



# Department of Development Services

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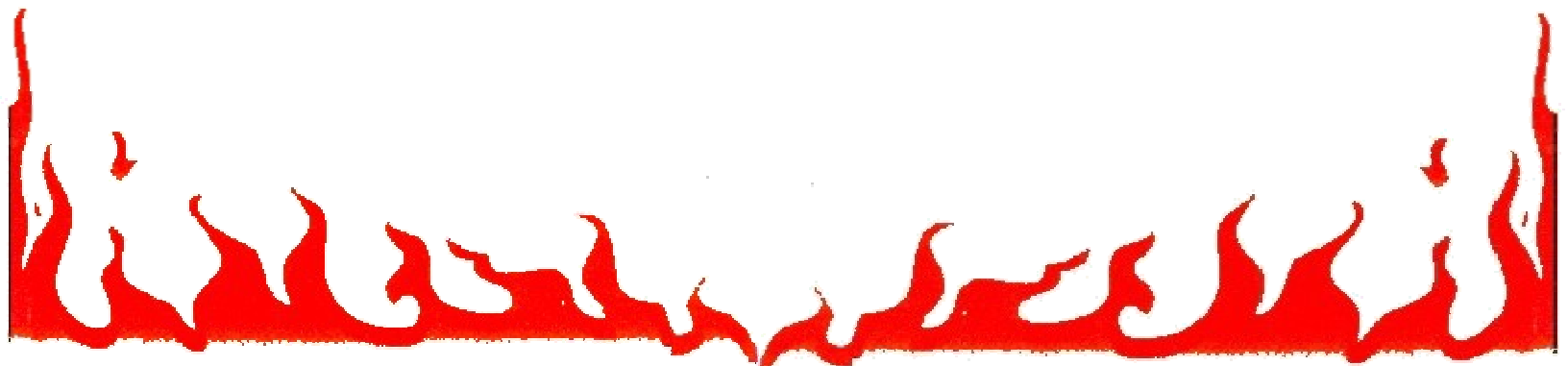
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# Large Building Fires and Subsequent Code Changes

by

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## **Large Building Fires and Subsequent Code Changes**

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## **I. Building Fire History**

The first controlled use of fire by mankind occurred about 500,000 years ago. Taming fire was a major milestone in human development because it allowed our ancestors to move from Africa into the colder climates of Europe, Asia and the Americas. The first habitable dwellings built by man about 11,000 years ago were stick frame with clay covering. Fire was used in ancient buildings for heat, light and cooking. Early cities were densely populated for security reasons, often individual dwellings shared common walls; typical roofs were thatched. Early chimneys were often short with a fairly large opening and allowed embers to travel to neighboring dwellings and set the thatched roof on fire. A fire in early cities often resulted in the destruction of the entire city since early firefighting equipment and methods were primitive and ineffective. After Rome burned several times, a night patrol of slaves called a “vigile” was organized to alert a neighborhood in event of a fire. This Latin word was the basis for our words vigil and vigilante.

The French and English established an hour by which all fires had to be extinguished; it came to be known as the curfew (taken from words meaning “cover fire”). Early London, including the original London Bridge, burned several times. London suffered a major fire in 1212 with over 3,000 people killed; afterward, thatch roofing and wooden chimneys were restricted. Early English arson punishments included being burned alive or dragged to death. Moscow suffered a 1571 fire which killed approximately 200,000 people and 90% of the city (30,000 homes) was burned again in 1812 prior to occupation by Napoleon.

The Great Fire of London in 1666 burned for five days; destroyed 13,000 homes (2/3 of the city) and left over 200,000 people homeless. The fire occurred after a summer-long drought and was spread by high winds. The first fire insurance companies and first fire departments were founded after this fire. This fire led to the first requirements for the use of fire pumps (fed by bucket brigades), fire insurance and ladders for fire suppression/rescue. New building laws, passed after the fire, prevented use of timber, mandated brick or stone construction and greatly widened streets.

Other world cities which have been devastated by fire include Bombay, India in 1803, Hamburg, Germany in 1842, Quebec, Canada in 1845, Rangoon, Burma in 1850, Vancouver, Canada in 1886, Shanghai, China in 1894, Ottawa, Canada in 1900, Montreal, Canada in 1901, Toronto, Canada in 1904 and Istanbul, Turkey in 1871, 1911 and 1912.

Fires were common in many of the early cities in America. Jamestown, Virginia and Plymouth, Massachusetts suffered extensive fires soon after colonization. Wood chimneys and thatch roofs were prohibited in Boston in 1631 after a serious fire. New York City outlawed wood

chimneys in 1648 after several fires. 1/3 of the families in Boston were left homeless after a 1653 fire. This fire led to requirements for every house to be equipped with a ladder and a 12-foot long pole with a wet swab to extinguish burning embers on the roof, restrictions on outdoor fires and fires aboard docked ships, the imposition of the death penalty for arson, and a requirement for fireproof containers when carrying burning embers used as fire starters. Despite these requirements, Boston had more large fires in 1676, 1679, 1711, 1760 and 1872 (776 buildings).

Philadelphia had a major fire in 1730 after which they ordered 3 fire pump engines. Although hand-pumped, the best of these early fire pumps could throw water 180 feet. Ben Franklin founded the first volunteer fire company in Philadelphia in 1736. Philadelphia initiated hydrant inspections in 1806 after a major fire and still lost 400 buildings in an 1850 fire.

Charleston, South Carolina experienced a large fire in 1740 and most of the city was destroyed by an 1861 inferno. New York City had severe fires in 1741, 1776 (493 buildings destroyed), 1811 (102 buildings destroyed) and 1835 (680 homes burned). A New Orleans fire in 1788 destroyed 900 homes and the city experienced another large fire in 1830. An 1805 fire destroyed Detroit and an 1820 blaze burned 460 buildings in Savannah. An 1845 fire in Pittsburgh during a drought destroyed 1,500 homes, much of the downtown area and ¼ of the city; an 1846 fire destroyed 300 buildings in Nantucket, Massachusetts and severely affected the American whaling fleet; an 1848 fire destroyed 600 buildings in Albany, New York; an 1849 blaze burned 420 buildings in St. Louis; most of San Francisco (2,500 buildings) burned in 1851; Atlanta was hit by huge fires in 1864 and 1917 (1,940 buildings); Portland, Maine lost 1,500 buildings (half the city) in a 4<sup>th</sup> of July 1866 blaze started by fireworks; Seattle lost 31 city center blocks to an 1889 fire; Lynn, Massachusetts lost 330 city center buildings in an 1895 fire (mostly factories); Patterson, New Jersey lost 525 buildings to a fire in 1902; Chelsea, Massachusetts lost 3,500 buildings in a 1908 fire; a 1913 fire burned 518 buildings in Hot Springs, Arkansas; a single 1914 fire burned 1,600 buildings in Salem, Massachusetts; a 1922 fire burned 30 blocks in Astoria, Oregon; and a 1934 fire in Nome, Alaska destroyed 20 blocks.

