The Modern Day Houston City Centre.

TEXAS

AIR CONDITIONING & ARCHITECTURE

1919-2009

BRIAN ROBERTS

<2>

HOUSTON GULF OIL BUILDING

Built in 1929, the office tower (shown with top illuminated) was air conditioned.

THE DRISKILL HOTEL IN AUSTIN

CONTENTS by page numbers

BMR, Budleigh Salterton, Summer 2021.

DALLAS BANK OF AMERICA 1985

1985: Height 921 ft, 74 floors, tallest building in Dallas.

INTRODUCTION

The Republic of Texas was established in 1836, becoming the 28th State of America in 1845. It is the second largest State after Alaska and has the second largest population after California. The major cities in Texas, ranked in the USA by population are 4-Houston, 7-San Antonio, then 9-Dallas, 11-Austin and 13-Fort Worth.

During the 1970s and early 1980s, I made a number of business trips to Dallas and Houston, looked at a few skyscrapers and their air conditioning and attended meetings of ASHRAE as a member of two Technical Committees (Large Building Air Conditioning and Load Calculations). I also visited Fort Worth, but unfortunately never got to San Antonio to see the Milam Building, the first air conditioned high-rise, which dates from 1928. And I never visited Austin either.

For the record, a number of early Texas movie theatres were air conditioned: the Majestic, Dallas (1921), the Palace, Dallas (1924), Iris and Texan in Houston (1925), the Texas in San Antonio (1926) and the Jefferson in Beaumont (1929): see the Heritage Group website. Other early air conditioned buildings, all in Houston, include the Gulf Office Tower (1929) and the Rice Hotel (1913, air conditioning added later) and the State Hotel (built 1929). Now there are tall air conditioned skyscrapers in all major Texas cities.

HOUSTON THEN AND NOW


Main Street, 1910 p. 18


Main and Preston, 1915 p. 22


Houston Water Works, 1879 p. 38


Old Cotton Exchange, 1884 p. 50


City Hall and Market Square, 1909 p. 52


Moorish Federal Building, 1889 p. 60

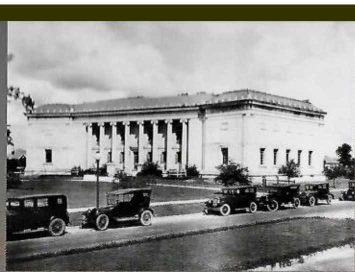

Union Station, c. 1940 p. 68


Allen Parkway, 1955 p. 86


Magnolia Brewery, 1912 p. 88


Grand Central Station, 1915 p. 92


Rice University, 1912 p. 98


Museum of Fine Arts, 1924 p. 102


Hermann Park, 1925 p. 106


Glenwood Cemetery, 1871 p. 124


Astrodome, 1965 p. 126


USS Texas, 1920 p. 134


Lynchburg Ferry, 1920 p. 138


NASA Manned Spacecraft Center, 1962 p. 140

J.P. MORGAN CHASE TOWER HOUSTON

1982: 1002 ft, 75 floors. Tallest building in Texas.

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WELLS FARGO BANK HOUSTON

1983, 902 ft, 71 floors.

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TC ENERGY CENTRE HOUSTON

1983, 780 ft, 56 floors.

TC ENERGY CENTRE HOUSTON

The atrium lobby.

<10>

WILLIAMS TOWER HOUSTON

1982, 901 ft, 64 floors.

<11>

GALLERIA SHOPPING CENTRE HOUSTON

1970, 4 floors, over 300 stores and an ice rink.

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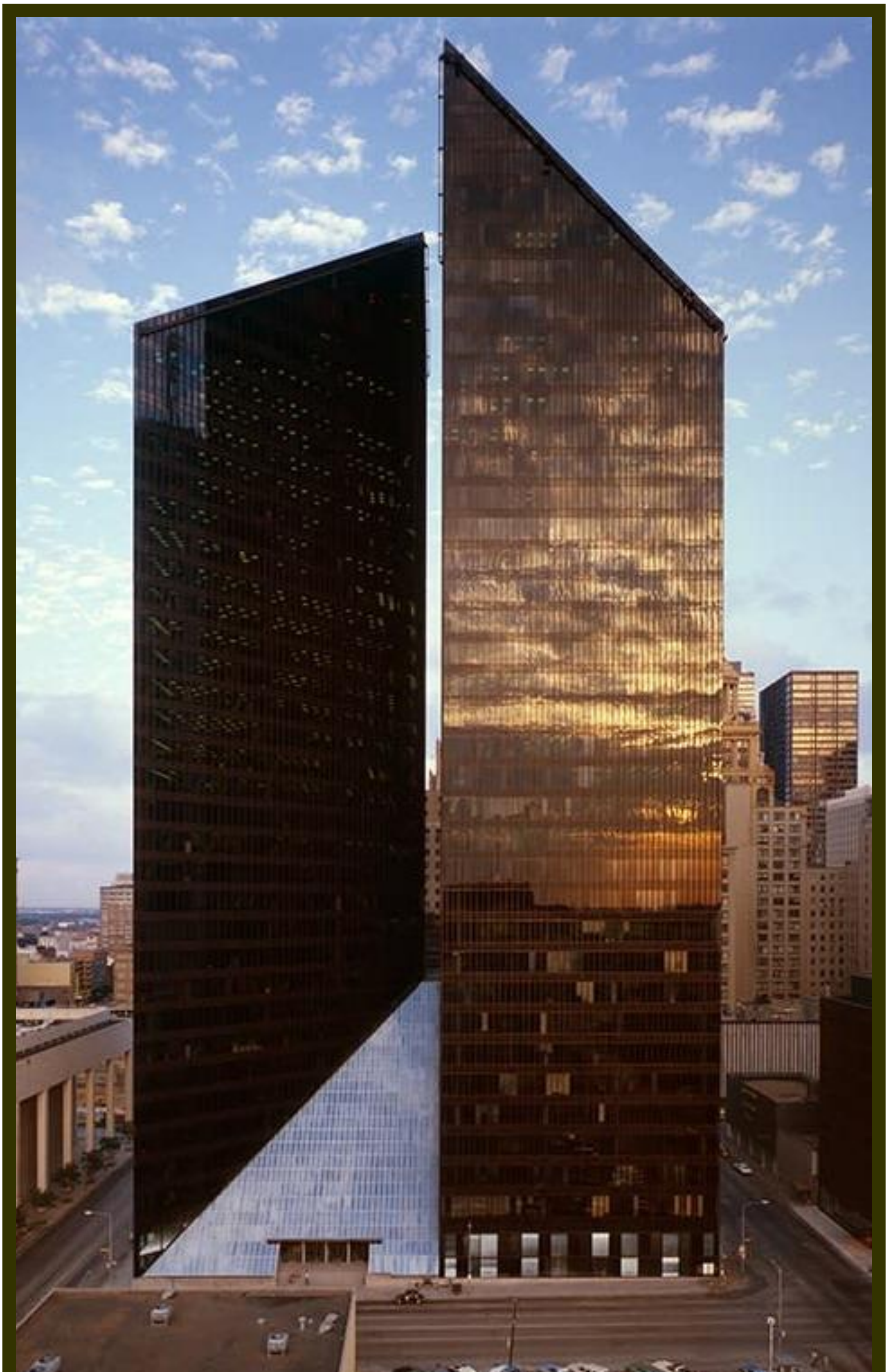
PENNZOIL PLACE HOUSTON



1976, two trapezoidal towers, 495 ft, 36 floors, linked by atrium pyramid.

PENNZOIL PLACE HOUSTON

The atrium lobby.

