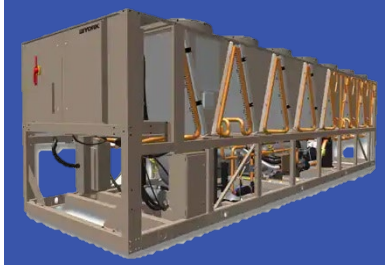
משב-ארדן מערכות
אנשים בונים הצלחה

# פעולת צ'ילר במשטר מהופך כאמצעי אפקטיבי לקירור בחינם

# Upside Down, Inverted Operation Chiller



# פעולת צ׳ילר במשטר מהופך כאמצעי אפקטיבי לקירור בחינם

- מונחים
  - מִגבָּה טמפרטורה- Temperature Lift
  - הִתקָרְבוּת- Approach / Small Temperature Difference

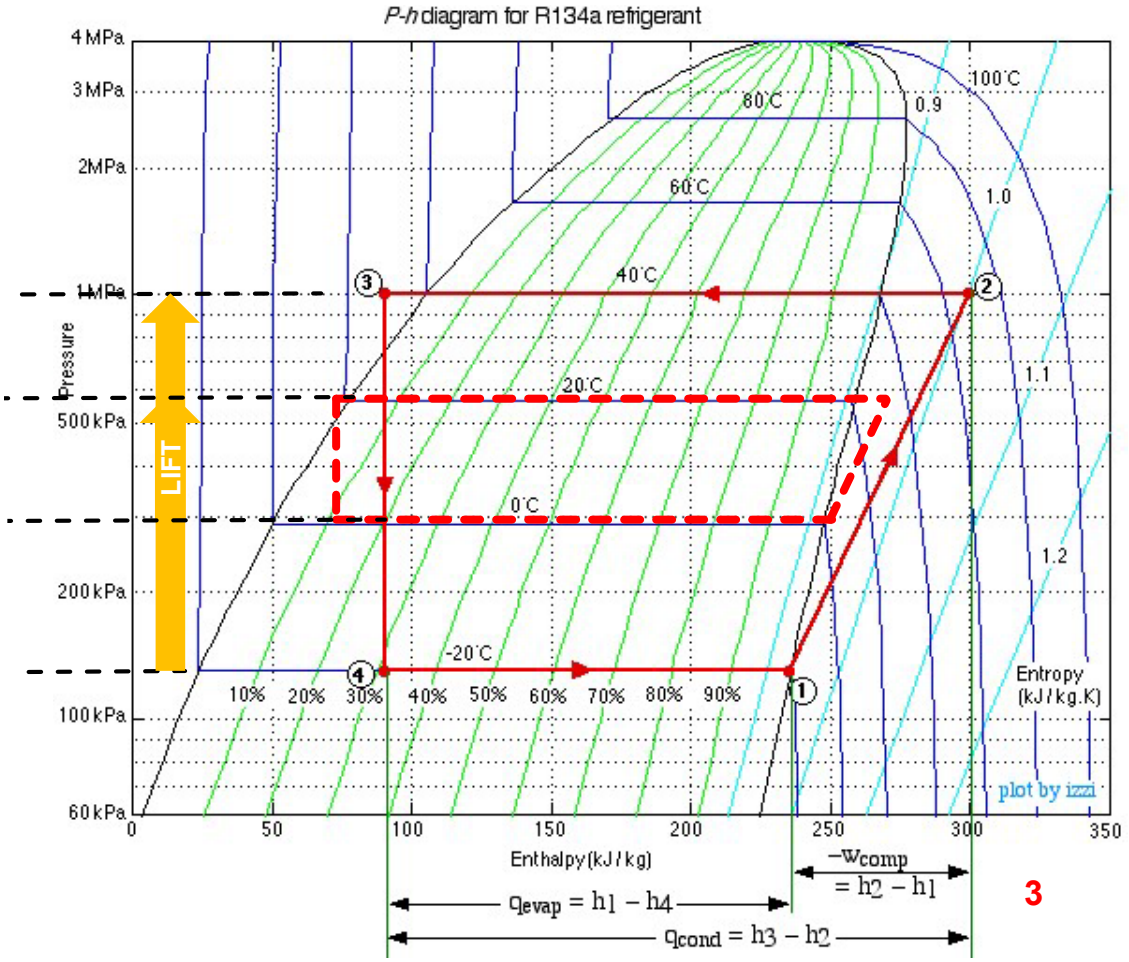
# מִגבֶּה טמפרטורה במחזור קירור בסיסי

$$COP = Q_{evap} / W_{comp}$$

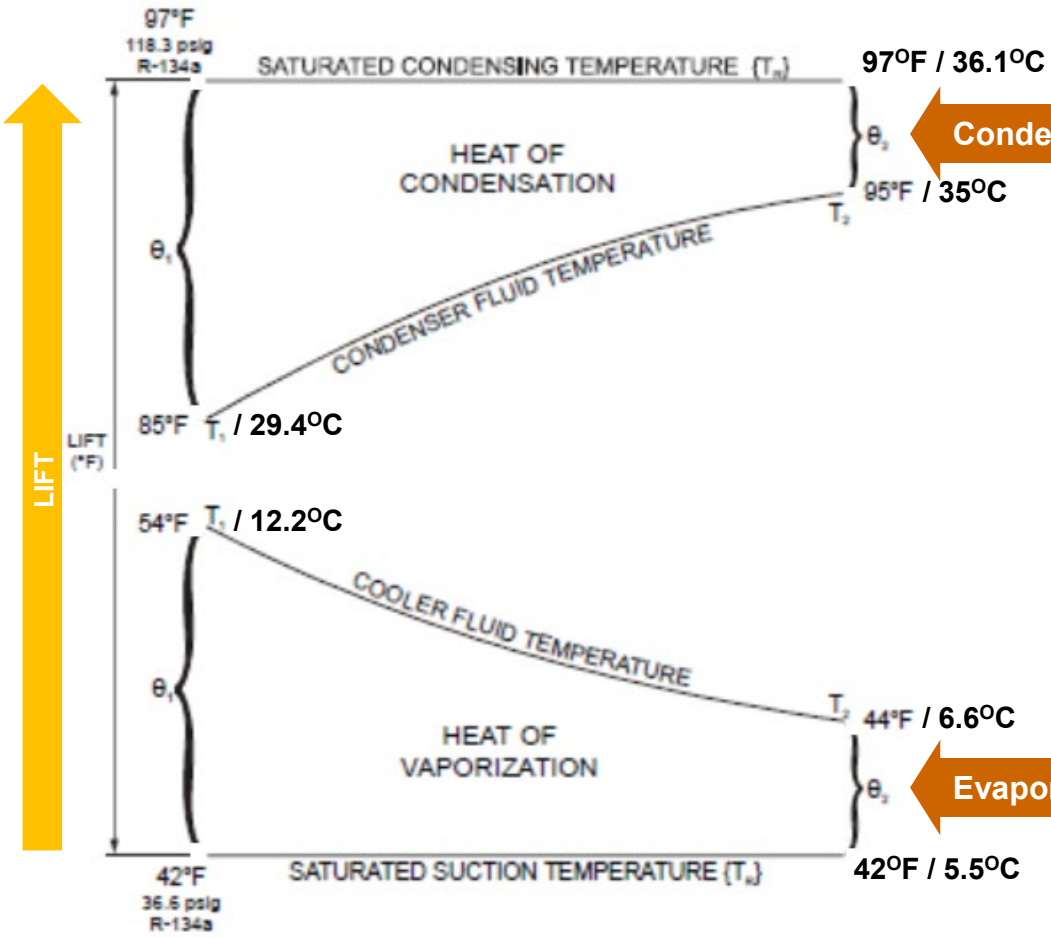
$$COP_2 > COP_1$$

Refrigerant Condensing Temperature

Refrigerant Evaporating Temperature



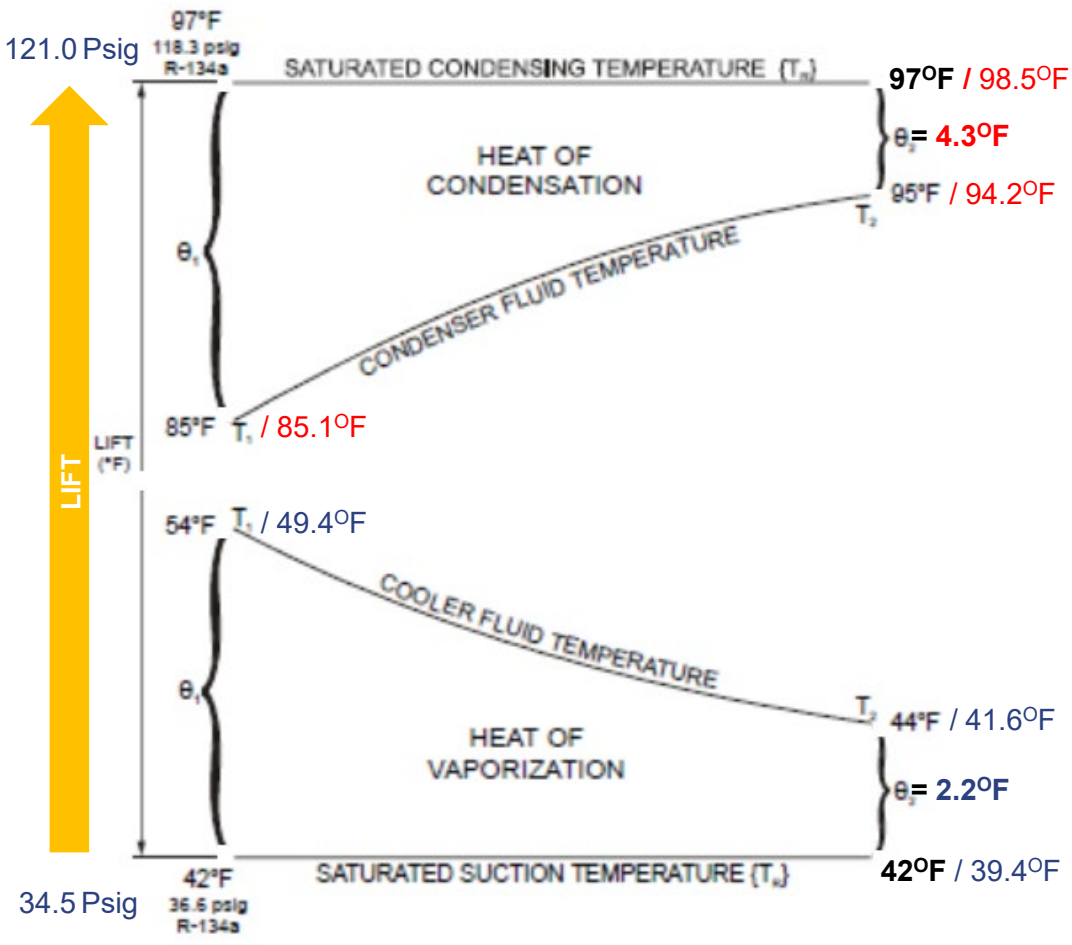
# מִגבָּה טמפרטורה ושיעורי הִתקָרְבוּת בצ׳יללר

