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## Tragic fire at the Ycuá Bolaños Botánico Supermarket in Asunción, Paraguay

# NO EXIT

AN AUGUST 1 FIRE in a two-story, unsprinklered Paraguayan supermarket that killed more than 400 people<sup>1</sup> and injured more than 360 people, has highlighted the problem of building modern, sophisticated structures in emerging nations without following the fire protection and life safety measures those buildings have in the developed world.

Perhaps the most important observation about this fire is that it happened in a new building, in which the application of internationally accepted regulations such as NFPA codes and standards could have prevented or limited the loss of life.>>



PHOTOGRAPH: CORBIS



Although NFPA wasn't officially invited to investigate this fire, the authors visited the scene, conducted interviews, and collected information available at the time, some of it from newspaper sources and conversations with witnesses. We also reviewed the U.S. Department of Justice's International Response Team's (IRT) cause-and-origin report. This team, which is part of the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF), investigated the fire at the request of Paraguayan authorities through the U.S. Embassy in Asunción. Unanswered questions about this fire remain, and we've identified those issues we couldn't corroborate.

### Building Location and Description

Asunción, the capital of Paraguay, has 513,000 inhabitants, making it one of the most important cities in the country. The Ycuá Bolaños Botánico Supermarket was located near the Asunción Botanical Gardens in a district known as Santísima Trinidad, which consists of single-family dwellings and a few retail shops. It was a part of a chain that includes two other stores.

The two floors of the supermarket, which opened in 2001, each had approximately 43,000 square feet (4,000 square meters) of floor area, and the ground-floor included covered parking areas. There was also an open-air parking area. The sales area, the food court, the food court kitchen, storage areas, and other service areas were on the second floor, and mezzanines on the south and north sides of the building contained the administrative offices and an additional area for the food court, respectively. The food court, which sat 324 on both levels, was separated from the sales area by glass walls. The sales area, covering 34,000 square feet (3,152 square meters), had an estimated occupant load of 1,126. It appears that the building had no firewalls.

The building was constructed of cement-block masonry walls, concrete floors, and a sloped steel-truss, metal-clad roof supported by metal joists and, in some areas, metal reticulated beams. The roof's corrugated metal deck was coated with sprayed-on polyurethane foam between 1 and 10 inches (25 and 250 millimeters) thick. It was not fireproofed.

**Most shoppers entered the building through the two vehicle accesses, next to one of which was an open stair and ramp for supermarket carts.**



Aerial view of Ycuá Bolaños Botánico

A suspended ceiling approximately 18 feet, 4 inches (5.6 meters) above the floor separated the roof from the sales area and the food court. The ceiling was covered in polystyrene tiles measuring 4 feet (1.2 meters) by 2 feet (0.6 meters), sandwiched between two layers of plasterboard and supported by a light-metal grid attached to the roof joists with metal cables. Air conditioning ductwork passed over the sales area and food court above the suspended ceiling.

Also passing above the suspended ceiling was the chimney of the food court kitchen's charcoal grill, which crossed over the food court mezzanine and through the roof deck, where an electric extractor was located. It's reported that in at least one, and possibly two, locations, the chimney had horizontal transitions to avoid structural elements. The stoves in the food court kitchen were fueled by gas from two propane-butane tanks in the service area, and the remaining cooking systems, including the bakery ovens, were electric.

The building's pedestrian entrance connected through an open stairwell with the sales area on the second level, where a door led to the food court. Another open stairway led from the food court to the mezzanine, where there were additional tables. However, most shoppers entered the building through the two vehicle accesses, next to one of which was an open stair and a ramp for supermarket carts. The ramp and stair connected the parking area with the sales area on the upper level. Neither the stair nor the ramp was enclosed by fire-resistant partitions.

A loading dock at the rear of the store led to the service areas. Store employees had an independent access stair that connected the parking area to the service area on the top level.

The building was equipped with fire hose cabinets, presumably fed by the building's water supply system

through a Siamese connection for fire department use, and located on the façade of the building.

