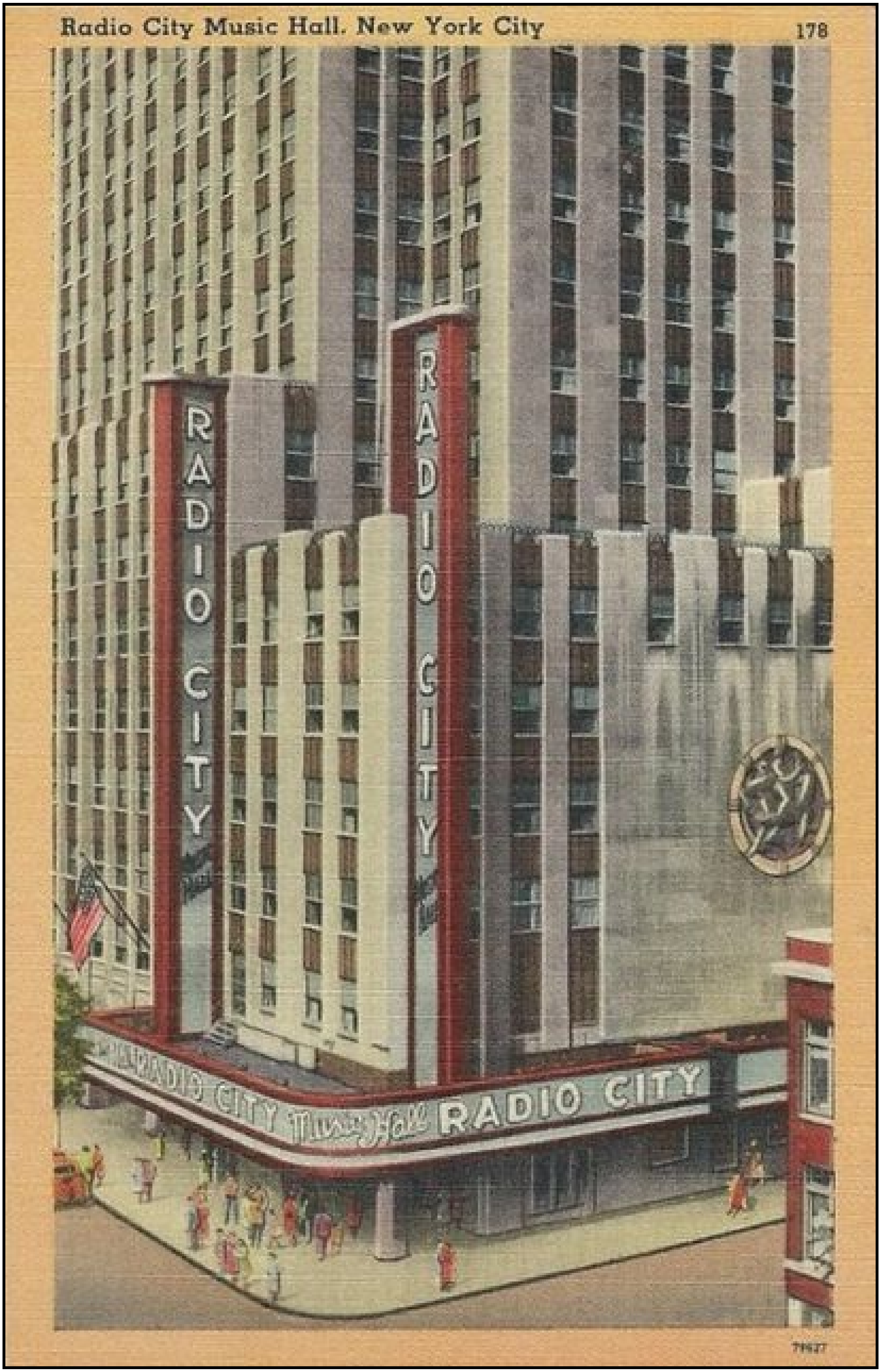
Air Conditioning American Movie Theatres 1917-1932