THE ORIGINAL AIR CONDITIONING SYSTEM

The 36-storey twin office towers are linked by a giant atrium. The towers are air conditioned by an all-air dual duct system with two air plants per floor. The atrium is served by 16 air handling units. Refrigeration is provided by four 1400 TR water chillers (5600 TR total) linked to a single five-cell roof top cooling tower. The main piping systems are four 250 mm diameter for chilled water and four 150 mm diameter for heating hot water. The heating plant consists of two 5 MW MTHW boilers with nitrogen pressurisation generating primary hot water at 120 degC serving heat exchangers operating at a secondary temperature of 82 degC. The boiler flues discharge through a 10 m high stack at the pavement edge (an unusual arrangement as shown in the above photograph). There is pressurised smoke ventilation for staircases in the event of fire and the atrium and lower levels of the tower are provided with fire sprinkler systems.

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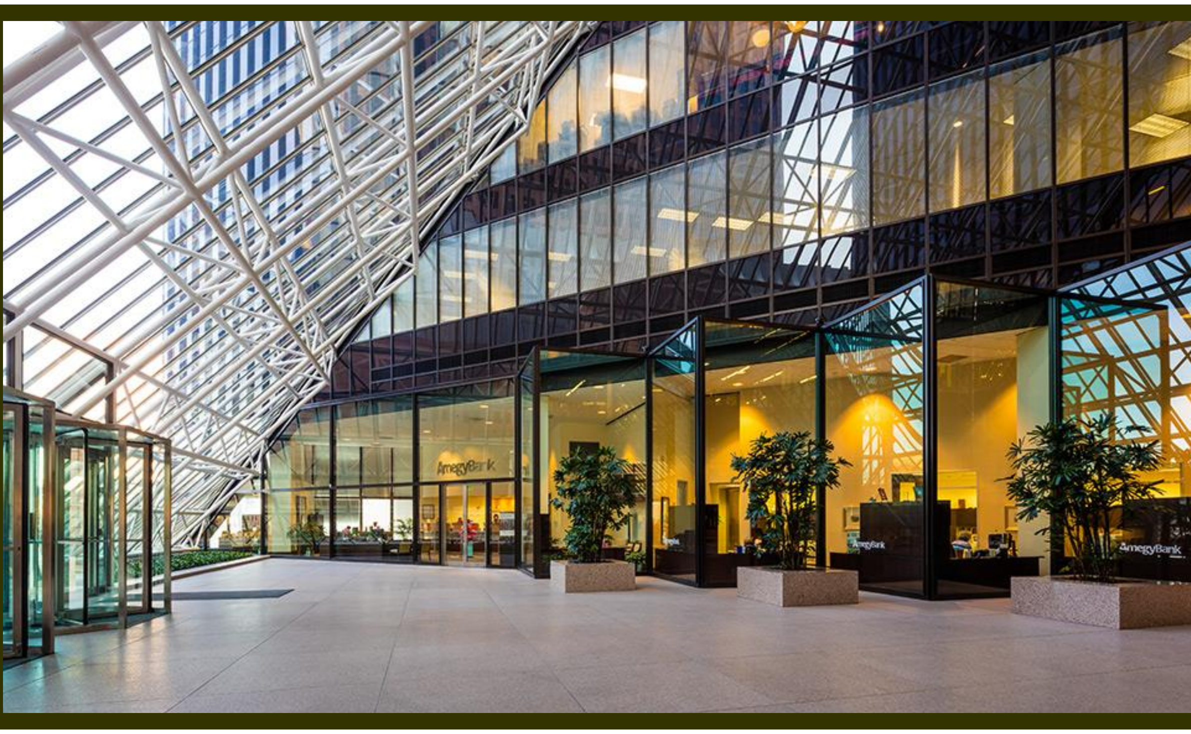
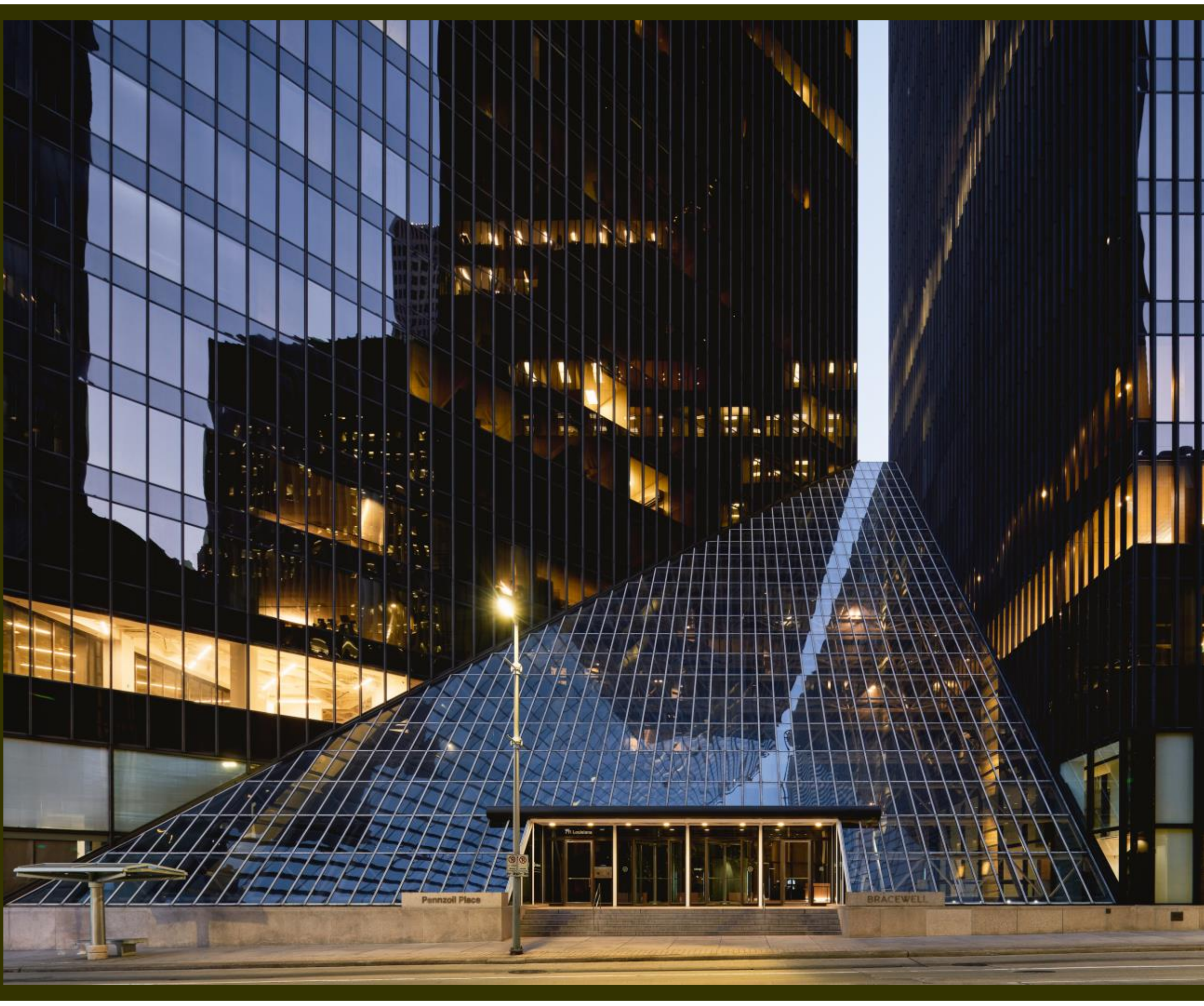
PENNZOIL PLACE HOUSTON

Glass pyramid-shaped atrium 115 ft high.

PENNZOIL PLACE HOUSTON





Two views of the atrium.

PENNZOIL PLACE HOUSTON

The curtain walls sheathed in solar glass. Named "Building of the decade."

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PENNZOIL PLACE HOUSTON

Looking down from the top of the atrium pyramid.

MILAM BUILDING SAN ANTONIO

The following of pages are from the 1991 report compiled by ASME (The American Society of Mechanical Engineers). These give details of the air conditioning and refrigeration systems recorded as being the first installed in a new high-rise building.
1928, 21 floors, 375 TR.

