FIRE AT
THE MGM GRAND
• Rapid fire and smoke development on the Casino level due to available fuels, building arrangement, and the lack of fire-resistant barriers.
• Lack of fire extinguishment in the incipient stage of fire.
• Unprotected vertical openings contributing to smoke spread to the high-rise tower.
• Substandard enclosure of interior stairs, smoke-proof towers, and exit passageways contributing to heat and smoke spread, and impairing the means of egress from the high-rise tower.
• Distribution of smoke throughout the high-rise tower through the heating, ventilating, and air-conditioning equipment.
• Smoke spread through elevator hoistways to the high-rise tower.

These were the major factors that accounted for the loss of 85 lives, injuries to about 600 people, and more than $30 million in property damage at the MGM Grand Hotel in Las Vegas, Nevada, on November 21, 1980.

The NFPA’s full report on the fire was completed in November 1981 and shows how these factors combined to produce the worst hotel fire in the United States since 1946, when a fire at the Winecoff Hotel in Atlanta, Georgia, killed 119 people.

This article is based on the NFPA’s investigative study, Investigative Report on the MGM Grand Hotel Fire, Las Vegas, Nevada, November 21, 1980, by Richard B. Best, NFPA Senior Fire Analysis Specialist, and David P. Demers, P.E., Consultant to the NFPA. The full report will be published by the NFPA. Copies may be requested from the NFPA Fire Investigations Department.

This investigation was conducted by the National Fire Protection Association (NFPA) under a contract with the Federal Emergency Management Agency. It was jointly funded by the Federal Emergency Management Agency, the National Bureau of Standards, and the National Fire Protection Association.

The substance of this investigative report is dedicated to the public. It may be freely reprinted with the customary crediting of the source. The authors and publisher are solely responsible for the accuracy of statements or interpretations contained herein.

The NFPA’s investigative report is based on the Clark County Investigation Report and on-the-scene observations made by the NFPA during the Clark County investigation.

The MGM high-rise building, constructed in the early 1970s, consisted of 21 stories of guest rooms situated above a large, ground-level complex comprised of a Casino, showrooms, convention facilities, jai alai fronton, and a mercantile complex. About 3,400 registered guests were in the hotel at the time of the fire. The hotel was partially sprinklered, but major areas, including the Main Casino and The Deli (the area of fire origin), which was on the east end of the Casino, were not sprinklered.

As reported by the Clark County Fire Department, the most probable cause of the fire was heat produced by an electrical ground-fault within a combustible concealed space in a waitress serving station of The Deli.

Following full involvement of The Deli, a flame front moved through the Casino. Smoke spread to the high-rise tower through stairways, seismic joints, elevator hoistways, and air-handling systems. The means of egress from the high-rise tower was impaired because of smoke spread into stairways and exit passageways, in addition to smoke spread through corridors.

The high-rise tower evacuation alarm system apparently was not activated or did not sound, and most guests in the high-rise were alerted to the fire when they heard or saw fire apparatus, saw or smelled smoke, or heard people shouting or knocking on doors. Many occupants were able to exit down stairways, unassisted. Others were turned back by smoke and sought refuge in rooms. Many broke windows to signal rescuers or to obtain fresh air. The fire department confined the fire to the Casino level in slightly over one hour. Evacuation of all the guests took approximately four hours.

The NFPA became aware of the MGM Grand Hotel fire on November 21, 1980 and sent a Fire Analysis Specialist to the scene immediately; he arrived at the Hotel late evening on November 21. Additional NFPA technical specialists joined the on-scene investigation in the days that followed; a total of five NFPA staff members were involved in the two-week field effort. Entry to the fire scene and data collection activities were carried out with the cooperation of the Clark County Fire Department. The NFPA conducted its investigation of the fire in cooperation with the Federal Emergency Management Agency/United States Fire Administration (FEMA/USFA) and the National Bureau of Standards (NBS) under a standing agreement with FEMA. This study was jointly funded by the NFPA, FEMA, and NBS.

The Clark County Fire Department conducted its official investigation of the fire and has published a report, MGM Report, Clark County Fire Department, May 19, 1981. The Clark County investigation team included support from the NFPA, FEMA, and NBS personnel. The Fire Department was responsible for the overall direction of the official investigation, securing the fire scene, the release of information, and subsequent publication of their investigative report.

The information presented here is based on the best
data available immediately after the fire and that obtained during subsequent follow-up.

**BACKGROUND**

(For more information on the basic construction of the MGM Hotel, see the NFPA's full report on the MGM Grand fire, available from the NFPA’s Fire Investigations Department.)

The 23-story MGM Grand Hotel building (the hotel numbering system indicated 26 levels) consisted of a large ground-floor area (Casino level) that contained the Casino, restaurants, showrooms, a convention center, and the upper level of a jai alai fronton. The below-grade level (Arcade level), which had approximate outside dimensions that were the same as the Casino level, contained the lower level of the jai alai fronton, a movie theater, a large number of shops and boutiques, service areas, and underground parking. The hotel, consisting of three wings, was located above the Casino and Arcade levels. The T-shaped tower contained approximately 2,083 guest rooms. (See Figure 3)

The codes in effect in Clark County, Nevada, when the MGM Grand was constructed were:

**CONSTRUCTION**

The building was of mixed construction; the high-rise portion was of fire-resistive construction, while the low-rise (Casino) level consisted of both protected and unprotected noncombustible construction. Classification according to NFPA 220 — 1979, *Standard on Types of Building Construction*, would include both Type I and Type II construction.

The high-rise construction consisted of structural steel protected with both reinforced concrete and gypsum wallboard. Most interior partitions were of gypsum wallboard on steel studs, including enclosures around the means of egress.

In the low-rise portion of the building, floors were concrete slab and partitions also were gypsum wallboard on steel studs. Most partitions extended above ceilings; however, in some cases there were openings in the partitions above the ceiling to facilitate return-air movement for the heating, ventilation, and air-conditioning (HVAC) systems.

