Title: **The Post-Crisis Tall Building**

Authors:

Subjects: Building Case Study
COVID
Occupancy/Lifestyle/User Experience
Social Issues

Keywords: COVID-19
Life Safety
Pandemic
Public Health

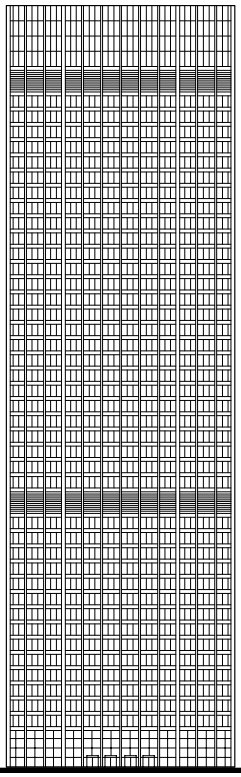
Publication Date: 2020

Original Publication: CTBUH Journal 2020 Issue IV

Paper Type:
1. Book chapter/Part chapter
2. **Journal paper**
3. Conference proceeding
4. Unpublished conference paper
5. Magazine article
6. Unpublished

The Post-Crisis Tall Building

This data study proposes a "generic" 200-meter office building, located in Chicago, displaying several key modifications that could take place if certain indicative public-health restrictions were implemented. This graphic should be read in conjunction with the research paper "Towards Post-Crisis Tall Buildings and Cities" (pages 12–21), which goes into greater detail on how the figures presented here were generated.



Example Building

Data inputs from CTBUH.org

- Height: 200 meters
- Function: Office
- Building lifespan: 41 years
- Number of floors
  - 43 floors above ground
  - 1 floor below ground
- Total gross floor area: 103,200 m^2
- Total net internal area: 74,132 m^2

Data inputs from considering case studies

- Structure
  - Reinforced concrete core
  - Steel columns
  - Composite floors
- Building core
  - Center core
  - 480 m^2 per floor
- Elevator banks (3 No.)
  - Floors 1–15
  - Floors 16–28
  - Floors 29–43
- Number of elevators: 18 cars, 14 passengers per car

Data inputs from research

- Whole building occupancy
  - Full (100%): 4,925 people
  - Partial (25%): 1,231 people
- Building density (occupancy): 14 m^2 per person
- Number of MEP floors: 2, at floors 15 and 43
- Internal climate set points
  - Temperature: 21°C
  - Humidity: 40%
- Workday: 8-hour workday (261 workdays per year)
- Ventilation: 1.33 fresh air changes per hour (ACH)
- Filter efficiency: MERV 8
- Breathing/Exhalation
  - 0.66 m^3/h breathing rate
  - 6.0 quanta/h exhalation rate

Notes:

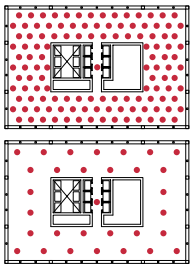
- Partial Lease: Area exclusive of corridors and common areas.
- Full Lease: Area includes entire floor plate to edge of elevators/core.
- Example Building based in Chicago, using Cook County, Illinois infection rates, taken 12 October 2020.
- Annual infection rates assumes micro-bacterial buildup and COVID infection rates remaining level, and building flushing periods are not practiced.

See Acknowledgments and References, "Towards Post-Crisis Tall Buildings and Cities," page 21.

Occupancy

For each workday, a Chicago office worker's chances of infection can be reduced if:

Building population is restricted to 25% occupancy.



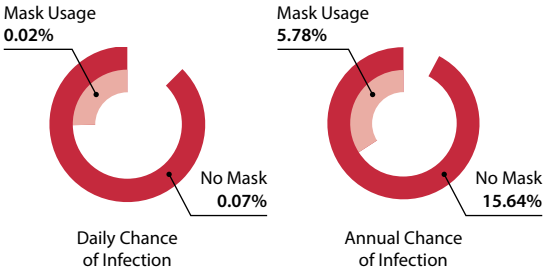
Pre-COVID: 123 People

- Daily chance of infection: 0.07%
- Annual chance of infection: 15.64%
- New people infected per year: 19

Post-COVID: 31 People

- Daily chance of infection: 0.02%
- Annual chance of infection: 4.10%
- New people infected per year: <1

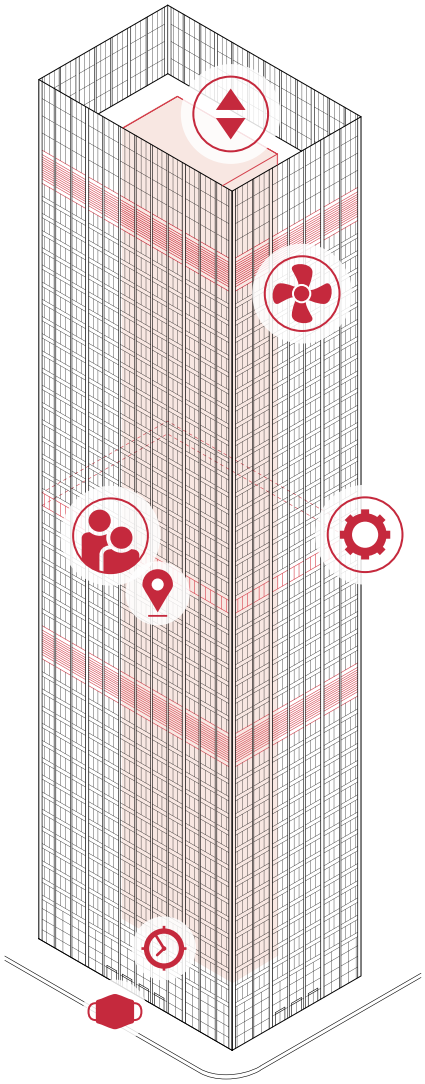
All employees are wearing a variety of masks at all times.



