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## Collective Common Sense:

# A Study of Human Behavior During the World Trade Center Evacuation

*Results from this study will help us document engineering details that affected behavior during this incident, improve fire safety in similar occupancies, and develop more effective emergency evacuation models.*

**S**hortly after noon on February 26, 1993, more than 100,000 people were evacuated from the World Trade Center plaza in New York City after a bomb exploded in a subterranean garage. Six employees died in the explosion, and more than 1,000 people were treated for injuries they suffered during the explosion and the evacuation. In addition, the explosion and subsequent fire caused extensive structural damage to several basement levels.

The fire itself was confined to the garage and involved 25 to 30 vehicles parked near

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the explosion site. However, smoke from the fire and the bomb, as well as structural dust, spread up the elevator shafts and migrated to upper floors. Few in the twin towers heard any alarms, and without cues from the disabled emergency system, many had to decide for themselves how to escape from the smoky buildings.

The World Trade Center is a complex of seven buildings, six of them situated on the plaza. Twin 110-story office towers are joined at sidewalk level by a 22-story hotel. The other three buildings on the plaza are 6 and 8 stories tall.

Approximately 40,000 people work in each tower, and an estimated 50,000 visit the two towers during the course of a normal business day. Both towers, as well as the other buildings on the plaza, were evacuated on the day of the explosion. The seventh building, located across the street, was not affected by the explosion or the smoke spread.

Preliminary results from this study, funded by the National Institute of Standards and Technology, the General Services Administration, the NFPA, and the National Research Council of Canada, concern only the people who were evacuated

from the two towers, from floors 11 and above. Analyses of other occupants' behavior will be conducted later.

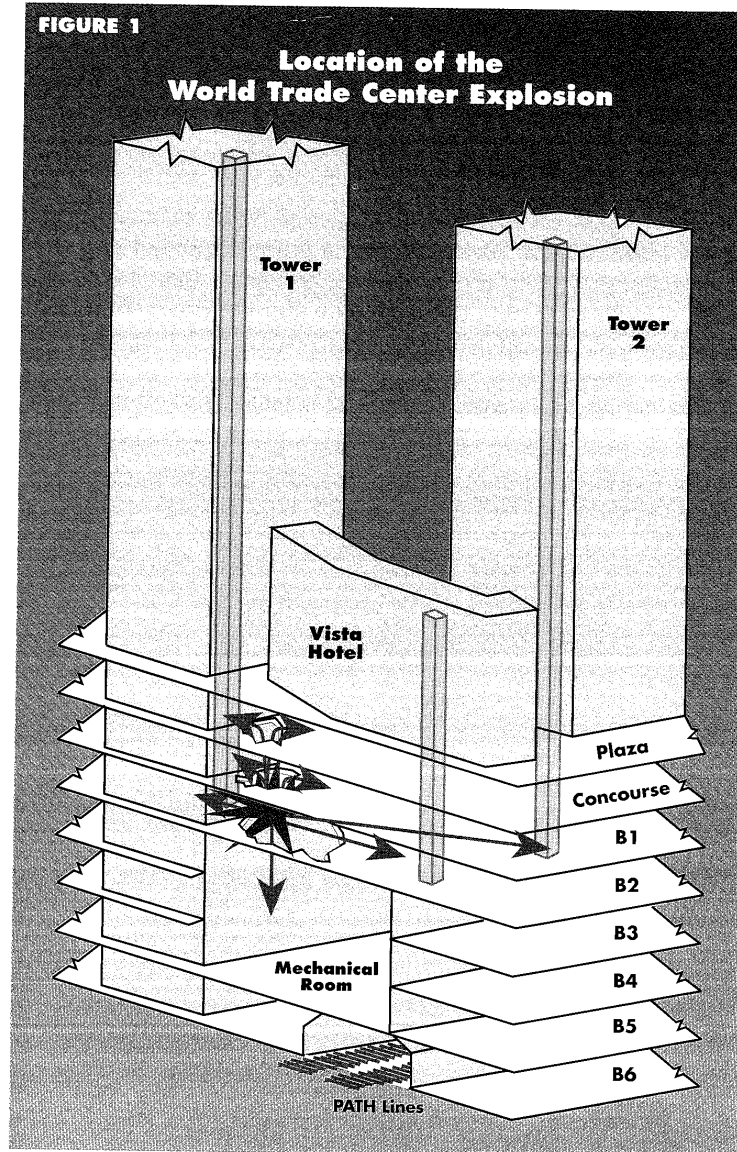
Human behavior data gathered from this project will help us generalize from individual experiences in order to better understand what people do in fires and how their actions conform to the assumptions used in planning for life safety in large buildings. This study is designed to document, to the extent possible, engineering details that affected behavior, such as building design, fire safety features, and smoke spread. The results will help us work toward improving fire safety in similar occupancies and develop more effective emergency evacuation models. The information elicited will also complement the technical investigation conducted by the NFPA and will contribute to the body of knowledge used for modeling evacuations of high-rise buildings worldwide.<sup>1</sup>

### Study design

The Port Authority of New York and New Jersey, which owns and operates the World Trade Center complex, implements a fire safety training program that requires every tenant to appoint a fire warden trained in building evacuation. Each tenant is supposed to conduct at least two fire drills a year. Any tenant holding space on more than one floor must appoint a fire warden for each floor. Twenty-five fire safety directors coordinate the fire wardens' activities, and these directors are, in turn, supervised by two Port Authority employees.

