

INVESTIGATION REPORT ON THE MGM GRAND HOTEL FIRE

**Las Vegas, Nevada
November 21, 1980**

Report Revised: January 15, 1982

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In cooperation with
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UNITED STATES FIRE ADMINISTRATION
and NATIONAL BUREAU OF STANDARDS



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Finally, information provided by Dr. John Bryan through his examination and analysis of the dynamics of the human behavior in the MGM Hotel was extremely helpful and is appreciated.

ABSTRACT

A fire at the MGM Grand Hotel on November 21, 1980, resulted in the deaths of 85 guests and hotel employees. About 600 others were injured and approximately 35 fire fighters sought medical attention during and after the fire.

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

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 waitresses' 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 due to smoke spread into stairways, exit passageways and through corridors.

The high-rise tower evacuation alarm system apparently 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 yelling or knocking on doors. Many occupants were able to exit unassisted down stairs. Others were turned back by smoke and sought refuge in rooms. Many broke windows to signal rescuers or to get fresh air. The fire department confined the fire to the Casino level in a little over one hour. It was approximately four hours before all guests were evacuated.

Of the 85 fatalities, 61 victims were located in the high-rise tower, and 18 were on the Casino level. Five victims were moved before their locations were documented. The 85th victim died weeks after the fire. Of the 61 victims found in the high-rise tower, 25 were located in rooms, 22 were in corridors, 9 in stairways and 5 were found in elevators. One person died when she jumped or fell from the high-rise tower.

The major factors that contributed to the loss of life that occurred as a result of this fire incident are the following:

- Rapid fire and smoke development on the Casino level due to available fuels, building arrangement, and the lack of adequate fire barriers.
- Lack of fire extinguishment in the incipient stage of fire.
- Unprotected vertical openings contributed to smoke spread to the high-rise tower.
- Substandard enclosure of interior stairs, smokeproof towers and exit passageways contributed to heat and smoke spread and impaired 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.

I INTRODUCTION

The National Fire Protection Association (NFPA) investigated the MGM Grand Hotel fire in order to document and analyze significant factors resulting in the high loss of life. This study was conducted 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 NFPA, FEMA, and NBS.

The National Fire Protection Association became aware of the MGM Grand Hotel fire on November 21, 1980, and a Fire Analysis Specialist was dispatched immediately, arriving at the MGM 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 and through the Clark County Fire Department. This report presents findings from the NFPA data collection and analysis effort.

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 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 investigation report.

As a separate research project, a human behavior study of hotel occupants was conducted by NFPA to examine and analyze the dynamics of the human behavior in the MGM Hotel fire. The principal investigator for the study was Dr. John L. Bryan, Professor and Chairman, Department of Fire Protection Engineering, University of Maryland. The Human Behavior Study, *An Examination and Analysis of the Dynamics of the Human Behavior in the MGM Grand Hotel, Clark County, Nevada, on November 21, 1980*, will be available as a separate published report from NFPA.

This report is another of NFPA's studies of fires having particularly important educational or technical interest. The information presented is based on the best data available immediately after the fire incident and that obtained during subsequent follow-up.

This report describes fire safety conditions at the MGM Grand Hotel and presents findings on contributing factors to the loss of life based on the NFPA analysis of collected data and observations during the investigation. NFPA codes and standards were used (except where otherwise noted) as criteria for this analysis so that conditions at the MGM Hotel on the date of the fire could be compared with current fire protection practice as represented by NFPA codes and standards in existence when the report was written. It is recognized that these codes and standards may not have been in effect in Clark County during construction or operation of the MGM Hotel. NFPA has not analyzed the MGM Grand Hotel as to compliance with the codes or standards which were in existence

in Clark County when the MGM Grand Hotel was built or during its operation.

At the time of publication of this report, materials identification verification and fire hazard characteristic test results of interior finish and contents samples were not available. Additionally, some building design drawings and detailed construction specifications were not available. Detailed hotel emergency plan documentation regarding alarm procedures and occupant evacuation was not obtained and reviewed. Additional information on this fire may exist which will further amplify aspects of the report.

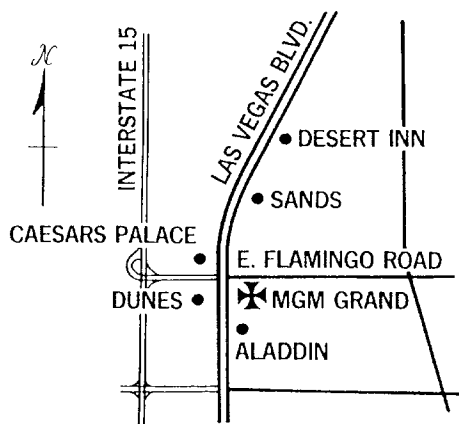
The objective of this report is to document and analyze a very significant fire incident in order to prevent a recurrence of such a multiple death loss in the future. In view of the loss of life in the high-rise tower and Casino areas, the scope of this report is limited to those portions of the MGM 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, NFPA was advised that litigation had been initiated concerning the fire at the MGM Grand Hotel. It is not NFPA's intention that this report pass judgment on, or fix liability for, the loss of life and property at the MGM Grand Hotel.

II BACKGROUND

OVERVIEW

The MGM Grand Hotel was located on the southeast corner of the intersection of East Flamingo Road and Las Vegas Boulevard. The 23-story building (the hotel numbering system indicated 26 levels — see Figure 4) was constructed during 1972 and 1973 and opened in December of 1973. This building was not located within the limits of the City of Las Vegas, but was located in the jurisdiction of Clark County as are most of the large hotels on the famous Las Vegas “Strip.”



The building 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 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 gross dimensions of the Casino and Arcade levels were approximately 380 feet by 1200 feet. The Casino itself was approximately 150 feet by 450 feet. The hotel, consisting of three wings, was located above the Casino and Arcade levels. (See Figures 2 and 3.) Each wing was approximately 70 feet by 320 feet. The “T” shaped tower contained approximately 2,083 guest rooms.

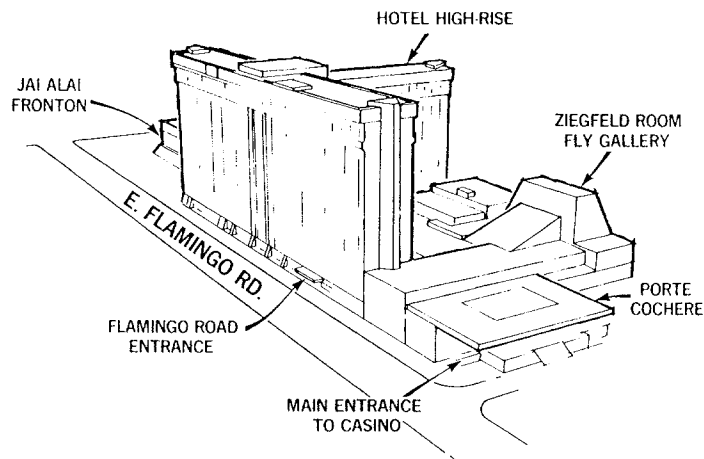


Figure 1. Perspective view from northeast.

TERMINOLOGY

Arcade: The Arcade level, also known as the Grand Arcade level, and Grand Shopping Arcade, was the level below the Casino level. Numerous shops and services (such as health spas) were located on the Arcade level, in addition to the entrance to the MGM movie theatre.

Flamingo Road Entrance:	The north entrance and exit from Main Casino area, referred to also as Flamingo entrance, side entrance, side door, and north entrance.
Elevators:	Sixteen passenger elevators were located on the east end of the Main Casino, along the north-outside wall. Eight service elevators were across the lobby to the south. "Elevators" refers to the passenger elevators if not otherwise specified.
"Eye in the Sky":	A security walkway within the interstitial space above the Casino ceiling from which the gaming tables could be observed.
Fronton:	A jai alai arena, located at the easternmost end of the Casino level.
High-Rise:	Any building, the upper floors of which are beyond the reach of aerial equipment, and in which fires must be fought from the inside. Various code definitions refer to different heights. The MGM Grand Hotel is considered a high-rise building. In reference to the MGM Hotel in this report, "high-rise" or "high-rise tower" means the guest room floors 5-26 as opposed to the Casino or Arcade levels.
Interstitial Space:	The concealed space between the ceiling and roof of the Casino level.
Jai Alai:	A court game somewhat like handball played on a three-wall court with a ball and a long curved wicker basket. Spectators may bet on the game's outcome.
Keno:	A game resembling bingo. Numbers are bet or played and displayed on a back-lit board.
Main Entrance:	The entrance to the Main Casino from under the porte cochere, located at the west end of the Casino, also referred to as the front entrance.
Orleans Coffee House:	Also called the Coffee Shop in statements by employees and guests.
PBX:	Telephone company abbreviation for Private Branch Exchange.
Porte Cochere:	The canopy or roofed structure extending from the main entrance of the Casino over the adjacent driveway and sheltering those getting into and out of vehicles.

Seismic Joint: A shaft separating wings of the hotel to minimize damage to the building by earthquake or earth vibration.

Serving Station: Located on the south wall of The Deli, referred to in statements and other reports as: bus station, bus station number 2, bus station area, bus area, Deli station, Deli substation, Deli side station, side station, station, side stand, side stand number 2, and waitress station.

The Deli: The Deli Restaurant is also referred to in statements and other reports as: Deli, Deli Room, and Deli Area.

PUBLIC FIRE PROTECTION

Three separate departments, the Clark County Fire Department, the Las Vegas Fire Department, and the North Las Vegas Fire Department, provide fire protection to the Greater Las Vegas Valley metropolitan area. The area includes Las Vegas City and "The Strip," which, as noted, is located in Clark County, not in the City of Las Vegas.

Clark County Fire Department

The Clark County Fire Department's geographic jurisdiction is divided into three areas: the McCarran International Airport; the 130-square-mile county area outside the greater Las Vegas Valley, which is protected by twelve volunteer fire departments; and the greater Las Vegas Valley area.

In the greater Las Vegas Valley, the Clark County Fire Department operates as a fully-paid department. The department is headed by a chief and deputy chief; three assistant chiefs are in charge of suppression activities, supplies and logistics, and fire prevention and investigation activities. There are eight battalion chiefs, six of whom are assigned to structural fire suppression. One is assigned to crash fire/rescue, and one is assigned to training.

Fire suppression personnel are divided into three platoons, each working a 24-hour shift. They man thirteen engines, six rescue units, two hose wagons, three ladder trucks, five crash fire/rescue units, plus an additional tanker, a light unit and other support apparatus located in twelve stations.

The boundary between Clark County and Las Vegas City is at Sahara Boulevard. One Las Vegas

City station and five Clark County Fire Department stations are in the immediate vicinity of "The Strip."

CODES AND ENFORCEMENT

The following codes were in effect in Clark County, Nevada according to the Clark County Office of Building and Safety in 1972 and 1973:

1. *Uniform Building Code*, 1970 edition.
2. *Uniform Mechanical Code*, 1970 edition.
3. *Uniform Plumbing Code*, 1970 edition.
4. *National Electrical Code*®, 1968 edition.

The County Office of Building and Safety had primary responsibility for code enforcement during the construction phase of projects. The Fire Department did not have any building code enforcing authority.

Reportedly, a system of on-site resident inspectors was used for the code enforcement procedure during the building process. These inspectors were hired by the Clark County Office of Building and Safety which in turn was reimbursed by the Hotel.

Note that NFPA has not analyzed the MGM Hotel as to compliance with the codes or standards which were in existence in Clark County when the MGM Grand Hotel was built or during its operation.

WEATHER CONDITIONS

The weather conditions on November 21, 1980, were recorded by the National Weather Service at McCarran International Airport, Las Vegas, Nevada. (See Table 2.1.)

Table 2.1

Time	Temp. (°F)	Wind Direction	Wind Speed (Knots)
7:00 A.M.	38	W/SW	6
8:00 A.M.	42	N/NW	5
9:00 A.M.	52	—	calm
10:00 A.M.	56	—	calm
11:00 A.M.	58	NE	5
12:00 noon	61	E	5
1:00 P.M.	62	SE	5
2:00 P.M.	64	—	calm
3:00 P.M.	64	E/NE	5
4:00 P.M.	63	N/NW	5

THE BUILDING

The Main Casino and The Deli

The Main Casino extended approximately one-third the length of the Casino level. The main entrance to the hotel and Casino was on the west end of the Casino. Another entrance from East Flamingo Road was on the north side, with the hotel registration desk between the two entrances. The Ziegfeld and Celebrity Showrooms were south of the Casino. Elevators to the high-rise tower were northeast of the Casino; east and southeast were the restaurants — the Orleans Coffee House, The Deli, Barrymores', Caruso's and Cafe Gigi. (See Figure 7.) The restaurants were below the south wing of the high-rise tower.

Above the Main Casino ceiling was a security walkway called the "eye in the sky." Reportedly, the gaming tables could be observed through vision panels from the walkway which was in the concealed space between the Casino ceiling and the roof above.

The Deli entrance was just south of the stairs and escalator leading from the Casino level to the Arcade level and MGM Theatre. There were three waitresses' serving stations in The Deli; serving station number one was on the north side, serving station number two on the south and serving station number three was on the east wall. (See Figure 11). "Serving Station" refers to serving station number two in this report unless otherwise noted.

A pie or pastry case was built into the north wall of serving station number two, accessible from the customer side. Above the entrance to the serving station was a Keno board.

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. The low-rise portion included protected noncombustible construction; however, large areas of structural steel had either never been protected or, over the life of the building, the protection had been removed. Classification, according to NFPA 220-1979, *Standard on Types of Building Construction*, included 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 were of gypsum wallboard on steel studs. Most partitions extended above ceilings; however, in some cases there were openings in the partitions above the ceilings. These openings facilitated 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 high-rise tower south wing.

The ceiling assembly in The Deli was 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 gypsum wallboard on steel studs. The finish material observed on the south wall just west of the serving station and behind the hostess' desk appeared to be a vinyl covering approximately $\frac{1}{16}$ -inch thick. On the north wall of The Deli was ceramic tile around a bar, down to a three-foot chair rail level. Below the chair rail was a vinyl wall covering on gypsum wallboard.

The Deli was remodeled in 1978. It appeared that the interior finish materials were applied over other layers of material, such as vinyl wall covering.

The floor of The Deli had carpeting with a fiber-type pad over the concrete deck. (See Appendix A for carpet fire test results performed by the National Bureau of Standards.)

Just north of the entrance to The Deli was a display case made of wood containing pies and cakes. Around booths in The Deli were wooden columns that were 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 within The Deli was $\frac{3}{8}$ -inch gypsum wallboard on steel studs. Vinyl wall covering on the wallboard was covered with $\frac{1}{2}$ -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 $\frac{1}{4}$ -inch wood paneling which in turn was covered by $\frac{1}{8}$ -inch wood paneling. The ceiling of the serving station had plastic laminate adhered to $\frac{3}{8}$ -inch thick gypsum wallboard.

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

The Casino interior finish included plastic decorative trim such as simulated marble, wood

decorative trim and plastic mirrors in the ceiling. These mirrors were reported to be made of methyl methacrylate. This plastic mirrored appearance continued to the porte cochere on the west exterior of the Casino which had over three hundred, 30- by 30-inch such reflective panels.

In general, the fuel load in The Deli and Casino areas was provided by contents in addition to 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 wrap-around booths, which also appeared to be padded with thick polyurethane foam and covered with a vinyl material. (See Figure 11.)

The fuel load in the Casino, approximately 68,000 square feet in area, included furnishings, other contents and interior finishes comprised of plastic materials that appeared to have included polyvinyl chloride, polyurethane, polystyrene and methyl methacrylate. The Casino furnishings included gaming tables with thick foam plastic padding with plastic covering around the edges. The seating for restaurants and lounges contained foam plastic padding. In addition, the area above the ceiling of the Casino contained a fuel load in the form of plastic insulation on electrical power distribution and communications wiring.

Enclosure of Vertical Openings

For the purpose of this report, stairs have been identified S1 and S2 (south wing), E1 and E2 (east wing), and W1 and W2 (west wing). (See Figure 5.)

The enclosure walls of the stairways and the exit passageways were gypsum wallboard on metal studs. The stairways were enclosed by two layers of $\frac{3}{8}$ -inch gypsum wallboard on each side of the studs. The exit passageways were enclosed with two layers of $\frac{1}{2}$ -inch gypsum wallboard on each side of the studs for walls

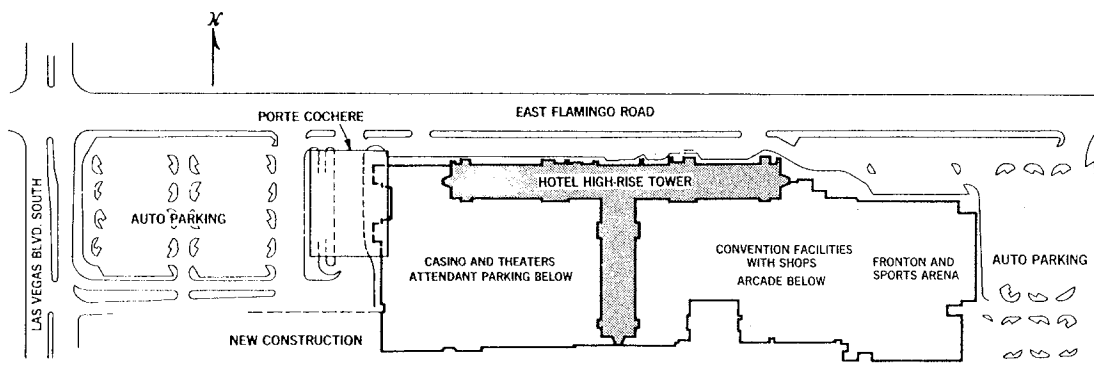
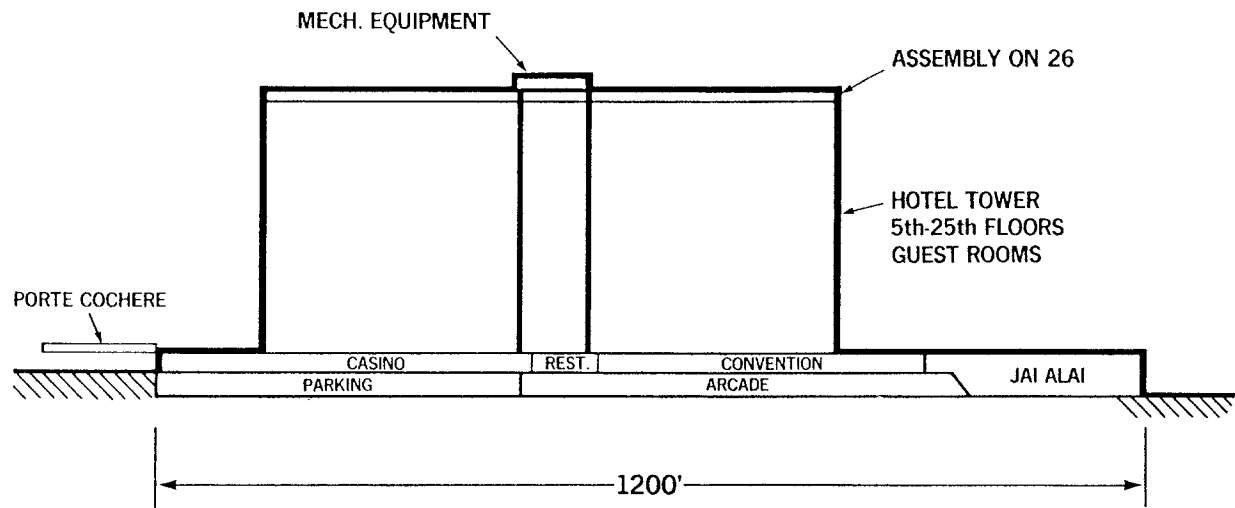


Figure 2. Site plan.



ELEVATION
(Facing north)

Figure 3.

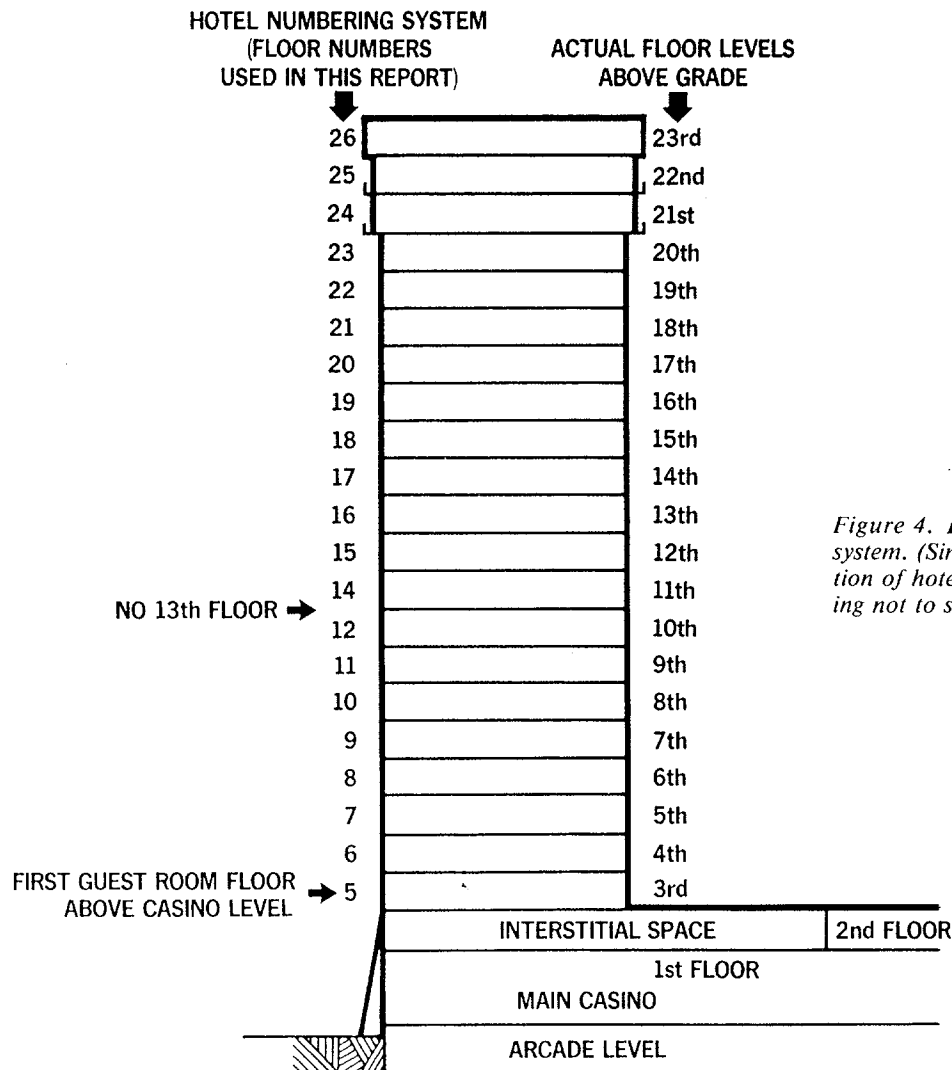


Figure 4. Floor numbering system. (Simplified representation of hotel west wing. Drawing not to scale.)

and one layer of $\frac{5}{8}$ -inch gypsum wallboard for ceilings. In many places the enclosures were not complete which resulted in spaces of approximately $\frac{1}{8}$ inch in width running the entire length of the stair stringers. In addition, in many locations fire protection for the steel components of the stairs was nonexistent. (See Photo top left, page 57.) These 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 stairs were smokeproof towers, consisting of stairways connected to the floors by exit vestibules. The vestibules were vented directly into smoke shafts that terminated at the top of and within the stair shafts. The smoke shafts were naturally vented directly to the outside. Many of the vents from the smoke shafts were covered by exterior sheathing of the building. 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. A plywood base also existed in the E2 stairway.

Elevator hoistways were enclosed with 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, there were 6-by 6-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 there were several gypsum wallboard vertical shafts that were used for toilet exhaust ducts from guest rooms.

The building was designed with two seismic joints. These seismic joints 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 above the Casino level were shafts approximately 12 inches wide extending from the interstitial space above the Casino level ceiling through the high-rise tower to the roof. Openings in wall areas created by the 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 with rated construction. Also, openings at the bottom of these shafts in the concealed space above the Casino were unprotected.

Means of Egress

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

The guest room tower was a fairly typical double-loaded corridor arrangement (rooms on both sides of the corridor) served by six stairways. These six stairways were evenly distributed, with two stairways serving each of the three wings. Each wing had a smokeproof tower at the end of the wing and an interior stairway located approximately one-third of the distance from the elevator lobby to the end of the wing. The stairs were equipped with illuminated exit signs at each door and also signs on the doors stating:

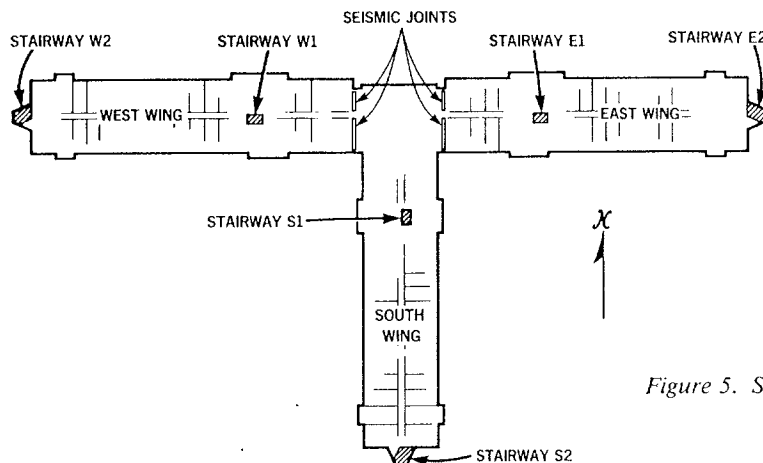


Figure 5. Stair locations.

EMERGENCY FIRE EXIT ONLY—NO ACCESS TO OTHER FLOORS.

With the exception of E2, all the stairways discharged to the outside via enclosed horizontal exit passageways located within 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 in length. (See Figure 8.) The intent of the exit passageways was to connect the bottom of the stair towers to the outside, providing continuous paths of exit travel. Stairway E2 discharged directly to the outside without going through an exit passageway.