The first water mains, made from bored pine logs, were installed in the early 1800s and horse-drawn, steam-powered fire engines capable of throwing water 300 feet were introduced in 1854. Raised aerial ladders were developed in San Francisco in 1870, the first mechanically-raised aerial ladder appeared in 1882 and the 100-foot ladder truck was introduced in the mid 1930s. Gasoline fire engines began replacing steam engines in the early 1920s. Fire departments stopped using safety nets in the 1930s since they are only effective for jumps of 3 stories or less and because most people miss them.

Early building code changes resulting from large fires mandated exterior fire escapes and installation of standpipes for high rises, as well as improved exiting from assembly areas. A change in fire characteristics occurred after WWII due to the use of synthetic materials, which give off dense toxic fumes, replacing the use of cotton and wood furnishings, which burned faster with less smoke. While more use and storage of hazardous materials also contributed to potentially flammable conditions, the growing scarcity of timber led to increased use of concrete, steel, glass and masonry for building materials. Another change involved improving and increasing the methods of saving lives rather than just protecting property.

Individual mills and dockside warehouses were first sprinklered in the 1880's, using river or sea water. The first contemporary sprinkler system, using domestic water, was developed in 1953. Major recent innovations have been improvements in alarm notification; sprinkler installation; frame fireproofing; building partitioning with fire-resistive construction; improved emergency exiting; emergency communications; automatic heat, flame and smoke detection including ionization, infrared, photo-electric, optical, ultraviolet, aspirating, spark/ember, video, carbon monoxide, carbon dioxide, combination and particle beam detectors; automatic fire suppression systems; pressurized and fireproofed exit stairs; installation of standpipes and hose racks; smoke control; automatic elevator recall; signage on elevators and stairs; development of flame and smoke-resistant interior furnishing materials; segregation and special protection for hazardous materials, and installation of refuge chambers. Current building and fire codes concentrate on building frameworks and do not pay equal attention to building contents and interior furnishings.

The first building built with a smoke control system that exhausted the zone of incidence and pressurized adjacent zones was the Seattle Federal Office Building, built in 1972. Prior to this, smoke control consisted of normal supply fans shutting down during a fire. Stairwell pressurization began in the mid 1970s, as did smoke exhaust with normal supply fans (by reversing the fan motor direction of rotation). Modern smoke control design uses dedicated smoke exhaust fans or reversible normal supply fans, plus numerous detectors and dampers for control. Stairwell pressurization is important because it allows occupants to safely exit the building, while firefighters can safely access an upper level fire.

The goal of modern zoned smoke control in buildings is to create a pressure sandwich by exhausting the area of the fire to confine smoke to the fire area only. Smoke causes 90% of firefighter injuries. Smoke usually contains unburnt gases and can reach temperatures of 1,300 degrees Fahrenheit. The maximum temperature a human can breathe is 300 degrees Fahrenheit (dry air and short duration only). Smoke control reduces the need for firefighters to access a roof to

ventilate these gases and smoke and allows them to concentrate on fire control and victim rescue. Another important feature of smoke control is to maintain a smoke-free stairwell in a high-rise building or maintain a high-level of smoke in a large low-rise building for safe occupant evacuation. Smoke control in Las Vegas is invoked for any occupiable floors located more than 55 feet above the lowest level of fire department vehicle access (in most jurisdictions it is 75 feet).

The best fire or smoke control system can still be defeated by people propping doors open (fearing doors will lock); additional wall, floor or ceiling penetrations that are not properly sealed; or by a change in interior finishes or furnishings that creates a higher fuel or smoke load than the system was designed to handle. The reliability of complex modern fire protection systems is questionable, due to the complexity of the controls, and needs continuous improvement. These extensive modern systems can be disabled, often unknowingly, by many people. Periodic testing of the systems is the only way to ensure reliability. Hallway urinals in hotels disable fire alarm cabinets in Las Vegas every Saturday night, which also happens to be the time of highest occupancy. Currently, people don't react properly to fire alarms because they are accustomed to frequent false alarms. An emergency public address system is important to alert occupants when there is an actual fire.

## **II. Building Fire Facts**

About 12,000 lives were lost to fire in the United States in 1974; 3/4 of them losing their lives in residential fires. The death rate was reduced to 4,000 by 2003, due mainly to increased use of smoke detectors, less combustible interior materials, improved firefighting capabilities and increased sprinkler use in industrial/commercial buildings. Sprinklers, when activated, are 96% effective in controlling fire spread in buildings and property loss drops 80% when a building is sprinklered. Currently, buildings are involved in 36% of all reported fires in the U.S. Smoking is the largest single fire and death cause. Electrical hazards are the leading building fire cause. The leading cause of U.S. home fires is cooking. Arson is indicated in 1/3 of all large building fires. Only 2% of arson fires lead to arrest and conviction. The U.S. has the 2<sup>nd</sup> highest fire rate and the highest death rate from fires in the world. The South has the highest regional death rate.

Most large building fires start as small fires and occur when the building is unoccupied, which leads to delayed notification to the fire department. The worst quarter of the year for U. S. building fires is October-December when internal heating is first activated. 90% of fire deaths and large building fires occur in the 12-hour period between 8 p.m. and 8 a.m. Only 20% of sleeping people

are awakened by the smell of smoke. Smoke detector failure rate has been as high as 33% and is usually caused by dead batteries. Smoke inhalation causes 2/3 of the deaths that occur in large building fires. Half of U.S. motel/hotel deaths are caused by smoking and another 1/4 by arson. Fire spreads fastest vertically upward, therefore, elevator shafts, utility chases and stairways must be enclosed in fire resistive construction to prevent serving as chimneys for building fires. The ratio of false alarms to real alarms is 15:1.

Fire watch is very effective for early notification and is commonly used in industrial buildings when construction is nearing completion, when alterations are being performed or when a building is unoccupied. Fire watch should be recommended for large buildings nearing completion because they are vulnerable, due to the high load of combustible packing and construction materials, the availability of fire sources due to welding, grinding, saw-cutting and torch-cutting activities, and the incomplete status of sprinklers, alarms and smoke control systems. 7% of fires started at construction projects to burn trash have spread to and consumed the buildings under construction. Firefighter's initial efforts are to encircle and contain the fire (surround and drown) and rescue trapped people. Once a building fire starts, heavy structural timber provides better collapse resistance than unprotected steel supports. Steel loses 30% of its yield strength at 1,000 degrees Fahrenheit and 80% of its yield strength at 1,400 degrees Fahrenheit (temperatures reached in 5 minutes on unprotected steel in a standard fire). Steel collapse in a fire is impossible to predict and often occurs instantaneously. 2 inches of concrete cover over steel can provide 4-hour protection. Flammable materials contain roughly twice the heat load of ordinary combustibles.