MILAM BUILDING SAN ANTONIO

The Milam Building

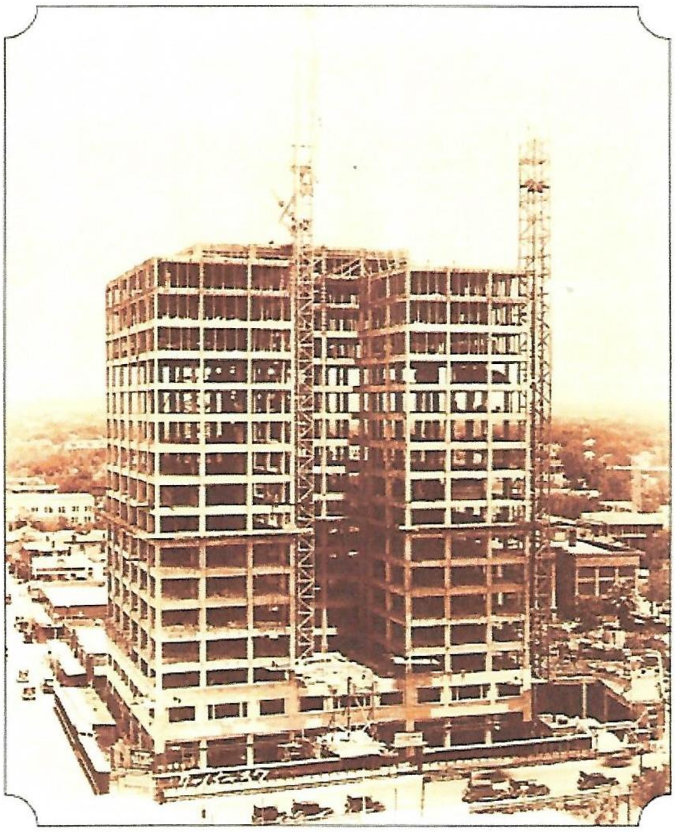


Photo courtesy of Trammell Crow Company

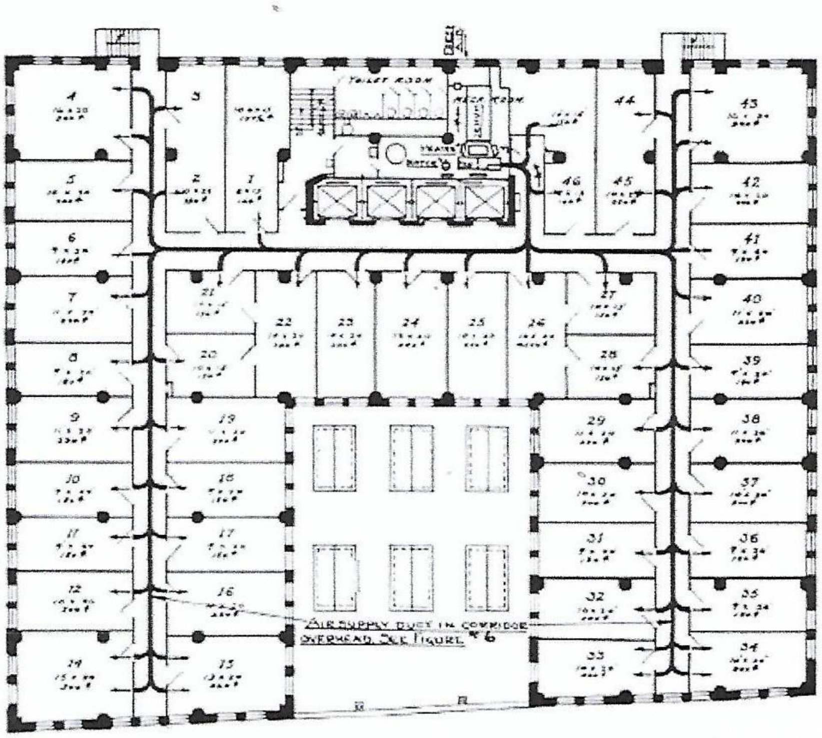
In July Of 1927 When This Photo Was Taken, The Milam Building Was The Tallest Reinforced-Concrete High-Rise Office Building In The Nation.

WHEN IT opened in January 1928, San Antonio's 21-story Milam Building, originally owned by the Travis Investment Company, was the nation's tallest brick and reinforced-concrete structure — taller than comparable concrete-framed buildings in New York and Chicago — and the first high-rise air-conditioned office building in the country.

Named for Col. Ben Milam, who was considered by many Texans the real hero of Texas independence, the 210,851 square-foot tower was a blend of modern technology and Gothic majesty. The owner's progressiveness, ably backed by the architect, consulting engineer and contractors — all of whom were from San Antonio — quickly established 115 East Travis Street as the address of choice for many of the state's and nation's leading oil and gas companies, such as Shell, Standard Oil, Mobil and Sun Ray Oil.

Cover Photo: The Milam Building-1928. Reprint Of Photo Report, "The Milam Co. Of San Antonio, Texas." Originally, The Report Was Property Of D.G. Francis Who Was Treasuer Of The Milam Co. Photographer: Harvey Patteson. Photo courtesy of San Antonio Conservation Society.

MILAM BUILDING SAN ANTONIO



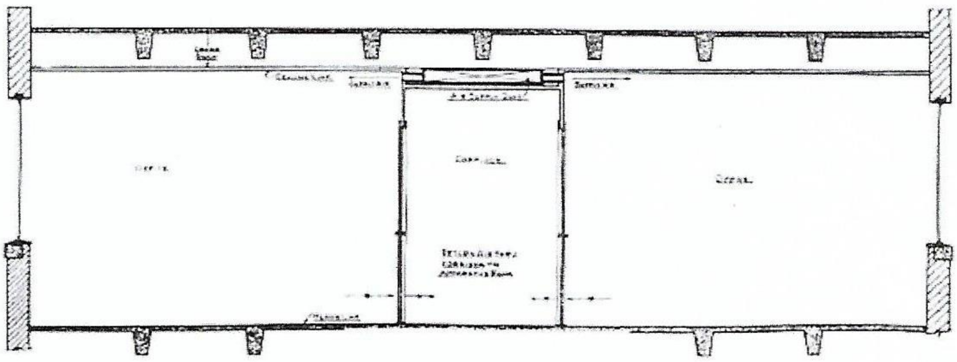
A Typical Floor Plan Shows Office Layout, Air Distribution Ducts And The Air-Handling Equipment Room.

Motor-driven dampers were placed in the main duct lines on each floor in the building and arranged to allow the bulk of the conditioned air to be shifted from one side of the building to the other, depending on the location of the sun. In addition, the dampers could be positioned to balance the air flow evenly to both sides of the building on cloudy days.

For more precise area heating, main air-supply ducts on every floor were equipped with automatic steam heaters, located at several key points, or zones, along the inside duct walls. Beyond each steam heater — located several feet further from the source of the air supply — was a thermostat, which measured the temperature in each zone. When the temperature dropped below the ideal, 70 degrees, the thermostat sensed the drop in temperature and added steam to the conditioned air in the main supply duct.

From the main air-supply ducts, connections branched to each office. Within each branch connection was a permanently-set, air-volume adjuster that provided uniformity of air flow throughout the building. Each branching duct dead-ended inside each office at an adjustable air-supply grill in the corridor wall near the ceiling.

This Air Flow Diagram Illustrates That Fresh Air Entered The Offices From The Air-Supply Duct In The Corridor Above While. The Warmer Air Returned To The Air-Handling Or Blower Room Below Through Louvres In The Bottom Of The Door.



MILAM BUILDING SAN ANTONIO

Return Air

TO OPERATE the Milam's air-conditioning system efficiently, large portions of conditioned air were re-used, re-purified and reconditioned, drawing in just enough outside air for proper ventilation. The air delivered to each office returned to the corridor through "V-shaped" louvres in the lower part of office doors, then returned along the corridor to the back of the air-handling unit near the rear of the elevator shaft. The corridor thus serves as a return-air duct.