Access to guest room floors (5th through 26th) from the Casino level was by elevator only. There were stairs and an escalator between the Casino and Arcade levels, but once above the Casino level, on the high-rise guest room floors, guests could not travel between floors by stair. Upon entering the stairways from corridors, the self-closing doors locked to prevent return to the corridor or entry to other floor levels. The expected course available to anyone entering the stairways was to travel down the stairs to ground level where discharge of all six stairs was to the outside. The stairways at the ends of each wing also led to the roof (S2, E2, W2), however, doors to the roof were locked.

Means of exit from the Casino level consisted of stairs off the main corridor (Hall of Fame) that served the convention section, doors on each side of the Flamingo Road entrance as well as the doors at

the Flamingo Road entrance, the Main Entrance and doors to the southwest of the Casino floor along with a series of doors and stairs off the service corridor along the south side of the building. (See Figure 7.)

A further discussion of the means of egress requirements is presented in Analysis, Section E, *Life Safety Code Analysis*.

Fire Alarm System

The building was equipped with a fire alarm system that had the main control panel located in the PBX room on the Arcade level, 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, not in the security office.)

There were no manual alarm initiation devices located on the Arcade, Casino, or second floor levels other than 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 (5th through 26th) of the building.

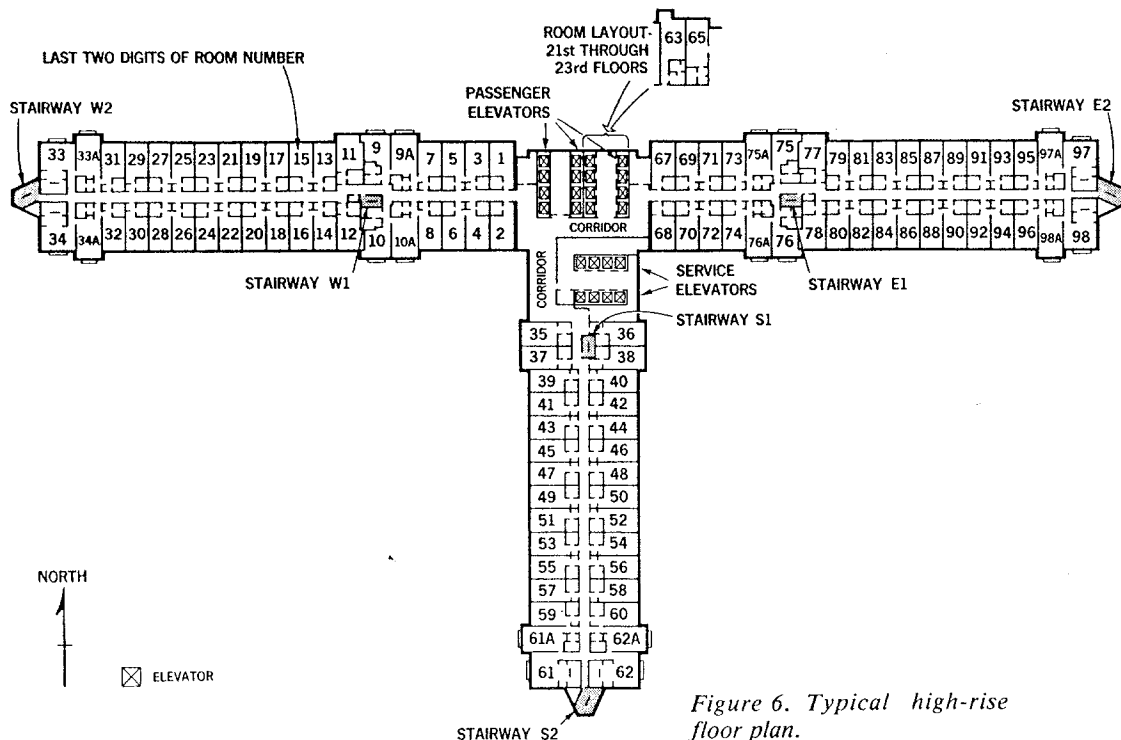


Figure 6. Typical high-rise floor plan.

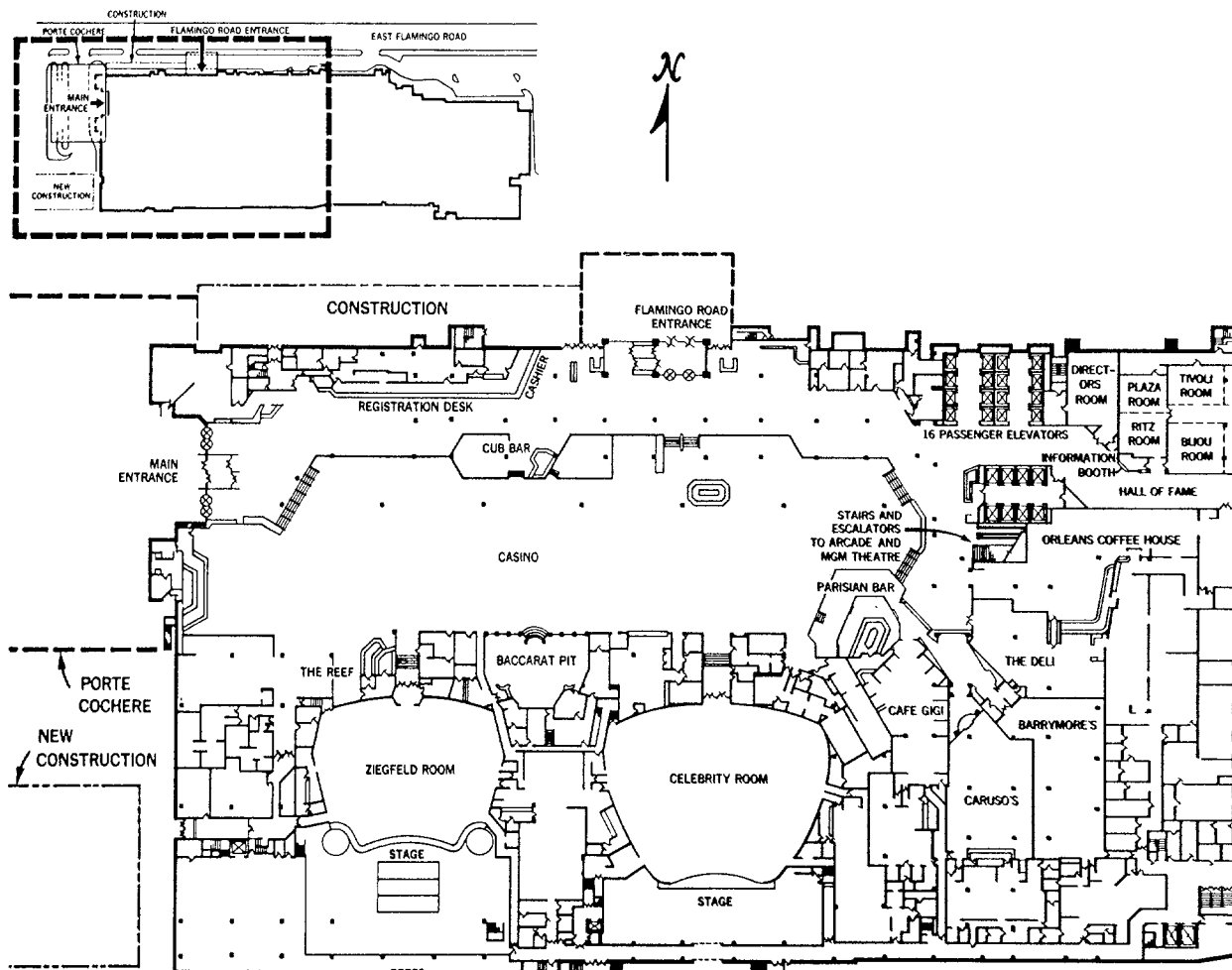


Figure 7. Casino level. (Above — area shown in detail)

Each floor had seven pull stations; there was one at each stairway and one in the central core area near the elevator lobbies. Additionally, each floor was provided with evacuation alarm sounding devices.

The fire alarm system had a pre-signal feature. The sounding of evacuation alarms for the building appears to have been designed to be operated only by manually-activated devices at annunciator panels. (The public address system could be used to alert occupants of the Casino level to a fire emergency.) Activation of alarm initiation devices would transmit signals to the fire alarm annunciator panels. Hotel security personnel would then be sent to investigate the source of the alarm. In addition, the alarm signal was automatically transmitted to a remote central station. However, the alarm would not be telephoned to the fire department by central station personnel until after an initial five-minute delay period. The

alarm would then be transmitted to the fire department if the MGM system had not been reset or if a fire was confirmed by telephone.

With respect to the MGM fire, there have been no reports of any fire alarm signal sounding during the entire fire incident. However, in the early stages of the fire, according to statements by PBX operators, announcements were made to evacuate the Casino over the public address system.

There were three emergency generators for the building. Two were in the central plant and one was within the mechanical equipment penthouse on the roof.*

*Reportedly, the two generators in the central plant operated during the fire, but the one in the penthouse on the roof did not. Further data was not available and this information was not verified.

Fire Suppression Systems

Large portions of the Casino and Arcade levels of the building were protected with automatic sprinklers. The Main Casino, The Deli, and the Orleans Coffee House (all within the fire area), however, were not protected with automatic sprinklers.

The determination of whether sprinklers were required or not 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. It could not be determined why certain areas were provided with sprinkler protection and others were not. Apparently, the final determination was based upon the hours of operation of the area in question. Those areas not operating on a 24-hour basis were required to have automatic sprinkler protection. 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 were not installed in this area.

The assembly areas on the 26th floor were also protected with automatic sprinklers; however, none of the other high-rise floors (5th through 25th) was protected with sprinklers.

The building had standpipes with fire department connections located in each stairway and hose outlets on the roof. The system was designed to have a residual pressure of 50 psi on the roof with 500 gpm flowing from the hydraulically most remote standpipe on the roof while flowing 250 gallons per minute from each of the other standpipes. Occupant-use hose in cabinets with breakable glass fronts was located throughout the building, including guest room floors and the Arcade and Casino levels.

Water supply to the building was through large public mains. Hydrants were distributed throughout the area. Hydrants connected to an 8-inch loop around the hotel were fed from a 10-inch public main in East Flamingo Road. The 10-inch main was fed from two directions, including a 30-inch main in Las Vegas Boulevard South. A 24-inch main was located on the north side of East Flamingo Road. Twenty-four- and 36-inch mains were located in intersecting streets east of the hotel. The building was also equipped with a 2,000-gpm diesel-driven fire pump.

Mechanical Systems

The MGM Grand Hotel had four subsystems for heating, ventilation and air conditioning (HVAC) that were significant relative to this fire incident. The four subsystems were for the Main Casino, tower

corridors, individual guest rooms and toilet exhaust. There were several other HVAC subsystems in the building.

The Main Casino, showrooms, and adjacent spaces (including The Deli) had air conditioning provided by a large variable air volume system. There were two large mixing rooms located on the second floor on the southern side of the Casino. (See Figure 12.) Each of the two mixing rooms had three 60,000 cubic feet per minute (cfm) air handling units in addition to fresh air intakes, heating coils, other small air

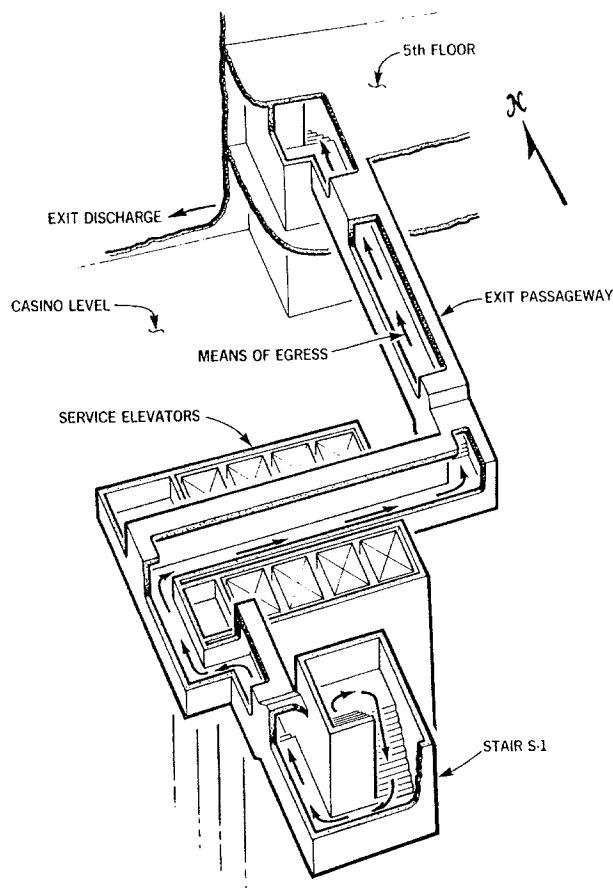


Figure 8. Exit passageway. (Simplified representation of Stairway S1 passageway. Drawing not to scale.)

conditioning and ventilation units, and related equipment such as dampers and filters. Air moving through the 60,000 cfm units was double filtered.

Chilled and heated water was piped to the mixing rooms from the main power plant and cooling towers located on the southeast corner of the building. The mixing rooms were not fire-rated compartments due

to various penetrations in the enclosures. Fire dampers were provided in the supply ducts and return air control assemblies where they penetrated the mixing room walls above the Casino ceiling. The automatic (fusible link-activated) function of fire dampers for two return air control assemblies had been impaired prior to the fire in the easternmost mixing room. This was done by bolting steel straps across the dampers so they could not close. In addition, it was noted that several dampers had fusible links replaced with steel wire.

One of the mixing rooms was protected with automatic sprinklers. This room was also used for storage and as a field office area. No smoke detectors were noted anywhere in the air handling equipment during the NFPA investigation.

Supply air was distributed by sheet metal ducts and flexible connectors to the various rooms on the Casino level. Return air was 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. The entire area over the Casino ceiling, including the Main Casino, the showrooms and restaurants, was one plenum without fire walls or fire dampers. The following are notes from the building's mechanical drawings:

"When interior partitions close off one room from another provide openings above ceiling of 2 square feet to allow passage of air from one space to another."

"Check air passages thru (sic) attic spaces to insure free return of stage air and theater air to main Casino ceiling plenum, provide added openings thru (sic) main fire separation walls if required with fire dampers where required."

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 located on the roof. This penthouse also contained the service elevator and high-rise passenger elevator equipment, two air condition-

ing units for the 26th floor assembly areas, and 26th floor kitchen ventilation units. There was a large return air plenum for the 26th floor between the 26th floor and the roof and penthouse. There were several unprotected openings from this plenum into the penthouse. There were fire dampers adjacent to the return air control dampers from the assembly areas.

There were four air handling units for the tower corridors. A 43,200 cfm unit supplied the center lobbies. The three other units, one for each wing, were rated at 48,000 cfm each. These units took their air, through double filters, directly from within the penthouse. The penthouse was open at the roof line through louvers to the exterior. No smoke detectors were found within these air handling units.

The tower air conditioning units fed through fusible 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. (See Photo bottom left, page 54.) 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. (See Photo bottom right, page 54.) These were 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. This air was filtered along with air that was recirculated within the room. Cooling was provided by piped chilled water and heating provided by electrical resistance heat tape.

There were sixteen toilet exhaust fans located on the roof that, reportedly, ran continuously. They varied in size from 1625 cfm to 19,600 cfm. These provided exhaust from all the guest rooms. There were several vertical ducts that were used for toilet exhaust from guest rooms throughout the tower. These ducts were connected to the toilet exhaust fans on the roof through duct headers that traveled horizontally above the 25th-floor ceiling and then vertically to the roof. Several of the ducts 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, an infrared type, was on a timer switch. The 80-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.

Elevator Systems

There were three main banks of elevators serving the MGM Grand Hotel. These three banks and the levels served were the following:

Elevator Designations	Levels Served
P1-P8, Low-rise passenger	Arcade, Casino, 5-16
P9-P16, High-rise passenger	Arcade, Casino, 16-26
S1-S8, Service	All Levels

The Arcade level was considered the “dispatch level” or main floor level. Fire fighter manual recall key-activated switches were provided on the Arcade level. The two banks of passenger elevators opened directly onto elevator lobbies. There were no enclosed passenger elevator vestibules. The service elevators were enclosed with non-fire-rated construction.

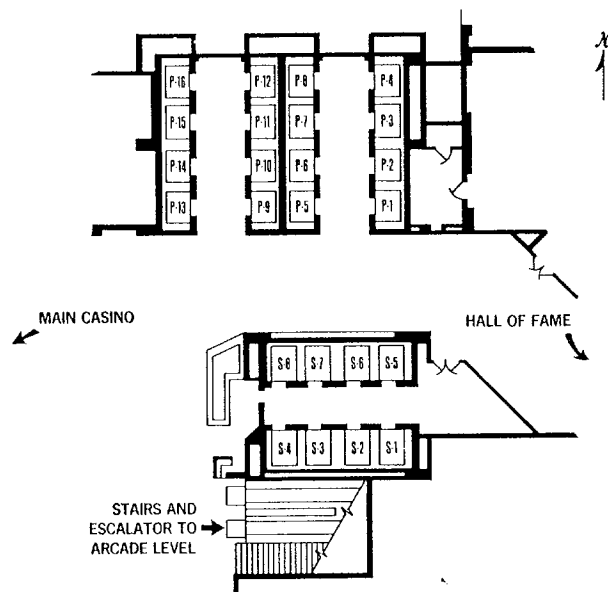


Figure 9.

*See NFPA 90A, *Air Conditioning and Ventilating Systems*, 1978, 3-3.3.3, Exception No. 2 for requirements and arrangements for subducts in vertical exhaust risers.

The venting of elevator hoistways is indicated in Figure 10. The common hoistway for passenger elevators P1 through P4 was vented directly to the exterior on the north face of the building. The low-rise elevator hoistway for elevators P5 through P8, which was back-to-back with the high-rise hoistway for elevators P9 through P12, was vented into the high-rise hoistway and also to the P1-P4 hoistway.

The high-rise elevator hoistway for elevators P9 through P12 was vented through a duct to the hoistway for passenger elevators P13 through P16. This hoistway had a screened opening to the exterior of the building at the roof level. It was reported that this vent had been restricted to 35 by 36 inches with a piece of plywood.

Information regarding the venting of the service elevator hoistways was not obtained; however, this hoistway was not a significant factor in the spread of heat and smoke during this fire incident.

CASINO AND HOTEL OPERATIONS

A new guest room wing was under construction west of the Ziegfeld Room on the date of the fire. The 800-room addition was not connected to the hotel complex at the time of the fire and the new construction was not involved in the fire. Construction workers who participated in fire fighting and rescue operations at the MGM were from this construction project.

The major entertainment and dining facilities at the MGM Hotel were on the Casino and Arcade levels. The Main Casino was located on the lobby floor with roulette, blackjack (twenty-one), craps, baccarat and slot machines. Keno was played in the 200-seat Keno Lounge, as well as in The Deli, the Orleans Coffee House, and the cocktail lounges. Electronic Keno scoreboards showing game information and recording the numbers being drawn for each game were located in restaurant and lounge areas.

The entertainment rooms included the Celebrity Room, a 1,200-seat nightclub; the Ziegfeld Room, a 900-seat showroom with moving stages; and the MGM Theatre, a movie theater with tiered seating. The two showrooms off the Main Casino were closed at the time of the fire and reportedly were not scheduled to reopen for several weeks.

The jai alai fronton, located on the east end of the hotel complex, provided tiered seating for 2,176 spectators.

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

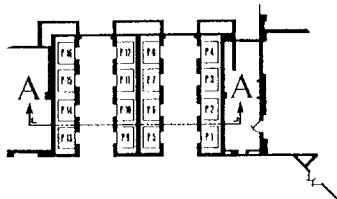
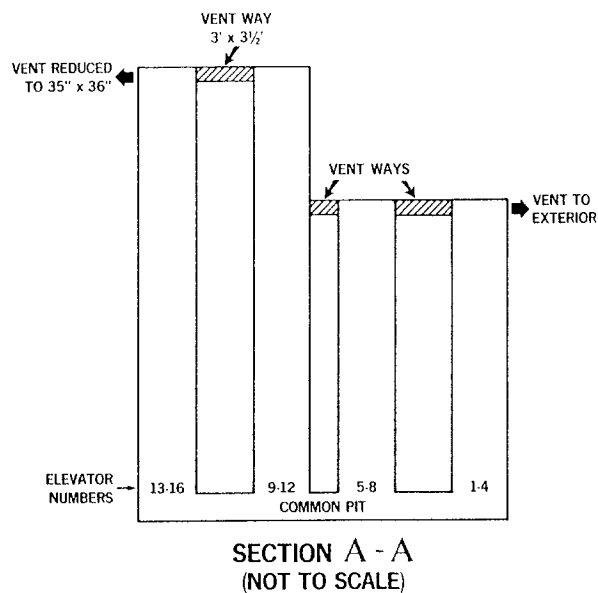


Figure 10. MGM passenger elevator hoistway arrangement.

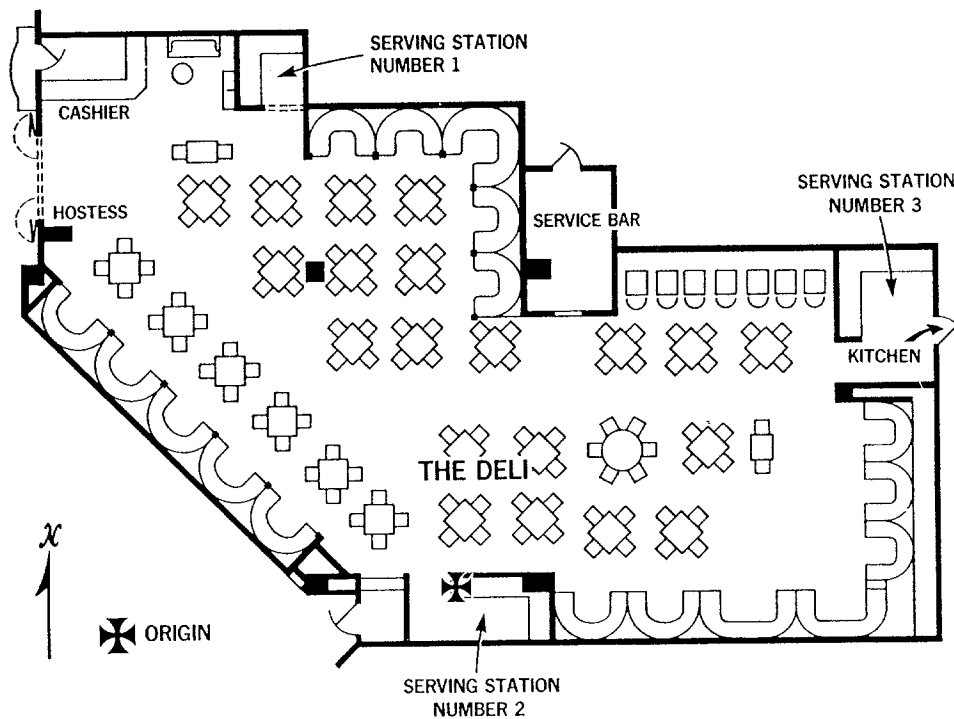


Figure 11. The Deli floor plan.

— were open during dinner hours. The Orleans Coffee House operated 24 hours a day; however, The Deli was no longer operating around the clock and was closed on the morning of November 21, 1980.

In summary, the Main Casino was operating on the morning of the fire, although it is estimated that very few people occupied the Casino at about 7:00 A.M. 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.

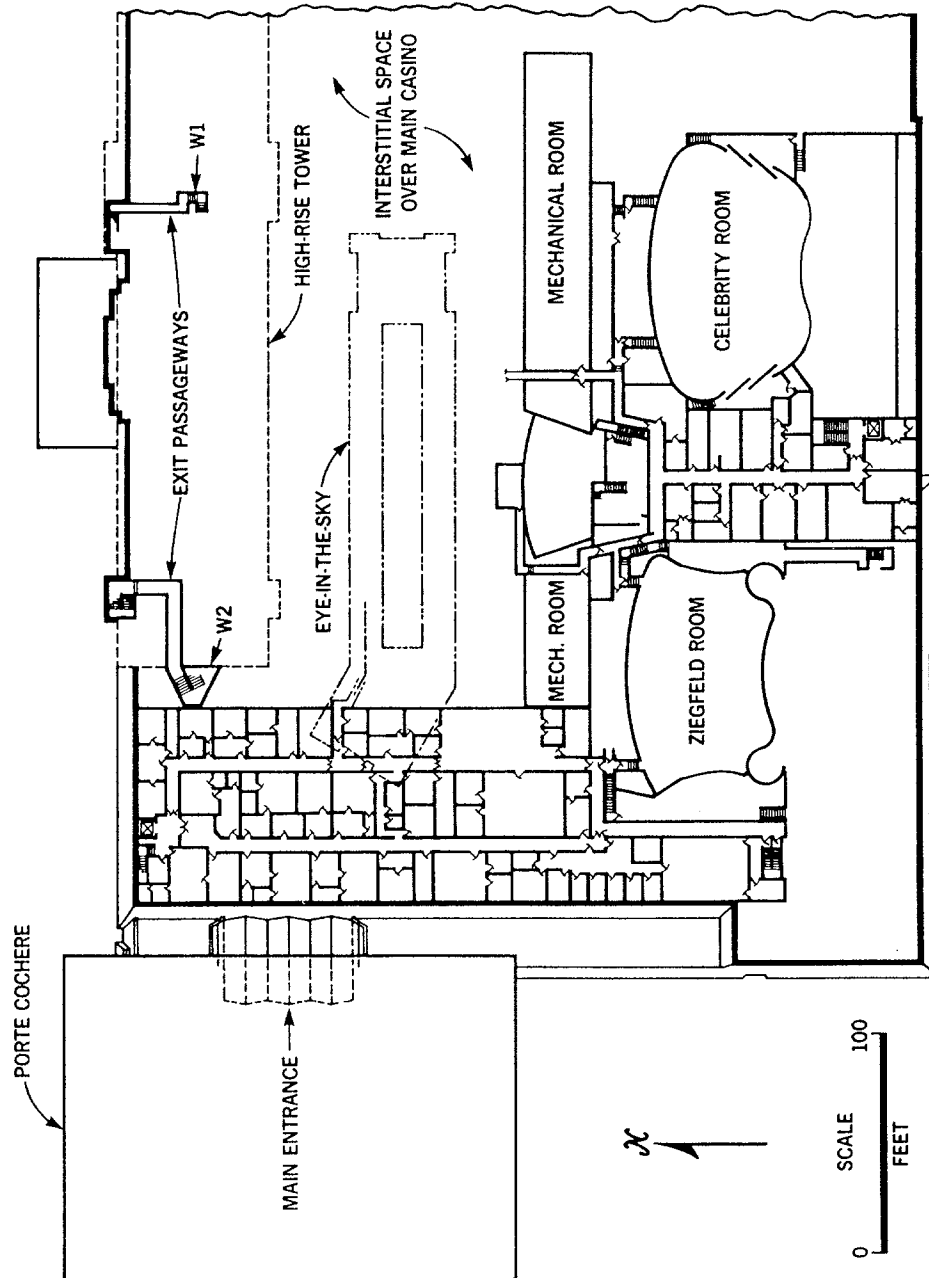


Figure 12. Second floor and interstitial space. (The proximity of the Eye in the Sky to the second floor was not determined.)