The Deli was severely fire-damaged when this investigation was conducted, and a complete description of construction and finish materials prior to the fire could not be obtained. The roof assembly above the east half of The Deli consisted of a built-up roof covering on a poured deck supported by steel joists and framing. Above the west half of The Deli was the south-wing high-rise tower.

The ceiling assembly in The Deli consisted of gypsum wallboard fastened to a metal suspension system. The ceiling had simulated wood beams constructed of nominal one-inch wood boards. Cellulosic ceiling tile was adhered to the gypsum wallboard ceiling between the beams. Ceiling tile similar in appearance found in other portions of the building had a flame spread rating of 20, fuel contributed rating of 20, and smoke developed rating of 0.

The walls of The Deli were constructed of gypsum wallboard on steel studs. The finish material observed on the south wall just west of the serving station behind the hostess' desk appeared to be a vinyl covering approxi-
mately ⅛-inch thick. On the north wall of The Deli, ceramic tile was applied around a bar, down to a three-foot chair-rail level, and below the chair rail level was a vinyl wall covering on gypsum wallboard.

The Deli had been remodeled in 1978. It appeared that the interior finish materials had been applied over other layers of material, such as vinyl wall covering. The floor of The Deli was carpeted, with a fiber-type pad over the concrete deck.

Just north of the entrance to The Deli was a wood display case containing pies and cakes, and around The Deli booths were wooden columns decoratively carved to look like stacked cubes.

The gypsum-wallboard-on-steel-stud wall that separated The Deli and Main Casino did not extend above the ceiling (steel studs extended above the ceiling, but gypsum wallboard was not applied to the wall).

The wall construction of the serving station in The Deli consisted of ¾-inch gypsum wallboard on steel studs. Vinyl wall covering on the wallboard was covered with ¾-inch-thick laminated plastic paneling. The south wall of the serving station was of similar construction, except that the vinyl wall covering was covered by ½-inch wood paneling, which in turn was covered by ⅛-inch wood paneling. The ceiling of the serving station had plastic laminate adhered to ¾-inch thick gypsum wallboard.

The ceiling west of The Deli appeared to be similar in construction to the ceiling in other areas, with gypsum wallboard fastened to a steel suspension system plus glued-on ceiling tiles.

The Casino interior finish included plastic decorative trim such as simulated marble, wood decorative trim, and plastic mirrors on the ceiling that were reportedly made of methyl methacrylate. This plastic mirrored appearance continued to the porte cochere on the west exterior of the Casino, which had over 300 30-by-30-inch plastic reflective panels.

The fuel load in The Deli and Casino areas was provided by the contents and the previously described interior finishes. The contents of The Deli, which was about 3,500 square feet in area, included free-standing chairs padded with what appeared to be polyurethane foam. Along the south wall were wraparound booths, which also appeared to be padded with thick polyurethane foam and covered with a vinyl material.

The fuel load in the Casino, which was approximately 68,000 square feet in area, included furnishings, contents, and interior finishes comprised of plastic materials that appeared to include polyvinylchloride, polyurethane, polystyrene, and methyl methacrylate. The Casino furnishings included gaming tables with thick foam plastic padding and plastic covering around the edges. The seating in the restaurants and lounges had foam plastic padding.

Enclosure of Vertical Openings

For the purpose of this report, stairways have been identified as S1 and S2 (south wing), E1 and E2 (east wing), and W1 and W2 (west wing).

The enclosure walls of the stairways and the exit passageways were constructed of gypsum wallboard on metal studs. The stairways were enclosed by two layers
TOP: 7:40 am. View from southeast shows occupants on roof of south wing. INSET: Smoke vents activate on roof of fly gallery of MGM's Ziegfeld Room. (NOTE: The times in this series of color photographs were estimations by the photographers.)
RIGHT: 8:06 am. From southeast. General view shows immense area of Casino, theaters, convention, and jai alai level. MIDDLE LEFT: 8:07 am. Guests wait on balconies on 24th and 25th floors for rescuers. MIDDLE RIGHT: 8:19 am. View from southwest. New construction was not involved in the fire. BOTTOM: 8:20 am. View from south, southeast from a distance shows massive amount of smoke stratified above MGM hotel.
ABOVE: 8:20 am. View from south. Greatest amount of smoke is from Main Casino and Showroom areas.

ABOVE LEFT: 8:21 am. From west, looking along rear of new construction and south wing. MIDDLE: 8:25 am. Guests at balconies and windows from 21st through 25th floors. LEFT: 8:28 am. Same as 8:25 view, this of guests at windows of 18th through 21st floors.
BELOW: 8:35 am. View from north side shows Flamingo Road entrance and ladder rescues from tenth floor.
RIGHT: 8:54 am. View from west. Main entrance porte cochere is above MGM sign. BOTTOM: 9:15 am. Rescue activity at the rear of the south wing. Stair at left is from Stair S2.
of ⅝-inch gypsum wallboard on each side of steel studs. The exit passageways were enclosed on each side with two layers of ⅝-inch gypsum wallboard for walls and one layer of ⅝-inch gypsum wallboard for ceilings. In many places, the enclosures were not complete, which resulted in spaces approximately ⅝-inch wide running the entire length of the stair stringers. In addition, in many locations fire protection for the steel components of the stairs was nonexistent. The spaces, along with the lack of fire-resistance protection for the stairs, openings covered with nonrated sheet metal access panels into the stairways and exit passageways, and insufficient quantities and thickness of gypsum wallboard, resulted in inadequate protection of stairways and exit passageways. These deficiencies were confirmed for the S1, W1, and E1 stairways.

