



Conflagration to Code: How Historic Building Fires Shaped Modern Codes

Thomas W. Gardner, PE, FSFPE, LEED AP
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Overview

- Historic Building Fires
 - Building background information
 - Fire cause
 - Contributing factors
 - Resulting fire and building code modifications
- Questions & Answers

Early code development



- The Code of Hammurabi: original "law and order" king Ruled Babylon 1795-1750 B.C.
- 1896 "Rules and Regulations of the National Board of Fire Underwriters for Sprinkler Equipments, Automatic and Open Systems"
- 1897 National Electric Code
- 1912 NFPA publishes pamphlet "Exit Drills in Factories, Schools, Department Stores and Theaters." In 1927, Name changed to "Building Exits Code"
- 1966 "Building Exits Code" changed to "Code for Safety to Life from Fire in Buildings and Structures" NFPA 101

Iroquois theater fire (December 30, 1903)

- Located in Chicago, Illinois
- Opened 5 weeks earlier
- Sold-out crowd of 1,900
- Advertised as “Absolutely Fireproof”
- 25 Exits
- Asbestos curtain
- Smoke vents
- Firefighters backstage



Obviously not fireproof

- Canvas scenery brushes a light and ignites
- Kilfyres is ineffective on overhead fire
- Burning scenery falls onto velvet curtain and combustible props
- Asbestos curtain becomes jammed in tracks
- Vents above stage incomplete and nailed shut
- Vents above house operate
- Actors use stage exits and fresh air fans flames
- House vents act as chimney and fire sweeps out over the house
- 602 fatalities

What went wrong?

- Exit lighting/marking
- Complicated door latches
- Inward opening doors
- Locked stair gates
- Locked exit doors
- Incomplete fire escape
- No sprinklers
- No fire alarm



Image



Code impact

- Emergency exit lighting
- Fire sprinkler systems
- Fire extinguishers
- Outward opening exit doors
- Fire resistive scenery



Triangle shirtwaist factory (March 25, 1911)

- Washington Square in Manhattan, NY
- Loft factory
- Nearly 600 workers on 8th and 9th floors
- Two interior exit stairs, one fire escape, two elevators
- 27 Buckets of water and a standpipe system



27 Buckets of Water **vs.** 2,000 pounds of burning cloth

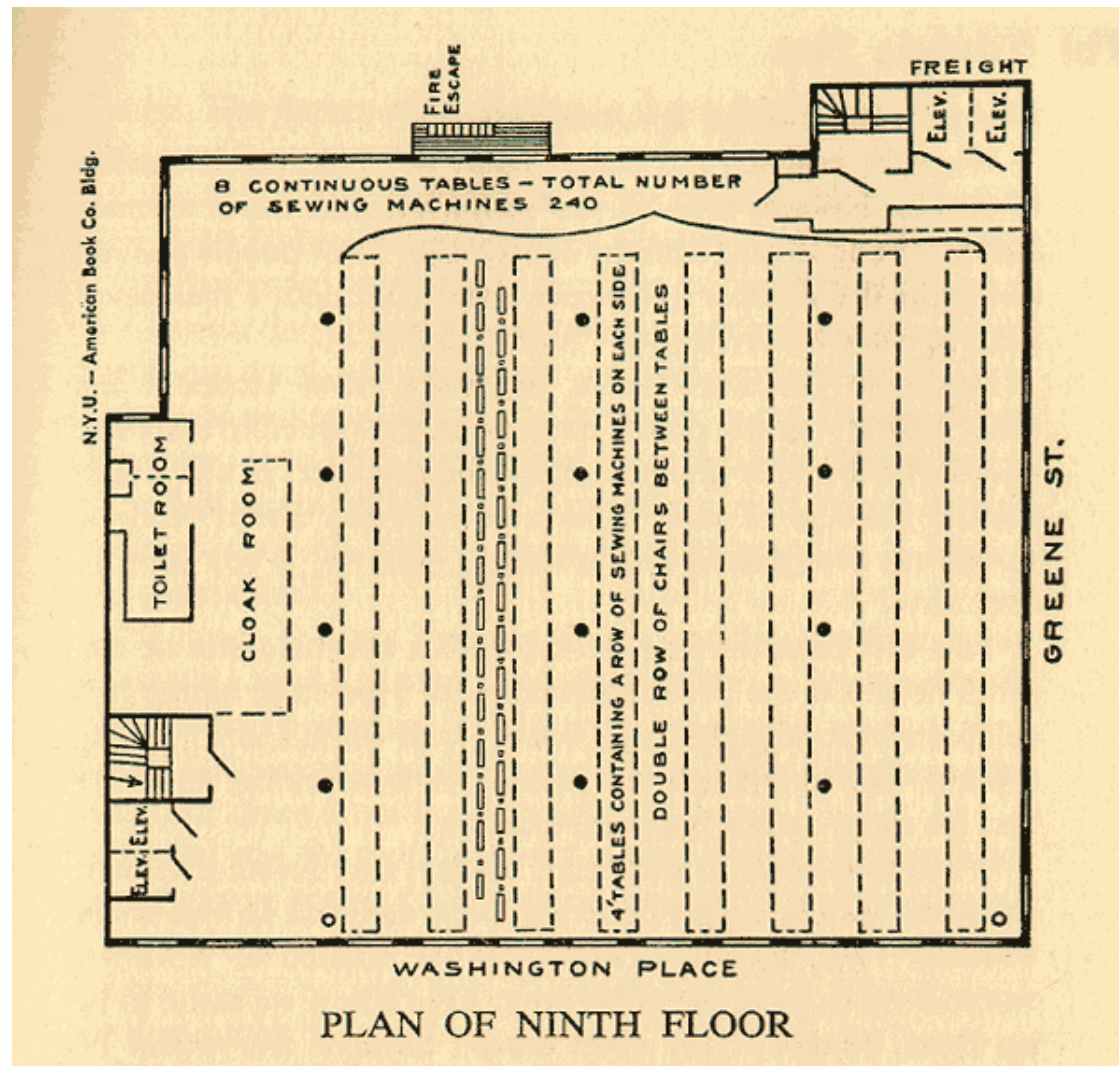
- Fire breaks out in scrap bin at quitting time
- Standpipe system is inoperable
- 27 Buckets of water is inadequate for the 2,000 pounds of fabric
- Workers rush for exits including elevators
- Fire escape collapses
- Fire department equipment only reaches the 7th floor
- With no way to escape, many jump to their deaths.
- 146 Fatalities

What went wrong?

- Inoperable standpipe system
- Locked exit stair
- Inward swinging doors
- Crowded room configuration
- Fire escape to enclosed courtyard
- Narrow stairs (2' 9" wide)



9th Floor Plan



Code impact

- New York State Factory Investigating Commission
 - 36 New labor code laws
- NFPA
 - Committee on private fire departments and fire drills
 - Focus shift from preventing city-wide conflagrations to protecting life (safety)
 - Foundation of Committee on Life Safety



Cocoanut grove night club (November 28, 1942)

- Located in Boston, MA
- Estimated 1,000 persons in club
(Limit = 600)
- Many patrons were servicemen & dates
after Holy Cross vs. Boston College
football game
- Many tables setup on the dance floor
- 492 dead.



Cocoanut grove pre-fire

- Boston Fire Department inspected the club 8 days before the fire:
 - Sufficient exits & extinguishers
 - Occupant load: Broadway Lounge 100 persons, main dining room/caricature bar 400 persons
 - No flammable decorations present per a “match test”
 - Overall condition: “Good”



Cocoanut grove pre-fire

- Boston Building Department also conducted a recent inspection:
 - Noted missing fire door between new Broadway Lounge & Main Dining Room
 - Club allowed to open without required certificate of inspection.



Cocoanut the fire

- The Caricature Bar, The Broadway Lounge, and The Melody Lounge (below grade) “standing room only”
- Melody Lounge, busboy lights match while replacing fixture in imitation palm tree
- Patrons notice palm tree on fire
- Bartenders attempt extinguishment



Cocoanut the fire

- Fire quickly travels across fabric ceiling
- Bottleneck occurs at stairs to first floor
- Victims pile up on stairs
- Occupants who did reach first floor find locked door.



What went wrong?

- Revolving door jammed (no adjacent swinging doors)
- Main dining room/caricature occupants become aware of fire & attempt to exit where entered
- Lighting system failed



What went wrong?