Lavatories in the Milam were not air conditioned or ventilated as part of the main air distribution system — they were cooled by air leakage from both the corridor and the stair tower and independently ventilated. Corridor air leakage, therefore, provided for some lavatory cooling.

Outside return-air dampers were originally controlled manually to bring in 100, 70, 40 or 15 percent outside air, depending on existing weather conditions. All of the dampers for the 11 air handlers could be controlled manually from the basement by the building engineer. During periods when the air was heated or cooled, the engineer could, at his discretion, bring in outside air beyond the volumes required for ventilation, although taking in more fresh air than necessary increased the cost of operation. The building engineer was considered the best judge of the requirements, which is one reason manual control of fresh air was preferred at the Milam Building over fully automatic control.

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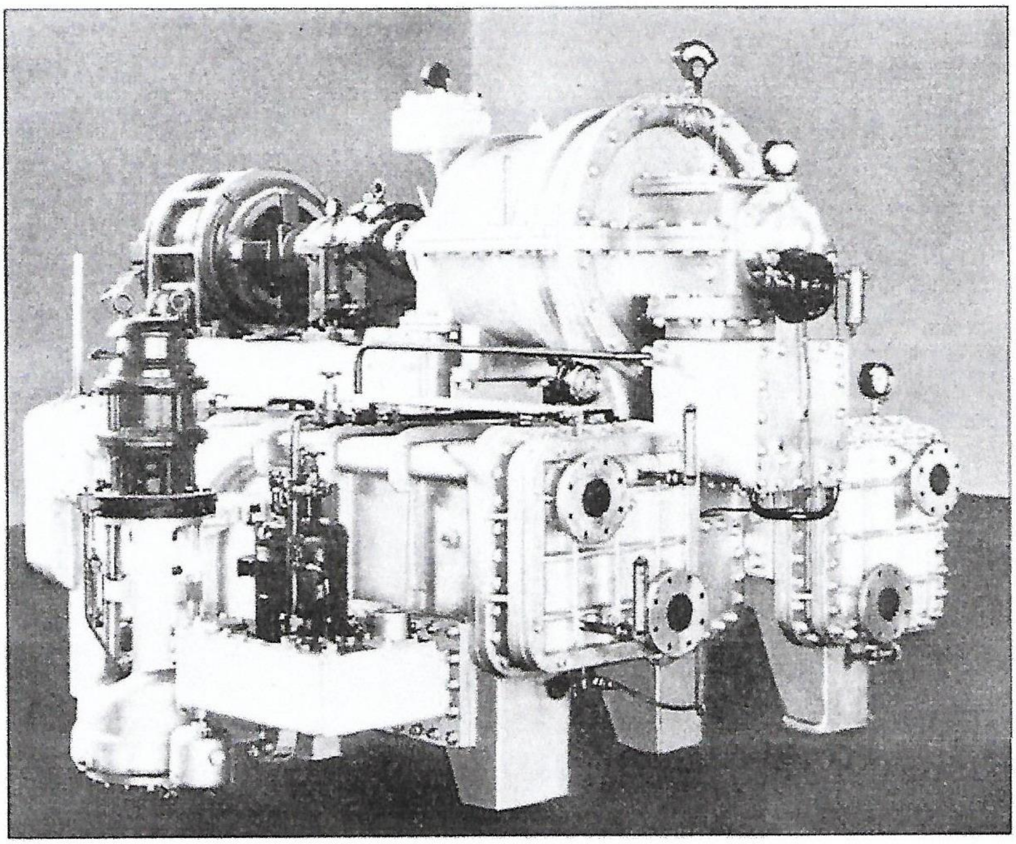
One Of The Two Original Carrier Centrifugal Refrigeration Units Used In The Milam Building. Each Unit Had The Capacity To Chill 650 Gallons Of Water Per Minute And Occupied Approximately 215 Square Feet Of Floor Space.



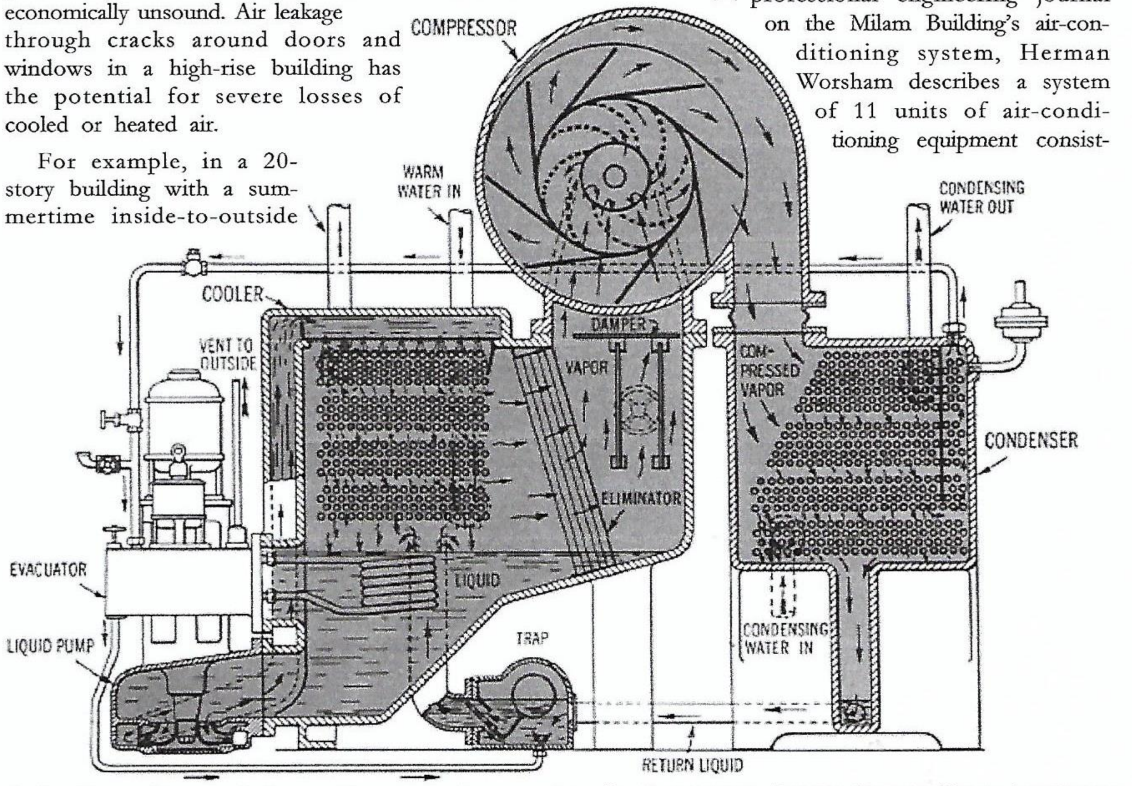
MILAM BUILDING SAN ANTONIO

Air Leakage

THE TIGHTNESS of a high-rise building is a factor that affects the quantity of fresh air to be used. The more air that leaks from the building through windows and doors and other openings, the greater the demand for fresh-air replenishment. Special windows were incorporated into the Milam Building's design to make the structure quite tight. For this reason, little conditioned air was wasted, which helped keep the cost of operation down.

Had not building tightness been a design consideration, the entire air-conditioning project potentially could have been inefficient and thus economically unsound. Air leakage through cracks around doors and windows in a high-rise building has the potential for severe losses of cooled or heated air.

For example, in a 20-story building with a summertime inside-to-outside temperature differential of 20 degrees, a column of denser, cooler inside air one-foot square and 200 feet high (20 stories) will weigh 0.6 of a pound more than an equal column of outside air. The total volume of air inside such a building will weigh 7,500 pounds more than an equal volume outside. The column of denser air exerts a tremendous downward pressure, tending to force its way outward on the lower floors. As it does so, outside air is drawn in at the upper floors. The pressure is sufficient, with a 20-degree temperature difference, to create an outward and downward velocity of 1,360 feet per minute through any cracks or crevices.