III FIRE INCIDENT

FIRE DISCOVERY

Statements of occupants and hotel employees were obtained by Bureau of Alcohol, Tobacco and Firearms Special Agents, Clark County Fire Department investigators, Clark County District Attorney's Office and other fire investigators, on November 21 and following the fire. The employees that were interviewed reported the odor of smoke in The Deli, observed a smokey haze and smelled smoke in surrounding areas for hours, even on the day before the fire was discovered. However, many of the reports appear not to be associated with the actual fire.

Although a few employees entered The Deli prior to discovery of the fire, they reported no indication of fire in The Deli. The head hostess of the Orleans Coffee House, The Deli and Dealer's Lounge closed The Deli at approximately 1:10 A.M. and checked it again at 2:30 A.M. before going off duty. She did not smell any smoke or notice anything unusual. Another employee was in each serving station of The Deli before five and six A.M. 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 was in The Deli and she noticed blue sparks coming out of the Keno board*, followed shortly by black smoke. She went to the kitchen and told the assistant chef about the fire, 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 observed the south wall of The Deli burst into flame. She left the area immediately.

A chef was cooking bacon on the broiler when a waitress told him there was a fire in The Deli. He went into The Deli and observed flame accompanied by black smoke extending approximately two feet all around the Keno board. He immediately went to the telephone and notified 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. The chef then dropped the hose. The lights went out in the kitchen Deli area. He saw 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.

An employee of the hotel was just starting work on Friday, November 21:

"...At 7:00 I picked up my keys, went to the shop, opened it up...I came out of the garage, down through security by the elevators, up the escalators past the coffee shop and into The Deli. I have a habit of going through The Deli because it is closed this time of the day... As I entered, I opened the doors in The Deli (...the doors are always closed, they are not locked, they are just closed). I walked inside, getting inside about halfway, probably near the column in the middle there, I heard a crackling sound to the right of The Deli, or the right-hand side there.

"...I went over there immediately and looked inside and there was fire shooting from the stainless steel pan up to the ceiling. It was a sheet of fire. I could not see the wall, it was just a sheet of fire there. But it was just from the pan to the ceiling. So I immediately ran back through the tables to the entrance there and behind the cashier's counter there is a telephone. I pushed the buttons, 4481, notified the security they had a fire in The Deli. He said, 'Is it enough to roll the fire department?' I says, 'Yes, get them going.' I immediately went back to the scene of the fire in the bus station. Just as I started in there I realized as I am headed for it that there is a fire hose cabinet on the back side of the small hallway that goes from The Deli to the Barrymore, or Restaurant Row, there. There is a fire hose cabinet there.

"...three security officers came from the Casino, one of them running very hard and trying to take off his gun at the same time. He asked me, 'Is there a fire hose cabinet in this area?' I said, 'Yes, around by the Barrymore.' And I ran as hard as I

*The Keno board location was above the entrance to the serving station and adjacent to the pastry case.

**The hose referred to in the statement as "the water hose," is believed to be a 1½-inch standpipe hose abandoned by others.

can around through Restaurant Row back through the Barrymore and I beat him there and I hesitated there for a second thinking he was there and would have a key. And when he wasn't there, I broke the glass on (the) fire hose cabinet, opened it and I reached for the hose and at that time he got a hold of the hose, I assume that it was him. I never seen (sic)...there was somebody alongside of me who grabbed the hose, started reeling it out and turning the water on. There was a bottle there, fire extinguisher bottle. I grabbed the bottle and when he went into the Restaurant Row I went around through this. I don't know whether he knew that that was a traveler's entrance into The Deli or not. It was the shortest distance to the fire, but he would not have known that. I did....

"...I started around the corner to go into the bus station, which is directly around the corner from the alcove and the smoke, pressure, whatever, pushed me backwards, knocking me into the alcove...It was not heat, it was not fire, it was pressure and extreme black smoke. It blew me back against the wall...I turned to go back toward the Casino, to go around that way to confront it and either smoke or the electricity went off, because I had not more...I could not see anything and I could not breathe. The smoke engulfed me and I could not breathe and I hit the deck and the hose was going out so I assumed that they were confronting the fire from the front and I could not see where the Casino was. I had no idea where it was, it was totally black."

An Illinois fire fighter vacationing in Las Vegas was staying at the MGM Hotel. He observed the following:

"We walked into the Orleans Room at 7:15 — the reason I know that is that there was a man sitting at the first table and he asked the waitress what time it was and she said 7:15 and I jokingly remarked to him, 'That's A.M.' We sat down, they brought us our coffee, had a couple sips, a security guard walked in through the door — we were about the second table in

to the right as you faced into the restaurant — and I could see him walk in, he was looking right at me. He said (not quoted) Gentlemen, I'm going to have to ask you to leave, there's a small fire next door and we're evacuating this area as a precautionary measure. So we got up and left and were the first ones to reach the door and there were people already running out from behind us. The smoke at that point out in the hallway was about a little bit higher than head height, we looked into The Deli, which was to our left, and there was heavy smoke in there and we could see flame through the smoke.

"There was a security guard standing there — I don't know if it was the same one who asked us to leave, but we identified ourselves as fire fighters and asked him for a fire extinguisher or hose line and we'd help knock down the fire till the fire department got there. He said they were not accessible, said they couldn't get to them so we went looking for some ourselves. We walked all the way back to the north wall and then back to the east past the elevators looking for a fire extinguisher or hose line and we couldn't find one, so we went back to the restaurant area outside the doors.

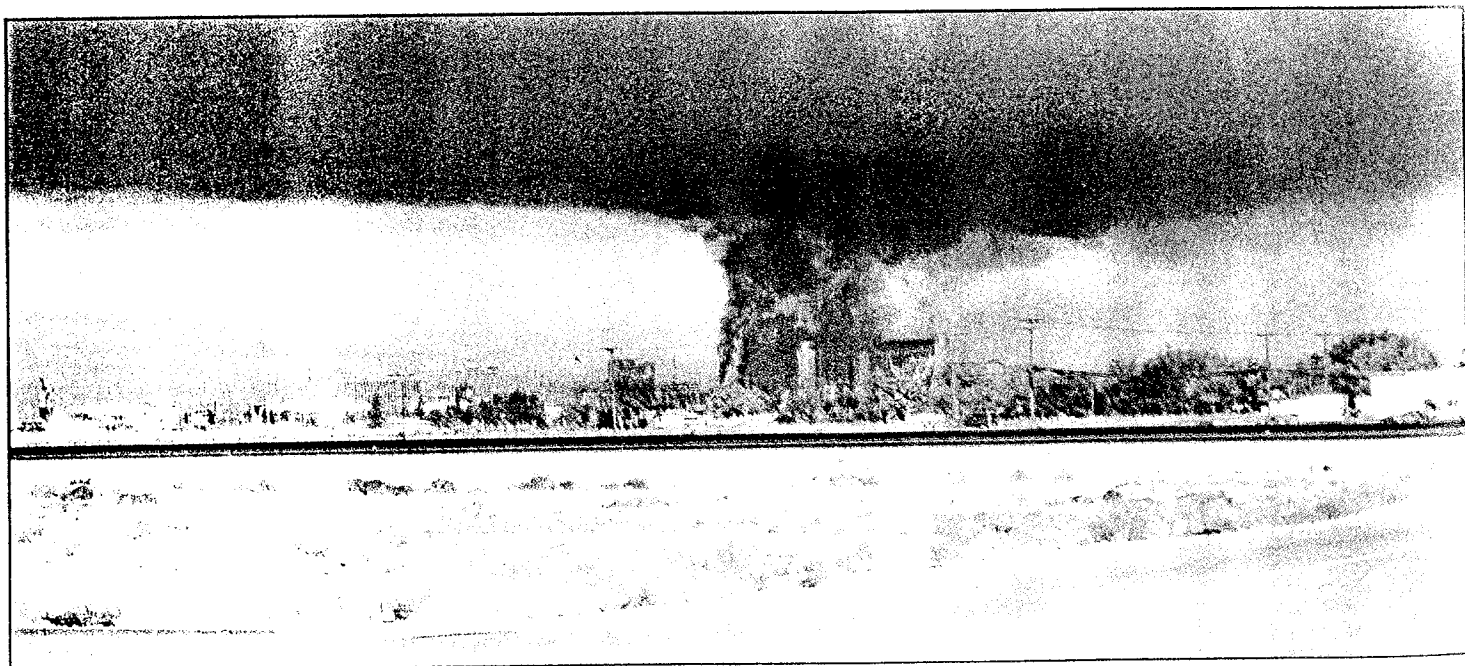
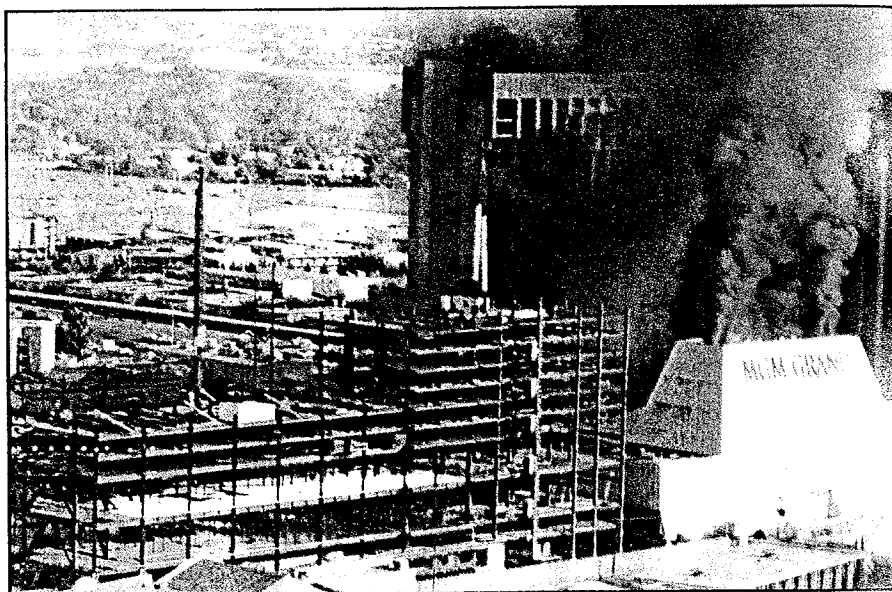
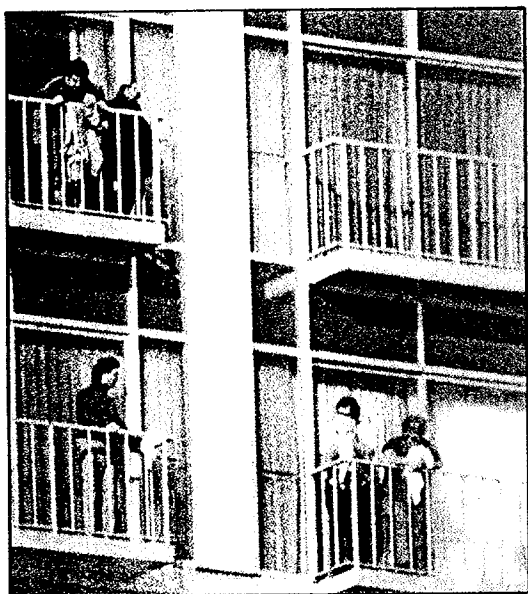
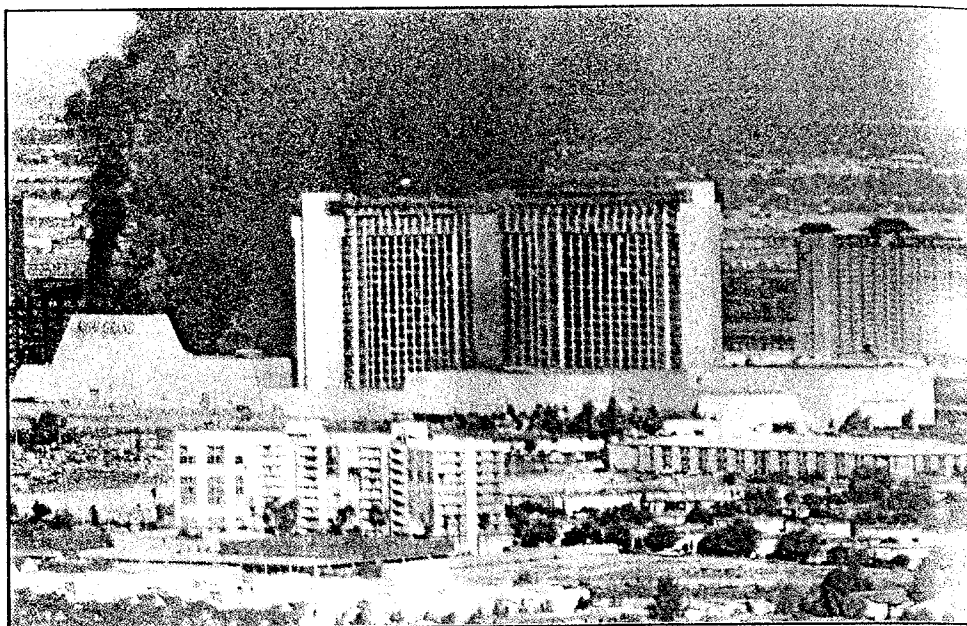
"By that time the smoke was really billowing out of The Deli area. You could see quite a bit more flames. The smoke at that point out in the hall area was about waist height and there were still people coming out of the Orleans Room, so we instructed them to all get down low and make their way out that way so they could get fresh air, of course. We started working our way toward these fire exit doors along the north wall here ourselves. When we got here there was one door open, we opened the rest of the doors, we stayed back to make sure everybody was out. The only people we saw still in there were Casino people, several guards, and perhaps a small handful of (I imagine) they were dealers.

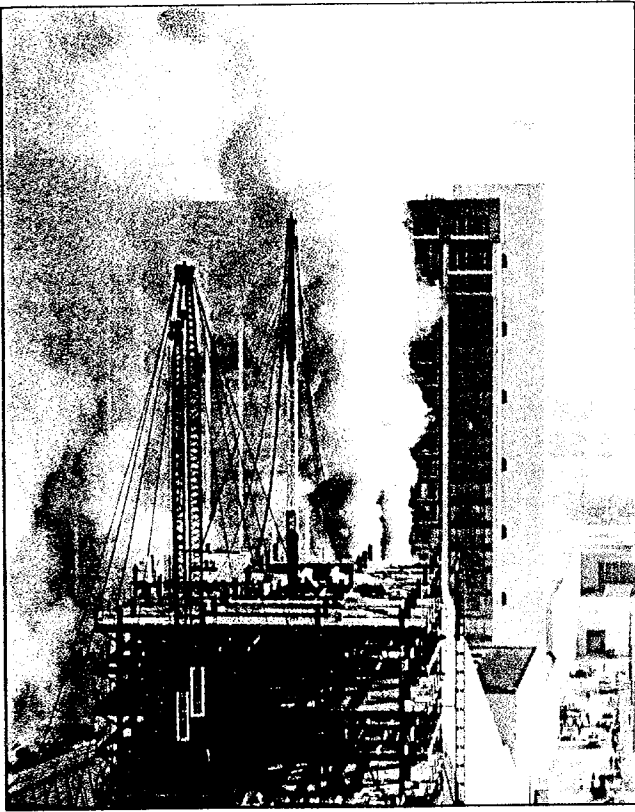
"At that point there was a loud click, the lights went out, and the whole Casino



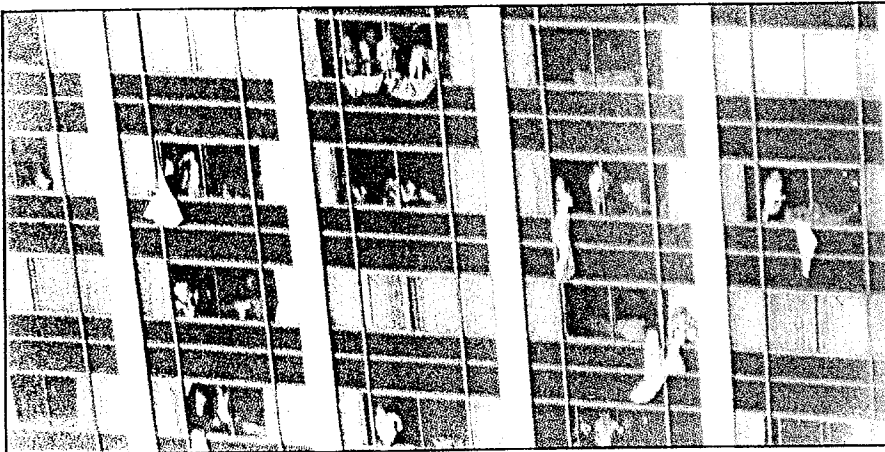
TOP: 7:40 am. View from southeast shows occupants on roof of south wing. INSET: Smoke vents activate on roof of fly gallery of MGM's Ziegfeld Room. (NOTE: The times in this series of color photographs were estimations by the photographers.)

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.



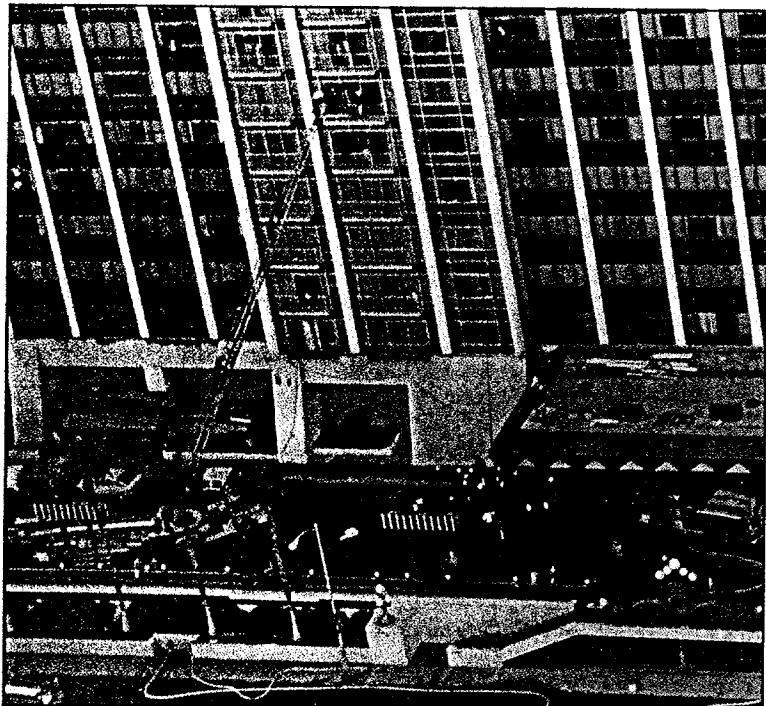


ABOVE: 8:20 am. View from south. Greatest amount of smoke is from Main Casino and Showroom areas.



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.



darkened. You could hardly see the smoke billowing across the ceiling, all the way across the Casino floor toward the west end. We looked back toward the restaurant area and the flames were already coming out toward where the ceiling raises up over the Casino.

"At that point, standing at this door over here in the middle of the north wall, the heat was already so intense we had to leave...I came out before the line was advanced into the building through this door and we were standing approximately right here in front of these revolving doors and that's when the chairs and suitcases and everything else started coming through the windows, so we went across the street and just watched from there.

"Eight to ten minutes after we were asked to leave the restaurant that canopy was burning. It was so super heated within no more than four minutes could have elapsed, that by the time we got to these doors we stood there until we couldn't take the heat anymore. I don't know, within three or four minutes — it was super heating along the top of the ceiling and once that flame hit the higher Casino roof, there was no stopping it."

FIRE SERVICE RESPONSE

The consolidated alarm office of the City of Las Vegas, Clark County, and North Las Vegas, Nevada, received a telephone call at 7:16 A.M., on Friday, November 21, 1980, reporting a fire in The Deli area of the MGM Grand Hotel. At 7:17:36 A.M., Fire Control transmitted the following message: "We have a report of a fire in a building in The Deli of the MGM, entrance number two. That's entrance number two to the MGM for The Deli."

The Clark County Fire Department dispatched the normal first-alarm assignment for such an occupancy: four engines, one ladder, one hosewagon, and one rescue, with a battalion chief (Battalion 2) and 23 fire fighters. First-due Engine 11 and a rescue unit responded from Station 11, which lies directly across Flamingo Road from the north side of the MGM Grand Hotel. (See Figure 13.) Engine 11's crew of four investigated and reported smoke showing at 7:19 A.M. (Two rescue units were reported to be on the scene at 7:18 A.M.)

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 went down to the exit entry ramp to the Casino floor....It's roughly 36 to 40 feet.

"...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....Okay, at the same time we noticed this stratified layer which was probably down about six to eight feet from the ceiling....

"...A fire ball 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 engine (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...."

A transmission over the Engine 11 portable radio called for a line from Engine 11 and for Engine 18 to pull in front and bring in lines, but Engine 18 was temporarily out of service. At 7:21 A.M., Engine 11 transmitted a second alarm, which brought in four additional engines, a ladder, a battalion chief (B-3) and a rescue unit (R-13). (The latter was on a call and did not immediately respond. It was immediately replaced with R-12.)

When the chief of Battalion 2 arrived at 7:22 A.M., smoke was coming from the front entrance, the Flamingo Road entrance, the west side of the building, and from the stairway of the west high-rise wing (W2). The battalion chief (B-2) requested traffic control and reported that they were working an Evolution 3, which responded an additional alarm, the fire chief, deputy fire chief, three assistant fire chiefs, a battalion chief (B-1), utility company personnel, and support personnel.

In his early size-up and attack preparations, the battalion chief (B-2) was confronted by a huge building showing heavy smoke. Fire conditions were visible at the front entrance, and people were standing at the windows of rooms, waving towels and dangling sheets. Many occupants had broken windows to acquire fresh air. The battalion chief ordered his aide to remove a body. One victim had either jumped or fallen and had landed on the overhang created by new construction. The battalion chief's prime concerns were: (1) protecting the high-rise area since, at that hour of the morning, most guest rooms were occupied; (2) placing responding units; and (3) establishing traffic control.

By 7:24 A.M., Engines 11 and 12, at the Flamingo Road entrance, were committed to fire fighting in The Deli area. Hosewagon 18 was ordered to block traffic on Flamingo Road. The battalion chief (B-2) established a command post directly across from the hotel's north entrance. Heavy smoke was pouring from the north entrance; the porte cochere over the main entrance was heavily involved in fire; and people coming out of the hotel were reporting to the chief that others were trapped inside.

Units reported their status. Engine 21 transmitted that it was covering the south side, or the rear, of the hotel. Engine 12 had connected to the sprinklers and standpipes and they were pumping into two of the four fire department standpipe connections. The battalion chief transmitted orders to Engine 18 which was now in service; upon its arrival it was to connect to the remaining standpipes.

At 7:26 A.M., the battalion chief (B-2) requested Control to dispatch ambulances. Engine 19 reported and was positioned west of the porte cochere to lay double hose lines at that location. Engine 21's crew

was assigned to evacuation of the south wing high-rise. Additional crews were sent to the west wing high-rise for evacuation operations.

When Portable 12* reported just before 7:30 A.M. that fire was in the basement, the chief ordered an oncoming shift crew to position a 2½-inch line at the escalator. Hosewagon 18 laid a 5-inch supply line from Engine 19, whose crew was directed to extinguish the porte cochere, thereby enabling crews to continue into the Casino area from the west entrance.

Shortly after 7:30 A.M., a battalion chief (B-3) arrived, conferred with the deputy chief, and was assigned to direct evacuation operations inside the high-rise. The deputy chief began directing incoming crews east of the Flamingo entrance and the placement of lines from Engine 12 into the main elevator lobby. Ladders manned by oncoming crews were placed east and west of the Flamingo entrance for rescue operations.

The operations commander, the incident commander, the deputy chief and the battalion chief quickly decided to attempt to cut off the fire between the Casino and the hotel's high-rise portion, conducting operations according to the Clark County Fire Department's high-rise plan.

Another assistant fire chief arrived and began to coordinate rescue and fire fighting operations. By this time, fire had broken into a room of the fifth floor; fire fighters from Engine 21 used a 1½-inch high-rise pack line to extinguish it. The assistant chief conferred with the battalion chief (B-2) and the deputy chief, then called back 30 fire fighters, while the deputy chief requested that a "MEDALERT"*** plan be put into operation which automatically responded all available ambulances.

When the chief of the department (C-1) arrived and became operations commander, the assistant chief (C-3) became incident commander. Assigned as sector commanders were the deputy fire chief (C-2), east section; a battalion chief (B-1), west section; and an assistant fire chief (C-4), who set up a second command post and directed operations at the south section. Arriving chief officers reinforced the command team. Battalion chief (B-2) remained with the command post and assisted the incident commander as the plans chief.

The almost total lack of windows and doors into the Casino severely limited attack positions. Engine 11's initial attack through the north entrance was followed up by taking 2½-inch attack lines through

*A captain from Station 12.

**Code word for Clark County Civil Defense plan to provide emergency medical services to injured victims of a major disaster occurring in Clark County.