- Door from Main Dining Room was opened to Shawmut Street but Tables & Chairs Hamper Egress
- Broadway lounge occupants pile up at single exit (door opens inwards)
- Boston Fire Commissioner: Fire travels from point of ignition to first floor – a distance of 225 feet – in 5 Minutes.







Code impact

- Locked exits
- Each exit had something functionally wrong
- Combustible structure and interior finish
- Multilevel configuration – did not understand its impact
 - Fire and building codes revamped
 - Exits, combustible materials, emergency lighting, and automatic sprinklers

Code impact

- Definition of places of public assembly was expanded
- The Cocoanut Grove fire remains the deadliest nightclub fire and the second-worst building fire in United States history.

Winecoff hotel (December 7, 1946)

- Atlanta, GA
- 15 stories
- Over 280 guests
- Central stair and elevator shafts
- No sprinkler system
- No fire detection
- Standpipe system
- Brick exterior with fireproofed steel frame
- Advertised as ‘fireproof’



Again, not fireproof

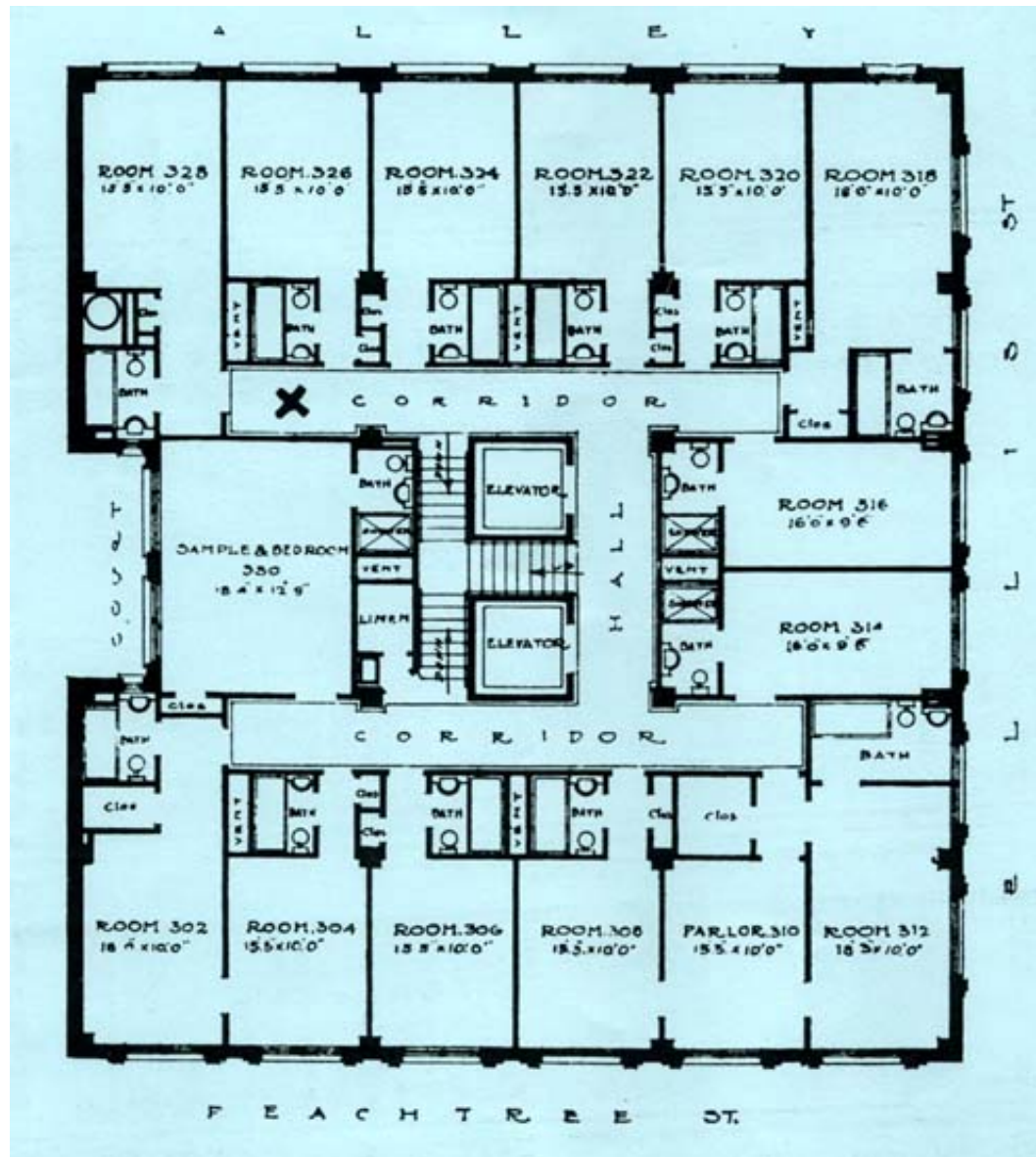
- Smell of smoke on 5th floor around 3:00am
- Fire department not notified until 3:45am
- Fire spreads up through stairway
- Open transoms and highly combustible wall coverings feed fire
- Fire department ladders only reach 7th floor
- Narrow alleyway prevents fire dept. access to two sides
- With smoke-filled corridors, many jump
- 120 fatalities

What went wrong?

- Combustible wall finishes
- Open stairwell
- Thin guestroom doors
- Transoms above doors
- No sprinkler system
- No fire alarm



Typical floor plan



Code impact

- Local codes verses national codes
- Retroactive code enforcement
- NFPA
 - Guide for Hotel Fire Safety Law
 - New hotel chapter in the Building Exits Code (later NFPA 101)



Our Lady of The Angels (December 1, 1958)

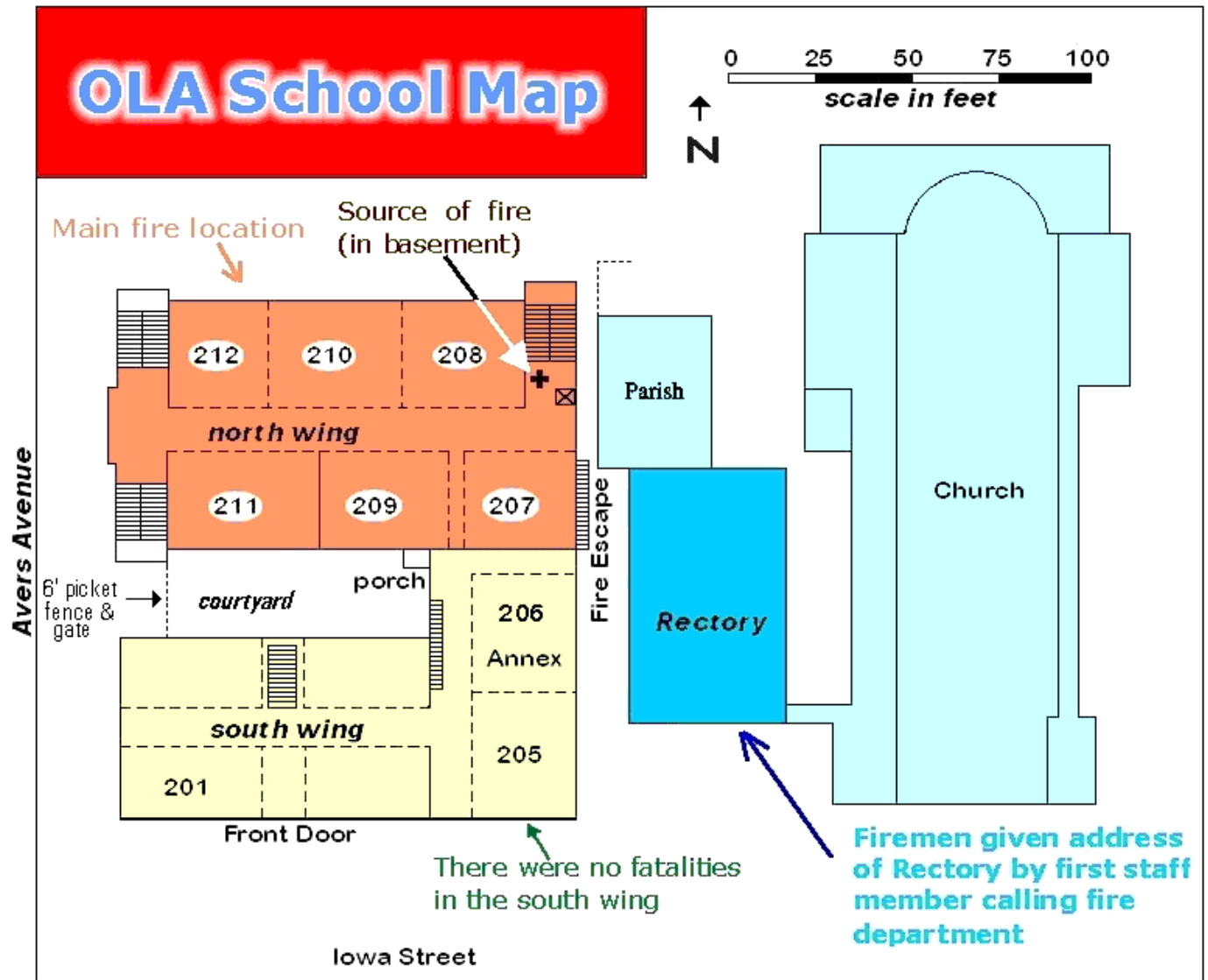
- Chicago, IL
- Elementary school
- 1,200 to 1,300 people
- Two story wood joist construction
- Multiple remodels
- 5 interior and 1 exterior stairs
- No sprinkler
- Masonry wall between north wing and annex