It also had an automatic fire detection and alarm system. Photoelectric smoke detectors had been installed in the sales area, the food court, and much of the service area, and rate-of-rise heat detectors protected the parking area, bakery, confectionary, and kitchen. The system included 90 combined smoke detectors, 49 heat detectors, 10 manual fire alarm boxes, and 10 warning devices with sound alarms and strobe lights, as well as 3 sound-alarm devices. The alarms were grouped in 20 fire detection zones and connected to a combined intrusion/fire detection panel.

### The Fire

According to the ATF report, the fire was accidental. It started in the kitchen in the horizontal transition of the charcoal grill chimney, where a large accumulation of grease served as fuel load. The heat of the fire melted the chimney's metal bands, allowing the fire, until then confined to the duct, to break through the upper surface of the transition and rise up the pitch of the roof, where it ignited polyurethane insulation and ceiling tiles.

The fire continued to spread through the concealed space between the ceiling and the roof deck in a south-southwest direction, weakening the ceiling supports near the grill. It eventually broke through the ceiling around the grill's chimney on the mezzanine, causing the glass wall separating the food court from the sales area to break. This was the first time customers and employees saw the fire.



Exterior view of Ycuá Bolaños Botánico

## FIRE TIMELINE

The following chronology is based on information obtained from interviews with witnesses and firefighters, press clippings, and information from ATF's origin and cause determination report.

**Before 9 a.m.** A grease fire starts in a horizontal transition portion of the charcoal grill's chimney in the food court.

**11:19 a.m.** One of the last clients to leave the supermarket before the fire pays for his purchase at the cash register. There were no visible signs of fire.

**11:22 a.m.** The fire breaks through the suspended ceiling and becomes visible. The plaster panels start to fall from the suspended ceiling. Many inside the food court start to run towards the ramp leading to the vehicle parking area.

**11:32 a.m.** The dispatch center at the local fire department receives the first telephone call reporting the fire from a neighbor.

**11:33 a.m. (approximately)** A volunteer firefighter who lives in the neighborhood helps several people out of the building through the pedestrian entrance. A security guard tries to prevent customers from leaving the building and fires two shots in the air. Moments later, he closes the doors, allegedly to keep people from leaving without paying. The gate separating the ramp for the supermarket carts from the parking area is also closed.

**11:35 a.m. (approximately)** Neighbors and passersby start throwing stones against the exterior glass walls in an unsuccessful attempt to help the trapped victims out of the building.

**11:37 a.m.** The first fire company, which consist of a fire engine with five to seven firefighters, a cistern truck, and an ambulance, reaches the scene. A second alarm is declared, and the fire is immediately qualified as "a high-magnitude incident." The firefighters' main priority is to rescue victims; so structural firefighting efforts are postponed. The firefighters have difficulty entering the building because the doors are closed [locked?].

**11:45 a.m. (approximately)** A second fire company arrives.

**11:50 a.m.** The fire spreads to the supermarket's service area.

**12:30 p.m. (approximately)** Firefighters vent the fire through openings in the roof.

**5:30 p.m.** The rescue of injured victims continues. It is unclear when the fire was controlled.

**7 p.m.** The fire department ends rescue efforts. A number of people died on the ramp to the parking garage when the fire rolling down the ramp overtook them. However, there is no conclusive information as to where most loss of life occurred.

The rush of oxygen-rich air through the broken glass generated a fireball that rolled in a south-southeast direction above the suspended ceiling, causing additional ceiling tiles to fall in the main sales area. This further increased the available oxygen fueling the fire until it eventually reached the southern wall of the supermarket.

By this time, most of the goods in the sales area had been engulfed in flames. The most severe fire damage occurred in the extreme southern part of the building, where the fire load, which included clothing, textiles, and similar merchandise, was greater than that of the north side of the sales area, which contained mostly foodstuffs.

As the fire continued to burn, it generated a pressure wave that pushed the flames down toward the lower parking level through the ramp connecting the garage with the supermarket.

The ATF's description of the fire propagation coincides with witnesses' reports, some of which refer to a fire "that fell from the roof." The numerous explosions the witnesses noted can be explained by the fire's effect on aerosol cans, the cold storage compressor, and other items.