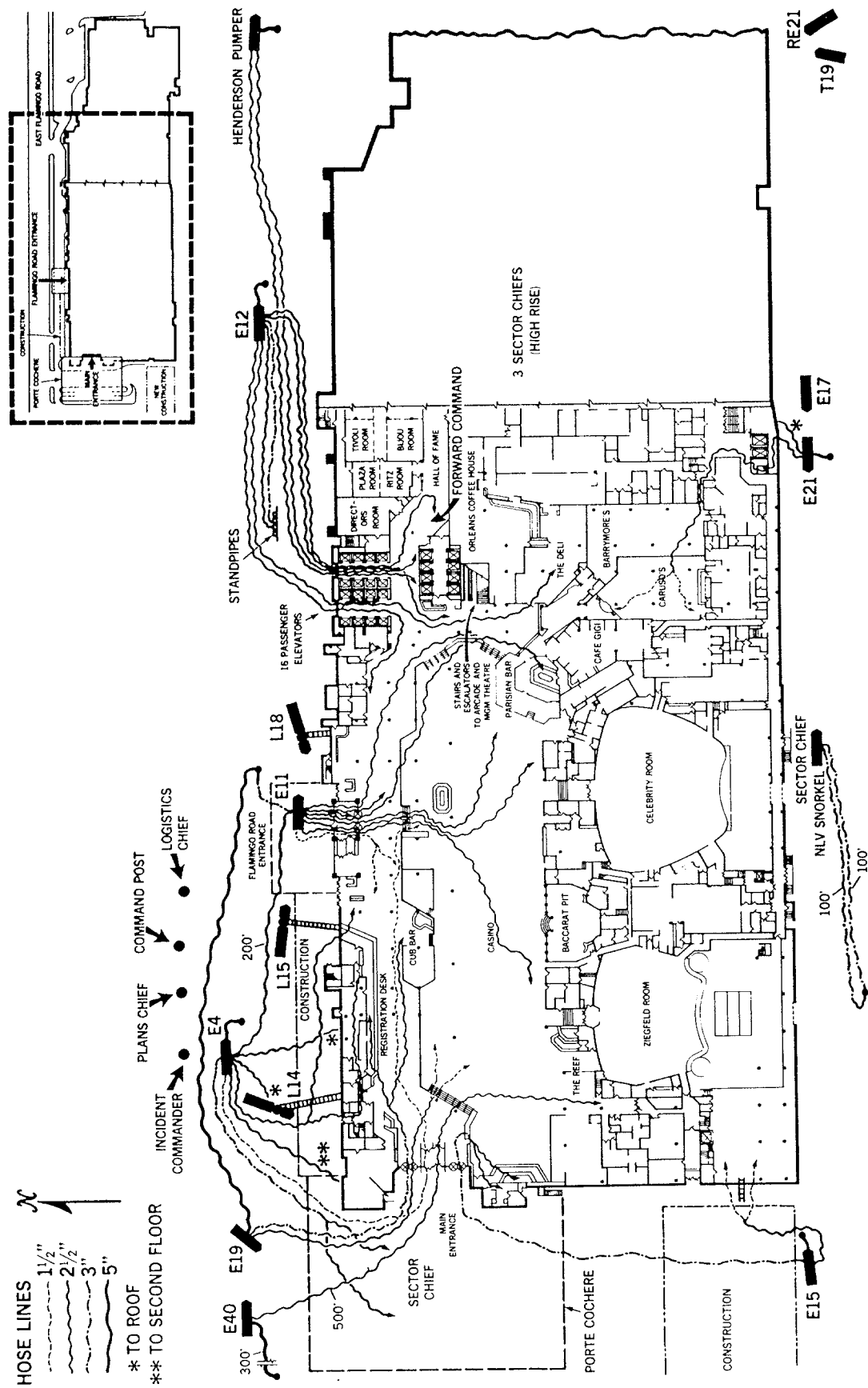


Figure 13. Fire suppression drawing. (Above — area shown in detail)

windows adjacent to the elevators along the north wall. The fire fighters, commanded by the deputy chief (C-2) in the early stages of the fire, were eventually turned over to an assistant fire chief (F-1). They faced heavy fire and smoke and, in spite of their multiple 2½-inch lines, had difficulty advancing down corridors between the elevator banks.

The crews of Engines 19, 4, and 40 advanced 2½-inch attack lines through the main entrance where the fire was not as heavy. However, these crews were delayed not only by fire and smoke, but also by slot machines and other furnishings. In addition, the expanse to be covered required them to shut down and extend their lines frequently.

Several times during operations, hotel security reported a fire on the roof above the area of a stage. Actually, this was smoke which was discharging from smoke vents on the roof of the Ziegfeld Room fly gallery designed for that purpose. (See Figure 1 and Photos top, page 18; mid right page 18.)

At about 7:50 A.M., the deputy chief reported knockdown in his sector on the east side. Rescue 12 was dispatched to the east side to assist with the people that Metropolitan (Metro) Police Department helicopters had removed from the roof. The assistant chief, who had assumed command of the south sector, requested a ladder truck and manpower. An elevating platform reported and laid two lines to the Casino level roof area to protect the towers. Then the unit was used for rescue and evacuation from the south tower.

An assistant chief (F-1) reported fire coming up through the elevator shaft. Two minutes later the spread of fire in the Casino to the west side was reported, and the elevator shaft fire was confirmed. Engine 14 arrived at the east side and stretched two hose lines from the elevator lobby to Engine 12. Crews advanced additional lines to the elevator shaft, extinguished that fire, and continued into the coffee shop.

The Incident Commander was informed then that there was fire in the ceiling from east to west along the length of the ground floor. Engine 15 proceeded to the southwest corner of the building. Two lines were laid, a 3-inch and a 2½-inch line. Two 1½-inch wyed lines were advanced into the Casino to extinguish the ceiling fire. Fire fighters took 1½-inch lines to the roof of the one-story section, where fire had vented through a wall.

At 8:00 A.M., it was reported to the incident commander by Engine 4 that the total Casino was involved. At that time, six lines were committed to the Casino area through the west entrance. This confirmed what was believed earlier when the attack plans were formulated by the fire chief and his staff.

About 25 minutes later, Portable 4 reported they had progressed to the center of the Casino and were advancing (the fire was at a controlled stage and extinguishment of the main body was occurring at this time). In the meantime, Control reported that Nellis Air Force Fire Department was on standby and that all the city's available air cylinders were being sent.

At 8:30 A.M., the west side stairway (W2) was usable. The Command Post was dispatching ambulances to the areas requesting them. NOTE: The main fire was controlled at approximately 8:30 A.M., but total extinguishment was completed later.

Soon after 8:30 A.M., the Incident Commander made two battalion chief call backs. At that time, the chief of Battalion 1 was in the Casino area coordinating the fire fighting within. He reported confinement to the east section of the Casino. About ten minutes later, an officer reported fire on the Casino floor moving toward Flamingo Road. Lines were put into operation by hand laying a line from Engine 4.

Shortly before 9:00 A.M., the Sector Commanders were beginning to report floors clear of occupants. But soon after, Battalions 7 and 8 reported that there was still heavy smoke on the 16th, 17th, and 18th floors. The Incident Commander assigned five fresh people to respond with air cylinders and a high-rise hose pack. A few minutes later, it was reported that the fire under the high-rise area was confined or extinguished. At that time, evacuation was going well and air cylinders were being taken to the upper floors as requested.

Sector Commanders were directing manpower to areas needed for rescue and evacuation operations.

It was later reported that there was fire in the roof over the area west of the Casino and west of the high-rise. Ladder 14 was placed in position and 2½-inch plus 1½-inch lines were laid to the roof area. Forcible entry tools were also advanced. The fire was controlled and extinguished.

At approximately 9:30 A.M., rescue personnel, oxygen, and manpower were being requested on the upper floors from the 19th through the 26th floors. Deceased persons and heart attack victims were being reported by the crews evacuating.

Helicopters from Nellis Air Force Base were causing problems with down drafts on the south side and the northwest side where rescue operations and fire fighting operations were in progress. The Incident Commander requested the helicopters to move their operations farther east. The stairways were clear of smoke and the occupants were being walked down by the evacuation crews.

Sometime after 10:00 A.M., priests were requested to the upper floors to administer the last rites to victims. Air cylinders were being transported to the roof

by a Metropolitan (Metro) Police Department helicopter. At that time, deaths were being confirmed; evacuation of the upper floors was almost completed.

At 10:35 A.M., orders were given not to move victims who were confirmed dead until given the Coroner's approval. All Sector Commanders reported having ample manpower* and the fire fighting areas reported spot fires only. At 10:45 A.M., self-contained breathing apparatus was not needed to continue work details.

By 1 P.M., lines were being pulled out of the Casino area. Two lines were left, one at each end, to control any hot spots that should appear. From 2 P.M. to 9 P.M., Battalion 3 and Battalions 6, 7 and 8 under the direction of the deputy chief conducted searches and assisted with the removal of dead victims from the building.

RESCUE AND AIR OPERATIONS

Rescue operations at the MGM Hotel began with the actions** of MGM security guards and other hotel employees in the Main Casino and surrounding areas on the Casino level immediately after discovery of the fire. Two Clark County Fire Department rescue units were on the scene at 7:18 A.M., two minutes after the alarm was received. Early-arriving engine companies were assigned to the high-rise floors of the hotel to begin evacuating occupants as previously reported.

At approximately 7:30 A.M., as the life-threatening situation became apparent on the upper floors, a Las Vegas Metropolitan (Metro) Police Department helicopter pilot called his dispatch center and requested "all available helicopters" to the site. By 8:30 A.M., a total of 20 helicopters had responded, including nine United States Air Force aircraft.

An estimated 300 persons were evacuated from the roof, with another 12 persons rescued from balconies by the Air Force helicopters.*** In addition to occupant rescues, helicopters were utilized to deliver fresh self-contained breathing apparatus bottles to the scene, airlift fire department personnel and equip-

ment to the roof of the hotel, and, later, to move bodies off the roof to the temporary morgue in the east parking lot.

Emergency medical services during the incident were coordinated by three or four key persons, including the manager of a Las Vegas ambulance company, Las Vegas and Clark County Fire Department captains and the director of the Clark County health district.

The ambulance company manager arrived first, becoming the on-scene EMS coordinator. He was directed by the deputy chief to call a "MEDALERT" and established the first medical command post at the north and west entrances of the MGM Hotel on Flamingo Road. The two Clark County rescue units, Rescue 11 and Rescue 12, were already on the scene at that time. The four paramedics had set up the rescue units as aid stations.

Two additional rescue units from the county arrived between 8:30 and 9:00 A.M. Then three additional rescue units from the city with fire equipment arrived. The Clark County Fire Department EMS coordinator, a captain, arrived on the scene at that time, observing two triage stations on Flamingo Road. He assisted the fire ground commander for the first four or five hours coordinating rescue operations, overseeing the triage operation and assisting in setting up the transport arrangement. The ambulance company manager, a member of the Clark County School Board, was asked by the deputy chief to request school buses to transport the ambulatory victims, persons who were not seriously ill or injured, to the Las Vegas Convention Center. Another captain also directed victims from the south triage station to buses for transport out of the area.

Helicopter operations were jointly coordinated by McCarran International Airport Approach Control and the Metropolitan (Metro) Police Department. A Metro police sergeant at the command post maintained communications with the Metro helicopters. All of the on-site helicopter operations were coordinated by the Metro Police Department helicopter. Metro helicopters were in the air almost continuously, coordinating the operations of all other helicopters.

The major problem reported with the use of helicopters involved communications, rotor noise, and rotor wash. Rotor noise and rotor wash were special problems with the Air Force Heavy Lift Aircraft. As the large helicopters hovered above the hotel, noise was so severe that fire officers had extreme difficulty hearing their fire radios. Rotor wash, from 23 stories above, was severe enough to blow loose debris and blankets about the north triage-treatment area. Helicopters that landed in desert areas also created a major dust problem.

*A total of 544 fire fighters responded to the MGM Hotel fire at various times during the incident.

**Actions included telling occupants to leave the building and assisting others to an exit.

***The number of persons reportedly evacuated from the roof was not confirmed. Important factors in the helicopter operation included clear weather, daylight conditions and the unusual availability of nine Air Force helicopters involved in area maneuvers. Note that in order to gain access to the roof, occupants had to force open a locked door.

returned. A preliminary NIOSH report* indicated that approximately 35 fire fighters sought medical care during and after the fire. Fifteen were hospitalized for periods of from one day up to two weeks, mainly due to the effects of smoke inhalation. At least three fire fighters received lengthy medical care. Two hundred to three hundred fire fighters experienced headaches, dizziness and rhinitis (inflammation of the mucous membrane of the nose) for several days after the fire but did not seek medical care.

Table 3.2. Employee Case Numbers and Locations

1433	Casino level	—	Registration Desk
1441	Casino level	—	Ritz Room
1442	Casino level	—	Ritz Room
1490	21st floor	—	Room 2115
1468	22nd/23rd floors	—	Stair S1
1455	24th floor	—	Elevator lobby
1518	26th floor	—	Elevator

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 and heat and smoke damage on upper floors, but the major damage by fire was 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. The Deli, the Orleans Coffee House, Cafe Gigi, the Parisian Bar, Cub Bar, gift shop and other areas at the top of the escalator, including the Casino level elevators and elevator lobby, were all severely damaged by fire. 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. There was no evidence of flame damage in the sprinklered Barrymores' Restaurant adjoining 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. (See Figure 19.)

Above the Casino level, there were no burned out rooms or corridors so typical of other large loss of life hotel fires in the past.**

There was extensive damage to the passenger elevator cars, the elevator hoistways and related elevator machinery. The hoist ropes parted on one high-rise elevator and one low-rise elevator that were parked at the Casino level with the hoistway doors open. When these wire ropes parted due to fire exposure, the cars dropped but stopped very quickly due to the safety brakes activating. The related counterweights plunged down the hoistways which caused significant damage. The hoist ropes moving through the sheaves in the elevator equipment rooms resulted in damage to the walls due to the whipping action of the hoist ropes.

The following Table lists the location of passenger elevators after the fire. The locations were taken from the selectors:

Table 3.3. Location of Passenger Elevators

1. Between Casino and Arcade, burned out and fell
2. Top of hoistway
3. Casino level
4. Casino level
5. Top of hoistway
6. Between Casino and 5, just above Casino
7. Casino
8. 5th floor
9. 16th floor
10. 2 ft below Casino
11. 20th floor
12. Between Casino and Arcade, burned out and fell
13. 20th floor
14. Casino
15. 20th floor
16. 1 ft below Casino

Due to the heat in the elevator hoistways during the fire, the plastic covers of lobby light fixtures were melted on several floors and elevator plastic "non-vision wings"*** were fused together. As a result, it was difficult to open hoistway doors after the fire on several levels. Activated sprinkler heads in the elevator lobby on the 26th floor and next to the

*Interim Report #1, *Federal Firefighter of Nevada Medical Survey*, National Institute for Occupational Safety and Health, Cincinnati, January, 1981.

**See *Fire Journal* articles listed in Appendix C, Bibliography.

***Non-vision wings are located between the elevator cab and hoistway to prevent passengers from seeing down the hoistway.

CASUALTIES

Eighty-five guests and hotel employees died as a result of the November 21st fire. Eighty-three victims were located on the day of the fire. The 84th casualty, a female employee, was located on Saturday, November 22, in a service elevator on the 26th floor. The 85th victim died weeks after the fire in a hospital in Houston, Texas.

Of the 84 victims who died the day of the fire, 79 body locations were documented. In some cases, victims were moved before locations could be recorded. Three bodies were removed from the roof of the high-rise tower; their locations within the tower were not 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.

The Clark County Coroner reported toxicology analysis of blood samples for 74 victims. As determined by the 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 and smoke and carbon monoxide inhalation,

located predominately in rooms and corridor areas between the interior stairs and central core areas on nine floors. (See Figure 18.) On the 24th floor, eight victims were located in the central core. Figures 14, 15, and 16 show location details; victims are identified with Clark County Coroner case numbers. A summary of victim location data is presented in Table 3.1.

The locations of 18 victims on the Casino level are shown in Figure 17. Six victims were found in the Registration Desk area; three of these victims (case numbers 1433, 1434, and 1436) had extensive body surface 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 victims were found in the Casino level elevator lobby. One victim (case number 1430), previously discussed, died of a massive skull fracture when she either jumped or fell from the high-rise tower.

Seven victims were identified as employees including three on the Casino level and four on upper floors. Case numbers and locations are listed in Table 3.2

Some 600 persons injured as a result of the fire were treated, transported from the scene and ultimately seen by hospital personnel. Of the 600 injured, 318 were admitted to hospitals, and 282 were

Table 3.1. Summary of Victim Locations

Floor No.	Corridors	Elevators	Stairs	Rooms	Totals
16	—	—	—	1	1
19	—	—	2	2	4
20	6	4	—	4	14
21	1	—	2	5	8
22	1	—	1	1	3
23	3	—	3	8	14
24	9	—	—	1	10
25	2	—	1	3	6
26	—	1	—	—	1
	22	5	9	25	61

and one victim located outside on the roof of new construction died of a massive skull fracture. Appendix B provides a detailed list of victims keyed to the Coroner's case numbers.

Of the 61 fatalities in the high-rise tower whose body locations were documented, 25 were located in rooms, 22 were in corridors, 9 in stairways and 5 in elevators. The 20th and 23rd floors had the highest number of victims, with 14 each. Fatalities were

treated and evaluated in hospital emergency rooms and released later the same day.

The National Institute of Occupational Safety and Health (NIOSH) surveyed Las Vegas area fire fighters involved in the MGM Hotel fire to examine respiratory problems and other health symptoms. Of the 350 fire fighters from various jurisdictions involved in fire fighting and rescue operations who were surveyed by NIOSH, 330 questionnaires were

seismic joint that separated south and west wings, also on the 26th floor, provided additional evidence of the heat conditions in elevator hoistways and the seismic joint shafts. The greatest evidence of smoke in the high-rise after the fire was in the S1 and W1 stairways. Smoke or soot deposits were heavy in the elevator lobbies, but only in the immediate areas around the elevator doors. The corridors throughout all wings of floors 5 through 26 showed only the faintest evidence of smoke particles or smoke stain. A brownish deposit could be detected on tables at the south end of the elevator lobby when ash trays or other articles were removed to show clean spots.

The guest rooms, in general, were also clean or free of smoke deposits. (See Photo top, page 54.) In some of the rooms on various floors, it was difficult to find any trace of smoke or soot deposits. The most evidence, in general, was 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 dur-

ing the fire were documented. (See Chapter IV, Section D, Occupant Notification, Exposure and Evacuation.) Apparently the lack of visible evidence of smoke particles after the fire in areas where occupants reported 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 NFPA by any representative of MGM. Estimates of property damage reported by Clark County Fire Department and *Business Insurance* magazine* ranged from in excess of \$30 million to a loss of \$50 million. The MGM Hotel fire was one of the largest property damage dollar loss fires in the United States in 1980.

*Rhonda L. Rundle, "Liability Limits May Not Cover MGM Fire Claims," *Business Insurance*, December 1, 1980, p. 1, cols. 1-4.

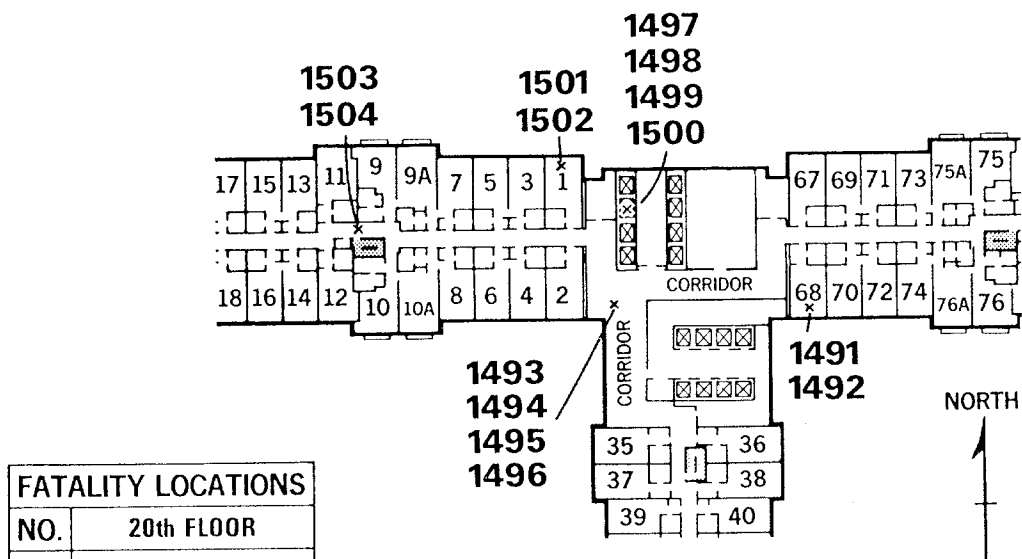
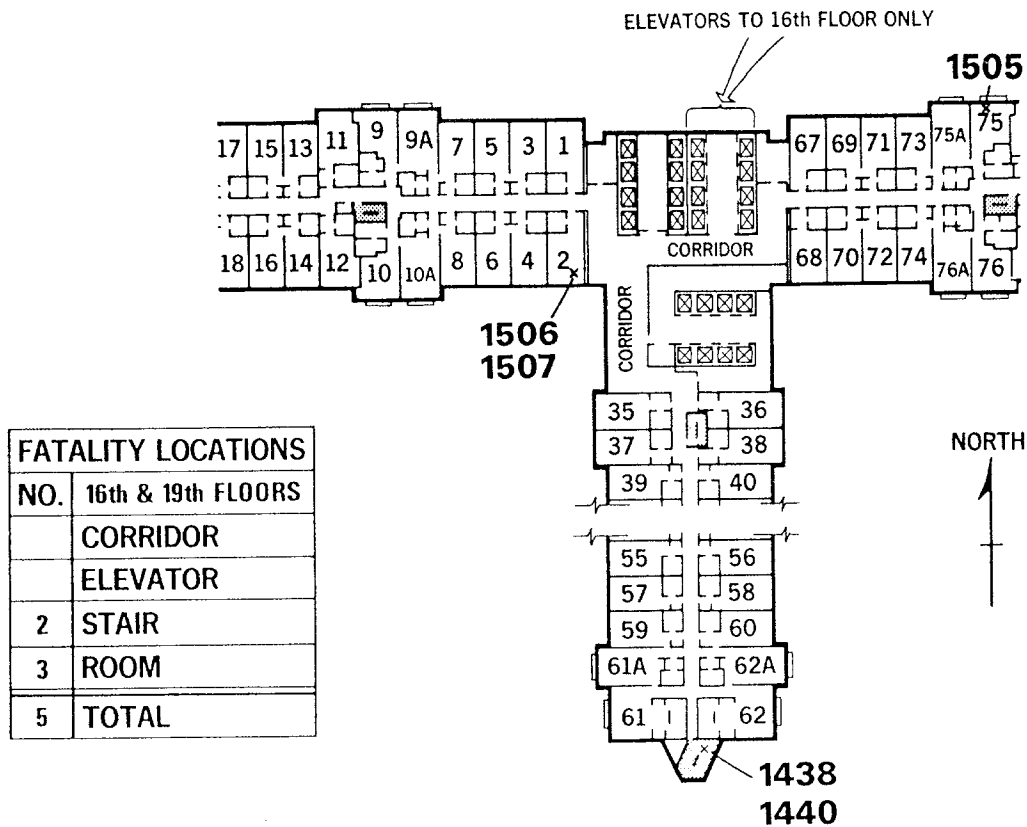


Figure 14.

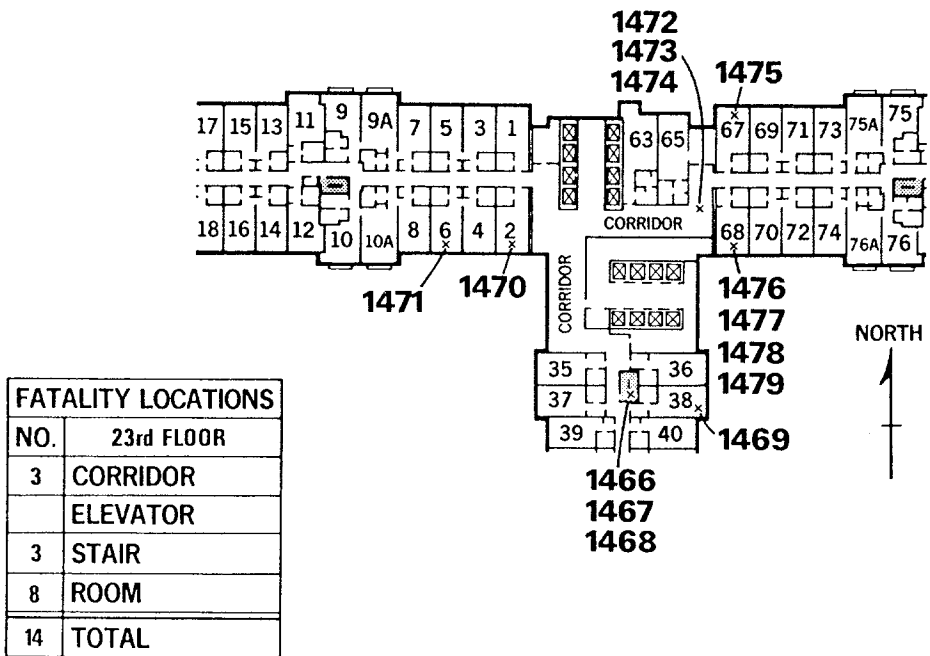
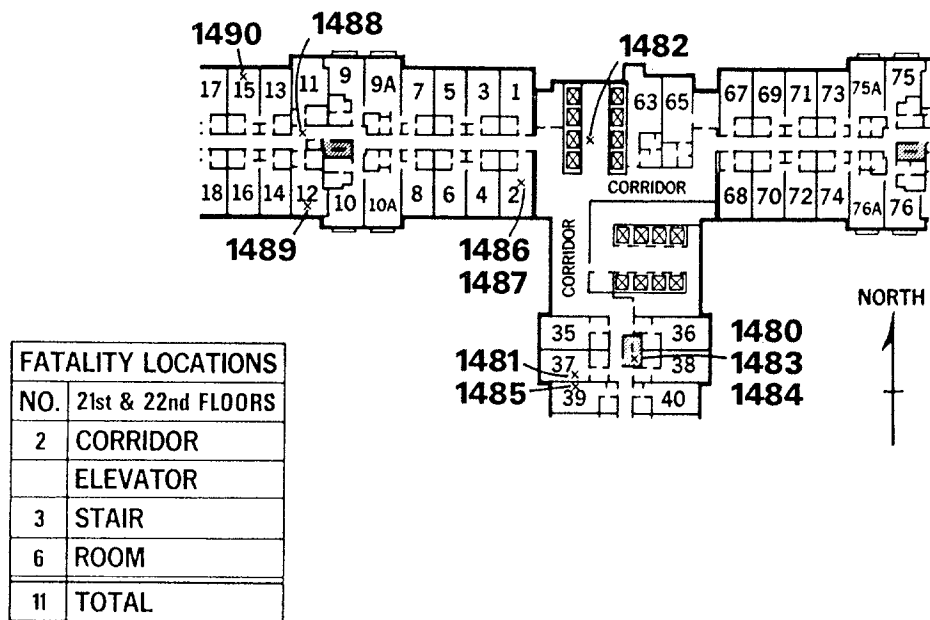


Figure 15.