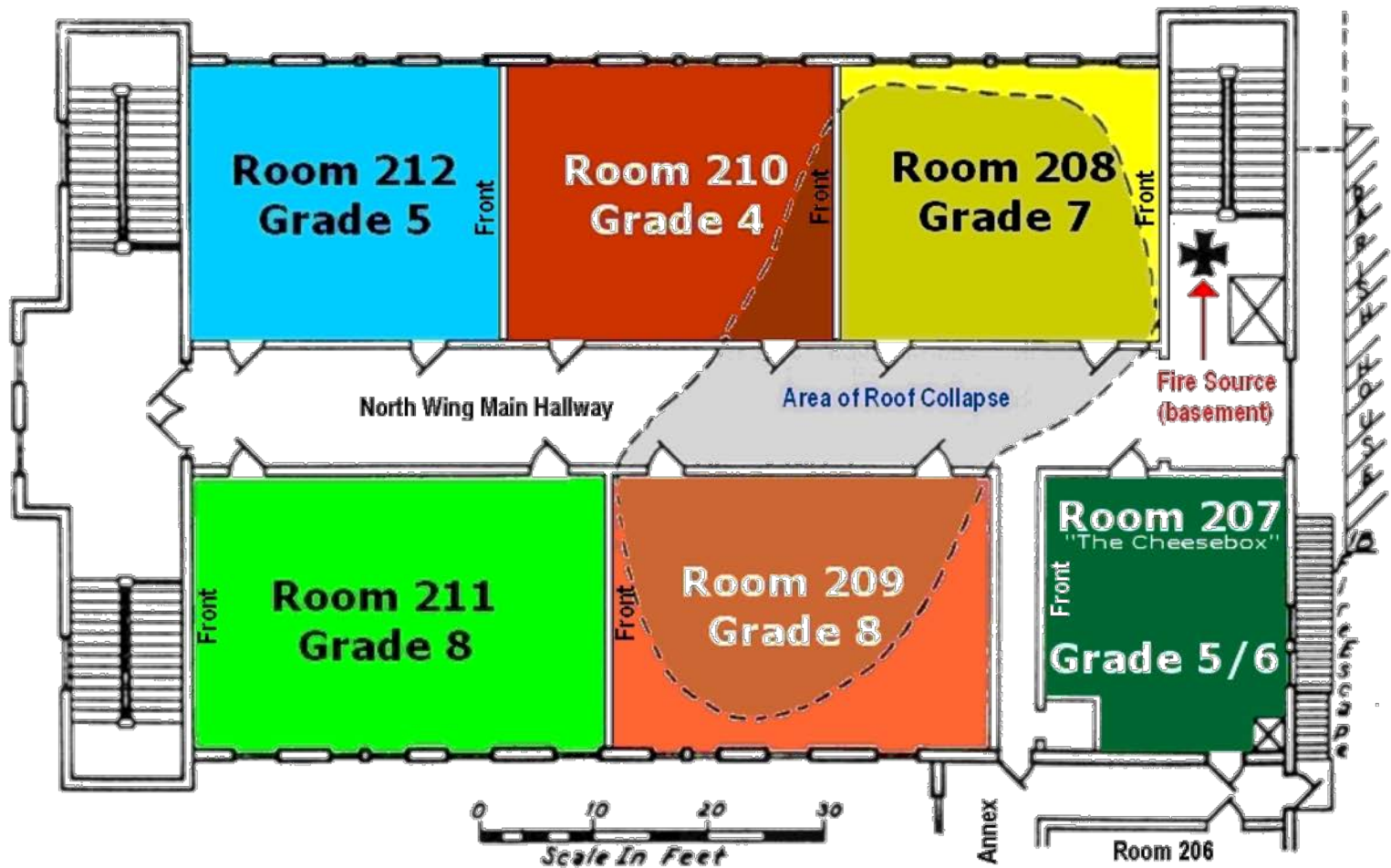
The fire

- Fire starts in stairwell in north wing
- Student reports smell of smoke and teachers spend several minutes attempting to locate the principal
- Upstairs hall and attic fills with smoke and before fire alarm activates
- Attic flashes over
- Opening and closing of classroom doors fans fire
- Fire department sent to wrong address
- Students attempt to evacuate through any possible route – including jumping
- 95 fatalities – 93 of them were children

Floor plan

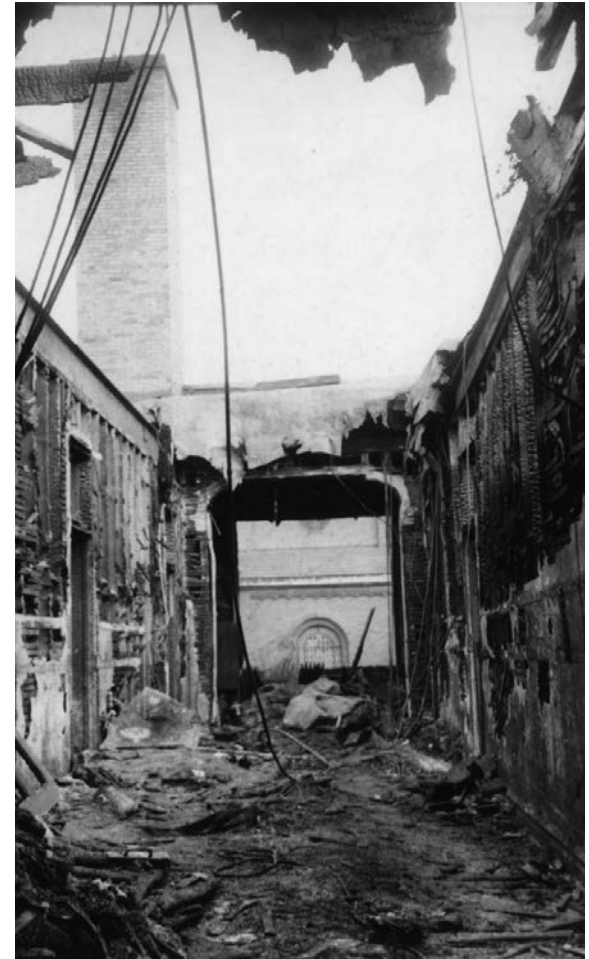


North wing floor plan



What went wrong?

- Inadequate exits
- Unenclosed stairs
- Combustible wall and ceiling finish
- Locked gate to courtyard
- No sprinklers
- Fire extinguishers mounted too high on wall
- Manual fire alarm by unmarked switches 6' off floor
- Undersized standpipe (valve 6' off floor)



Code Impact

- Fire alarms with fire department monitoring
- 1-hour stairways
- Self-closing exit doors
- Fire doors at stairwells and corridors
- Sprinkler systems (as an alternate) in schools
- Mandatory fire drills



Medical Impact

- With no internet, doctors from around the world telephoned and send letters with advice for burn treatment and skin grafting
- St. Anne's Hospitals' Chief of Staff Dr. Jim Callahan, was a Major General in the Medical Core of the Army. Much help was obtained from Dr. Callahan's contacts across the U.S.
- The state-of-the-art in burn medicine took a quantum leap forward.