#### Building Code Analysis

The Ycuá Bolaños Botánico Supermarket complied with local codes. Architect Teresa Miranda, director of the Urban Administration Department for Asunción, told the local press that the supermarket met Municipal Regulation 25097 of the city of Asunción's building code, "not having found any radical objection meriting observations or rejections of the submitted permit documents." The regulation adopted in 1988, establishes fire and life requirements for establishments such as the Ycuá Bolaños Botánico Supermarket, including maximum travel distance to exits; fire enclosures for means of egress; and swinging direction of exit doors. It also lists the types of buildings, such as the supermarket, in which fire detection and alarm systems, fire hose cabinets, and water supplies are required.

In contrast to the 2003 edition of NFPA 101®, *Life Safety Code*®, however, the Asunción regulation does not require automatic sprinklers in such occupancies. As a result, the supermarket was not sprinklered.

However, it was protected by a fire detection system, which the *Life Safety Code* does not require in this type of occupancy. According to the *Life Safety Code*, fire detection systems aren't an acceptable replacement for sprinkler systems unless a performance-based design is used.

By reference, the *Life Safety Code* requires compliance with NFPA 96, *Ventilation Control and Fire Protection of Commercial Cooking Operations*, which states in Appendix A.7.1.2 that "vertical or substantially pitched ducts are preferred over horizontal ducts because of their capacity to drain grease and to transfer heated vapors more rapidly to the exterior of a building." The fire began in a horizontal portion of the duct. However, we have insuffi-

cient information to determine whether the duct met NFPA 96's requirements for minimum clearance between the duct and combustible materials, particularly the polystyrene ceiling tiles.

The Asunción regulation requires fewer exits for a building such as the supermarket than the *Life Safety Code*, as well. As a result, the food court, which had an occupant load of 324, had one exit instead of two, and the sales area, with an occupant load of 1,126, had only two exits, not the four the *Life Safety Code* would have required.

In the sales area, the maximum travel distance was 315 feet (96 meters), instead of the maximum 150 feet (46 meters) the *Life Safety Code* requires, and the capacity of the available means of egress was 821 persons, even though the occupant load was 1,450. And this doesn't take into account the occupants of the service areas. Furthermore, a review of drawings and photographs reveals that none of the exit doors swung in the direction of egress travel, as the *Life Safety Code* requires.