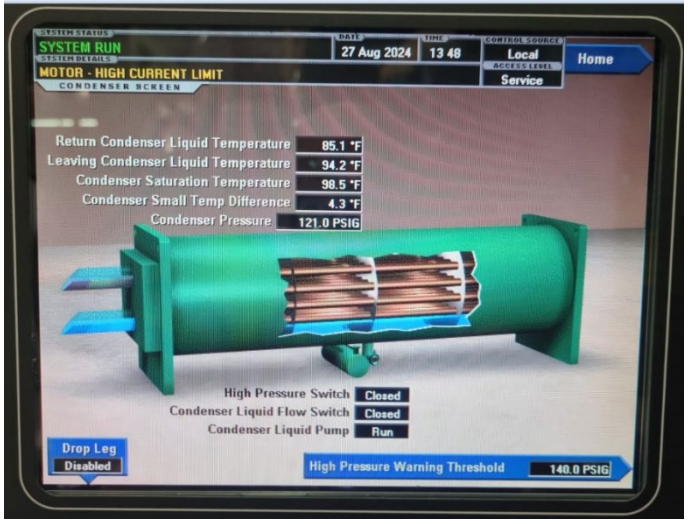


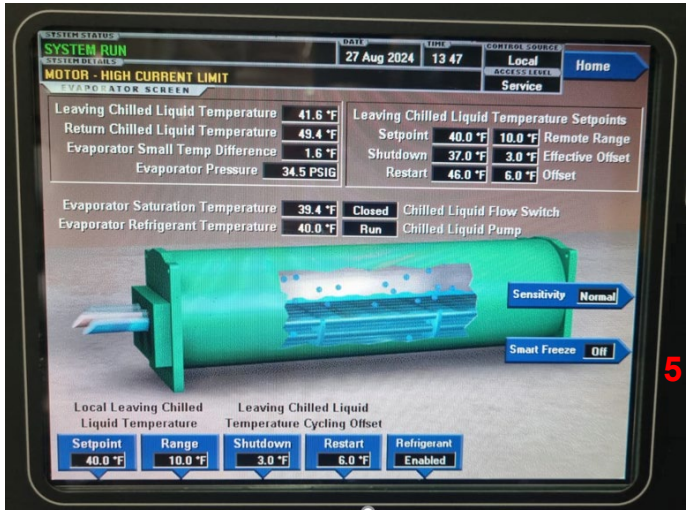

**Condenser Small Temperature Difference / Approach**

**Evaporator Small Temperature Difference / Approach**

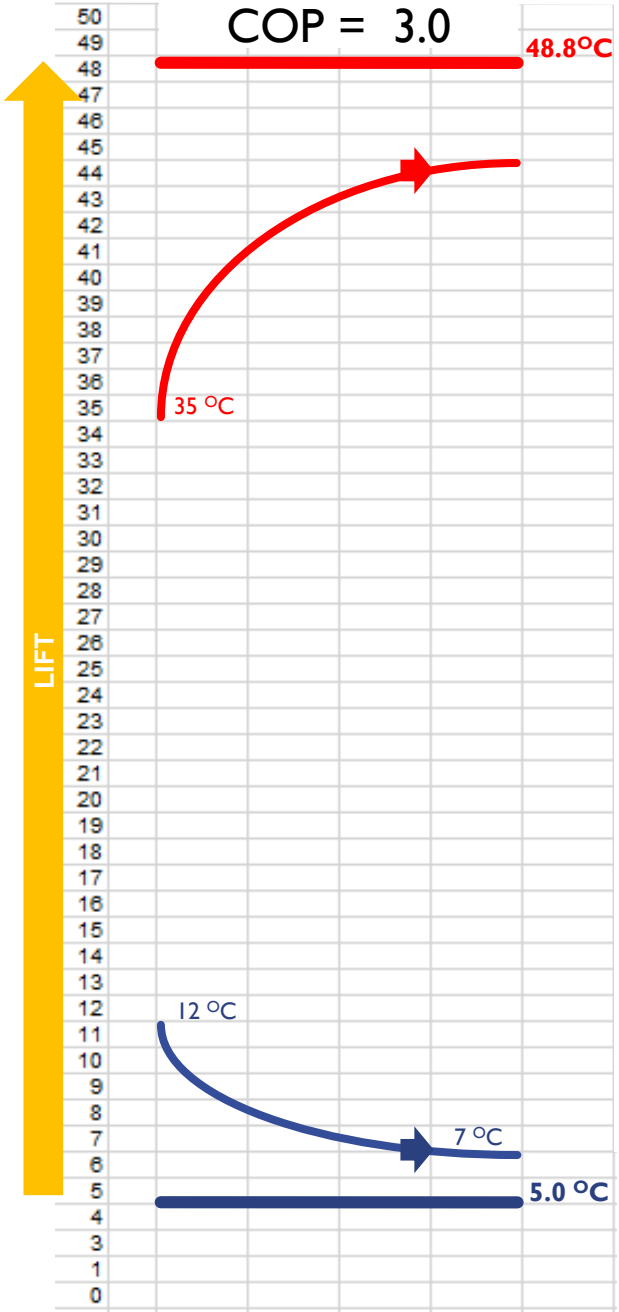
# מִגבָּה טמפרטורה ושיעורי הִתקָרְבוּת בצ׳ילר