The simple fire triangle shows fuel, heat and oxygen, in the right quantities, are required to create fire. Flashover occurs when combustible and flammable materials, including carbon particles, tar balls and carbon monoxide, are given off as byproducts of combustion during a fire and accumulate in a confined space until reaching the proper temperature and oxygen content for ignition. The confined space will appear to burst into flame instantly. Backdraft occurs if these unburnt materials are heated to ignition temperature but lack sufficient oxygen to ignite and then a door or window is suddenly opened and provides the missing oxygen; an explosion often results. A smoke control system can work to reduce the possibility of flashover or backdraft by exhausting heat and the combustible and flammable materials, preventing their accumulation to ignition levels.

The number of people killed in individual large fires has declined steadily, but the potential for large loss of life in an individual fire grows larger each year because the maximum number of occupants in a single building increases constantly as buildings grow larger and taller. Maximum occupancy for a large Las Vegas casino property could be as many as 56,000 people onsite with few

property exits for such a large number of people, which also impedes fire department access. 40,000 people worked in each of the 2 World Trade Center Towers in New York City and the complex received as many as 90,000 visitors daily. A typical 18-story building takes 30 minutes for total evacuation while a 50-story building takes 75 minutes.

The possibility of panic increases as the number of occupants increases. 111 people were trampled to death in a Birmingham, Alabama church in 1902 when someone yelled “quiet” which the congregation of more than 2,000 misinterpreted as “fire” and stampeded for the building exits in a panic, even though there was no fire. The evacuations in many large building fires have exhibited classic crowd panic behavior.

Many tall buildings have now gone to zoned evacuation where people seek refuge areas while awaiting their turn to evacuate due to the limited number of exits. Zoned evacuation is dependent on building compartmentation, which should be by floor, with each floor divided into a minimum of 2 compartments. Success of zoned evacuation depends on emergency communication to the occupants to remain in place, since most people will try to evacuate. The Denver building code mandates refuge centers in high-rises. Any building taller than 7 stories is usually considered a high-rise. 10% of office building fires and 10% of apartment building fires occur in a high-rise.

Helicopters have rescued many probable victims from roofs, particularly hotel rooftops, however, most high-rises in North America have no roof access and most helicopters have no winch. Helicopter rescue is not feasible in many high-rise fires due to flames, smoke, roof obstructions or insufficient capacity. Modern fire departments, including Las Vegas, have aluminum hydraulic-lift aerial ladders with a maximum length of 105 feet, which means they can reach vertically about 80 feet above ground. Hydraulically elevated platforms, called snorkel units, can reach vertically up to 150 feet, however, few fire departments have the tallest snorkel units and they can only rescue a few people per trip.

Modern elevators automatically recall to ground level for firefighter use so smoke and fireproof stairwells are the only usually available means to rapidly evacuate most high-rise occupants during a fire or other emergency. Periodic evacuation training should be conducted in high-rise buildings to familiarize occupants with the stair location and layout. Piping and tanks have been installed in some newer high-rise buildings as a rescue air system for firefighters to refill air tanks without carrying bottles up stairs during an emergency.

There were 10,000 high-rise fires in the U. S. in 1998. 1 in 5 hotel/motel fires, 1 in 10 office fires, 1 in 12 apartment fires and 1 in 3 health care facility fires occur in high-rises. Smoke inhalation causes 80% of the fatalities in high-rise fires. Smoke travels beyond the room of fire

origin in 1/3 of high-rise fires. Most high-rise fires are in apartment buildings and most high-rise fires and deaths are in non-sprinklered residential buildings. Sprinklers reduce property damage and death rates in high-rises by 2/3. Compared to low-rise fires, more high-rise fires begin in exit passages. Fire danger is actually greater in low-rise office, hotel or apartment buildings than in high-rise buildings of the same type.

Chicago had fires in the 110-story Sears Tower and the 100-story John Hancock Center and requires high-rise buildings built after 1975 to be either compartmented or sprinklered; most are sprinklered. Chicago still has approximately 1,000 non-sprinklered high-rises, including 85% of their high-rise residential buildings. New York had fires in the 102-story Empire State Building and the 110-story World Trade Center before 9/11. In Moscow, an 1,800-foot high TV/observation tower caught fire in 2000 and burned for 30 hours, killing 4. In 2003, the 1,069 foot Eiffel Tower caught fire at the 910-foot level and the 101-story Taipei Tower caught fire during construction.

Fire represents the greatest single danger to buildings in most jurisdictions. Fire property damage nationwide in 2003 was \$12.3 billion. There were 1,584,500 U. S. fires in 2003. Structure fires declined from a high of 1,098,000 in 1977 to 519,500 in 2003. Civilian fire deaths were 3,925 in 2003 and a total of 105 firefighters were killed in 2003.

Large record or merchandise storage facilities represent a unique challenge due to their density of combustible and flammable materials overwhelming sprinkler systems and also because of lack of fire department access to their interiors. Compartmentalization of large-area buildings is crucial in efforts to limit fire spread. Large, low buildings present an exiting challenge due to their extensive populations. The Pentagon is a 6.6 million square foot building with 23,000 occupants. The Superdome in New Orleans holds 88,000 people and has suffered an interior fire. The Mall of America in Minnesota is 4.2 million square feet, has 12,000 employees, nearly 1,000,000 shoppers/week at busy times, and plans a 5.0 million square foot expansion.

### **III. Conflagrations**

A conflagration is an intense, area-wide, disastrous fire characterized by great sheets of flame and cyclonic winds. Severe updraft in a conflagration causes winds on the perimeter to reach near hurricane strength and can suck people into the firestorm. The deadliest single location fire in the world, which killed 1,700 people, was a 1949 conflagration at a Chungking, China riverfront complex.

The Great Chicago Fire of 1871 (possibly started by Mrs. O'Leary's cow) killed 300 people;

destroyed 18,000 buildings; left 100,000 homeless of a 300,000 population; caused \$2,069,000,000 (current dollars) damage and burned over 1/2 of the city area (2,000 acres). The Great Chicago Fire occurred during a drought and was fed by 57 miles of wood paved streets, 651 miles of wood sidewalks, large wooden wharfs at riverside and extensive wood fencing at the stockyards. 93% of the city buildings were built of wood. The burn area measured 1 mile wide by 6 miles long; however, the fire lasted only 29 hours. Most buildings were rebuilt with Indiana limestone.