We surveyed only the fire wardens of the 1,200 tenants in the complex for a sample that covered every occupied floor and was a manageable size—a total of 1,598 people. Although the fire wardens represented less than 1 person in 50 of those in the building, we felt that their special training gave them a context for describing what happened, giving us a comprehensive and valid basis for analysis. Since it would have been prohibitively expensive, both in terms of time and staff, to survey the tens of thousands of people who evacuated the complex that day, we contacted only this subset of the population. Special characteristics of the buildings' population make this decision technically appropriate, as well as financially feasible.

This study was based on a design originally developed by Dr. John Bryan of the University of Maryland. His model was first used for Project People in the 1970s. The NFPA has enhanced Bryan's design and applied it to studies of several fires over the years, including investigations of the fires at the Beverly Hills Supper Club, the MGM Grand Hotel, and the Westchase Hilton Hotel. NFPA used this method most recently to study the



Westin Hotel fire in Boston on January 2, 1984.

For the World Trade Center study, we designed a structured questionnaire and mailed it to the 1,598 fire wardens, assistant fire wardens, and designated searchers and rescuers identified by the Port Authority of New York and New Jersey. To encourage cooperation, we promised strict confidentiality.

#### Survey response

A total of 419 surveys were returned, and 406—or 25.4 percent of those sent out—were usable. The other 13 were returned by people who had not been in the complex on the day of the explosion because they were away on vacation, out on maternity leave, off-site for lunch, or out for another reason. The respondents ranged from 22 to 70 years old and included 199 women and 197 men.

The 406 usable survey responses included 229 occupants of Tower 1; 163 occupants of Tower 2; 7 occupants from the concourse levels; 1 each from the Vista Hotel, the World Financial Center, and 5 World Trade Center; and 4 who didn't report their locations. Four of the occupants of Tower 1 and six of the occupants of Tower 2 were at subgrade, concourse, or lobby levels in the buildings or in an elevator.

In the cover letter we mailed with the survey, we asked floor wardens who were not in the building at the time of the incident to pass the survey on to a colleague who had been present. Unfortunately, the survey didn't ask whether respondents were part of the fire safety team, but it seems clear from some of the responses that we did, in fact, receive surveys from people who were not.

Preliminary studies were based on the 382 occupants who were in the two towers—that is, those who were on floors 11 and above—who make up 23.9 percent of the surveys sent. There were 225 such respondents from Tower 1 and 157 from Tower 2. The following analyses do not

TABLE 1

#### How did you first become aware that there was something unusual occurring in the building?

	Tower 1	Tower 2
Heard or felt the explosion	38%	27%
Lost power or phone or noticed lights flicker	5	11
Saw or smelled smoke	4	6
Was told	5	3
Heard explosion and lost power	27	30
Heard explosion, lost power, and saw or smelled smoke	6	5
Heard explosion and saw or smelled smoke or dust	11	7
Heard explosion, with or without another cue	84%	74%
Lost power, with or without another cue	40%	53%

TABLE 2

#### How serious did you believe the situation was at first?

	Tower 1	Tower 2
Not at all serious	7%	14%
Only slightly serious	26	30
Moderately serious	39	38
Extremely serious	28	18

include the 24 respondents who were on the concourse or lobby levels of the two towers or in other buildings in the complex. These returns have been set aside and will be analyzed later.

As shown in Figure 1, the bomb was placed closer to Tower 1 than Tower 2, and responses to many of the questions reflect this difference. The following analyses highlight results that we found statistically significant.

#### How people became aware of the situation

Occupants were asked how they first became aware that something unusual was happening (see Table 1). Respondents mentioned hearing or feeling the explosion, losing lights or telephones, noticing smoke or dust, hearing sirens and alarms, getting information from others, and seeing other people evacuating the area.

Of the respondents in Tower 1, 84 percent reported that they were alerted by the explosion, with or without another cue, compared to 74 percent in Tower 2. Looking at the responses in another way, 53 percent of the respondents in Tower 2 reported that they became aware of the incident by a loss of power, with or without another cue, compared to 40 percent of the occupants of Tower 1. These responses are not mutually exclusive,

since the explosion and loss of power were mentioned in combination by many of the respondents—35 percent in Tower 1 and 38 percent in Tower 2. In both of these analyses, the difference in response was significant.