The E2, S2, and W2 stairways were smokeproof towers, consisting of stairways connected to the floors by exit vestibules. The vestibules were vented directly into the smoke shafts that terminated at the top of and within the stair shaft. The smoke shafts were vented directly to the outside. Many of the vents from the smoke shafts were covered by the building’s exterior sheathing. It was further noted that the bottom of the W2 smoke tower, which was exposed to the concealed space above the Casino level, was sheathed in plywood. The E2 stairway also contained a plywood base.

Elevator hoistways were enclosed by gypsum wallboard on steel studs and framing. There was a common pit for all of the passenger and service elevators. At the top of the hoistways were six-by-six-inch cable slots where the wire ropes entered elevator machine rooms.

Air-conditioning supply ducts were gypsum wallboard-enclosed shafts the full height of the high-rise tower. There was no evidence of any unprotected openings in the shaft enclosures. Throughout the tower were several gypsum wallboard vertical ducts that were used for toilet exhaust from guest rooms.

The building was designed with two seismic joints that separated the east and west wings of the building from the south wing and core; there were essentially three separate structures for earthquake protection. The seismic joints, approximately 12 inches wide, went from the Casino level to the roof. Openings in wall areas created by these seismic joints were covered with “accordion-fold” steel, and floors were fitted with unrestrained metal floor plates to allow building movement. These openings were not protected by rated construction. Also, openings at the bottoms of these shafts, in the concealed space above the Casino, were unprotected.

Means of Egress

For purposes of this report, the means of egress from the MGM Grand Hotel were considered to be divided into four separate parts. The first part was the high-rise guest-room tower, with the exception of the top floor; the second part was the top floor of the tower; the third part was the Casino level; and the fourth part was the jai alai fronton and lower Arcade level. Only the guest-room floors and the Casino level, which were most directly affected by the fire, have been considered in this report.

The guest-room tower was a fairly typical “double-loaded” corridor arrangement (with rooms on both sides of the corridor), served by six stairways that were evenly
distributed; two stairways served each of the three wings. Each wing had a smokeproof tower at the end of the wing and an interior stairway that was located approximately one-third of the distance from the elevator lobby to the end of the wing. The stairways were equipped with illuminated exit signs at each door and also signs on the doors that stated: EMERGENCY FIRE EXIT ONLY, NO ACCESS TO OTHER FLOORS.

With the exception of stairway E2, all the stairways discharged to the outside through enclosed horizontal exit passageways located in the space between the ceiling and the roof above the Casino level, which also served as a plenum. In some cases, the passageways were well over 100 feet long.

The exit passageways were designed to connect the bottom of the stair towers to the outside, thereby providing continuous paths for exit travel. However, stairway E2, which had no exit passageway, discharged directly to the outside.

The only access to guest-room floors (floors 5 through 26) from the Casino level was by elevator. Stairs and an escalator connected the Casino and Arcade levels, but once they were above the Casino level, people on high-rise guest-room floors could not travel between floors by stairways. Self-closing doors from the corridors to the stairways locked behind people entering the stairway, preventing anyone from returning to the corridor or entering any other floor level. The only recourse available to anyone who entered the stairways was to travel down the stairs to ground level, and then go directly to the outside. The stairways at the ends of each wing (S2, E2, and W2) also led to the roof, but doors to the roof were locked.

Means of exit from the Casino level consisted of stairs off the main corridor that served the convention section, doors on each side of the Flamingo Road entrance and at the Flamingo Road entrance, the Main Entrance, and doors southwest of the Casino, plus a series of doors and stairways off the service corridor along the south side of the building.

Fire Alarm System

The main control panel of the fire alarm system was located in the PBX (private branch exchange) room on the Arcade level. There was a remote annunciator and control panel in the security office on the Casino level, and, reportedly, a remote evacuation alarm activation switch at a "secondary command post" on the Casino level. (The existence of this remote evacuation alarm activation switch and the exact location of the "secondary command post" could not be verified; reportedly, it was in the area of the registration desk.)

There were no manual alarm initiation devices on the Arcade, Casino, or second-floor levels other than those at the main control panel and the remote panel in the security office. Various waterflow switches associated with the partial-coverage sprinkler systems were connected to the alarm system.

Manual pull stations were located in the guest-room tower floors, on the fifth through twenty-sixth floors. Each floor contained seven pull stations, one at each stairway and one in the central-core area, near the elevators.

The sounding of the building's evacuation alarms appeared to have been accomplished only by manually activated devices at annunciator panels. Activation of alarm-initiation devices transmitted signals to the fire alarm annunciator panels, and hotel security personnel were sent to investigate the source of the alarm. Evacuation alarms were evidently activated only by manually activated switches that sounded devices on all levels; the public address system could also be used for evacuation purposes. In addition, the alarm signal was automatically transmitted to a remote central station. Central station personnel would not telephone the alarm to the fire department until after an initial five-minute delay period. They would then transmit the alarm to the fire department if the MGM system had not been reset or if the fire was confirmed by telephone.

There have been no reports that any fire alarm signal
sounded during the entire fire. However, PBX operators stated that in the early stages of the fire, an announcement to evacuate the Casino was made over a nonfire public address system.

Fire Suppression Systems

Although large portions of the Casino and Arcade levels of the MGM Hotel were protected by automatic sprinklers, the Main Casino, The Deli, and the Orleans Room (all within the fire area) were not sprinklered. The determination of areas to be sprinklered was based on requirements of the Uniform Building Code. Before 1976, casinos in Las Vegas were not considered “exhibition halls” and sprinklers were not required by the authority having jurisdiction. Meetings held at the time, reportedly, were not documented, and the reasons why certain areas were provided with sprinkler protection were not determined. Apparently, the final determination was based on the hours of operation of the area in question. Automatic sprinkler protection was required for areas not operating on a 24-hour basis. Sprinklers were not required if the area was occupied around the clock. The Deli originally was open 24 hours a day, and as a result, sprinklers had not been installed in this area; however, The Deli was no longer operating around the clock and was closed on the morning of the fire.

The assembly areas on the twenty-sixth floor were also protected with automatic sprinklers, but none of the other high-rise floors (floors 5 to 25) were sprinklered.

