Fire unchecked

Fire spreads in South America's tallest high-rise building in Caracas, Venezuela, because its sprinkler system had not been properly tested or maintained.

By **Jaime A. Moncada, P.E.**

SOMETIME BEFORE MIDNIGHT on October 15, 2004, a fire began on the 34th floor of the East Tower of the Parque Central, a 56-story government office building in Caracas, Venezuela, and South America's tallest high-rise. Fortunately, the building was unoccupied at the time, except for a handful of security personnel who evacuated safely.

Despite the fact that a sprinkler system had been installed in the Parque Central the fire did more than U.S. $250 million in damage, burning the structure's contents from the 34th floor to the 50th. Why? Because, as previous inspections revealed, the sprinkler system had not been properly tested or maintained, thus it wasn't in a working condition; the building designers said local fire alarm panels weren't connected to a building-wide panel; and the standpipe system was inoperable at the time of the fire. >>

Fire Timeline

1:10 am—Fire at the southern elevator tower. Firefighting efforts about to start.

2:06 am—Fire gains intensity on the 34th floor.

2:24 am—Main staging area on the 27th floor where one of the booster pumps was located.

3:48 am—Fire advances to the 35th floor. At this point there are two 2-1/2" hose lines working the fire.

4:20 am—Floors 34 & 35 fully involved.

5:00 pm—Firefighters get ready for a defensive position on the 38th floor.

5:51 am—Fire moving upward very slowly thanks to the defense strategy by the CFD.

6:12 am—Fire still in check. Booster pumps soon start to fail.

Collecting credible first-hand information about major fires in Latin America is, in general, very difficult, as such events tend to become politically sensitive. As of February 1, the investigation had not yet been concluded or the cause-and-origin report issued. Indeed, the cause and origin of this fire may never be completely clear. If nothing else, however, it highlights the need for ongoing inspection, testing, and maintenance of fire protection systems.