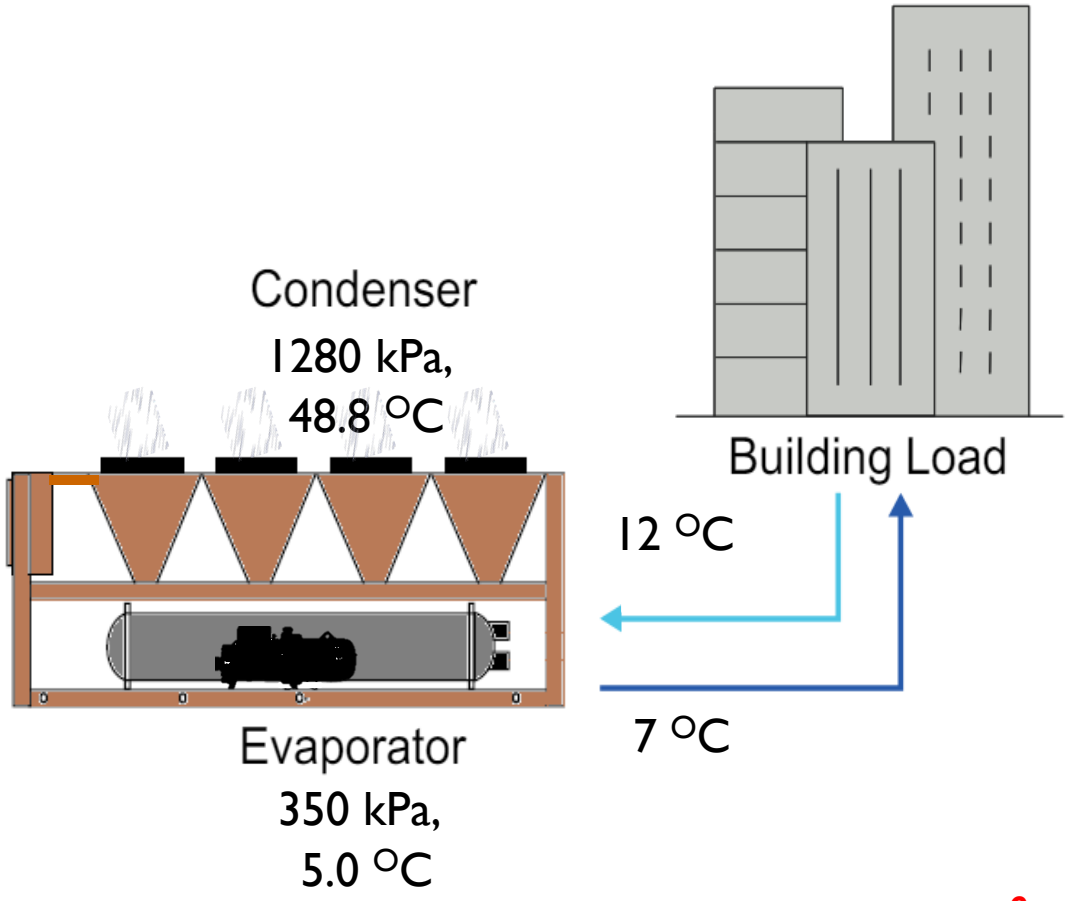


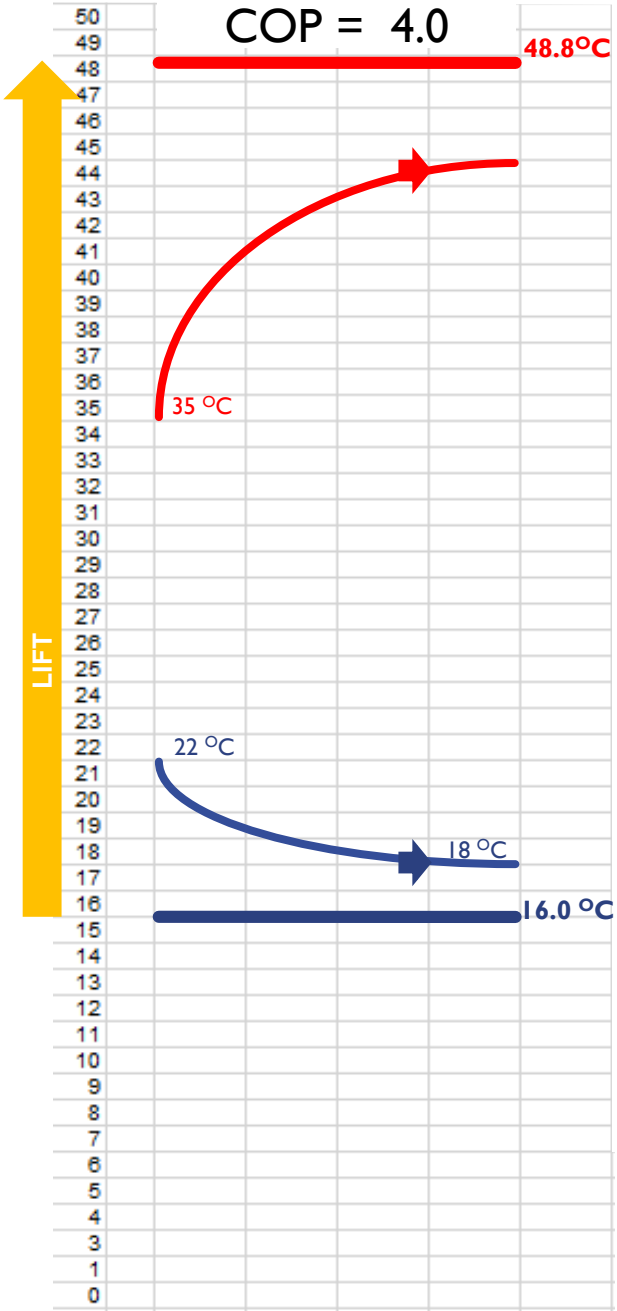



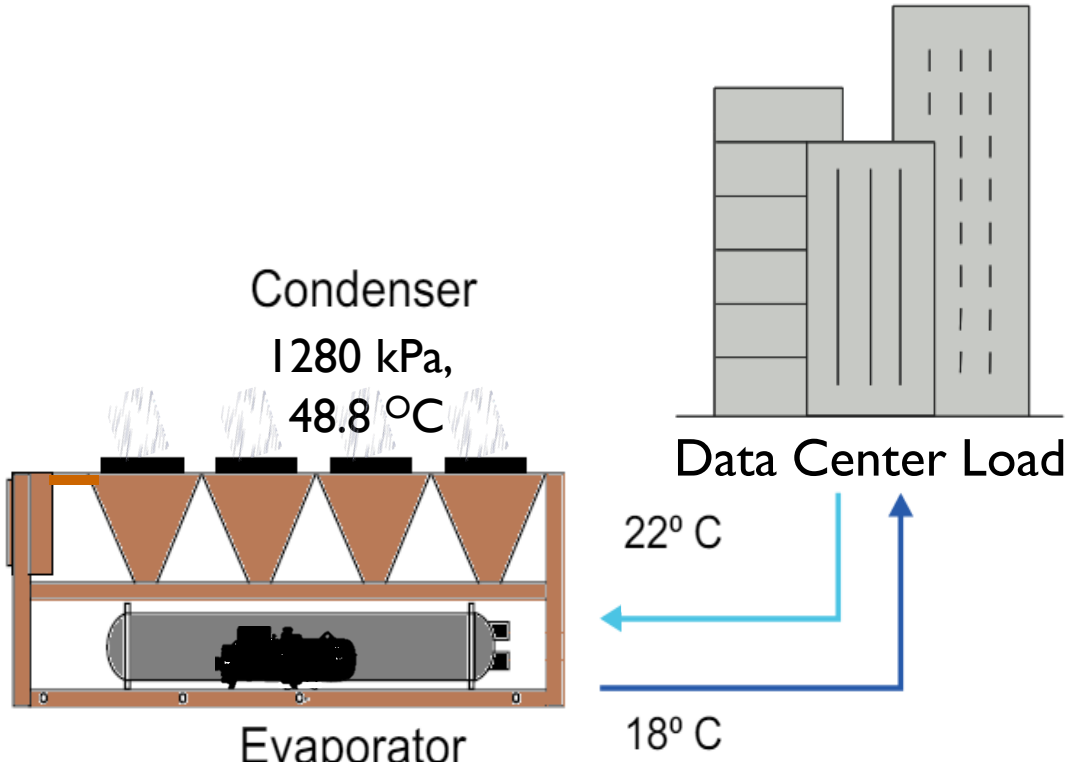
# AIR COOLED CHILLER
# BUILDING LOAD NORMAL OPERATION



# AIR COOLED CHILLER
# DATA CENTER LOAD NORMAL OPERATION

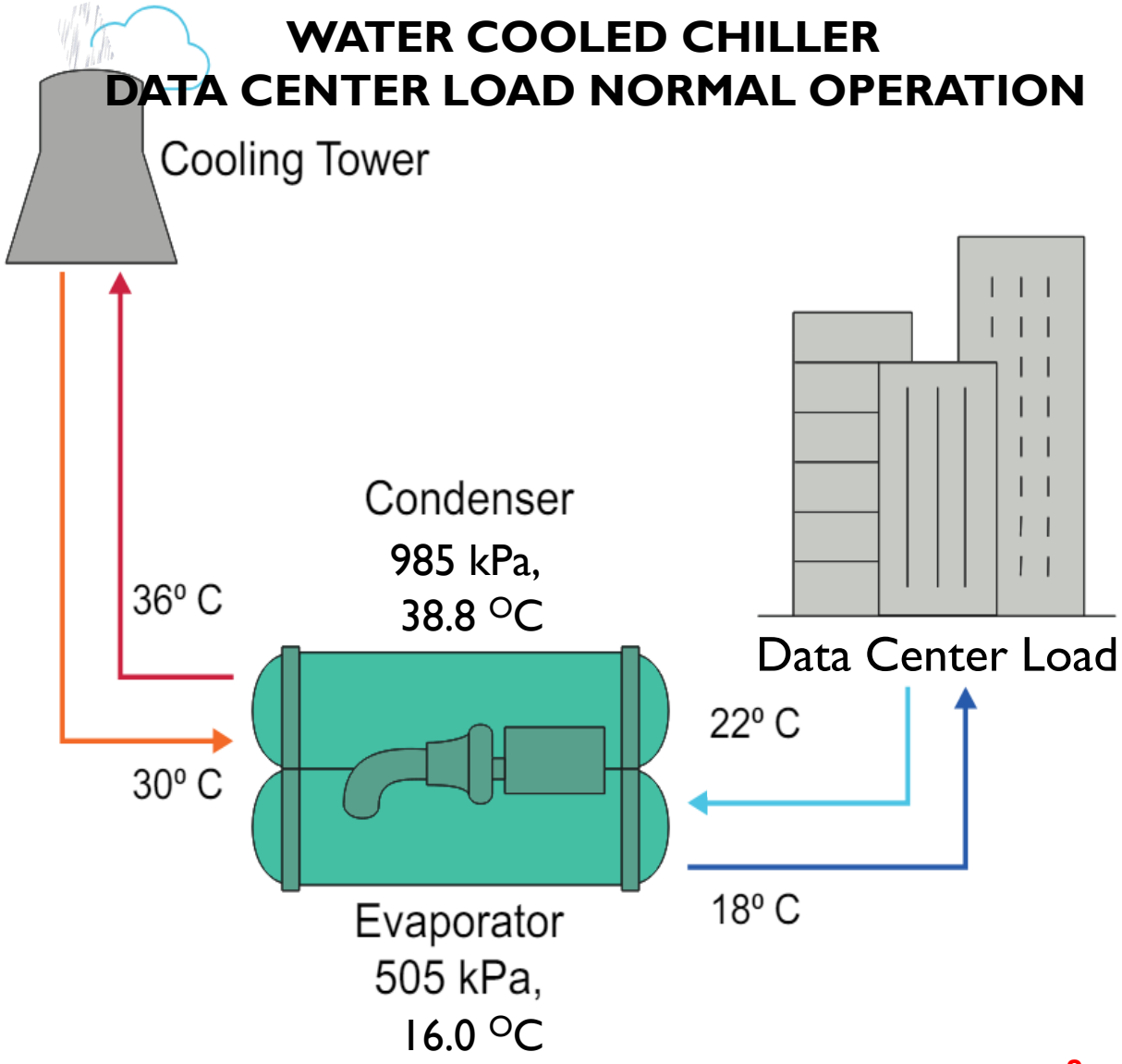


COP = 9.0

38.8°C
36 °C
30 °C
LIFT
22 °C
18 °C
16.0 °C

# WATER COOLED CHILLER
# DATA CENTER LOAD NORMAL OPERATION



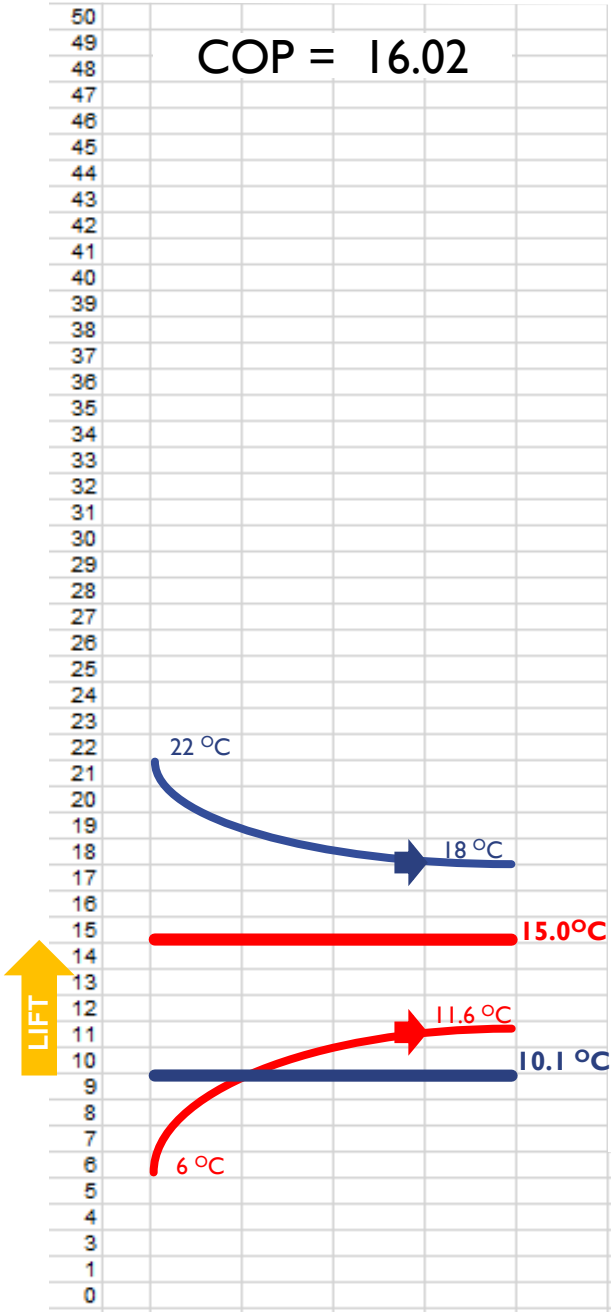
# פעולת צ׳ילר במשטר מהופך כאמצעי אפקטיבי לקירור בחינם

- מקרה בוחן
  - משטר נורמלי בעומס מלא- Full Load Normal Operation
  - משטר מהופך בעומס מלא- Full Load Inverted Operation
  - משטר מהופך בעומס חלקי- Part Load Inverted Operation
- יישומים
  - קירור בחינם- Free Cooling Applications
  - מרכזי מערכות מידע- Data Centers

