Lab X6 - Vapor Compression Refrigeration Cycle (Air Conditioner)

Bridge between Thermodynamics and Heat Transfer.

HVAC equipment has it all.

1st Law = Conservation of energy

2nd Law = Water flows downhill (unless you pump it up)
= Heat flows “down temperature” (unless you pump it up)

An AC-unit is a device for doing this, at a price.

Coefficient of Performance = (Heat pumped up / Work required)

Lab X6 - Vapor Compression Refrigeration Cycle

This lab will have two parts:

(1) Go to Chiller Plant and observe 2750 ton units.

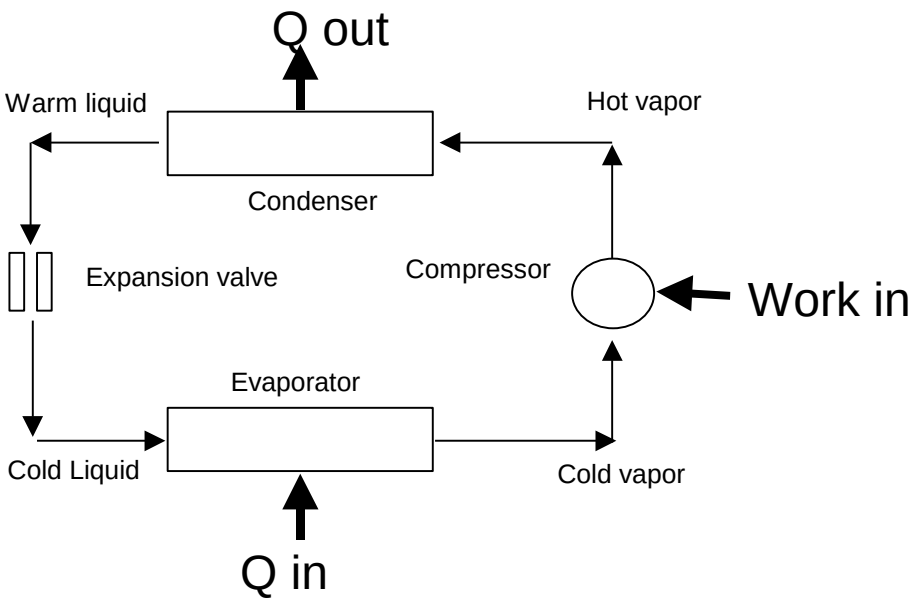
(2) Take data to calculate the coefficient of performance

- You are familiar with AC's where heat exchange is between refrigerant and air in a room or your car.

- In the campus system, water ("chilled water") is used as an intermediate between refrigerant and air.

- It is not practical to pump chilled air to campus buildings

Lab X6 - Vapor Compression Refrigeration Cycle



What does the real thing look like?
What are actual conditions at each point?
How close to “ideal” does it come?

Efficiency: What you get / What you paid for

For the Boilers: Steam out / Fuel in

For a Vapor Compression cycle: Qin / Work In

This is called the COP =Coefficient of Performance
It will be > 1, or why bother?

REFRIGERANT – The fluid circulating around the cycle

What is it?