A 1904 fire in Baltimore destroyed 1,500 buildings (80 blocks) over 2 days, killed 1,000 people and caused \$821,000,000 (current dollars) damage. Fire department hose couplings and threads were standardized after this fire because neighboring departments could not connect to the Baltimore equipment. The largest U. S. conflagration followed the 1906 San Francisco earthquake of magnitude 8.3 and may have killed as many as 800 people over a 4-day period. It destroyed more than 3,000 acres of the city (28,000 buildings; 490 city blocks and 75% of the city); caused \$5,700,000,000 (current dollars) damage; injured 3,500 people; left 300,000 people homeless and was stopped only by backfires, a change in wind direction and dynamiting blocks of buildings into rubble to deny combustible materials to the fire. This fire resulted in building code requirements for seismic analysis and earthquake resistant design.

The largest natural conflagration in world history followed a 1923 magnitude 8.3 earthquake (same magnitude as the 1906 San Francisco) and burned rapidly through the dense wood and paper housing of Tokyo and Yokohama, Japan, killing over 140,000 people. A group of 38,000 people died in an open refuge area when flames enveloped the surrounding neighborhoods. Firefighting post-earthquake conflagrations is complicated by fallen rubble blocking vehicle access, ground fissures in roadways and lack of water pressure due to severed mains.

Many large conflagrations in the early 1900s in the U. S. were caused by the popularity of wood shingle roofs. A 1901 fire in Jacksonville, Florida consumed 2,000 buildings; 3 fires in 1916 consumed 1,440 buildings in Paris, Texas, 648 buildings in Nashville, Tennessee and 682 homes in Augusta, Georgia; a 1917 fire in Atlanta consumed 1,938 buildings; a 1923 fire in Berkeley, California consumed 640 buildings and a 1961 Los Angeles fire destroyed 505 homes. A great number of smaller U. S. conflagrations were attributed to wood shingle roofs, which led to over 650 cities prohibiting their use by the 1940s. Wood shingles continue in use in some areas and these roofs are the leading factor contributing to the spread of conflagrations, particularly in California.

Major American forest conflagrations include the 1825 Miriamichi fire in Maine and New Brunswick which burned 3 million acres; the Peshtigo, Wisconsin fire of 1871 which burned 4 million acres (2 billion trees) and killed almost 1,500 people at the same time as the Great Chicago

Fire; the 1881 Thumb fire in Michigan which killed 380 people, burned over 1 million acres and destroyed 3,000 buildings; the 1894 Hinckley, Minnesota fire which destroyed 12 towns and killed 600 people; the 1908 Metz fire in Michigan which killed 43 people and burned 2.5 million acres; the Bitterroot Mountains holocaust of 1910 which burned 5 million acres (3 million in 2 days), killed 86 people (78 firefighters) in Idaho and Montana, and led to the establishment of the U. S. Forest Service; the Cloquet fire of northern Minnesota in 1918 which killed 1,000 people; a 1952 fire which burned 2 million acres in Kentucky and West Virginia; the 1988 Yellowstone Fire which burned 800,000 acres of the 2.2 million acre national park; the 1991 Oakland Wildfire which destroyed over 3,500 homes, killed 25 people and caused \$1,631,000,000 damage and the Cedar fire of 2003 near San Diego which destroyed 2,800 buildings. A 1987 forest fire in Heilongjiang Province, China killed 193 people.

The flame front can be 1,500 feet high in a huge forest conflagration. A 1947 conflagration in Acadia National Park, Maine burned 7.5 miles in 25 minutes. A range fire on July 1, 2000 at the sparsely vegetated Hanford Nuclear Reservation in Washington State traveled 20 miles in 90 minutes. Huge forest fires can create their own weather when towering smoke columns transform into clouds with lightning, the lightning then strikes the ground and creates new fires. Early detection and suppression are vital to the prevention of forest conflagrations.

90% of forest fires are caused by human activities. The 2000 summer fire season consumed over 7.4 million acres of forest and grassland in over 92,000 fires. Some conflagrations have been caused by forest fires engulfing a small town or city, usually resulting from a combination of natural causes that include drought, lightning and high winds. More urbanization in forest areas increases the occurrence and the consequences of conflagrations. City areas with dense apartment or row housing or dense commercial development are possible conflagration locations, particularly during construction.

Some conflagrations have been deliberately set by incendiary bombing of cities, including Coventry (800 killed) and London (1,500 killed), England; Hamburg (100,000 killed) and Dresden (300,000 killed), Germany; and Tokyo, Japan (185,000 killed). Some of these conflagrations were so severe people on the outskirts died from oxygen starvation as 125 to 150 mph winds fed the firestorms and vacuumed air from their lungs. These intense fires will explode buildings as they approach, due to the air pressure difference between the interior and exterior of the building, and usually burn all buildings in a city down to the brick walls, with no steel remaining.

## IV. Major Building Fires

1. **1836 The Lehman Theatre in St. Petersburg, Russia** (killed 800); circus fire occurred in this building.
2. **1845 The Theatre in Canton, China** (killed 1,670); largest single building fire ever.
3. **1860 Elm Street Tenement in New York City** (killed 200); fire in a 6-story building resulted in a requirement for fire escapes in buildings over 6 stories and multiple exits in new buildings.
4. **1863 The Church of La Compania in Santiago, Chile** (killed 1,500); fire started by paraffin lamp.
5. **1871 Shanghai, China** (killed 900); theater fire.
6. **1876 Mrs. Conway's Brooklyn Theater in New York City** (killed over 300); fire started in stage backdrop; crowd began slow evacuation, then panicked; many crushing deaths.
7. **1881 Ring Theatre in Vienna, Austria** (killed 794); fire started on stage.
8. **1883 Circus Ferroni in Berditschoft, Poland** (killed 430).
9. **1885 Bull Theatre in Moscow, Russia** (killed 300).
10. **1886 Tinnerly Theatre in India** (killed 100).
11. **1887 Theatre Royal in Exeter, England** (killed 188); fire started on stage.
12. **1887 Opera Cornique in Paris, France** (killed 200); gas lamp started fire.
13. **1897 Charity Bazaar in Paris, France** (killed 200); fire occurred in a temporary building at Rue Jean Goujon.
14. **1903 Iroquois Theatre in Chicago** (killed 603); new building; largest theatre in Chicago; 2,000 people in matinee audience; 500 performers in backstage area; supposedly equipped with an asbestos curtain; short circuit in footlight ignited velvet stage draperies; fire-resistant curtain hung up on stage lights when lowered; curtain burned completely and was later found to be non-fireproof; actors directed audience to remain in seats; actors fled through backstage door; only 1 performer died; incoming air through the backstage door ignited a fireball inside the theatre; no extinguishers or firehose; fire burned through in 15 minutes and extinguished in 30 minutes; most killed by smoke or trampling; 250 injured; unmarked, blocked exits; inward-opening doors, locked exits; incomplete fire escape; theatre later re-opened for 20 years; deadliest single-building fire in U. S. history, subsequent code revisions required emergency exit lighting, sprinkler systems, extinguishers, fire restrictive scenery and outward-opening doors in public buildings.
15. **1908 Rhodes Opera House in Boyertown, Pennsylvania** (killed 170).

