TRAPPED IN A COLLAPSE: QUEENS GAS EXPLOSION

BY RAY DOWNEY AND TERENCE S. HATTON

On January 26, 1994, a gas explosion in a Queens, New York, restaurant caused a fire and collapse that tested the resources of the City of New York (NY) Fire Department. The restaurant, located at the corner of 38th Avenue and 22nd Street in the Long Island City section of the borough, was a one-story building of ordinary construction measuring 20 by 60 feet. It had similar buildings on both sides. Four inches of snow were on the ground, and the temperature was in the 20s.

At 8:23 a.m., the first call came in to the fire department that an explosion had ripped through the restaurant while about 10 customers were inside, causing portions of the floor to fall in and the windows and walls to blow out. The 14-inch-thick unreinforced concrete floor supported by 16-inch steel I-beams was blown up and broken into sections that came to rest on the first floor and in the basement, along with interior furnishings.

Units were on the scene within four minutes of initial calls to the fire department. The initial response included the normal complement of three engines, two

Photos courtesy of *New York Post*/David Rentas.

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ladders, one heavy rescue company, and a battalion chief. Numerous calls to the communications center indicated the incident was much more serious than originally reported. On arrival of the first units, the incident commander transmitted a major disaster signal that brought additional units—three more heavy rescue companies, a collapse unit, a technical response vehicle, tactical support units, and more engine and ladder companies.

OPERATIONS

Lieutenant Terence S. Hatton, the officer in charge of Rescue Co. 4, the first rescue company to arrive on the scene, began a size-up of the building's exterior walls. The walls had severe deformities. The roof was damaged but was still on the structure. The attached exposures did not appear to be damaged.

A quick survey of the building's interior showed signs of major structural damage. The major rubble pile consisted of numerous slabs of broken concrete measuring 10 by 10 feet.

The FDNY Collapse Rescue Plan, consisting of five stages, was implemented.

Stage 1: Surveying for trapped victims. Members performed a survey and reconnaissance of the entire area for trapped victims.

Stage 2: Removing surface victims. While a small fire was extinguished, firefighters started extricating and removing surface victims. Information gathering is essential at this time. Questioning the removed victims helps the IC decide his next plan of action. If all reports indicated everyone was accounted for, he could withdraw all members and proceed with the operation without urgency. If there were reports of missing victims, the game plan would change drastically.

A number of other tasks were performed simultaneously at this time.

- The shutdown of all utilities—gas, electricity, and water—is a primary concern in all rescue operations to ensure victims' and rescuers' safety. At this incident, because the basement was involved in the explosion, access to utilities was denied. The IC immediately requested utility companies to respond to the scene as soon as possible.
- Adjacent buildings were checked for possible victims and damage.
- The collapse unit began shoring up the remaining sections of the building.

Stage 3: Exploring voids and removing victims. Lt. Hatton and Firefighter Kevin Dowdell of Rescue Co. 2 were searching the voids when they heard the voice of a waitress trapped under rubble in the basement. The force of the explosion had ripped apart the concrete floor she was standing on into a variety of configurations. Many of these sections were resting precariously over the area where the victim was trapped.

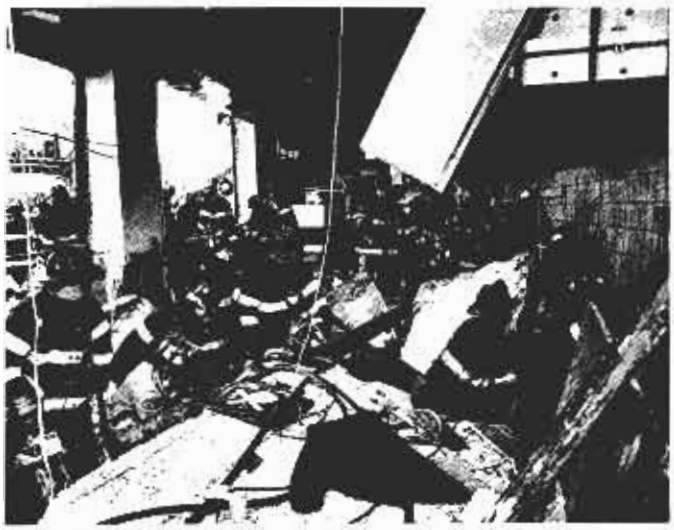
Rescuers faced other problems. The sections of concrete were of a size and weight that prevented moving or completely removing them to gain access to the victim. Every action has a reaction, and any movement or removal of the wrong structural member can cause a secondary collapse that can prove fatal to rescuers and victims. Thus, SOPs call for the operations chief to use only experienced rescue personnel in such situations. Both Hatton and Dowdell had such experience.