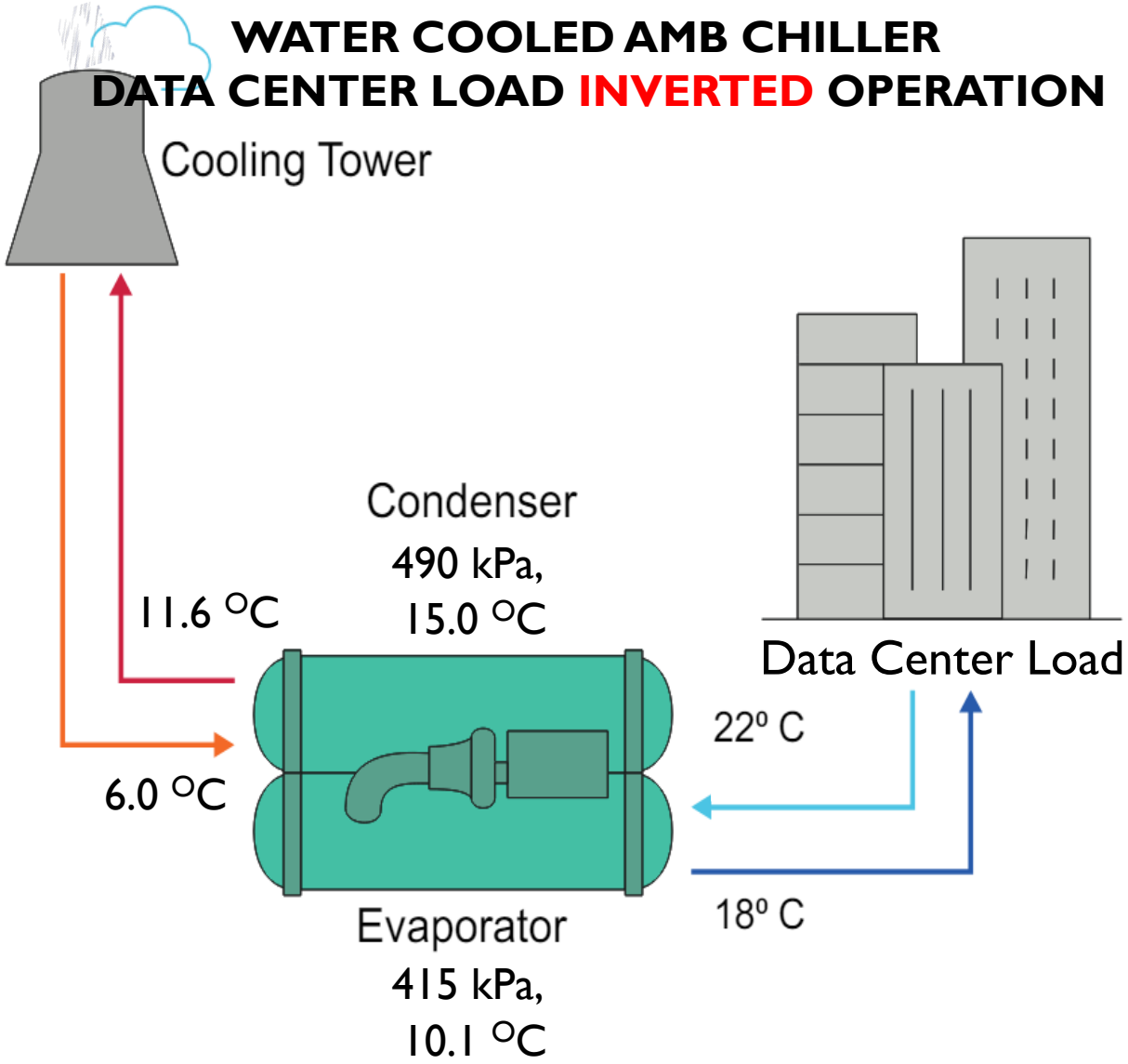

TEST CASE
CHILLER


TEST CASE
RESULTS

COP = 16.02



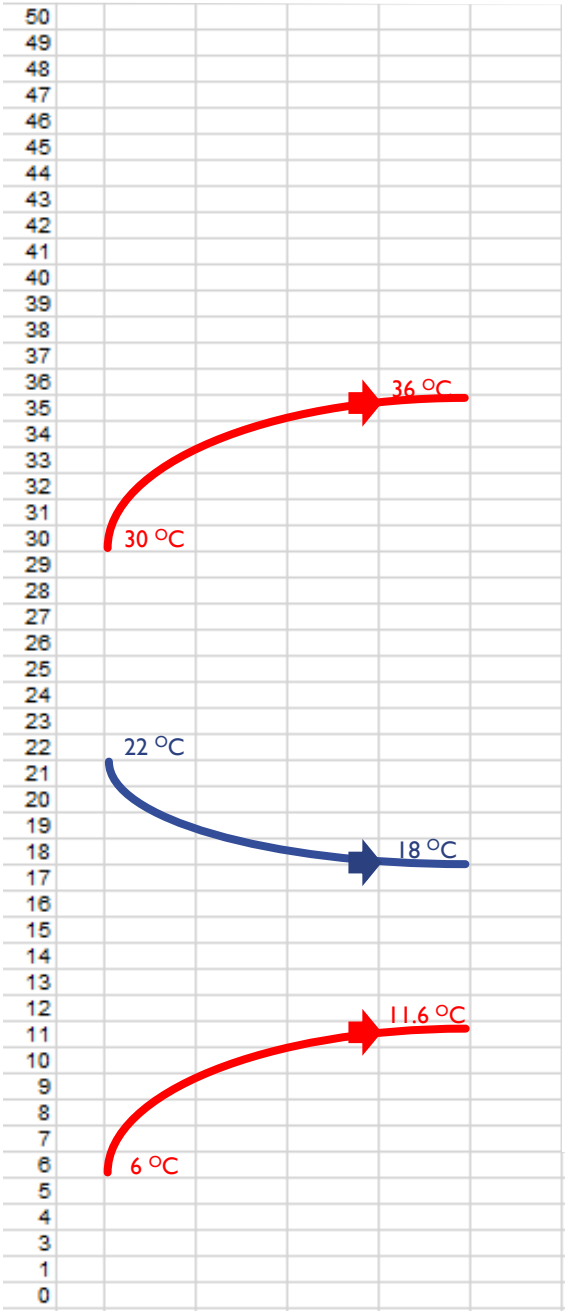

# WATER COOLED AMB CHILLER
# DATA CENTER LOAD INVERTED OPERATION

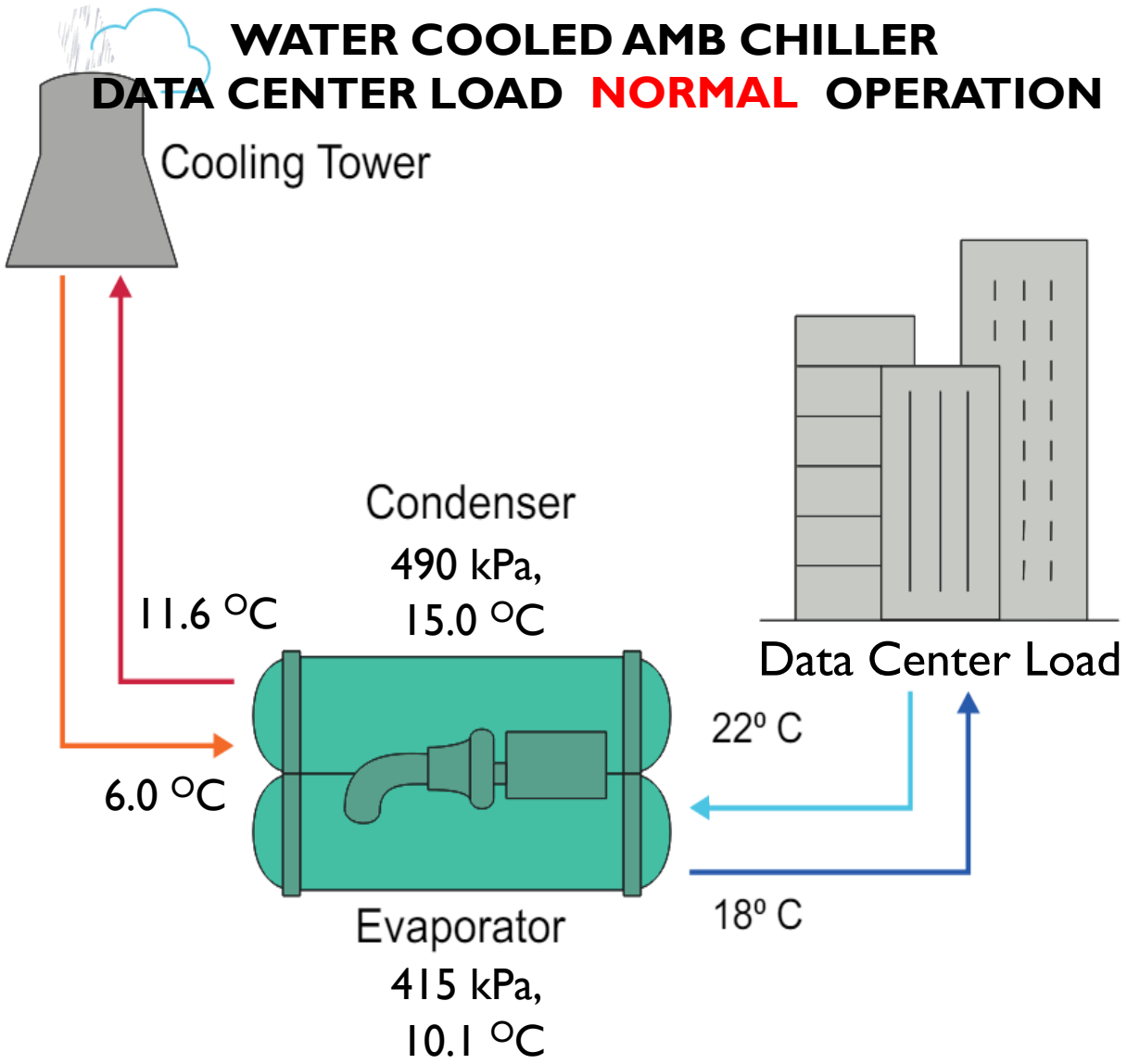





**Full Load Inverted Operation -משטר מהופך בעומס מלא**

# WATER COOLED AMB CHILLER
# DATA CENTER LOAD NORMAL OPERATION

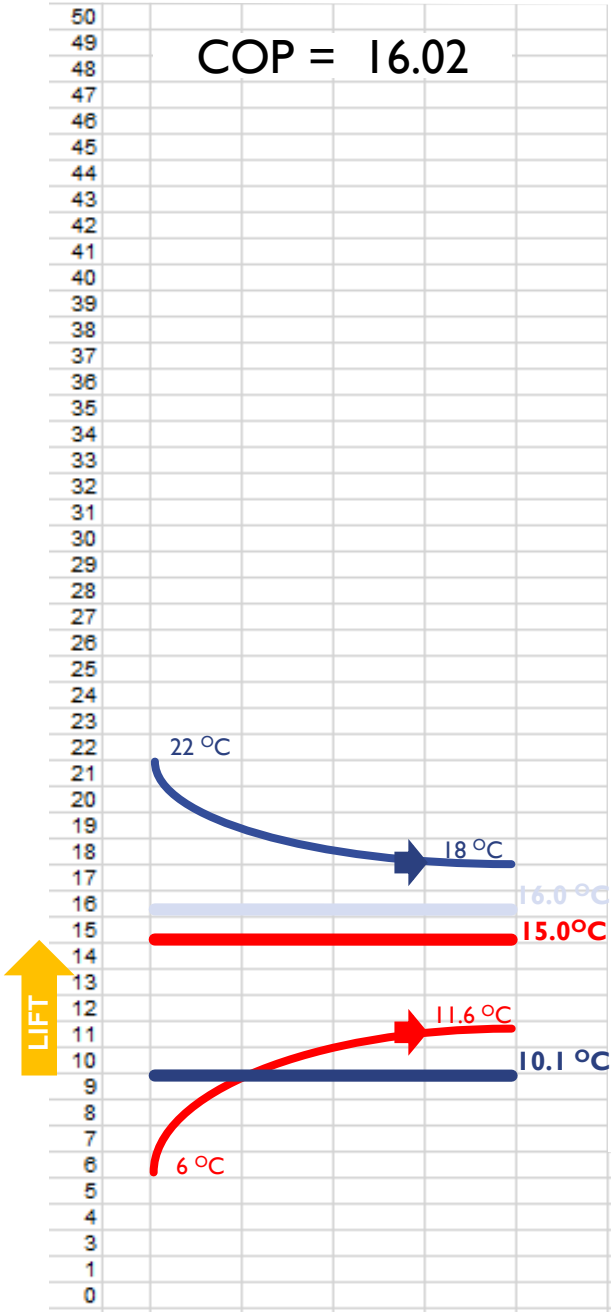


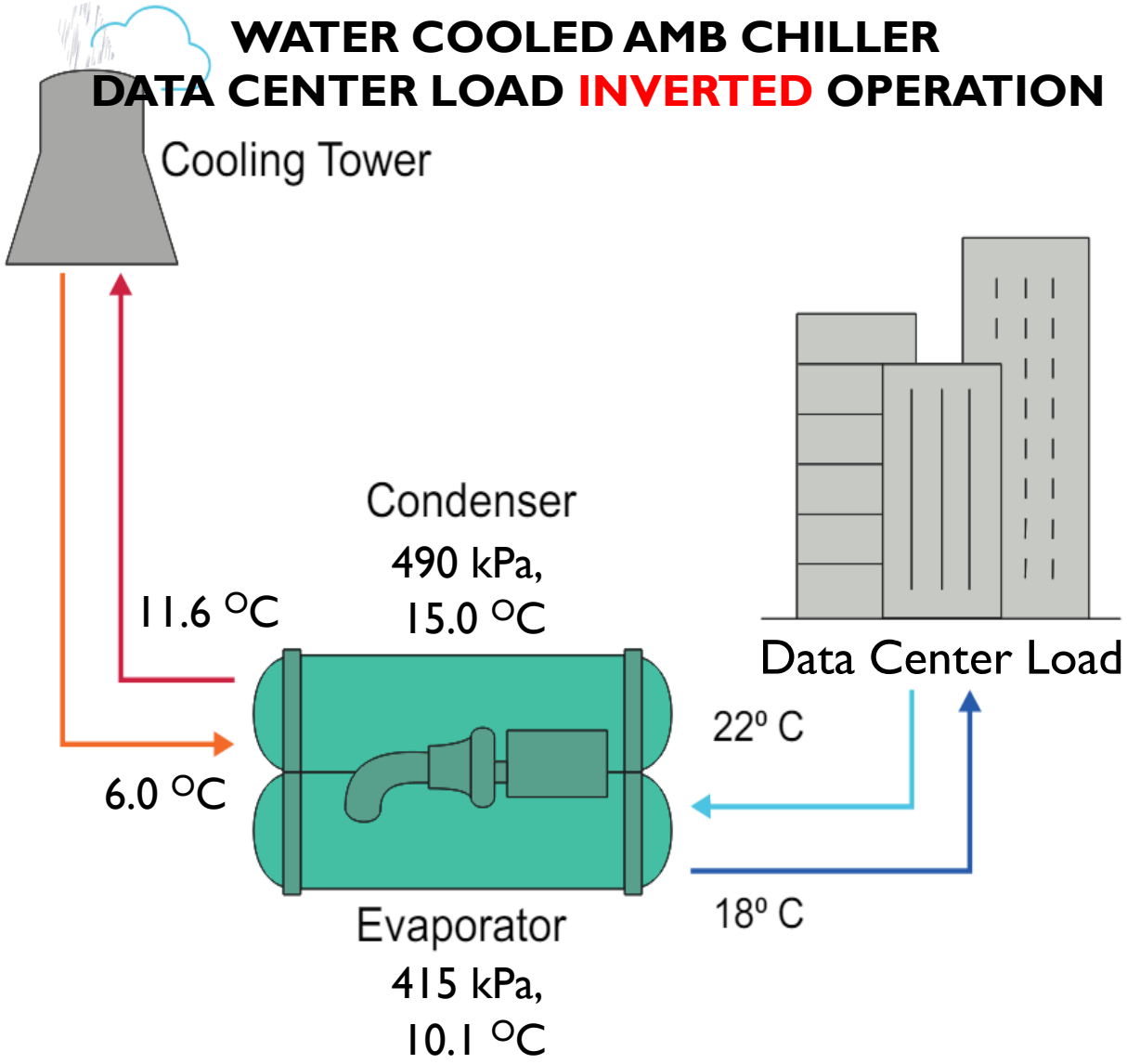



**Full Load Normal Operation -משטר נורמלי בעומס מלא**

COP = 16.02



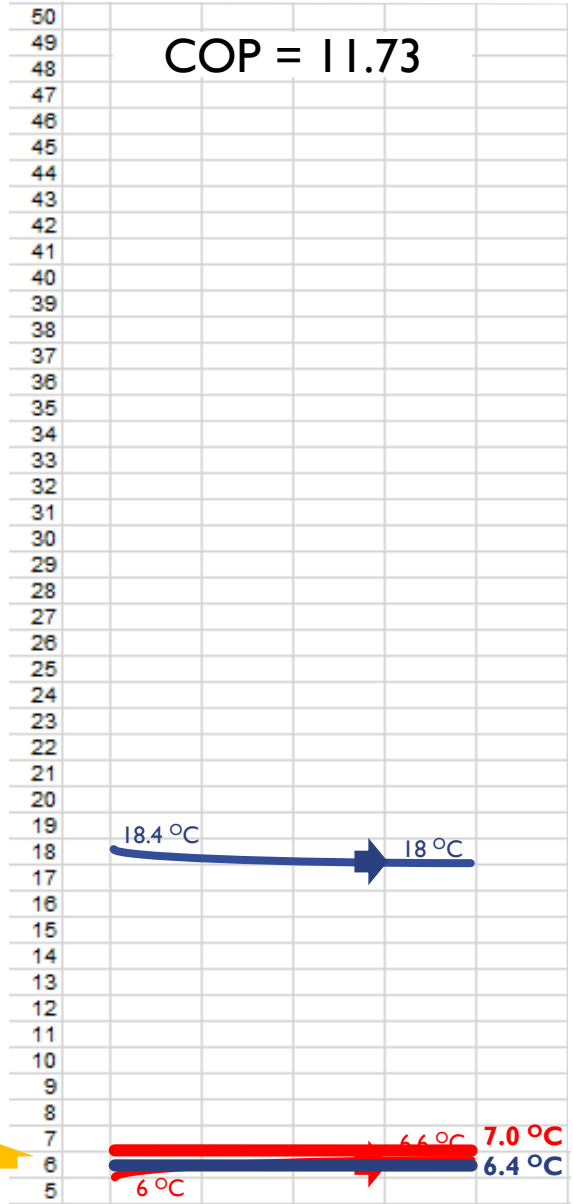

# WATER COOLED AMB CHILLER
# DATA CENTER LOAD INVERTED OPERATION



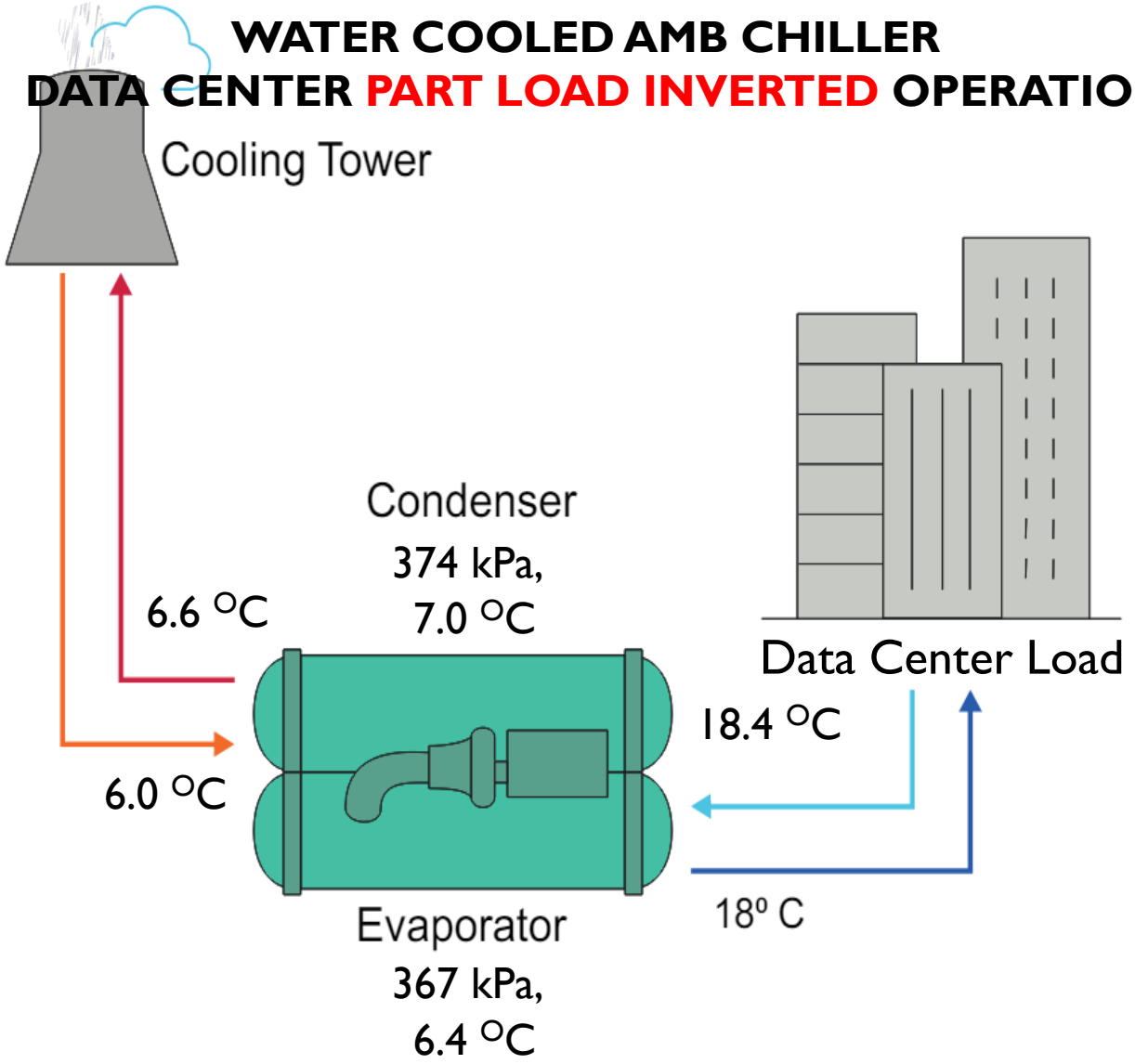



**Full Load Inverted Operation -משטר מהופך בעומס מלא**

COP = 11.73



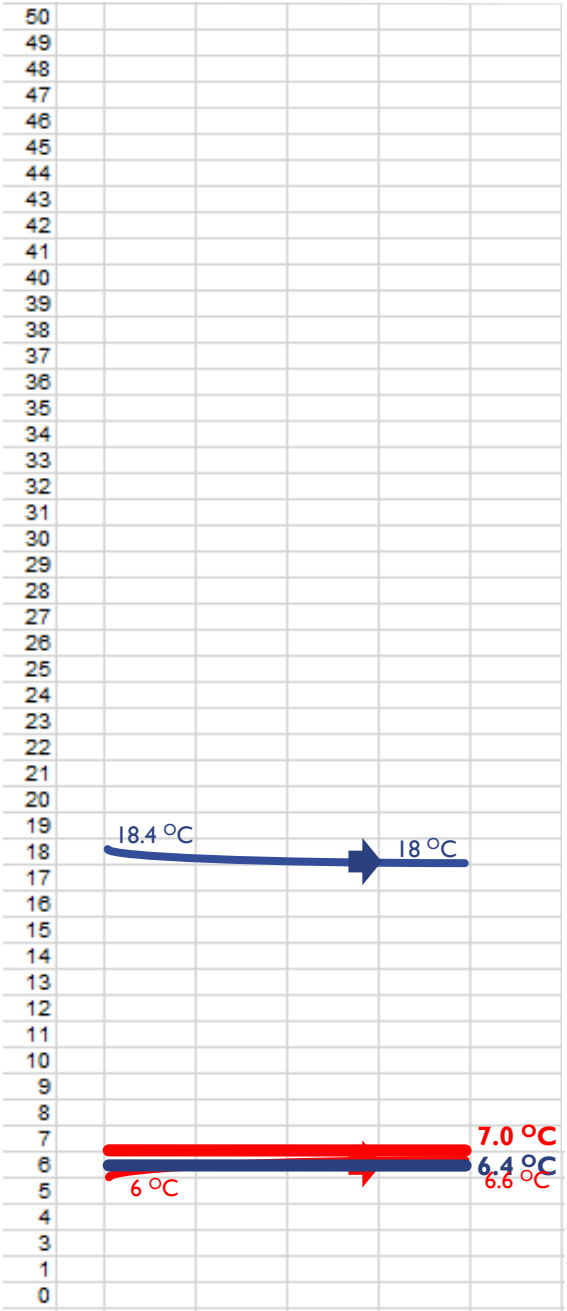