McCormick place (January 16, 1967)

- Chicago, IL
- Built: 1960
- \$40 million structure
- >500,000 sq.ft. exhibition space
- 92% Not sprinklered
- 1,250 booths for a show
- 9 alarms
- 500 firefighters
- 94 pieces of apparatus



The fire

- Fire started: 2:00 am
- Janitor tries to fight fire with broom
- Alarm delayed 6 minutes
- Fire department arrives quickly
- Strikes second alarm 5 minutes after initial alarm
- Almost immediate failure of water supply
- Relay water 1/4 mile.

What went wrong?

- Exhibits constructed of highly flammable wood, paper & plastic
- Exhibit temporary wiring: not code compliant
- Non sprinklered exhibition hall
- Water supply failed
- Facility private hydrants: not reopened after construction on Stevenson Expressway
- Private pumping system: defective & inadequate
- Lack of compartmentation
- Large amount of fuel
- Unprotected steel roof trusses (columns >20 ft.)

Code impact

- Underwriter's laboratories conducted full-scale tests on exhibit booths
- Established sprinkler criteria:
 - Increased discharge density
 - Larger design area of operation
 - Quick-response sprinklers
- Life Safety Code requires sprinklers & limited combustile construction for exhibit booths

Dale's penthouse restaurant (February 7, 1967)

- Montgomery, AL
- Walter Bragg Smith Apartment Building
- Now known as Capitol Towers
- 10-story high rise with penthouse and two basements
- 2 stairwells/standpipes
- Partially sprinklered
- 75 to 100 occupants
- 25 Dead. Largest fatal restaurant fire in US since Cocoanut Grove (1942)



Original building

Building Permit Number 14-143:

Issued: Apartment Building and Restaurant

Dated: May 24, 1950

Architects: Sherlock, Smith and Adams

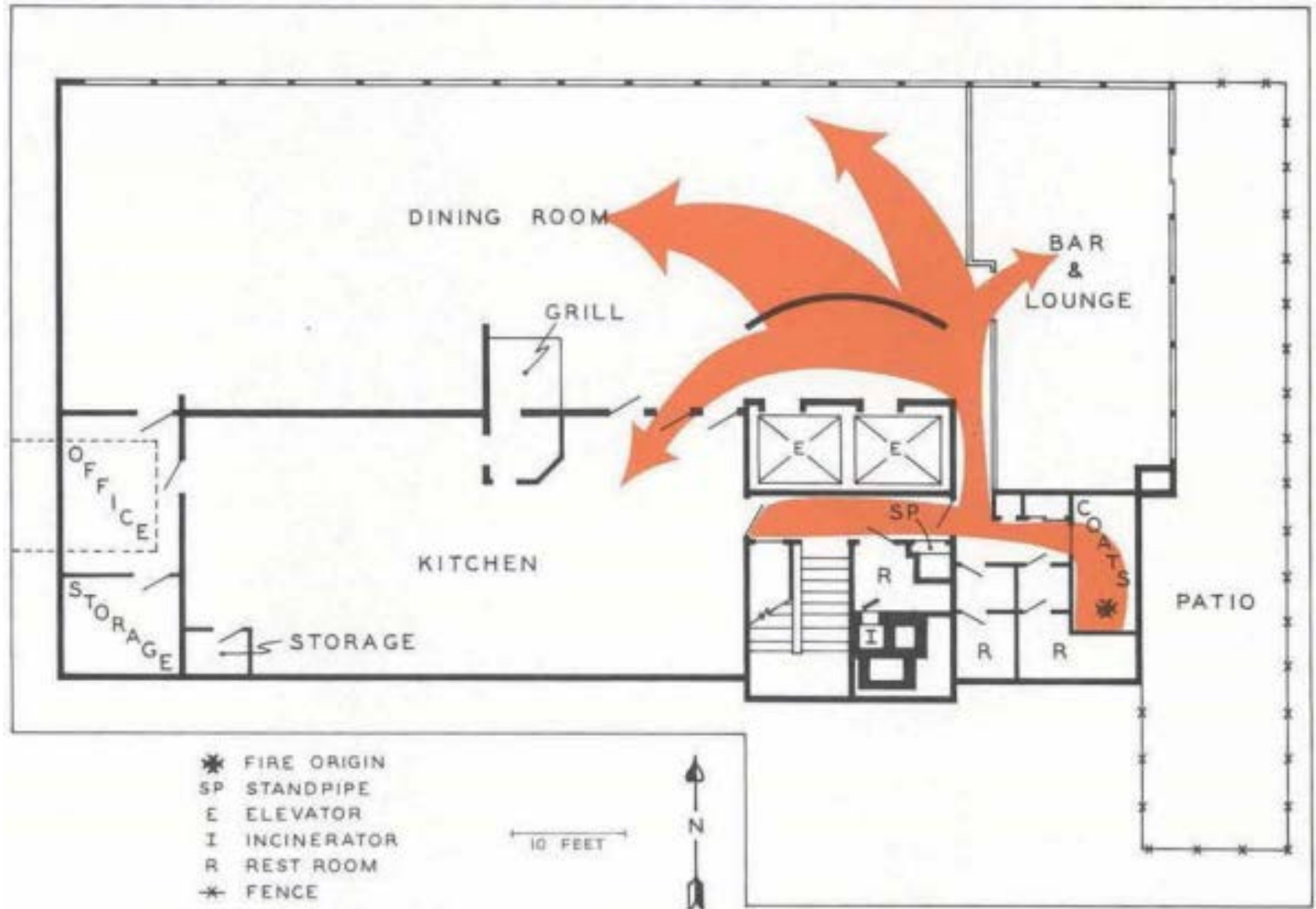
Owners: Montgomery Towers, Inc.

Applicant: Bear Brothers

The fire

- Fire discovered in unattended coat room
- Customer discovered fire; reported it to manager
- Manager found chef already attempted to use a portable extinguisher and then attempts to warn apartment occupants
- Chef takes 2 car loads of people down by elevator
- No one warned customers
- Fire reaches combustible ceiling – extends into dining room, cutting off access to stair from the coat-room side.
- Hostess leads customers thru kitchen, but finds stair access impassable.
- Most bodies are found in the kitchen above location of the 2nd stair below.

Penthouse layout (4,700 square feet)



What went wrong?

- Renovation expanded penthouse but did not extend 2nd stair to penthouse level
- Non sprinklered assembly occupancy
- Combustible ceiling tile, paneling and decorations
- Delay in calling fire department
- Elevators failed



Code impact

- Fire triggered new fire safety rules in Montgomery and across America
- Mandate for multiple exits
- Changes in construction of stairwell opening protectives
- “In case of fire, use stairs” signs
- Requirement for non-flammable carpet cleaners
- Protection of steel members (SFRM)



Beverly hills supper club (May 28, 1977)

- Southgate, KY
- 2,400 to 2,800 occupants
- Mostly 1 story
- Second floor above main bar
- Basement below south portion
- Multiple additions
- Assembly uses
- 8 Exits
- No sprinkler or fire alarm



The fire

- A fire starts above the ceiling in the Zebra room
- Discovered by staff who attempt to extinguish it
- When extinguishment is unsuccessful, staff starts notifying occupants to evacuate
- Fire spreads through corridor blocking 2 of the 3 Cabaret room exits
- Approximately 1,300 occupants attempt to use a single exit in Cabaret room
- 164 fatalities

Floor plan

6 SATURDAY, MAY 24, 1997

THE POST

THE BEVERLY HILLS TRAGEDY

SATURDAY, MAY 24, 1997 7

The fire's destructive toll

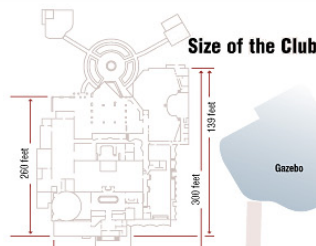
"I felt a great sense of danger coming over me. Like, you know, we were really in trouble."

Janetta Johnson
Beverly Hills Supper Club waitress

Reports from three teams of investigators, including one named by then-Governor Julian Carroll indicated that many factors contributed to the May 28, 1977 fire. Among these were inadequate

wiring, no sprinkler systems, combustible wall and carpet materials and the absence of an alarm system.

Below is a detailed look at the causes and effect of the fire.