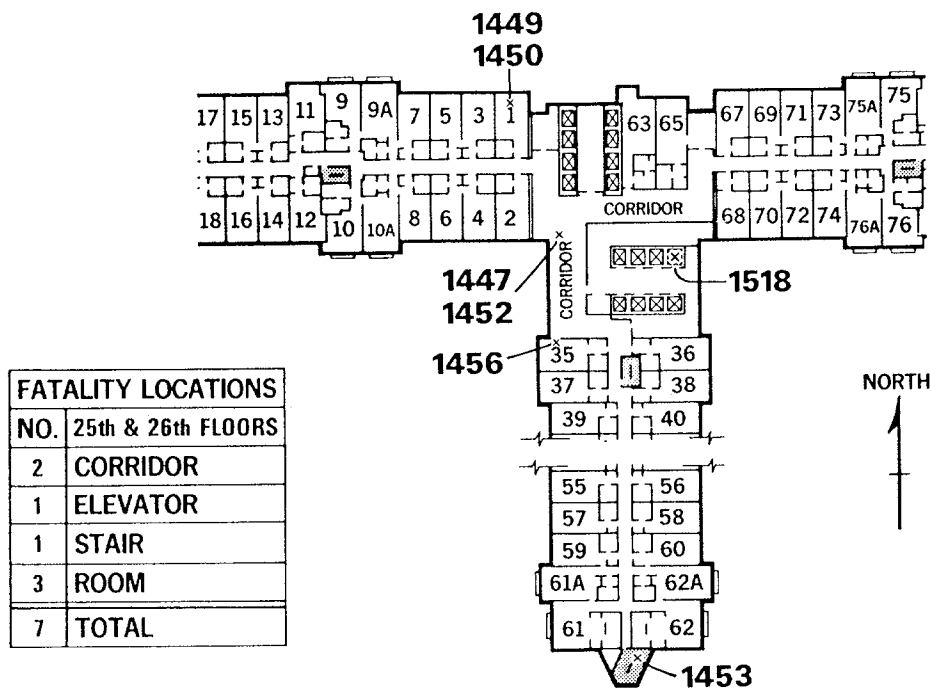
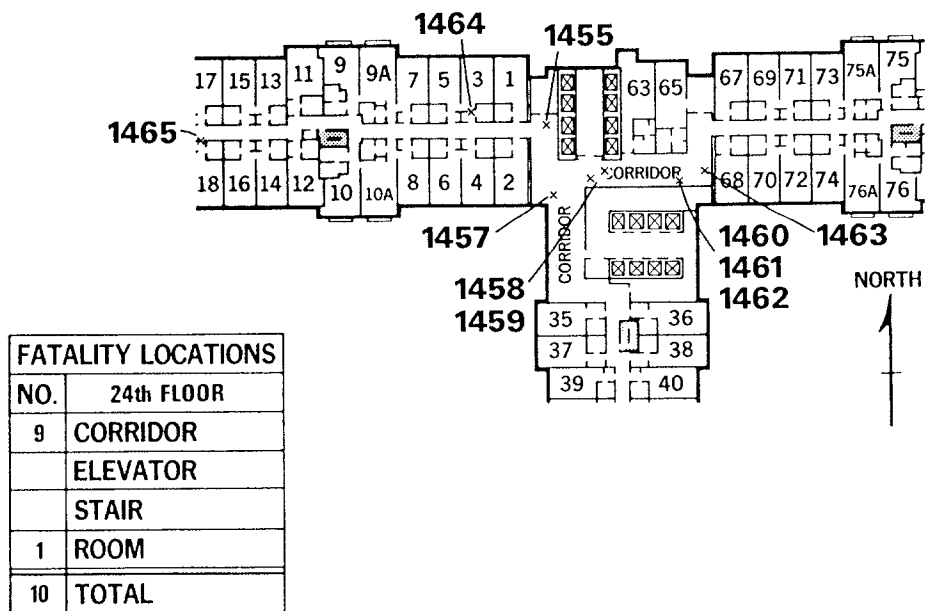


Figure 16.

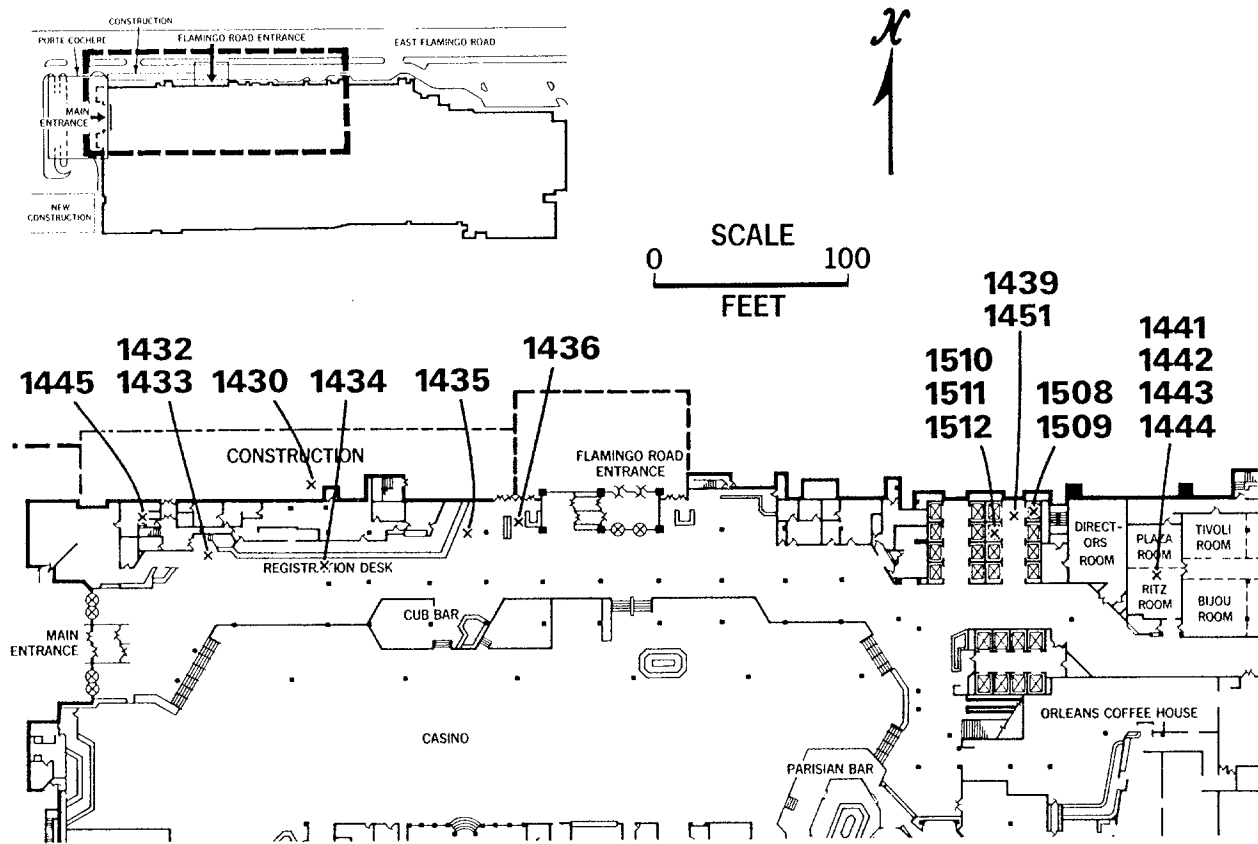


Figure 17. Casino level fatality locations. (Above — area shown in detail)

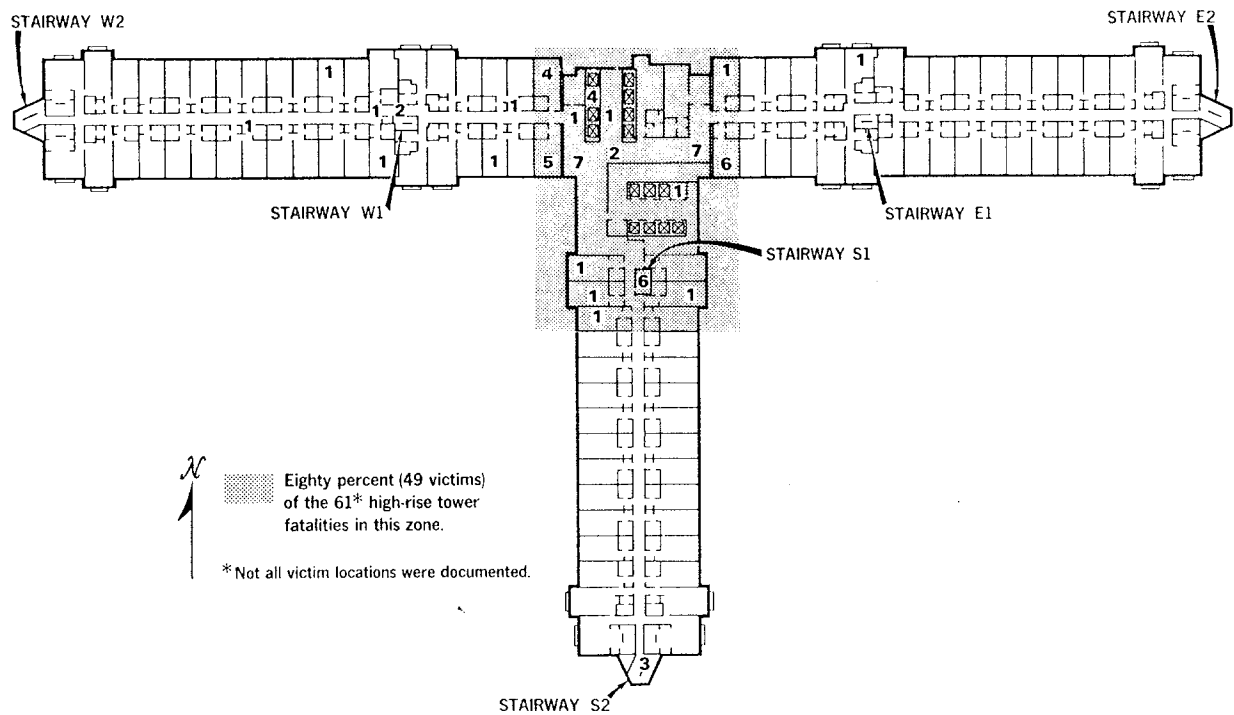


Figure 18. The numbers on this figure indicate victim totals in approximate locations on nine floors. (Floors 16 through 26 — see also Figures 14 through 16 and Table 3.1)

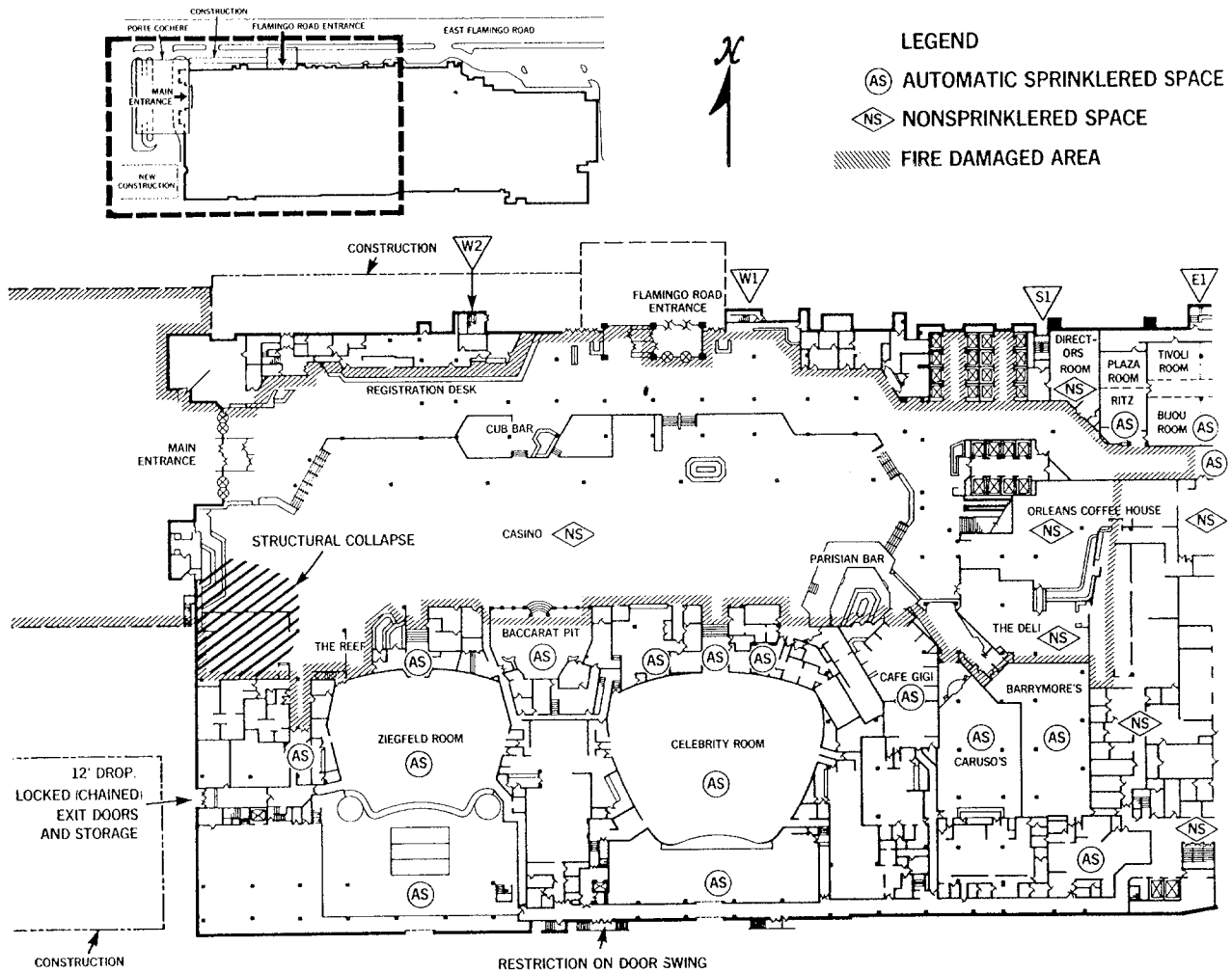


Figure 19. Damage. (Above — area shown in detail)

Table 3.4 Time Line

<i>Time¹</i>	<i>Fire Growth/Smoke Spread</i>	<i>Fire Service Activity</i>	<i>Occupant Activity</i>
6:30–7:00 a.m.			Earliest fire awareness and successful evacuation reported. ²
7:05–7:10 (approximate)	Fire on wall in Deli from countertop to ceiling. Pressure and extreme black smoke reported.		7:05–7:10 (approximate)
7:06–7:15			18 human behavior study respondents reported smoke outside. 29 respondents reported they smelled smoke. ²
7:15	Smoke overhead in hallway. Heavy smoke and flame in Deli.	PBX operator notified of fire and telephoned Fire Department.	7:06–7:15
7:16		Alarm received-consolidated alarm office.	7:15
7:19		Apparatus from Station 11 arrived at MGM. ³	Announcement in Orleans Room of fire in Deli. By now, 14% of human behavior respondents reported successful evacuation. ²
7:20	Smoke billowing out of Deli. Stratified layer of smoke 6' – 8' from ceiling in Casino.	Station 11 crew observed fire in Deli. ³	7:16
7:21	Flames out of restaurant at ceiling. Flame front and smoke moving through Casino.	Second alarm transmitted. ³	7:19
7:22	Smoke coming from front entrance, Flamingo Road entrance, west side of building and from stairway W2.	Evolution 3 (additional alarm responded).	7:20
7:24	Heavy smoke pouring from north entrance. Porte cochere over main entrance heavily involved in fire following movement of flame through the Casino.		7:21
7:26		Battalion chief requested ambulances.	7:22
			7:24
			7:26

7:30		Metro Police helicopter pilot requested all available helicopters to scene.	By now, 30% of human behavior study respondents reported successful evacuation. ²	7:30
7:35	Minor fire extensions to room on 5th floor.			7:35
7:50		Deputy chief reported fire controlled in his sector on east side. (East of Casino)		7:50
8:00	Total Casino involved with fire.			8:00
8:16-8:30			Stairway W2 utilized for evacuation. ²	8:16-8:30
8:30	Main Casino fire controlled.			8:30
9:00		Sector commanders reporting floors clear of occupants.	All human behavior study respondents have reported awareness of fire by 9:00. ²	9:00
9:24	Fire in the roof over the west of the Casino area and west of the high-rise.			9:24
10:00			Stairway S2 clear enough for fire fighters to assist people from roof down stairway.	10:00
11:00			All but 5 human behavior study respondents report successful evacuation. ²	11:00
1:00 p.m.		Most hose lines pulled out of Casino.		1:00 p.m.
3:00	Fire extinguished. ³	Evacuation operation ended. ³		3:00
8:00		End of search and removal of victims. ⁴		8:00

Footnotes

¹Unless otherwise specified, times were obtained from witnesses and are considered best estimates.

²Dr. John L. Bryan, *An Examination and Analysis of the Dynamics of the Human Behavior in the MGM Grand Hotel, Clark County Nevada, on November 21, 1980*, NFPA, Quincy, 1981.

³Clark County Fire Department.

⁴84th victim located November 22.

IV ANALYSIS

ORIGIN AND CAUSE OF FIRE

The following description and diagram of the origin and cause of fire were developed by NFPA based upon the Clark County Investigation Report and on-scene observations made by 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, the 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 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. (See Figure 11.) 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. (See Photo top, page 53.)

The wiring system for The Deli serving station originated in an electrical panelboard located in the Barrymores' 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. (See Figure 20,

Detail "A".) The flexible metal conduit then traveled across a length of ½-inch electrical metallic tubing above the suspended ceiling to a metal junction box mounted above the ceiling. Leaving this junction box were two ¾-inch flexible metal conduits (aluminum), one going to the pie case and the other entering a void space between the pie case and the top 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 (not shown on illustration). 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. (See Figure 20, Detail "B".) This was found 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 partition framing members at the top of the east wall. (See Figure 20, Detail "A".) The above-mentioned 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 in contact with the flexible conduit causing sparking and arcing to take place at the point of contact (Point "C"). The current followed a path along

*Clark County Fire Department, *MGM Report*. Las Vegas: Clark County Fire Department, May 19, 1981.

**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.

***Wiring methods are described in NFPA 70, *National Electrical Code*.

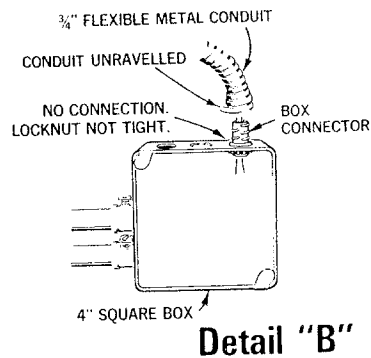
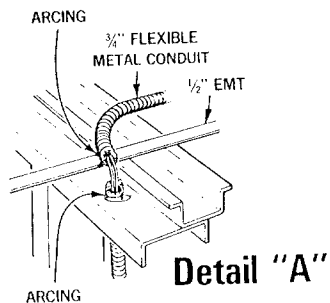
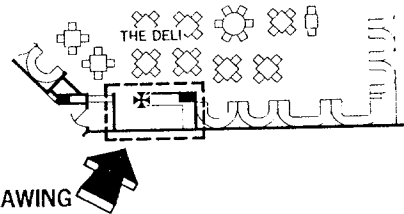
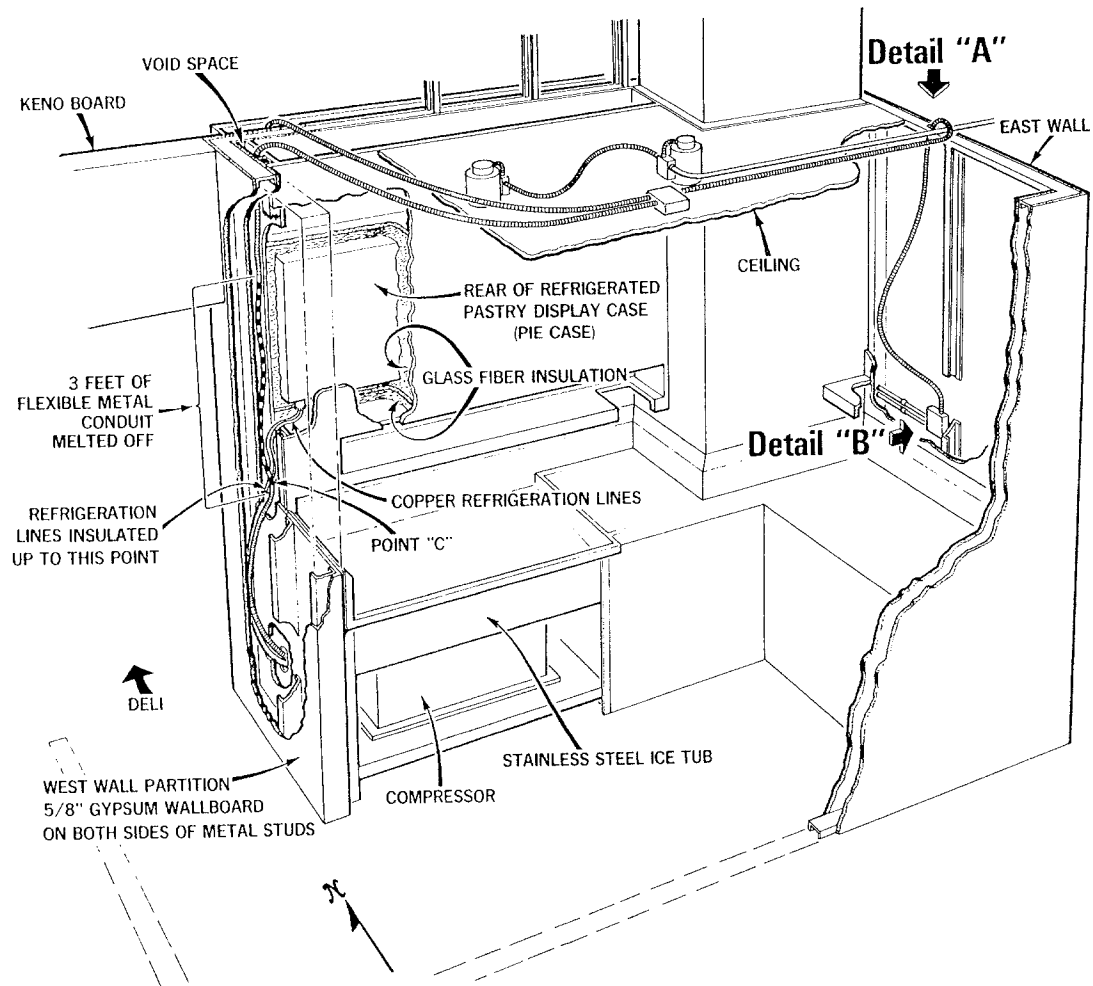


Figure 20. The Deli serving station.

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. (See Figure 20, Detail "A".) 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 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 fire 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 breaking out of the concealed space and into The Deli serving station at approximately 7:05 to 7:10 A.M. 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 spreading on lightweight fuels such as plastic and paper products 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 of chairs and booths.

After full involvement (possibly flashover) of the serving station and then of The Deli occurred, the lack of sprinklers and adequate fire 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 air supply for the fire. Combustible furnishings, other contents and combustible interior finish primarily in the form of plastic decorative trim and mirrored plastic ceiling panels were present in the Casino. 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 involving the porte cochere. The porte cochere was fully involved with fire by 7:25 A.M.

Even though the entire Casino to the west of the fire origin became involved, the fire was very effectively stopped in sprinklered areas to the south and east. These sprinklers inhibited fire spread into the showrooms and into 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 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 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 spread of heat and smoke 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. (See Figure 21.)

The smoke spread within the interior stairways was due to the lack of enclosure of the stairs with two-hour fire-rated construction. In the case of at least one interior stair, W1, the exposed steel underside of the bottom of the stair was directly open to the concealed space above the Casino ceiling. In addition, there was a space approximately ⅛-inch wide that had not been sealed off between the stair stringers and the gypsum wallboard. These conditions allowed smoke and heat to penetrate the stairways. There were non-fire-rated sheet metal access panel doors 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 this smokeproof tower consisted of ½-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 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 for the smoke entering this tower was not determined.

Passenger elevator hoistways provided a major avenue for smoke and heat spread in this fire. The location of nine elevators, some with open doors, on or near the Casino level and the failure of hoist ropes on two elevators allowing 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.*

Unprotected vertical openings terminated in a plenum area above the 26th floor ceiling. Heat and smoke spread to this plenum and subsequently to the mechanical penthouse located on the roof. In addition, some heat and smoke were 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 supplied 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 within 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 room doors had gaskets around them to reduce air movement; however, several guest room doors were found that appeared to be undercut by at least one-half inch.

One guest reported that when he opened his exterior window, smoke began pouring out of the fan-coil unit; however, when he closed the window the smoke was reduced. Evidently in this case, the opening of the window caused a pressure differential be-

tween 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 the guest rooms themselves. Smoke which was traveling vertically in some toilet ventilation systems overpowered their exhaust capacity and leaked into bathrooms.

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.

FIRE SERVICE OPERATIONS

During fire suppression and rescue operations at the MGM Hotel, fire officers found it difficult to acquire tactical information due to (1) the size of the building; (2) the heavy smoke at the rear roof of the Casino and the main entrance; and (3) the lack of information provided by the units operating inside the structure. Because of the size of the structure, the battalion chief at his command post location could not see the east, south, and west sides of the building. This is a problem that fire officers must contend with, even with smaller structures.