# WATER COOLED AMB CHILLER
# DATA CENTER PART LOAD INVERTED OPERATION

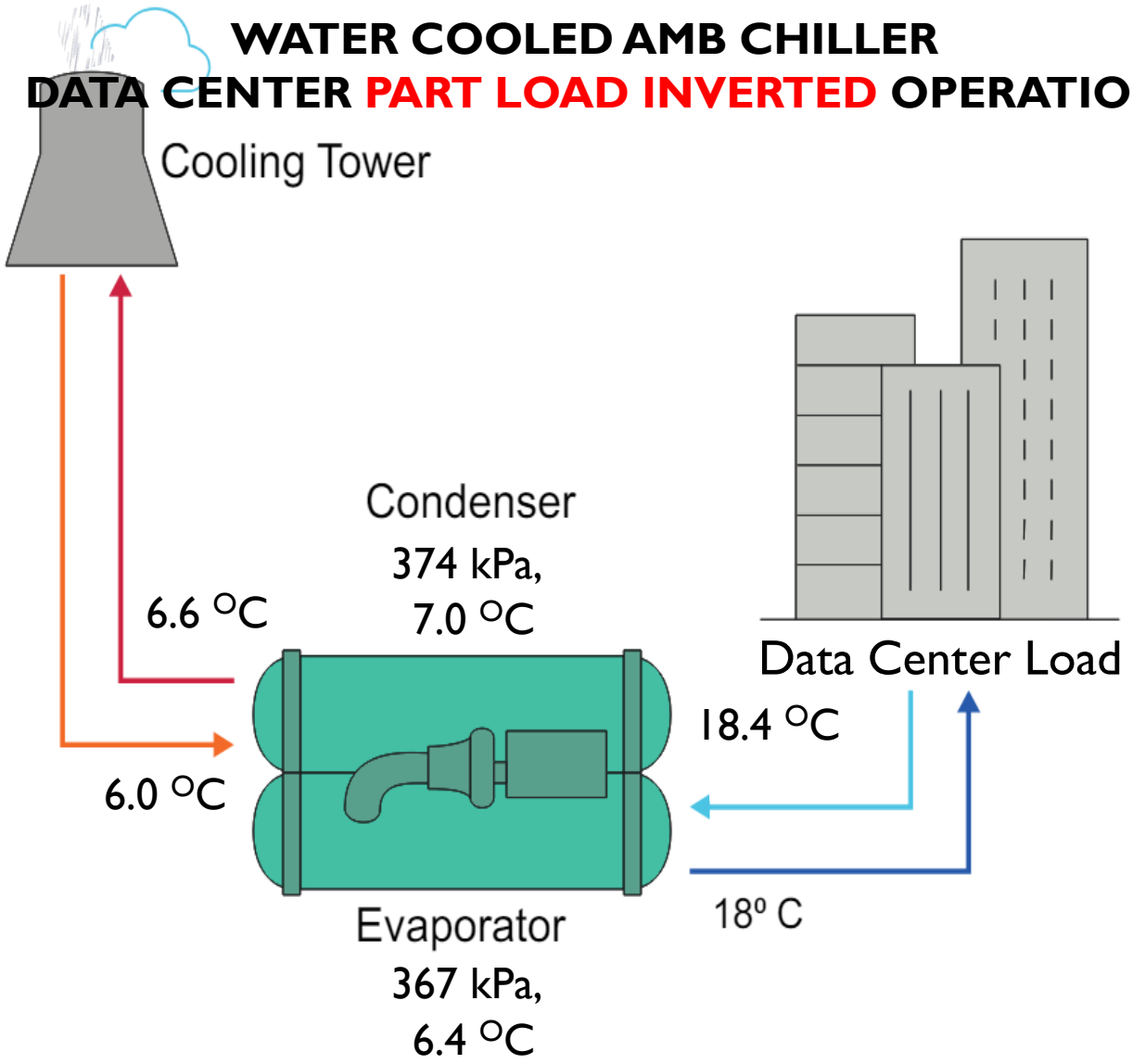





**Part Load Inverted Operation -משטר מהופך בעומס חלקי**

# WATER COOLED AMB CHILLER
# DATA CENTER PART LOAD INVERTED OPERATION

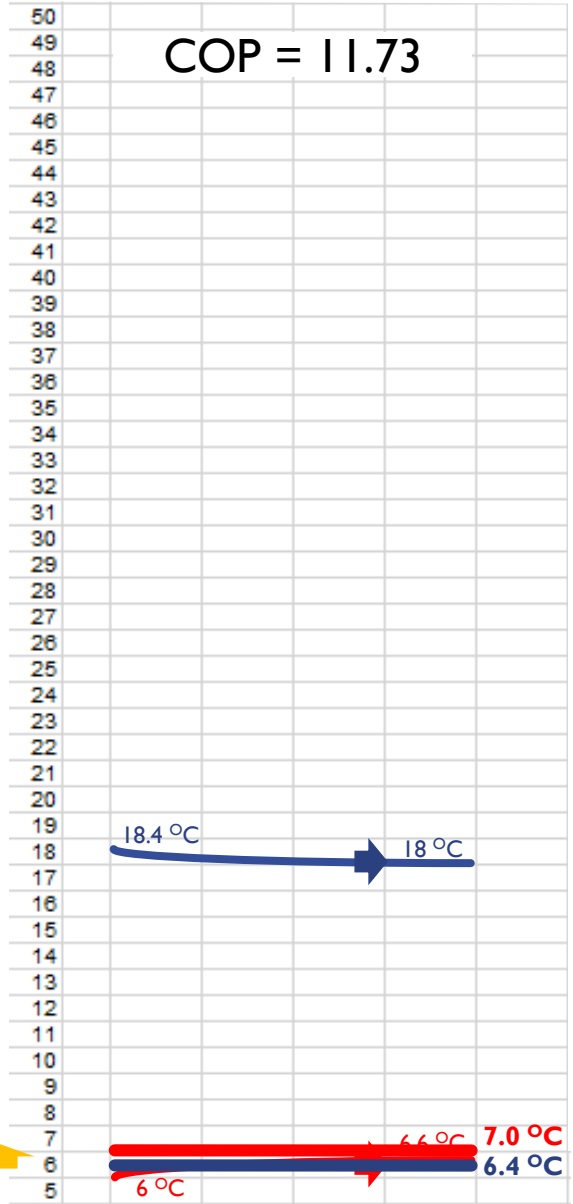


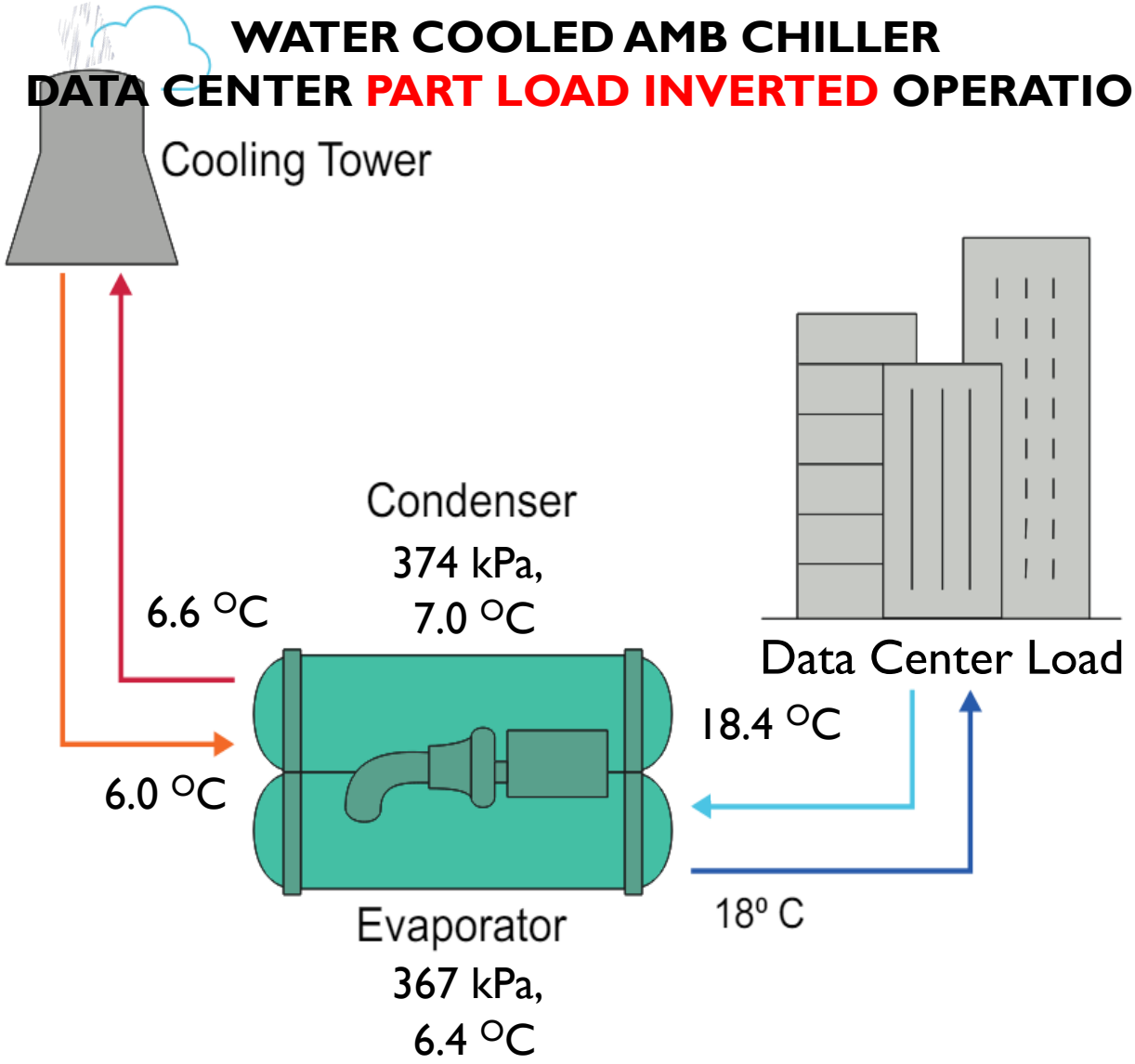



**Part Load Inverted Operation -משטר מהופך בעומס חלקי**

COP = 11.73

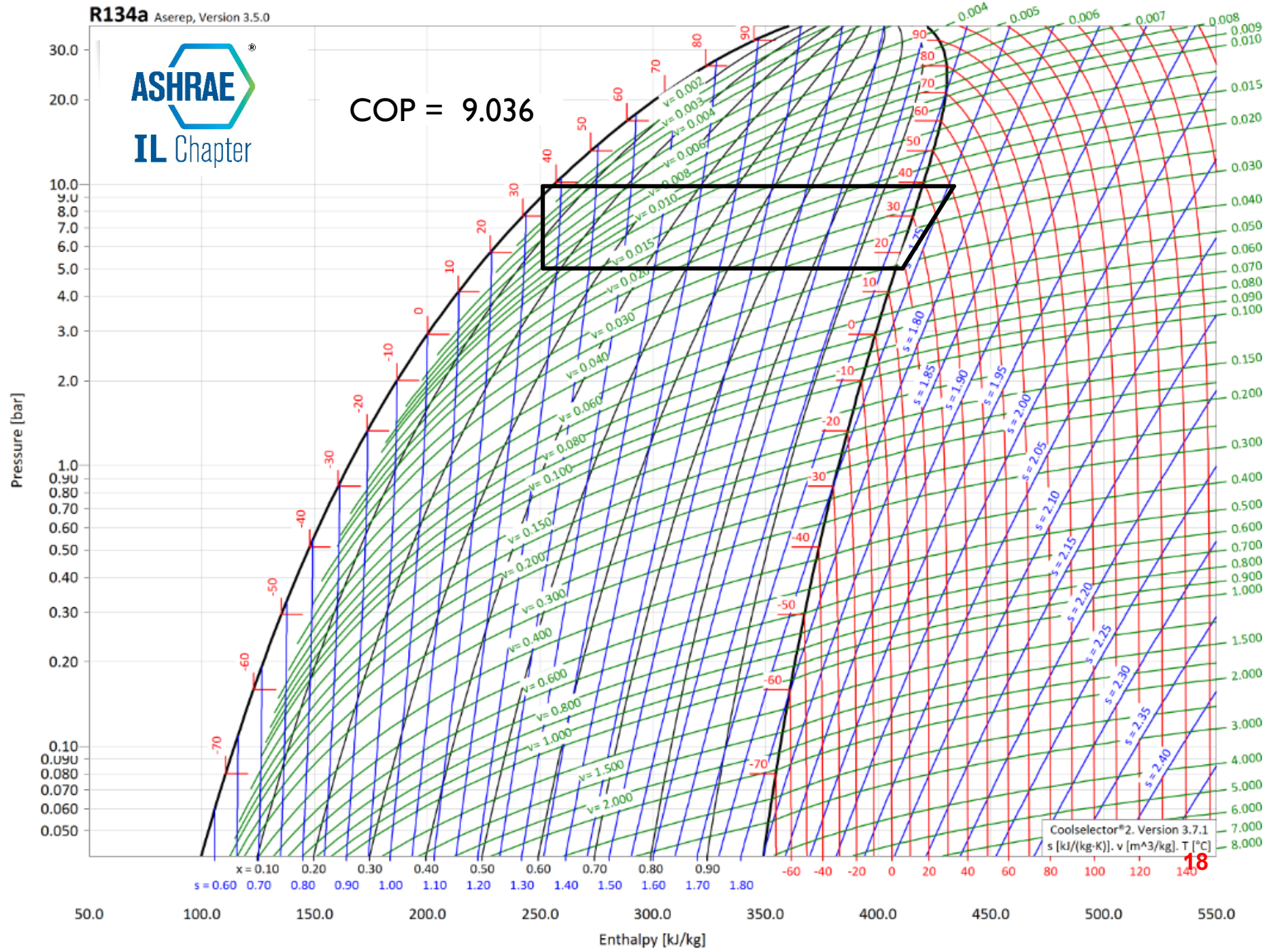


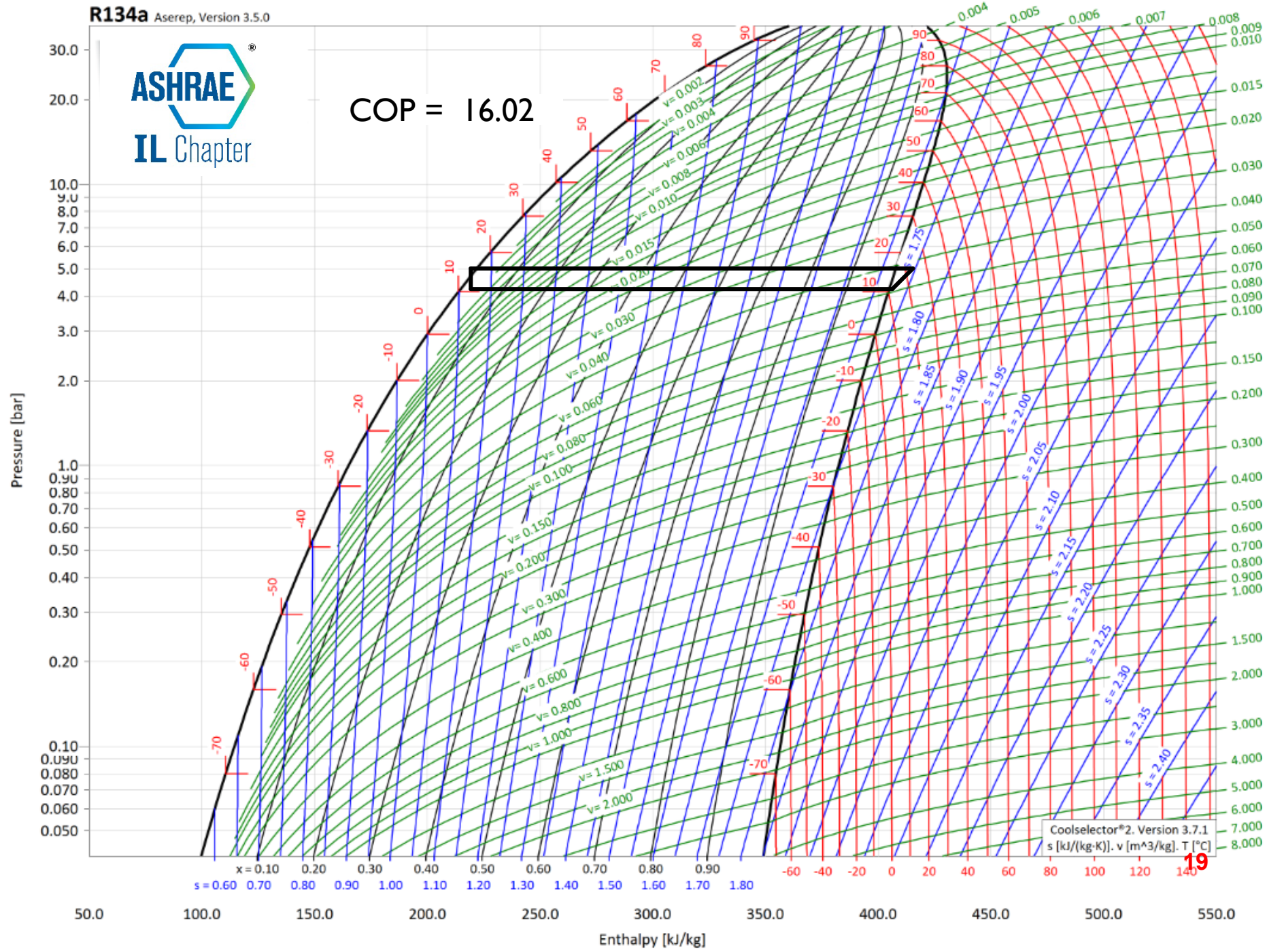

# WATER COOLED AMB CHILLER
# DATA CENTER PART LOAD INVERTED OPERATION

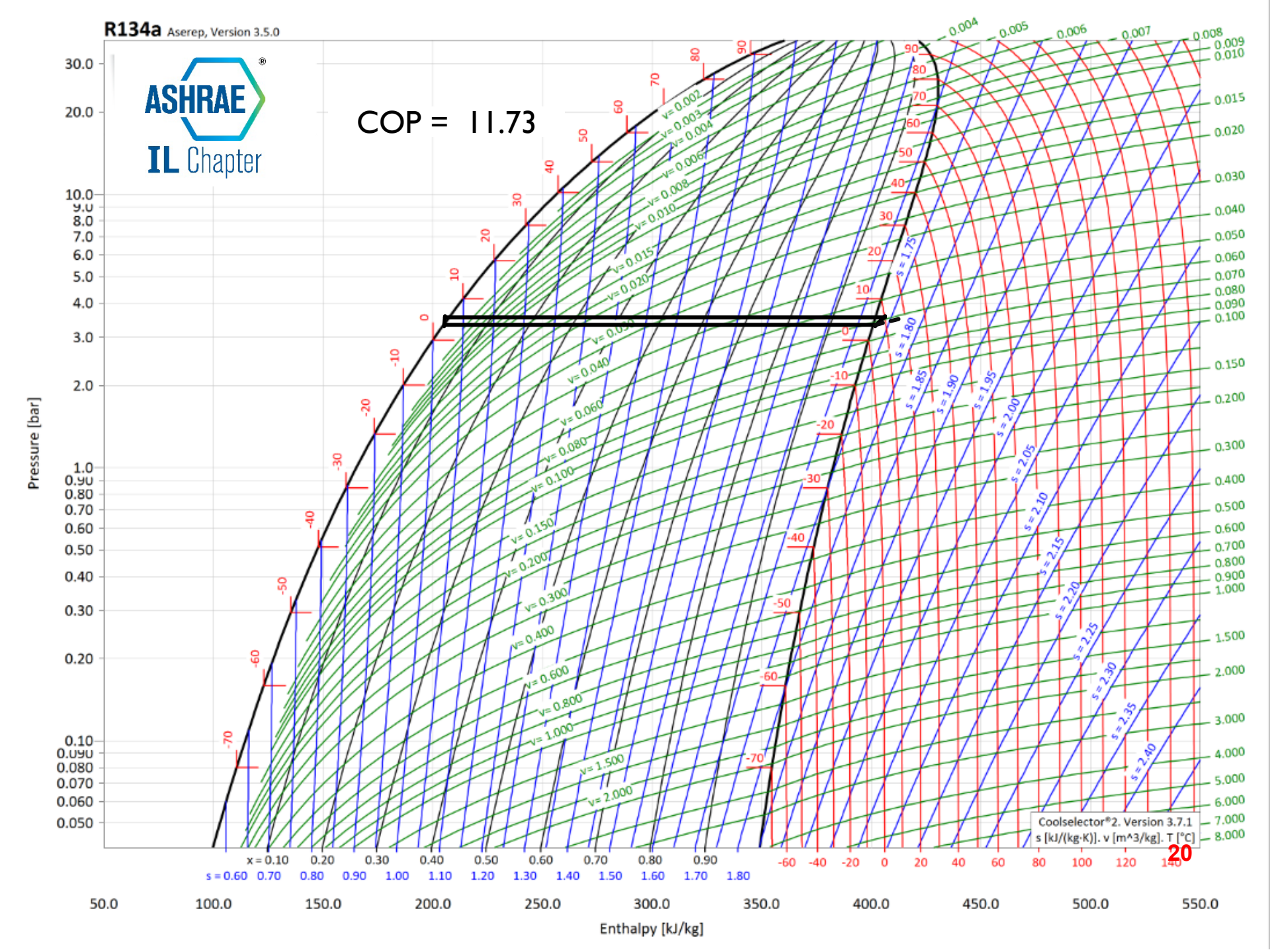





**Part Load Inverted Operation -משטר מהופך בעומס חלקי**


R134a Aserep, Version 3.5.0
ASHRAE
IL Chapter
COP = 9.036
Pressure [bar]
Enthalpy [kJ/kg]
Coolselector®2. Version 3.7.1