16. **1908 Lakeview Grammar School in Colinwood, Ohio** (killed 176); malfunctioning basement furnace started a fire which quickly engulfed the front door; construction materials and open stairway caused rapid fire spread in 6-year old, 3-story building with 300 students; single exterior fire escape saved most students from 3<sup>rd</sup> floor; inward-opening doors, back door locked; most deaths from bottom 2 floors; fire burned out in 3 hours.
17. **1909 Flores Theatre Cinema in Acapulco, Mexico** (killed 250).
18. **1911 Triangle Shirt Waist Factory in New York City** (146 killed); non-sprinklered high-rise garment factory; 625 workers on the 8<sup>th</sup>, 9<sup>th</sup> and 10<sup>th</sup> floors; 70 injured; 4 fires in new building previous year; some exits locked from outside, inward-opening exit doors, narrow exits; wood floors and window sashes; only 2 staircases rather than 3 required by building code; 1 of 2 freight elevators was inoperable, remaining elevator soon failed; open gas lighting; cigarette dropped on cloth cuttings started afternoon fire on 8<sup>th</sup> floor; 1 stair on 9<sup>th</sup> floor was blocked by fire; locked door on other stair; inward opening doors; sole exterior fire escape collapsed under initial escapees; Fire Department ladders only reached to 6<sup>th</sup> floor; standpipe hose line was rotted, valves were rusted shut; most workers on 8<sup>th</sup> and 10<sup>th</sup> floors were able to evacuate, most on 9<sup>th</sup> died; 60 young factory girls leaped to their deaths on sidewalk from 8<sup>th</sup>, 9<sup>th</sup> and 10<sup>th</sup> floor windows; some jumped down elevator shaft from 8<sup>th</sup> floor; some escaped to adjacent high rise; fire burned through in less than 20 minutes, Asch building is still standing; resultant code changes required fire-proofing, sprinkler systems and improved exiting from high-rises; this fire resulted in creation of the first New York City Bureau of Fire Protection, better conditions for workers, enforcement of fire codes for compulsory fire drills and sprinkler installation in factories and eventually led to development of NFPA 101, The Life Safety Code.
19. **1919 Teatro Yaguez Theatre in Mayaguez, Puerto Rico** (killed 150).
20. **1929 Cleveland Clinic Hospital in Cleveland, Ohio** (killed 125); 8-year old, 4-story building with 300 occupants; basement steam explosion or cigarette ignited highly-combustible x-ray film; fire door did not work correctly; poisonous yellow smoke carried throughout building by ventilation shafts and stairways; firemen arrived quickly but were unable to enter due to gas fumes; two street entrances blocked by patients; stairways clogged with patients; many fire survivors died days later from gas effects; use of safety film was subsequently required by law.
21. **1930 Ohio State Penitentiary in Columbus, Ohio** (killed 329); total population of 4,300 inmates; interior finish contributed to flame spread, possible arson fire started in adjacent scaffold, spread to highly combustible roof; guards delayed unlocking cells; Fire Department arrived 2 minutes after alarm, some prisoners attempted to cut hose, firefighters controlled fire in 2 hours; most deaths occurred in upper 2 tiers of 6-story prison.
22. **1937 Antoung Movie Theater in China** (killed 658).
23. **1940 Rhythm Club in Natchez, Mississippi** (killed 207); fire in a crowded, 1-story dance hall; combustible decorations, 1 decoration caught fire; victims tried to exit through front of 38-foot by 120-foot building, sole exit opened inward; 200 injured in crowd of 700.
24. **1942 Coconut Grove Night Club in Boston** (killed 492); Boston Building Department inspected and approved new addition to brick and stucco building shortly before this 5-alarm fire; Fire Department approved inspection performed 8 days prior to fire; electrical wiring by unlicensed contractor; crowd of 1,000 with an occupancy rating of 600; insufficient exits,

many rooms with confusing floor plan, numerous alterations; interior decorations of cloth, paper and bamboo; rattan, simulated leather and wood covered walls; ceiling of suspended satin fabric; underage busboy's match ignited gauze draperies in large basement Melody Lounge; crowd delayed exiting while 10 p.m. fire fought by customers; sole basement exit stair blocked within 2 minutes by crowd, smoke and fire; exterior door at top of basement stair was locked by management because panic hardware was broken; revolving doors at club entrance were jammed by bodies of evacuating guests; 2 other exit doors locked; some doors welded shut; nearby firemen responded to fire prior to receipt of 1<sup>st</sup> alarm at Fire Department; overturned chairs and tables impeded evacuation; curtains and interior decorations concealed unmarked exits; doors and windows were covered with paint and decorations; lighting system failed; inward-opening door in new street level Broadway Lounge jammed; fire spread throughout complex in just 5 minutes and burned through 4 rooms in 12 minutes; 200 people died in front of 2 revolving doors where bodies were stacked 4 and 5 deep; 100 died in front of new Broadway Lounge exit; bodies blocking doorways prevented firefighter entrance for either rescue or fire suppression; over 200 people injured; something wrong with every building exit; fire officials later stated outward-opening doors could have saved 300 people; little structural damage; subsequent building and fire code changes required revolving doors be supplemented with outward-opening hinged doors and battery-powered emergency exit lighting; led to requirements for a minimum of 2 separate exits for public assembly areas, better marking of exit doors, maximum occupancy certificates, posting of occupancy limits, prohibitions on use of basement areas for assembly, minimum aisle width between tables, securing tables to floor to prevent overturning, limitations on combustibility of interior furnishings, changed code requirements for construction materials and listing restaurants and nightclubs as public assembly areas; eventually led to nightclub requirements for sprinkler systems and accessible exits marked by emergency lighting; many improvements resulting from this fire were incorporated into the Life Safety Code; grand jury indicted 10 people; owner convicted of manslaughter and received 12-15 year sentence; contractor convicted of building law violations and sentenced to 2 years; criminal indictments issued against Building Commissioner, head of the Fire Prevention Bureau, fire inspector and police night captain, all later acquitted; worst multi-death nightclub fire of the 20<sup>th</sup> century, deadliest U. S. nightclub fire; 2<sup>nd</sup> deadliest U. S. fire in a single building; eventually led to development of counseling programs for victim family members.