The Main Casino operated 24 hours a day, like most of the other casinos on “The Strip.” The restaurants — Cafe Gigi, Caruso’s, and Barrymores — were open during dinner hours.

On the day of the fire, the Main Casino was operating, although it is estimated that very few people occupied it at about 7:00 am as compared to normal operations at night. The Registration Desk was busy with guests checking out, and the Orleans Coffee House was open for breakfast. Other restaurants and the two showrooms were closed.

The Role of the HVAC System

The four hotel heating, ventilation, and air-conditioning (HVAC) subsystems significant in this fire were those for the Main Casino, the tower corridors, individual guest rooms, and the toilet exhaust. Air conditioning in the Main Casino, showrooms, and adjacent spaces (including The Deli) was provided by a large, variable air volume system. Two large mixing rooms on the second floor on the southern side of the Casino each contained three 60,000-cubic-feet-per-minute (cfm) double-filtered air-handling units, in addition to fresh-air intakes, heating coils, other small air-conditioning and ventilation units, and related equipment such as dampers and filters.

The mixing rooms were not fire-rated compartments because of various penetrations in the enclosure. Fire dampers were provided in the supply ducts and return-air control assemblies where they penetrated the mixing room wall above the Casino ceiling. The automatic (fuse-link-activated) function of fire dampers for two return-air control assemblies in the easternmost mixing room had been impaired before the fire by steel straps bolted across the dampers so that they could not close. It was also noted that fuse links in several dampers had been replaced by steel wire.

One of the mixing rooms was protected by automatic sprinklers. This room was also used for storage and as a field office area. NFPA investigators found no smoke detectors anywhere in the air-handling equipment.

Supply air was distributed by sheet metal ducts and flexible connectors to the various rooms on the Casino level. Return air went through ceiling-mounted air-transfer grills open to the space between the ceiling and the floor above. The large plenum contained the “Eye in the Sky” security walkways over the Casino. The entire area over the Casino ceiling, including the Main Casino, the showrooms, and restaurants, was one plenum with no fire walls or fire dampers.

No main fire separation walls or fire dampers were found between the stage-theater plenum and the Casino ceiling plenum.

The corridors and elevator lobbies of the Tower guest-room floors were supplied with conditioned air from air-handling units located in a mechanical-electrical penthouse on the roof, which also contained the service elevator and high-rise passenger elevator equipment, two air-conditioning units for the twenty-sixth floor (assembly areas), and kitchen ventilation units for the twenty-sixth floor. A large return-air plenum for the twenty-sixth floor was located between the twenty-sixth floor and the roof and penthouse. Several unprotected openings led from this plenum into the penthouse. There were fire dampers adjacent to the return-air control dampers from the assembly areas.

Four air-handling units for the Tower corridors consisted of a 43,200 cfm unit that supplied the center lobbies, plus three other units, one for each wing, that were rated at 48,000 cfm each. These units took their air directly from within the penthouse, through double filters. The penthouse was open at the roof line through louveres to the exterior. No smoke detectors were found in these air-handling units.

The Tower air-conditioning units fed through fuse-link-operated fire dampers and down shafts, where the conditioned air was supplied to each floor through large, vertical, adjustable-volume air-transfer grill assemblies equipped with fire dampers. There was no return air from the guest rooms or guest-room floor corridors.
Each guest room was equipped with at least one fan-coil unit. Larger rooms, suites, and two-story town house units had more than one unit. Make-up air for the guest-room fan-coil units was provided from the corridors through air-transfer grills equipped with fusible-link-operated fire dampers located in the corridor walls, above the door to each room. Air traveled from the corridors into guest rooms through gypsum wallboard ducts to the fan-coil units and was filtered along with air being recirculated in the room. Cooling was provided by piped chilled water, and heating by electrical resistance heat tape.

Sixteen toilet exhaust fans located on the roof reportedly ran continuously. They varied in size from 1,625 cfm to 19,600 cfm and provided exhaust from all of the guest-room toilets through several vertical ducts throughout the Tower. These ducts were connected to the toilet exhaust fans on the roof through duct headers that traveled horizontally above the twenty-fifth floor ceiling and then vertically to the roof. Several of the shafts used for toilet exhaust of guest rooms were also used for toilet exhaust on the Casino level.

The bathrooms for each guest room were equipped with combined fan/light ceiling-mounted fixtures. There were two bulbs; one for lighting was on a switch, and the other was an infrared-type on a timer switch. The 90-cfm fans operated with the lighting switch.

The fan/light fixtures were connected by a flexible connector to the vertical ducts. Where the flexible connectors entered the ducts, the mechanical drawings indicated that no fire dampers were needed if the connection extended vertically a minimum of 22 inches up the duct. The ducts were not disassembled during the investigation to determine the actual construction arrangement.

THE FIRE

At approximately 7:10 am on November 21, 1980, an employee discovered the fire in a serving station in The Deli, a restaurant at the east end of the Main Casino.

Employees who were interviewed reported that they had noticed the odor of smoke in The Deli, and had seen a smokey haze and smelled smoke in surrounding areas for hours before (and even the day before) the fire was discovered; however, none of the reports appear to be associated with the actual fire.

A few employees had entered The Deli prior to discovery of the fire, but they reported seeing no indication of fire. The head hostess of the Orleans Coffee House, The Deli, and Dealer’s Lounge had closed The Deli at approximately 1:10 am and checked it again at 2:30 am, before she went off duty. She said that at that time, she did not smell smoke or notice anything unusual. Another employee had been in each serving station of The Deli before 5:00 and 6:00 am and “didn’t see a thing.”

The first observations of actual fire, however, consistently placed the fire in The Deli and specifically in the area of the serving station on the south wall of The Deli.

An employee of the Orleans Coffee House who was in The Deli noticed blue sparks coming out of the Keno board, followed shortly by black smoke. She went to the kitchen, told the assistant chef, then went to tell her boss, who was sitting at the counter.