s [kJ/(kg·K)]. v [m^3/kg]. T [°C]
18


R134a Aserep, Version 3.5.0
ASHRAE
IL Chapter
COP = 16.02
Pressure [bar]
Enthalpy [kJ/kg]
Coolselector®2. Version 3.7.1
s [kJ/(kg·K)]. v [m^3/kg]. T [°C]
19


R134a Aserep, Version 3.5.0
ASHRAE
IL Chapter
COP = 11.73
Pressure [bar]
Enthalpy [kJ/kg]
Coolselector®2. Version 3.7.1
s [kJ/(kg·K)]. v [m^3/kg]. T [°C]
20

# פעולת צ׳ילר במשטר מהופך כאמצעי אפקטיבי לקירור בחינם

- יישומים
  - קירור בחינם- Free Cooling Applications
  - מרכזי מערכות מידע- Data Centers

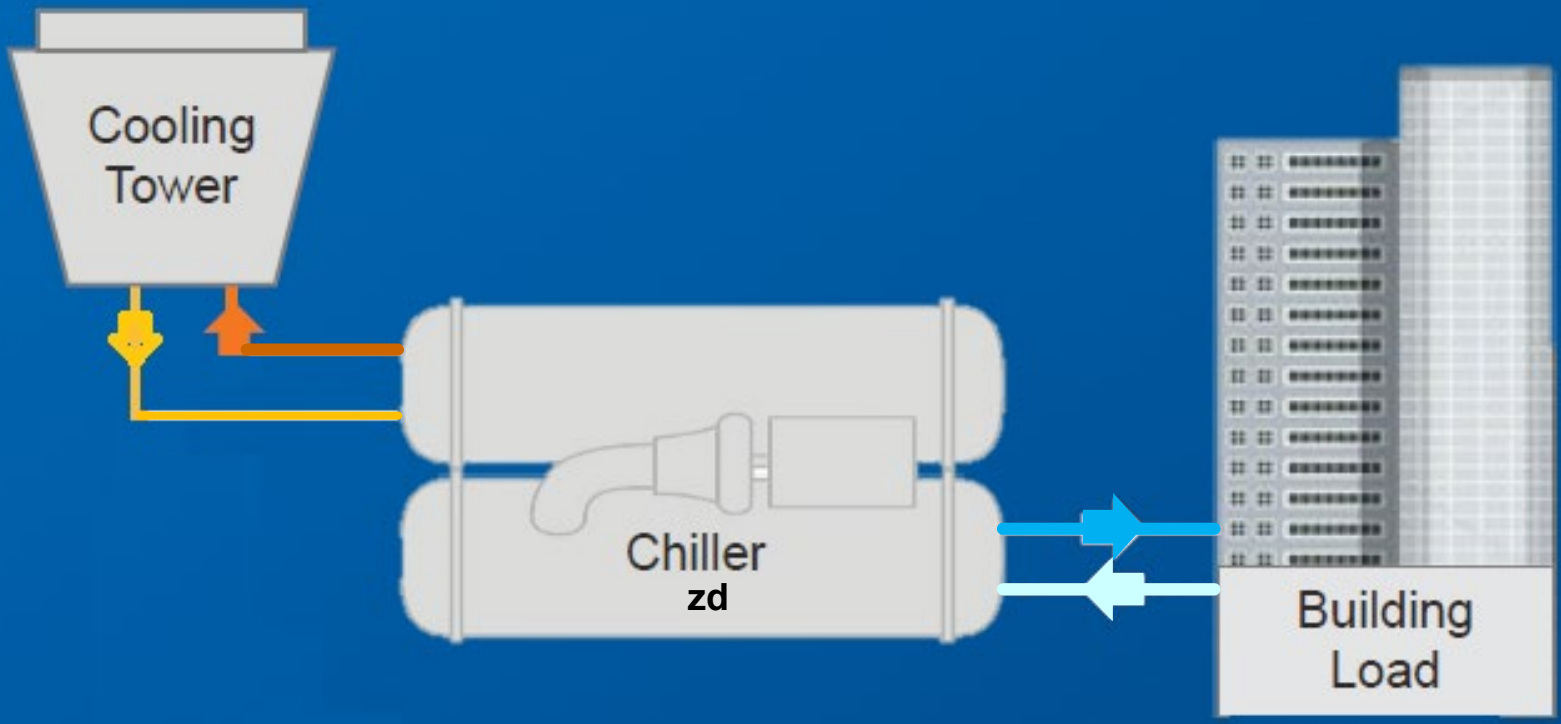
# יישומי קירור בחינם

| Partload Data (Minimum Condenser Water Temperature) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CEFT | % LOAD | | | | | | | | | |
| | 100% | 90% | 80% | 70% | 60% | 50% | 40% | 30% | 20% | 10% |