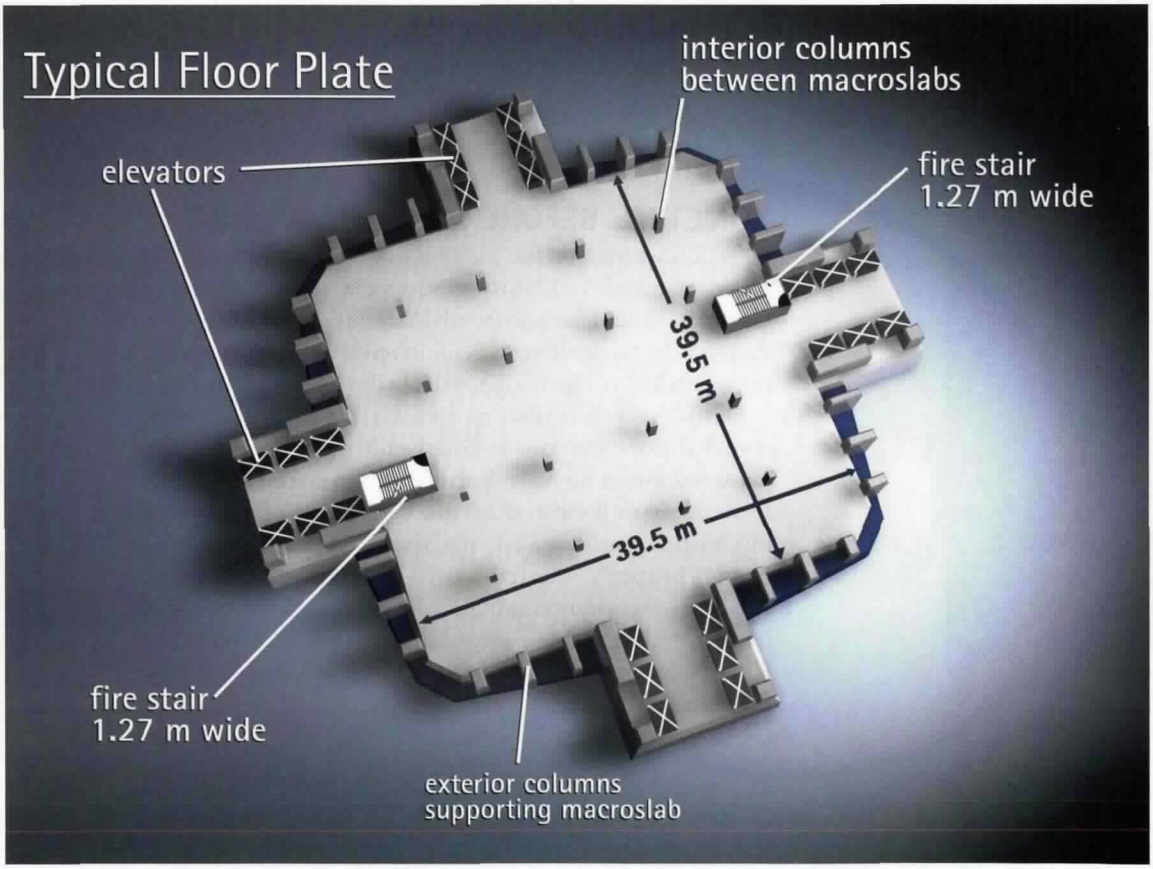
The structure

Although NFPA was not officially invited to investigate the Parque Central fire, I visited the scene the day after the fire to interview Caracas' fire chief, incident commander Colonel Rodolfo Briceño, who oversaw the incident, his commanders on the ground and other responding personnel, the designer of the building's original sprinkler system, and building maintenance personnel. I also collected information from newspapers and walked through Parque Central's West Tower, which is virtually identical to the East Tower.

The twin towers of the building were completed in 1982 as part of a 25-acre (10-hectare) complex known as Parque Central, which was built between 1970 and 1982. The complex also contains more than 1,100 retail stores, seven 40-story residential towers, and a 35-story hotel. The East Tower has 56 floors above ground and 4 underground, with a total height of 725 feet (221 meters). Each floor plate covers an area of 20,450 square feet (1,900 square meters) that includes eight elevator banks and two enclosed, remote fire exit stairwells (see floor plan).

The reinforced concrete structure consists of perimeter columns connected by post-tensioned concrete "macroslabs" that are each 10 feet (3 meters) deep and above the second–floor mezzanine, the 14th, 26th, 38th, and 49th floors. There's no central core.

Individual floors between the macroslabs have a steel-deck floor supported by steel beams, all protected underneath with spray-on Cafco Blaze Shield DC/F mineral glass fiber wool with cement fireproofing. According to Cafco's Manny Herrera, the floor was designed to meet U.S. standards for a two-hour fire resistance rating. However, the overall fire compartmentalization of each floor slab was decreased by the addition of several



unrated floor panels to provide access to mechanical and plumbing systems.

Five structural bays rest on four lines of columns in each direction supporting the steel deck. In effect, the concrete structure includes five stacked steel buildings, each supported by a macroslab. During the fire, two steel decks partially collapsed; other than that, there was no collapse inside the building. However, deflection in some steel beams was severe.

Fire protection and life safety

The original designers took extraordinary care to design a building that included state-of-the-art high-rise fire safety for the 1970s. The building had fire detection and alarm systems, fire hose cabinets, and pressurized stairs. A wet-pipe sprinkler system, utilizing copper tube and designed following the pipe-schedule method, was installed and connected to on-off sprinklers. The on-off sprinklers were Grinnell's Aquamatic, Model F920B, with a temperature rating of 165°F (74°C), manufactured in 1981. The UL-listed, FM-approved F920B is designed to reset itself after operation by way of an internally mounted pilot valve with a heat-responsive bi-metallic snap disk and a piston assembly.

According to maintenance personnel, the sprinklers leaked soon after the building was put into service, and, instead of replacing the sprinklers, valves were added over the years to "manage" the leaks. All the control valves I saw in the West Tower were closed, so it is reasonable to conclude that the sprinkler system on the East Tower was disabled, as well. According to Chief Briceño, several Caracas Fire Department (CFD) inspections had noted that the sprinkler system was not operational.