Occupants were asked how they realized that what was occurring was a fire or an explosion. Responses were similar to those for the previous question, again either a single cue or a combination of cues, but most people mentioned noticing the explosion or smoke. Of the respondents in Tower 1, 69 percent reported that the explosion and smoke made them

aware that a fire or an explosion had occurred, compared to 57 percent of the respondents in Tower 2. Again, we found this difference statistically significant.

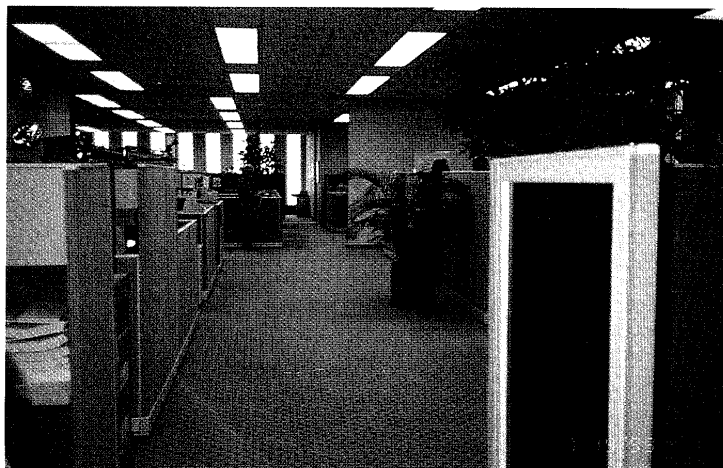
#### Perception of seriousness

The occupants of Tower 1 were more likely to consider the incident very serious than the occupants of Tower 2, a statistically significant difference in perception (see Table 2). We tested for the possibility that differences in age or gender distribution between the two buildings might explain the discrepancy, and we found that neither influenced the results. Perception of severity didn't differ significantly by floor within the towers, either.

Within each tower, we checked responses to see if the perception of severity differed significantly depending on how people became aware of the situation. For Tower 1, respondents' perception of severity didn't differ significantly, whether they were alerted to the situation by the explosion or by the power loss. In contrast, Tower 2 respondents were significantly more likely to believe that the situation was extremely serious if they were alerted to it by the explosion rather than the power loss.

#### Attempts to communicate

Respondents were asked if they called or tried to call the fire department (see



**Each floor of the two towers measures approximately 1 acre. The floors are column-free to assure maximum layout flexibility.**

Table 3). Of the 222 respondents from Tower 1 who answered the question, 195—or 88 percent—didn't call the fire department, and 27 others—or 12 percent—called the fire department, the complex's emergency telephone number, or 911.

Of the 195 people from Tower 1 who didn't call, 21 gave reasons. Six said that the telephone system was down; six said that someone else called, would have called, or should have called; three said that the fire department already knew, or was already there; three said that they didn't know what was happening; two said they were in contact with Port Authority personnel, who knew; and one replied that he didn't call the authorities because his primary concern was for his fellow employees.

Fourteen of the 27 people in Tower 1 who called or tried to call the fire department commented. Seven said that the telephones were down, three said there was no answer, one said the fire department already knew, one said the alarm had already been pulled, one said there was no power at the box, and one said the emergency phone in the stairway was locked.

Of the 156 respondents in Tower 2 who answered the question, 123—or 79 percent—didn't call the fire department, and 33 others—or 21 percent—called the fire department or the emergency number.

Thirty-one of the 123 people in Tower 2 who didn't call gave reasons. Nine said the fire department already knew, eight said someone else called, five said the telephone system was down, three said

who called or tried to call the fire department commented. Four said there was no answer, four said the lines were busy, two said the telephones were down, and one said he wanted to let the fire department know where he and his fellow workers were.

Respondents were asked if they operated or tried to operate a manual pull station. Of the 222 respondents from Tower 1 who answered the question, 185—or 83 percent—didn't, and 37—or 17 percent—did.

Fourteen of the 185 people who didn't pull or attempt to pull a manual pull station, gave reasons. Five said someone else already had or should have, two said they didn't know where it was or couldn't see it, two said everyone already knew, and two others said they didn't know what was happening, one said there was no power and the pull station didn't work, one said the fire department was already there, and one said she just wanted to get out.

Fifteen of the 37 people who did or tried to operate the pull station said there was no power and it didn't work. Six said there was no answer, one pulled the alarm while trying to contact the Port Authority, one pulled the alarm shortly after smoke became visible, and one said she didn't expect it to work but no one else had tried.