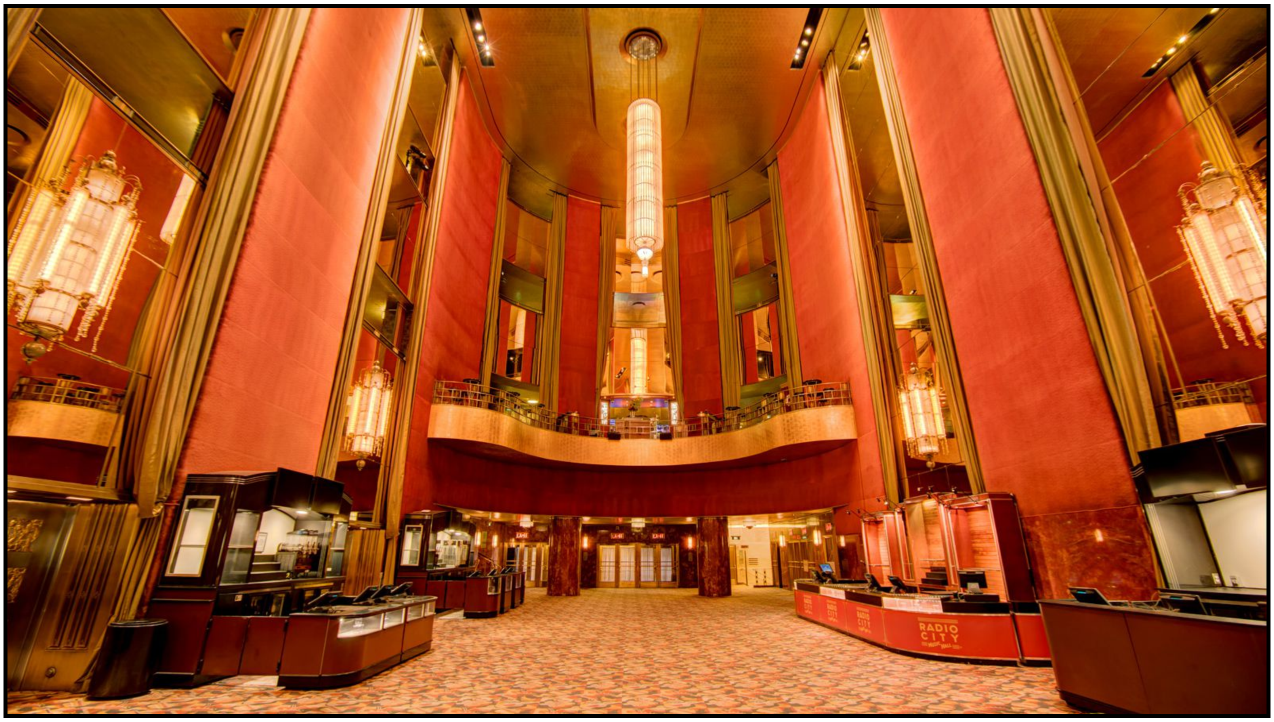
Radio City Music Hall

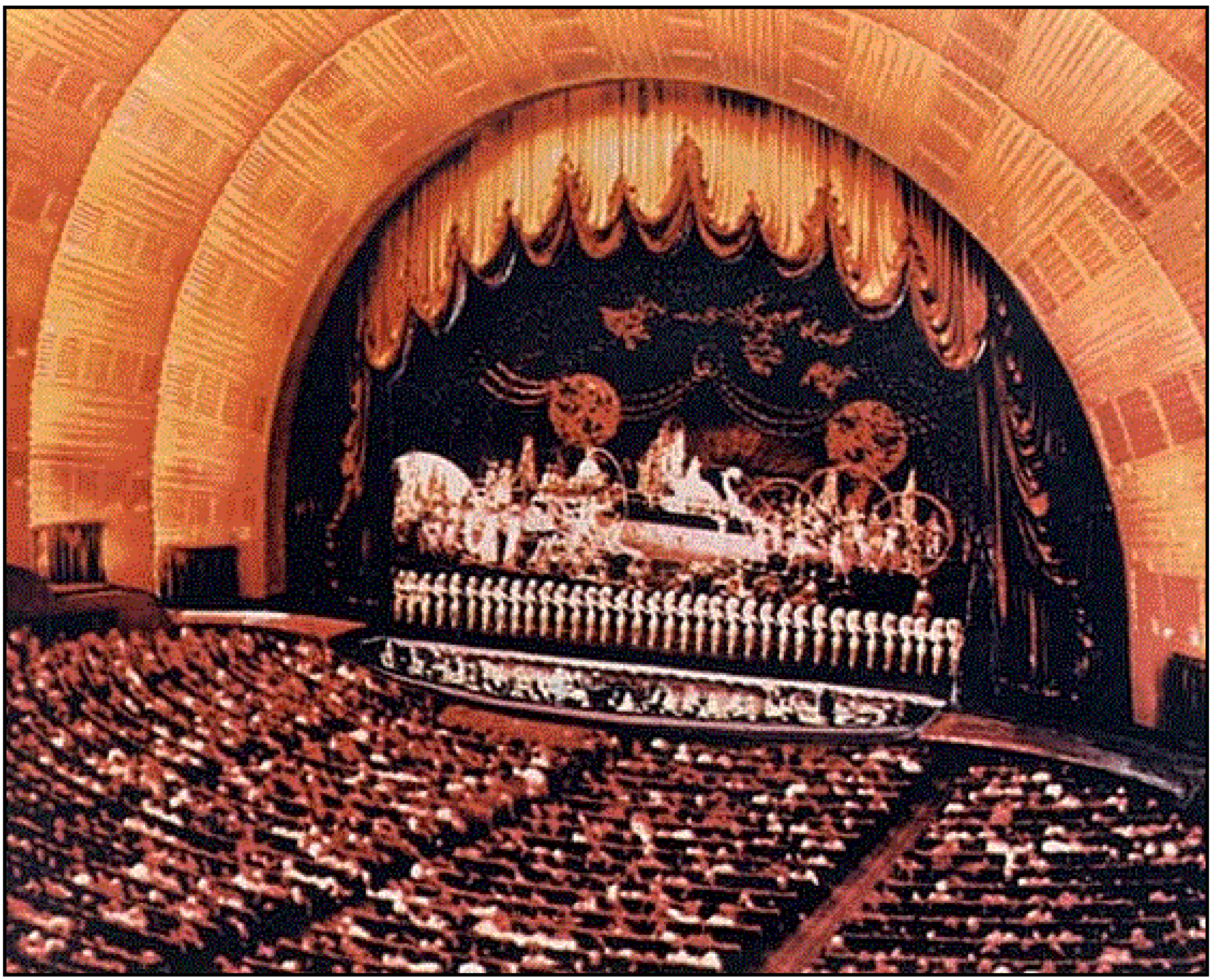
ROCKEFELLER CENTRE, NEW YORK

Date Opened: 27th December, 1932
Seating Capacity: 6000
Owner: Radio-Keith-Orpheum (RKO)
Architect: Raymond Hood (for Associated Architects)
Air Conditioning: Carrier Corporation
Refrigeration: Carrier centrifugal chillers


