Federal Emergency Management Agency (FEMA) and the Structural Engineering Institute of the American Society of Civil Engineers (SEI/ASCE). In conducting the study, the BPS Team received tremendous cooperation from the State of New York, the New York City Department of Design and Construction (DDC), the New York City Office of Emergency Management (OEM), the Port Authority of New York and New Jersey (hereafter referred to as the Port Authority), the National Institute of Standards and Technology (NIST), and the Structural Engineers Association of New York (SEAoNY). In addition, the BPS Team was supported by a coalition of organizations that included the American Concrete Institute (ACI), the American Institute of Steel Construction (AISC), the Council of American Structural Engineers (CASE), the International Code Council (ICC), the Council on Tall Buildings and Urban Habitat (CTBUH), the National Council of Structural Engineers Associations (NCSEA), the National Fire Protection Association (NFPA), the Society of Fire Protection Engineers (SFPE), and the Masonry Society (TMS).

FEMA and ASCE began discussing site studies and teams on September 12, as engineers and emergency management agencies all over the nation rallied to provide support. A number of the team members were at the site immediately after the attacks to assist as needed. As soon as the rescue operations were halted and the