Of the 152 respondents from Tower 2 who answered the question, 116—or 76

percent—didn't operate or attempt to operate a manual pull station, and 36—or 24 percent—did. Sixteen of the 116 who didn't gave reasons. Five said someone else already had or should have, five said the fire department was already there, two said there was no power and it didn't work, two said everyone already knew, one said she didn't know enough about what was happening to consider it, and one said that pulling the alarm

would have caused a panic. Of those who operated or tried to operate the pull station, six said there was no power, five said there was no answer, and one said there was no tool to break the glass.

Respondents were asked if they called or tried to call the switchboard (see

**TABLE 3**

### Did you try to call anyone?

Did you try to call the fire department?	Tower 1	Tower 2
No	88%	79%
Yes	12	21
<b>Did you try to pull the fire alarm?</b>		
No	83%	76%
Yes	17	24
<b>Did you try to call the switchboard?</b>		
No	78%	80%
Yes	22	20
<b>Did you try to call friends or relatives?</b>		
No	62%	40%
Yes	35	58

they were in contact with Port Authority personnel, two said there was no telephone in the area, two said they didn't know what was happening, one said the alarm had been pulled, and one said staff had been instructed not to call.

Eleven of the 33 people in Tower 2

Table 3). Of the 222 respondents from Tower 1 who answered the question, 174—or 78 percent—didn't call the switchboard and 48 others—or 22 percent—called the switchboard, building services, or an emergency number.

Thirty-two of the 174 who didn't call gave reasons. Six said the phones were down, five said everyone knew about the situation, five said someone else called, four were at receptionists' stations, three just left, two didn't know what had happened, two said there was no switchboard to call, and one each reported that there was no telephone in the area, that he or she could not see the phone, that it was not the procedure, that they were waiting for instructions, and that the receptionist was out to lunch.

Sixteen of the 48 people who called or tried to call commented. Seven said the phones were out, four said there was no answer, two said the line was busy, one started to call but then realized that everyone was in the same predicament, one called the company switchboard outside the building to notify the operators that the power was off, and one said the receptionist was at lunch.

Of the 156 respondents from Tower 2 who answered the question, 124—or 80 percent—didn't call the switchboard, and 32 others—or 20 percent—called the switchboard, building services, or an emergency number. Thirty-six of the 124 who didn't call gave reasons. Ten said the phones were down, eight said someone else called, four said everyone knew about the situation, three were at receptionists' stations, three said there was no switchboard, two said there was no phone in the area, two said it was not the procedure, two didn't know what was happening, one said everyone was calling him, and one just left.

Six of the 32 respondents who called

**TABLE 4**

**Did you hear the fire alarm?**

	<b>Tower 1</b>	<b>Tower 2</b>
No	96%	95%
Yes	3	4
Don't remember	1	1

**TABLE 5**

**Did you move through smoke?**

	<b>Tower 1</b>	<b>Tower 2</b>
Yes	94%	70%
No	6	30

or tried to call said there was no answer, three said the phones were out, two said the line was busy, two said they didn't know what had happened, one found the security guard gone and the office locked, one tried to inform his company (off-site) of the problem, and one called and was told it was a transformer explosion.

A higher percentage of respondents from Tower 2 called friends or family than from Tower 1, possibly because the fire cues in Tower 2 were less clear and long delays before evacuation gave people in Tower 2 more time to call (see Table 3). Of the 223 respondents from Tower 1 who answered the question, 138—or 61 percent—said they didn't call friends or family, 78 people—or 35 percent—said they did call, and another 7—or 3 percent—said they called after they left the building.

Sixty-two of the 78 who made calls called people outside the building, 11

called people inside the building, and 3 called people both inside and out.

Of the 156 respondents from Tower 2 who answered the question, 62—or 40 percent—didn't call friends or family, 91 people—or 58 percent—did call, and another 3—or 2 percent—said they called after they left the building. Seventy-nine of the 91 people who made calls called people outside the building, while 4 called people inside the building, and another 4 called people inside and out.

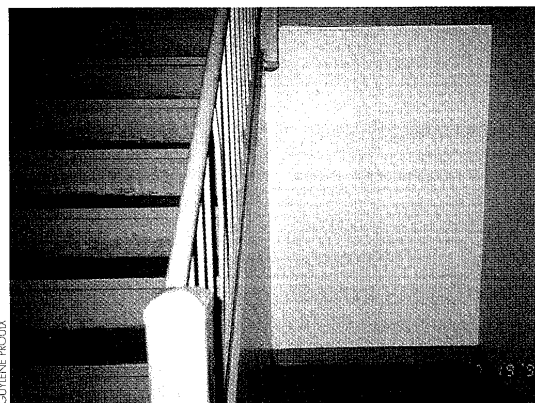
The survey asked respondents if they had heard the building fire alarms (see Table 4). Due to the severe damage to the emergency systems in the explosion, it is not surprising that 96 percent of all occupants in Tower 1 and 95 percent in Tower 2 said they didn't. Those who reported that they did hear an alarm may have been reporting local alarms, including door alarms. Most who reported a time when they heard the alarm gave times at, or almost immediately after, the explosion. Alarm durations ranged from 5 minutes to continuous.

