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Federal Building and Fire Safety Investigation of the World Trade Center Disaster

Analysis of Published Accounts of the World Trade Center Evacuation

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NIST National Institute of Standards and Technology • Technology Administration • U.S. Department of Commerce

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U.S. Department of Commerce
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In addition, a substantial portion of the evidence collected by NIST in the course of the Investigation has been provided to NIST under nondisclosure agreements.

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ABSTRACT

Published stories of the survivor's of the World Trade Center (WTC) attacks were collected to document the event and as background material to guide the development of the National Institute of Standards and Technology (NIST) Investigation on occupant behavior during the evacuation of the WTC. These first-person accounts came from newspapers, radio and television programs, e-mail exchanges, and a variety of web sites. The accounts analyzed were from survivors located in several areas in each tower, providing a distribution of floors from the upper, middle, and lower strata of the two towers. In total, 745 accounts were analyzed, representing 435 survivors from WTC 1 and WTC 2.

This large quantity of material was coded and analyzed to obtain a better understanding of the personal evacuation experiences of different survivors located on the different floors of the two towers. This report documents that analysis. The analysis was solely based on written accounts and does not include first-person interviews conducted as part of the NIST Investigation. Rather, the analysis provided background for the development of the telephone and face-to-face interviews conducted for the NIST Investigation.

Keywords: Building fires, egress, egress modeling, emergency communication, evacuation, human behavior, interviews, World Trade Center.

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List of Acronyms and Abbreviations

Acronyms

NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
WTC 1	World Trade Center 1 (North Tower)
WTC 2	World Trade Center 2 (South Tower)
WTC 7	World Trade Center 7

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PREFACE

Genesis of This Investigation

Immediately following the terrorist attack on the World Trade Center (WTC) on September 11, 2001, the Federal Emergency Management Agency (FEMA) and the American Society of Civil Engineers began planning a building performance study of the disaster. The week of October 7, as soon as the rescue and search efforts ceased, the Building Performance Study Team went to the site and began its assessment. This was to be a brief effort, as the study team consisted of experts who largely volunteered their time away from their other professional commitments. The Building Performance Study Team issued its report in May 2002, fulfilling its goal "to determine probable failure mechanisms and to identify areas of future investigation that could lead to practical measures for improving the damage resistance of buildings against such unforeseen events."

On August 21, 2002, with funding from the U.S. Congress through FEMA, the National Institute of Standards and Technology (NIST) announced its building and fire safety investigation of the WTC disaster. On October 1, 2002, the National Construction Safety Team Act (Public Law 107-231), was signed into law. The NIST WTC Investigation was conducted under the authority of the National Construction Safety Team Act.

The goals of the investigation of the WTC disaster were:

- To investigate the building construction, the materials used, and the technical conditions that contributed to the outcome of the WTC disaster.
- To serve as the basis for:
  - Improvements in the way buildings are designed, constructed, maintained, and used;
  - Improved tools and guidance for industry and safety officials;
  - Recommended revisions to current codes, standards, and practices; and
  - Improved public safety.

The specific objectives were:

1. Determine why and how WTC 1 and WTC 2 collapsed following the initial impacts of the aircraft and why and how WTC 7 collapsed;
2. Determine why the injuries and fatalities were so high or low depending on location, including all technical aspects of fire protection, occupant behavior, evacuation, and emergency response;
3. Determine what procedures and practices were used in the design, construction, operation, and maintenance of WTC 1, 2, and 7; and
4. Identify, as specifically as possible, areas in current building and fire codes, standards, and practices that warrant revision.

NIST is a nonregulatory agency of the U.S. Department of Commerce's Technology Administration. The purpose of NIST investigations is to improve the safety and structural integrity of buildings in the United States, and the focus is on fact finding. NIST investigative teams are authorized to assess building performance and emergency response and evacuation procedures in the wake of any building failure that has resulted in substantial loss of life or that posed significant potential of substantial loss of life. NIST does not have the statutory authority to make findings of fault nor negligence by individuals or organizations. Further, no part of any report resulting from a NIST investigation into a building failure or from an investigation under the National Construction Safety Team Act may be used in any suit or action for damages arising out of any matter mentioned in such report (15 USC 281a, as amended by Public Law 107-231).

Organization of the Investigation

The National Construction Safety Team for this Investigation, appointed by the then NIST Director, Dr. Arden L. Bement, Jr., was led by Dr. S. Shyam Sunder. Dr. William L. Grosshandler served as Associate Lead Investigator, Mr. Stephen A. Cauffman served as Program Manager for Administration, and Mr. Harold E. Nelson served on the team as a private sector expert. The Investigation included eight interdependent projects whose leaders comprised the remainder of the team. A detailed description of each of these eight projects is available at http://wtc.nist.gov. The purpose of each project is summarized in Table P–1, and the key interdependencies among the projects are illustrated in Fig. P–1.

Table P–1. Federal building and fire safety investigation of the WTC disaster.

Technical Area and Project Leader	Project Purpose
Analysis of Building and Fire Codes and Practices; Project Leaders: Dr. H. S. Lew and Mr. Richard W. Bukowski	Document and analyze the code provisions, procedures, and practices used in the design, construction, operation, and maintenance of the structural, passive fire protection, and emergency access and evacuation systems of WTC 1, 2, and 7.
Baseline Structural Performance and Aircraft Impact Damage Analysis; Project Leader: Dr. Fahim H. Sadek	Analyze the baseline performance of WTC 1 and WTC 2 under design, service, and abnormal loads, and aircraft impact damage on the structural, fire protection, and egress systems.
Mechanical and Metallurgical Analysis of Structural Steel; Project Leader: Dr. Frank W. Gayle	Determine and analyze the mechanical and metallurgical properties and quality of steel, weldments, and connections from steel recovered from WTC 1, 2, and 7.
Investigation of Active Fire Protection Systems; Project Leader: Dr. David D. Evans; Dr. William Grosshandler	Investigate the performance of the active fire protection systems in WTC 1, 2, and 7 and their role in fire control, emergency response, and fate of occupants and responders.
Reconstruction of Thermal and Tenability Environment; Project Leader: Dr. Richard G. Gann	Reconstruct the time-evolving temperature, thermal environment, and smoke movement in WTC 1, 2, and 7 for use in evaluating the structural performance of the buildings and behavior and fate of occupants and responders.
Structural Fire Response and Collapse Analysis; Project Leaders: Dr. John L. Gross and Dr. Therese P. McAllister	Analyze the response of the WTC towers to fires with and without aircraft damage, the response of WTC 7 in fires, the performance of composite steel-trussed floor systems, and determine the most probable structural collapse sequence for WTC 1, 2, and 7.
Occupant Behavior, Egress, and Emergency Communications; Project Leader: Mr. Jason D. Averill	Analyze the behavior and fate of occupants and responders, both those who survived and those who did not, and the performance of the evacuation system.
Emergency Response Technologies and Guidelines; Project Leader: Mr. J. Randall Lawson	Document the activities of the emergency responders from the time of the terrorist attacks on WTC 1 and WTC 2 until the collapse of WTC 7, including practices followed and technologies used.

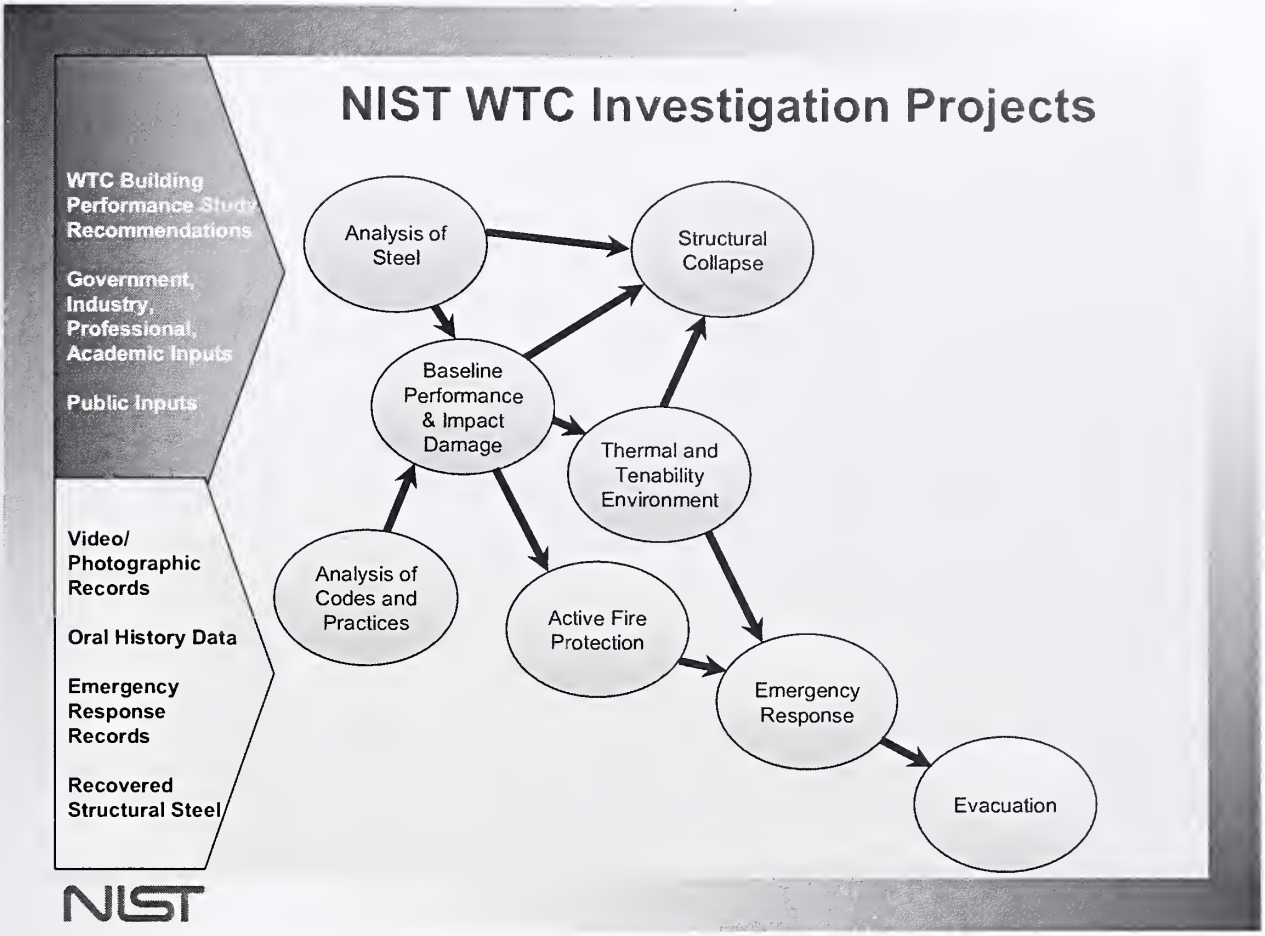

Figure P–1. The eight projects in the federal building and fire safety investigation of the WTC disaster.

National Construction Safety Team Advisory Committee

The NIST Director also established an advisory committee as mandated under the National Construction Safety Team Act. The initial members of the committee were appointed following a public solicitation. These were:

- Paul Fitzgerald, Executive Vice President (retired) FM Global, National Construction Safety Team Advisory Committee Chair
- John Barsom, President, Barsom Consulting, Ltd.
- John Bryan, Professor Emeritus, University of Maryland
- David Collins, President, The Preview Group, Inc.
- Glenn Corbett, Professor, John Jay College of Criminal Justice
- Philip DiNenno, President, Hughes Associates, Inc.

- Robert Hanson, Professor Emeritus, University of Michigan
- Charles Thornton, Co-Chairman and Managing Principal, The Thornton-Tomasetti Group, Inc.
- Kathleen Tierney, Director, Natural Hazards Research and Applications Information Center, University of Colorado at Boulder
- Forman Williams, Director, Center for Energy Research, University of California at San Diego

This National Construction Safety Team Advisory Committee provided technical advice during the Investigation and commentary on drafts of the Investigation reports prior to their public release. NIST has benefited from the work of many people in the preparation of these reports, including the National Construction Safety Team Advisory Committee. The content of the reports and recommendations, however, are solely the responsibility of NIST.

Public Outreach

During the course of this Investigation, NIST held public briefings and meetings (listed in Table P–2) to solicit input from the public, present preliminary findings, and obtain comments on the direction and progress of the Investigation from the public and the Advisory Committee.

NIST maintained a publicly accessible Web site during this Investigation at http://wtc.nist.gov. The site contained extensive information on the background and progress of the Investigation.

NIST's WTC Public-Private Response Plan

The collapse of the WTC buildings has led to broad reexamination of how tall buildings are designed, constructed, maintained, and used, especially with regard to major events such as fires, natural disasters, and terrorist attacks. Reflecting the enhanced interest in effecting necessary change, NIST, with support from Congress and the Administration, has put in place a program, the goal of which is to develop and implement the standards, technology, and practices needed for cost-effective improvements to the safety and security of buildings and building occupants, including evacuation, emergency response procedures, and threat mitigation.

The strategy to meet this goal is a three-part NIST-led public-private response program that includes:

- A federal building and fire safety investigation to study the most probable factors that contributed to post-aircraft impact collapse of the WTC towers and the 47-story WTC 7 building, and the associated evacuation and emergency response experience.
- A research and development (R&D) program to (a) facilitate the implementation of recommendations resulting from the WTC Investigation, and (b) provide the technical basis for cost-effective improvements to national building and fire codes, standards, and practices that enhance the safety of buildings, their occupants, and emergency responders.

Table P–2. Public meetings and briefings of the WTC Investigation.

Date	Location	Principal Agenda
June 24, 2002	New York City, NY	Public meeting: Public comments on the *Draft Plan* for the pending WTC Investigation.
August 21, 2002	Gaithersburg, MD	Media briefing announcing the formal start of the Investigation.
December 9, 2002	Washington, DC	Media briefing on release of the *Public Update* and NIST request for photographs and videos.
April 8, 2003	New York City, NY	Joint public forum with Columbia University on first-person interviews.
April 29–30, 2003	Gaithersburg, MD	NCST Advisory Committee meeting on plan for and progress on WTC Investigation with a public comment session.
May 7, 2003	New York City, NY	Media briefing on release of *May 2003 Progress Report.*
August 26–27, 2003	Gaithersburg, MD	NCST Advisory Committee meeting on status of the WTC investigation with a public comment session.
September 17, 2003	New York City, NY	Media and public briefing on initiation of first-person data collection projects.
December 2–3, 2003	Gaithersburg, MD	NCST Advisory Committee meeting on status and initial results and release of the *Public Update* with a public comment session.
February 12, 2004	New York City, NY	Public meeting on progress and preliminary findings with public comments on issues to be considered in formulating final recommendations.
June 18, 2004	New York City, NY	Media/public briefing on release of *June 2004 Progress Report.*
June 22–23, 2004	Gaithersburg, MD	NCST Advisory Committee meeting on the status of and preliminary findings from the WTC Investigation with a public comment session.
August 24, 2004	Northbrook, IL	Public viewing of standard fire resistance test of WTC floor system at Underwriters Laboratories, Inc.
October 19–20, 2004	Gaithersburg, MD	NCST Advisory Committee meeting on status and near complete set of preliminary findings with a public comment session.
November 22, 2004	Gaithersburg, MD	NCST Advisory Committee discussion on draft annual report to Congress, a public comment session, and a closed session to discuss pre-draft recommendations for WTC Investigation.
April 5, 2005	New York City, NY	Media and public briefing on release of the probable collapse sequence for the WTC towers and draft reports for the projects on codes and practices, evacuation, and emergency response.
June 23, 2005	New York City, NY	Media and public briefing on release of all draft reports for the WTC towers and draft recommendations for public comment.
September 12–13, 2005	Gaithersburg, MD	NCST Advisory Committee meeting on disposition of public comments and update to draft reports for the WTC towers.
September 13–15, 2005	Gaithersburg, MD	WTC Technical Conference for stakeholders and technical community for dissemination of findings and recommendations and opportunity for public to make technical comments.