Radio City Music Hall. New York City
178
RADIO CITY
RADIO CITY
RADIO CITY
RADIO CITY Music Hall
79627


RADIO CITY
MUSIC HALL
RADIO CITY
MUSIC HALL
Music Hall RADIO CITY
Music Hall
EXPRESS
030-778

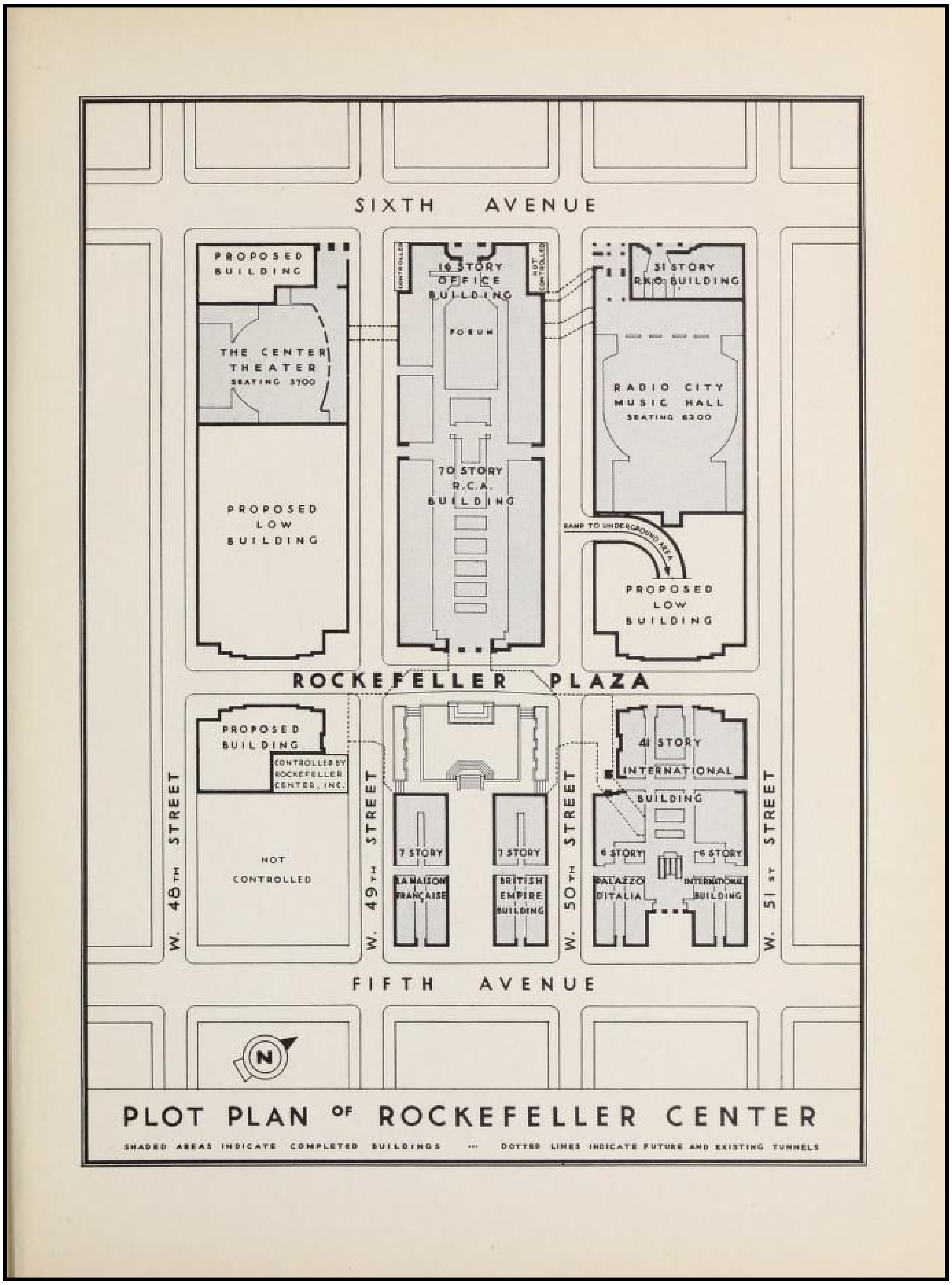

RADIO
CITY



Rockefeller Centre

The history of the Radio City Music Hall is inextricably linked with that of Rockefeller Centre. In 1928, the site's then-owner, Columbia University, leased the land to John D. Rockefeller who envisioned the construction of a new Metropolitan Opera building. This plan fell through.

Various plans were discussed before the Rockefeller family commissioned a complex of some one dozen buildings in Art Deco style which included a music hall and a 66-storey skyscraper, a sunken plaza and an ice-skating rink. One of the first buildings to be completed was the Music Hall which opened on 27th December, 1932, followed a few days later on 29th December by the Center Theater (which opened as the New RKO Roxy Theatre).