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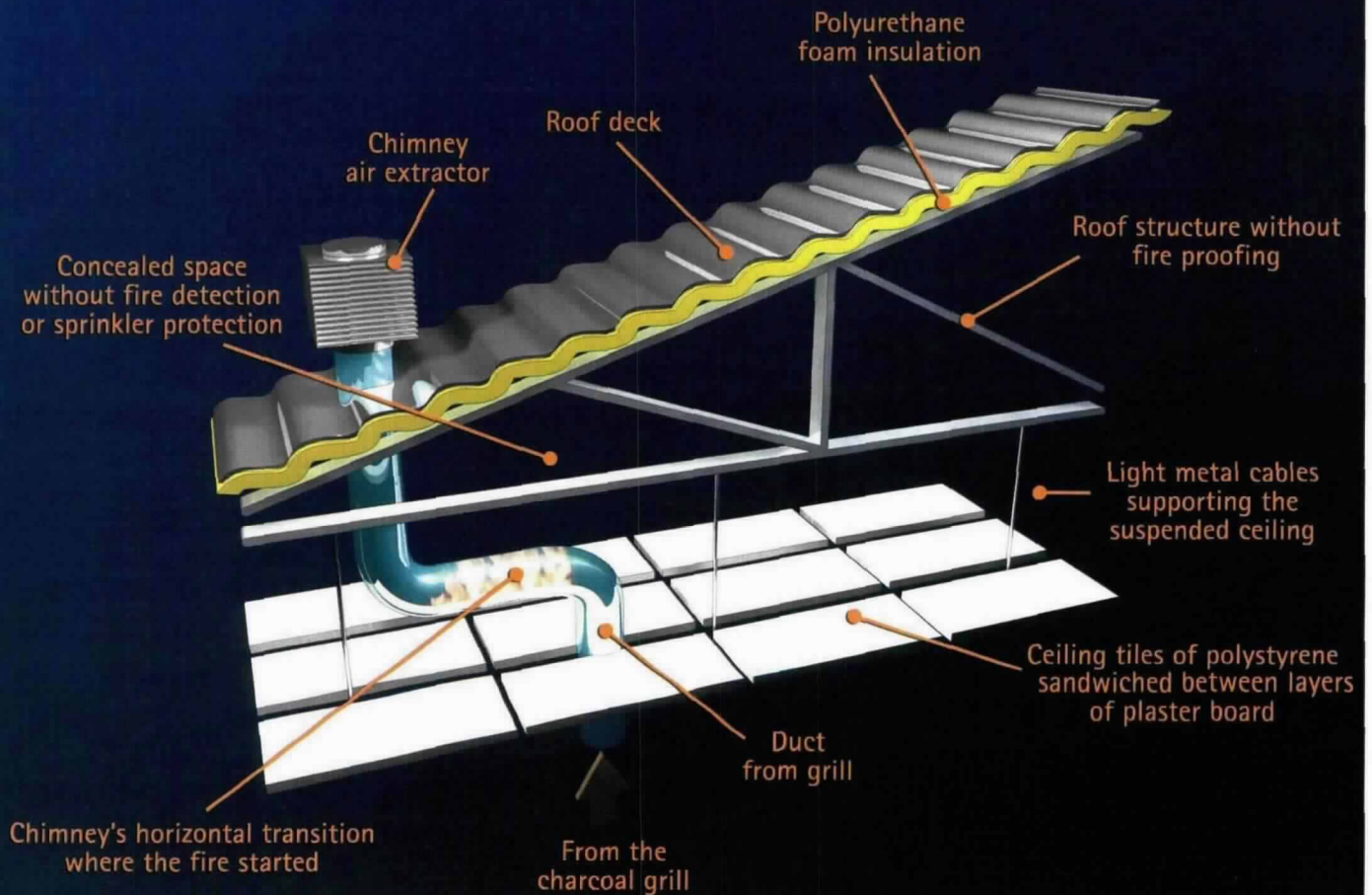
The ATF is currently conducting laboratory flame-spread tests of the polyurethane foam applied to the supermarket's roof deck. Although we have no information as to whether the foam met ASTM C-1029, *Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation*, or the roof assembly met UL 1256, *Standard for Safety for Fire Test of Roof Deck* or FM 4450, *Test Standard for Class 1 Insulated Steel Deck Roofs*, we do know that many construction assemblies used in the developing world have not been tested or studied under fire conditions.

#### Conclusions

This fire tragically underscores the problem that currently exists in many emerging countries, where architectural designs mirroring those of more developed countries are implemented without regard to their more rigorous life safety and fire protection requirements.

It not only highlights the risks involved when large buildings are not protected with automatic sprinkler systems and the means of egress do not meet minimum travel distances, number of exits, egress capacity, and management criteria of NFPA codes and standards, but

## Sketch of concealed space between roof deck and suspended ceiling



it also calls into question the strategy of protecting large buildings only with occupant-use fire hoses and fire detection and alarm systems. In this fire, there was no evidence that that building occupants used the fire hoses to control the fire or that the fire alarm system provided an alarm in a timely fashion. In fact, none of the witnesses reported having heard the fire alarm system during the fire, and there's no indication that the supermarket had contracted with a central station monitoring service at the time of the fire, even though the panel was capable of communicating to a central station.

As far as what we can learn about this fire vis-à-vis NFPA codes and standards, we believe further study of the chimney and its horizontal section is in order. We're also interested in the results of the ATF's flame spread analysis of the polyurethane samples taken from the building. Should that information become available, we will report on it in future issues. 🔥

### Acknowledgements

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### Endnotes

1. As of August 16, 2004: 331 bodies had been identified; 48 people were missing; 43 remains were in the process of being identified; 67 people had died at various hospitals; and 296 survivors had been medically treated.

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