- A dissemination and technical assistance program (DTAP) to (a) engage leaders of the construction and building community in ensuring timely adoption and widespread use of proposed changes to practices, standards, and codes resulting from the WTC Investigation and the R&D program, and (b) provide practical guidance and tools to better prepare facility owners, contractors, architects, engineers, emergency responders, and regulatory authorities to respond to future disasters.

The desired outcomes are to make buildings, occupants, and first responders safer in future disaster events.

National Construction Safety Team Reports on the WTC Investigation

A final report on the collapse of the WTC towers is being issued as NIST NCSTAR 1. A companion report on the collapse of WTC 7 is being issued as NIST NCSTAR 1A. The present report is one of a set that provides more detailed documentation of the Investigation findings and the means by which these technical results were achieved. As such, it is part of the archival record of this Investigation. The titles of the full set of Investigation publications are:

NIST (National Institute of Standards and Technology). 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Final Report on the Collapse of the World Trade Center Towers.* NIST NCSTAR 1. Gaithersburg, MD, September.

NIST (National Institute of Standards and Technology). 2006. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Final Report on the Collapse of World Trade Center 7.* NIST NCSTAR 1A. Gaithersburg, MD.

Lew, H. S., R. W. Bukowski, and N. J. Carino. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Design, Construction, and Maintenance of Structural and Life Safety Systems.* NIST NCSTAR 1-1. National Institute of Standards and Technology. Gaithersburg, MD, September.

Fanella, D. A., A. T. Derecho, and S. K. Ghosh. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Design and Construction of Structural Systems.* NIST NCSTAR 1-1A. National Institute of Standards and Technology. Gaithersburg, MD, September.

Ghosh, S. K., and X. Liang. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Comparison of Building Code Structural Requirements.* NIST NCSTAR 1-1B. National Institute of Standards and Technology. Gaithersburg, MD, September.

Fanella, D. A., A. T. Derecho, and S. K. Ghosh. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Maintenance and Modifications to Structural Systems.* NIST NCSTAR 1-1C. National Institute of Standards and Technology. Gaithersburg, MD, September.

Grill, R. A., and D. A. Johnson. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Fire Protection and Life Safety Provisions Applied to the Design and Construction of World Trade Center 1, 2, and 7 and Post-Construction Provisions Applied after Occupancy.* NIST NCSTAR 1-1D. National Institute of Standards and Technology. Gaithersburg, MD, September.

Razza, J. C., and R. A. Grill. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Comparison of Codes, Standards, and Practices in Use at the Time of the Design and Construction of World Trade Center 1, 2, and 7.* NIST NCSTAR 1-1E. National Institute of Standards and Technology. Gaithersburg, MD, September.

Grill, R. A., D. A. Johnson, and D. A. Fanella. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Comparison of the 1968 and Current (2003) New*

York City Building Code Provisions. NIST NCSTAR 1-1F. National Institute of Standards and Technology. Gaithersburg, MD, September.

Grill, R. A., and D. A. Johnson. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Amendments to the Fire Protection and Life Safety Provisions of the New York City Building Code by Local Laws Adopted While World Trade Center 1, 2, and 7 Were in Use*. NIST NCSTAR 1-1G. National Institute of Standards and Technology. Gaithersburg, MD, September.

Grill, R. A., and D. A. Johnson. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Post-Construction Modifications to Fire Protection and Life Safety Systems of World Trade Center 1 and 2*. NIST NCSTAR 1-1H. National Institute of Standards and Technology. Gaithersburg, MD, September.

Grill, R. A., D. A. Johnson, and D. A. Fanella. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Post-Construction Modifications to Fire Protection, Life Safety, and Structural Systems of World Trade Center 7*. NIST NCSTAR 1-1I. National Institute of Standards and Technology. Gaithersburg, MD, September.

Grill, R. A., and D. A. Johnson. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Design, Installation, and Operation of Fuel System for Emergency Power in World Trade Center 7*. NIST NCSTAR 1-1J. National Institute of Standards and Technology. Gaithersburg, MD, September.

Sadek, F. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Baseline Structural Performance and Aircraft Impact Damage Analysis of the World Trade Center Towers*. NIST NCSTAR 1-2. National Institute of Standards and Technology. Gaithersburg, MD, September.

Faschan, W. J., and R. B. Garlock. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Reference Structural Models and Baseline Performance Analysis of the World Trade Center Towers*. NIST NCSTAR 1-2A. National Institute of Standards and Technology. Gaithersburg, MD, September.

Kirkpatrick, S. W., R. T. Bocchieri, F. Sadek, R. A. MacNeill, S. Holmes, B. D. Peterson, R. W. Cilke, C. Navarro. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Analysis of Aircraft Impacts into the World Trade Center Towers*, NIST NCSTAR 1-2B. National Institute of Standards and Technology. Gaithersburg, MD, September.

Gayle, F. W., R. J. Fields, W. E. Luecke, S. W. Banovic, T. Foecke, C. N. McCowan, T. A. Siewert, and J. D. McColskey. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Mechanical and Metallurgical Analysis of Structural Steel*. NIST NCSTAR 1-3. National Institute of Standards and Technology. Gaithersburg, MD, September.

Luecke, W. E., T. A. Siewert, and F. W. Gayle. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Contemporaneous Structural Steel Specifications*. NIST Special Publication 1-3A. National Institute of Standards and Technology. Gaithersburg, MD, September.

Banovic, S. W. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Steel Inventory and Identification.* NIST NCSTAR 1-3B. National Institute of Standards and Technology. Gaithersburg, MD, September.

Banovic, S. W., and T. Foecke. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Damage and Failure Modes of Structural Steel Components.* NIST NCSTAR 1-3C. National Institute of Standards and Technology. Gaithersburg, MD, September.

Luecke, W. E., J. D. McColskey, C. N. McCowan, S. W. Banovic, R. J. Fields, T. Foecke, T. A. Siewert, and F. W. Gayle. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Mechanical Properties of Structural Steels.* NIST NCSTAR 1-3D. National Institute of Standards and Technology. Gaithersburg, MD, September.

Banovic, S. W., C. N. McCowan, and W. E. Luecke. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Physical Properties of Structural Steels.* NIST NCSTAR 1-3E. National Institute of Standards and Technology. Gaithersburg, MD, September.

Evans, D. D., R. D. Peacock, E. D. Kuligowski, W. S. Dols, and W. L. Grosshandler. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Active Fire Protection Systems.* NIST NCSTAR 1-4. National Institute of Standards and Technology. Gaithersburg, MD, September.

Kuligowski, E. D., D. D. Evans, and R. D. Peacock. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Post-Construction Fires Prior to September 11, 2001.* NIST NCSTAR 1-4A. National Institute of Standards and Technology. Gaithersburg, MD, September.

Hopkins, M., J. Schoenrock, and E. Budnick. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Fire Suppression Systems.* NIST NCSTAR 1-4B. National Institute of Standards and Technology. Gaithersburg, MD, September.

Keough, R. J., and R. A. Grill. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Fire Alarm Systems.* NIST NCSTAR 1-4C. National Institute of Standards and Technology. Gaithersburg, MD, September.

Ferreira, M. J., and S. M. Strege. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Smoke Management Systems.* NIST NCSTAR 1-4D. National Institute of Standards and Technology. Gaithersburg, MD, September.

Gann, R. G., A. Hamins, K. B. McGrattan, G. W. Mulholland, H. E. Nelson, T. J. Ohlemiller, W. M. Pitts, and K. R. Prasad. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Reconstruction of the Fires in the World Trade Center Towers.* NIST NCSTAR 1-5. National Institute of Standards and Technology. Gaithersburg, MD, September.

Pitts, W. M., K. M. Butler, and V. Junker. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Visual Evidence, Damage Estimates, and Timeline Analysis.* NIST NCSTAR 1-5A. National Institute of Standards and Technology. Gaithersburg, MD, September.

Hamins, A., A. Maranghides, K. B. McGrattan, E. Johnsson, T. J. Ohlemiller, M. Donnelly, J. Yang, G. Mulholland, K. R. Prasad, S. Kukuck, R. Anleitner and T. McAllister. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Experiments and Modeling of Structural Steel Elements Exposed to Fire.* NIST NCSTAR 1-5B. National Institute of Standards and Technology. Gaithersburg, MD, September.

Ohlemiller, T. J., G. W. Mulholland, A. Maranghides, J. J. Filliben, and R. G. Gann. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Fire Tests of Single Office Workstations.* NIST NCSTAR 1-5C. National Institute of Standards and Technology. Gaithersburg, MD, September.

Gann, R. G., M. A. Riley, J. M. Repp, A. S. Whittaker, A. M. Reinhorn, and P. A. Hough. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Reaction of Ceiling Tile Systems to Shocks.* NIST NCSTAR 1-5D. National Institute of Standards and Technology. Gaithersburg, MD, September.

Hamins, A., A. Maranghides, K. B. McGrattan, T. J. Ohlemiller, and R. Anleitner. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Experiments and Modeling of Multiple Workstations Burning in a Compartment.* NIST NCSTAR 1-5E. National Institute of Standards and Technology. Gaithersburg, MD, September.

McGrattan, K. B., C. Bouldin, and G. Forney. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Computer Simulation of the Fires in the World Trade Center Towers.* NIST NCSTAR 1-5F. National Institute of Standards and Technology. Gaithersburg, MD, September.

Prasad, K. R., and H. R. Baum. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Fire Structure Interface and Thermal Response of the World Trade Center Towers.* NIST NCSTAR 1-5G. National Institute of Standards and Technology. Gaithersburg, MD, September.

Gross, J. L., and T. McAllister. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Structural Fire Response and Probable Collapse Sequence of the World Trade Center Towers.* NIST NCSTAR 1-6. National Institute of Standards and Technology. Gaithersburg, MD, September.

Carino, N. J., M. A. Starnes, J. L. Gross, J. C. Yang, S. Kukuck, K. R. Prasad, and R. W. Bukowski. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Passive Fire Protection.* NIST NCSTAR 1-6A. National Institute of Standards and Technology. Gaithersburg, MD, September.

Gross, J., F. Hervey, M. Izydorek, J. Mammoser, and J. Treadway. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Fire Resistance Tests of Floor Truss Systems.* NIST NCSTAR 1-6B. National Institute of Standards and Technology. Gaithersburg, MD, September.

Zarghamee, M. S., S. Bolourchi, D. W. Eggers, Ö. O. Erbay, F. W. Kan, Y. Kitane, A. A. Liepins, M. Mudlock, W. I. Naguib, R. P. Ojdrovic, A. T. Sarawit, P. R Barrett, J. L. Gross, and

T. P. McAllister. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Component, Connection, and Subsystem Structural Analysis.* NIST NCSTAR 1-6C. National Institute of Standards and Technology. Gaithersburg, MD, September.

Zarghamee, M. S., Y. Kitane, Ö. O. Erbay, T. P. McAllister, and J. L. Gross. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Global Structural Analysis of the Response of the World Trade Center Towers to Impact Damage and Fire.* NIST NCSTAR 1-6D. National Institute of Standards and Technology. Gaithersburg, MD, September.

McAllister, T., R. W. Bukowski, R. G. Gann, J. L. Gross, K. B. McGrattan, H. E. Nelson, L. Phan, W. M. Pitts, K. R. Prasad, F. Sadek. 2006. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Structural Fire Response and Probable Collapse Sequence of World Trade Center 7.* (Provisional). NIST NCSTAR 1-6E. National Institute of Standards and Technology. Gaithersburg, MD.

Gilsanz, R., V. Arbitrio, C. Anders, D. Chlebus, K. Ezzeldin, W. Guo, P. Moloney, A. Montalva, J. Oh, K. Rubenacker. 2006. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Structural Analysis of the Response of World Trade Center 7 to Debris Damage and Fire.* (Provisional). NIST NCSTAR 1-6F. National Institute of Standards and Technology. Gaithersburg, MD.

Kim, W. 2006. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Analysis of September 11, 2001, Seismogram Data.* (Provisional). NIST NCSTAR 1-6G. National Institute of Standards and Technology. Gaithersburg, MD.

Nelson, K. 2006. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: The Con Ed Substation in World Trade Center 7.* (Provisional). NIST NCSTAR 1-6H. National Institute of Standards and Technology. Gaithersburg, MD.

Averill, J. D., D. S. Mileti, R. D. Peacock, E. D. Kuligowski, N. Groner, G. Proulx, P. A. Reneke, and H. E. Nelson. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Occupant Behavior, Egress, and Emergency Communication.* NIST NCSTAR 1-7. National Institute of Standards and Technology. Gaithersburg, MD, September.

Fahy, R., and G. Proulx. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Analysis of Published Accounts of the World Trade Center Evacuation.* NIST NCSTAR 1-7A. National Institute of Standards and Technology. Gaithersburg, MD, September.

Zmud, J. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Technical Documentation for Survey Administration.* NIST NCSTAR 1-7B. National Institute of Standards and Technology. Gaithersburg, MD, September.

Lawson, J. R., and R. L. Vettori. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: The Emergency Response Operations.* NIST NCSTAR 1-8. National Institute of Standards and Technology. Gaithersburg, MD, September.

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EXECUTIVE SUMMARY

In the days following events at the World Trade Center (WTC) on September 11, 2001, the National Fire Protection Association (NFPA) and the National Research Council Canada decided to collaborate in collecting survivors' accounts to document the event. First-person accounts were collected from newspapers, radio and television programs, e-mail exchanges, and a variety of web sites. Additional accounts were provided by the National Institute of Standards and Technology. Over a period of 18 months, a total of 745 first-person accounts were collected. These accounts had been published up to 14 months after the event. Although media accounts do not provide the scientific rigor of a proper study, they do present important insights into the events of the day. The large number of accounts found, the level of detail in some of these accounts as well as their time of publication, which is much closer to the event than any human behavior and evacuation research could be conducted, supported the decision to conduct an analysis of the first-person accounts.