A review of radio transcripts indicates that, in spite of the four frequencies used and the control of company and command officers, radio channels were almost overwhelmed during the fire operations. Command activities were hindered by helicopters operating on the roof and returning to the parking lot south of the building. Blowing sand from rotor wash, radio interference, and high noise conditions were some of the problems.

Fire fighters on the exterior of the building were hampered by falling glass, furniture, and debris that occupants used to break windows in search of fresh air or assistance.

Fire fighters had little difficulty advancing lines simultaneously from opposite directions because of the large interior dimensions of the Casino, the ventilation available and the movement of smoke into the high-rise. Fusible link-operated smoke vents in the roof above the stage fly gallery greatly contributed to ventilation of smoke and heat. There was no difficulty reported in interior orientation due to (1) pre-fire visits, and (2) survival of landmarks such as the Cub Bar and the slot machines.

Fire spread above the Casino level was limited by fire fighters operating 2½-inch hand lines in the elevator bank and The Deli area in conjunction with

*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*.

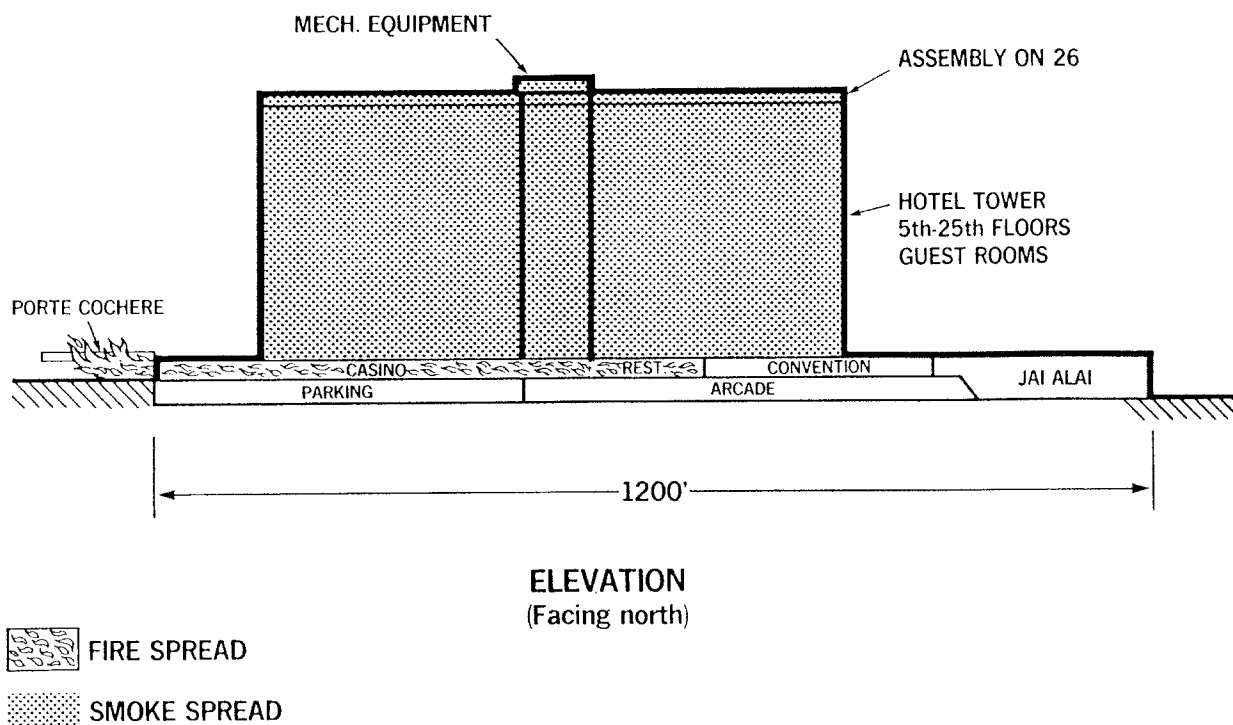


Figure 21. Fire and smoke spread.

sprinkler operation in the Hall of Fame. The effectiveness of this attack is proven by the fact that the fire did not extend above the fifth floor area.

Water Supply

Water supply was ample throughout the entire fire. At some period early in the fire, a 6-inch horizontal run of pipe supplying a standpipe system in the showroom area ruptured, but this did not cause a substantial drop in residual pressure in the water supply to fire apparatus. An estimated forty 1½- and 2½-inch hose lines were in operation at the height of fire fighting operations, and a total of 47 hose streams were reportedly in use at various times during fire suppression operations. Only one master stream (from Engine 19) was in evidence and this was used to finish extinguishment of the porte cochere at the main entrance, which had been "knocked down" by Engine 4's crew as they began their attack. The building's 2,000-gpm, diesel-driven fire pump operated during the fire. A 14,500 gpm maximum waterflow was reported, but included water supplies to sprinkler systems and the broken pipe.

The ability to move water from hydrant to pumper was greatly increased by the use of 5-inch hose by Clark County and Las Vegas Fire Department units. Five (5) engines, operating at hydrants, supplied

handlines with either 3-inch lines wye'd to two 2½-inch or directly to 2½-inch handlines. An example of the heavy reliance on well-positioned pumpers is Engine 11 which supplied seven 2½-inch and two 1½-inch handlines through the north entrance. (See Figure 13.) Water supply in the rear (south side) of the building was adequate with only two engines supplying the limited needs in this sector.

OCCUPANT NOTIFICATION, EXPOSURE, AND EVACUATION

A study of human behavior responses of guests of the MGM Hotel was conducted for NFPA by Dr. John L. Bryan.* The Study involved a survey of 1,960 guests registered at the MGM Grand Hotel the night of November 20-21, 1980, using a mailed questionnaire, and was based on the responses from the 554 guests who returned the questionnaires. In addition, 131 questionnaires developed by the Clark County Fire Department for their personnel were

*Dr. John L. Bryan, *An Examination and Analysis of the Dynamics of the Human Behavior in the MGM Grand Hotel, Clark County, Nevada, on November 21, 1980*, NFPA, Quincy, 1981. This NFPA study was a separate research project funded in part by NFPA, the Federal Emergency Management Agency/United States Fire Administration, National Institute for Occupational Safety and Health, and the Mobil Foundation.

reviewed to verify observations and accounts of guests. No personal interviews were conducted with any of the guests.

This section summarizes hotel tower occupant notification, exposure and evacuation actions. The human behavior study by Dr. Bryan is referred to as "the Study" and specific data referenced are from analysis of responses from the Study population. These data should not be extrapolated to nonrespondent guests or to other personnel not participating in the Study. (At the time of the fire some 3,400 guests were registered at the hotel.)

The means by which the Study population became aware of the fire incident was examined. The most frequently mentioned means of awareness was the hearing or seeing of "fire apparatus." Some guests apparently knocked on the doors of other rooms and yelled a warning to alert other guests. Guests smelled smoke or saw smoke outside, in their rooms or in the corridors. Other guests were aware of the fire incident when told by their roommates or other occupants.

It is noted in the Study that nearly half of the guest Study population (48.9 percent) were aware of the fire incident prior to the fire department arrival at 7:18 A.M. A slightly smaller percentage of the Study population (45.8 percent) apparently became aware of the fire after fire department arrival. The greatest number of guests became aware of the fire in the time interval from 7:11 to 7:15 A.M., which included approximately 24 percent of the Study population. A few guests indicated they were not aware of the fire until between 8:00 A.M. and 9:00 A.M.

None of the guests in the Study population reported being alerted by a fire alarm or internal signaling system in the hotel. However, announcements were made over the public address system from the PBX telephone operator position at approximately 7:18 or 7:19 A.M. in the Casino area: "May I have your attention, please evacuate the Casino immediately and carefully, thank you."*

Bryan reports that the location of guests in the hotel directly affected their capacity for an effective evacuation. This observation was due to relative smoke and heat conditions to which occupants were exposed at various locations.

"It would appear the only stairway from the tower portion of the hotel to remain relatively free of smoke throughout the fire incident was stair 6 (E2), located at the east end of the east wing of the hotel as indicated on Figure 1 (Figure 5). Thus,

guests located in the east wing were able to evacuate with less exposure to untenable smoke conditions, at least in the stairway, than guests located in the west and south wings of the hotel. Due to the area of fire origin being located directly under the south wing adjacent to the junction with the east and west wings, and the propagation of the fire in a westerly direction, the rooms on the south side of the west wing, and the rooms on the west side of the south wing experienced the most extreme smoke migration from the exterior into the rooms. Thus, in both the south and the west wings, guests tended to move across the hall or to select rooms across the hall for the creation of areas of refuge. In the west wing another incentive for movement to the north side of the wing was the exterior access for observation and communication to the fire and rescue personnel located on the Flamingo Road side of the hotel."

The location of guests by floor level also varied the possibility of evacuation (again due to relative smoke and heat conditions experienced by the Study population). Guests on floors below the tenth floor encountered less severe conditions in the means of egress. Guests from the 18th floor and above observed severe heat conditions in the means of egress in addition to the smoke.

Chapter IV, Section B, Fire Growth and Development, documents overall smoke movement through the high-rise tower with the resulting smoke logging of corridors and stairs as well as smoke migration into rooms. Of those guests in the Study population reporting obstructions to escape, 59.9 percent (179 persons) indicated that the principal obstruction was smoke. The upward movement of the smoke through stairs and into corridors was perceived by nearly two-thirds of the Study population as a condition that was untenable.

Evacuation status responses (Did guests successfully evacuate on notification, attempt to evacuate or stay in their rooms?) indicated that 19.3 percent (107 persons) of the Study population remained in their rooms, 43.3 percent (240 persons) were able to evacuate successfully upon notification, and 37.2 percent (206 persons) were unsuccessful in their evacuation attempts, returning to their rooms or another room as an area of refuge. It appeared that guests who were aware of the fire early in the fire incident before the arrival of the fire department were generally able to successfully evacuate without assistance.

*Clark County Fire Department, MGM Report. Las Vegas: Clark County Fire Department, May 19, 1981.

The most frequent means of egress reported by the Study population was use of the stairs — 78.8 percent (437 persons); followed by use of doors — 6.1 percent (34 persons). Apparently those individuals reporting use of exterior doors were located on the Casino level at the time of the fire. Use of helicopters was reported by 5.8 percent of the guests (32 persons). The predominant use of stairs included unassisted initial evacuation and evacuation with fire fighter assistance. Only one response from the Study population indicated use of elevators for evacuation. It is known from review of other statements that some guests boarded elevators during the fire without knowing that a fire emergency existed. A total of ten people died in elevators which were at the Casino level and at the 20th and 26th floors.

Over half of the Study population (300 persons) reported assistance in their evacuation by others. Of the 300 reporting assistance, 78 percent (234 persons) were assisted by fire fighters and 5 percent (15 persons) were assisted by hotel staff. In addition to those reporting assistance by hotel staff, 38 persons in the Study population reported receiving instructions from hotel staff. Other assistance responses of less than five percent included spouse or roommate, other guests, construction workers, and security personnel or police.

As previously discussed, the primary means of evacuation was by stairways. Stair E2 received the greatest usage followed by stairs W2 and S2. The evacuation by guests prior to the arrival of the fire department was predominately over stairs E2 and S2. The guests' usage of stairs E2 and S2 was distributed throughout the entire time spectrum presented, from 6:45 A.M. to after 1 P.M. Stair W2 was untenable for approximately 1½ hours into the incident until the Casino fire was controlled. Evacuation down W2 began between 8:16 and 8:30 A.M.

Guests reported being trapped in stairs in several instances due to heat and smoke, and being unable to leave the stairs due to the locked doors on the stair side. Guests also reported moving down stairs, and then back up away from the smoke and heat before obtaining egress from the stairs. The guests in the Study population who gained access to the roof and were evacuated by helicopter all moved to the roof by stair S2 at the end of the south wing. (See Photo top, page 17.) Prior to the opening of a roof access door from stair S2, guests reported that approximately 50 persons were in the stairs unable to go up or down due to smoke, and unable to leave due to doors locked on the stair side. Reportedly, the roof access door was forced open by occupants.

The least utilized stairs were those located nearest the center of each wing: stairways E1, W1 and S1.

Due to their location and exposure to the Casino level fire conditions, the interior stairs became untenable early in the incident. Table 4.1 displays stair egress distribution based on 437 respondents in the Study population:

The principal threat to guests who stayed in their rooms, or to guests who attempted evacuation and then returned to their rooms or took refuge in other rooms, involved smoke migration into the rooms. The most serious means of smoke migration into the rooms as reported by the 388 guests in the Study population in descending order were: room entry doors, fan-coil units, windows, bathroom vents, and electrical outlets. Many guests reported more than one means of smoke egress into their rooms.

A behavioral action primarily related to smoke migration into guest rooms was the opening or breaking of windows to improve room conditions. These actions included opening of balcony doors. Almost half of the Study population, 45.8 percent, were involved in this activity. The effect of opening or breaking windows was reported by 173 of the guests. Conditions became better in 75 occurrences (43.4 percent), conditions became worse in 63 occurrences (36.4 percent) and no change was observed in 27 occurrences (15.6 percent). Indications were that exterior smoke migration conditions were worse on the south side of the west wing and the west side of the south wing due to a more severe exterior smoke exposure on the southwest side of the building.

LIFE SAFETY CODE ANALYSIS

The analysis in this section is primarily based on the application of the 1981 NFPA *Life Safety Code*. This report does not include an analysis of the MGM Grand Hotel fire in terms of other Codes (except where otherwise noted) that may have been applicable.

The 1981 edition of the *Life Safety Code* was used for this analysis so that the conditions at the MGM Hotel on the date of the fire could be compared to the latest edition of the *Life Safety Code*. It is recognized that the 1981 edition of the *Life Safety Code* was not in effect in Clark County during construction or operation of the MGM Hotel.

The *Life Safety Code* deals with life safety from fire and similar emergencies. It covers construction, protection, and occupancy features to minimize danger to life from fire, smoke, fumes, or panic before buildings are vacated; and it specifies the number, size, and arrangement of exit facilities sufficient to permit prompt escape of occupants from buildings in case of fire. The *Code* recognizes that

life safety is more than a matter of exits; accordingly, it deals with various matters besides exits that are considered essential to life safety. The *Code* does not attempt to cover general fire prevention or building construction features, such as are commonly dealt with in fire prevention codes and building codes.

The *Life Safety Code* analysis of the MGM Hotel for this report deals only with specific areas of the Casino level and high-rise tower directly affected by the November 21 fire. The jai alai fronton, Arcade level, and the 26th floor assembly areas were not included in this analysis.

Chapter 17 of the *Code* deals with existing hotels and was utilized for the high-rise tower code analysis. Chapter 9, Existing Places of Assembly, of the *Code* was utilized for code analysis for the assembly areas — i.e., the Casino and restaurants (having a capacity of 50 or more) on the Casino level.

Chapter 31, Operating Features, of the *Code* covers emergency procedures for fire emergencies and drills in those procedures.

High-Rise Hotel Tower

The types of exits provided in the high-rise tower were interior stairs (S1, E1, and W1) and smokeproof towers (S2, E2, and W2). All interior stairs and two of the smokeproof towers utilized exit passageways to provide travel from the base of the stairway, just below the fifth floor level, to the outside of the hotel and then down additional stairs to street level.

Chapter II, Section F, of this report describes stairway construction and arrangement, and Chapter IV, Section B, covers smoke spread into the stairways that resulted in the major impairment to the means of egress from the high-rise tower. The arrangement of the stairways and exit passageways together with deficiencies previously described indicate clearly that the resulting lack of integrity of stairway and passageway enclosures was a major factor in allowing untenable conditions within the stairways. The

Life Safety Code contains requirements for stairway and passageway enclosures.

Exit passageways (Section 5-2.7) are permitted by the *Code* as an exit component providing they conform to all other requirements of Section 5-1 (Means of Egress, General) and specifically to 5-1.3, as follows:

5-1.3 Separation of Means of Egress (see also Section 6-2).

5-1.3.1 When an exit is required to be protected by separation from other parts of the building by some requirement of this Code, the separating construction shall meet the requirements of Section 6-2 and the following requirements:

(a) The separation shall have at least a 1-hour fire resistance rating when the exit connects three stories or less. This applies whether the stories connected are above or below the story at which exit discharge begins.

(b) The separation shall have at least a 2-hour fire resistance rating when the exit connects four or more stories, whether above or below the level of exit discharge. It shall be constructed of an assembly of noncombustible or limited-combustible materials and shall be supported by construction having at least a 2-hour fire resistance rating.

(c) Any opening therein shall be protected by an approved self-closing fire door (also see 5-2.1.2.3).

Exception: Fire doors which have been specifically approved as a pair not requiring an astragal at the meeting edges.

(d) Openings in exit enclosures shall be limited to those necessary for access to the enclosure from normally occupied spaces and for egress from the enclosure.

As previously described, the construction of the exit passageways at the MGM Hotel did not provide the necessary 2-hour fire-resistance rating. Access panels that existed in the hotel passageways would not be allowed in the separating construction [Section 5-1.3.1 (d)] by the *Code*.

Smokeproof towers (*Life Safety Code*, Section 5-2.3) are also permitted in the *Code* as an exit com-

Table 4.1. Stair Egress Distribution

Stairway	Number Using Stair	Percent of Total Responses
S1	6	1.4
S2	74	16.9
W1	11	2.5
W2	110	25.2
E1	40	9.2
E2	196	44.8

ponent providing they conform to all other requirements of Section 5-2.3 including:

5-2.3.3 *A smokeproof tower, as herein specified, shall be a continuous, fire-resistive enclosure protecting a stairway from fire or smoke in the building served, with communication between the buildings and the tower by means of balconies directly open to the outer air.*

5-2.3.4 *Stairs, enclosure walls, vestibules, balconies, and other components of smokeproof towers shall be of noncombustible materials, and all other requirements specified in 5-2.2 for inside stairs shall apply to stairs in smokeproof towers.*

Interior stairs are also recognized exit components providing they conform to all other requirements of Section 5-2.2, including Section 5-2.2.1.3 which in turn references Section 5-1. This Section, as with exit passageway provisions, requires 2-hour fire-resistance-rated enclosures constructed of an assembly of noncombustible or limited-combustible materials, supported by construction having at least a 2-hour fire-resistance rating.

Section 6-2, Construction and Compartmentation, is referenced under Means of Egress sections cited above; the following provision is included in Section 6-2:

6-2.2.9 *The enclosing walls (fire barriers) of floor openings serving stairways or ramps that are required exits shall be so arranged as to provide a continuous path of escape, including landings and passageways, in accordance with 5-2.2, providing protection for persons using the stairway or ramp against fire, or smoke therefrom, in other parts of the building.*

All of the interior stairs and at least two of the three smokeproof towers at the MGM Hotel did not provide the required protection according to the *Life Safety Code* for persons using the stairway. None of the exit stairways completely complied with the requirements of the *Life Safety Code*. Some of the discrepancies were minor in nature, such as the "vision holes" (viewers) in exit doors, and had no direct bearing on the outcome of the fire. Other discrepancies as described in Chapter II, such as the substandard enclosure of stairs, smokeproof towers and exit passageways, are considered significant factors that contributed to the loss of life and injuries in this fire.

A detailed analysis of other aspects of the high-rise tower means of egress is not included; however, such features as arrangement of exits (Section 17-2.5), illumination (Section 17-2.8) and travel distance (Section 17-2.6) appeared to comply with the re-

quirements of the appropriate sections of the *Code*.

In Section 17-2.10 exit access doors are required to have illuminated exit signs and illuminated directional signs where necessary.

17-2.10 Marking of Means of Egress.

17-2.10.1 *Every exit access door from public hallways or from corridors on floors with sleeping accommodations shall have an illuminated sign in accordance with Section 5-10. Where exits are not visible in a hallway or corridor, illuminated directional signs shall be provided to indicate the direction to exits.*

Because of offsets (jogs) in the corridors of the MGM Hotel guest room floors, there were many locations where exit signs were not visible.

Protection of vertical openings for existing hotels is required in Section 17-3 (stairway enclosure requirements have been previously discussed). Seismic joints that separated the east and west wings from the south wing would likewise be required to be protected or enclosed. Section 6-2.2 requires that openings in such shaftways be protected as appropriate for the fire-resistance rating of the fire barrier. Provisions of Section 6-2.2.3.2 require a minimum of ½-hour fire barriers in existing buildings and 2-hour fire barriers enclosing floor (vertical) openings in new construction of five stories or more. As described in Chapter II, seismic joints were not enclosed with rated construction, and moreover, the bottoms of shafts were open to the plenum area above the Casino level ceiling.

In Section 17-3.4 (Alarm and Communication Systems) an alarm system is required in hotels like the MGM Grand, in accordance with Section 7-6, which in turn refers to NFPA 72A, *Standard for the Installation, Maintenance and Use of Local Protective Signaling Systems for Watchman, Fire Alarm and Signaling Service*. During the NFPA investigation, there was no evidence that the fire alarm system at the MGM Hotel was activated, or if activated, operated to alert high-rise tower occupants endangered by the November 21 fire. (The exact reason the system did not operate is not known.)

If automatic sprinkler systems are installed they are required to be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems* (see Section 17-3.5).

A sprinkler line installed in the exit passageway from stair S1 (apparently installed for partial protection) was not properly supported. Toggle bolts used to support the pipe were fastened through gypsum wallboard and pulled loose during the fire. The sprinkler pipe collapsed, broke and was rendered useless; in fact, it created a safety hazard to anyone

attempting to travel through the passageway.

Minimum fire-resistance requirements for protection of guest rooms and corridors are contained in Section 17-3.6. For existing hotels, fire resistance of corridors must be a minimum of 30 minutes, guest room doors must have a protection rating of at least 20 minutes (previously approved 1¾-inch solid bonded wood core doors may remain in use) and doors between guest rooms and corridors must be self-closing. Guest room doors at the MGM were not self-closing.

Building services equipment such as heating, ventilating and air conditioning systems are covered in Section 17-5.2 which refers to Section 7-2.1, which in turn references NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*:

7-2.1 Air conditioning, heating, ventilating ductwork, and related equipment shall be installed in accordance with the Standard for the Installation of Air Conditioning and Ventilating Systems, NFPA 90A, or Standard for the Installation of Warm Air Heating and Air Conditioning Systems, NFPA 90B (see Appendix B), as applicable.

Exception: Existing installations may be continued in service, subject to approval by the authority having jurisdiction.

The 1978 edition of NFPA 90A contains the following section:

2-2.2 Public corridors in health care, penal, and residential occupancies shall not be used as a portion of a supply, return, or exhaust air system serving adjoining areas other than toilet rooms, bathrooms, shower rooms, sink closets and similar auxiliary spaces opening directly on the corridor. Air transfer because of pressure differential in health care occupancies and infiltration into residential occupancies from corridors is acceptable, provided door clearances shall not exceed those specified for fire doors in the Standard for Fire Doors and Windows, NFPA 80. Further, doors and/or wall grills shall not be used.

As previously described, smoke movement through the high-rise corridors and into guest rooms through fan-coil units was a significant problem. NFPA 90A prohibits the use of corridors as supply portions of the HVAC system as was the case in this incident. Additionally, in Section 17-3.6.6 the *Life Safety Code* contains important provisions for transfer grills between corridors and guest rooms in existing hotels. Fusible link operated fire dampers were located in the corridors in conjunction with the fan-coil units. (See Photos bottom right, page 54.)

17-3.6.6 Transfer grills, whether protected by fusible link operated dampers or not, shall not be used in these walls or doors.

Exception No. 1: Where a corridor smoke detection system is provided which when sensing smoke will sound the building alarm and shut down return or exhaust fans which draw air into the corridor from the guest rooms. The grills shall be located in the lower one-third of the wall or door height.

Exception No. 2: Where automatic sprinkler protection is provided in the corridor in accordance with 19-3.5.1 and where the transfer grill is located in the lower one-third of the wall or door height.

In addition to the above provision contained in Section 2-2.2 of NFPA 90A, the standard contains other requirements for HVAC systems to restrict the spread of smoke through duct systems. For systems over 15,000 cfm, Section 4-3.2 of NFPA 90A contains requirements for smoke dampers and automatic shutdown of fans.

4-3.2 Except as required by provisions of 4-2, in systems of over 15,000 cfm (7080 L/sec) capacity, smoke detectors approved for duct installation shall be installed and arranged to automatically shut down fans. For this purpose, the detectors shall be provided as follows:

(a) at a suitable location in the return air stream prior to exhausting from the building or being diluted by outside air, and

(b) at a suitable location in the main supply duct on the downstream side of the filters.

Smoke dampers (see 1-3.15) shall be installed to isolate the air handling equipment (including filters) from the remainder of the system so as to restrict circulation of smoke, and arranged to close automatically when the system is not in operation, and also by operation of the smoke detecting apparatus and by the manual emergency fan stop.

Exception: In lieu of the automatic fan shutdown, systems may incorporate automatic exhaust when acceptable to the authority having jurisdiction.

As described in Chapter IV, Section B, of this report, during the fire HVAC systems continued to operate distributing smoke and other products of combustion throughout the high-rise tower.

The *Life Safety Code* requires that elevators in hotels and places of assembly comply with the *American National Standard Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks*, ANSI A17.1-1978 (see Bibliography). An exception allows existing installations to continue in service, subject to approval by the authority having jurisdiction. Section 211 of ANSI A17.1-1978 deals with elevator emergency operation. Smoke detectors

Table 4.2. Typical High-Rise Floor Occupant Load and Exit Capacity¹

Typical high-rise floor	65,383 sq ft	Occupant load determined using gross floor area. ²
Occupant load	327 persons	Gross floor area divided by 200 sq ft per person.
Existing units ³ of exit width	4.5 units 6 units	Doors—100 persons per unit ⁴ of exit width. Stairs—75 persons per unit of exit width.
Exit capacity	900 persons	4.5 units (three exits) × 100 6 units (three exits) × 75
Additional units of exit width required for total occupant load	NONE	Exiting capacity exceeded occupant load.

¹ Based on *Life Safety Code*, NFPA 101, Chapter 17, Existing Hotels.

² Occupant load determined on basis of gross floor area or maximum probable population, whichever is greater (17-1.7.1).

³ Means of egress measured in units of 22 inches (5-3.2.1).