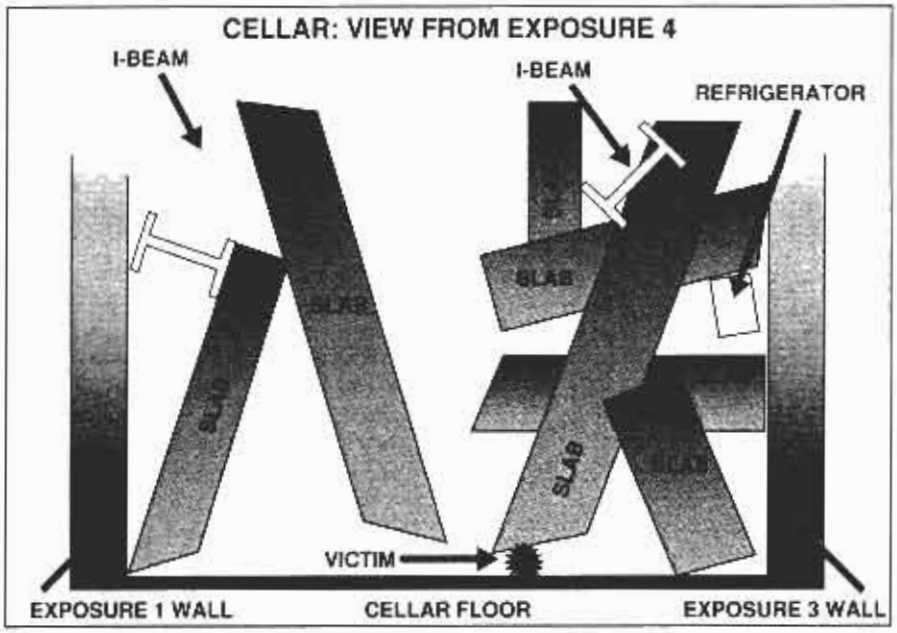
Operating in the void also exposed rescuers to pockets of gas that had built up in the basement prior to the explosion. (The cause of the explosion is thought to have been gas leaking from the street into the basement that went undetected. After a sufficient accumulation reached an ignition source, the explosion occurred, with the resulting collapse.)

Stage 4: Removing selected debris. Only the debris that prevents access to the victim is removed. This has a twofold purpose: Reducing the amount of debris handled can reduce the chances of secondary collapse, and safer operations are ensured. Hatton and Dowdell, in radio communication with the operations chief, worked to carefully remove debris.

Firefighters used trench jacks and wood cribbing to try to stabilize the concrete near the victim. The void opening that provided access to the victim was narrow and limited—rescuers tunneled into position near her through an opening only 24 inches wide by 40 inches long, varying in height from one to four feet. Only one rescuer at a time could work on the victim. This became an even bigger problem when a paramedic had to enter the void space to treat the victim for crush syndrome, an injury that can prove fatal if not treated promptly and properly (see sidebar "Crush Syndrome" by Dr. Dario Gonzalez, who was in charge of medical personnel at the scene). In this case, the excellent medical treatment administered to the victim during the prolonged rescue operation resulted in her full recovery.

When they reached the victim, they





began psychological reassurance to calm her. They were able to work her upper torso free with little difficulty. However, her legs were trapped under large sections of flooring and rubble that didn't appear easy to remove. As they worked to free her legs, a piece of flooring prevented them from seeing how deep one leg was trapped. Rescuers working from above slowly removed debris from this area.

Firefighter Bill Lake of Rescue Co. 2 was held upside down and lowered into a V-shaped void, where he was able to work the leg free. Using air bags, hydraulic rams, cutting tools, a Swiss army knife to reach areas that saws could not, and ingenuity, rescuers freed the victim after three hours of entrapment.

The only opening through which the victim could be transported had to be enlarged from above. Rescuers used an oxyacetylene torch to cut away part of a steel I-beam that was blocking the only viable means of egress. Since the explosion was gas-related, burning operations could not begin until meter readings ensured the atmosphere was safe.