The objectives of the analysis of the first-person accounts were to gain insight into the variability of human behavior and response time displayed during the evacuation, with the findings to be used as a guide for future research and additional investigation. Data gathered would help to create a better understanding of individual experiences of occupants in specific locations by documenting, to the extent possible, the information available to the person, and the conditions on their floor and along their evacuation route.

To analyze the content of the first-person accounts, a questionnaire tool was developed and used to "interview" each account. The questionnaire had 33 questions such as: "On what floor was the person?," "What was the first cue of the event?," "Was the person injured?," "What were the conditions in the stairs?" Not every account provided answers for all 33 questions, since some accounts lacked certain details, but this is similar to a respondent who did not answer some questions in a survey. All the accounts were reviewed independently by two researchers who summarized the responses into a matrix. When completed, the matrix summaries were compared, and any discrepancies were discussed and resolved. Once the 745 first-person accounts were summarized, multiple accounts from the same person were merged into one, which provided accounts for 465 individuals. (Some survivors provided multiple accounts through different sources.)

Based on the responses to each question, a coding scheme was developed and each individual's account was coded. Before any analysis began, the database was further limited to the 435 civilians who were in either WTC 1 or WTC 2 on that day.

In summary, the accounts analyzed were from 435 individuals: 251 occupants of WTC 1 and 184 occupants of WTC 2. They represented the three different floor strata of the two towers. The accounts were mainly from men (314 vs. 118) and from people varying in age from 20 years to 89 years old. Among the interesting results found was the means of egress used that morning. Out of 158 people who mentioned their means of egress in WTC 2, 18 used the elevators and 26 used a combination of stairs and elevators to leave the tower. It was found that the higher the person was located in the tower initially, the more likely it was that this person used an elevator to evacuate. In WTC 1, out of 202 people who mentioned their means of egress, 198 used the stairs, one used an elevator, and three used a combination

of stairs and elevator. This does not include the 22 people who were stuck in elevators when WTC 1 was hit. The most common adverse floor condition mentioned by people in WTC 1 was the presence of smoke (mentioned by 74 people), debris or collapsed walls, ceilings or floors (72 people) and fires (41 people). In WTC 2, 37 people reported debris or collapsed walls, ceilings, or floors on their floor, and 25 people saw smoke.

The most prevalent condition reported for the stairwell was that it was crowded and hot (mentioned by 106 people). A particular condition mentioned for the stairs in both towers was the presence of smoke, mentioned by 78 people in WTC 1 and 29 in WTC 2. The presence of water, usually on the lower stairwell floors, was mentioned by 49 people in WTC 1 and 4 people in WTC 2. Jammed or locked doors were mentioned by 20 people in WTC 1 and 2 people in WTC 2.

In WTC 2, 96 people mentioned hearing a message over the communication system to "stay or return to their office." The majority of them, 69 people, decided to disregard the instructions and continued their evacuation. The 16 people who decided to remain in their offices or decided to turn back did not have time to travel very far before the second plane hit; at that point they all resumed their evacuation down.

Overall, 154 mentioned that others were calm. The 41 people who were at the WTC on the day of the 1993 bombing indicated that they were better prepared this time to face the emergency. This past experience, they said, made them readily start their evacuation.

Among the accounts analyzed, 27 people reported having a disability and 47 were injured that morning. All these people were supported in their evacuation by coworkers. Half of them stated that they started their evacuation immediately and one-third mentioned some delay to get organized and seek first-aid. Several people who were disabled or injured evacuated the towers swiftly as occupants formed a single line to let them through rapidly down the stairwell. Many people (143 in WTC 1 and 26 in WTC 2) mentioned being reassured and felt safe when meeting firefighters in the building. Although the emergency crews disrupted the evacuation in the stairwell by going against traffic, the people appreciatively cheered them on. Phone calls were made by 151 survivors to family and friends to give and obtain information; 20 people called their bosses or colleagues; and another 12 people made calls to authorities. Another 14 people used e-mail wireless technology and pagers to exchange information, which seems to be the only reliable devices used from inside the stairwells.

Content analysis of first-person accounts has important limitations. Essentially, the questions asked by journalists are usually unknown; questions might vary from interview to interview. Further, some details might be left unreported and the most dramatic stories might be over-represented. Consequently, the results cannot be generalized to the overall population of the WTC towers. Results of this analysis are useful for documenting some specific details that should be investigated further, using a scientifically recognized methodology to obtain generalizable data.

Chapter 1
INTRODUCTION

In the days following the September 11, 2001, attacks on the World Trade Center (WTC), the National Fire Protection Association in collaboration with the National Research Council Canada, decided to collect survivors' stories to document the event and to use this background material to develop future studies on occupant behavior during the evacuation of the WTC. First-person accounts were collected from newspapers, radio and television programs, e-mail exchanges, and a variety of web sites. Additional accounts were received at a later date from the National Institute of Standards and Technology (NIST). This large quantity of material was coded and analyzed to obtain a better understanding of the personal evacuation experiences of different survivors located on the different floors of the two towers. This report documents that analysis. The analysis was solely based on written accounts and does not include first-person interviews conducted as part of the NIST investigation. Rather, it provided background for the development of the telephone and face-to-face interviews conducted for the NIST investigation.

At 8:46 a.m. on Tuesday, September 11, 2001, American Airlines Flight 11, a hijacked Boeing 767, hit WTC 1 of the WTC complex. This impact caused extensive damage on seven floors, from 93 to 99 of the 110-story tower, trapping those above. Sixteen and a half minutes later, at 9:03 a.m., a second hijacked Boeing 767, United Airlines Flight 175, struck WTC 2 of the WTC, damaging nine floors, from 77 to 85.

Despite the massive localized damage caused by the impact, each structure remained standing. However, as each aircraft impacted the building, jet fuel on board ignited. Part of this fuel immediately burned off in large fireballs that erupted at the impact floors. Remaining fuel flowed across the floors and down elevator and utility shafts, igniting intense fires throughout upper portions of the buildings.

At 9:59 a.m., WTC 2, the second building to be hit, collapsed after burning intensely for 56 minutes. WTC 1 withstood its injury longer than WTC 2, collapsing to the ground at 10:28 a.m. after burning for 102 minutes (FEMA 2002). It is estimated that approximately 2,800 people were killed and 800 others injured by the attacks and eventual collapse of the towers on September 11, 2001, including building occupants and first responders (Cauchon 2001).

Although the events of September 11, 2001, involved the WTC, the Pentagon and the hijacked airliners, the evacuation of the two towers is the focus of this research. The attacks precipitated the evacuation of the entire WTC complex. The evacuation of WTC 1 and WTC 2 was largely initiated by the occupants themselves.

The WTC was a complex of seven buildings, including the two 110-story office towers. Approximately 50,000 people worked in each tower (100,000 total), with an estimated 70,000 visitors to the complex during the course of a normal business day (Yamasaki 2002). However, the occupancy of the towers on the morning of September 11, 2001, was not at its maximum capacity. According to *USA TODAY*, 5,000 to 7,000 people were in each tower at 8:46 a.m. that morning, the time of first impact (Cauchon 2001). It has been suggested that the towers were not at their maximum capacity for several reasons. That morning marked New York City's mayoral primary, and it is assumed that many people stopped to cast their ballots before heading in to work. The New York Stock Exchange does not open

until 9:30 a.m., therefore many people from trading firms had not come into work yet. Tuesday, September 11, 2001, was the first day of school in several primary school districts, and many parents accompany their children to school on this day. Visitor hours had not started yet, as the viewing platform in the WTC 2 did not open to the public until 9:30 a.m. Perhaps the biggest factor of all was the early hour—many simply had not arrived at work by 8:46 a.m. In addition, dozens of investment firms in the WTC had closed their offices or cut employment sharply. Some offices were leased but empty or under renovation (Cauchon 2001).

By certain measures, the evacuation of the WTC towers on September 11, 2001, could be termed a success (Cauchon 2001). Under the impacted floors, nearly every occupant who could physically get out did get out. According to *USA TODAY*, in each tower, 99 percent of the civilian occupants below the crash sites survived. Their analysis shows that two-thirds of WTC 2 occupants started their evacuation of the upper floors during the 16.5 minutes between the attacks, and survived. Among the occupants under the impacted floors in WTC 1, 72 people died, whereas under the impacted floors in WTC 2, 4 people died. Some fraction of the deaths below the impacted floors in WTC 1 occurred in the elevators, which were carrying people at the time of impact.

Chapter 2
BACKGROUND LITERATURE

Understanding the basic concepts of human behavior in fire is necessary to envision occupants' likely response during an emergency. Human behavior in fire is a scientific field that identifies facts, concepts and relationships established through systematic observation and experimentation. What is known about human behavior in fire is that the three dimensions of the emergency, namely the occupant, building and fire characteristics, interact to explain or predict occupant response to fires (Proulx 2001).

During a fire, the nature of the information obtained, the limited time to react and the assessment of danger will create a feeling of stress. This stress is not an abnormal reaction; on the contrary, stress is regarded as a necessary state to motivate reaction and action. During the course of the event, the intensity of stress experienced will vary as a function of the information newly-perceived and the assessment of the decision taken (Proulx 1993). Key factors which increase stress include: the perception of threat to oneself or others, the suddenness of the threat and the available time to respond or prepare, the amount of sensory input needed to be processed, and the degree of physical effort (aerobic and anaerobic output) that is engaged during the incident. If the individual is physically wounded or injured, the effect will be even greater (Grossman 2002). Taking all of these factors into account, it can be said that most evacuees of the World Trade Center (WTC) were experiencing extremely high levels of stress.

Most people assume that individuals cease to act in a predictable, orderly fashion in the face of disaster, and that norms which govern our behavior collapse into Durkheim's anomie, a state of normlessness (Fisher 1998). This mindset, known as *disaster mythology*, has been greatly nourished by the mass media and movie industry to capitalize on strong emotional images (Proulx 2002). Today, it is largely known that in the face of the extreme stress of a disaster, there is an absence of widespread, irrational, antisocial and dysfunctional behavior that has often been described as 'panic' (Quarantelli 1998). Thus, the false but common belief that people will panic in disaster situations is a myth (Sime 1980, and Keating, 1982). In human behavior fire research, it is found that panic behavior is extremely rare (Proulx 2002). Decision making during an emergency is, however, different from day to day decision making for three main reasons (Janis and Mann 1977). First, there is much more at stake in emergency decisions—often the survival of the person and of the people he or she values the most is at risk. Second, the amount of time available to make a decision before crucial options are lost is limited. Third, the information on which to base a decision is ambiguous, incomplete and unusual. Further, it is usually impossible to look for more appropriate information due to the lack of both time and the means to get information (Proulx 1993).

Turning to the literature of the evacuation of the WTC following the 1993 terrorist bombing, it was concluded that there was a lack of panic flight during the evacuation, even though the occupants had to descend the crowded and smoky stairwells in total darkness. No official evacuation orders were issued by recognized emergency and building officials after the explosion, and no official information was provided about safe or proposed exit routes (Isner and Klem 1993). However, it was found that there was an overall mood of orderly evacuation during the 1993 evacuation (Wenger et al. 1994; Fahy and Proulx 1995). This lack of panic during the 1993 evacuation may be explained by the fact that although the explosion created immediate danger, it was not perceived by participants as particularly severe.

Secondly, people were not alone; they were with coworkers, friends and associates. This web of social integration among participants works against the adoption of norms that would support individual, competitive flight behavior to favor the emergence of cooperative, altruistic, helping and orderly behavior (Wenger et al. 1994).

In contrast to the panic scenario of a competitive scramble towards an exit, Dr. Jonathan Sime argues that the most common behavior during a fire is movement towards familiar persons and places (Sime 1985). This is known as the *affiliation* model which suggests that detached groups will attempt to reunite before evacuating, and evacuation movement is most likely to be through a familiar way in and out of the building (Sime 1985). The grouping of people during an emergency is sometimes known as the *milling process*: the communication process that takes place among participants in a crisis setting as they attempt to define the situation, propose and adopt new appropriate norms for behavior and seek coordinated, collective action (Wenger et al. 1994). High levels of social interaction were reported during the 1993 evacuation as the tenants engaged in milling behavior regarding the definition of the situation, the attempt to give meaning to the crisis (i.e. to determine "What is happening?"), the appropriate response to it or proposed cues for action, and the attempt to give direction to the behavior of the participants by offering new, emergent norms (i.e., "What should we do? What is appropriate?") (Wenger et al. 1994).

Identification of the information available to occupants in defining the situation is essential in attempting to understand the decision-making process during an emergency. The social context of the occupants and the opportunity to observe and interact with others are also fundamental considerations when attempting to understand occupant response and the overall outcome of evacuations.

Chapter 3
STUDY OBJECTIVES

This exploratory research project was conducted in order to gain an overall understanding of the circumstances surrounding the evacuation of the World Trade Center (WTC) towers on September 11, 2001. More specifically, this research project endeavors to gain insight into the variability of human behavior and response time displayed during the evacuation, with the findings to be used as a guide for future research. This study provides insight for the National Institute of Standards and Technology Investigation into the WTC event. Human behavior data gathered from this project helped to create a better understanding of the individual experiences of occupants in specific locations by documenting, to the extent possible, the information available to occupants, such as conditions on their floor and along their evacuation route, perceived behavior of others, and escape conditions and timing.

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Chapter 4
METHODOLOGY

In the moments following the attack of the World Trade Center (WTC) towers on September 11, 2001, journalists started interviewing survivors to obtain the story of their evacuation. These first-person accounts were presented on television or radio and published in newspapers, magazines, or web sites and later reported in books and special media programs. During the three months following the events, over 280 first-person accounts were collected. These accounts included media reports (newspapers, magazines, television and radio), as well as material from books, training videos, personal web sites and emails. The information provided in some of these accounts was so detailed that it provided sufficient material for a study. Additional accounts were gathered over the next year for a total of 745 first-person accounts from 465 individuals, as some survivors provided multiple accounts through different sources. The 435 accounts retained for analysis are from evacuees of WTC 1 and WTC 2 only. Although numerous accounts were found from occupants of the surrounding WTC complex, only those civilians who had evacuated the actual towers were considered. For those survivors for whom numerous accounts were found, the information across the accounts was collapsed into one highly detailed account, containing the combined information from all of the given accounts. For instance, 16 survivors provided 5 to 12 different accounts to the media. These survivors had dramatic accounts and, therefore, were of particular media interest. The study involved no first-person interviews.