IN THIS TYPICAL DIAGRAM OF CARRIER CENTRIFUGAL REFRIGERATION, THE REFRIGERANT, DIELENE, REACHED NEARLY ATMOSPHERIC PRESSURE AT THE COMPRESSOR OUTLET IN THE CONDENSER. THE TRAP WITH FLOAT ACTED AS AN EXPANSION VALVE TO HOLD HIGHER PRESSURE IN THE CONDENSER. AN EVACUATOR REMOVED AIR AND WATER CONTAMINATION FROM THE ENCLOSED SYSTEM WHILE THE ELIMINATOR PREVENTED LIQUID SLUGS FROM ENTERING THE COMPRESSOR AND DAMAGING THE BLADES.

During the winter, the air inside is lighter and the direction of air leakage is reversed, leaking in at the bottom and out at the upper levels. Thus the building becomes a huge stack. Because temperature variances in the winter are usually greater than in the summer, the "stack" action is even more pronounced. It's apparent that structural tightness was an important design consideration for the 21-story Milam Building.

Air Delivery

IN A 1929 technical article from a professional engineering journal on the Milam Building's air-conditioning system, Herman Worsham describes a system of 11 units of air-conditioning equipment consisting of fans, dehumidifiers, heaters and motors (see air-handling figure, bottom of page 3). He states that dehumidification was accomplished by a spray water system of air conditioning. Research shows that such a system was installed in 1924 at the Palace Theater in Dallas, Texas, however, visual inspections and staff interviews seem to indicate that such a system did not exist at the Milam building. Therefore, it is possible Worsham was in error and that the 11 original air handlers were actually surface condensation systems with cooling coils. The present-day air-handling unit consists of air filters, cooling coils, heaters and a centrifugal fan.

MILAM BUILDING SAN ANTONIO

Refrigeration and Cooling Equipment

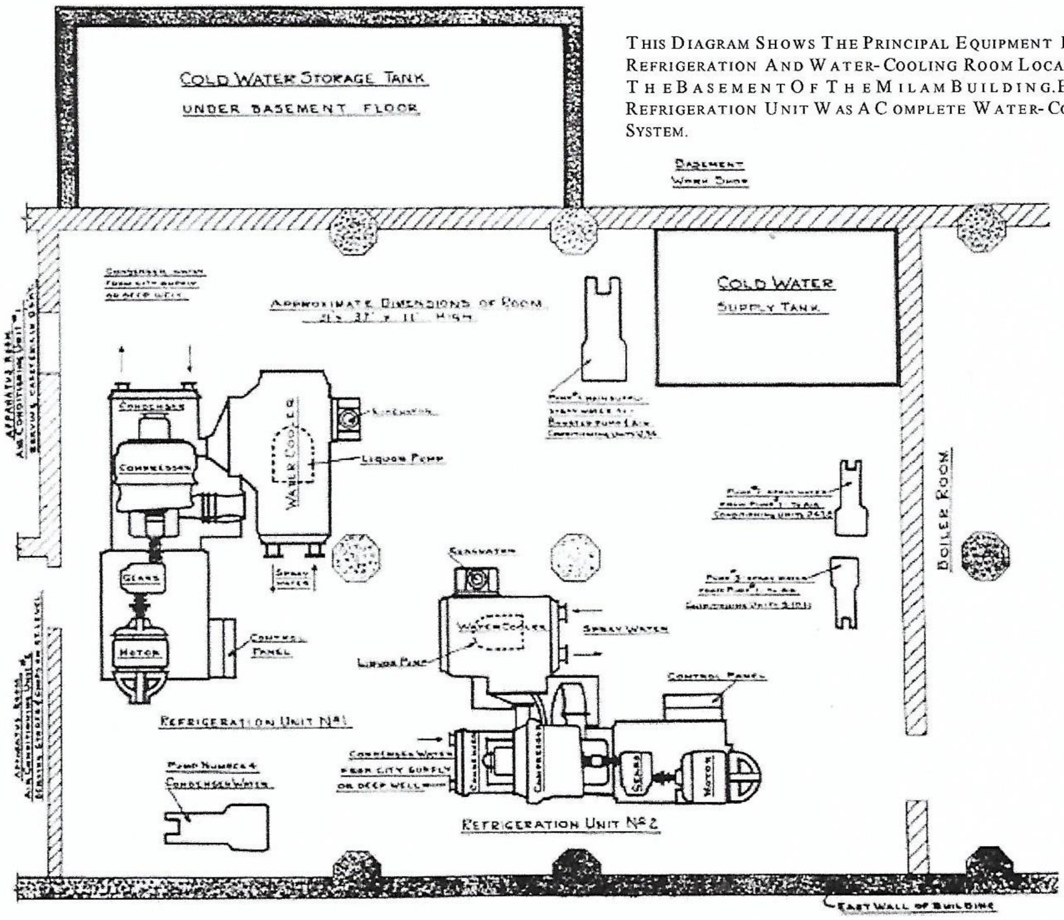
THE REFRERATION and cooling equipment is located in the basement. Originally, two centrifugal refrigeration units with a total cooling capacity of 375 tons (nominally 300 tons) served the Milam Building. That capacity approximates the cooling effect of 375 tons of ice (750,000 pounds) melting over a 24-hour period.

Since office rental space produced most of the owner's income, space limitations necessitated the use of a compact system of refrigeration. In addition to compactness, the system also had to be simple, safe and economical. A storage tank for chilled water was originally provided under the basement floor, which allowed the refrigeration equipment to be operated at non-peak electric rate periods to reduce the cost of operation. With one refrigeration unit operating at night, the tank had the capacity to store enough chilled water so that only one refrigeration unit was required in service the following work day. If the weather was cool that day and the chilled water was not needed, it could be held for several days with only a slight rise in temperature.

Also, both refrigeration units could be shut down and the building cooled with chilled water from the storage tank alone. The use of storage water from the tank was under positive automatic control, with the amount of chilled water withdrawn varying from zero to 100 percent depending on load. The tank was designed to prevent relatively warm returning water from mixing directly with the cold tank water.