Stage 5: Removing general debris. After rescuers removed the victim and were certain there were no other possible victims, general debris removal began.

LESSONS LEARNED AND REINFORCED

- The six-sided approach is the safest means of void exploration. In this rescue, two teams, one working from above and the other gaining access from the side, worked together to successfully rescue the victim.
- Using the five stages of collapse rescue helps ensure the safety of victims and rescuers. It also provides a logical sequence of tactics in rescue operations.
- Don't assume that smaller collapsed structures will be less of a problem than larger structures. Although this building was only 20 by 60 feet, large, heavy sections of broken concrete flooring were a major obstacle for rescuers. It was extremely unsafe and impractical to consider breaking up the concrete or attempting to move it while a victim was trapped underneath.
- Information gathered early in the operation helps the incident commander plan a course of action. A total of 12 people were injured at this incident. The early accountability of missing victims was extremely helpful to the IC in planning the rescue operation.
- Timely medical treatment is a must. In this case, having a paramedic treat the victim during the rescue was the key to her full recovery. Crush syndrome training should be a part of every rescue training program.
- Communications must be horizontal and vertical. Everyone involved in the rescue must know what others are doing. Coordination between rescue teams working within the void and above was vital.
- Rescue operations can be quite lengthy. Your rescue operational plan must take this into consideration. You may reach a trapped victim relatively quickly but then spend hours working to free him. Safety of rescuers and victims is the primary consideration.
- Think positive. Victims have been successfully rescued after days of entrapment.
- Use your experiences and lessons learned to train others.■

CRUSH SYNDROME

BY DARIO GONZALEZ, M.D.

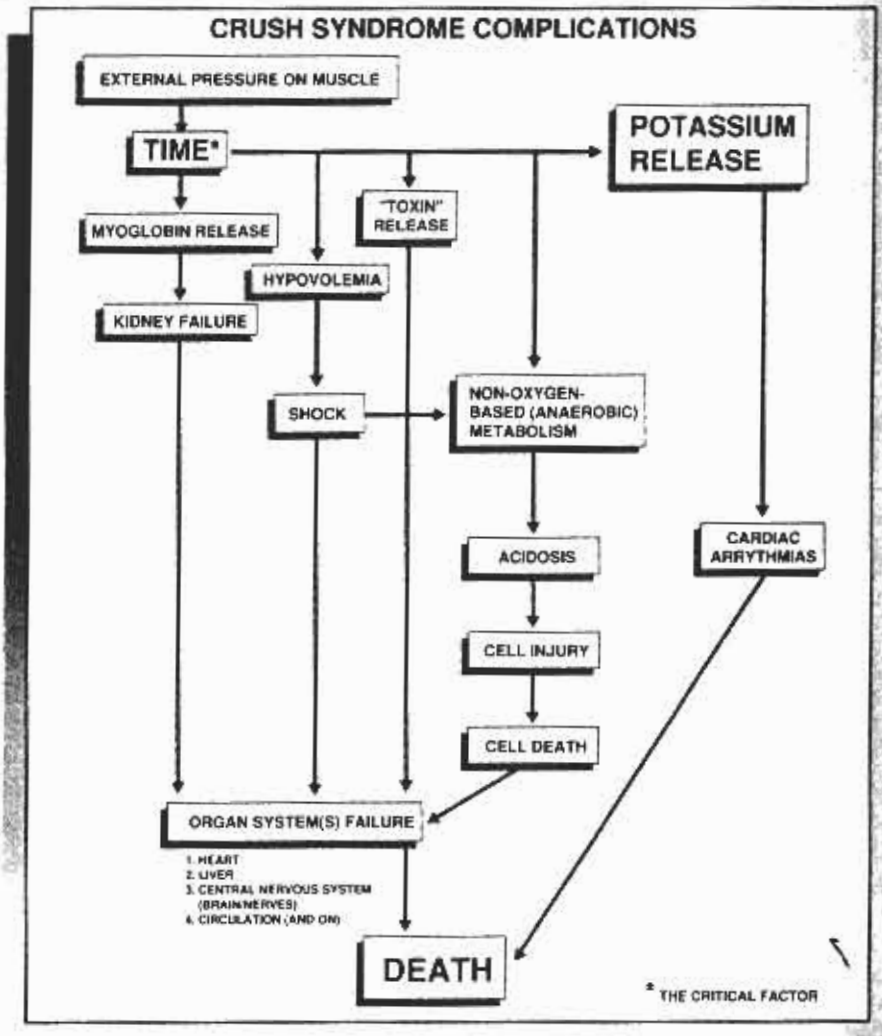
Crush syndrome has been recognized as a complication of collapsed structure incidents since the London bombings of the 1940s. The same findings were confirmed during reviews of the 1976 Tangshan earthquake in China. That event produced 361,300 victims, of which approximately 20 percent suffered from crush syndrome. Many patients described as "slow death" victims most probably were unrecognized fatal crush syndrome victims. This was repeatedly shown to be an issue that resulted in significant morbidity and mortality for Armenian earthquake survivors. In this earthquake, crush syndrome was one of the four leading causes of death and morbidity.