Size of the Club



KEY TO FIRST LEVEL

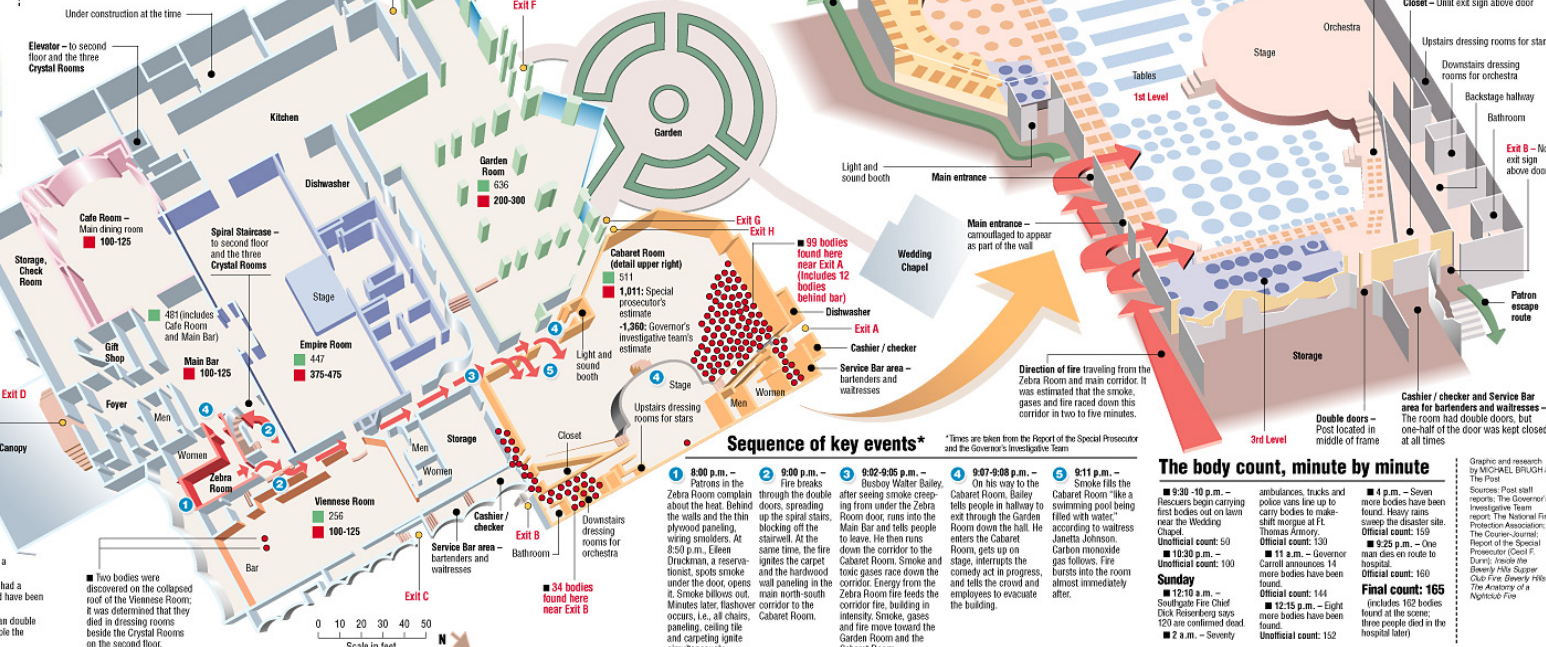
- Recommended room occupancy
- Actual room occupancy
- Exits
- Fatalities

First level

LIFE SAFETY CODE

- These code violations were noted, among others:
 1. Carpeting and paneling in the main north-south corridor contributed combustible gases to the fire.
 2. The club was not equipped with a fire sprinkler system.
 3. The Cabaret Room should have had a fourth exit, and all the exits should have been wider.
 4. The Cabaret Room had more than double the recommended number of people the night of the fire.

Two bodies were discovered on the collapsed roof of the Vietnamese Room; it was determined that they died in dressing rooms beside the Crystal Rooms on the second floor.



Sequence of key events*

- 1 8:00 a.m. - Patrons in the Zebra Room complain about the heat. Behind the walls and the this plywood paneling, wiring smolders. At 8:50 p.m., Glen Druckman, a reservationist, spots smoke under the door, opens it. Smoke billows out. Minutes later, flashover occurs, i.e., all chairs, paneling, ceiling tile and carpeting ignite simultaneously.
- 2 9:00 p.m. - Fire breaks through the double doors, spreading up the spiral stairs, blocking off the stairwell. At the same time, the fire ignites the carpet and the hardwood wall paneling in the main north-south corridor. Energy from the Cabaret Room.
- 3 9:02-9:05 a.m. - Busby Walter Bailey, after seeing smoke creep through the Zebra Room door, runs into the Main Bar and tells people to leave. He then runs down the corridor to the Cabaret Room. Smoke and toxic gases race down the corridor. Energy from the Zebra Room fire builds in intensity. Smoke, gases and fire move toward the Garden Room and the Cabaret Room.
- 4 9:07-9:08 a.m. - On his way to the Cabaret Room, Bailey tells people in hallway to exit through the Garden Room down the hall. He enters the Cabaret Room, gets up on stage, interrupts the comedy act in progress, and tells the crowd and employees to evacuate the building.
- 5 9:09-9:10 a.m. - Smoke fills the Cabaret Room "like a swimming pool being filled with water," according to waitress Janetta Johnson. Carbon monoxide gas follows. Fire bursts into the room almost immediately after.
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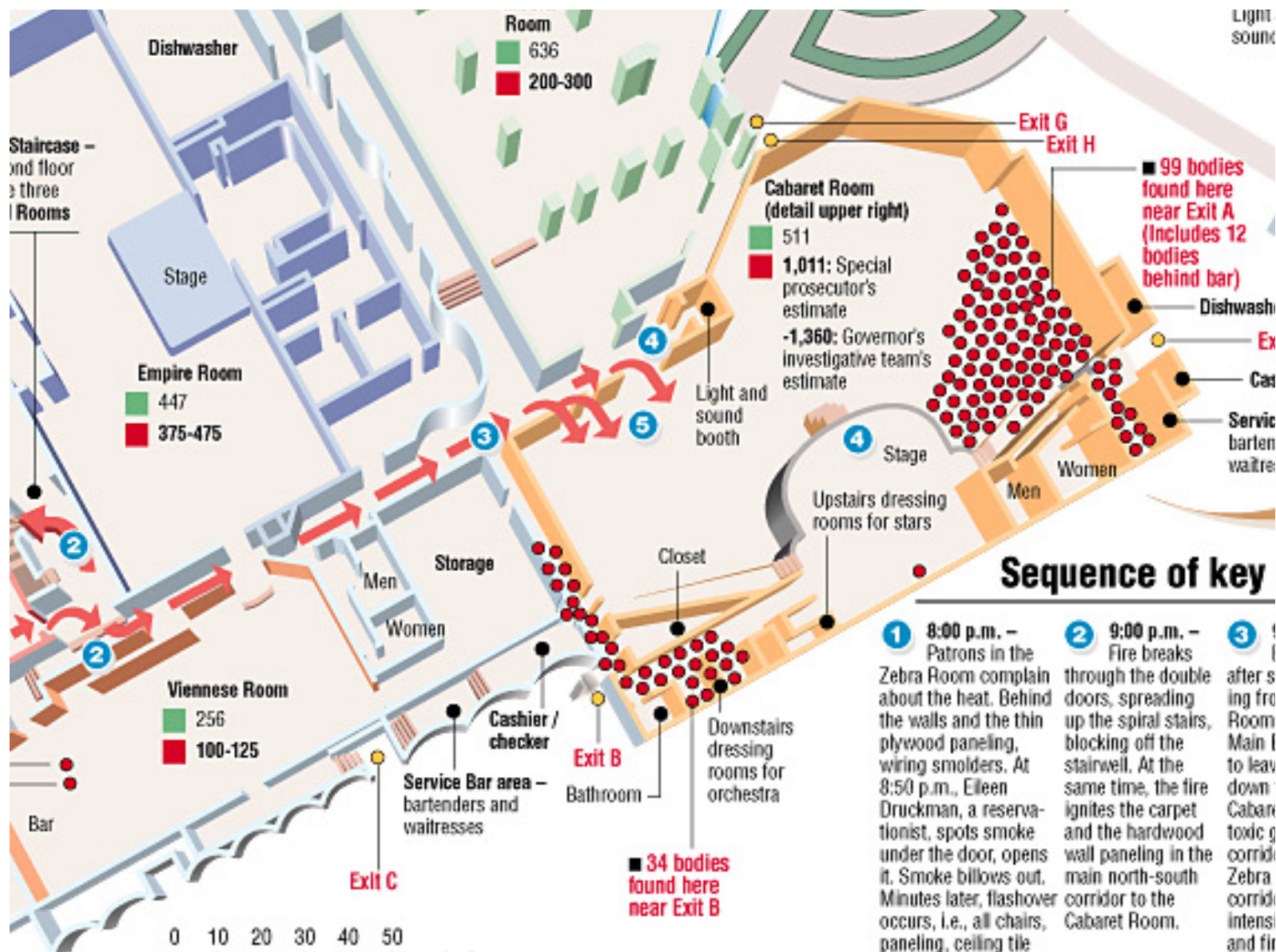
*Times are taken from the Report of the Special Prosecutor and the Governor's Investigative Team