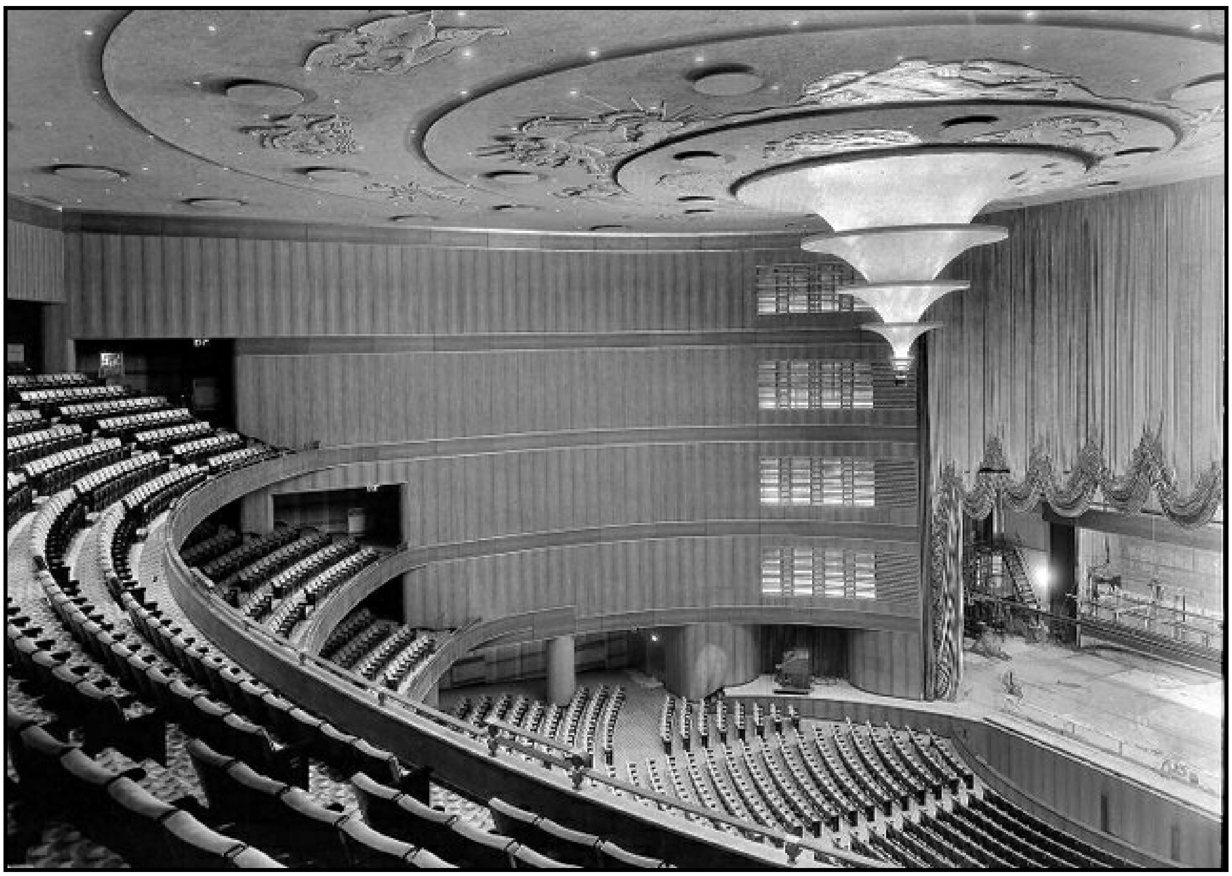


This plan of Rockefeller Centre shows Radio City Music Hall and the Center Theatre, located on opposite sides of the RCA Building

RCA Building, 1933

Center Theatre

ROCKEFELLER, NEW YORK



Date Opened: 29th December, 1932
Seating Capacity: 3510
Owner: Radio-Keith-Orpheum (RKO)
Architect: Raymond Hood (for Associated Architects)
Air Conditioning: Carrier Corporation
Refrigeration: Carrier centrifugal chillers

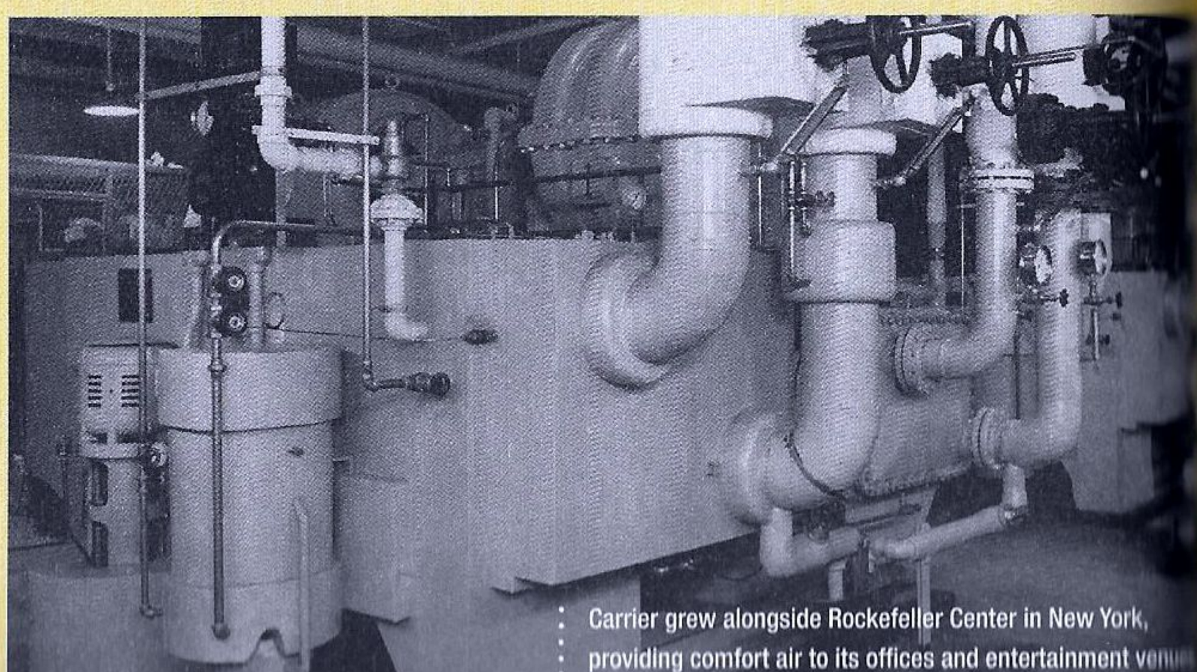

The CENTER Theatre
The CENTER Theatre
The CENTER Theatre
SONJA HENIE AND ARTHUR M WIRTZ PRESENT
A BIG MUSICAL "HATS OFF TO ICE"
"HATS OFF TO ICE"
The CENTER Theatre
SONJA HENIE AND ARTHUR M WIRTZ PRESENT
A MUSICAL "HATS OFF TO ICE" NOW PLAYING
CENTER