Crush syndrome is a condition that occurs in trapped collapsed structure victims. A combination of acute renal (kidney) failure, the cumulative consequences of muscle destruction, and hypovolemic shock are factors. The extended compression of muscle tissue from entrapment leads to the release of toxic breakdown products into the general circulation system, the primary toxin being myoglobin. The compression of the muscle can cause the muscle to swell to the point that it will cut off its own circulation. This in turn can cause the muscle to swell even more and eventually die. The continued breakdown of muscle results in the release of electrolytes (potassium in particular) and toxic metabolites. The potassium can result in cardiac arrhythmias and death.

Often the error is made in assessing the potential injury as a function of the size of the traumatized, trapped portion of the limb. The other silent component of the crush victim is the portion of the body bearing the victim's weight. For example, the largest muscle mass is the thigh and the gluteus (buttocks) muscle. The trapped victim might be lying on his back, unable to move, and therefore applying constant pressure to these muscle groups. It often is not appreciated that the nerves carrying pain sensation often are disrupted as a direct result of the complaint of discomfort. The thought of 200 pounds of pressure on the muscle group in the form of a slab of concrete is much more appreciated than the same amount of body weight. This may be even more deceiving in that the decision often is made not to treat this victim for crush syndrome since the degree of involved trapped and compressed tissue may be thought to be small (a trapped hand or wedged foot).

Treatment should begin "in the hole." Early, aggressive fluid management must be started as soon as possible. It is important to distinguish a potential crush patient from a "pin" job. The primary difference is that of time, since it takes at least one hour of muscle compression for muscle destruction to begin. All treatment starts with the ABCs of resuscitation—a clear airway (to prevent asphyxiation from dust) with supplemental oxygen and control of exsanguinating hemorrhage. The patient must be evaluated for hyperthermia (excessively high body temperature) or hypothermia (excessively low body temperature). IV should be started as soon as possible. Fluid replacement prior to extrication and decompensation must be started, even if the victim is asymptomatic.

The key to treatment is the recognition of the possibility of the condition and appreciation of the potential fatal complications. While the goal of the rescuer is the immediate removal of a trapped victim, rescuers should realize that a quick rescue of a trapped victim can result in the victim's death a short time later. Thus there is the need for treatment during disentanglement when access is made. This requires a team approach to the trapped victim, since the greatest danger for the extricated victim is at the time of rescue. ■



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resources must be such that sectoring of officers achieves stairway control.

- Common sense dictates that when units are special-called to high-rise buildings for search and evacuation under *nonfire* conditions (relief units at this incident), they should be advised in quarters, via command order through dispatch, to respond with street shoes. A 30-, 60-, or 90-story climb will tax even the best-conditioned firefighters, and reducing the weight carried by firefighters will cut down on injuries and enhance the operation. Seven-pound boots translate to 35 pounds of "back weight."
- As in any fire operation, a secondary search of all areas of the building must be made by fresh units to ensure that all occupants have been found, treated if necessary, and then removed from the building. When possible, these units should be provided with master keys to facilitate this secondary search, if these keys were not made available to the initial unit(s).
- The natural chaos at an incident of this magnitude will work against an incident commander's ability to plan ahead for potential problems involving personnel from other agencies. Every effort must be made to communicate with other agencies/personnel and coordinate actions. The rescuer-accountability challenges are also magnified; with search parameters so large, it is imperative that company officers achieve control at the company level and communicate developments as often as necessary through a well-defined communications relay system.
- Tools are an important aspect of search-and-rescue effectiveness. Firefighters must have the necessary tools before ascending the stairs—the 50th floor is not the place to remember the hydraulic door opener. Doors and elevators had to be forced, walls had to be breached, etc.
- Assess medical needs early in the incident. Establish a forward triage area, if possible, which will allow for a prioritized patient-assessment and removal process.
- Rescuing people through an elevator cab roof is performed only under extraordinary circumstances, such as those of the WTC incident. If power is restored to a stalled elevator involved in such an evacuation, such as that which occurred during the evacuation of the cabful of schoolchildren, rescuers and trapped occupants are placed in an extremely dangerous position.