It is recognized that the use of first-person accounts published in the media as main sources of information for a study has many limitations. The questions asked by reporters are unknown and can be different for each journalist and with each interview. It is also noted that the date an account was published does not necessarily represent the date that the specific interview took place; the account could have been held at some point and then published at a later date. It is suspected that the most dramatic experiences are reported and that some information may be emphasized or left unreported for the purpose of the article. As stated by Dr. H.W. Fischer, the mass media has greatly reduced the level of flamboyant exaggeration in what they report as typical behavioral and organizational response to disasters over the last 50 years; however, since a larger portion of the news is now devoted to reporting disasters, a less than accurate image is still commonly portrayed both in the print and broadcast media (Fischer 1998). It also must be stressed that the findings in this study are representative only of the individual experiences captured in first-person accounts and cannot be generalized to the population of the two towers.

Recall of details of an event depends on many factors, including the intensity of the event, time since the event, and influence from other information sources. Recollection of extreme events such as the WTC attacks may be far better than ordinary daily events. Conversely, traumatic situations may result in memory impairment or "critical incident amnesia." Finally, with the intense media attention that the events of September 11, 2001, received, it is highly likely that this coverage influenced survivors' recollection of events. This phenomenon, referred to as "contamination," occurs when information outside of the actual experience is integrated into the reconstruction of memory (Grossman 2002). Since different occupants of the WTC had a range of experiences on and after September 11, it is unclear to what extent memory issues impacted the reports included in this study.

Despite the drawbacks of using media sources for the basis of research, however, some of the accounts contained such a high level of detail, particularly the ones written by survivors themselves, they provided justification for the analysis of this information. It should also be stressed that these media accounts are the only documented descriptions of the WTC evacuation and immediate reactions of the survivors, as no research has been conducted or published 2 years after the events, regarding human behavior surrounding the events of September 11, 2001. Since documenting human behavior is time sensitive and considerable time has passed since the event, it may be said that these initial media accounts may hold significant detailed and accurate information that may only be available in these accounts.

4.1 CONTENT ANALYSIS

The most appropriate social research method for analyzing media communications is content analysis. To extract the important content from the accounts, a "questionnaire" was developed to "interview" each account. This procedure was used by Johnson (1987) to analyze police file statements related to the "Who Concert Stampede;"[1] it is also explained in some detail in Gamso's book "The Strategy of Social Protest" (1975). The approach relies on a series of identical questions used to "interview" each document. Once the information is gathered in a qualitative or descriptive database, codes are developed to reduce the variety of answers to each question to a manageable number. To ensure reliability of the coding, at least two researchers independently review each account and compare their coding. Any disagreement is discussed and resolved.

Questions to "interview" each account were designed to obtain manifest and latent information from the 745 first-person accounts. A majority of the questions, 30 of them, rely on manifest information or elements specifically reported in the account, such as the person's location at certain key moments. They are listed in Table 4–1. The remaining three questions called for latent information, such as words describing emotions. They are listed in Table 4–2. Data were retrieved from the accounts and entered into a qualitative database. Nominal and ordinal categories were conceptualized, which can be found in the coding scheme presented in Appendix A. It is important to note that not all questions were answered for each account gathered, as a number of the accounts were incomplete. The fact that an individual's account is silent on some point does not mean that this factor was not important or relevant in that individual's evacuation. It simply means that it was not included in the published account or that it was never mentioned by the individual. For those questions not addressed in the account, the category was awarded the code "9" or "99," accounting for the lack of information regarding that specific question. This lack of information for some items is the equivalent in a questionnaire survey to a respondent who did not answer some of the questions. The information gathered in the qualitative database was coded and transformed into a quantitative matrix from which descriptive statistics were calculated.

[1] On December 3, 1979, 11 people were crushed to death as fans rushed the entrance of a stadium in Cincinnati, Ohio, to see a sold-out concert.

Table 4–1. Questions on manifest information.

What is the date of published account?	Heard fire alarm?
Gender?	Location at WTC 2 impact?
Age?	Location at WTC 2 collapse?
In which building was the person at the time of first cue?	Location at WTC 1 collapse?
On what floor was the person at the time of first cue?	Location when met firefighters?
What was the first cue of event?	At what time person exited the building?
How long did the person take to start evacuation?	Who helped person during evacuation?
Did the person delay start time?	Was the person disabled?
What mode of egress was used?	Was the person injured?
What was the condition on floor?	Location when person placed phone call?
What was the condition on the stairs?	Who was the phone call recipient?
Were obstructions encountered during evacuation?	Was there social influence on decision making?
Heard announcement?	Use other (non-phone) communication technology?
Location when WTC 2 announcement heard?	Was person at the WTC during 1993 bombing?
Action after hearing WTC 2 announcement?	Did the person rest during evacuation?

Table 4–2. Questions on latent information.

What was the person's knowledge of the situation in the initial moment?
How serious did the person judge the situation to be?
What was the person's perception of others?

4.2 VARIABLES CONSIDERED

Conceptualization and operationalization involve precisely defining how the variables were measured and ensuring the attributes within those variables are mutually exclusive and exhaustive. There were 33 questions providing data ranging from demograhics and physical location, to response time and social interaction during the evacuation. Coded data included the evacuees' gender, age and which building and floor they were located in, as well as the date the account was published. The floors of the towers were categorized as lower (basement to floor 42), middle (floor 43 to floor 76), and upper (floor 77 to floor 110) based on the common areas referred to as "skylobbies" on the 44th and 78th floors, which separated the towers into three strata. The skylobbies on floors 44 and 78 served the occupants of floors 43 and 77, respectively. Mode of egress was recorded as stairs, elevators or a combination of both.

The first cue of the event was categorized according to whether the cues were "audio," such as hearing an explosion, crash or rumbling; "visual," such as seeing the plane approach the towers, or seeing fire, smoke or debris. Another category of first cue was "building movement" and was represented by feeling the building shake, sway or tremble, whereas moving office furniture, falling ceilings, jolting in the elevator and flickering lights were attributes of the variable category "contents movement." The remaining three categories were "warned by others" (either verbally or through their behavior),

"physically impacted" (e.g., burned, fell from chair, thrown against a wall), and "smelled smoke or fumes or felt heat." These cues were coded as check-off items so that multiple initial cues could be captured. Whether or not evacuees heard a building alarm during their evacuation was recorded in a separate field, if mentioned.

Time to start evacuation was recorded as immediately, shortly after impact (where the occupant took less than 5 minutes to retreive belongings before evacuating), delayed (representing those who took more than 5 minutes to start evacuating, taking time to search floors or gather company documents, etc.), stayed or stuck.

Conditions of floors immediately after the building was hit were recorded in two ways. One field summarized the conditions as follows: "devastated," meaning combinations of conditions such as scattered debris, fire, darkness and fallen ceilings and walls were reported; "abnormal," in that there was some smoke, heat or the smell of jet fuel; and "normal," represented by accounts describing usual conditions on their floors. A series of check-off columns then recorded whether a person's account reported the presence of specific conditions: door jammed, debris (e.g., from wall, floor or ceiling collapses), smoke, dust, no power or darkness, smell of fumes, water, fire, crowds or injured people, entrapment, or normal conditions. If the individual was not on an office floor when the building was struck, that was recorded in an additional check-off column. This allowed the recording of multiple conditions for each individual.

Similar check-off columns were used to record observations of conditions in stairwells during evacuation: normal, door locked or jammed, crowded and/or hot, no power, water, cracked wall, debris, smoky or smell of fumes.

If and where the evacuees heard the announcement stating that WTC 2 was secure were also noted, as were their actions after hearing the announcment (i.e., continued evacuating, continued but saw others return to offices, or returned to or remained in office). The survivors' location at the time of impact, collapse of the towers and meeting of firefighters were also coded, as well as who helped them during the evacuation. Those who provided help were categorized as firefighters, Port Authority employees, external officials such as New York Police Department, Federal Bureau Investigation, and coworkers. Individuals' disabilities were coded as "visually impaired," "hearing impaired," "physically challenged" (e.g., obese, pregnant, or with asthma or heart conditions), "wheelchair users," or 'injured." People who mentioned that they had aided a disabled or injured person during the evacuation were also noted in this variable category, as were those who reported seeing injured or disabled people during their evacuation.

Whether or not a person was present at the WTC during the 1993 bombing was recorded, as was whether or not each person delayed his or her evacuation on September 11, 2001. Where the evacuee placed a phone call and the recipient of it were coded, along with whether or not they rested and where they rested. A series of check-off columns recorded if a person experienced obstructions, such as door jams, debris, smoke, no power, smell of fuel, water, fire, crowds, injured and disabled people or became trapped during the evacuation. Multiple entries were possible for each individual.

Other variables included the survivors' knowledge of the situation, recorded as "high" for those who knew a plane had struck the towers or that there had been a terrorist attack; "moderate" for those who thought there was a fire, bombing or judged the situation as a serious emergency; and "low" for those who were not aware of the reasons behind the evacuation. The evacuees' indication of the level of

seriousness was recorded as "very serious," "somewhat serious" and "not serious" based on the perceived tone of the account. The variable "perception of others" included the categories of "calm," in that evacuees felt others to be orderly and composed; "upset," which represented those who judged others as nervous, anxious or visibly bothered. For survivors who described others as hysterical or pushing and shoving, this field recorded their perception of others as "momentarily panicked." When accounts reported that those around them lent assistance to others, this field was coded as "helpful."

Social influence on decision making was categorized according to who influenced the evacuee: authority figures, such as bosses or managers; groups of coworkers; or both authority figures and groups of coworkers. If a person indicated that he or she took on a leadership role, that was also captured. Use of new communication technology including utilizing text messaging over pagers or wireless e-mail devices, TV or radio to gain information was noted. (See Appendix A for further variable category definitions.)

The time that people reached the outside was recorded. It must be stressed that most accounts did not report specific times at which people took different actions. However, several occupants mentioned their location at key moments such as where they were when WTC 2 was hit or when WTC 1 or WTC 2 collapsed. For example, one survivor of WTC 1 reports, "When we got to the twentieth (floor) I remember hearing a rumble. One of the fellows looked at me and we knew it didn't sound good. It must have been WTC 2 coming down" (Fink and Mathias 2002). Thus, it was deduced that this survivor was on the 20th floor of WTC 1 at 9:59 a.m., when WTC 2 collapsed. Similarly, for many people, the time they reached the outside could be estimated from their description of events (e.g., WTC 2 being struck, WTC 2 collapsing) as they reached the outside.

4.3 PROCEDURE

Various media avenues were utilized in gathering first-person accounts including television, radio, newspapers, magazines, web sites, books and special media programs. Personal web sites and e-mails written by survivors themselves were also used and are of particular interest, as they have not been altered by media editors in any way, but appear in their full, original format. During the three months following the events, over 280 first-person accounts were collected. Eventually, a total of 745 accounts were gathered from 465 individuals, as numerous survivors gave multiple stories to different journalists.

The accounts, which were gathered over a period of 18 months, were published up to 14 months after September 11, 2001. The distribution of published accounts over time is shown in Fig. 4–1. Among the dated accounts studied, 51 percent were published in the first 2 weeks after September 11, with another influx of accounts surfacing around the one-year anniversary, 10 months to 12 months after the disaster.

Content analysis was performed on the 745 accounts using 33 questions for which the data were entered into a qualitative spreadsheet. Duplicate accounts were merged, resulting in a final study size of 435 individuals who were present either in WTC 1 or WTC 2. The data were then coded and transferred into a matrix for analysis.

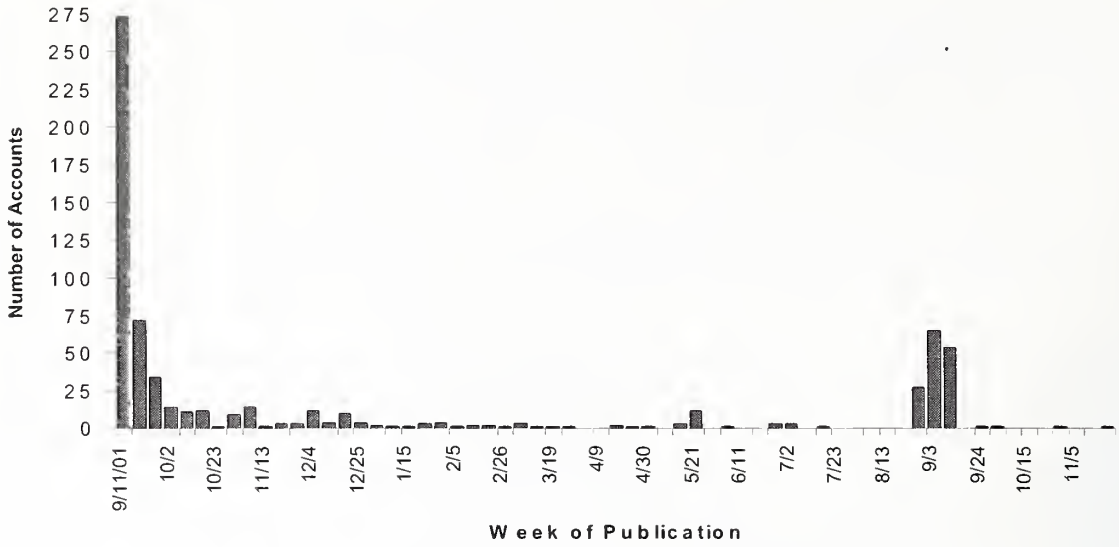

Figure 4–1. Distribution of publication dates of accounts.

Chapter 5
STUDY RESULTS

The raw data for each account were entered into an Excel spreadsheet and then coded. The coded data were transferred into SPSS 11.0 for statistical analysis. The statistical analysis conducted was essentially descriptive statistics to organize and summarize the information. Inferential statistical tests were not conducted since the data obtained are not a representative sample of the population. Results presented in this report should not be generalized to all occupants of the two towers on September 11, 2001. Although they are reported using terms such as "the occupants" and "the survivors," the results refer only to the accounts analyzed.

5.1 PROFILE: GENDER AND AGE

The study contained accounts from 435 survivors, ranging in age from 20 to 89 years old (mean = 39.5, standard deviation = 11.8). Included were accounts from 118 women (27 percent) and 314 men (72 percent); three accounts did not mention their gender (1 percent). It is speculated that the substantially higher number of men involved in these accounts occurred because there were more men working in the two towers than women or that men may be more likely to talk to the media than women. The breakdown by gender and age is shown in Fig. 5–1.

5.2 LOCATION AT THE BEGINNING OF THE EVENT

There were 251 individuals who were located in World Trade Center (WTC) 1, comprising 58 percent, with the remaining 42 percent or 184 people from WTC 2. In WTC 1, 90 people (36 percent) were from upper floors (77 to 110), 79 people (31 percent) were from mid levels (43 to 76) and 58 people (23 percent) were from the lower floors of WTC 1. Another 22 people (9 percent) were in elevators and two people did not specify a location. In WTC 2, 94 people (51 percent) were from upper floors, 57 people (31 percent) were from mid floors, 28 people (15 percent) were from the lower levels of WTC 2 and five people did not specify a location. Although the distribution of accounts in the two buildings was not identical, reports were obtained from the three strata in both buildings. It is likely that the higher fraction of individuals in WTC 1 and in higher floors reflects the more dramatic stories of those closest to the airplane impact locations in WTC 1 and WTC 2.