Three Million Pounds of Ice for Rockefeller Center

Carrier's November 1932 agreement to air condition the RCA Building at Rockefeller Center in New York City was the largest air-conditioning contract booked to that time, and people were dazzled by the size and scope of the project.

The RCA Building rose 70 stories over the Center and required air conditioning equivalent to three million pounds of melting ice a day. In hot weather, dehumidifiers removed 700 gallons of water from the air every hour. "Two batteries of great centrifugal refrigerating units will take care of the areas to be air-conditioned," the *New York Daily Investment News* reported. "One battery will serve the nine studio floors to be occupied by the National Broadcasting Company." The system also included state-of-the-art silencing equipment, and air filters to rid offices of dust. Each of NBC's 27 studios operated on its own system.

Carrier management proudly noted that this was the third project to be awarded the company in Rockefeller Center, having won two contracts the previous spring to air condition the 6,000-seat International Music Hall and the new R.K.O. Roxy Theatre.



Carrier grew alongside Rockefeller Center in New York, providing comfort air to its offices and entertainment venu

ROCKEFELLER CENTRE:
RADIO CITY MUSIC HALL & CENTER THEATRES

The Carrier advertisement (previous page) quotes the capacity of the refrigeration plant for one of the first phases of the construction of the Rockefeller Centre as equivalent to three million pounds of melting ice, which equates to 1500 TR.

The advertisement also refers to Carrier refrigeration installations for the Radio City Music Hall and Center Theatres but the capacity of the centrifugal water chillers is not given. Refrigeration plant installed in the nearby Roxy Theatre in 1926 comprised two Carrier machines providing 420 TR. The Roxy and the Radio City Music Hall had similar seating provision, about 6000 patrons. However, the Music Hall is said to be the largest movie theatre ever built, and an assumption is that the refrigeration capacity was between 500 and 600 TR (discounting any standby provision).

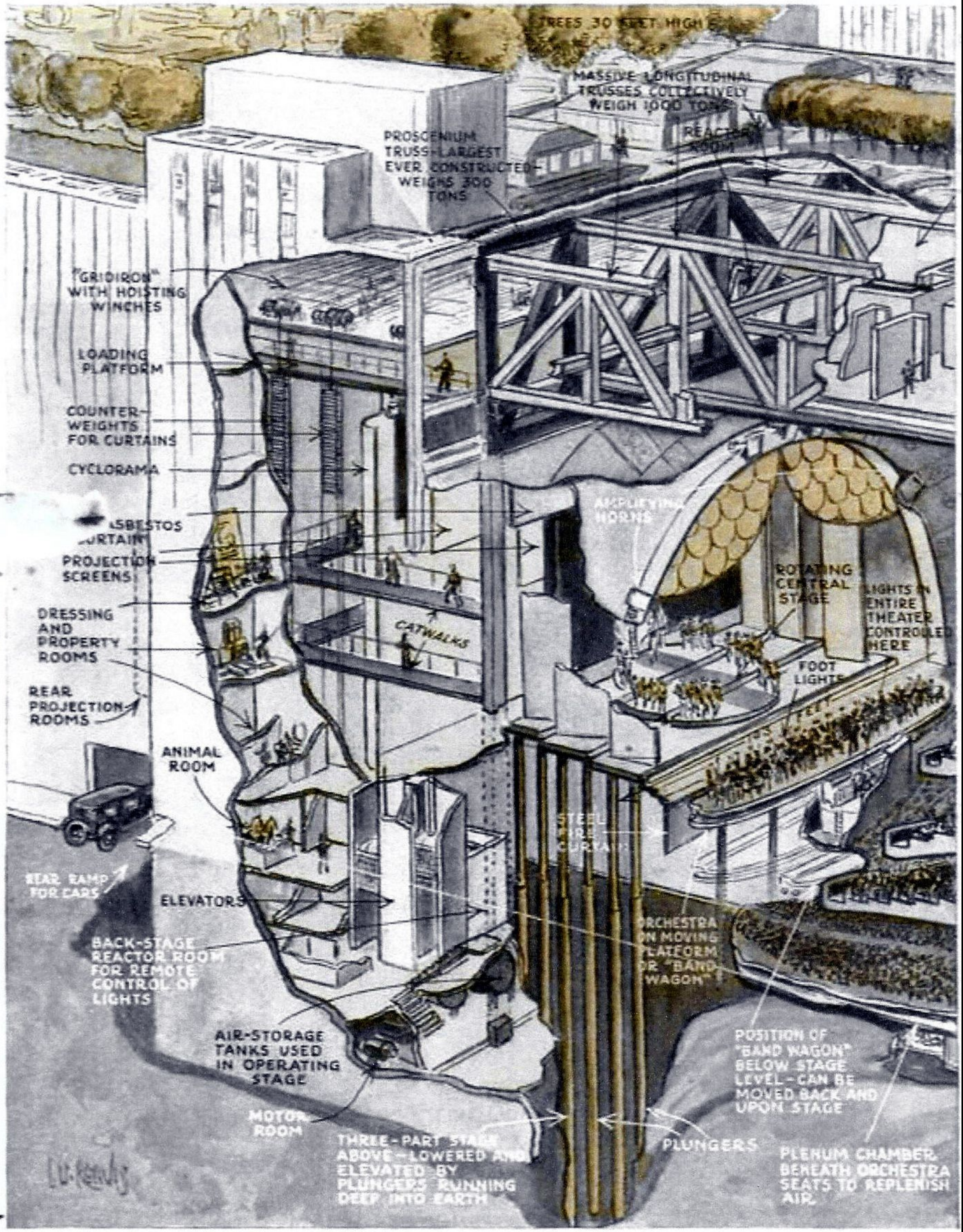
A history of the Music Hall reads:

> Apertures in the ceiling help provide the Music Hall patrons with a luxury that was a marvel of modern technology in 1932: air conditioning. The cooled air, forty cubic feet of it a minute for each patron in the theater, falls in a uniform blanket over the audience. The air is withdrawn through triangular outlets under the seats, and the recirculating process keeps the air purified even though smoking is permitted in the mezzanines.

With a seating capacity of 6000 this results in a supply air volume of 240,000 ft3/min. At typical New York design conditions and assuming 10 ft3/min of fresh air per person an estimate of the cooling load is some 600 TR. Using similar assumptions for the smaller 3500 seat Center Theatre gives about 300 TR. Actual refrigeration capacities have not been discovered.

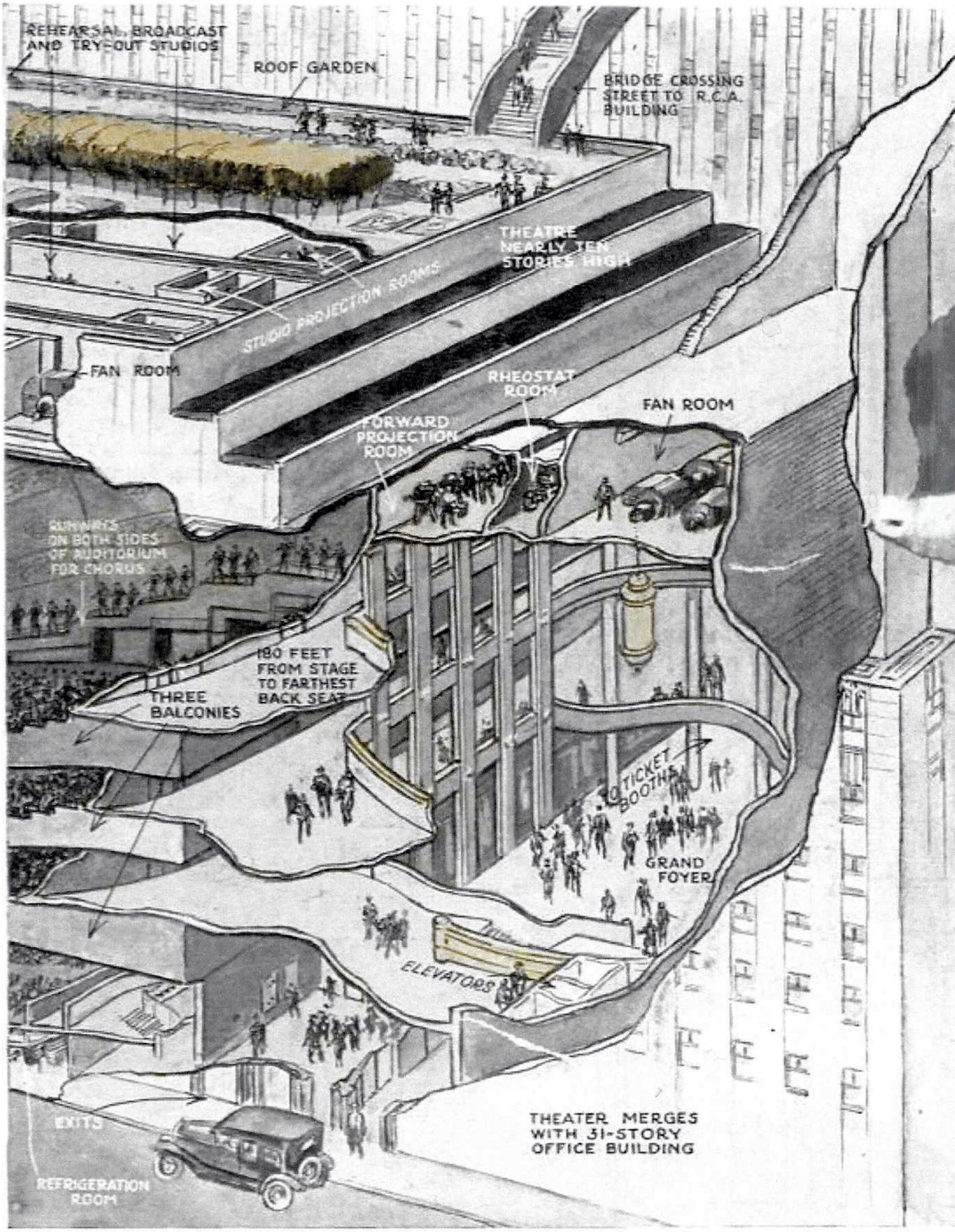
The diagrams on the following two pages are cut-away views of the Radio City Music Hall. The second of these views (noted as page 253) shows two fan rooms (one left, one right, about three-quarters from bottom of page) with a refrigeration room (bottom left corner).