All elevator cabs have an "on top of car inspection switch" as well as an emergency stop button on top of the car, which will keep the cab from moving if power is restored. These switches/buttons should be activated if rescues are conducted through the top of the cab. Activation of these switches/buttons will not, however, prevent a cab from being moved manually from the elevator machine room.■

Search and Rescue: An Overview

BY RAY DOWNEY

Within minutes of the initial explosion and resulting fire, rescues had begun. Port Authority personnel, including police officers at the command center on the B-1 level and maintenance personnel who had been having lunch on the B-2 level, received a major blast impact. A number of victims had to be removed from beneath the rubble by their fellow employees.

Firefighters arrived on the scene within minutes. By the time handlines were positioned and advanced toward the below-grade fires, rescues were taking place. As firefighters made their way down into the garage area, they were finding victims trapped under rubble piles, while other victims could be heard hollering for help. Although six people lost their lives, the potential for a much greater catastrophe was diminished by the heroic efforts of those involved in the rescue and suppression operations.

Self-evacuation of the towers had begun minutes after the explosion. Occupants of the upper floors reported that smoke entered their office spaces minutes after they felt the effects of the initial blast. The fire department command structure implemented for this operation provided for, in addition to the main command post, individual sector and subsector commands within the primary areas that required immediate search and rescue. The sector command posts were located in the Vista Hotel, Tower 1, and Tower 2. Subsector command was established at the lower levels for fire extinguishment and the rescue of Firefighter Kevin Shea.

Vista Hotel. All 829 rooms in the hotel had to be searched. After hearing and feeling the explosion, a number of occupants surprisingly remained in their rooms. Many others were found in the hallways and stairways and had to be assisted to safe

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locations. In addition, where master keys were not available, firefighters had to force numerous doors.

Tower 1. In Tower 1, where the smoke condition was the heaviest, those conducting a massive search and rescue operation were encountering a multitude of problems that had the potential for disastrous results. Each of the 110 floors had to be searched and occupants had to be assisted in evacuating. In many cases, firefighters physically removed victims to the street. Adding to these problems were 99 elevators that had to be located and searched; victims, some unconscious, were found in numerous elevators.

Tower 2. The search and rescue operation in Tower 2 was similar to that in Tower 1: All 110 floors and 99 elevators had to be searched and victims located and removed to the street. Fortunately, the smoke condition in Tower 2 was not as severe as that in Tower 1, but this didn't reduce the problems encountered. Thousands of occupants were self-evacuating, and the search of elevators and tenant spaces was equally exhausting.

Below grade. Major firefighting and search and rescue operations were required below grade near the large blast area. The parking garage, with a total capacity of 2,000 vehicles, was about half-filled at the time of the explosion. Many cars were involved in fire, creating the additional danger of exploding gas tanks. The search effort in this area also required checking each vehicle for possible victims. Victims rescued from rubble piles reported that a number of fellow employees might be trapped in the same area; this was later confirmed by Port Authority management. The destruction from the explosion prevented rescuers from using some stairways to the lower floors, forcing them to find alternative means of reaching victims. Usually this meant climbing over and through debris. The search and rescue operation below grade was complicated by the fact that firefighting efforts required the use of nine handlines for final fire extinguishment.

Firefighter rescue. During the rescues below grade, one of the firefighters himself became a victim. Firefighter Kevin Shea, while making his way toward the sounds of a trapped victim, fell through flooring into the crater formed by the blast. After falling more than 40 feet and being severely injured, he still was able to direct rescuers to his location. Firefighters conducted an all-out operation to reach him, and he was successfully removed from this precarious position while fire extinguishment operations were still underway.