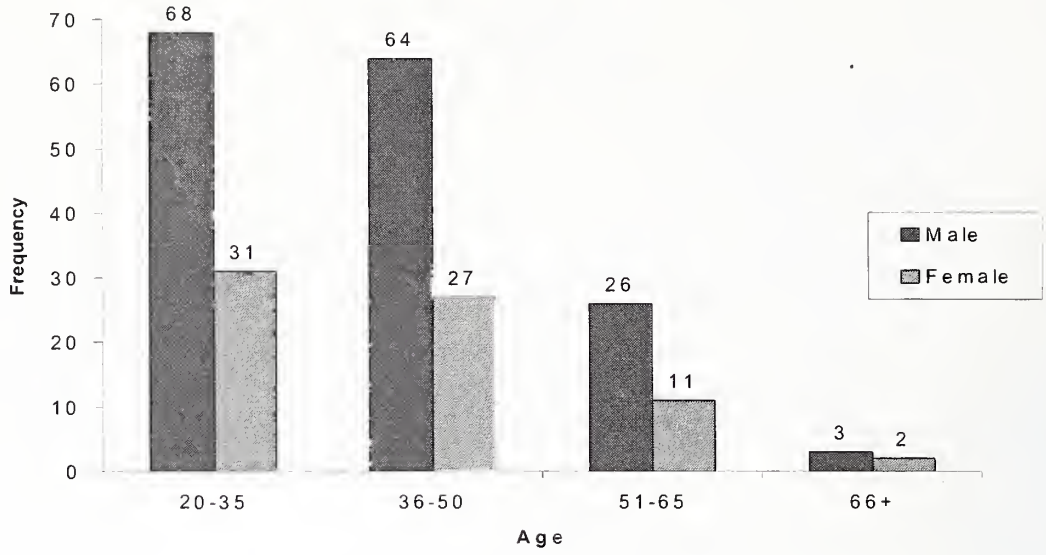

Figure 5–1. Gender and age distribution.

5.3 MEANS OF EGRESS USED

On September 11, 2001, almost all individuals from WTC 1 (198 people or 98 percent) reported using the stairs to evacuate while three used both stairs and elevator and one used the elevator only. The person who used the elevator for evacuation reported that he was in an elevator when the building was struck, and the elevator stopped on one of the floors. He was able to use the elevator to move people from that floor to the lobby. Two of the three who used both stairs and elevators were initially trapped in an elevator behind a 50th floor restroom. After freeing themselves, they were directed by firefighters to an elevator to the 44th floor, from which point they walked down. The third person who used both stairs and elevators rode with a person he was assisting from the 52nd floor to the 44th floor. Unable to find a working elevator on the 44th floor, he walked down the rest of the way. In WTC 2, 114 (72 percent of the total for that building) used the stairs while 18 people (11 percent) used elevators and 26 (16 percent) used a combination of elevators and stairs. These results are shown in Table 5–1. Of the 44 people who used the elevator to evacuate WTC 2, 37 were from floors served by the 78th skylobby and 7 were from floors between the 44th and 78th skylobbies. From these accounts, it seems that the higher up people were in WTC 2, the more likely they were to use the elevator as a means of egress.

Table 5–1. Means of egress used within the towers.

	WTC 1, n=202	WTC 2, n=158
Stairs	198 people (98.0 %)	114 people (72 %)
Elevator	1 person (0.5 %)	18 people (11 %)
Stairs and elevator	3 people (1.5 %)	26 people (16 %)

5.4 FIRST CUE REPORTED

The first cues of the event that were mentioned in the accounts were found to differ depending on which tower the person was located. For WTC 1, the first building hit, the most common first cue of the event reported by 146 people (69 percent of people in that tower) was "building movement," such as feeling the

building sway and tremble—many thought the building was going to tip over. WTC 2 occupants most commonly reported first becoming aware of the event from visual cues (96 people) such as fire, debris and smoke, most likely coming from WTC 1. Several people reported more than one first cue, so they may appear more than once in Table 5–2 and percentages total more than 100 percent.

Table 5–2. First cues of event within the towers.

First Cues	WTC 1, n=212	WTC 2, n=145
Audio cues: heard explosion, crash, rumble	107 (50 %)	69 (48 %)
Visual cues: saw fire, incoming plane, debris, smoke	87 (41 %)	96 (66 %)
Building movement: felt building sway, tremble, jolt	146 (69 %)	30 (21 %)
Contents movement: furniture movement, ceiling falling	66 (31 %)	11 (8 %)
Warning from others	14 (7 %)	34 (23 %)
Impact	29 (14 %)	1 (1 %)
Smelled fumes or felt heat	12 (6 %)	16 (11 %)

Interestingly, only 25 people made any mention of building alarms in their evacuation accounts. Of those, eight in WTC 1 and one in WTC 2 reported hearing alarms but did not specify where. Two in WTC 1 and one in WTC 2 heard alarms while on their floors and one person in each tower heard alarms while in the stairs. Eight people in WTC 1 stated that they did not hear alarms. Three people in WTC 2 said they never heard alarms, but two of them were outside the building when it was hit.

5.5 TIME TO START EVACUATION

After perceiving these first cues, 101 people from WTC 1 (47 percent) immediately started evacuating, while 84 people (52 percent) immediately started their evacuation of WTC 2. As can be seen in Fig. 5–2, similar numbers of people from both towers started evacuating shortly after the first cue of the event (28 in WTC 1 versus 27 in WTC 2). Another 46 people in WTC 1 and 40 people in WTC 2 delayed their evacuation. Some 23 people in WTC 1 (11 percent) reported they initially stayed, while 10 people from WTC 2 (6 percent) also said they initially remained on their floors. Of the 16 people who reported being stuck and therefore temporarily unable to start their evacuation, all but one were from WTC 1.

Among occupants who initially decided to stay, it is noteworthy to mention a group in WTC 1. Two survivors reported that a group of about 16 employees gathered in a conference room on floor 64 of WTC 1. The group stayed in the room discussing the situation for approximately 1 hour before deciding to evacuate the building.

Most of those who were not stuck but who took more than 5 minutes to begin evacuation delayed because they took the time to complete activities such as searching the floor, securing documents, making calls, or giving instructions, or because they felt it was the right thing to do. Twenty-one of 63 people in WTC 1 (33 percent) and 13 of 45 people in WTC 2 (29 percent) delayed starting their evacuation because

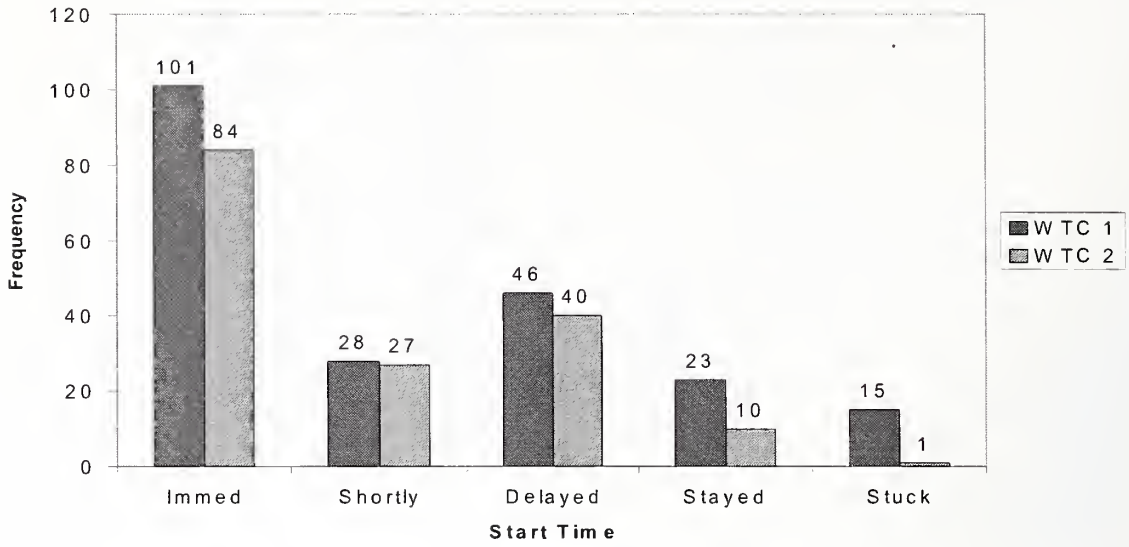

Figure 5–2. Distribution of time to start evacuation.

they were completing activities such as those described above. Of those in WTC 1 whom did not begin their evacuation within 5 minutes, 12 people simply decided to stay (19 percent), compared to 20 people in WTC 2 (44 percent). In WTC 1, 17 of those who did not begin their evacuation within 5 minutes (27 percent) were helping others or required assistance themselves, compared to only four people (9 percent) in WTC 2.

5.6 CONDITIONS ON FLOORS AND IN STAIRWELLS

It was possible to code multiple reported conditions on floors and in stairwells for each individual. Six people in WTC 1 and seven people in WTC 2 indicated that conditions on their floor were normal after their building was struck. For the 191 evacuees who commented on adverse conditions on their floors after the plane hit their tower, similar results emerged between the towers, in terms of the large proportions reporting smoke or debris and collapse damage on their floor. Specifically, the most frequently reported adverse conditions in WTC 1 were smoke (55 percent or 74 people), debris or collapse of wall, ceiling or floor (72 people or 54 percent), fire (41 people or 31 percent), darkness or loss of power (20 people or 15 percent) and smell of fuel (13 people or 10 percent). In WTC 2, the most frequently reported adverse conditions were debris or collapse of wall, ceiling or floor (38 people or 67 percent), smoke (25 people or 44 percent), darkness or loss of power (18 people or 32 percent), dust (10 people or 18 percent), smell of fuel (7 people or 12 percent) and injured people (7 people or 12 percent). Seven people in WTC 1 who mentioned jammed doors were in the upper strata of the building. Two people in WTC 2 who reported jammed doors had moved to middle floors of their building after the first impact. The complete details on conditions are presented in Table 5–3.

A large number of evacuees (106 people) mentioned that the stairwells were crowded and hot during their evacuation (71 people in WTC 1 and 35 in WTC 2). A total of 27 indicated that conditions in the stairwells were otherwise normal. For the 155 evacuees who commented on adverse conditions in the stairwells during their evacuation (other than crowdedness), the majority in both towers reported smoke and the smell of fuel in the stairs (79 people or 72 percent in WTC 1 and 29 people or 63 percent in

WTC 2). For other types of conditions in stairwells, responses between the two towers were quite different, as shown in Table 5–4.

Table 5–3. Adverse conditions on floor at impact.

	WTC 1, n=134	WTC 2, n=57
Debris (collapse)	72 (54 %)	38 (67 %)
Smoke	74 (55 %)	25 (44 %)
Fire	41 (31 %)	20 (35 %)
No power, dark	20 (15 %)	18 (32 %)
Smell of fumes	13 (10 %)	7 (12 %)
Dust	9 (7 %)	10 (18 %)
Water	7 (5 %)	3 (5 %)
Door jammed	7 (5 %)	2 (4 %)
Crowds, people injured	2 (1 %)	7 (12 %)
Trapped	5 (4 %)	2 (4 %)

Table 5–4. Adverse conditions reported in the stairs during evacuation.

	WTC 1, n=109	WTC 2, n=46
Smoke, smell of fuel	79 (72 %)	29 (63 %)
Water	49 (45 %)	4 (9 %)
Dark, no power	14 (13 %)	9 (20 %)
Debris (damage or belongings)	9 (8 %)	14 (30 %)
Cracked walls	5 (5 %)	14 (30 %)
Doors locked, jammed	12 (11 %)	2 (4 %)

5.7 OBSTRUCTIONS DURING EVACUATION

Tables 5–3 and 5–4 display details on the adverse conditions that resulted at the time of impact. These were things that were observed, but that might not have presented an obstacle. (For example, a person might have reported seeing smoke or debris, without being impeded by that debris.) Obstructions are things that limited or otherwise affected a person's ability to evacuate. Many of the same items were cited as both adverse conditions and obstructions. More than one obstruction during evacuation could be recorded for each person. A total of 153 people in WTC 1 and 59 people in WTC 2 indicated encountering obstructions during their evacuation. Almost half of the evacuees in each tower reported encountering crowds and injured people in the stairways, and indicated that they interfered to some degree in their evacuation (46 percent in each tower). The next most frequently reported obstructions were smoke and debris. The details are shown in Fig. 5–3.

Of the 22 evacuees who reported encountering jammed or locked doors, 20 were in WTC 1, and all but three were located on upper floors. One of the WTC 2 evacuees reported that an elevator door was jammed by debris, and the other reported a locked door on reaching the bottom of the stairs. Of the 25 evacuees who reported being trapped, nine were in elevators, eight were trapped by debris or smoke

when their building was hit, five were trapped in the collapse of WTC 2, and three were trapped when WTC 1 collapsed.

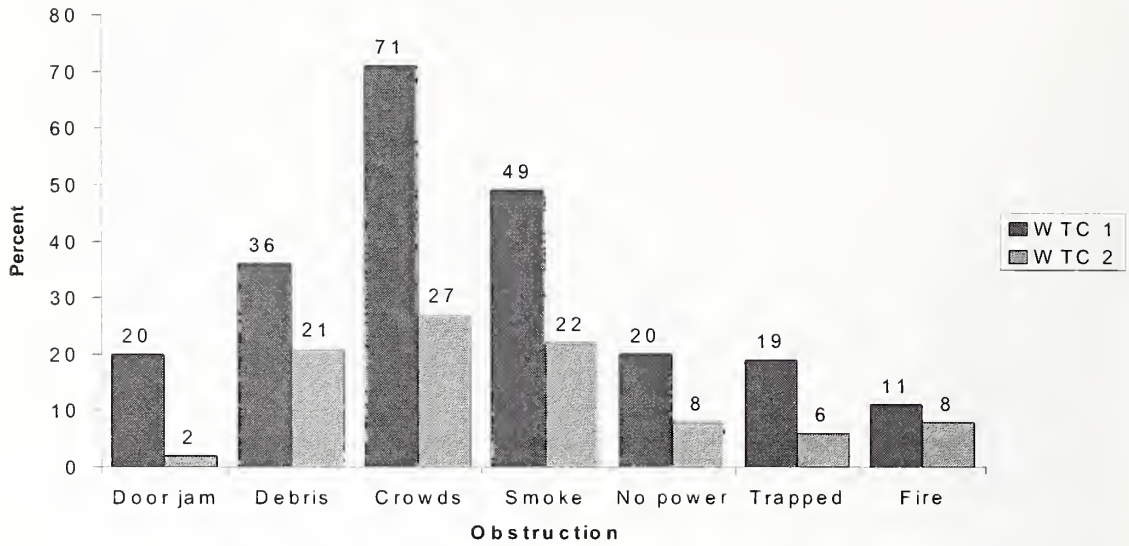

Figure 5–3. Obstructions encountered during evacuation in both towers.