⁴ The door widths were used for calculating the exit capacity of the smokeproof towers because the stairs were 72 inches wide to serve the assembly occupancy on the 26th floor.

are required in each elevator lobby at each floor, except the main floor*, in 211.3a-2:

2 Sensing Devices.

In addition to the key-operated switch required in 1 above, heat and smoke or products of combustion sensing devices shall be installed in accordance with NFPA No. 72D in each elevator lobby at each floor, except the main floor. The activation of a sensing device in any elevator lobby shall cause all cars in all groups that serve that lobby to return nonstop to the main floor. The operation shall conform to the requirements of 211.3a-1-a to 211.3a-1-e. The key-operated switch required by 211.3a-1, when moved to the "by-pass" position, shall restore normal service independent of the sensing devices.

Fire fighters manual recall key-operated switches were provided for elevators at the MGM Hotel, but no smoke and heat detectors were located in the elevator lobbies.

Table 4.2 presents exit capacities available and estimated occupant loads for the high-rise tower as compared to the *Life Safety Code*. There was adequate exit capacity provided for the guest room floors of the tower as compared to Chapter 17 requirements.

Casino Level

The Casino level of the MGM Grand Hotel contained areas used for gatherings of 50 or more persons. This analysis section pertains in particular to

the Casino, The Deli, the Orleans Coffee House and pertinent areas as compared to the requirements of Chapter 9, Existing Places of Assembly. By Occupant Load provisions of the *Life Safety Code*, Section 9-1.7.1, the Casino and restaurant area of the MGM Hotel would be considered a Class A place of assembly having a capacity of 1,000 persons or more (see Section 9-1.4.1).

According to Section 9-2.3.2 any main exit of a place of assembly must be of sufficient width to accommodate one-half of the total occupant load. The main exit from the Casino level was not sufficient to accommodate one-half the occupant load. (For analysis purposes the main exit is considered as the exit from the hotel lobby main entrance.)

The number of exits required in a place of assembly are covered in Section 9-2.4. Every Class A place of assembly (1,000 persons or more) must have four separate exits. At the time of the fire, three exits were operational including the main exit (porte cochere), Flamingo Road and one from the Hall of Fame. A fourth located at the southwest corner of the Casino level was impaired due to construction and was chained and padlocked.

Travel distance requirements are contained in Section 9-2.6:

9-2.6 Measurement of Travel Distance to Exits. Exits shall be so arranged that the total length of travel from any point to reach an exit will not exceed 150 ft (45.72 m) in any place of assembly.

Exception: The travel distance may be increased to 200 ft (60.96 m) in assembly occupancies protected throughout by an automatic sprinkler system.

The Casino was not sprinklered and travel distance exceeded the 150-foot requirement in Section 9-2.6.

*The Arcade level was considered the "dispatch level" or main floor level at the MGM Hotel.

For example, travel distance from the baccarat pit to the Flamingo Road exit or to the main exit was over 200 feet.

Interior finish requirements for existing places of assembly are contained in Section 9-3.3 and include:

9-3.3.2 *Interior finish in all corridors and lobbies shall be Class A or B and in enclosed stairways Class A.*

9-3.3.3 *Interior finish in general assembly areas shall be Class A, B, or C.*

Alarm and communication system requirements for existing places of assembly in the *Life Safety Code* are contained in Section 9-3.4 including:

9-3.4.1 *Every Class A or B place of assembly shall be provided with a manual fire alarm system in accordance with 7-6.1.2.*

9-3.4.2 *The alarm system shall not automatically sound an alarm in the audience or seating portion of the place of assembly but shall sound an alarm in a constantly manned location.*

Exception: Places of assembly in educational occupancies.

9-3.4.3 *Provisions shall be made for transmitting voice messages by a public address system throughout the assembly area. Reliability of the public address system shall be assured by testing the system prior to allowing occupants into the assembly room.*

Exception: Places of assembly in educational occupancies.

9-3.4.4 *The public address system shall be provided with an emergency power source.*

Exception: Places of assembly in educational occupancies.

Additionally, Section 7-6.2.3 requires manual fire alarm pull stations located in the natural path of escape. Other than manual pull stations located in certain security areas as described in Chapter II, no evidence of pull stations located in the restaurant and Casino areas was noted during the investigation.

As previously described, The Deli (the area of origin) and the Casino were not protected by automatic sprinklers. The *Life Safety Code* contains certain provisions addressing the installation of sprinklers. Section 9-4, Special Provisions, references Section 30-7 regarding windowless buildings. The Deli and the Orleans Coffee House were windowless areas and the *Life Safety Code* would require sprinklers for those areas:

30-7.1.1 *Windowless or underground areas occupied by 100 or more persons shall be protected throughout by an approved automatic sprinkler system in accordance with Section 7-7.*

Travel distance deficiencies from the Casino were discussed earlier. It should be noted that an increase in travel distance (up to 200 feet) is allowed with automatic sprinklers (9-2.6).

It is noted in Chapter 8, New Places of Assembly, of the *Life Safety Code* that automatic sprinklers are required in every Class A (1,000 or more persons) and Class B (300 to 1,000 persons) place of assembly (except Class B places of assembly used as restaurants).

8-3.5.1 Fire Suppression Systems. *Every Class A and B place of assembly shall be protected throughout by an approved automatic sprinkler system.*

Exception No. 1: Auditoriums with fixed seating.

Exception No. 2: Multipurpose educational occupancy auditoriums of less than 12,000 sq ft (1115 sq m) area.

Exception No. 3: Passenger terminals at or above grade.

Exception No. 4: Gymnasiums used for no other purpose.

Exception No. 5: Skating rinks and swimming pools used exclusively for participant sport and no audience facilities for more than 300.

Exception No. 6: Class B places of assembly used as restaurants.

This requirement was added to the *Life Safety Code* following the Beverly Hills Supper Club fire of May, 1977, in which 165 people were killed in an unsprinklered place of assembly. This important code provision recognizes the importance of controlling fires in incipient stages to reduce the potential for serious life safety exposure in places of assembly.

The *Life Safety Code* requires that the capacity of the means of egress for any floor be sufficient for the occupant load thereof (5-3.1.1) and also that exits shall be sufficient for simultaneous occupancy of both the place of assembly and other parts of the building (9-1.2.4). The Casino level was therefore considered in total (excluding the jai alai fronton) to determine the adequacy of the means of egress. All exits south of the showrooms and from the convention facilities were required to provide for the occupant load of the showrooms (Ziegfeld and Celebrity Rooms) and the convention facilities. Exits off the east end of the Hall of Fame and along the south side of the Casino level, in other words, could not be considered for calculating exit requirements of the Main Casino. In addition, the *Life Safety Code* requires

that one-half of the total occupant load of the showrooms and restaurants be accommodated with a main exit. The main exits from the Ziegfeld and Celebrity Rooms and the restaurants, the Orleans Coffee House and Cafe Gigi were into the Main Casino area.

The exits from the Casino, therefore, were limited to the main exit and the Flamingo Road exit and had to accommodate the occupant load of the Main Casino plus one-half the occupant load of the showrooms and restaurants. The Hall of Fame exits were required for the occupant load of the convention facilities and the exit doors from the southwest corner of the Main Casino were locked due to construction. The following table shows the Main Casino occupant load and total exit capacity calculations. Notwithstanding that the *Life Safety Code* requires that the main exit accommodate one-half the total occupant load and that all other exits must accommodate two-thirds the occupant load, Table 4.3 shows that the two available exits from the Casino would accommodate less than one-half of the Main Casino's total occupant load.

Operating Features

Section 31-6 of Chapter 31, Operating Features, in the *Life Safety Code* contains requirements for emergency organization, procedures and drills for hotel occupancies.

31-6.1 Hotel Emergency Organization.

31-6.1.1 All employees of hotels shall be instructed and drilled in the duties they are to perform in the event of fire, panic, or other emergency.

31-6.1.2 Drills of the emergency organization shall be held at monthly intervals, covering

such points as the operation and maintenance of the available first aid fire appliances, the testing of guest alerting devices, and a study of instructions for emergency duties.

31-6.2 Emergency Duties.

31-6.2.1 Upon discovery of fire, some or all of these duties will become immediately imperative, the number and sequence depending upon the exact situation encountered —

Alarms

Notify office.

Notify public fire department.

Notify private fire brigade.

Guests

Warn guests or others who are or may become endangered.

Assist occupants to safety, with special attention to aged, infirm, or otherwise incapacitated persons.

Search rooms to be sure all occupants have escaped.

Man all elevators (including those of automatic type) with competent operators.

Extinguishment

Extinguish or control the fire, using available first aid equipment.

Send messenger to meet public fire department upon arrival in order to direct latter to exact location of fire. (The public fire department is in full command upon arrival.)

Special Equipment

Fire Pumps — stand by for instant operation.

Ventilating Equipment — in case of dense smoke, stand by, operate under proper instructions to clear area affected.

Refrigerating Equipment — if machines are definitely endangered, shut them down and blow refrigerant to sewer or atmosphere to prevent explosion.

Generators and Motors — protect against water damage with tarpaulins — shut down motors not needed — keep generators operating to furnish lights, elevator power, etc.

Boilers — if necessary to abandon boiler room, extinguish or dump fire and lower steam pressure by blowing to sewer or atmosphere to prevent possible explosion.

Table 4-3. Main Casino Occupant Load and Total Exit Capacity

Main Casino	57,000 sq ft	Occupant load determined using net floor area.
Occupant load	3,800 persons	Net floor area divided by 15 sq ft per person. ¹
One-half occupant load of showrooms and restaurants	1,500 persons	Occupant load from showrooms and restaurants (3,000) divided by 2.
Total occupant load	5,300 persons	Casino occupant load plus one-half occupant load from showrooms and restaurants.
Existing units of exit width	21.5 units	Main and Flamingo Road exits.
Total exit capacity	2,150 persons	100 persons per exit unit.
Additional units of level exit width required for total occupant load	31.5 units	The difference between total occupant load and existing capacity, divided by 100.

¹ A more concentrated use number (7 sq ft per occupant) could be used.

Section 31-2, Places of Assembly, of the *Life Safety Code* contains operating feature requirements for places of assembly such as the Casino including Section 31-2.1:

31-2.1 Drills. *The employees or attendants of places of public assembly shall be schooled and drilled in the duties they are to perform in case of fire, panic, or other emergency in order to be of greatest service in effecting orderly exit of assemblages.*

SUMMARY AND MAJOR CONTRIBUTING FACTORS

The MGM Grand Hotel incident was the second largest loss of life hotel fire in the United States. In 1946, 119 people were killed in the Winecoff Hotel disaster in Atlanta, Georgia. The MGM fire, which resulted in 85 deaths, was in a much larger "mega-structure" with some 3,400 registered guests in the high-rise tower and patrons on the Casino level in addition to employees throughout the building complex.

The life safety exposure included fire spread through the Casino following full involvement of The Deli and a heavy smoke exposure throughout the high-rise hotel tower. Seventeen victims were located on the Casino level, many of them trapped as the flame front moved through the Casino. Sixty-one victims located in the high-rise tower were among those exposed to untenable smoke conditions in rooms, corridors, stairways and elevator lobbies. Ten of the seventy-eight Casino level and high-rise victims were located in elevators on various floors. As determined by the Clark County Coroner, all high-rise victims and fourteen of the Casino level victims died of smoke and carbon monoxide inhalation. Three Casino level victims died of burns and carbon monoxide inhalation; one person who jumped or fell died of massive head injuries. Some six hundred persons were injured and required medical attention. The evacuation of the high-rise tower required about four hours. Some occupants evacuated early in the fire and others in later stages with fire fighter assistance.

The life safety exposure scenario at the MGM fire was not in itself unique, however, as there have been other hotel fires in which the fire was contained to a single floor with smoke spread resulting in fatalities on multiple floors above. In 1963, 22 occupants were killed at the Hotel Roosevelt* in Jacksonville, Florida, due to smoke spread to upper floors from a

fire in a ballroom on a lower level. A fire in the Inn on the Park Hotel** near Toronto, Ontario, in January, 1981, was similar to the MGM smoke spread scenario, but only six were killed and the building was much smaller.

Based on the NFPA investigative study, the following are considered to be the major contributing factors to the loss of life in the MGM Grand Hotel fire:

1. Rapid fire and smoke development on the Casino level due to available fuels, building arrangement, and the lack of adequate fire barriers.

As reported by the Clark County Fire Department, the most probable source of ignition in this fire was heat produced from electrical short-circuiting of an ungrounded conductor to a flexible metal conduit. This occurred in wiring 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. The first materials ignited included plywood used to enclose the pie case. The fire most likely smoldered for a period of time before breaking out of the concealed space and into The Deli's serving station at approximately 7:05 to 7:10 A.M.

Once open flaming in the serving station took place, the fire began spreading on lightweight fuel such as plastic, paper and combustible interior finish. Initially, smoke moved directly from the serving station through a transfer grill to the return air plenum above the ceiling.

Full involvement in the serving station and then The Deli along with the lack of adequate fire barriers allowed the transfer of heat and smoke into the Casino. A flame front moved through the Casino and it became heavily involved consuming combustible furnishings, contents and interior finish. The presence of fuel, air supply and a very large undivided area allowed for rapid fire spread and heavy smoke production.

2. Lack of fire extinguishment in the incipient stage of fire.

After the fire was discovered by an employee, an attempt was made to extinguish the fire manually but it had developed to an extent that it could not be controlled with the equipment

*Ernest E. Juillerat, "Jacksonville Hotel Disaster," *NFPA Quarterly*, April 1964.

**Jon C. Jones, "Hotel Fires, A Brief Look at the Hotel Fire Record," *Fire Journal*, May, 1981.

available and the employee's training. A reliable method to automatically extinguish fires in their incipient stage while the fire is small is to provide automatic sprinklers throughout all areas. If sprinklers had been provided in the area of The Deli and its serving station, the potential for a fire developing beyond the incipient stage and becoming life threatening would have been considerably reduced.

3. Unprotected vertical openings contributed to smoke spread to the high-rise tower.

Seismic joint shafts and elevator hoistways contributed to smoke movement into and throughout the high-rise tower. These shafts and hoistways had openings which allowed smoke movement through the 26th floor plenum area and elevator room to HVAC equipment which in turn contributed to smoke spread through the high-rise tower air supply systems.

4. Substandard enclosure of interior stairs, smokeproof towers and exit passageways contributed to heat and smoke spread and impaired the means of egress from the high-rise tower.

All three of the interior stairways were enclosed with construction that did not have a 2-hour fire-resistance rating. In addition, there were non-rated access panels that allowed smoke and heat to spread into these stairs. At least one of the smokeproof towers (W2) was enclosed with plywood on the bottom which burned through, allowing smoke spread into W2. The termination of stairways and the arrangement of exit passageways in the Casino level plenum area together with enclosure deficiencies contributed to smoke and heat exposure to the stairways and impairment of the high-rise tower means of egress.

5. Distribution of smoke throughout the high-rise tower through the heating, ventilating and air conditioning equipment.

HVAC systems operated during the fire and contributed to smoke spread through the high-rise tower. The equipment, as far as could be determined, was not equipped with smoke detectors arranged to shut down the systems upon sensing products of combustion. In addition, some fire dampers were arranged so that they could not close when the fusible links

melted and others did not close completely. High-rise tower corridors were utilized for supply air to guest rooms; this arrangement contributed to smoke movement in corridors and exposure to guest rooms.

6. Smoke spread through elevator hoistways to the high-rise tower.

Several elevator cars were stopped at or slightly above or below the Casino level, and two cars fell below the Casino floor. Door openings at the lobby level allowed smoke spread into the hoistways and smoke movement onto high-rise tower floors in elevator lobby areas.

The following are considered significant additional findings of the NFPA investigation study:

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 non-sprinklered areas.

2. There was no evidence of the execution of a fire emergency plan, and there was some delay in notifying occupants and the fire department. Following discovery of the fire (7:05-7:10 A.M.), the Casino level fire evacuation announcements were 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 moving 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 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 actual number of people present at the time of the fire was most likely much less than the 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) travel

distance limits for places of assembly are 150 feet, except, where sprinkler protection is provided, travel distances up to 200 feet are allowed.

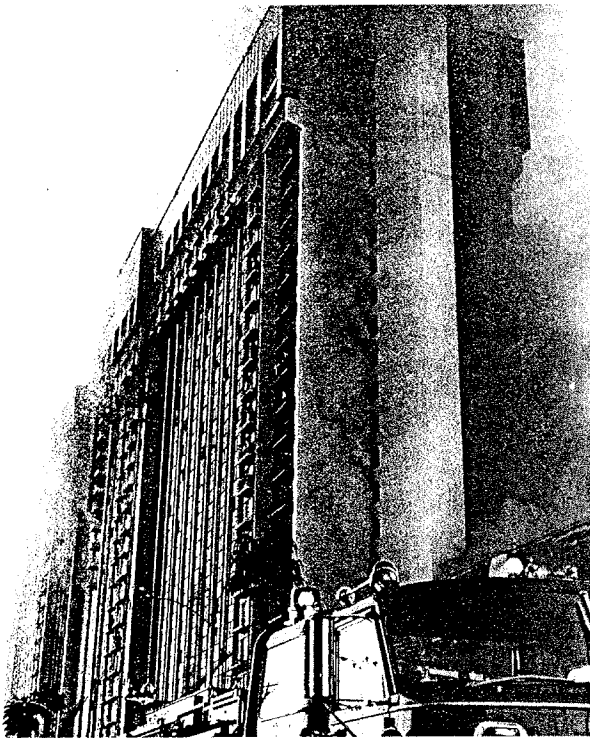
5. There was no evidence of manual fire alarm pull stations located in the natural path of escape on the Casino level. The 1981 Edition of NFPA 101, the *Life Safety Code*, requires manual fire alarm pull stations in the path of exit travel.

6. There was no automatic means of returning elevators to the main floor in event of fire, thereby avoiding the boarding of elevators by occupants during a fire. Ten victims were found in elevators at the MGM Hotel. Although their exact actions cannot 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 by helicopter from the roof of the high-rise tower. The NFPA Human Behavior Study shows that the majority of the study population evacuated over stairways. 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 procedural considerations for future operations:

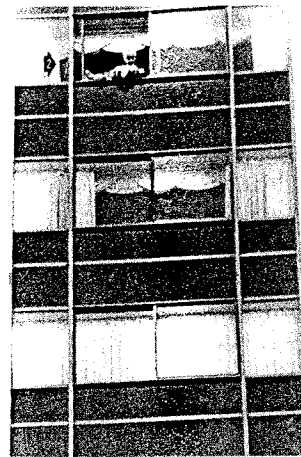
- Direct air-to-air and air-to-ground communications are necessary to coordinate helicopter operations by fire suppression and EMS incident commanders.
- Helicopters should avoid flying over command post and triage/treatment areas.
- Helicopter landing zones should be on grassy or paved areas where possible.



View from northwest early in fire shows smoke from upper floors and "smokeproof" tower, stair W2 (directly above apparatus cab). (Credit: Las Vegas News Bureau)



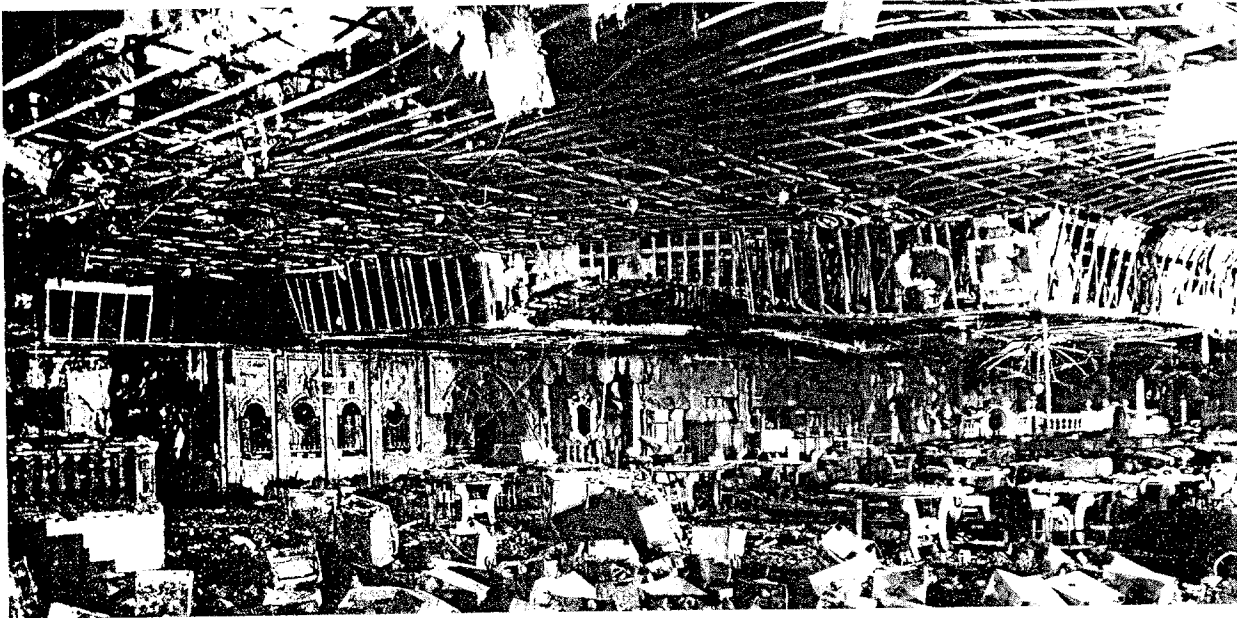
View of north face of hotel shows aerial ladder and construction hoist used to rescue some occupants. All but lowest (5th floor) guest room floors are shown. (Credit: Las Vegas SUN)



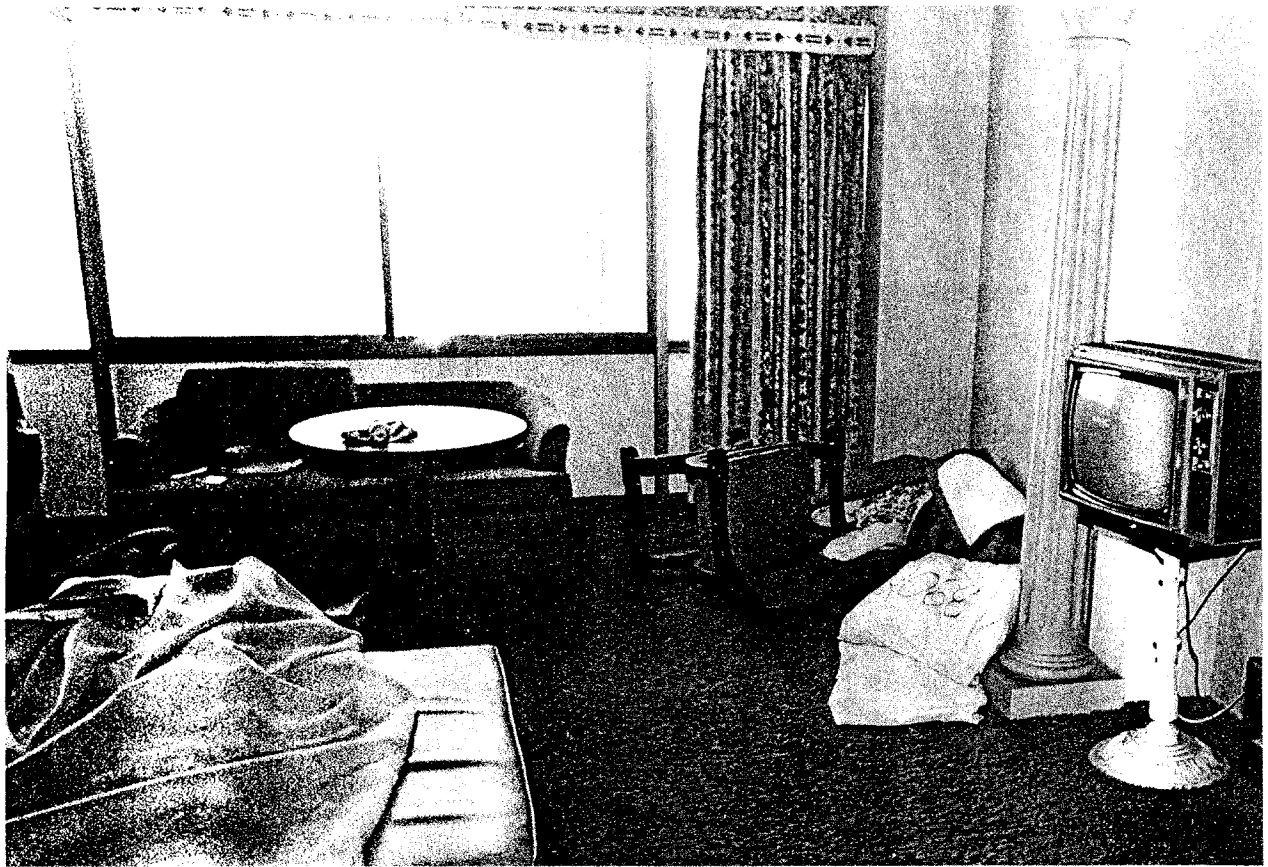
View of guests at windows shows variety of window conditions. (1) Window open to stop was extent of operation without removing stop. (2) Window open to stop, glass removed. (3) Window closed and two glass lights broken. (Credit: Las Vegas SUN)



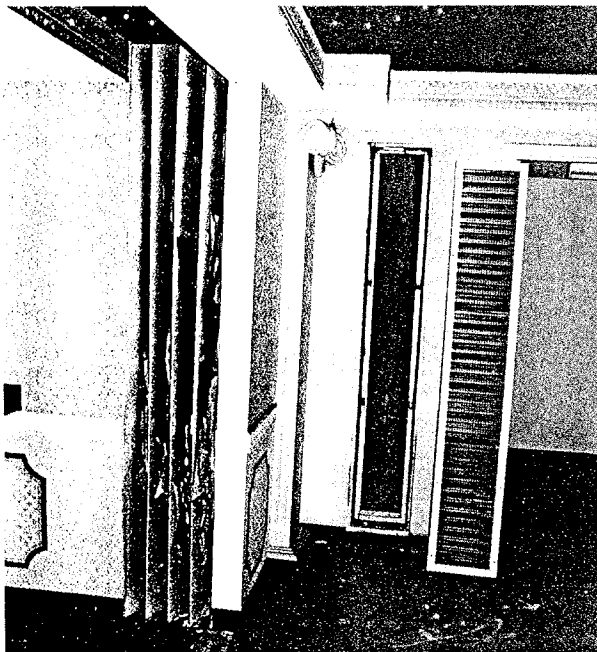
View of serving station in The Deli looking south. Note opening to serving station left of step ladder, Keno board above opening, pie (pastry) case left of opening. (Credit: NFPA)



Looking toward southwest in Main Casino, damaged slot machines are at bottom of photo. the eye in the sky was the lower ceiling section. (Credit: Las Vegas Metropolitan Police Dept.)