World's Largest Theater in Rockefeller



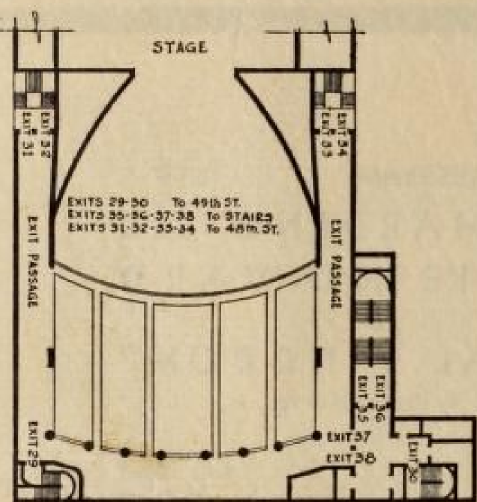
Sectional Drawing of International Music Hall under Construction at Rockefeller Center in New York; It is Nearly Ten Stories High and Will Seat Over 6,100 P[illegible]ns

Center Will Seat Six Thousand Persons

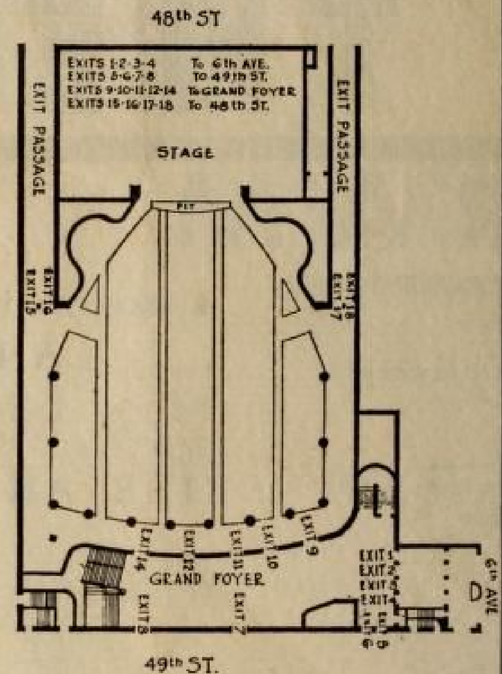


Note Revolving Central Stage and "Band Wagon" on Which Orchestra Can Be Moved from Position in Front to Place on Stage; the Stage, in Triplicate, Can Be Elevated Thirty-Two Feet

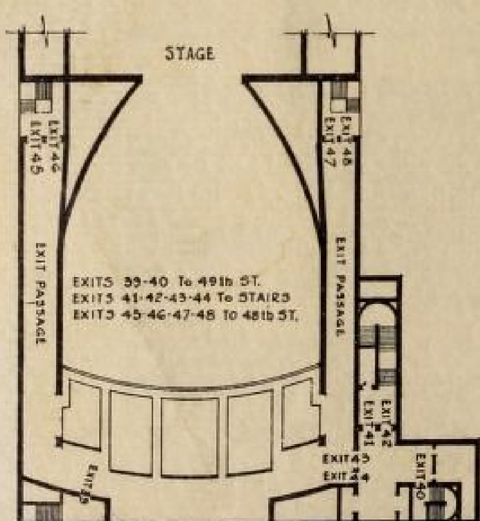
· ROXY THEATRE ·
· EXITS FROM SECOND MEZZANINE ·



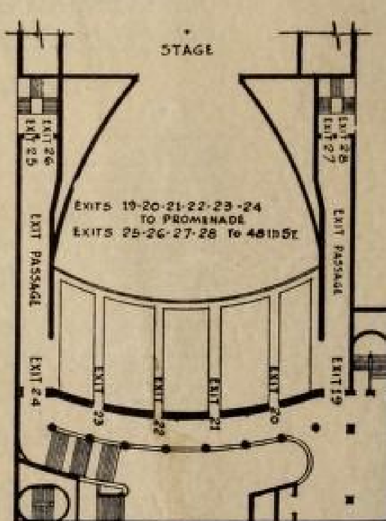
· ROXY THEATRE ·
· EXITS FROM ORCHESTRA ·



· ROXY THEATRE ·
· EXITS FROM THIRD MEZZANINE ·



· ROXY THEATRE ·
· EXITS FROM FIRST MEZZANINE ·



FIRE NOTICE

Look around NOW and choose the nearest exit to your seat. In case of fire walk (not run) to that exit. Do not try to beat your neighbor to the street.

JOHN J. DORMAN, *Fire Commissioner*

PROSPECT PRESS, INC.

Crowds who have just seen a performance at the Radio City Music Hall are pouring out to the Grand Foyer of the world's largest theatre. In the background can be seen the massive chandeliers and the famous Ezra Winter mural titled "The Author of Life."

Courtesy - Radio City Music Hall
Photo - Cosmo Sileo Co.


RADIO CITY
RADIO CITY

POSTSCRIPT

Rockefeller Centre Refrigeration Upgrade and Energy Storage

HPAC ENGINEERING, September 2012

Iconic New York City Property Kept Cool With Help of Energy-Storage Technology

Energy efficiency improved and energy costs lowered

Rockefeller Center in midtown Manhattan is one of the most recognized commercial properties in the world. Built during the Art Deco period of the early 1930s, the 10-building real-estate, shopping, and dining complex, which encompasses six square blocks and consists of approximately 8 million sq ft of rentable space, is home to NBC studios, Radio City Music Hall, and perhaps the world's most famous ice-skating rink and Christmas tree.