5.8 ANNOUNCEMENT

It is estimated that the WTC 2 announcement came over the public address system at approximately 9 a.m. The majority of survivors said they heard it just minutes before WTC 2 was struck, which occurred at 9:03 a.m. As one survivor from the 103rd floor of WTC 2 describes it, "When we reached the 70th floor we heard the announcement. The building was secure; no one needed to evacuate. We had descended down 3 more floors to the 67th when the second plane hit our tower" (csmonitor.com 2001). Of the 184 WTC 2 occupants, 96 people (52 percent) mentioned hearing this announcement in their accounts. The majority of them, 69 survivors, decided to disregard the instructions of the message and continue their evacuation; however, 16 people (17 percent) said they remained in their offices or decided to return back up to their offices after hearing the message. Those returning did not have time to travel very far before the second plane hit; at that point they all resumed their evacuation.

5.9 LOCATION WHEN WTC 2 WAS HIT

Of the 273 survivors who mentioned their location at the time WTC 2 was hit, 36 people reported being somewhere inside the stairwells of WTC 1, while 14 people reported being on various floors of WTC 1. Fifty-six did not give a specific location, and 15 had already reached the outside. Of the survivors from WTC 2, 65 people reported they were in the stairs and 52 occupants reported they were on various floors within WTC 2. Four did not give a specific location, and 31 had already left the building. Of the people who were on the floors within WTC 2, 19 were on the upper floors (77th and above) at impact and survived. One of these occupants, who survived the plane impact on the 78th floor of WTC 2, describes the stairwell: "a tornado of hot air and smoke and ceiling tiles and bits of drywall came flying up the stairwell. In front of me, the drywall split from the bottom up" (csmonitor.com 2001).

5.10 LOCATION WHEN WTC 2 COLLAPSED

WTC 2 was the first of the towers to collapse at 9:59 a.m. Of the 296 survivors who mentioned their location at the time of the collapse of WTC 2, 230 people (78 percent) were outside of the buildings, on the streets and surrounding areas. Some 47 of WTC 2 people (16 percent) were still inside WTC 1 on lower levels from the basement to the 42nd floor, and three people (1 percent) were on mid levels (43 to 76) in WTC 1 when WTC 2 fell. Thirteen did not give exact locations, and one was in an elevator. Three individuals were on the lower levels of WTC 2 (concourse) when it collapsed, and they survived.

5.11 LOCATION WHEN WTC 1 COLLAPSED

WTC 1, the second tower to collapse, fell at 10:28 a.m. As approximately 1 hour and 42 minutes had passed since the initial WTC 1 impact, almost everyone who reported their location at the time WTC 1 collapsed was outside (263 people or 98 percent). Four people were on the lower levels of WTC 1, and two were in the concourse when it collapsed, and they survived.

5.12 LOCATION WHEN THEY SAW FIREFIGHTERS

For the evacuees who mentioned seeing firefighters during their evacuation, the location where they met them was recorded to gain an understanding of the dispersion of emergency workers throughout the towers. For the 169 people who reported meeting firefighters, 143 people saw them in WTC 1, with only 26 people in WTC 2 mentioning their presence. In terms of floor location within WTC 1, it was found that a majority of the people (76 people) saw firefighters in WTC 1 on the lower levels (basement to 43rd); 74 of them saw firefighters in the stairwells, and two on a floor. Another 21 people saw firefighters on the mid floors (43rd to 76th)—17 of them were in the stairs while the other four people were on floors. Another three people saw firefighters on the upper floors (77th to 110th) in office areas. All three were trapped on the 83rd floor. One survivor stated: "We saw two flashlights belonging to two New York City firemen. They told us to leave all of our possessions and to quickly follow them." (Manning 2001). At the mezzanine, lobby or concourse level, 11 people reported seeing firefighters. The remaining 31 occupants who saw firefighters inside WTC 1 did not give a location.

Among the 26 people who mentioned seeing firefighters in WTC 2, eight saw them on the lower floors (basement to 42nd), and two saw firefighters in the mid floors of the building (43rd to 76th). Seven people saw firefighters at the mezzanine, lobby or concourse levels, while six people in WTC 2 mentioned seeing firefighters but did not indicate their locations. Three people indicated that they met firefighters outside WTC 2.

5.13 TIME OF EXIT

For evacuees from both towers who indicated at what time they exited, it was found that as more time passed, a progressively greater number of people exited the building, as shown in Table 5–5. Of the 183 WTC 2 occupants who indicated what time it was when they left the building, 77 exited between 9:31 and 9:58 a.m. WTC 2 collapsed at 9:59 a.m. Of the 211 WTC 1 occupants who indicated the time they left their building, 70 exited between 9:59 and 10:27 a.m. WTC 1 fell at 10:28 a.m. The six people who exited the towers after 10:28 a.m. were rescued from the rubble by firefighters up to several hours after the collapse.

Table 5–5. Time out of towers.

	WTC 1 (Impact – 8:46 a.m.) (Collapse – 10:28 a.m.) n=211	WTC 2 (Impact – 9:03 a.m.) (Collapse – 9:59 a.m.) n=183
8:48 a.m. to 9:02 a.m. (before WTC 2 impact)	19	37
9:03 a.m. to 9:30 a.m.	45	68
9:31 a.m. to 9:58 a.m. (before WTC 2 collapse)	72	77
9:59 a.m. to 10:27 a.m. (after WTC 2 collapse)	70	0
10:28 a.m. (after WTC 1 collapse)	5	1

5.14 HELP RECEIVED AND HELP GIVEN

Among the 435 accounts, 203 survivors described receiving help from others during their evacuation, with some mentioning more than one source of help. Some 84 people (41 percent) were helped by Port Authority personnel. Firefighters provided direct help to 65 people (32 percent). Another 65 people (32 percent) were helped by other first responders such as New York Police Department or other rescuers. Help from coworkers was received by 34 people (17 percent).

Overall, 166 people mentioned being comforted and reassured by passing firefighters. Several occupants of the two towers helped others during the evacuation. Among the first-person accounts, 20 people said they helped people with disabilities and 14 said they helped people who were injured during the event.

5.15 OCCUPANTS WITH DISABILITIES OR INJURIES

Among the 27 persons reporting a disability in their account, two were visually impaired, three were hearing impaired, three used wheelchairs and 19 others were physically challenged such as suffering from a heart condition, asthma, obesity, etc. Twenty-two people mentioned seeing people with disabilities.

Another 47 people who provided first-person accounts were injured that morning. Some accounts from people who suffered injuries reported exiting the buildings later in the evacuation process. However, in numerous accounts occupants mention moving aside in the stairwells to let badly injured and burned people pass, thus it is assumed that those with extreme injuries who were mobile exited the building faster than the majority of others. For instance, one survivor from floor 88 of WTC 1 who suffered burns to over 77 percent of her body reported that crowds parted in the stairwell to let her through (Kugler 2002). These victims were all accompanied by coworkers or emergency workers. Twenty-five people mentioned seeing injured people coming down in the stairwells.

Twenty-three individuals with disabilities and 43 with injuries mentioned a time to start. Of these 66 people, 50 percent (13 people with disabilities and 20 injured) started evacuating immediately, 5 percent (two disabled and one injured) left shortly after, 29 percent (7 disabled and 12 injured) delayed evacuating, 14 percent (one wheelchair user and eight injured) initially decided to stay, and 3 percent (two injured people) were initially stuck.

5.16 PHONE CALLS

An overwhelming 87 percent of those who placed phone calls (151 people) were trying to contact their families and friends to let them know their whereabouts and gather information from them. Only 12 people (7 percent) tried contacting authorities, such as building security or calling 911, and 20 people (12 percent) placed calls to their boss or colleagues. Eleven people (6 percent) did not say who they called.

The majority of people who placed phone calls that morning did so once they were outside (93 people or 54 percent); however, many did not get through. Forty-four people (25 percent) mentioned that they placed calls from their offices before evacuating, 13 people (8 percent) called from other floors and 10 people (6 percent) attempted to make phone calls while in the stairwells.

5.17 KNOWLEDGE OF SITUATION

In judging the evacuees' knowledge of the situation, categories were created. A "high level" of knowledge indicated knowing that planes had hit the towers or that there had been an explosion within the towers. Those who speculated about a bombing saw fire and debris or had reason to believe an emergency was occurring were said to have a "moderate level" of knowledge. Survivors who were not aware of the reasons behind the evacuation were classified as having a "low level" of knowledge. Level of knowledge was coded for 330 people. As shown in Fig. 5–4, survivors with "high levels" of knowledge totaled 69; 214 people were judged to have a "moderate level" of knowledge and 47 survivors had a "low level" of knowledge regarding the events of that morning.

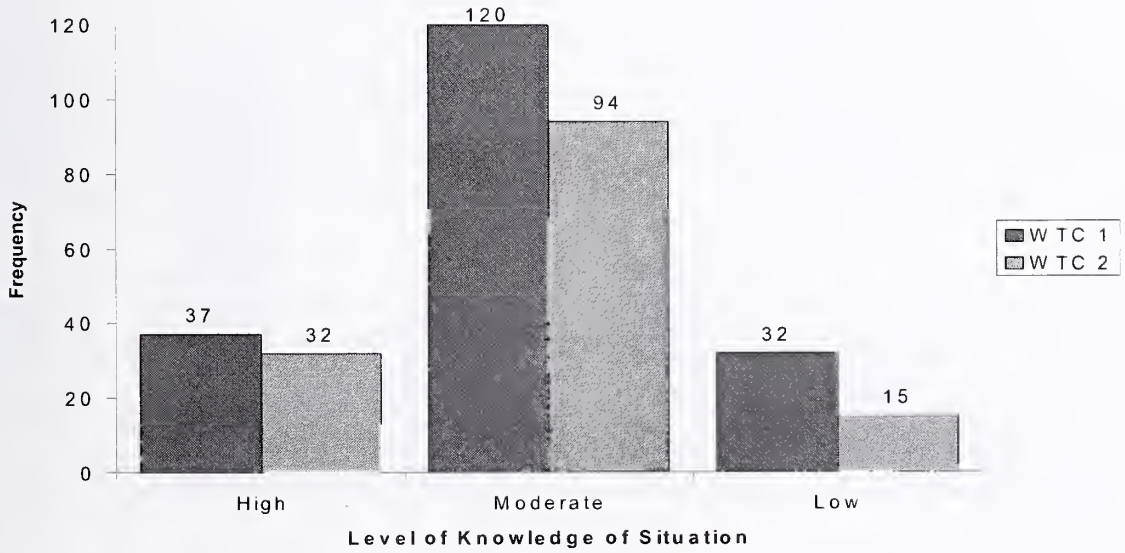

Figure 5–4. Knowledge of situation in the towers.

5.18 INFLUENCE OF OTHERS

One hundred and ninety-one survivors reported that their decisions during the evacuation were influenced by others. It appeared that 28 people were influenced by authority figures, such as their boss or manager,

and complied with their instructions. Another 97 survivors seemed to be influenced by groups of people and coworkers. One person appeared to have been influenced by both authority figure(s) and the group. Many individuals indicated that they took on leadership roles that morning. Sixty-six people reported they directed people to the stairs, searched for others, gave orders or somehow took part in organizing the evacuation.

Males were more likely to perceive themselves as taking on leadership roles that morning than females (see Table 5–6). Thirty-eight women (59 percent of the females for whom influence could be inferred) were influenced by groups of coworkers, whereas only 58 men (46 percent) were apparently influenced by the group. Concerning leadership roles, 52 men (41 percent) reported adopting this behavior, compared to the 14 women who mentioned taking a leadership role (22 percent of the women).

Table 5–6. Gender and influence of others.

	Males, n=127	Females, n=64
Authority figures (boss, manager)	17 (13 %)	11 (17 %)
Groups/coworkers	58 (46 %)	38 (59 %)
Both authority and groups	0 (0 %)	1 (2 %)
Took a leadership role	52 (41 %)	14 (22 %)

5.19 PERCEPTION OF OTHERS

How survivors perceived others during the evacuation was recorded for 268 people—others could have been perceived as "calm," "momentarily panicked," "upset," or "helpful." Multiple responses could be coded for each person. The results show that the majority (154 people or 57 percent) described people around them as calm and orderly. Some 84 people (31 percent) judged others as "upset," which included crying, shouting, nervous or anxious, but rational. There were 78 people (29 percent) who described others as "momentarily panicked," in that they were pushing, shoving or generally displaying behavior associated with chaos, while 59 people (22 percent) found others to be "helpful." More details are presented in Fig. 5–5.

It was found that of 155 people in WTC 1, 93 survivors judged others to be "calm," compared to 61 of 113 people in WTC 2. Only 33 people in WTC 1 described others as "momentarily panicked," compared to 45 people in WTC 2. For the people in WTC 2, the perception of "panic" occurred before WTC 2 was hit for at least three occupants, while another 29 survivors described others around them as "panicky" after WTC 2 was hit. For two others, the "panicky" behavior was reported at the point in time when each tower collapsed. It was not clear from the other 11 accounts from WTC 2 when the people around them were "panicky."

This variance in perception of others between the towers is illustrated by contrasting the following two accounts. One survivor from the 65th floor of WTC 1 said that those in the stairwells "maintained their calm really well" and went on to say that, a couple of people started crying a little, but we said, 'We're going to get out of here, we just have to take it one step at a time.' It wasn't quiet, people were talking–in fact someone was laughing, it was pretty normal (Anderson 2001). It is proposed that the occupants of

WTC 2 observed others "momentarily panicking" mainly once their tower had been hit. One survivor from the 70th floor of WTC 2 said she and her coworkers walked down to the 59th floor and took an elevator to the 44th floor, when at that point, another plane hit their tower and then there was a mad scramble down the stairs with people pushing, shoving and yelling (Black 2001).

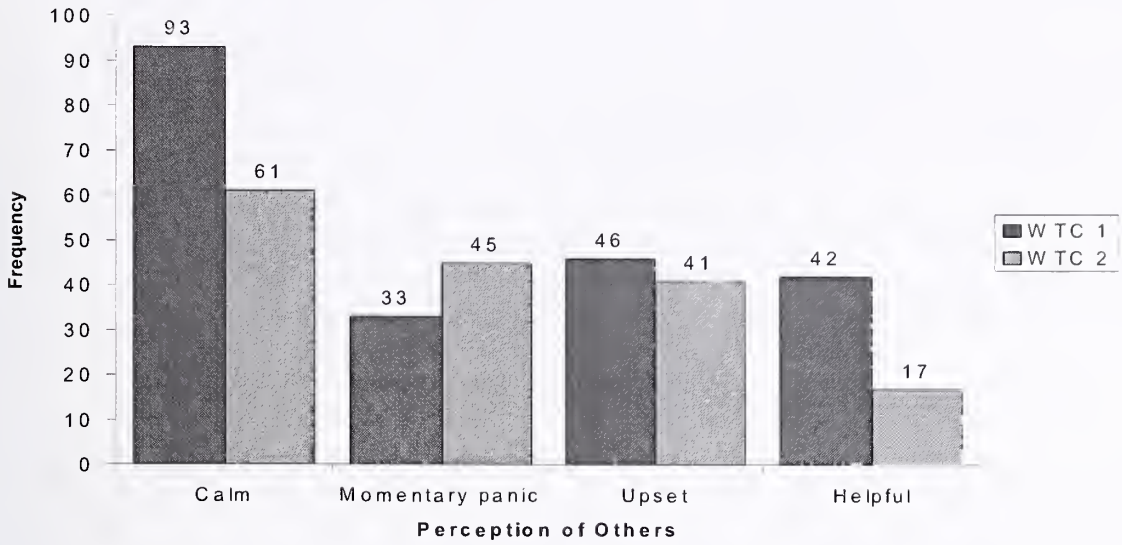

Figure 5–5. Distribution of perception of others between the towers.