The body count, minute by minute

- 9:30-10 p.m. - Firefighters begin carrying first bodies out on lawn near the Wedding Chapel. Official count: 50
- 10:30 p.m. - Official count: 100
- 11 a.m. - Governor Carroll announces 14 more bodies have been found. Official count: 144
- 12:15 p.m. - Eight more bodies have been found. Official count: 152
- 2 a.m. - Seventy
- 4 p.m. - Seven more bodies have been found. Heavy rains sweep the disaster site. Official count: 159
- 9:25 p.m. - One man dies en route to hospital. Official count: 160
- Final count: 165 (includes 162 bodies found at the scene; three people died in the hospital later)

Graphic and research by MICHAEL ELLIOTT / The Post
Sources: Post staff reports; The Governor's Investigative Team report; The National Fire Protection Association; The Governor's Investigative Team report of the Special Prosecutor Glen F. Dunn; Inside the Beverly Hills Supper Club Fire; Beverly Hills: The Anatomy of a Nightmare

Floor plan



What went wrong?

- No fire alarm
- Firefighting efforts delayed notification
- No sprinklers
- Flammable finishes
- Inadequate exits
- Overcrowding
- Disguised exits
- Locked exit doors



Code impact

- New assembly occupancies with >300 person capacity required sprinklers
- New and existing assembly occupancies with >300 person capacity required fire alarm with voice evacuation

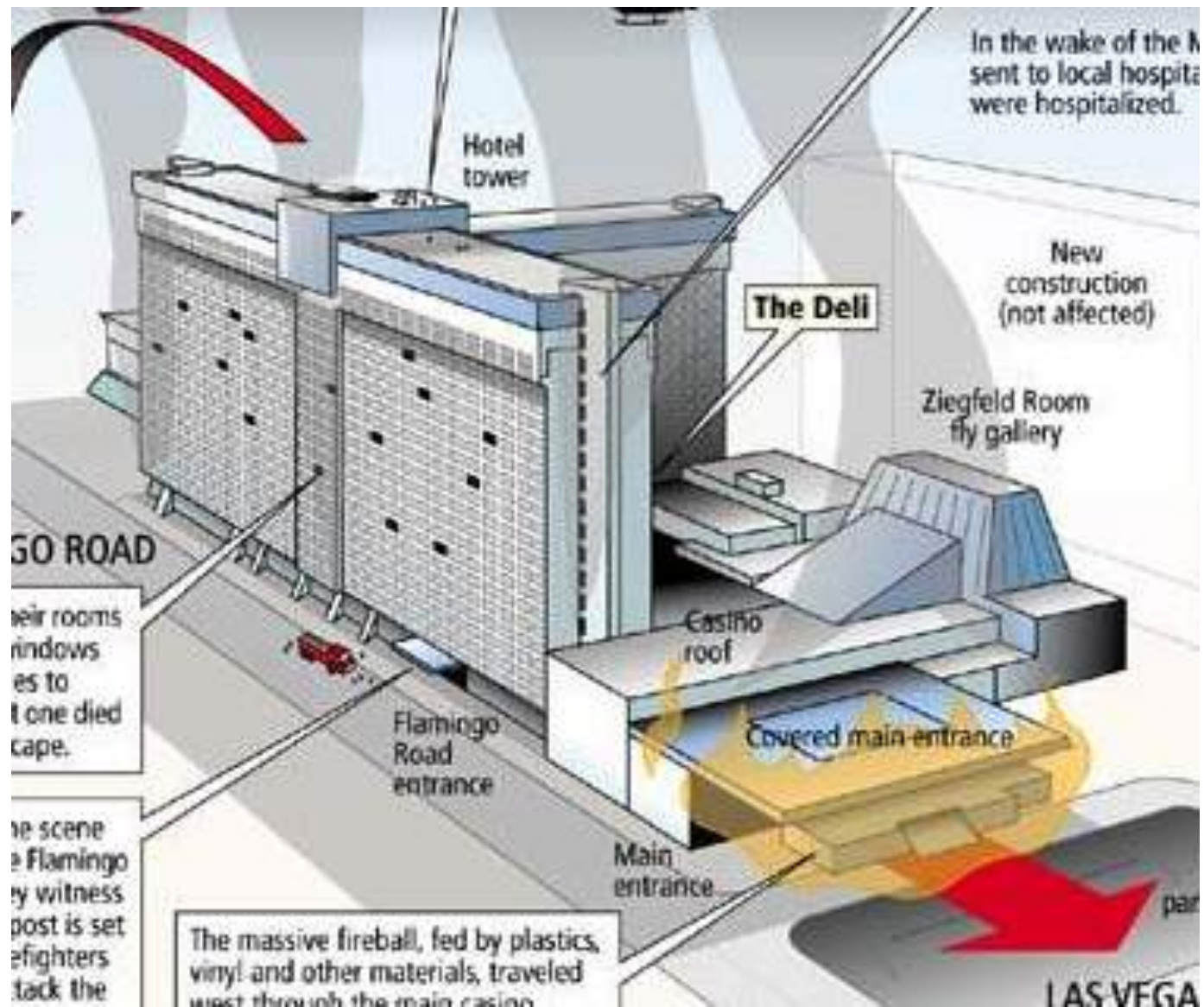


MGM grand (November 21, 1980)

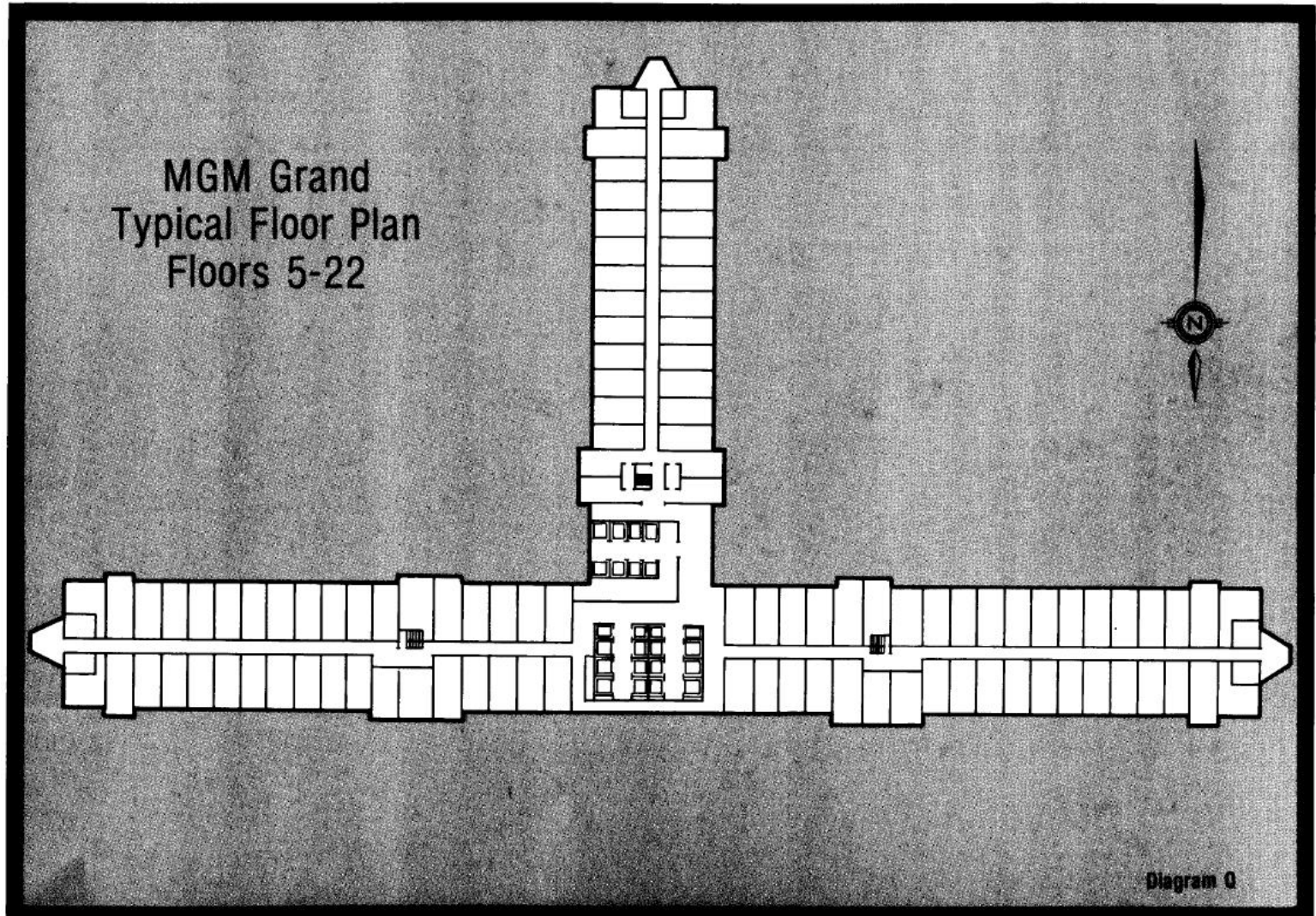
- Las Vegas, NV
- Hotel/Casino complex
- 5,000 people
- 26-story high rise
- 6 stairwells
- Partially sprinklered
- Manual fire alarm system
- 85 Dead