25. **1942 Knights of Columbus Hall in St. John's, Newfoundland** (killed 100); arson fire in dance hall spread rapidly; killed 100 and injured 107 of 500 people inside, mainly soldiers; windows in the new wooden building had been boarded for blackout purposes and doors were locked or barred from the exterior.
26. **1944 Ringling Brothers Circus Tent Fire in Hartford, Connecticut** (killed 169); 700 injured in 520-foot long, 180-foot wide tent with new canvas waterproofed with a mixture of 6,000 gallons of white gas and 18,000 pounds of paraffin; world's largest circus tent; crowd of 7,500 in 13,000 capacity tent; nearest hydrant 900 feet from tent; fire extinguishers were not distributed; 4 fire trucks were parked outside tent; fire probably started by cigarette flipped on roof; crowd delayed exiting; most victims tried to exit spectator entrance, few tried to exit the 2 performer entrances, most died in front of an exit blocked by animal cages; 2 blocked exits; fire department arrived shortly after the fire began; large tent support poles began falling 3 minutes after crowd stampeded; most of tent was ablaze 6 minutes after fire start; tent was consumed in 10 minutes; some survivors found alive under piles of bodies; psychotic arsonist later confessed to setting fire, then recanted confession, sentenced to 40 years, investigators

unable to verify his presence in Hartford; casualty count probably higher due to vagrancy, incineration and poor records; more than 100 children killed; 9 circus officials arrested, 7 served 1-year sentences; 2 American big tops with the same waterproofing had previously burned in 6-10 minutes in 1910 and 1912 and a huge tent burned in Los Angeles in 1929; fire resulted in development of NFPA (National Fire Protection Association) Standard 102 on Grandstands, Folding and Telescopic Seating, Tents, and Membrane Structures which requires tents be constructed from fire-resistive materials; 2000 International Building Code and 2003 NFPA 5000 Building Construction and Safety Code both reference NFPA 102; Connecticut subsequently banned circus big tops; circus profits for next 10 years paid for more than 600 damage claims; circus began treating tents with other flame retardants in 1945; fire was the deadliest American amusement facility fire.

27. **1946 Wincoff Hotel in Atlanta, Georgia** (killed 120); early morning fire injured another 168 of 304 guests; built in 1913, brick exterior with fireproofed steel frame; only one staircase in 15-story building; internal location of open stair rapidly spread flames throughout building; interior walls covered with painted burlap and wallpaper; open transom above light wood doors on half the guest rooms; window shutters prevented escape from some rooms; no fire detection or suppression system; no fire escape; building recently passed fire marshal inspection; delayed fire department notification; room temperatures exceeded 1,500 degrees Fahrenheit; many people saved by ladder bridges to adjacent building; many victims jumped to their deaths; fire extinguished after 6 hours; worst multiple-death U.S. hotel fire of the 20<sup>th</sup> century; building is still standing empty.
28. **1953 GM Transmission Plant in Livonia, Michigan** (killed 6); 4,200 evacuated safely; 1.5 million square feet under 1 flat roof of 4-year old building; no interior fire walls or partitions; oil-soaked wood floor; cutting torch ignited conveyor drip pan oil; building was 866 feet wide, hose streams penetrated only 75 feet; only 20% sprinklered; absence of fire walls and roof vents prevented containment of smoke and fire; no fire protection for flammable liquids; unprotected roof steel trusses collapsed in minutes allowing melted roof asphalt to drip feed fire; ineffective fire brigade; delayed fire department notification; cinderblock wall didn't stop fire; \$32 million damage; Ford Motor Company had suffered a major fire in 1952 at a Livonia tank plant; subsequent code changes included restrictions on use of combustible tar in built-up roofs, assignment of hazardous operations to separate buildings, increased sprinkler use in industrial buildings, fire coating of steel framing and introduction of automatic fire doors; fire led to development of NFPA 204, Guide for Smoke and Heat Venting.
29. **1958 Our Lady of the Angels Grade School in Chicago** (killed 95); built in 1910 and remodeled in 1958; inspected 2 months prior to fire; nearly 1,300 students in attendance; basement rubbish accumulation under stairs provided ignition source for afternoon arson fire; delayed notification to school and Fire Department; dense smoke quickly traveled up stairwell without fire doors into classroom corridors; no sprinkler system; open wood stairs contributed to fire spread through two upper floors; fire fighters arrived within 3 minutes and extinguished blaze in 1 hour; surviving children were mainly from 1<sup>st</sup> floor; 77 children injured; subsequently Illinois changed school fire code to require fire alarms, automatic sprinkler systems, 1-hour enclosed stairwells, noncombustible acoustic materials, additional exiting and signage, self-closing exit doors opening outward, 1-hour walls, dedicated emergency lighting circuits, 2-hour fire doors over basements, fire doors at corridors, stairwells and openings in room partitions and fire-resistant walls, ceilings and doors around furnaces; fire codes nationwide were revised to require sprinklers in schools; 2/3 of U. S. towns and cities subsequently improved school fire safety.

30. **1960 Amude, Syria** (killed 152); moviehouse fire killed mainly children.
31. **1960 Guatemala City, Guatemala** (killed 225); fire burned rapidly through a mental hospital; 300 injured.
32. **1961 Niteroi, Brazil** (killed 323); a fire set by an angry young former worker killed 323 people at the Gran Circus; mentally handicapped arsonist confessed to firing the nylon circus tent while an older accomplice splashed gasoline on the tent fabric.
33. **1967 McCormick Place Convention Center in Chicago** (killed 1); 6-year old \$40 million building was non-sprinklered, fire resistant, unprotected roof trusses, uncompartmented; early morning fire was caused by an accumulation of debris from a home furnishings trade show and consumed the building and \$100 million contents within one hour just prior to the trade show opening; fire department notified 6 minutes after fire discovery; a 200-foot long pre-cast concrete exterior wall section collapsed; subsequent testing proved high-ceiling sprinklers would have controlled this fire; 40,000 sprinkler heads were installed in the replacement McCormick Place.
34. **1967 L’Innovation Department Store in Brussels, Belgium** (killed 323); fire at a major department store.
35. **1970 Cing September Club in Saint-Laurent-du-Pont, France** (killed 146); fire at a dance hall built inside a large warehouse; lounges decorated with hardened cardboard furniture and polyester fabrics formed an interior maze; plastic ceiling above main dance floor, no phone or fire alarm in club; Halloween fire started by defective heater; Fire Department arrived soon after fire started; all exits were padlocked; turnstiles blocked main entrance; bodies were piled before exits; fire burned for 3 hours and killed mainly young adults and teens; 5 people, including mayor, were indicted and received suspended sentences.
36. **1971 Daeyongak (Taeyokale) Hotel in Seoul, South Korea** (killed 166); worst hotel fire ever.
37. **1972 Sennichi Department Store in Osaka, Japan** (killed 118); nightclub fire on the top floor of this 7-story building.
38. **1973 National Archives in St. Louis, Missouri** (killed 0); destroyed several hundred thousand military records relevant to 18 million veterans including 80% of Army personnel serving 1912-1960 and 40% of Air Force personnel serving 1947-1964.
39. **1973 Kumamoto, Japan** (killed 101); Taiyo department store fire.
40. **1974 Joelma Building in Sao Paulo, Brazil** (killed 227); 25-story high-rise office building; fire started in air conditioning unit on 12<sup>th</sup> floor; spread rapidly due to highly combustible interior wall coverings; many victims trapped on roof and balconies due to no fire escapes; several rescued by helicopter, 18 people rescued by rope path to adjacent building; many people jumped to their deaths.
41. **1977 Duc del Brabant Hotel in Brussels, Belgium** (killed 302).
42. **1977 Beverly Hills Supper Club in South Gate, Kentucky** (killed 167); injured 130; club experienced a large fire 7 years earlier; deficient wiring included aluminum wiring; state fire