**The evacuation**

Respondents were asked if they moved through smoke, and if they had, how far they moved, how far could they see, and whether they turned back (see Table 5). The responses to the distance questions were subjective, and it often wasn't clear if the respondent was referring to horizontal travel distance on the office floor or to vertical distance in the stairs. For the question about how far they could see, the responses often had as much to do with the darkness as with the smoke.

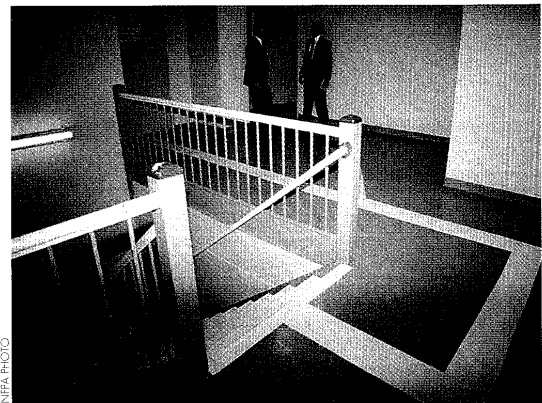
Almost all the respondents in Tower 1—94 percent—and more than two-thirds of the respondents in Tower 2—70 percent—reported that they tried to move through smoke. This difference is statistically significant. Almost half of the

**At crossover points in some of the stairwells, evacuees walked into blank walls and were forced to feel their way along exit paths.**



GUYEN PROUX

**Since the 1993 incident, exit paths in the stairwells have been marked for safety with phosphorescent paint.**



NFPA PHOTO

respondents in each tower who said they moved through smoke said they did so all the way out of the building. The proportion is probably even higher, since those who specified a distance or a number of floors may have been describing their entire travel path out of the building.

Of those who moved through smoke, more than three-quarters turned back. The difference between the two towers was not statistically significant. The most frequent reason given for turning back was the smoke. Other reasons included the crowd, locked doors, difficulty breathing, not being able to see, and being afraid.

Respondents were asked if they left or

attempted to leave voluntarily, or without being told to do so. If they didn't leave voluntarily, they were asked why not. If they did, they were asked at what

still others said they didn't know there was a problem. Some occupants said they stayed behind to make sure that others left safely, and some people cited

time they left (see Tables 6 and 7). Two-thirds of the respondents in Tower 1—66 percent—and almost half of the respondents in Tower 2—46 percent—left without being told to do so. An additional 8 percent in Tower 1 and 11 percent in Tower 2 tried to leave. The difference in responses between the two towers is statistically significant.

People who didn't leave voluntarily had several reasons for staying behind. Some said they were waiting for information or instructions, others felt it was better to wait or were told to wait, and

**TABLE 6**

**Did you leave voluntarily?**

	Tower 1		Tower 2		Total	
Yes, left	147	65.9%	71	45.5%	218	57.5%
Yes, attempted to	18	8.1	17	10.9	35	9.2
No	58	26.0	68	43.6	126	33.2
<b>Total</b>	<b>223</b>		<b>156</b>		<b>379</b>	

**TABLE 7**

**Reasons given for not leaving voluntarily**

	Tower 1	Tower 2
Were waiting for information or instructions	26	22
Decided it was better to wait or were told to wait	12	16
Didn't know there was a problem	6	10
Were making sure others left	9	5
Had health problems	3	3
Decided there was too much smoke	1	5
Were waiting for better conditions	1	3
Were waiting for the fire department, as instructed	0	1
<b>Total</b>	<b>58</b>	<b>65</b>

**The Worst Part Was the Fear of the Unknown**  
by Valerie Hershfield

**W**hen a terrorist bomb exploded beneath one of New York City's World Trade Center towers, thousands were trapped as smoke billowed up stairwells and into office spaces. In the long wait following the explosion and eventual evacuation, occupants were forced to cope with a situation for which they were not prepared.

According to Nelson Chanfrau, general manager of risk management for the Port Authority at the World Trade Center, a power outage complicated the evacuation of approximately 40,000 people who were anxious to escape from the towers.

"The blast knocked out all our fire protection systems," Chanfrau said. "We have six generators that provide emergency lighting for the complex. The blast severed the cooling systems for the generators. The generators ran for only about 12 minutes before they overheated and shut down."

The lights went out as hundreds of emergency vehicles congregated below.

Although there was no power in the buildings, there were some working telephones and a few floors had battery-powered radios and walkie-talkies.

**Initial responses**

Mary Ellen Kane, a corporate counselor for a company occupying three floors of one of the towers, met with many of the company's 273 building employees following the terrorist attack.

"These are people who sit at desks for a living," Kane said. "They don't expect to face life and death situations the way fire fighters or police officers do. Those professionals are trained in facing trauma. Our employees don't have the benefit of that training."