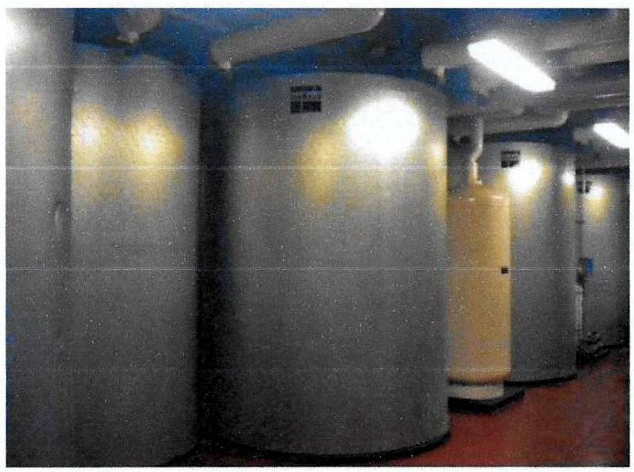
The buildings of Rockefeller Center are served by a central chilled-water plant containing 14,500 tons of steam and electric chillers. Water is distributed through a primary water loop around the perimeter of the site. Six primary pumps—four with 6,000-gpm capacity at 125 hp and two with 2,000-gpm capacity at 50 hp—are located in the main plant. Seventeen primary chilled-water riser pumps, which range in size from 1,000 gpm at 40 hp to 3,500 gpm at 200 hp, send chilled water to heat exchangers located in each building. The secondary sides of the heat exchangers have pumps that serve air handlers and fan coils that serve tenant spaces.

Traditionally, one of the biggest challenges had been supplying chilled water at a temperature and flow satisfying tenant-comfort and lease requirements in all buildings throughout the year. While the supply and pumping capacity always had met requirements, co-owner and manager Tishman Speyer sought a way to deliver the water more efficiently and lower overall energy costs.

Storing Energy Is the Answer

After learning of the successful application of thermal storage in buildings throughout New York, Joseph Szabo, managing director of operations for Tishman Speyer, asked Fred Limpert of Trane and Mark MacCracken of CALMAC to determine the feasibility of applying Trane high-efficiency electric chillers and CALMAC ice-storage technology.

Trane and CALMAC spent the subsequent weeks investigating the financial and efficiency benefits of applying thermal-storage technology in Rockefeller Center.


CALMAC IceBank energy-storage tanks installed at Rockefeller Center.

Instead of meeting summer peak demand with a single electric chiller, Tishman Speyer elected to install an ice-making chiller sized to provide 8,600 ton-hours of energy storage. Especially during peak-demand periods, the ice-storage tanks are used instead of the electric chiller, keeping electricity demand as low as possible.

An additional benefit of the energy storage is greater operational flexibility. The stored cooling can be used as needed from a couple of hours to several hours to optimize plant efficiency while keeping demand and cooling costs low.

Because of the expansive footprint of the Rockefeller Center site, a number of locations were considered for a thermal-energy-storage plant. The optimal location was determined to be away from the main plant, on the opposite side of the property. This shifted the burden of pumping chilled water from the main plant to the outer buildings. As ice melt, or "burn," enters the primary chilled-water loop, variable-frequency drives on the main plant's primary chilled-water pumps can be ramped down.

Plant operators are able to run the primary chilled-water pumps at lower amperage levels. During summer, with ice burning during peak-demand periods (usually, noon to 6 p.m.), only one of the three chillers runs. (Typical burn times are 8 hr during summer and 15 hr during winter.) During winter, when cooling loads are low, operators can get by with only running the ice-making chiller at night—no chillers need to run during the day.

"The ice plant has provided a level of operational flexibility that has allowed my engineering staff to make intelligent decisions at any point in time that ensures we are able to balance tenant comfort with plant operational efficiency," Szabo said. "The thermal-energy-storage installation has simplified plant operations, and we no longer have to make those tough, on-the-spot decisions as to when and if to turn on chillers in the main plant. Turning on chillers of this size can result in large electrical-demand cost penalties, especially in New York City, which has a high-electrical-demand utility rate structure."

Ice = Frozen Assets

As Tishman Speyer began incorporating the energy-storage plant into its overall HVAC strategy at Rockefeller Center, it began to see a positive ripple effect on all aspects of the plant's operation. While there was an immediate benefit in allowing plant operators to shift cooling loads, there was an added benefit in allowing plant operators to use the rate of burn to meet the needs of the buildings. Burn rate can be adjusted from four hours to 10 hours as needed, based on plant conditions.

Prior to the energy-storage plant, on peak cooling days, building engineers would run one 4,000-ton steam-turbine chiller, one 4,000-ton electric chiller, and one 2,500-ton electric chiller. Incorporating ice burn into the operation of the main plant allowed Tishman Speyer to avoid putting the 2,500-ton electric chiller online.

"Not only does the ice-storage refrigeration plant provide 'banked' cooling capacity for peak-demand periods during the day, it also increases your operational flexibilities to the assets during spring and fall seasons, when you can side-stream the ice reserve with smaller refrigeration machines to reduce your overall demand in shoulder months," Szabo said.

The installation of a thermal-energy-storage system has improved the energy efficiency of Rockefeller Center and lowered overall energy costs.

Conclusion

Ice storage can be used for a variety of applications, from schools and hospitals to commercial office buildings and retail establishments. System design takes into account the number of chillers and tanks a building has, how often the chillers and tanks are online, if operators are needed, building size and use, and more.

While the operating staff at Rockefeller Center utilizes an ice chiller at night and a partial-storage strategy during the day, the staff at another building may utilize an ice chiller in conjunction with ice tanks to provide cooling during the day. Each installation is different, but for each, ice storage works to reduce cooling costs and peak electricity demand.

Information and photograph courtesy of CALMAC.

Circle 100

See also under **Technical Note 3**