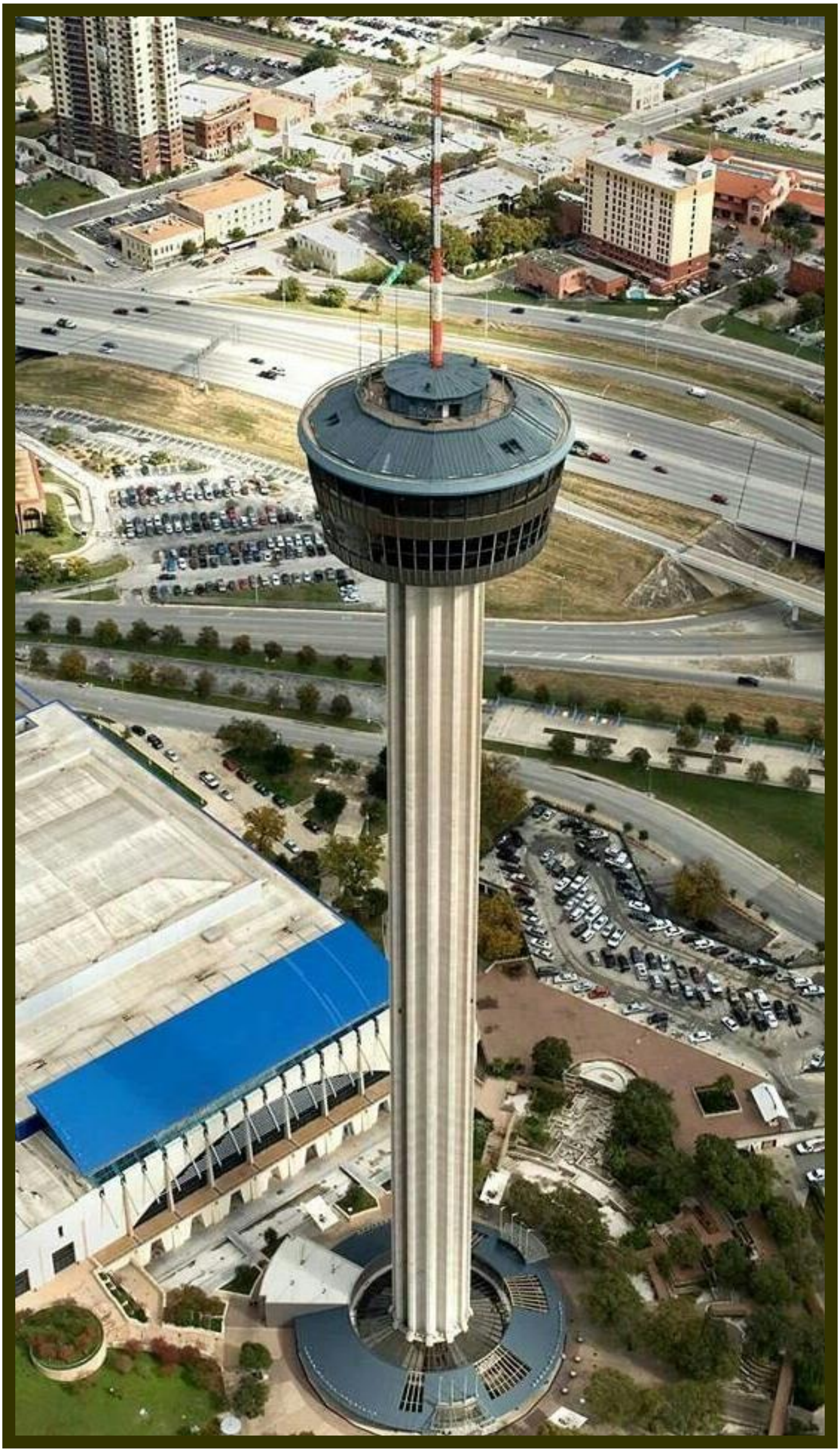
Chilled water was delivered to the 11 air-conditioning (air-handling) units by three motor-driven centrifugal pumps, located near the collection tank in the refrigeration room. In the Milam's chilled-water system, it was necessary to use an open system of water circulating lines, thereby losing the "head" due to the elevation of the water in the risers.

Given this condition, dividing the 11 air-handling units into three pumping groups permitted a savings in the total power consumption for pumping. Pump 1 was large enough to handle the entire quantity of chilled water at a pressure sufficient to deliver it to all the units on or below the 5th floor. Pumps 2 and 3 were booster pumps, with Pump 2 supplying floors six through 14 and



This Diagram Shows The Principal Equipment In The Refrigeration And Water-Cooling Room Located In The Basement Of The Milam Building. Each Refrigeration Unit Was A Complete Water-Cooling System.

TOWER OF AMERICAS SAN ANTONIO



1968, 750 ft, 3 floors in observation deck at top.

MARRIOTT RIVER CENTRE SAN ANTONIO

1988, 546 ft, 38 floors, 1000 room hotel.

WESTON CENTRE SAN ANTONIO

1989, 444 ft, 32 floors.

GRAND HYATT HOTEL SAN ANTONIO

2008, 424 ft, 34 floors, 1000 rooms.

<28>

BANK OF AMERICA DALLAS

1985, 921 ft, 74 floors.

RENAISSANCE TOWER DALLAS

1974, 886 ft, 56 floors.

COMMERCIAL BANK TOWER DALLAS

1987, 787 ft, 60 floors.

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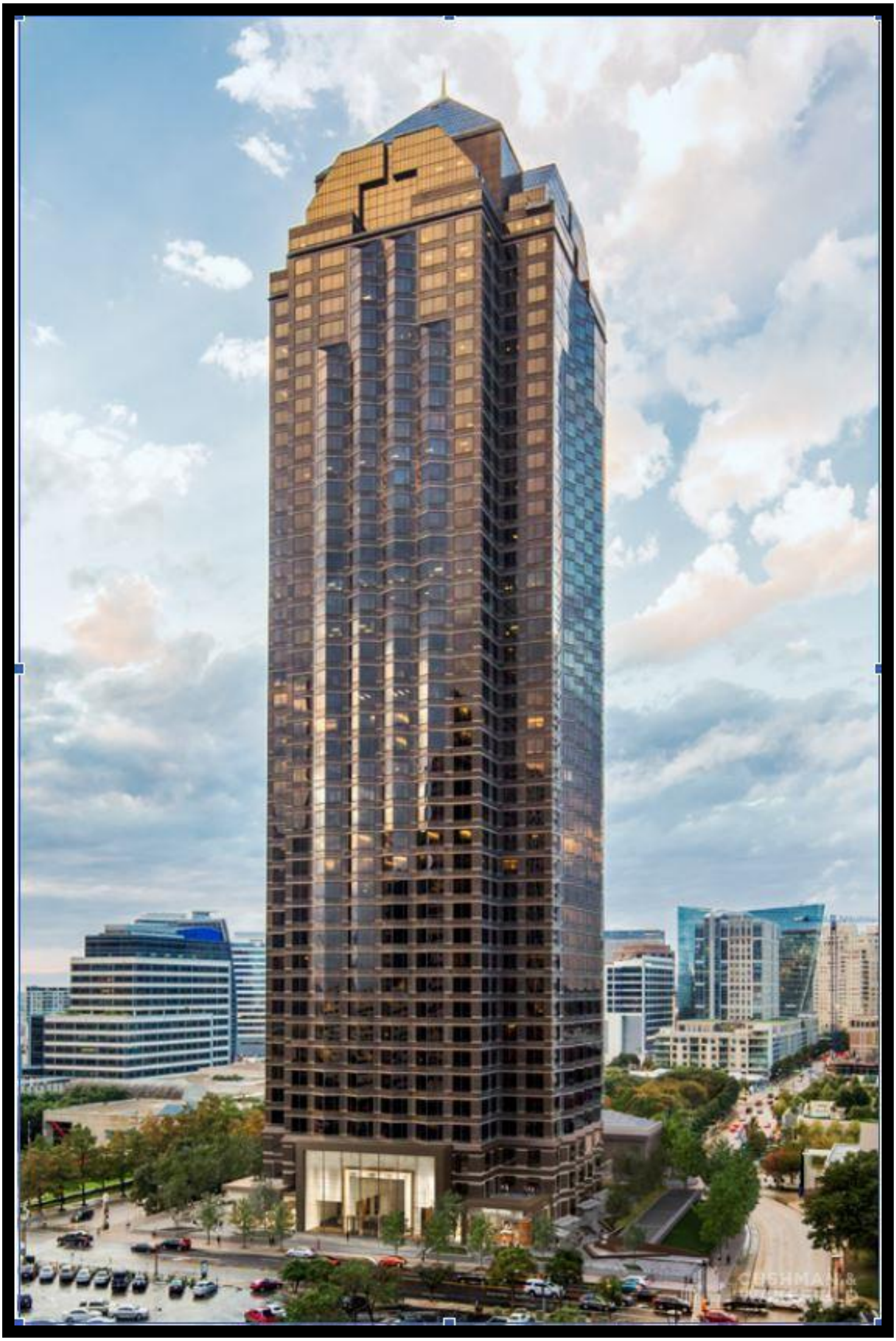
J.P. MORGAN CHASE TOWER DALLAS

1987, 738 ft, 55 floors.