"The worst part of people's experience was their fear of the unknown. They all knew something terrible had happened, but the human mind goes into denial. People thought, 'this can't be real,' so they minimized what they were experiencing," Kane said.

"I was in a meeting with the staff,"

said Tom Hurlbut, division operations manager for Kemper National Insurance Companies. "I thought a plane had hit the building. Some thought it was a blown transformer. I looked up South Broadway, and the magnitude of the emergency services told us it was not a transformer."

Linda Kitowski, a support supervisor in one of the towers, remembers that the lights on her floor flickered and smoke began to fill the other side of the office.

"Even though I could see the smoke, my first thought was that Con Edison was doing some work on the power lines," Kitowski said.

"Another employee saw the explosion from across the street and thought they were making a movie," Kane said. "The tendency of the victims to deny that an emergency was unfolding conflicted with their next typical reaction, which was to switch to survival mode."

One woman called her family to assure them that "everything was okay, then followed the reassurance with a plea that

health reasons for staying. Other respondents said that there was too much smoke, they were waiting for better conditions, or they were waiting for the fire department, as instructed.

We compared the times the respondents said they became aware that something unusual had occurred with the times they gave for leaving. Then we compared the times they gave for leaving with times they gave for becoming aware that there had been a fire or explosion (see Table 8).

For Tower 1, the times from awareness of the event to leaving the building ranged from 0 to 4 hours 5 minutes, with a mean—or average—time of 15.3 minutes and a median—or midpoint—

**TABLE 8**

**Comparison of elapsed time between awareness of event, awareness of fire, and beginning evacuation**

Delay times to leave the building	Tower 1	Tower 2
<i>Time from awareness of event to leaving:</i>		
<b>Range</b>	0–4 hrs 5 min	0–3 hrs 27 min
<b>Mean</b>	15.3 min	34.7 min
<b>Median</b>	10 min	15 min
<i>Time from awareness of fire or explosion to leaving:</i>		
<b>Range</b>	0–4 hrs 5 min	0–3 hrs 5 min
<b>Mean</b>	11.3 min	25.4 min
<b>Median</b>	5 min	10 min
<b>Delay times for those who attempted to leave the building</b>		
<i>Time from awareness of event to attempt to leave:</i>		
<b>Range</b>	2–30 min	10 min–4 hrs 14 min
<b>Mean</b>	8.9 min	39.9 min
<b>Median</b>	8 min	25 min

time of 10 minutes. For Tower 2, the times ranged from 0 to 3 hours 27 minutes, with a mean time of 34.7 minutes

and a median time of 15 minutes. This difference was statistically significant.

Similarly, for Tower 1, the times from awareness of a fire or explosion to leaving ranged from 0 to 4 hours 5 minutes, with a mean time of 11.3 minutes, and a median time of 5 minutes. For Tower 2, the times ranged from 0 to 3 hours 5 minutes, with a mean time of 25.4 minutes and a median time of 10 minutes. This difference was also statistically significant.

For those who tried to, but didn't, leave the building, the differences between the time they reported becoming aware of something unusual to the time they reported attempting to leave were statistically significant, as

her mother take care of her daughter if anything should happen to her."

"Clearly there was distress; some were crying," Hurlbut said. "Interestingly, I have never seen so much peer group support for one another. People consoled and comforted people who needed to be comforted. So much happened spontaneously. It was heavily skewed to the positive."

Kitowski said that when she began to hyperventilate as smoke filtered toward her side of the office, she was quickly comforted by a co-worker.

André Guibord, a tourist from Hull, Québec, was visiting the 107th-floor World Trade Center observation deck when the bomb exploded.

"We were completely out of touch," Guibord said. "We could see that all of the vital functions of the building had stopped functioning. Some officials had walkie-talkies, but we could only hear screams and garbled orders being given. There were a lot of screams."

Guibord reflected on his first impressions of the event. "We didn't panic, but we felt we were captive. We felt unsafe going down the stairs and elevators, of course. There was a lot of smoke coming up. Our biggest fear was asphyxiation." He said that even when the screaming stopped, "you could feel the tension."

**Switching to survival mode**

Once everyone had registered that there was a crisis, their reactions depended upon their experience, according to Kane.

"In survival mode," Kane said, "all of the senses are heightened, and the adrenaline takes over."

"It was quite frightening at first because no one seemed to be in charge and everyone was looking for a leader," Guibord said. "I took the initiative and began to look for evacuation routes. I would not call myself a hero; we were just trying to save our skins."

"The smoke was beginning to hurt

our eyes and breathing was difficult. Our greatest concern was fresh air," Guibord said. "At first we thought of breaking a window, but we had no way to break the safety glass. We looked for tools, but none were visible. Even the furniture was anchored, like at McDonalds. We would probably have been asphyxiated."