Another employee of the Orleans Coffee House saw smoke coming from The Deli area and then saw the south wall of The Deli burst into flames. She left the area immediately.

A chef was cooking bacon when a waitress told him about the fire in The Deli. He went into The Deli, saw flames and black smoke extending approximately two feet all around the Keno board, and immediately went to the telephone and told the operator that there was a bad
fire in The Deli. He then grabbed a fire hose and was about to use it on the fire when someone told him not to put water on an electrical fire, so he dropped the hose. The lights then went out in the kitchen Deli area. He saw that the fire was getting out of control and advised his fellow workers to get out of the kitchen. They exited through a smoke-filled hallway to an exit door.

Another witness was an employee who was just starting work at approximately 7:00 am and went through The Deli. Halfway through, he “heard a crackling sound to the right of The Deli.”

“I went over there immediately and looked inside and there was fire shooting from the stainless steel pan up to the ceiling. . . . So I immediately ran back through the tables to the entrance there and behind the cashiers counter there is a telephone. I pushed the buttons, 4481, notified the security they had a fire in The Deli. . . .”

At 7:16 am on Friday, November 21, 1980, the consolidated alarm office of the City of Las Vegas, Clark County, and North Las Vegas, Nevada, received a telephone call reporting the fire.

The Clark County Fire Department dispatched the normal first-alarm assignment for this type of occupancy: 4 engines, 1 ladder, 1 hosewater, and 1 rescue unit, with a battalion chief and 23 fire fighters.

A Clark County fire fighter related his first observations as follows:

“When we pulled in . . . there wasn’t any indication of any panic or anything. . . . We . . . put on our high-rise gear, walked in through the swinging doors, and walked down to the exit entry ramp to the Casino floor.

. . . “There were . . . maybe 20 people at the most, on the Casino floor. . . . I saw three or four people coming out of the delicatessen area, and they started running across this ramp. . . . to these doors in front of us. . . . At that time all of us stopped . . . you can see . . . sort of a stratified layer of black smoke, just a small one back in, say, the first quarter of the Casino floor. . . . At the same time, we noticed this stratified layer, which was probably down about 6 to 8 feet from the ceiling. . . . “A fire hall and a heavy, dense black cloud with a little bit of flame visible in the perimeter of the flames started rolling out. . . . It was dense black smoke and you could see little fringes of flame breaking out as the cloud came out. . . . The main body of the rolling cloud was in contact with the ceiling, and as it came out towards the center of the Casino . . . it just sort of angled back to where it was touching the floor as it came out. At that time, we saw it first coming towards us; we turned back around and it took roughly 12 seconds to get . . . back to the doors. By that time, the smoke had dropped down to within about four feet of the floor.

. . . “When we got to the doors . . . it felt like the fire had pushed us outside, the smoke had dropped so fast. . . . At the same time we got to the entrance (about 25 seconds), I looked down to the west end of the hotel and saw the fire break out of the overhang for the valet parking area. . . . At the same time, the fire through these glass doors off to this side threw them open and the fire was burning with a fire storm appearance . . . from the floor up . . . it was swirling, and that’s where we set our first attack line . . .”

The main fire was controlled at approximately 8:30 am, but total extinguishment was completed later. It was 11:00 am before all but a few of the survivors were evacuated from the building. (See the January 1982 issue of Fire Service Today for full details of fire-fighting operations. See also the March 1982 issue of FIRE JOURNAL for details on human behavior and evacuation.)

Casualties

Eighty-five guests and hotel employees died as a result of the fire. Bodies of 83 victims were located on the day of the fire. The eighty-fourth casualty, a female employee, was located the next day in a service elevator on the twenty-sixth floor, and the eighty-fifth victim died weeks after the fire in Houston, Texas, hospital.

Of the 84 victims who died the day of the fire, 79 body locations were documented. In some cases, victims were moved before their locations could be recorded. Three bodies were removed from the roof of the high-rise tower; their locations within the tower had not been recorded. Two additional victims were transported and pronounced dead on arrival at hospitals. Overall, locations of 61 victims were documented in the high-rise tower and 18 victims were located on the Casino level.

As determined by the Clark County Coroner, all of the fatalities located in the high-rise tower died of asphyxiation secondary to carbon monoxide inhalation. Of the 18 victims located on the Casino level, 14 died of smoke and carbon monoxide inhalation. Three victims died of burns plus smoke and carbon monoxide inhalation, and one victim located outside on the roof of the building area under construction died of a massive skull fracture.

Of the 61 fatalities in the high-rise tower whose body locations were documented, 25 were found in rooms, 22 were in corridors, 9 in stairways, and 5 in elevators. The twentieth and twenty-third floors contained the largest number of victims; 14 were found on each floor. Bodies of victims were located predominately in rooms and corridor areas between the interior stairs and central-core areas on nine floors. On the twenty-fourth floor, eight victims were located in the central core.

Of the 18 victims on the Casino level, six were found in the Registration Desk area; three of these victims had suffered extensive burns in addition to smoke and carbon monoxide inhalation. It appears that these victims were overrun by the flame front moving through the Casino.

Four victims were found in the Ritz Room, five in elevators, and two in the Casino-level elevator lobby. One victim, previously discussed, died of a massive skull fracture when she either jumped or fell from the high-rise tower. Seven of the victims were identified as employees, including three on the Casino level and four on upper floors.

Approximately 600 persons injured as a result of the fire were treated, transported from the scene, and ultimately attended to by hospital personnel. Of the 600
injured, 318 were admitted to hospitals and 282 were treated in hospital emergency rooms and released later that day.