inspection performed 4 months prior to fire; fire of electrical origin began in Zebra Room where heat was noted by an exiting wedding party; fire flashed over Zebra Room 20 minutes later; building staff decided guests in a large ballroom called the Cabaret Room were not jeopardized due to remote location from fire origin; busboy later notified 1,300 guests in crowded Cabaret Room (3 times capacity) to evacuate 20 minutes after fire discovery; hot fire and smoke traveled down corridor to Cabaret Room and flashed over this room minutes later, trapping occupants and leaving only 2 other exits; chairs in aisles and chairs on stage ramps; excess crowd stood in hallways; temperatures reached above 2,000 degrees Fahrenheit in Cabaret Room; 125 people died before 1 exit and 34 people died before the 2<sup>nd</sup> exit; only 2 fatalities outside Cabaret Room; corridor finish materials contributed to rapid flame spread; fire burned for 5 hours and smoldered for another 24; many additions and other modifications; building was 500 people over capacity with 2,800 occupants; labyrinthine corridors in 1.5-acre building; poorly marked exits; some blocked exits; some unmarked exits; narrow exits; unprotected door and window openings; most exits led to corridors rather than exterior; insufficient exiting, code required 28 exits, 17 existed; inward-opening doors; combustible wall coverings included paneling and smoky plastics, fabrics and composite structural materials; foam seat cushions accelerated fire spread; combustible ceiling tiles; no sprinklers (required by current Kentucky code), detectors, alarms or fire separations; staff delayed evacuation announcement for 10 minutes after fire discovery and delayed fire department notification; staff had no emergency training or evacuation plan; staff assisted evacuating patrons; over \$60 million paid to settle insurance claims; subsequent code changes required sprinklers in nightclubs and public assembly areas over 300 capacity, banned aluminum wiring; first fire where scene was preserved for investigation.

43. **1977 Xinjiang, China** (killed 694); 597 people killed were children.
44. **1978 Abadan, Iran** (killed 377); arson fire at crowded theater.
45. **1980 Eventide Nursing Home in Kingston, Jamaica** (killed 157); possible arson fire.
46. **1980 MGM Grand Hotel in Las Vegas** (killed 87); injured 750; deadliest U. S. fire of 1980s and second deadliest U. S. hotel fire; most deaths on upper levels due to smoke inhalation; demonstrated importance of sprinkler systems; led to extensive Las Vegas retrofit program.
47. **1981 Municipal Theatre in Nice, France** (killed 200); caused by gas pipe.
48. **1982 K-Mart Distribution Center in Falls Township, Pennsylvania** (0 killed); \$100 million damage; 1.2 million square foot building measuring 1,085 feet by 1,180 feet, divided into 4 quadrants by firewalls; firewall openings protected by deluge system rather than fire doors; unprotected structural steel; fire started in falling carton of carburetor cleaner aerosol cans; quadrant filled with smoke in 3 minutes; roof burned through in 20 minutes; sprinklers overwhelmed by large flammable load; explosions blew flaming aerosol cans through firewall openings spreading fire to other quadrants; building engulfed within 1 hour; firewalls not designed to be free-standing after burnout in 1 quadrant; 225 employees escaped.
49. **1983 Nassameer, Egypt** (killed 357).
50. **1987 Dupont Plaza Hotel/Casino in San Juan, Puerto Rico** (killed 97); arson fire in casino ballroom set by 3 workers; Sterno cans ignited new furniture wrapping, then furniture; combustible ballroom interior and partition; fire flashed over ballrooms 9 minutes after

ignition; fire spread rapidly through foyer to casino with 300 occupants and 2 exits; first exit blocked by smoke, second exit was an inward opening door which took 2 simultaneous actions to open, second exit jammed, fireball engulfed most victims, many found by second exit; smoke spread to high rise through elevator shafts, HVAC system and stairwells; no sprinkler system; no detection system; manual alarm not working; fire department notified 18 minutes after fire discovered; 85 of 97 victims found in casino; helicopters rescued some from 20-story hotel tower roof; 140 injured; fire led to legislation requiring sprinklers in U. S. motels and hotels.

51. **1990 Happy Land Social Club in New York City** (killed 87); illegal occupancy in an unlicensed club; insufficient egress; insufficient fire protection; locked exit doors; this building in the East Tremont area of the Bronx was repeatedly closed for code violations then reopened illegally; no sprinkler system on 1<sup>st</sup> floor; 2<sup>nd</sup> floor sprinkler system branch line was plugged; bouncer ejected patron after argument with ex-girlfriend; patron returned with plastic gas can and set flash fire by splashing 1 gallon of gasoline at ground entrance (only exit available for patrons); flashover in ground floor barroom; toxic smoke quickly traveled up only (open) stairway into club and filled 2<sup>nd</sup> story room; little flame reached upper floor; majority of victims were Honduran immigrants trapped on 2<sup>nd</sup> floor who died within seconds from smoke inhalation and carbon monoxide poisoning; fire exits blocked to prevent entry without paying cover charge; some escapees broke a metal gate over 1 door; arsonist went home and fell asleep; arsonist confessed hours later and was convicted of 87 arson/murder counts and sentenced to 25 years in jail; club ordered to close based on building and fire code violations; combustible interior finish materials; insurance claims settled for \$15 million; New York City later increased efforts to monitor licensed clubs and close illegal clubs.
52. **1993 Bangkok, Thailand** (killed 187); doll factory fire; 500 injured; deadliest factory fire in the world.
53. **1994 Fluxin Discotheque in Liaoning, China** (killed 234); fire in dance hall, many crushing deaths at emergency exits that were chained shut.
54. **1994 Karamay, China** (killed 385); concert hall fire killed mainly children; all exit doors except one were locked.
55. **1995 Rajiv Marriage Palace in Mandi Dabwali, India** (killed 540); spark from a short circuit in an electric generator ignited a synthetic tent erected under the tin roof of a building with brick walls; no construction permit for building; afternoon fire at the main entrance trapped 1,500 occupants inside with only a single exit door available for evacuation; fiber mats and plastic chairs contributed to rapid spread of 5-minute fire, 170 children killed.
56. **1996 Ozone Discotheque in Manila, Philippines** (killed 160); sparks at a deejay booth started a fire which consumed and collapsed the ceiling in this nightclub with 400 teens packed into a converted residence licensed for 60; crowd thought sparks were part of a strobe effect; fire flashed over club within 2 minutes when the sole, narrow, inward-opening door was ripped down by the escaping crowd; soundproofing on walls accelerated fire spread; 2<sup>nd</sup> exit blocked by neighboring construction; owner and several officials indicted and sentenced to probation.
57. **1997 Yanshan Hotel in Changsha, China** (killed 200).
58. **1997 Iron Mountain Records Storage in South Brunswick, New Jersey** (0 killed); arson