"There were a couple of people who seemed to be in authority, but no one had the key to the rooftop terrace door, which was locked. When we forced open the door to the roof, we saw there were actually three flights of stairs, which was a problem because there were a lot of elderly and physically and mentally handicapped people who needed help. There was one tour guide—I think his name was Tom—probably a retired person, who helped get everyone on the roof and later led everyone down 110 flights of stairs."

During Kane's 17 debriefing sessions with the bombing victims, she stressed that everyone is different and that no re-



well. For Tower 1, the times ranged from 2 to 30 minutes, with a mean time of 8.9 minutes and a median time of 8 minutes. For Tower 2, the times ranged from 10 minutes to 4 hours 14 minutes, with a mean time of 39.9 minutes and a median time of 25 minutes. These time differences were not statistically significant.

Respondents were also asked how long it took them to leave the building (see Table 9). The purpose of this question was to collect evacuation times that could be used to test, or validate, evacuation models. Unfortunately, many of the respondents included time they spent resting or waiting in areas of refuge in their total travel time, but we were frequently able to extract the actual time spent leaving. Accordingly, more than 70 percent of the respondents in Tower 2 said they left the building in an hour or less, compared to 40 percent of the respondents in Tower 1. Fifty-two percent of the respondents in Tower 1 reported that it took them 1 to 3 hours to leave the building. A significantly higher percent-

**TABLE 9**

### How long did it take you to leave the building?

	Tower 1	Tower 2
Less than 5 minutes	1%	1%
5 to 30 minutes	13	23
30 minutes to 1 hour	26	47
1 to 3 hours	52	28
Over 3 hours	9	1

age of respondents in Tower 2 evacuated in less time than respondents from Tower 1 because many delayed their evacuation until told to leave by the fire department, when conditions in the stairs had improved and more lighting was provided, making stairway travel easier and faster.

#### Previous experience with fire alarms

Respondents were asked if they were aware of previous fire alarms in the building. If so, how many had there been in the past year? Did they evacuate the building or move to another floor during these alarms?

Many of the respondents who said they had been aware of fire alarms in the building specified that the alarms

were fire drills. Others who simply checked off "yes" may have meant the same thing. Since the occupants' actions should have been the same whether the alarm was due to an actual incident or a drill, these responses can be looked at altogether (see Table 10).

Most of the respondents in both towers never left the building or the floor when alarms went off or drills were held. More than 90 percent of the respondents in Tower 2 never evacuated the building and never moved to another floor. In Tower 1, 79 percent of the respondents never moved to another floor, and 88 percent never evacuated. These results help explain why many respondents were unfamiliar with the stairs, in spite of the fact that most of the occupants who responded to the survey were fire wardens.

#### What we can learn

Respondents reported that they were trained only to meet in the corridor and wait for instructions. According to one

### The Worst Part Was the Fear of the Unknown (continued)

action to a traumatic situation is wrong.

"Imaginations ran wild. Some people were afraid to open the doors to the stairwells, thinking bodies would be piled at the other side of the door," Kane said. Most of the people she interviewed told her that they believed they would not survive the incident.

"One of those trapped in the building was ashamed to admit that she became territorial when she saw a group of people approaching her part of the building after smoke had forced them out of their own area," Kane said. "She said, 'I realized that I didn't want them over here taking my air. These were my co-workers and friends, and I was willing to abandon their survival needs for my own.'"

"In traumatic situations, we don't always act as positively as we would like to think, but everyone involved was courageous," Kane said.

Some of the bravest people were the children who were visiting the observation deck when the bombing occurred.

"They were really well-behaved," Gui-

bord said. "Their teachers had them sing songs and kept them stomping around, probably to keep them warm. It was snowing and quite windy and cold."

#### Cooperation

Five hours later, many people were still just beginning to walk down as many as 110 flights of stairs to leave the building.

"When we walked down the stairs, we had to have one hand on the guy's shoulder in front of us," Guibord said. "It was terrifying walking in the dark. Some people were lighting matches and lighters. After 20 floors, we were confronted with a cement wall, for fire prevention, I guess. Someone lit a cigarette and created such a fuss. The smoke from the cigarette sent everyone into a panic. I was several flights above the smoker, and I could hear people screaming at him."

Kitowski echoed Guibord's reaction to their rescue.

"We were the last to be led out of the building," she said, "so most of the

smoke had cleared by the time we left. The scariest part was finding our way down the stairs in the dark, since electricity had still not been turned on. The only guide I had was the shoulder of the person in front of me."

As frightened as the evacuees were, Chanfrau was impressed with their behavior.

"We had all the ingredients for panic and chaos, but it just didn't happen," he said. "The sense of order in an atmosphere of darkness and smoke was exceptional. No one was trampled, nor were there any incidents of that sort."