Damage

Fire damage other than smoke damage at the MGM Hotel was almost entirely limited to the Casino level and second-floor office area. There was minor flame damage in one or two guest rooms on the fifth floor, plus heat and smoke damage on upper floors, but the major fire damage occurred in the Main Casino, the lobby areas at the main and Flamingo Road entrances, the hotel registration area, and the west end of the Hall of Fame. Severely damaged by fire were The Deli, the Orleans Coffee House, the Cafe Gigi, the Parisian Bar, the Cub Bar, the gift shop, and other areas at the top of the escalator and including the Casino-level elevators and elevator lobby. The second floor above the east end of the Casino received some fire damage and structural damage.

There was a distinct separation between damaged and undamaged areas that corresponded with the line between sprinklered and unsprinklered areas. No evidence of flame damage could be seen in the sprinklered Barrymores' Restaurant that adjoined The Deli on the south side. In the Hall of Fame, it was very evident that fire spread stopped where sprinkler protection began. The entrance to the Ziegfeld Room likewise showed very effective stopping of the fire south of the Main Casino, where sprinklers were provided.

Above the Casino level was little evidence of a major fire. There were no burned-out rooms or corridors so typical of other large-loss-of-life hotel fires in the past.

The guest rooms, in general, were also clean or free of smoke deposits. In some of the rooms on various floors,

Room 2068 (adjacent to elevator lobby on twentieth floor) where male victim was found next to open window in tipped-over chair. Room is typical of guest rooms throughout hotel, with little evidence of smoke or soot particles.

it was difficult to find any trace of smoke or soot deposits. The most evidence, in general, was found in the bathrooms, as compared with the sleeping areas. Some smoke deposits were visible inside the doors to the guest rooms, along the carpeting.

Heavy smoke conditions in the high-rise tower during the fire were documented. (See the full NFPA report of the MGM Grand fire, available from the NFPA Fire Investigations Department.) Apparently the lack of visible evidence of smoke particles after the fire in areas where occupants had reported that heavy smoke conditions existed was due to the continued operation of HVAC equipment in the hotel during the fire. The heavy particles of smoke were filtered out by the HVAC as the smoke within the mechanical penthouse was pumped through filters into corridors, and also by fan-coil units in rooms that filtered smoke from the corridor and within the room. This theory is reinforced by evidence of extremely heavy deposits of soot in the HVAC filters.

The amount of property damage dollar loss caused by the fire was not released to the NFPA by any representative of MGM. Estimates of property damage reported by Clark County Fire Department and Business Insurance magazine4 ranged from in excess of $30 million to a loss of $50 million. The MGM Grand Hotel fire was one of the largest property damage dollar-loss fires in the United States in 1980.

ANALYSIS

The following description and diagram of the origin and cause of fire were developed by the NFPA based upon the Clark County Investigation Report and on-the-scene observations made by the NFPA during the Clark County investigation. The investigation began late morning on the day of the fire, which was the earliest that investigators could enter The Deli following fire suppression operations. The entire area surrounding the Deli and including The Deli, Orleans Coffee House, and Barrymores' Restaurant was secured throughout the approximately nine-day duration of the on-site investigation.

The most probable source of ignition in this fire, as reported by the Clark County Fire Department, was heat produced in the west wall partition of The Deli serving station as a result of electrical short-circuiting (a ground fault) of an ungrounded electrical circuit conductor to a flexible metal conduit. This occurred in wiring

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5 Clark County Fire Department, MGM Report. Las Vegas: Clark County Fire Department, May 19, 1981.
6 Newspaper and magazine articles since the fire have suggested arson as a possible cause of the fire. At the time of issuance of this report, NFPA was unaware of any official finding or determination that arson was a probable cause.
Figure 5, The Deli serving station
within a combustible concealed space on the west side of a pie case in a waitresses’ serving station, along the south wall of The Deli. This wiring was an extension of the original wiring in The Deli serving station, and provided power to the refrigeration compressor unit and evaporator fan for the pie case located on the north wall of the serving station.

The wiring system for The Deli serving station originated in an electrical panelboard located in the Barrymore Room’s kitchen area. The wiring method used from the panelboard to The Deli consisted of ½-inch electrical metallic tubing (EMT) connected to a 4-inch square (trade size) receptacle outlet box located in the east wall of the serving station. Wiring from this outlet box supplied power to a refrigeration compressor and The Deli pie case. The wiring system used in the serving station was ¾-inch flexible metal conduit (aluminum).

The ¾-inch flexible metal conduit originated at the 4-inch square receptacle outlet box, and traveled upward within the serving-station wall, where it passed through a hole in the top metal plate. The flexible metal conduit then traveled across a length of ¾-inch electrical metallic tubing above the suspended ceiling to a metal junction box mounted above the ceiling. Two ¾-inch flexible metal conduits (aluminum) left this junction box; one went to the pie case and the other entered a void space between the pie case and the west wall partition next to the pie case.

The flexible conduit that traveled downward alongside the pie case was routed into the partition and then turned into the compressor compartment, where it terminated in an outlet box. The grounding of the electrical equipment for this installation was apparently intended to be accomplished by interconnection between the electrical metallic tubing, flexible metal conduit, and fittings. A continuous grounding path would be obtained by the proper connection of the raceways to the grounded panelboard enclosure.

The circuit wiring consisted of two number 12 AWG copper conductors spliced to circuit conductors in the receptacle outlet box in the serving station east wall. There was no separate equipment grounding conductor within the flexible metal conduit. Overcurrent protection was provided by a 20 ampere, single-pole circuit breaker.

The investigation revealed that where the flexible metal conduit was supposed to be mechanically and electrically connected to the receptacle outlet box in the east wall, the flexible metal conduit and the box connector were not in contact with each other. This was discovered within a closed wall with no direct fire damage.

The flexible metal conduit was not effectively grounded, but it was in contact with grounded surfaces. For example, the flexible metal conduit was lying across the metal supports of the suspended ceiling, the ½-inch electrical metallic tubing at the serving station east wall, and the horizontal sheet metal portion framing members at the top of the east wall. The aforementioned metal sections of the ceiling and metal studs, and the contact with the grounded electrical metallic tubing and horizontal framing member provided a relatively high impedance path to ground.