The installation protocol for this sprinkler is atypical. Before installation, the installer must take a series of steps that include flushing the piping and precharging the sprinklers using a manifold connected to a pressure source of at least the system pressure or 10 psi (0.7 bar). After precharging, each sprinkler must be operated by applying minimum heat with a propane torch to the sprinkler snap disk until the sprinkler opens. After this procedure, the sprinkler can be removed from the manifold and installed on the sprinkler system.

According to Grinnell, failure to precharge may result in water discharge from sprinklers until pressure at the sprinkler reaches about 10 psi (0.7 bar).

Top photograph shows the fire reaching the 47th floor of the Parque Central in Caracas, Venezuela. The middle photograph shows one of the last attempts by the government helicopters to cool down the fire using water-filled buckets. The bottom photograph shows an image taken by retreating fire personnel as they left the partially collapsed 35th floor.

PHOTOGRAPHS: COURTESY JAIME MONCADA

Fire Timeline (continued)

8:50am—Fire starts to gain speed. Five floors fully involved.

10:49am—Fire gets close and is temporarily delayed by the Macroslab 4.

12:04pm—Fire Chief orders the firefighting operation be abandoned.

1:31 pm—Fire regains intensity.

3:07pm—one of the last attempts by government helicopters to cool down fire using buckets.

3:08 pm—Fire reaches the 47th floor.

5:00 pm—Fire reaches the top floor.

Next morning—Fire consumes all floors from the 34th to 50th. The 51st and 52nd floors were partially burned.

The sprinkler leakage soon after the building was put into service coincides with problems the building experienced with its water supply system. Originally, the system was to be supplied by a large-capacity elevated tank on a hill not far from the site. The head or gravity pressure from this tank was reportedly sufficient to pressurize the system up to the 25th floor through an 8-inch (203-millimeter) standpipe, and booster pumps were installed on the 26th floor to pressurize the system in the remainder of the building.

However, the elevated tank failed soon after the building was opened and was replaced by a connection to a high-pressure municipal water main and later to water pumps that were not listed for fire pump service. A plausible explanation for the sprinkler issue is that the precharging protocol was never adhered to and, with the water supply problem, system pressures fell below 10 psi (0.7 bar) throughout, allowing some sprinklers to leak.

Each office floor also had an independent fire alarm panel connected to smoke detectors and horns. The original design called for these independent panels to be interconnected to a building-wide panel, but according to the building designers, that project was never funded. The local panels I saw on the West Tower were not operational.

Means of egress from the towers consisted of two enclosed stairwells 50 inches (1.27 meters) wide that reportedly were pressurized. Egress capacity and travel distance were well within the requirements of NFPA 101®, *Life Safety Code®*, requirements.

The fire

The first report of the fire came at 12:05 a.m. on Sunday from a neighbor who called the CFD dispatcher. The first responding unit from a fire station within the Parque Central complex arrived at the base of the building a few minutes later and was

NFPA's contribution to Latin American fire safety

LAST YEAR, THREE major fires occurred in South America. On August 1, a fire at the Ycuá Bolaños Supermarket in Asunción, Paraguay claimed 426 lives. On October 15, a fire destroyed the Parque Central's East Tower in Caracas, Venezuela. And on December 30, a fire at an overcrowded rock concert in Buenos Aires, Argentina, killed 191 people.

Despite these and other catastrophic fires, the overall perception in Latin America is that the area has no "fire problem." Perhaps the perception is rooted in the fact that Latin America's fire problem is with large, modern buildings, not residential occupancies.

Still, we do not know the extent of the fire problem in Latin America. Josè Torero, a professor of fire protection engineering at the University of Edinburgh, believes "fire losses, as a percentage of the gross domestic product, are generally higher in Latin America than in the U.S.," even though we lack accurate fire statistics for the region.