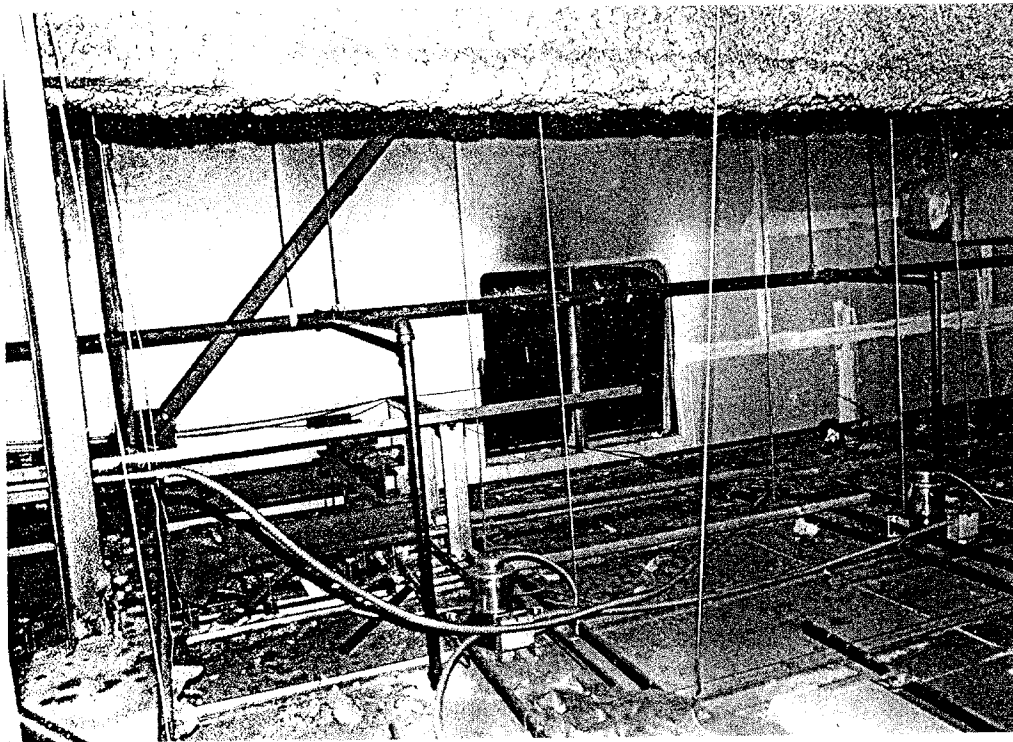
Room 2068 (adjacent to elevator lobby on 20th floor) where male victim was found next to open window in tipped-over chair. Room is typical of guest rooms throughout hotel with little evidence of smoke or soot particles. Window noted open to stop in earlier photo showing victim. (Credit: NFPA)



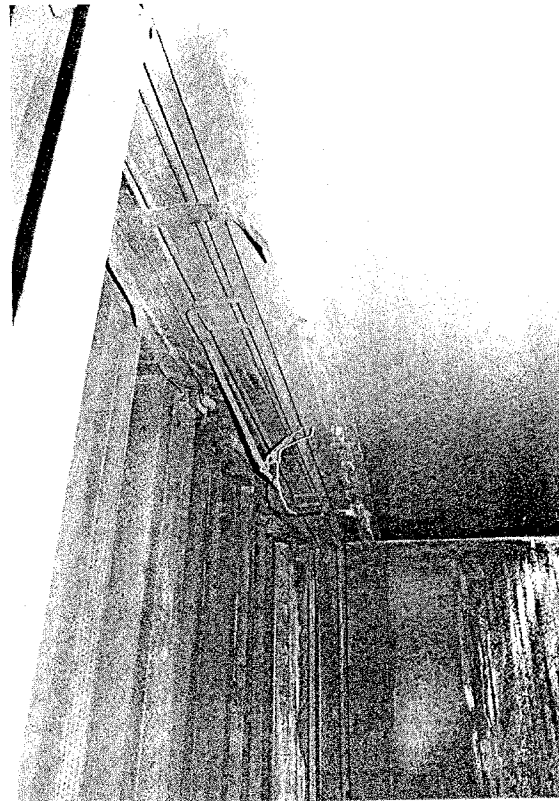
In high-rise tower, note air transfer grill fire damper unit removed and accordion fold metal at seismic joint. (Credit: NFPA)



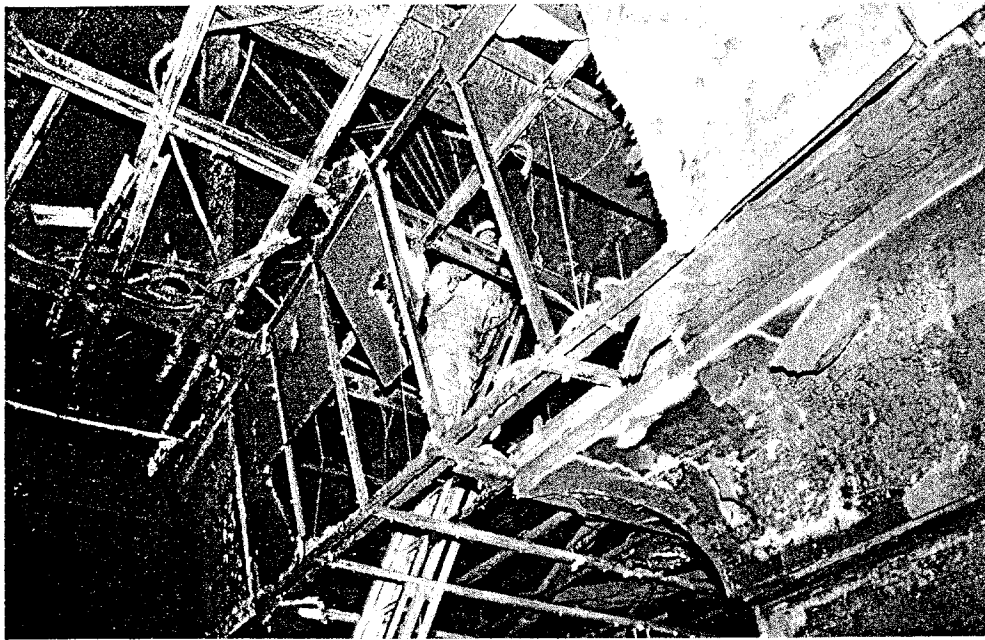
From corridor looking into guest room, fan-coil unit within room took make-up air from corridor through air inlet above door. Fan-coil unit in room delivered air to room (air outlet at top) taking make-up air from corridor and recirculating room air thru air inlet at bottom. (Credit: NFPA)



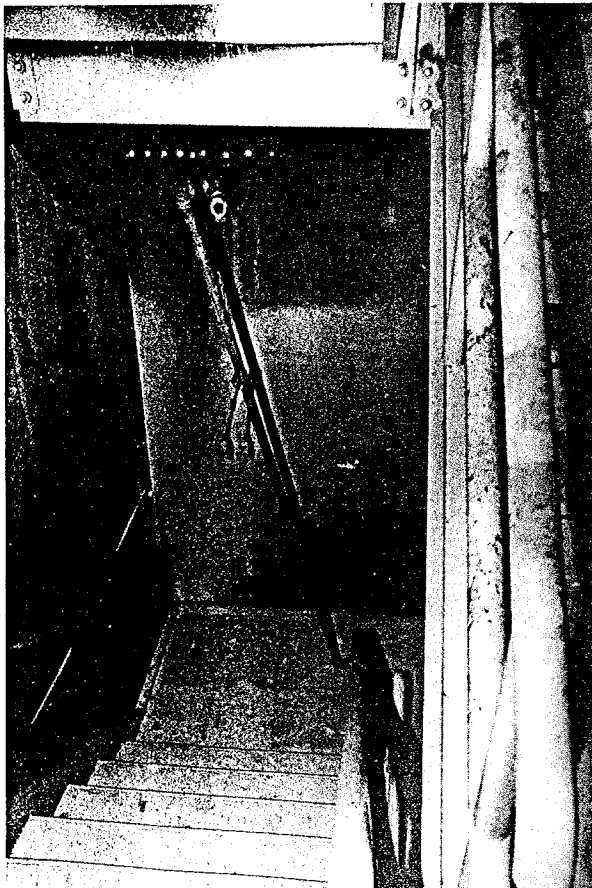
View of opening in partition above Casino level ceiling; ceiling space above Hall of Fame is on other side of partition. Photo taken near E1 stair. (Credit: NFPA)



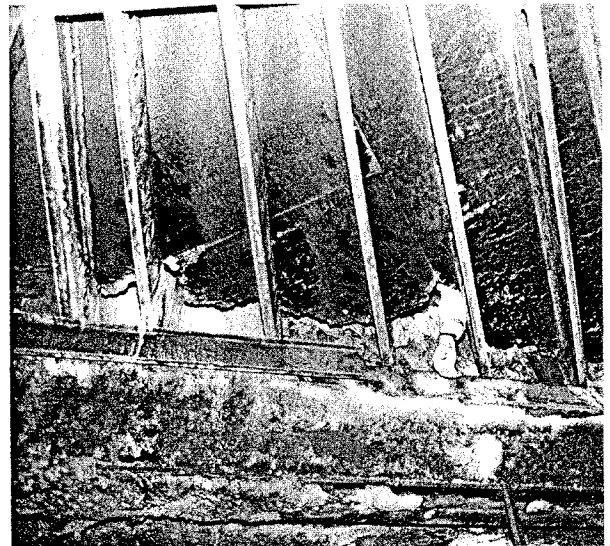
View of fire damper with straps arranged to prevent damper from closing. (Credit: NFPA)



View from the Casino level shows fire investigator on ladder in concealed space directly beneath the base of W2 stair. (Credit: NFPA)

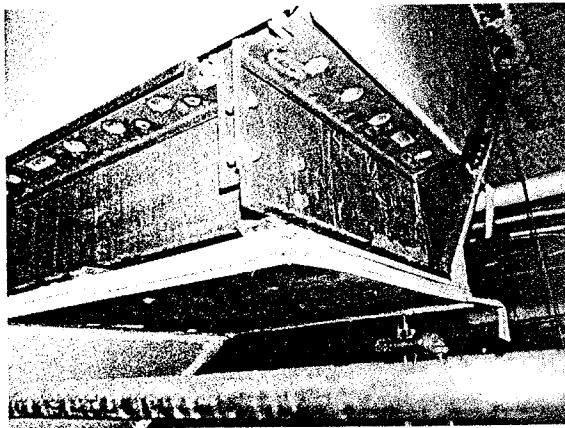
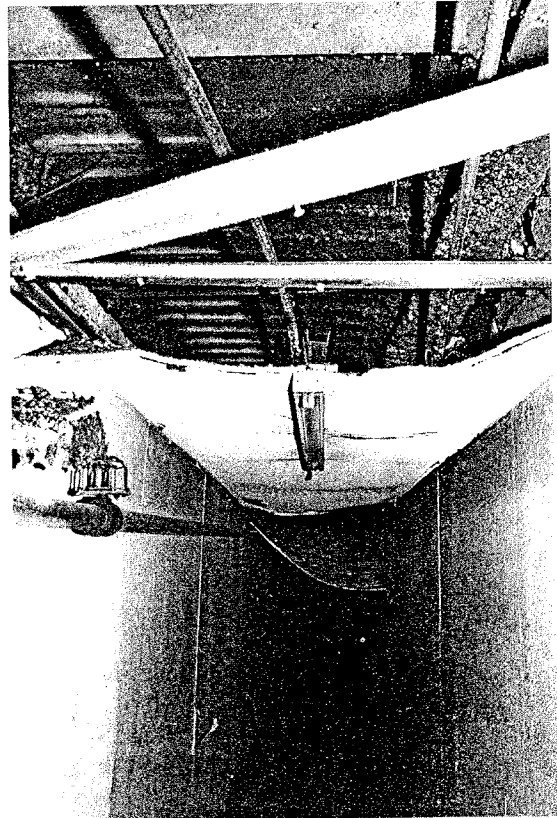


From about the 5th floor landing looking down S1 stair toward exit passageway. Note collapsed sprinkler piping. (Credit: NFPA)

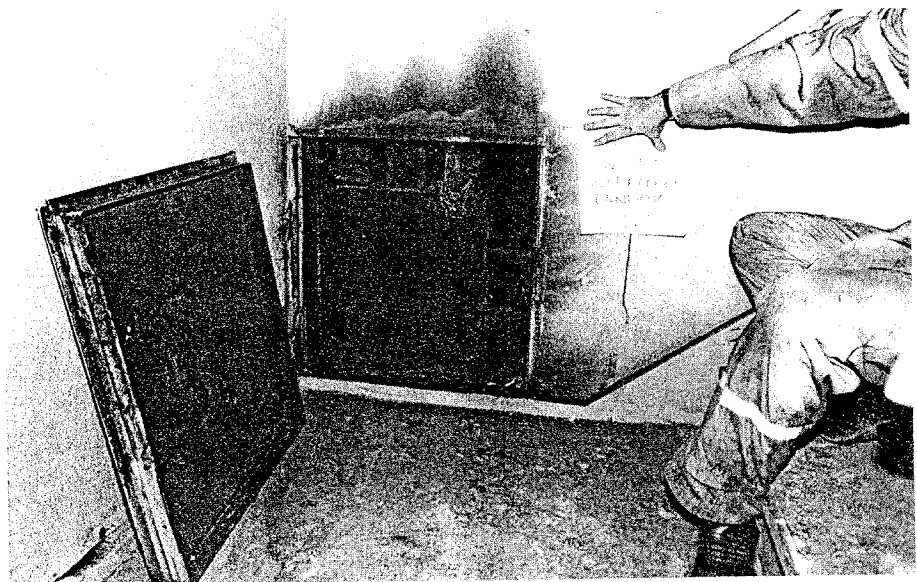


View from concealed space above Casino level ceiling looking at plywood deck of the S2 smokeproof tower air shaft. Note investigator's arm extending through gap where plywood is burned away. (Credit: NFPA)

Exit passageway from S1 stairway, note single thickness gypsum wallboard ceiling and sprinkler piping pulled from ceiling (Credit: NFPA)



View of stairway EI base from the concealed space above Casino level ceiling. Note lack of protection of steel members and openings to stair interior. (Credit: NFPA)



View is from stair W1 interior looking at access opening to concealed space above Casino. Note heat damage and soot pattern from smoke exposure. (Credit: NFPA)

APPENDICES

APPENDIX A

NBS Testing Results

January 9, 1981

MEMORANDUM FOR: Richard L.F. Custer, Acting Chief
Fire Performance Evaluation Division

From: Sanford Davis, Head
Construction and Materials Research

Subject: MGM Grand Hotel Carpet Samples

This is to document the work carried out on the carpet and pad samples from the MGM Grand Hotel which were provided on January 5, 1981.

Two materials were identified as follows:

No. 22 Carpet
No. 22 Underlayment

Test specimens were prepared for determination of the critical radiant flux (CRF) of this floor covering system in accordance with ASTM E 648 (NFPA 235), Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source. (Critical radiant flux is that level of external irradiance below which the flame will not continue to spread.) Because of the limited amount of material available, only one specimen of each was prepared in place of the three called for in the standard. The specimens were cut, vacuumed, and placed in the conditioning room on January 5, 1981. On January 8, they were sealed in a plastic bag and transported to the CPSC Engineering Laboratory for testing by our technician and under our supervision.

The results were as follows:

Carpet over underlayment (one specimen only) did not ignite ($CRF > 1.1 W/cm^2$)

This carpet performed well; it is not usual to find a carpet tested over underlayment to provide such a high value. This carpet system would be acceptable for use in hospitals and health care facilities; a CRF of $0.5 W/cm^2$ or better is generally accepted for these occupancies. Other regulated occupancies, such as commercial and residential buildings, require a value of $0.25 W/cm^2$ for carpet used in corridors and exitways.

The burned samples have been retained for examination, if needed.

SDAVIS:mlh:753.07:1/9/81

APPENDIX B

Victim Lists

LIST OF FATALITIES

Clark County Coroner-Medical Examiner Case Number	Sex	Age	Registered Room Number	Location Where Victim Found				Clark County Office of Coroner- Medical Examiner Cause of Death	% of Carbon Monoxide Saturation*	Comments
				Floor Number	Corridor	Elevator	Stair	Room Number	Windows Broken	
1430	F	46	1731	Outside						Fell/jumped - No. side of MGM Hotel.
1432	F	48	1050	Casino Level						Registration Desk - West End
1433	M	25	Employee	"						"
1434	M	25	2369	"						Registration Desk - slightly east of center.
1435	M	58	2382	"						Registration Desk - East End
1436	F	20	1094	"						Between Registration Desk & Flamingo Entrance.
1437	M	53	2279	Not Known						Low Hemoglobin; DOA - Sunrise Emergency Rm.
1438	F	34	1916	19			S2			Removed by LVFD Amb at South Triage area.
1439	F	64	605	Casino Level	X					Casino elevator corri- dor east bank (see 1451).
1440	M	36	1916	19			S2			(Same as 1438)

*Not corrected for post-mortem hemolysis.

LIST OF FATALITIES (cont.)

Clark County Coroner-Medical Examiner Case Number	Sex	Age	Registered Room Number	Location Where Victim Found				Clark County Office of Coroner- Medical Examiner Cause of Death	% of Carbon Monoxide Saturation*	Comments
				Floor Number	Corridor	Elevator	Stair	Room Number	Windows Broken	
1441	M	37	Employee	Casino Level				Ritz		Smoke & carbon monoxide inhalation
1442	M	53	"	"				Ritz		" " "
1443	M	24	1274	"				Ritz		" " "
1444	M	24	1274	"				Ritz		" " "
1445	F	23					X			" " "
1446	M	75	1871	Roof						Stairway between Casino level and 2nd floor
1447	N	48	2565	25	X					Delivered by chopper from rooftop
1448	M	65	2150	Not Known						DOA at Desert Springs Emergency Room.
1449	F	19	2502	25				2501	Yes	Inside room.
1450	F	36	2502	25				2501	Yes	Inside room.
1451	M	61	605	Casino Level		X				Casino elevator corri- dor east bank (see 1439)
1452	F	39		25	X					22.2
1453	F	60	2167	25			X			33.5
1454	M	31	2090	Roof						25th floor south stairway. Found on roof

*Not corrected for post-mortem hemolysis.

LIST OF FATALITIES (cont.)

Clark County Coroner-Medical Examiner Case Number	Sex	Age	Registered Room Number	Location Where Victim Found					Clark County Office of Coroner- Medical Examiner Cause of Death	% of Carbon Monoxide Saturation*	Comments
				Floor Number	Corridor	Elevator	Stair	Room Number			
1455	F	55	Employee	24	X			2535	Smoke & carbon monoxide inhalation	53.0	
1456	F	33	2547	25					" " "	26.2	Inside room.
1457	M	23		24	X				Asphyxiation/smoke inhalation & carbon monoxide inhalation	39.6	
1458	M	40	2470	24	X				" " "	19.2	
1459	F	23		24	X				Smoke & carbon monoxide inhalation	47.0	
1460	M	30	2413	24	X				Asphyxiation/smoke inhalation & carbon monoxide inhalation	35.8	
1461	F	23		24	X				" " "	no test	Low hemoglobin
1462	M	22	2402	24	X				" " "	26.2	
1463	F	43	2402	24	X				" " "	no test	Low hemoglobin
1464	M	46	2402	24				2403	" " "	9.2	Immediately inside door in room
1465	M	40	2448	24				2418	" " "	no test	Immediately in doorway of room. (half in/half out)
1466	M	59	2445	23			X		Smoke & carbon monoxide inhalation	39.8	On 1st step going upstairs.

*Not corrected for post-mortem hemolysis.

LIST OF FATALITIES (cont.)

Clark County Coroner-Medical Examiner Case Number	Sex	Age	Registered Room Number	Location Where Victim Found				Clark County Office of Coroner- Medical Examiner Cause of Death	% of Carbon Monoxide Saturation*	Comments
				Floor Number	Corridor	Elevator	Stair	Room Number		
1467	F	59	2445	23			X	Smoke & carbon monoxide inhalation	no test	Prone position, face down, heading stairs.
1468	F	53	Employee	23			X	Asphyxiation/smoke inhalation & carbon monoxide inhalation	no test	Landing between 22nd & 23rd floor stairway. (sitting position)
1469	M	48	2338	23				Smoke & carbon monoxide inhalation	14.5	Inside room - parallel and immediately adjacent to window.
1470	M	44	2302	23				Asphyxiation/smoke inhalation & carbon monoxide inhalation	20.8	Inside room - crouching position - immediately adjacent to window.
1471	M	46	2306	23				" " "	no test	Inside room at foot of bed.
1472	M	37	2370	23	X			" " "	17.8	
1473	F	38	2370	23	X			Smoke & carbon monoxide inhalation	50.8	
1474	F	43	2304	23	X			Asphyxiation/smoke inhalation & carbon monoxide inhalation	18.6	
1475	M	43	2304	23				" " "	38.8	Inside room at foot of bed.

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LIST OF FATALITIES (cont.)

Clark County Coroner-Medical Examiner Case Number	Sex	Age	Registered Room Number	Location Where Victim Found				Clark County Office of Coroner- Medical Examiner Cause of Death	% of Carbon Monoxide Saturation*	Comments
				Floor Number	Corridor	Elevator	Stair	Room Number	Windows Broken	
1476	M	37	2368	23				2368	Yes	Smoke & carbon monoxide inhalation
1477	M	49	2372	23				2368	Yes	Asphyxiation/smoke inhalation & carbon monoxide inhalation
1478	F	40	2372	23				2368	Yes	Smoke & carbon monoxide inhalation
1479	F	36	2368	23				2368	Yes	Asphyxiation/smoke inhalation & carbon monoxide inhalation
1480	M	44	2138	22			X			" " " " Sitting on bottom step.
1481	F	71	2237	22				2237	No	Smoke & carbon monoxide inhalation
1482	F	53	2285	22	X					Smoke & carbon monoxide inhalation; focal second degree postmortem burns
1483	M	35	2135	21			X			Smoke & carbon monoxide inhalation

*Not corrected for post-mortem hemolysis.

LIST OF FATALITIES (cont.)

Clark County Coroner-Medical Examiner Case Number	Sex	Age	Registered Room Number	Location Where Victim Found				Clark County Office of Coroner- Medical Examiner Cause of Death	% of Carbon Monoxide Saturation*	Comments
				Floor Number	Corridor	Elevator	Stair	Room Number	Windows Broken	
1484	F	33	2135	21			X			Prone position, face down
1485	M	59	2139	21				2139	No	Inside room near win- dow - slight angle.
1486	M	46	2102	21				2102	No	Inside room parallel to wall.
1487	F	35	2102	21				2102	No	Inside room parallel to window in same area as 1486.
1488	M	35	582	21	X					Corridor outside 2111.
1489	M	25	1814	21				2112	Yes	Inside room parallel to mantle.
1490	M	36	Employee	21				2115		Inside room extended position on couch covered with blanket.
1491	M	72	2068	20				2068	Yes	Inside room seated in chair in front of window.
1492	F	69	2068	20				2068	Yes	Inside room parallel to bed, head to wall.
1493	F	30	2028	20	X					
1494	M	35	2043	20	X					
1495	F	33	2043	20	X					Low hemoglobin. no test

*Not corrected for post-mortem hemolysis.

LIST OF FATALITIES (cont.)

Clark County Coroner-Medical Examiner Case Number	Sex	Age	Registered Room Number	Location Where Victim Found					Clark County Office of Coroner- Medical Examiner Cause of Death	% of Carbon Monoxide Saturation*	Comments
				Floor Number	Corridor	Elevator	Stair	Room Number	Windows Broken		
1496	M	31	2028	20	X				Smoke & carbon monoxide inhalation	35.6	
1497	F	70	2251	20		X			Asphyxiation/smoke inhalation & carbon monoxide inhalation	26.8	
1498	M	63	2251	20		X			Smoke & carbon monoxide inhalation	28.4	
1499	M	22	1818	20		X			" " "	54.0	
1500	M	32	1818	20		X			Asphyxiation/smoke inhalation & carbon monoxide inhalation	51.4	
1501	F	41		20				2001	Yes	30.0	Inside room.
1502	M	44		20				2001	Yes	52.2	Inside room.
1503	F	35	582	20	X				" " "	32.0	Near W1 stair.
1504	M	46		20	X				" " "	45.2	Near W1 stair.
1505	F	50	1871	16				1675	No	33.4	Removed from room 1675 by F.D.
1506	M	69	2568	19				1902	No	no test	Inside room adjacent to window.
1507	F	63	2568	19				1902	No	66.5	Inside room adjacent to window.
1508	F	37	548	Casino Level		X			" " "	52.1	

*Not corrected for post-mortem hemolysis.

LIST OF FATALITIES (cont.)

Clark County Coroner-Medical Examiner Case Number	Sex	Age	Registered Room Number	Location Where Victim Found				Clark County Office of Coroner- Medical Examiner Cause of Death	% of Carbon Monoxide Saturation*	Comments
				Floor Number	Corridor	Elevator	Stair	Room Number	Windows Broken	
1509	M	39	548	Casino Level		X		Asphyxiation/smoke inhalation & carbon monoxide inhalation; multiple superficial and deep burns	40.0	
1510	M	39	547	"		X		Smoke & carbon monoxide inhalation	41.4	
1511	M	56	1002	"		X		" " "	40.2	
1512	F	36		"		X		" " "	39.0	
1513	M	69	Not Known	Roof				Asphyxiation/smoke inhalation & carbon monoxide inhalation	no test	Tagged in landing stage parking lot.
1518	F	31	Employee	26		X		" " "	48.2	Found Sat. 26 floor elevator (service) SB.
Not Listed				Not Known						

NOTE: Data in this table are from Clark County
Coroner Autopsy Reports and fatalities from
the MGM Hotel fire except guest room and
victim location data verified by NFPA.

*Not corrected for post-mortem hemolysis.

APPENDIX C

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