Because it was around noon, many of the employees were out for lunch. Nonetheless, they, too, experienced stress related to the incident. People who were not in the building said they felt guilty.

"They felt powerless," Kane said, "because they weren't there. One woman tried to run into the building after the bomb went off because she didn't want her friends to be scared."



person who answered the survey, "Fire wardens need better training; before the explosion, it was nonexistent, after, they had training sessions, which were helpful, but didn't use a hands-on approach (i.e., take us on a tour of different stairwells and ways to exit the building), which I think would be more useful. To this day, our floor is lacking a floor warden, who is responsible for the floor in the event of a fire."

This lack of fire safety training might have caused a much bigger disaster. One respondent wrote, "I believe a bigger disaster was averted because most people were calm. With so many on the stairwell, many more could have been hurt if panicked people started to push or shove or cause others to be trampled. It was very important to keep a clear head."

Another respondent credited "a collective common sense and lack of panic for the fortunate absence of injuries."

Many people who participated in our study complained about their lack of emergency training and information.

### Lingering fears

Last February saw the second anniversary of the terrorist attack. Kane said she expects lingering fears to stay with the victims indefinitely.

Guibord said he still has trouble riding elevators.

"I don't like to be in confined areas, even airplanes," he said. "It makes you realize how helpless you really are. There we were, fully able-bodied, amply able to do anything, and completely helpless."

Guibord still discusses the bombing with his family and friends. "Talking about it helps to get it out of your system, if you can," he said.

"This event addressed how vulnerable we are as people," Kane said. "If this had resulted from natural causes, it would not have been so intense."

The day Hurlbut was interviewed for this article, a bomb exploded on a New York City subway. He observed "a lot of anxiety" among employees who had experienced the bombing 2 years earlier.

**TABLE 10**

**During previous alarms did you . . .**

	Tower 1		Tower 2	
	Evacuate the building	Move to another floor	Evacuate the building	Move to another floor
Always	6%	5%	2%	1%
Usually	2	6	0	3
Sometimes	4	11	6	4
Never	88	79	92	92

Many didn't understand the rationale behind basic fire safety protocols. One respondent wondered why they weren't allowed to break windows for fresh air, for example. Another reported that the air got better after people broke windows, "proving" that the rule against breaking windows was wrong.

Recent human behavior studies have shown that people will move through smoke, but this incident demonstrated that people will keep moving, even as conditions get worse. Many evacuees believed they were heading straight into the fire, but they kept going down, through increasingly thick smoke, without regard for the possible consequences of this behavior.

This incident also demonstrated that, in an emergency, floor wardens need enough information to be able to make

"People were sent home," he said. "The attitude was: 'Not this again. I don't want to have to deal with this.'"

In addition to the stress associated with surviving this traumatic situation, victims expressed despair for the future.

Kitowski said she is "disgusted with the horrible condition of our society."

"The bombing brought me face to face with the fact that we don't need natural disasters to create havoc," Guibord said. "Who needs earthquakes when humans can destroy themselves so much more quickly?"

"[Since the bombing], there is more of a sense of 'I'm tired of this,'" Hurlbut said. He referred to the recent string of airplane crashes. "You can avoid taking an airplane, but a nut with a gun can open up on a commuter train or put a bomb in the place where you work. This is what makes it personal."

*Valerie Herschfield is a freelance reporter based in California.*

safe decisions when the power shuts down and no information is forthcoming from authorities.

But training should not be limited to members of the fire safety team. Many fire wardens weren't even in their areas when the incident

occurred. This is always a possibility, due not only to vacations, lunch breaks, and other regular leaves, but also to meetings that take place off-site or in other parts of the building.

All building occupants need some level of training or education if they are going to react safely to a fire in a high-rise. They should understand smoke movement in high-rises, the stack effect, and the dangers of falling glass to people below. If fire wardens are properly trained, occupants should look to them in fire emergencies. In some cases, fire wardens reported that they were overruled by their managers, even though the managers had no better or additional fire safety training.

People should also understand how emergency workers operate. Many who waited for hours on upper floors in Tower 2 complained about the time it took fire fighters to reach them. They were never told that if power is cut off, people on the upper floors of a high-rise, who are in no immediate danger, can expect fire fighters to take several hours to reach them.

Work on this project continues. There are additional variables that should be analyzed, including respondents' occupations—a variable found to be significant in some previous human behavior studies. In addition, responses from people on the same floor should be compared, particularly their descriptions of smoke and their perception of severity. Reported delay times require further evaluation, too, so that we can better estimate time before evacuation begins and what variables affect delays in evacuation.

This data could have great value for human behavior and evacuation modeling and will be detailed in future reports. ♦

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I. Michael S. Isner and Thomas J. Klem, "Fire Investigation Report—World Trade Center Explosion and Fire, New York, New York, February 26, 1993," NFPA unpublished report.