Hotel complex layout



Hotel floor plan



The fire

- Electrical fire discovered in deli
- Security and employees attempt to fight the fire
- Fire spreads to the casino
- Casino is fully involved within 6 minutes of fire discovery
- Seismic joints, elevator shafts and common plenum spread smoke through the hotel



The fire

- Occupants learn of fire when they smell and see smoke
- Stair shafts fill with smoke
- People become trapped in stairs
- Sprinkler system extinguishes fire



The fire

How the MGM Grand fire started

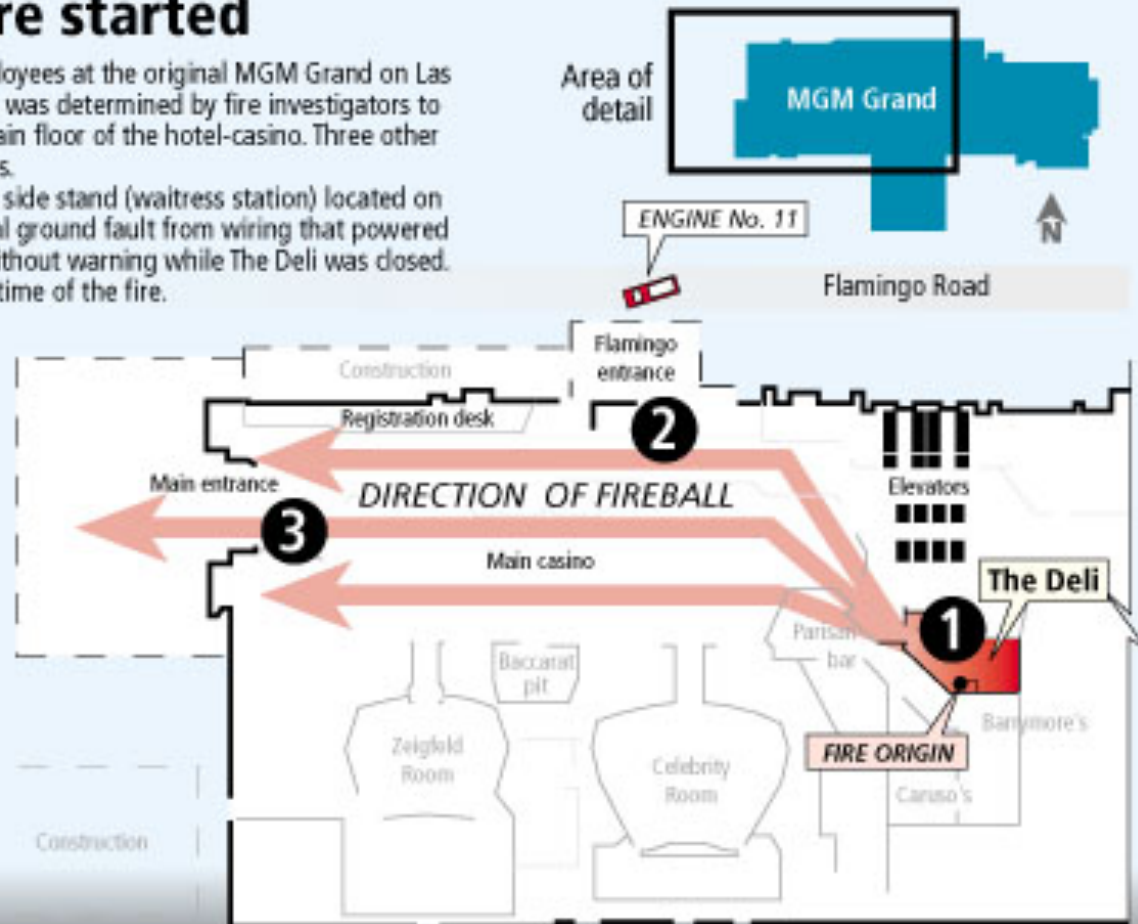
The fire, which claimed the lives of 84 guests and employees at the original MGM Grand on Las Vegas Boulevard and Flamingo Road on Nov. 21, 1980, was determined by fire investigators to have started in The Deli, a restaurant located on the main floor of the hotel-casino. Three other people would die within a year from fire-related injuries.

Evidence indicates the fire started inside the wall of a side stand (waitress station) located on the south wall of The Deli. It was caused by an electrical ground fault from wiring that powered a compressor located under a pie case, which ignited without warning while The Deli was closed. Approximately 5,000 people occupied the hotel at the time of the fire.

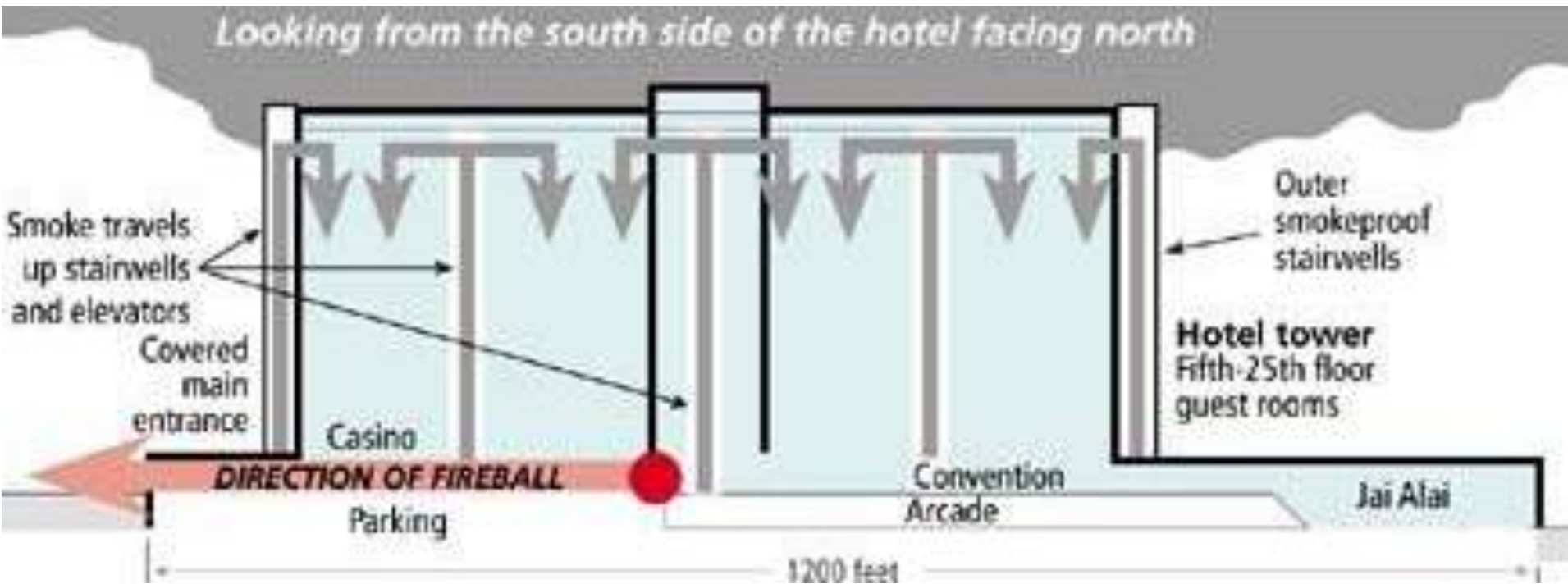
The first alert

The main casino floor plan on the right helps illustrate the sequence of events that follows:

- 1 7:15 a.m.** — An electrical fault that had been smoldering for hours flares up in The Deli restaurant and is reported by a maintenance supervisor passing through the restaurant while starting his shift.
- 2 7:19 a.m.** — Firefighters from Clark County Engine No. 11 arrive and enter the casino just as the fireball emerges from within The Deli.
- 3 7:19-7:24 a.m.** — Flames fueled by flammable materials race through the main casino at speeds estimated at 15 to 19 feet per second, blowing out the main entrance doors on the west end of the property and engulfing the covered main entrance.