Perception of others and gender are compared in Fig. 5–6.

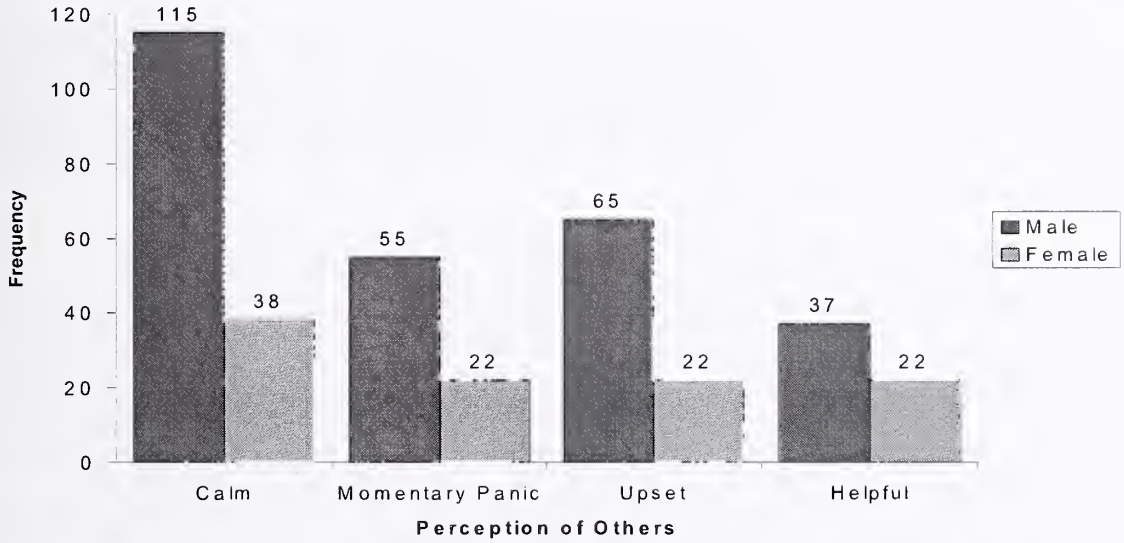

Figure 5–6. Distribution of gender and perception of others.

The distribution of perception of others by age group is shown in Table 5–7. It is interesting to note that some of the most dramatic language ("chaos," "total chaos," "mayhem") was used by the youngest males.

Table 5–7. Distribution of age and perception of others.

	21–35 yr old (n=74)	36–50 yr old (n=58)	51–65 yr old (n=21)
Calm	39 (53 %)	31 (53 %)	9 (43 %)
Panicked	25 (34 %)	14 (24 %)	6 (29 %)
Upset	31 (42 %)	22 (38 %)	4 (19 %)
Helpful	16 (22 %)	17 (29 %)	8 (38 %)

5.20 TECHNOLOGY TO GAIN INFORMATION

In addition to the people mentioned earlier who made cell phone calls from the stairwells, 10 people used technology such as wireless e-mail devices and text pagers as a means of gathering information about the situation. Thirteen listened to the radio or watched television, among them three evacuees who stopped to watch TV on the mid floors (43 to 76) of WTC 1 and saw live media coverage of the events.

5.21 IMPACT OF THE 1993 EVACUATION

Only nine percent, 41 people, reported being present during the 1993 bombing and evacuation of the WTC. Of them, three people explained that their experience in 1993 helped them decide to start their evacuation immediately on September 11, 2001. Five people who were present in 1993 mentioned being better prepared this time with evacuation kits. These emergency escape kits were described as being equipped with flashlights, masks, glow sticks, whistles and water (Murphy and Levy 2001). Another 18 people specifically mentioned that 1993 was on their mind during their evacuation, although they were not present during the events of 1993.

Four survivors reported seeing photoluminescent stripes on the stairs, railings and stairwell doors—an improvement the Port Authority made following the 1993 bombing. As one survivor stated, "All you had to do was follow those yellow-green stripes. They were wonderful." The stripes were especially valuable when the emergency stairs stopped and people had to travel horizontally through mechanical equipment spaces that had many doors (Masetti 2001).

A paraplegic survivor from WTC 1 who was also present for the 1993 evacuation of the WTC commented on the successful use of an evacuation chair on September 11, 2001. The evacuation chairs were part of the improvements made to the WTC evacuation process after the 1993 bombing, and this survivor credits the chair with saving his life. In 1993, he was bounced down the stairs in his electric wheelchair from floor 69 to floor 43, where he was then transferred to a stretcher and carried down the rest of the way. It took him 6 hours to evacuate from floor 69 in 1993. On September 11, using the evacuation chair enabled him to escape floor 69 of WTC 1 and get to street level in 1 hour and 30 minutes. He went on to say, "If it weren't for the evacuation chair and the 10 people that brought me down, I would not have made it, that's for sure. That evacuation chair made the difference" (Fink and Mathias 2002).

Chapter 6
SUMMARY RESULTS

Although it is recognized that content analysis of first-person accounts has limitations, and the results cannot be generalized to all occupants of the towers, this methodology was found to be particularly useful in this case. With the large number of accounts that were gathered from a variety of sources (print media, television, radio, internet, emails, etc.), the similar themes and experiences within these texts became more than merely anecdotal stories. Considering that a great majority of the accounts became public within three weeks following the events and that recollection of human behavior is delicately time sensitive, it was important to analyze this information. This methodology could prove useful in future projects dealing with first-person accounts, although events of the magnitude of September 11, 2001, which produced such a large number of first-person accounts, are extremely rare.

For the accounts gathered from media sources, it is recognized that they may represent the most dramatic stories of the evacuation. At the same time, those survivors who have dramatic stories of escape may be more inclined to share them compared to other survivors who may judge their evacuation as less eventful. However, the accounts analyzed were from survivors located in several areas in each tower, providing a distribution of floors from the upper, middle and lower strata of the two towers. In total, 745 accounts were analyzed, representing 435 survivors from World Trade Center (WTC) 1 and WTC 2.

An interesting and important observation involves the emergence of new first-person accounts from survivors who had not previously shared their stories, around the first anniversary of the event. In trying to explain this phenomenon, it is speculated that survivors who had not previously shared their stories were now prepared to do so after having time to cope and deal with their experience. Many of the evacuees mentioned that telling their stories proved to be a therapeutic exercise. Media sources may have also held accounts gathered from an earlier date or searched for new, untold stories and published them as part of the anniversary coverage.

An important observation stemming from the accounts analysis encompasses the issue of evacuation strategies. It was found that 44 people, about 24 percent of WTC 2 occupants in this study, used the elevators at some point during their evacuation. It has long been accepted among fire safety experts that people know they should not use elevators as a means of egress during an emergency, but those in WTC 2 who chose to use the elevators may have thought it was the quickest or safest route of escape and may have believed that because they were not in immediate danger, they were justified in their decision to use the elevators to evacuate. The same theme is echoed when examining the reactions of the 96 WTC 2 occupants who heard the public address announcement, which told them their building was secure and to return to their offices. Only 16 people took heed of this message and stopped their evacuation, making their way back to, or remaining in, their offices. Through all accounts studied (with the possible exception of one) there was no doubt that people understood the message, as there were no audibility or intelligibility issues; the content of the message was clear. However, the majority of 69 occupants made their decision based on the information that they had at that point in time and decided to disregard the order and continue evacuating. As one survivor stated, "I was thinking that there is a real difference of opinion here about what my eyes are seeing and what the announcement was saying."

(Murphy and Levy 2001). The decision to carry on with the evacuation may also reflect the concept of commitment: as these occupants had already made the decision to leave, they pursued this task.

It is also interesting to note that the official procedure for emergencies in the WTC was to meet in the lobby area on each floor and wait for instruction. Nevertheless, the majority of occupants of both towers decided to evacuate on their own after WTC 1 was hit, without waiting for an official building announcement. Thus, this is further evidence that people will make decisions based on what they judge the proper action to take despite official procedures.

Those who had experienced the 1993 terrorist bombing of the WTC left promptly. Although their past experience could have suggested that the evacuation was going to be long and difficult and that people who stayed behind would be evacuated by rescuers later on, very few used this rationale. Instead, most occupants with experience from 1993 felt an urgency to leave immediately.

The results show that 18 people who were identified as having "high levels" of knowledge delayed evacuating. Those who delayed their evacuation reported that they rushed to gather their belongings or went to backup important company files, for they suspected they would not be returning to the building for an extended period of time. These are rational actions; therefore, it is concluded that those with "high levels" of knowledge who delayed evacuating had to have been in areas where the perceived threat to personal safety was not high.

The overall impression of the emotional atmosphere during the evacuation, after reading all 745 accounts, was that of calm and order. Although some reported crying and being anxious or nervous, the majority viewed themselves and others as composed. A stark contrast in perceived behavior was found to exist between the two towers, with the majority of WTC 1 occupants reporting others as "calm" (93 of 155 people), where as a large proportion of WTC 2 occupants perceived others to be "panicked" (45 of 113 people). The perception of "panic" occurred before WTC 2 was hit for at least three occupants, while another 29 survivors perceived others as "panicked" after WTC 2 was hit. After their building had been struck, WTC 2 occupants may have realized they were under attack, which could possibly explain the heightened level of anxiety in the tower. (It is important to note, however, that the colloquial use of the word panic more often describes a state of mind—high anxiety, for example—rather than the irrational actions that more correctly define "panic.")

Emergency crews disrupted evacuation in the stairwells while going against traffic, but many evacuees who mentioned seeing firefighters felt reassured and safe due to their presence. It is assumed that this counter flow did not prevent occupants from evacuating, as the last people to exit reported being alone in the stairs while they were descending rapidly seconds before the collapse. Evacuees used technology such as cell phones, wireless e-mail devices, and text messaging over pagers during their descent as a means of gathering information about the situation unfolding around them.

Chapter 7
FUTURE WORK

Future research is needed to fully understand the evacuation behavior of the occupants who were in the two towers of the World Trade Center (WTC) on September 11, 2001. A variety of approaches should be used to gather this information such as interviews and questionnaires. Unfortunately, the extended amount of time that has elapsed since the events is an important factor to mitigate, since occupants' recollection may be incomplete and contaminated by what has been seen, read, or heard since September 11.

Technology clearly played a role in providing occupants with information about the event during their evacuation. This phenomenon raises important issues regarding the information age and how new technologies can be taken advantage of to aid in emergency situations. If technology can help to disseminate timely information to the public in times of crises, strategies should be developed to enable authorities to fully utilize such technology.

This major event, which was repeatedly broadcast on television around the world, may also influence fire safety in high-rise buildings in general. It is essential to study how the perception of risk in high-rise buildings has changed since September 11, 2001. Do people who live, work or visit high-rise structures feel more at risk of a potential fire or fear that the building might collapse if there is a fire? If the occupants feel more at risk, what is their likely behavior and response in future emergencies? Studies should be conducted to explore the impact of high-rise risk perception on intended behavior in future emergencies. Are occupants prepared to follow procedures and instructions? Would they comply with a protect-in-place approach or to move to a refuge floor? If all occupants want to evacuate to the ground floor or exit during an emergency, requirements for stair design and building height might need to be revisited. Drills should be conducted to observe unannounced emergency evacuations in high-rise buildings, varying evacuation strategies and information provided to occupants to assess actual response. Longitudinal studies should also be conducted to assess the impact of September 11 over time on high-rise building occupants.

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Chapter 8
REFERENCES

Anderson, P., 2001. *We the living: One company that made it.* CNN, September 21.

Black, B., 2001. How the telephone linked an anxious family on September 11. *Concordia's Thursday Report*, November 22.

Cauchon, D., 2001. For many on September 11, survival was no accident," *USA TODAY*, December 19.

csmonitor.com/2001/0917/pls1-usgn.html, *The Christian Science Monitor*, accessed September, 2002.

Fahy, R., G. Proulx. 1995. Collective Common Sense: A study of the human behavior during the World Trade Center evacuation, *NFPA Journal*, Vol. 89, No. 2, pp. 59-67.

FEMA (Federal Emergency Management Agency), 2002. *World Trade Center Building Performance Study: Data Collection, Preliminary Observations, and Recommendations.* Federal Insurance and Mitigation Administration, Washington, D.C.

Fink, M., L. Mathias. 2002. *Never Forget. An Oral History of September 11, 2001.* Harper Collins Publishers, New York, NY, pp. 124-127.

Fischer III, H.W., 1998. *Response to Disaster. Fact versus Fiction and Its Perpetuation.* University Press of America, Maryland, pp. 13-45. (With foreword written by Quarantelli)

Gamson, A.W., 1975. *The Strategy of Social Protest*, The Dorsey Press, Homewood, Illinois.

Grossman, D., B. Siddle. 2002. Critical Incident Amnesia: *The psychological basis and the implications of memory loss during extreme survival stress situations, The Firearms Instructor*, Issue 31.

Hays, W., 1994. *Statistics*, 5th ed. Harcourt Brace College Publishers, Orlando, Florida. p. 869.

Isner, M.S., T.J. Klem. 1993. *Fire Investigation Report: World Trade Center Explosion and Fire, New York, New York, February 26.* National Fire Protection Association, Quincy, MA, p. 32.

Janis, L., L. Mann, 1977. *Decision Making.* Free Press, Macmillan Publishing Co., New York, NY.

Johnson, R.N. 1987. Panic at The Who Concert Stampede: An Empirical Assessment, *Social Problems*, Vol. 34, No. 4, pp. 362-373.

Keating, P.J., 1982. The Myth of Panic, *Fire Journal*, Vol 76, No.3, National Fire Protection Association, Quincy, MA, pp. 57-61.

Kugler, S., 2002. WTC victim leaves hospital, *Boston Globe*, January 30.

Manning, C., 2001. Goffstown man tells of his escape from 83rd floor, *The Union Leader*, September 15. Section A, Page 1.

Masetti, A., 2001. Personal e-mail correspondence. December 10.