The ungrounded circuit conductor most likely came into contact with the flexible conduit, causing sparking and arcing to take place at the point of contact. The current followed a path along the flexible metal conduit to the ½-inch electrical metallic tubing at the serving station east wall, where arcing between the ½-inch electrical metallic tubing and the ¾-inch flexible metal conduit took place. Further arcing and heating took place where the flexible metal conduit passed through the horizontal metal framing member. The length of the flexible metal conduit between the ground-fault point and the point of contact between the flexible metal conduit and the ½-inch electrical metallic tubing was approximately 16 feet.

The ground-fault current traveling through the flexible metal conduit that was located within the concealed space between the plywood-covered pie case and the west-wall Deli partition caused high heat to develop in the flexible metal conduit. The temperature was high enough to cause melting of the aluminum flexible metal conduit from the point of the ground fault up to a point three feet above the ground fault.

Fire Growth and Development

The following section describes fire growth and development at the MGM Grand Hotel based on the NFPA analysis of collected data and observations made during the investigation. The fire most likely smoldered for a period of time before it broke out of the concealed space and into The Deli serving station at approximately 7:05 to 7:10 am. The first materials ignited included plywood used to enclose the pie case, and then the contents and interior finish of the serving station.

Initially, the probable movement of smoke was from the serving station to the return-air plenum through an air-transfer grill located in the ceiling within the serving station. Once open flaming took place, the fire began to spread on lightweight fuels and combustible interior finish. The fire then spread to The Deli from the serving station, consuming other available combustibles such as wood and decorative members and foam plastic padding on chairs and booths.

After The Deli became involved, the lack of sprinklers and fire-resistant barriers allowed the transfer of heat and smoke into the Casino. Large amounts of air flowing through the adjacent Orleans Coffee House and up from the Arcade through the open escalator provided a fresh

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Footnote: Wiring methods are described in NFPA 70, National Electrical Code.
air supply for the fire. The Casino contained combustible furnishings and contents, and combustible interior finish primarily in the form of plastic decorative trim and mirrored plastic ceiling panels. The presence of fuel, air supply, and a very large undivided area allowed for extremely rapid fire spread and heavy smoke production. The fire and its flame front developed out of The Deli and accelerated throughout the Casino until it reached the west end, where it “blew out” the doors and began to involve the porte cochere, which was fully involved with fire by 7:25 am.

Even though the entire Casino to the west of the area of fire origin became involved, the fire was very effectively stopped in sprinklered areas to the east. These sprinklers inhibited fire spread into the showrooms and to the Hall of Fame. In addition, even though the Orleans Coffee House was not sprinklered, the fire spread toward the east was restricted. A door from the Hall of Fame in the eastern end of the Orleans Coffee House was open at the time of the fire. This allowed air to flow in through the Orleans Coffee House from the sprinklered Hall of Fame, which is believed to have reduced the fire spread to the east within this space.

As the fire grew in The Deli and then in the Casino, large amounts of smoke spread through the plenum above the ceilings, along with a great deal of heat. This fire development resulted in the failure of the suspended ceiling system between the Casino and the “Eye in the Sky” security walkway system. Several unprotected vertical openings and vertical openings with enclosure deficiencies allowed the heat and smoke to spread to the high-rise tower. These vertical openings included seismic joints, interior stairways and smokeproof stair enclosures, toilet exhaust shafts, and other building service penetrations such as pipe chases.

The smoke spread in the interior stairways because the stairs were not enclosed with 2-hour fire-rated construction. In at least one interior stairway, W1, the exposed steel underside of the bottom of the stairway was directly open to the concealed space above the Casino ceiling. In addition, a space approximately 1/8-inch wide between the stair stringers and the gypsum wallboard construction had not been sealed off. These conditions allowed smoke and heat to penetrate the stairways. Nonfire-rated, sheet metal access panel doors were located in the interior stair enclosure walls, which also contributed to smoke spread into the stairs. The smokeproof stair enclosure located on the west end of the high-rise tower (W2) terminated above the Casino plenum. The bottom of the smoke shaft for the smokeproof tower consisted of 1/4-inch plywood that burned through, allowing the vertical spread of products of combustion. Smoke backed into the vestibules and was able to enter the stair shaft. Many of the vents from the smoke shaft were covered by exterior building sheathing. The plywood base also existed in the E2 stairway; however, since fire did not reach this end of the building, this base did not burn through and the stairway apparently remained usable throughout the fire. The S2 stairway accumulated smoke during the fire, but the exact means by which the smoke entered this tower was not determined.

Passenger elevator hoistways provided a major avenue for smoke and heat spread. The location of nine elevators, some with open doors, on or near the Casino level, and the failure of hoist ropes on two elevators, which allowed the cars to drop below the Casino level floor, created open hoistways for smoke and heat to travel upward. Heat and smoke spread out onto guest-room floors from the hoistway shafts.8

Unprotected vertical openings terminated in a plenum area above the twenty-sixth floor ceiling. Heat and smoke spread to this plenum and subsequently to the mechanical penthouse on the roof. In addition, some heat and smoke was able to pass through the top of the elevator hoistways through the cable slots to the high-rise passenger elevator room, and subsequently to the interior of the penthouse.

The air-handling units, which supply conditioned air down the shafts to the corridors of the high-rise portion of the building, were not equipped with smoke detectors arranged to shut down the systems upon detection of smoke. As a result, the units continued to operate, taking the smoke-laden air in the mechanical penthouse through their filters and continuing to pump it back down through shafts into the corridors of the guest-room portion of the hotel.

The fan-coil units for the individual guest rooms, as previously stated, took their make-up air from corridors. Depending on pressure differentials between the corridors and the guest rooms and whether or not the fan-coil unit was in operation, smoke in varying degrees migrated to the guest rooms. In most cases, gaskets around room doors reduced air movement; however, several guest-room doors were found that appeared to be undercut by at least 1/2-inch.