Bolstering Torero's opinion are reports that put the cost of rebuilding the Parque Central at $250 million. Venezuela's economy is one one-hundredth the size of the U.S. economy, so the impact of rebuilding on the Venezuelan economy scale is more than twice that of the World Trade Center rebuilding efforts on the U.S. economy.

According to the *Fire Protection Handbook*, fire death rates in Latin America is also inconclusive, although we do know that the annualized rate in Chile is 21 per million population, in Argentina 12 per million population, in Mexico 10 per million population, and in Venezuela 6 per million population. The fire death rate in the United States is about 17 per million population.

Documenting major fires

To compound the problem, most major Latin American fires are not analyzed for the fire protection lessons they can teach. Beyond basic news reports, there is no unified effort to document, from a fire safety standpoint, fires that lead to multiple deaths or multimillion-dollar losses. And, as John R. Hall, Jr., assistant vice-president of NFPA Fire Analysis and Research, notes, "good fire statistics are essential to good fire safety policy." Indeed, the lack of good statistics means a lack of a comprehensive overview of what is going wrong and how much damage results from each problem. This makes it all too easy for building authorities, insurers, engineers, architects, and building owners across Latin America to overlook key aspects of design and practice as they address fire safety.

A classic example is the February 2003 terrorist bombing of the social club El Nogal in Bogotá, Colombia, in which 36 people died and 136 were injured. The bomb destroyed the high-rise's façade and its only enclosed exit. Most local reports discussed the security and structural aspects of the disaster but failed to note that a second, remote fire exit would have reduced the loss of life.

directed to the fire floor in the East Tower by the dispatcher, who could see the fire from CFD headquarters eight blocks away.

On the fire floor, the first responders found a developing fire and connected their hose lines to the building standpipe system. When they discovered that the standpipe system wasn't working, the fire chief ordered a 9,250-gallon (35,000-liter) cistern connected to a fire engine with a 1,200 gallon-per-minute (4,500-liter-per-minute) pump to pressurize the standpipe using the building's fire department connection. However, they were unable to pump any water into it. According to fire department personnel, a lack of maintenance made the standpipe inoperable.

Commanders at the scene decided to bring a 2-inch (63-millimeter) hose line, fed by fire engines at the ground level, all the way up one of the fire stairs. Two portable booster pumps, each flowing 264 gallons per minute (gpm) at 58 psi (1,000 liters per minute [lpm] at 4 bar), were used to provide adequate pressure above the fire floor.

At approximately 1:15 a.m., firefighters working with two 1-inch (38-millimeter) hose lines from different locations above the 34th floor were able to slow the upward movement of the fire considerably. By 3 a.m., a second 2-inch (63-millimeter) hose line, identical to the first one, had been put into service, and firefighters confined the fire to three to four floors above the 34th floor. This approach was successful through the first five or six hours of the fire, when the fire spread vertically at a rate of approximately one floor every three hours. The 27th floor became the main staging area for about 100 firefighters.

At 7 a.m., some of the booster pumps started to malfunction, and the fire regained intensity, spreading vertically at a rate of about one floor per hour until approximately 10 a.m. Around 11 a.m., the fire breeched the fifth macroslab, below the 39th floor, and around noon, the stairwells' fire enclosure started to

The building was subsequently repaired and reopened, still without a second exit or sprinkler protection.

What we will consider

After the tragedies last year, the public cried out for more legislation, stronger enforcement, and punishment for those responsible. In Latin America, however, more regulations do not necessarily translate into improved safety, because one cannot simply "legislate" improved fire safety. One must also create a climate in which fire safety is valued.

To help create this climate, NFPA has translated more than 60 NFPA codes and standards into Spanish and undertaken comprehensive fire safety education in the region, delivering 50 professional development seminars there last year. NFPA chapters have been approved for Argentina, Colombia, the Dominican Republic, Mexico, Puerto Rico, and Venezuela, and NFPA successfully held its first Congress in Latin America last year in Mexico.

As NFPA continues to promote fire safety in the developing world,consideration is being given to two approaches focusing on codes and third-party certification.