CONTROLLING THE OPERATION

What are the means by which such an enormous rescue operation is controlled? An expanded incident command system that ensures adequate span of control but yet is flexible and adaptable. Sectoring and subsectoring the incident were critical. The sector commanders split up their areas of responsibility into manageable parts each under the control of an officer. For example, the commander of Tow

er 1 split the building in half and designated two chiefs for those areas; then he designated several officers responsible for coordinating the search and rescue operations on 10 to 20 floors. Approximately eight to 10 units were assigned to each of these areas. This type of coverage was designed to ensure that all floors would be searched in a controlled mode.

Since each floor was equivalent to an acre in size, search would be a time-consuming job. Although the majority of occupants were ambulatory, those who were disabled, elderly, pregnant, or in need of immediate first aid required assistance that eventually reduced the number of rescuers available, creating the need for additional personnel and requiring the transmission of additional alarms. Well-coordinated communications within the command structure were required so the incident commander could keep informed of the needs of his subcommands.

Staffing was an ongoing problem throughout the operation. Tasks such as removing victims in wheelchairs from upper floors required four firefighters. Rescuers also were required to assist in evacuating occupants down the smoke-filled stairways to the street. Factors such as these required that the subcommands and the incident commander adjust and adapt the operational plan accordingly.

ELEVATOR SEARCH AND RESCUE: A UNIQUE PROBLEM

Locating the elevators in each of the buildings required a coordinated effort. Normally, building maintenance personnel would have been able to provide invaluable help at the very outset of the incident. Unfortunately, many maintenance personnel had been located in the area of the blast when it occurred. It would be hours before some of them were available to assist with elevator rescue operations. Even in buildings where elevator personnel were available, in some cases they still had to climb 110 flights to reach the uppermost sky lobby and recall some elevators—and the climb could take four hours.

The elevators serving the local floors had discharge doors that could be opened easily, and rescuers could look into the shafts for elevator locations. However, the heavy smoke condition was traveling up the shafts to the upper floors, causing additional problems for rescuers trying to locate elevators; each shaft had to be checked at every possible access opening for locations.

Locating express elevators in blind shafts presented the biggest problem. As these blind shafts pass through the floors, there is no visible indication of shaft location at each floor. Those rescuers assigned to locate elevators, lacking the assistance of building maintenance personnel, had to rely on their experience, knowledge, and training to accomplish this most difficult assignment. Even after locating a shaft, heavy smoke conditions required rescue teams to make floor-by-floor inspections into the shaft until they eventually found the elevator in a shaft. Fortunately, through rescuers' efforts, numerous trapped occupants were saved. In one case, a firefighter located an elevator, forced open the car doors, and found 10 victims lying unconscious on the car floor. All the victims were successfully resuscitated because of the rescuer's efforts.

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The search, rescue, and evacuation of the World Trade Center was the largest and most complex operation to which FDNY has responded. The effective implementation and utilization of the incident command system, the resources available to FDNY, and the training and professionalism of its members enabled this department and its rescuers to accomplish one of the most successful search and rescue missions in fire service history.■

At the Bottom of the Crater

BY KEVIN SHEA

Rescue 1 responded to the World Trade Center on February 26 on the initial alarm. When we arrived, the incident already had grown to a second alarm. We were waved over to the Vista Hotel lobby by hotel employees, who reported that people were trapped. We proceeded by stairway from the concourse to the B-1 level to search. We encountered offices whose ceilings had come down and lockers that had been overturned. We thought initially that we were dealing with a transformer explosion and fire.

As I was about to search around the lockers, my officer, Lt. Jack McAllister, called for help—he had found a live victim. The lieutenant was in a small, tight, cage-like area that contained air cylinders; he was perched on top of some of the overturned bottles. He told our company to look for another way to approach his location.

I went around a cubicle wall and opened a door. It was black and smoky inside. I yelled and the same victim responded. I knew this was an alternate way to reach him. With my partner, Gary Geidel, I went down what I thought was a long hallway—the door was a normal size, not unusually wide, and the floor didn't change surfaces (for example, from carpeting to tile or from tile to concrete) to indicate I had left the hallway. Then the floor angled up, and I felt broken

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