FOUNTAIN PLAZA DALLAS

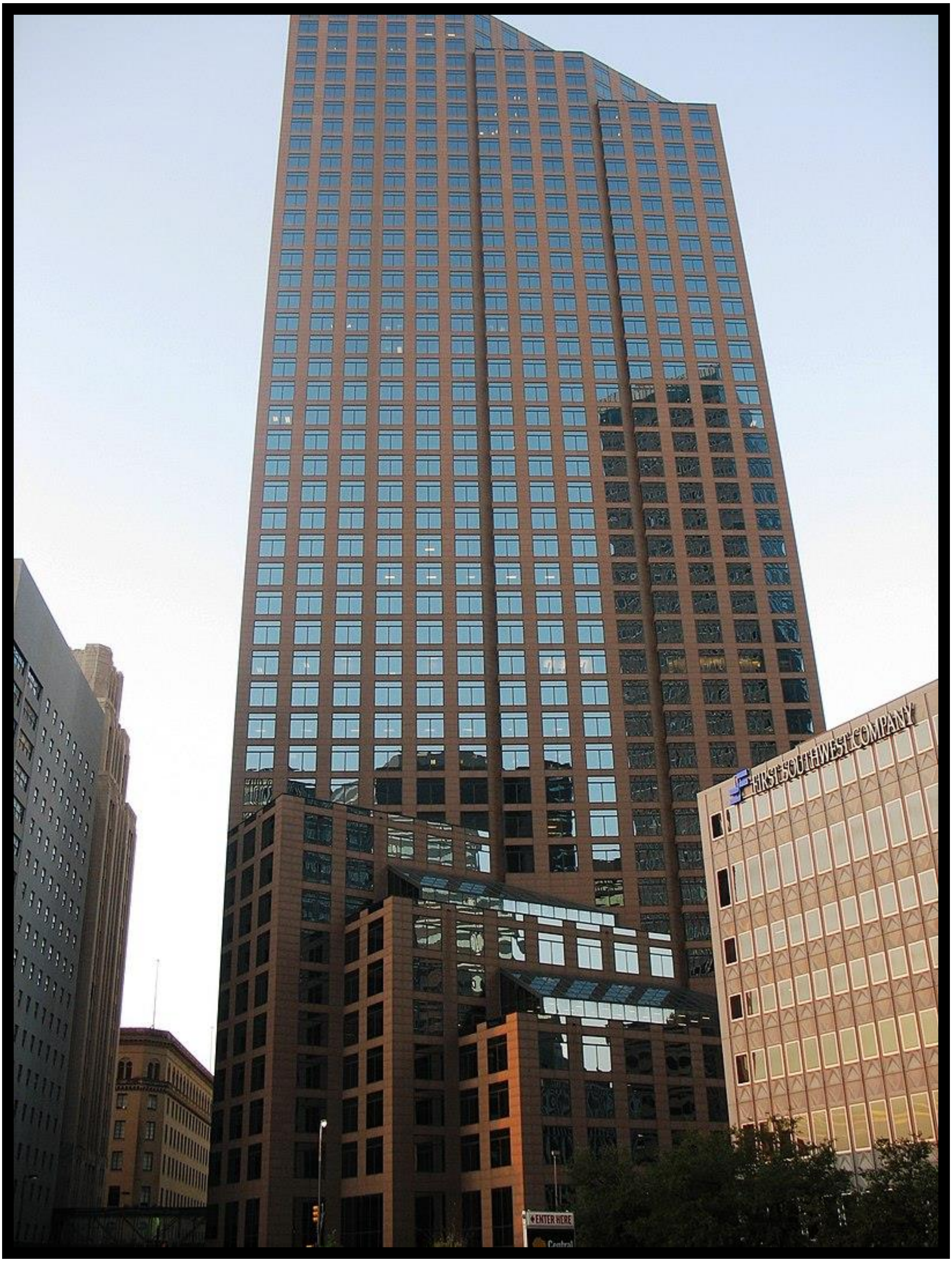
1986, 720 ft, 62 floors.

TRAMMELL CROW CENTRE DALLAS



1984, 686 ft, 50 floors.

1700 PACIFIC DALLAS



1983, 655 ft, 50 floors.

REUNION TOWER DALLAS

1978, 560 ft.

<36>

BURNETT PLAZA FORT WORTH

1983, 567 ft, 40 floors.

D.R. HORTON TOWER FORT WORTH

1984, 547 ft, 38 floors. Look-alike design to Wells Fargo Tower (p.39).

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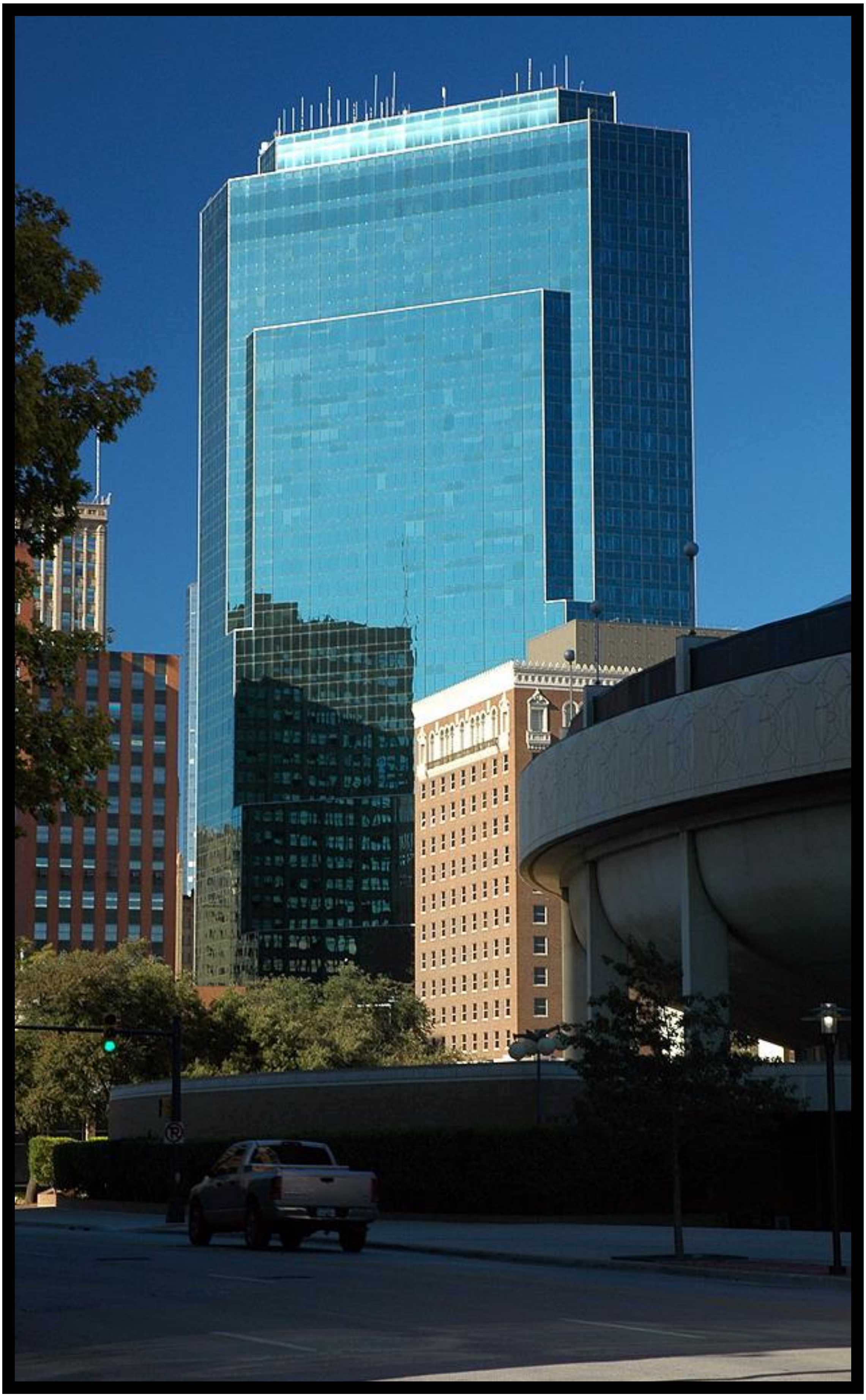
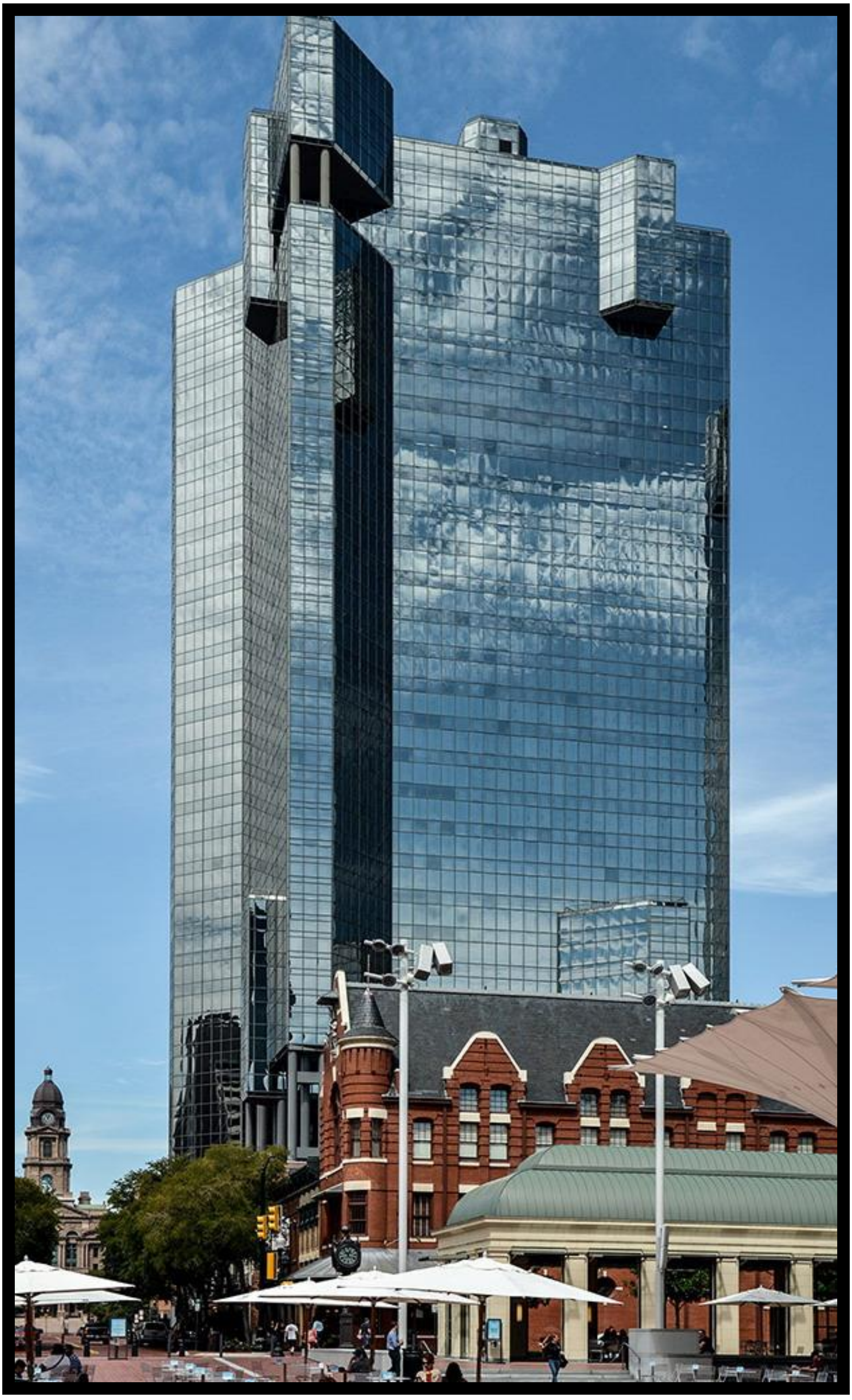
777 MAIN STREET FORT WORTH