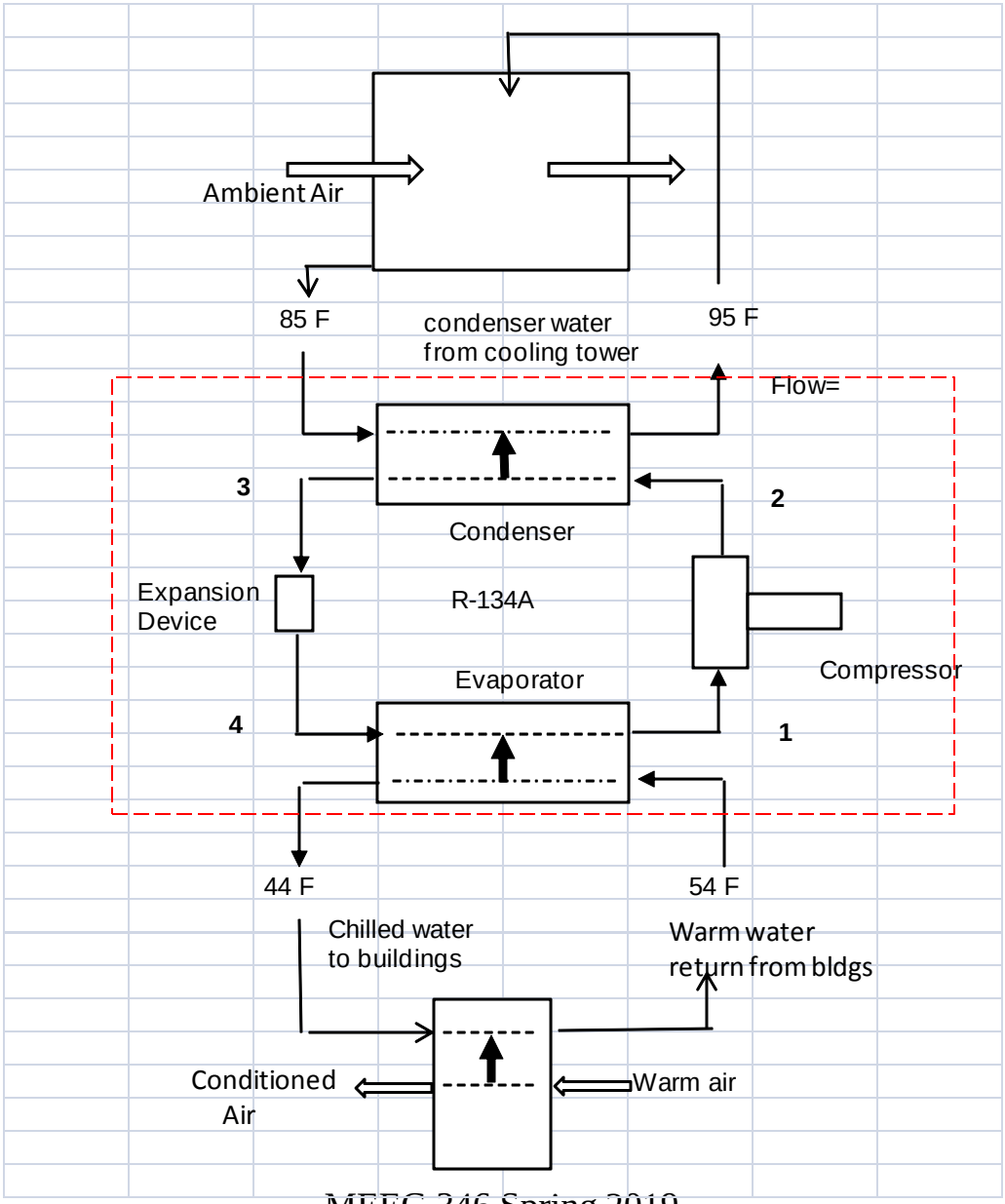
Can be any fluid in principle
Its Boiling Point is the key – what do you want?

Nitrogen – very low temperatures
Ammonia – low temperature, commercial food freezers
Methane, propane

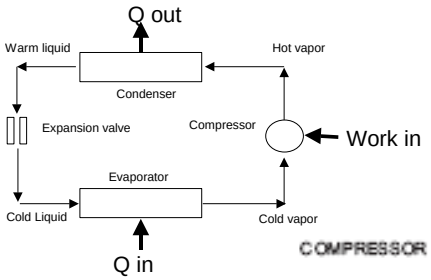
Many artificial compounds invented for comfort cooling:
Freons, R134a, R1, etc.

Ongoing (climate effects, atmosphere, etc.)