At the 2002 World Safety Conference and Exposition®, a group met to discuss adapting NFPA 101®, *Life Safety Code*®, for emerging countries. The group discussed performance-based designs that took into account emerging nations' limited economic resources, in essence conceptually producing a document that could provide an equivalent level of safety while eliminating detailed criteria geared toward the infrastructure and legal environment of the United States.

Perhaps more challenging is developing a management standard for fire safety systems that would entail certification by a third-party audit, at least during the design and installation phases.

Worldwide, there has been tremendous growth in private, volunteer certification programs. Although these certification systems are not usually required by law, thousands of companies, mostly outside the U.S., embrace them voluntarily through independent third-party certification.

Would this work for fire safety?

In a building's proposal, contract, or operations and management documents, the owner would require that the fire safety systems be certified as meeting appropriate NFPA codes and standards. This would require the building designer and builder to hire a competent, independent third party to certify compliance through a fire safety audit, bypassing the authority having jurisdiction's approval, which are not always an option in most of the developing world.

If this system were embraced by governments and private corporations in the developing world, insurers would probably look favorably at it. That alone would have a ripple effect, strengthening those who practice fire safety by the book, increasing industry professionalism, and improving the level of fire safety of facilities worldwide.

fail. Concerned that the building might collapse, the fire chief immediately ordered that interior firefighting operations be abandoned. It should be noted that the CFD only reported minor injuries among its personnel during this risky operation.

This fire highlights the importance of periodic inspection, testing, and maintenance of fire protection systems, as well as the importance of strictly following manufacturers' installation instructions.

The fire continued to move upwards through the afternoon, at a rate of about 2 1/2 floors per hour. Between 2 and 3 p.m., the Venezuelan government began using helicopters with water buckets, commonly used on forest fires, in an unsuccessful attempt to slow the fire down.

The fire eventually burned itself out at 3 a.m. on Monday morning, after spreading and consuming the contents of some 17 floors, more than 24 hours after it began.

Conclusion

Past history and performance shows that this fire could probably have been controlled quickly by a standard wet-pipe sprinkler system and that the fire department's chances of controlling the fire at, or a few floors above, the floor of fire origin would have increased if the standpipe system had been working. This fire highlights the importance of periodic inspection, testing, and maintenance of fire protection systems, as well as the importance of strictly following manufacturers' installation instructions.

This incident once again reminds us of the fire safety challenges high-rise buildings present and demonstrates that no fire department, no matter how large, professional, and well-equipped, can effectively control a fire without properly designed passive and functioning active fire protection systems. The CFD performed admirably in an impossible task, and its commanders made difficult decisions that ultimately proved to be the correct ones.

Acknowledgments

I wish to thank CFD fire chief Colonel Rodolfo Briceño for his assistance, as well as the many men and women of the CFD who provided information and support during my visit. Comandante Briceño retired on November 24, 2004, after 40 years of service with the CFD.

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DISCO FIRE in BUENOS AIRES, ARGENTINA By Eduardo Alvarez, SFPE

Last December 30, a fire at a rock concert in an unsprinklered disco in Buenos Aires, killed 191 people, the largest loss of life in a fire in Argentina's history. The Republica Cromagnon disco was a one-story building of approximately 1,500 square meters (16,150 square feet), with an occupancy permit for 1,037 spectators. But an estimated 3,000 people were inside on the night of the fire.

The fire started at 10:50 p.m., a few minutes after the concert had started, when fireworks thrown by a spectator set fire to the combustible acoustic lining of the ceiling, presumably made with polyurethane foam. The fire spread quickly through the ceiling. Smoke inhalation claimed the most victims. There was a lack of compliance with local codes regarding the combustible acoustic lining and the use of fireworks inside buildings.

Other factors contributing to the large loss of life included a main exit door that had been closed with a padlock, and the lack of emergency lighting and exit signs. In fact, a few minutes after the fire had started, electrical power was cut off and there was total darkness inside the overcrowded space, making a chaotic situation even worse.

NFPA, in cooperation with International Fire Safety Consulting (IFSC), is documenting this fire. A Summary Report should be available in late February.

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