Murphy, D., Levy, C., 2001. The evacuation that kept a horrible toll from climbing higher, *The New York Times*, September 21.

Proulx, G., 1993. A stress model for people facing a fire, *Journal of Environmental Psychology*, Vol.13, pp. 137-147.

Proulx, G., 2001. As of the year 2000, what do we know about occupant behavior in fire?, *The Technical Basis for Performance Based Fire Regulations*, United Engineering Foundation Conference, San Diego, pp. 127-129.

Proulx, G., 2002. Understanding human behavior in stressful situations. Workshop to Identify Innovative Research Needs to Foster Improved Fire Safety in the United States, *National Academy of Sciences*, Delegate Binder Section 7, Washington, D.C., pp. 1-5.

Sime. J.D., 1980. The Concept of Panic, *Fires and Human Behaviour*, D. Canter, Editor, John Wiley and Sons, Ltd., pp. 63-81.

Sime, J.D., 1985. The outcome of escape behavior in the Summerland fire: panic or affiliation?, International Conference on Building Use and Safety Technology, Los Angeles, CA.

Wegner, D., B. Aguirre, G. Vigo, 1994. Evacuation behavior among tenants of the World Trade Center following the bombing of February 26. *Hazard Reduction Recovery Center Publications*, Texas A&M University.

Yamasaki, M., 2002. World Trade Center Fact Sheet, Prepared by Minoru Yamasaki Associates, Architects. www.m-yamasaki.com/projs/wtcfs.htm. Accessed on December 9.

Appendix A
WTC First-Person Accounts Code Book

1. BLDG - 'Building Location at the Time of Awareness / Perception of First Cue'

1 = Tower 1, North Tower

2 = Tower 2, South Tower

3 = Plaza/Outside

4 = Concourse

5 = Mall

6 = PATH Train

7 = Bldg 7 or Bldg 3

99 = n/a

2. FLR - 'Floor Location at Perception of First Cue'

SPLIT COLUMN EXACT FLOOR AND CATEGORY

1 = T1 Lower (basement-42) in stairs

2 = T1 Lower (basement-42) on a floor

3 = T1 Mid (43-76) in stairs

4 = T1 Mid (43-76) on a floor

5 = T1 Upper (77-110) in stairs

6 = T1 Upper (77-110) on a floor

7 = T1 in stairs, level not specified

8 = T1 location not specified

9 = T1 mezzanine, lobby, concourse

10 = T2 Lower (basement-42) in stairs

11 = T2 Lower (basement-42) on a floor

12 = T2 Mid (43-76) in stairs

13 = T2 Mid (43-76) on a floor

14 = T2 Upper (77-110) in stairs

15 = T2 Upper (77-110) on a floor

16 = T2 in stairs, level not specified

17 = T2 location not specified

18 = T2 mezzanine, lobby, concourse

19 = Outside

22 - T1 elevator - lower floors

23 - T1 elevator - mid floors

24 - T1 elevator - upper floors

25 - T1 elevator, level not specified

99 = n/a

3. SEX - 'Sex of Evacuee'

1 = male

2 = female

99 = n/a

4. AGE_CODE - 'Age of Evacuee'

SPLIT COLUMN EXACT AGE AND CATEGORY

1 = 21-35

2 = 36-50

3 = 51-65

4 = 66 +

99 = n/a

5. DATE - 'Date of Record'

SPLIT COLUMN EXACT DATE MENTIONED

1 = Week of (09/11/2001-09/15/2001)

2 = 2 weeks after (09/16/2001-09/30/2001)

3 = 1-3 months after (10/01/2001-12/31/2001)

4 = 4-6 months after (1/01/2002-3/31/2002)

5 = 7-9 months after (4/01/2002-6/30/2002)

6 = 10-12 months after (7/01/2002-9/30/2002)

99 = n/a

6. EGRESS - 'Evacuation Method'

1 = Stairs

2 = Changed stairwells

3 = Elevator

4 = Combo of stairs and elevator

99 = n/a

7. FSTCUE - 'First Cue of Event'

COLUMN CHECKED OFF FOR EACH INITIAL CUE MENTIONED

1 = Audio (boom, crash, explosion, thunder, blast, roar, rumbling)

2 = Visual (smoke, fire, bodies, plane approaching, panicked people, debris falling)

3 = Building Movement (impact, sway, shake, earthquake, rocking, jolt)

4 = Content Movement (chairs moving, ceiling falling, bounce in elevator, debris in halls/offices, lights flickering, change in air pressure, burned by fire)

5 = Warn by others (directly told or behavior of others)

6 = Physically impacted (burned, fell, or thrown out of chair)

7 = Smelled fumes or felt heat

99 = n/a

8. ALRM – Heard Alarm

1 = Yes, heard alarm

2 = Heard alarm on floor

3 = Heard alarm in stairs

4 = 'I did not hear an alarm'

99 = n/a

9. STTIME - 'Time to Start Evacuation'

1 = Immediately (ran, right away, rapidly): 1 minute

2 = Shortly after (short delay, picked up belongings, warn others): up to 5 minutes after

3 = Delayed (gathered belongings, look out window, make phone calls, watch TV, kept working, checked security, planned with coworkers, shut equip off, Post T2 Impact)

4 = Stayed (to help: headcount, direct people, assisted coworkers, waited to be rescued/given instructions; went up)

5 = Stuck (behind debris, walls, in elevator)

99 = n/a

10. CNDFL - 'Condition on Floor When Building was Hit'

1 = Devastated (combo of debris, fire, walls collapsed, ceiling/lights down, darkness, water/sprinklers, smoke, jet fuel, glass, bodies)

2 = Abnormal (some smoke, heat, smell fuel, power out, dusty, debris past windows, some reason for alarm/evacuation)

3 = Normal (usual working conditions)

99 = n/a (incl. not on floor when building was hit)

11. CNDFL – 'Condition on Floor'

COLUNM CHECKED OFF FOR EACH CONDITION MENTIONED.

1 = Normal

2 = Door Jammed

3 = Debris – Wall, ceiling collapsed

4 = Smoke

5 = Dust

6 = No power – dark

7 = Smell

8 = Water

9 = Fire

10 = Crowd, injuries

11 = Trapped

12 = Not on a floor

99 = n/a

12. STRS - 'Condition in Stairwell During Evacuation'

COLUMN CHECKED OFF FOR EACH CONDITION MENTIONED.

1 = Normal

2 = Door locked, jammed

3 = Crowd, hot

4 = No power

5 = Water

6 = Cracked wall

7 = Debris

8 = Smoky, smelly

99 = n/a

13. ANCHRD - 'Heard Announcement'

1 = T1 Yes

2 = T1 No (mentioned specifically not hearing message)

3 = T2 Yes

4 = T2 No (mentioned specifically not hearing message)

99 = n/a

14. ANCACT - 'Action After Hearing T2 Announcement'

1 = Continued evacuating

2 = Continued evacuating saw some returned

3 = Returned to office/Stay on location

99 = n/a

15. ANCFLR - 'Location when T2 Announcement Heard'

10 = T2 Lower (basement-42) in stairs

11 = T2 Lower (basement-42) on a floor

12 = T2 Mid (43-76) in stairs

13 = T2 Mid (43-76) on a floor

14 = T2 Upper (77-110) in stairs

15 = T2 Upper (77-110) on a floor

16 = T2 in Stairs not specified

17 = T2 Location not specified

18 = T2 mezzanine, lobby, concourse

19 = Outside

20 = T2 in Elevator

99 = n/a

16. LT2IMP - 'Location at T2 Impact'

1 = T1 Lower (basement-42) in stairs

2 = T1 Lower (basement-42) on a floor

3 = T1 Mid (43-76) in stairs

4 = T1 Mid (43-76) on a floor

5 = T1 Upper (77-110) in stairs

6 = T1 Upper (77-110) on a floor

7 = T1 in stairs, level not specified

8 = T1 location not specified (incl. Inside elevator)

9 = T1 mezzanine, lobby, concourse

10 = T2 Lower (basement-42) in stairs

11 = T2 Lower (basement-42) on a floor

12 = T2 Mid (43-76) in stairs

13 = T2 Mid (43-76) on a floor

14 = T2 Upper (77-110) in stairs

15 = T2 Upper (77-110) on a floor

16 = T2 in stairs, level not specified

17 = T2 location not specified (incl. Inside elevator)

18 = T2 mezzanine, lobby, concourse

19 = Outside

99 = n/a

17. LT2COL - 'Location at T2 Collapse'

1 = T1 Lower (basement-42) in stairs

2 = T1 Lower (basement-42) on a floor

3 = T1 Mid (43-76) in stairs

4 = T1 Mid (43-76) on a floor

5 = T1 Upper (77-110) in stairs

6 = T1 Upper (77-110) on a floor

7 = T1 in Stairs not specified

8 = T1 in Elevator

9 = T1 mezzanine, lobby, concourse

10 = T2 mezzanine, lobby, concourse

11 = T2 Lower (basement-42) in stairs

12 = Outside

13 = Other WTC building

14 = Subway

99 = n/a

18. LT1COL - 'Location at T1 Collapse'

1 = Lower T1 (basement-43) stairs

2 = T1 mezzanine, lobby, concourse

3 = Outside

99 = n/a

19. LFFS - 'Location When Met Firefighters'

1 = T1 Lower (basement-42) in stairs

2 = T1 Lower (basement-42) on a floor

3 = T1 Mid (43-76) in stairs

4 = T1 Mid (43-76) on a floor

5 = T1 Upper (77-110) in stairs

6 = T1 Upper (77-110) on a floor

7 = T1 in stairs, level not specified

8 = T1 location not specified

9 = T1 mezzanine, lobby, concourse

10 = T2 Lower (basement-42) in stairs

11 = T2 Lower (basement-42) on a floor

12 = T2 Mid (43-76) in stairs

13 = T2 Mid (43-76) on a floor

14 = T2 Upper (77-110) in stairs

15 = T2 Upper (77-110) on a floor

16 = T2 in stairs, level not specified

17 = T2 location not specified

18 = T2 mezzanine, lobby, concourse

19 = Outside

99 = n/a

20. HELP - 'Who Helped Evacuee during Evacuation'

COLUMN CHECKED OFF FOR EACH HELPER MENTIONED

1 = Firefighter

2 = Port Authority (building staff/security)

3 = External Official (police, Federal Bureau of Investigation, emergency medical team, rescue workers)

4 = Coworkers

5 = Passed Firefighters in Stairs

99 = n/a

21. DSBLD - 'Evacuee Disability and Injury'

1 = Visual impairment

2 = Hearing impairment

3 = Physically challenged (obese, asthma, heart condition)

4 = Wheelchair user

5 = Injured during event (burned, sprained ankle, broken bones, emotional trauma)

6 = Helped disabled (during the evacuation)

7 = Saw disabled (during the evacuation)

8 = Helped injured

9 = Saw injured

99 = n/a

22. B1993 - '1993 WTC Bombing Presence'

1 = Yes

2 = Yes, prepared since (evacuation packs)

3 = Yes, reason evacuated early

4 = Yes, reason stayed

5 = No

6 = 1993 bombing in the back of their mind but were probably not there at the time

99 = n/a

23. DELAY - 'Reason for Delay in Evacuation'

1 = Decide to stay

2 = Activity to complete before leaving (search floor, secure document, made calls, instruct others)

3 = Went Up/Return

4 = Stuck or trapped

5 = Help others, disabled or injured/Being helped

6 = Told to stay

99 = n/a

24. LPHONE - 'Location when Evacuee Made Phone Call'

1 = Office

2 = Other floor

3 = Stairs

4 = Outside

5 = Multiple locations

99 = n/a

25. WPHONE - 'Recipient of Evacuee Phone Call'

COLUMN CHECKED OFF FOR EACH GROUP MENTIONED

1 = Family and friends (spouse, parents, home)

2 = Colleague or boss

3 = Authorities (building security, 9-1-1)

99 = n/a

26. REST - 'Rest during Evacuation'

1 = T1 Lower (basement-42) in stairs

2 = T1 Lower (basement-42) on a floor

3 = T1 Mid (43-76) in stairs

4 = T1 Mid (43-76) on a floor

5 = T1 Upper (77-110) in stairs

6 = T1 Upper (77-110) on a floor

7 = T1 in stairs, level not specified

8 = T1 location not specified

9 = T1 mezzanine, lobby, concourse

10 = T2 Lower (basement-42) in stairs

11 = T2 Lower (basement-42) on a floor

12 = T2 Mid (43-76) in stairs

13 = T2 Mid (43-76) on a floor

14 = T2 Upper (77-110) in stairs

15 = T2 Upper (77-110) on a floor

16 = T2 in stairs, level not specified

17 = T2 location not specified

18 = T2 mezzanine, lobby, concourse

19 = Outside

99 = n/a

27. OBSTCN - 'Obstructions Encountered During Evacuation'

COLUMN CHECKED OFF FOR EACH OBSTRUCTION MENTIONED

1 = Door Jam (locked or jammed)

2 = Debris (wall falling, floor collapse, material damaged)

3 = Smoke

4 = No power

5 = Smell (of fuel)

6 = Water

7 = Fire

8 = Crowd, disabled, injured

9 = Trapped by building rubble

99 = n/a

28. TMOUT - 'Time Evacuee Exited Building'

1 = T1: 8:48-9:02

2 = T1: 9:03-9:30

3 = T1: 9:31-9:58

4 = T1: 9:59-10:27

5 = T1/T2: 10:28+

6 = T2: 8:48-9:02

7 = T2: 9:03-9:30

8 = T2: 9:31-9:58

99 = n/a

29. KNWSIT - 'Evacuee's Knowledge of the Situation in the Initial Moment'

1 = High (terrorism/plane attack/ T2 collapsed/saw plane approaching/hitting building)

2 = Moderate (fire/bomb/earth quake/serious emergency/speculated plane/rumors)

3 = Low (reason for evacuation unknown or limited)

99 = n/a

30. SRSNSS - 'Level of Seriousness to Themselves in the Initial Moment'

1 = Very serious (fear, scared, want to get out ASAP)

2 = Somewhat serious (worried, did not know what was happening)

3 = Not serious (not concerned)

99 = n/a

31. SOINFL - 'Social Influence on Evacuee's Decisions'

1 = Authority figure (boss, supervisor, manager)

2 = Coworkers/Group influence

3 = Survivor took leadership role

4 = Boss and group influence

99 = n/a

32. TCINFL - 'Technological Influence on Knowledge during Evacuation'

1 = Cell phone

2 = Blackberry, Text pager (deaf)

3 = TV, radio

4 = Walkie Talkie

99 = n/a

33. PERCEP - 'Perception of Others During Evacuation'

COLUMN CHECKED OFF FOR EACH PERCEPTION MENTIONED

1 = Calm/Orderly (civil, supportive, chatty, composed)

2 = Momentarily Panicked (running, pushing, shoving)

3 = Upset (crying, shouting, fearful, anxious)

4 = Helpful (assisting others)

99 = n/a

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