One guest reported that when he opened his exterior window, smoke began to pour out of the fan-coil unit; however, when he closed the window, the smoke was reduced. Evidently in this case, opening the window caused a pressure differential between the corridor and the room, allowing additional smoke spread.

Several bathrooms in the guest rooms were found to have heavier soot deposits on horizontal surfaces than were found in the guest rooms themselves. Smoke that was traveling vertically in some toilet ventilation systems overloaded their exhaust capacity and leaked into bathrooms.

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8 A thorough analysis of hoistway venting requirements and venting arrangement was not conducted during this investigation, but a survey of the elevators and hoistways was made by an investigation team for the American Society of Mechanical Engineers (ASME) A17 Safety Codes for Elevators and Escalators Committee. Their report will provide additional information in this area. ASME publishes ANSI A17.1, American National Standard Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks.
There was some evidence of smoke on the exterior of the building entering windows that had either been broken or opened. This was especially true on the west wing on the south face of the building. Even though this was a factor in smoke spread, it was relatively minor compared to the smoke spread within the building.

In addition to the major contributing factors in this fire, the following are significant additional findings of the NFPA investigation study. (For a detailed description of the major factors, see the full NFPA report of the fire, available from the NFPA Fire Investigations Department.)

1) The performance of automatic sprinkler protection in protected areas on the Casino level was excellent and halted the spread of fire into those areas. This performance is contrasted with extensive fire development and spread in nonsprinklered areas.

2) There was no evidence of a fire emergency plan being carried out, and there was some delay in notifying hotel occupants and the fire department. Following discovery of the fire (at 7:05-7:10 AM), the Casino-level fire evacuation announcement was not given until 7:15 or thereafter; and the fire department was not notified until 7:16. There was no evidence of a fire evacuation alarm signal alerting high-rise tower occupants. A number of victims were trapped by the flame front that moved through the Casino, and high-rise tower occupants became aware of the fire by means other than an alarm signal.

3) The number of exits and capacity of exits from the Casino at the time of the fire were deficient, based on the 1981 Edition of NFPA 101, the Life Safety Code.® These deficiencies were not necessarily directly related to the loss of life in the Casino, as the occupant load at the time of the fire was most likely much less than the actual exit capacity provided.

4) Travel distances in the Casino from certain areas such as the baccarat pit exceeded 150 feet. The Life Safety Code (1981 Edition) limits travel distance for places of assembly to 150 feet, except where sprinkler protection is provided, when travel distances up to 200 feet are allowed.


6) There was no automatic way to return elevators to the main floor in the event of fire, thereby preventing occupants from boarding elevators during a fire. Ten victims were found in elevators; although their exact actions could not be determined, the lack of an alarm and continued availability of elevators could have contributed to some of the fatalities. The location of elevator cars at the Casino level and open doors also contributed to smoke spread into elevator hoistways.

7) An estimated 300 persons were evacuated from the roof of the high-rise tower by helicopter.® Favorable factors in the MGM helicopter evacuation operation included clear weather, daylight hours, and an unusual availability of the participating Air Force helicopters.

Fire service operational problems during the helicopter operation suggest the following procedural considerations for future operations:

- Direct air-to-air and air-to-ground communications are necessary to coordinate helicopter operations by fire suppression and Emergency Medical Service incident commanders.
- Helicopters should avoid flying over command post and triage/treatment areas.
- Helicopter landing zones should be on grassy or paved areas, where possible.

® Note that in order to gain access to the roof, occupants had to force open a locked door.

The assistance of the Clark County Fire Department, especially Chief Roy Parrish, Deputy Chief John Pappageorge, Assistant Chief James Barrett, Captain William (Mike) Patterson, and other members of the Fire Investigation Team in preparing this report is acknowledged and greatly appreciated.

We acknowledge and thank numerous other agencies and representatives who were helpful during the investigation, especially the Las Vegas Metropolitan Police Department; Bureau of Alcohol, Tobacco and Firearms; the Clark County District Attorney's Office; Chief Deputy Coronor Richard A. Mayne, Office of the Coroner-Medical Examiner; and Emergency Medical Services Coordinator Karl Musniger, Clark County Health District.

The assistance of NFPA personnel is also acknowledged: John Callegaro, Assistant Electrical Field Service Specialist; James Bell, Washington Office, Legislative Technical Specialist; James K. Lathrop, Life Safety Code Specialist; Rita Faly, Mathematician; and Steven W. Hill, Fire Analysis Specialist.

Special thanks to A. Elwood Willey, Assistant Vice-President, Research & Fire Information Systems, for his guidance to investigators throughout the investigation and documentation of this fire; and to Geraldine Noonan and Lucy Hirshberg, Project secretaries.

A close working relationship between the NFPA and the United States Fire Administration of the Federal Emergency Management Agency (FEMA) has existed for many years. That association was continued during this investigation, and the assistance of Tom Klem, Fire Data Specialist, and Tom Wright, Director of Fire Data Systems, USF/FEMA, is appreciated and acknowledged.

Finally, information provided by Dr. John Bryan (Professor and Chairman of the Department of Fire Protection Engineering, University of Maryland), through his examination and analysis of the dynamics of the human behavior in the MGM Hotel fire, was extremely helpful and is appreciated.

The objective of the NFPA report and this article is to document and analyze a very significant fire in order to prevent a recurrence of such a multiple-death loss in the future. In view of the loss of life in the high-rise tower and Casino areas, the scope of this report is limited to those portions of the MGM Grand Hotel complex pertinent to an examination of fire problems and factors associated with the loss of life.

During the period that this report was being developed, the NFPA was advised that litigation had been initiated concerning the fire at the MGM Grand Hotel. It is not the NFPA's intention that this report pass judgment on, or its liability for, the loss of life and property at the MGM Grand Hotel.