Smoke path



What went wrong?

- Improper fire stopping
- Fire alarm system
- Partially sprinklered
- Locked stairwell doors
- Combustible load
- No HVAC shutdown
- No stairwell separation
- Casino exit capacity inadequate
- No elevator recall



Code impact

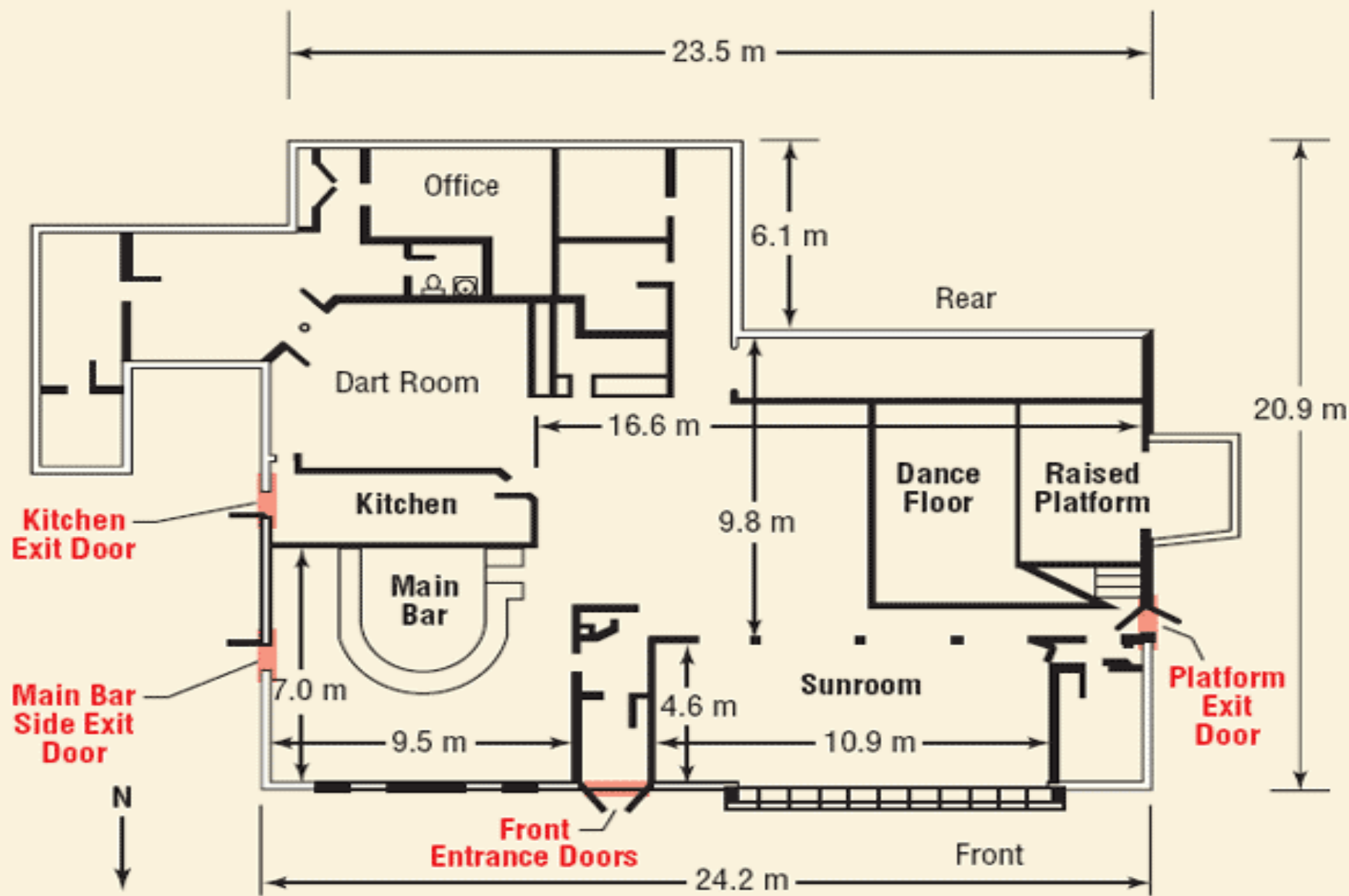
- Las Vegas sprinkler retro-fit program
- NFPA
 - Sprinklers for high rise buildings
 - HVAC shutdown
 - Stairwell re-entry floors
- Federal Government
 - All hotels over 3 stories must have sprinkler systems



The Station nightclub (February 20, 2003)

- West Warwick, Rhode Island
- 11PM, Over 400 People Gather to see Great White
- 60 Year Old Building
- 1 story, 4,484 sq. ft.
- Wood Frame
- WPRI-TV on Scene
- Fire Alarm
- No Sprinkler
- Passed Inspection on New Year's Eve





The Station nightclub

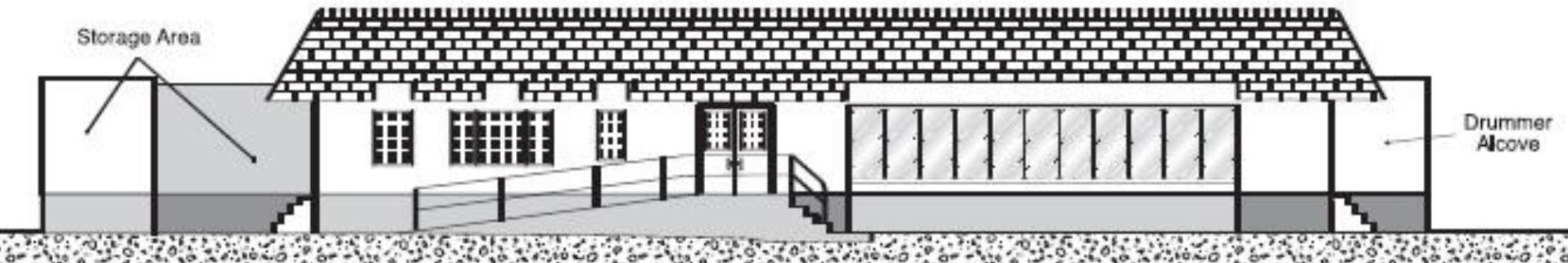


FIGURE 5 Front (north) View of The Station Nightclub.

The fire

- Pyrotechnics
- Soundproofing: urethane foam packaging
- Delay in evacuation
- Extreme flame spread
- Most egress to front door
- Few use 3 other exits
- People surge to front door - becomes blocked
- 96 fatalities on day of fire, final death toll of 100



Trapped



What went wrong?

- Interior finishes
- Open flames
- Obstructed means of egress
- No sprinklers
- Human response
- Front door capacity



Code impact

- New AND existing nightclubs require sprinklers (occupant load >100 for **existing**)
- Owners required to inspect means of egress before opening
- Crowd manager
- Life safety evaluation required for festival seating of more than 250 people
- Main entrance has to be sized for 2/3 of total occupant load
- Secondary exits have to be sized for 1/2 of total occupant load

Fire – “bad actors”

- Means of Egress
- Interior Finish
- Way finding
- Furniture Layout/Configuration
- Fuel Load
- Compartmentation
- Lack of Sprinklers
- Lack of Fire Alarm

Conclusion

- This presentation examined 10 significant fires
- These fires resulted in 1,999 fatalities
- These fires resulted in over 89 code changes
- Many lives saved due to the implementation of these code changes
- Understanding the intent of the code is necessary to correctly apply the letter of the code.

Thank you

Questions



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