1983, 525 ft, 40 floors.

WELLS FARGO TOWER FORT WORTH



1982, 477 ft, 31 floors. Look-alike design to D. R. Horton Tower (p.37).

THE INDEPENDENT AUSTIN

2019, 690 ft, 58 floors residential.

<41>

THE ASTONIAN AUSTIN

2010, 683 ft, 56 floors residential.

THE FAIRMONT AUSTIN

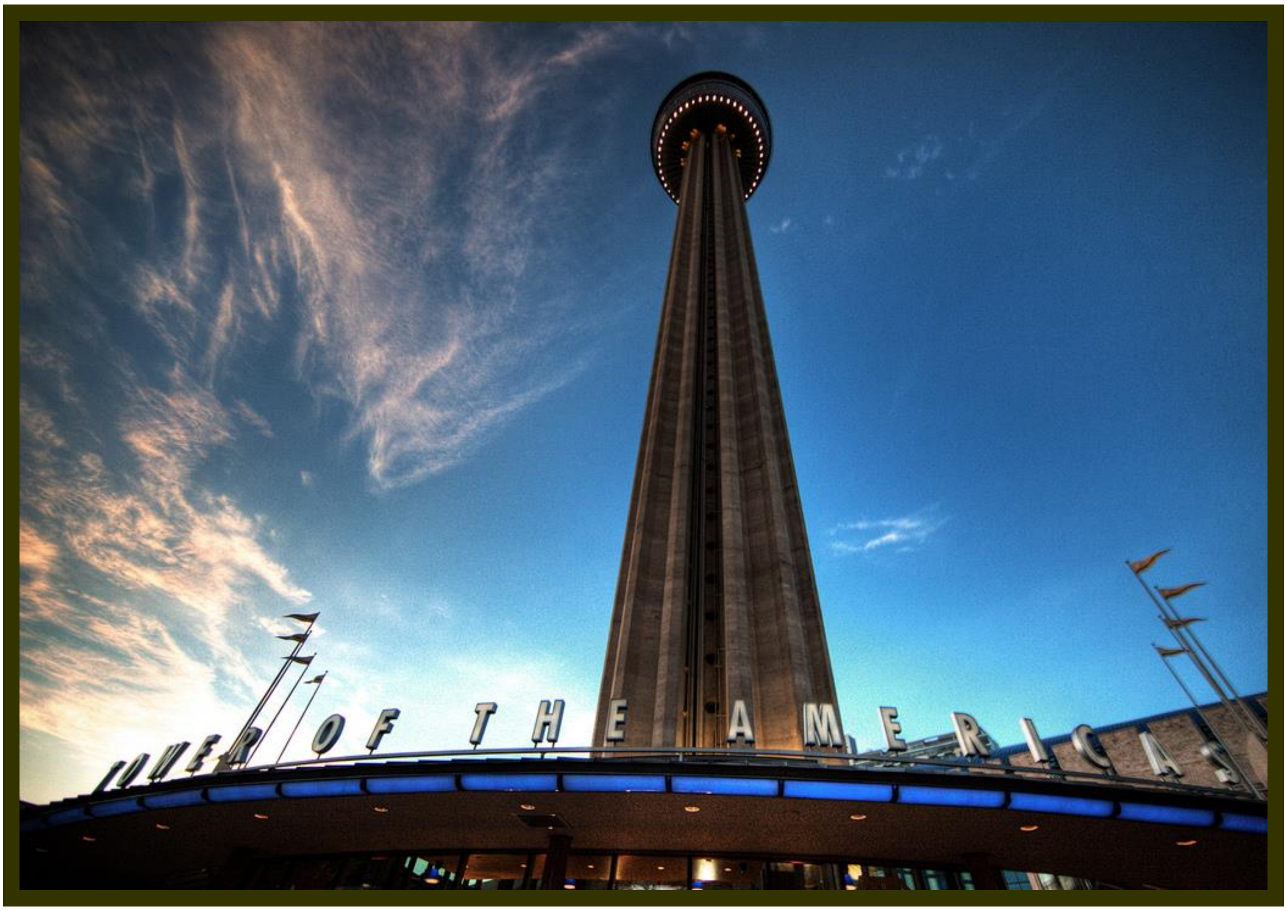
2018, 595 ft, 37 floors, hotel.

<43>

360 CONDOMINIUM AUSTIN

2008, 583 ft, 44 floors with 360 condominiums.

TOWER OF THE AMERICAS
SAN ANTONIO



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Illustrations & information has also been taken from Heritage Group Archive & Website and the Internet.