fire started while arson investigators were onsite investigating 2 previous fires and access was controlled to the area of origin; over 1,000,000 cartons of paper records (100 million documents) destroyed.

59. **2000 Dongdu Commercial Building in Luoyang, China** (killed 309); only construction crew and hundreds of disco patrons were in building on Christmas day; welders performing unlicensed renovation work in a large, 4-story shopping mall started a 9:30 p.m. basement fire by dropping molten metal on flannel rags and wooden furniture; welders fled without warning others; construction workers trapped on 2<sup>nd</sup> and 3<sup>rd</sup> floors; over 200 party guests in an illegal 4<sup>th</sup> floor discothèque were overcome by smoke quickly traveling up stairwells; no fire prevention equipment or emergency exits in the poorly lit room; construction materials blocked exits; a shop blocked 1 emergency exit, 1 of 2 disco exits was hidden behind a bar while the other was blocked by smoke; only 60 escaped the Christmas night fire which was extinguished after 3 hours; many jumped from 4<sup>th</sup> story; dozens injured; firefighters used cranes to rescue people from upper floors; fire extinguished after 3 hours; 12-year old building had a 3-year history of safety violations and failed a fire inspection 1 week before the fire due to merchandise blocking emergency exits; building had no fire alarms, sprinklers or smoke detectors; 23 people placed on trial; some sentenced to 7-13 years in prison including the construction manager, 2 policemen for bribery and 1 fire inspector who altered reports.
60. **2003 The Station Nightclub in West Warwick, Rhode Island** (killed 100); an 11 p.m. fire injured more than 200, many smoke inhalation injuries, backstage pyrotechnics at the start of a crowded indoor concert ignited combustible urethane foam packaging used as soundproofing on wall behind stage; foam soundproofing added 18 months earlier due to neighbor noise complaints; combustible foam purchased at half the cost of fire retardant foam; owner was well aware of combustibility of urethane foam; foam is 20 times more combustible than wood and emits dense, toxic smoke; flames climbed foam at 1 foot per second, then flames climbed curtains; lead singer failed to extinguish fire with a water bottle; no fire extinguishers on stage; crowd thought flames were part of the pyrotechnic effects; exiting crowd jammed main entrance; lights went out as crowd was evacuating; toxic smoke quickly filled low-ceiling room; most bodies were found piled at front entrance; some were trampled; few in crowd used 3 other fire exits; 60-year old building did not require sprinklers; local code exempted small buildings built before 1974 from sprinkler installation; club passed a fire inspection New Year's Eve; no pyrotechnics permit for this property; crowd was over capacity of 404; flames engulfed 1-story wood-frame building in 3 minutes; club owners claimed they denied permission for the band to use pyrotechnics; band claimed club owners granted permission; other bands claimed pyrotechnics were previously used at this club; other clubs claimed this band recently had used indoor pyrotechnics without permission; worst fire ever in Rhode Island which subsequently placed a moratorium on indoor pyrotechnics at facilities with less than a 300 person occupancy limit; charges of 200 counts of involuntary manslaughter were filed against the band manager and club owners; many states later began extensive nightclub inspections; 8 states tightened indoor pyrotechnics regulations; Boston banned indoor fireworks; the National Fire Protection Association (NFPA) adopted a new standard which recommended sprinklers in new clubs with 50 or more occupants and existing clubs with 100 or more occupants; Rhode Island adopted new regulations 5 months after the fire which banned indoor pyrotechnics in assembly facilities with less than a 1,000 person occupancy limit, required sprinklers by 7/1/2005 for nightclubs with more than 300 occupants, required sprinklers by 7/1/2006 for nightclubs with more than 150 occupants,

eliminated the “grandfather clause” exempting older buildings from new code compliance, required low-level exit signage for all nightclubs by 2006 and gave local fire officials the authority to inspect nightclubs during operating hours and close those violating fire codes.

61. **2004 Ycua Bolanos Botanico Supermarket in Asuncion, Paraguay** (killed 464); injured 524; grease buildup in a horizontal section of charcoal grille chimney started this noon fire in an upper level food court of this crowded, new, 2-story supermarket; emergency exit was welded; guards locked many of the main exits to prevent looting; exit doors did not swing outward; building was non-sprinklered; roof coated with sprayed urethane foam which was not fireproofed; building had fire hose cabinets, fire alarms, smoke and heat detectors; flames engulfed food court and lower level parking garage; flames burst through upper face of duct, then ignited foam roof; 1 floor collapsed; many children killed; firefighters knocked holes in walls of neighboring houses to access supermarket; store owners and 4 security guards arrested for questioning.
  
62. **2004 Cro-Magnon Republic Club in Buenos Aires, Argentina** (killed 188); fans shooting flares ignited a foam ceiling in this nightclub at 11 p.m. during the start of a rock concert attended by 4,000 people in a building with a capacity of 1,500; concert permit was for 1,100 guests; staff searched entering guests for firecrackers and flares and made announcements not to ignite pyrotechnics; some of the casualties were children in an improvised day care center located in a club restroom; 4 of 6 exit doors, including 2 emergency exits, were either tied shut or chained and locked to prevent entry without paying a cover charge; 1 usable exit door was narrow while wider doors were locked; many bodies piled up before 1 locked exit; building quickly filled with thick smoke; crowd panicked and stampeded for exits; fire was quickly extinguished; many fatalities from smoke inhalation; 889 injured; firefighters inspected club 8 months previously and foam ceiling was installed after this inspection; club owner was arrested and mayor subsequently closed all nightclubs in city for 15 days.