2,084 all-office buildings over 150 meters have been built or started construction since 1980.

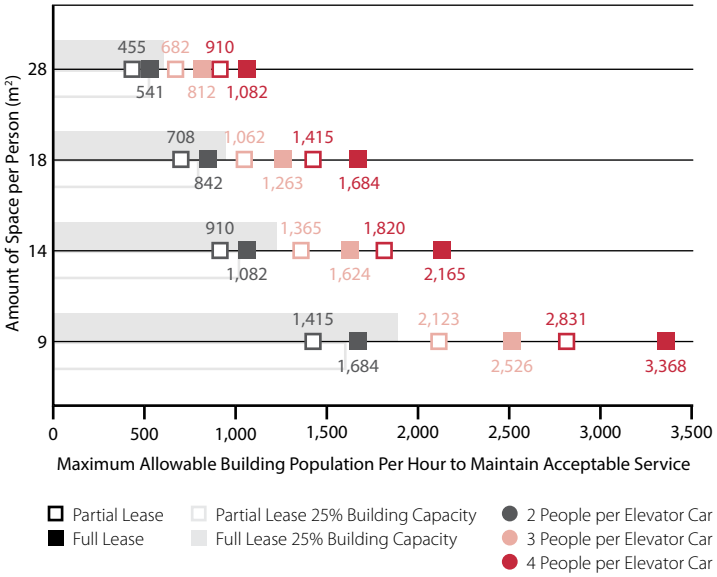
Increasing the proportion of **outside air from 20% to 90%** doubles the requirement for chilled water and for the amount of coolant coming from the chiller plant.

For capacity calculations, **elevators** are assumed to carry 65% of their rated load.



Elevators

In the example building, if **3 or more people can board elevators, then the building can support 1,231 people at 25% occupancy**, but 2 or fewer people per car would cause increased strain on the system and increased waiting times.



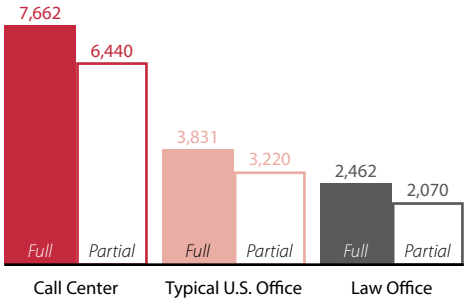
Staggering arrival times reduces lobby wait and ride times.

Peak Arrival Period	People per Car	Average Wait Time	Average Travel Time	Average Time to Destination
1 Hour	12–14	25.5 sec	48.0 sec	73.5 sec
2 Hours	4–5	15.0 sec	35.4 sec	50.4 sec
Difference	8–9 fewer people per elevator car per ride	(10.5 sec)	(12.6 sec)	(23.1 sec)

Based off analysis by Alan Taylor, HKA Elevator Consulting, of average travel times for Low-Rise, Mid-Rise, and Mid-High-Rise floors (0–46), serving a population of 2,340 people.

Occupant Function & Population

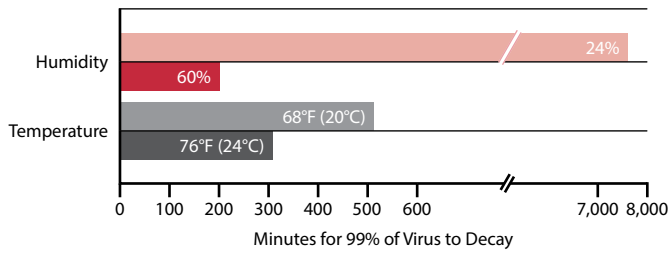
In identical tall buildings, the **population can change by over 300%** based on activity/industry.



HVAC

In a space with a **relative humidity of 60%, it could take only 200 minutes for 99% of the virus to decay**, compared to 7,600 minutes at 24% humidity.

In a space with a **temperature at 76°F (24°C) it could take only 303 minutes for 99% of the virus to decay**, compared to 510 minutes at 68°F (20°C).



Upgrading a building from MERV 8 filters to **MERV 13** filters could reduce the annual chance of infection from 15.64% to 9.38%.

Although higher humidity suppresses viral spread, exceeding 60% can cause **mold and condensation** issues in warmer climates.

Breathing at rest can emit 2.0 infectious doses (quanta) of pathogens per hour, while **light exercise and normal speaking** can produce 26.3 q/h.