| 30°C 86°F | 9.036 | 9.591 | 10.14 | 10.65 | 11.07 | 11.32 | 11.21 | 10.61 | 8.794 | 4.061 |
| 27°C 80.6°F | 10.46 | 11.21 | 11.99 | 12.76 | 13.44 | 13.95 | 14.01 | 13.41 | 11.60 | 6.514 |
| 24°C 75.2°F | 12.27 | 13.28 | 14.39 | 15.56 | 16.70 | 17.65 | 18.21 | 18.02 | 16.19 | 10.91 |
| 21°C 69.8°F | 14.54 | 16.03 | 17.73 | 19.55 | 21.47 | 23.42 | 25.09 | 25.83 | 24.60 | 18.48 |
| 18°C 64.4°F | 16.78 | 19.08 | 21.63 | 24.94 | 27.87 | 31.61 | 35.38 | 35.55 | 29.67 | 18.79 |
| 15°C 59°F | 19.66 | 23.29 | 27.30 | 32.45 | 37.15 | 41.84 | 45.50 | 36.55 | 22.86 | 12.19 |
| 12°C 53.6°F | 19.53 | 22.82 | 26.41 | 33.34 | 39.58 | 45.94 | 49.76 | 34.55 | 21.04 | 12.02 |
| 9°C 48.2°F | 17.93 | 21.15 | 24.59 | 29.73 | 37.30 | 43.45 | 56.29 | 36.51 | 21.63 | 11.87 |
| 6°C 42.8°F | 16.02 | 18.59 | 22.24 | 26.01 | 33.37 | 39.89 | 46.53 | 39.42 | 22.69 | 11.73 |
| 3°C 37.4°F | 13.87 | 15.96 | 18.80 | 22.72 | 27.30 | 35.75 | 42.12 | 44.39 | 24.48 | 11.70 |
| *Values are in COP | NPLV= 24.34 | | | EEFT/ELFT= 22°C/18°C | | | CEFT/CLFT= 30°C/36°C | | Q= 1800 Kw | |

Lube Free Inverted

| | | |
|---|---|---|
| | Rated point is 60% or higher efficiency compared to design operation point | R134a |
| | Rated point is 70% or higher efficiency compared to design operation point. | |
| | Rating point is 80% or higher efficiency compared to design operation point | |

# יישומי קירור בחינם



# פעולת צ׳ילר במשטר מהופך כאמצעי אפקטיבי לקירור בחינם

- יישומים
  - קירור בחינם- Free Cooling Applications
  - מרכזי מערכות מידע- Data Centers

# משב-ארדן מערכות

אנשים בונים הצלחה