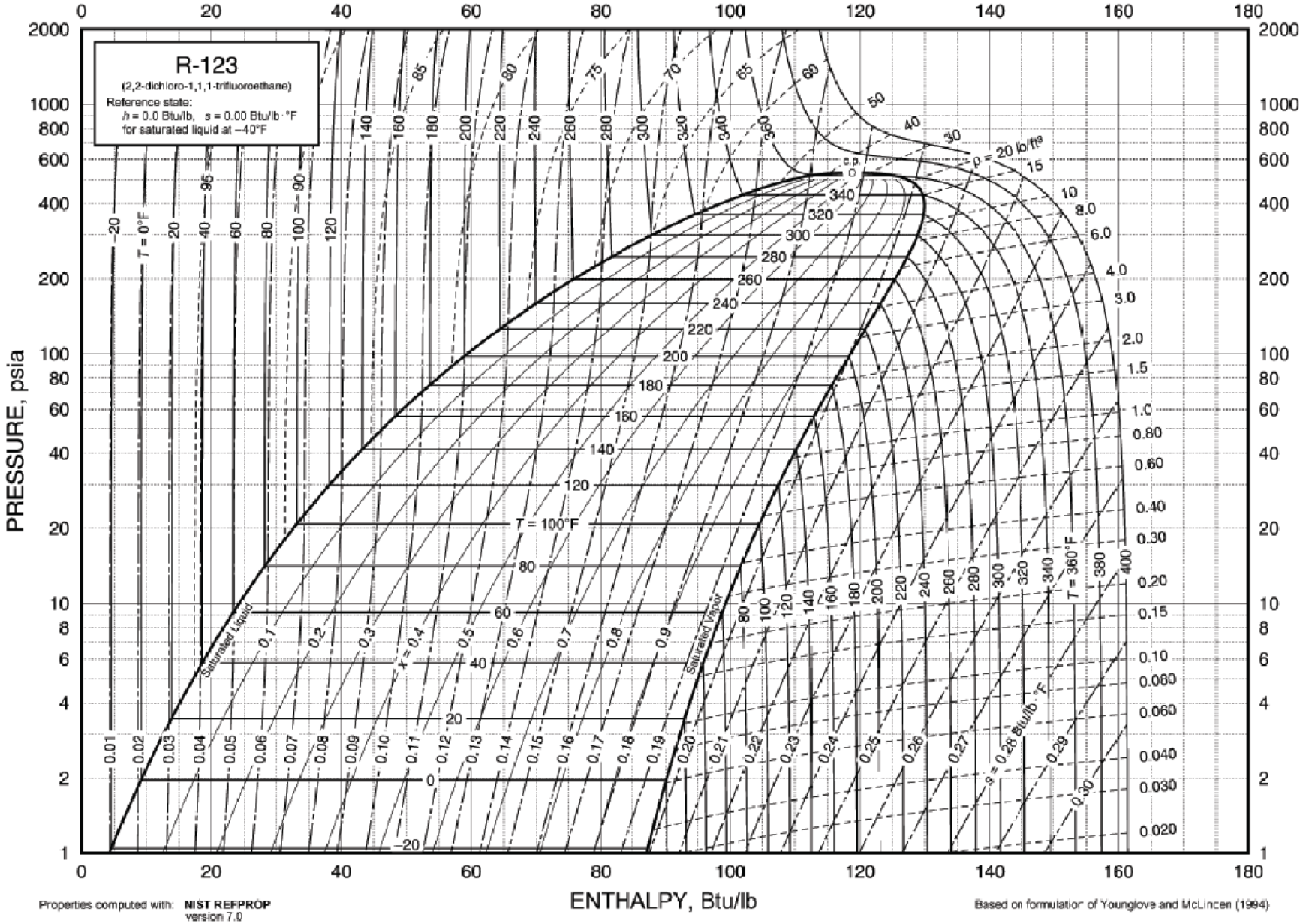
Plant Chill Water System

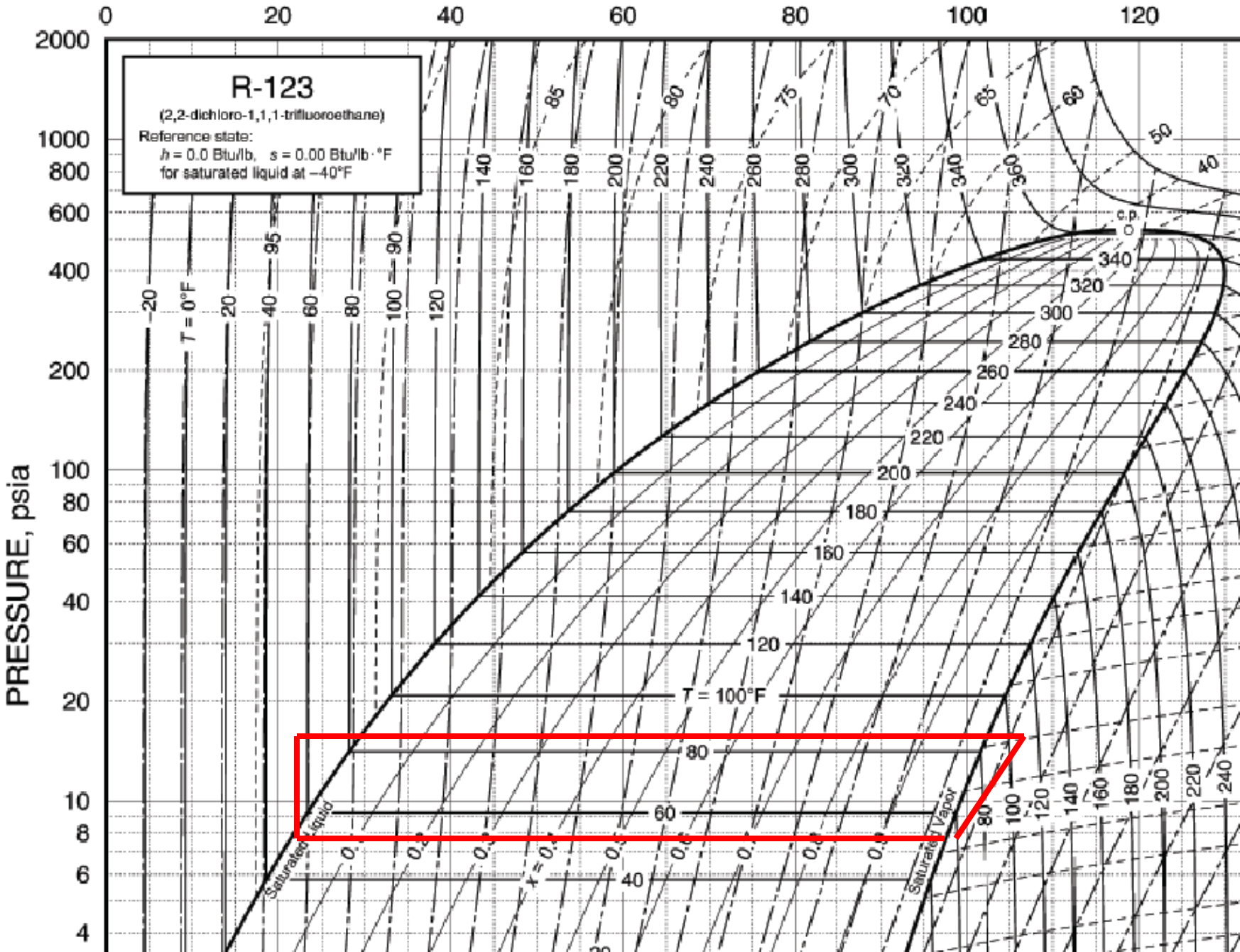


This is called a “Chiller”, because it chills water down to circulate to buildings, not air.



The refrigerant is on the shell side; the water is in the tubes


R-123
(2,2-dichloro-1,1,1-trifluoroethane)
Reference state:
h = 0.0 Btu/lb, s = 0.00 Btu/lb·°F
for saturated liquid at −40°F
PRESSURE, psia
ENTHALPY, Btu/lb
Saturated Liquid
Saturated Vapor
c.p.
T = 0°F
T = 100°F
T = 360°F
ρ = 20 lb/ft³
s = 0.28 Btu/lb·°F
Properties computed with: NIST REFPROP version 7.0
Based on formulation of Younglove and McLinden (1994)


R-123
(2,2-dichloro-1,1,1-trifluoroethane)
Reference state:
h = 0.0 Btu/lb, s = 0.00 Btu/lb · °F
for saturated liquid at −40°F
PRESSURE, psia
0
20
40
60
80
100
120
2000
1000
800
600
400
200
100
80
60
40
20
10
8
6
4
T = 0°F
T = 100°F
Saturated Liquid
Saturated Vapor
c.p.

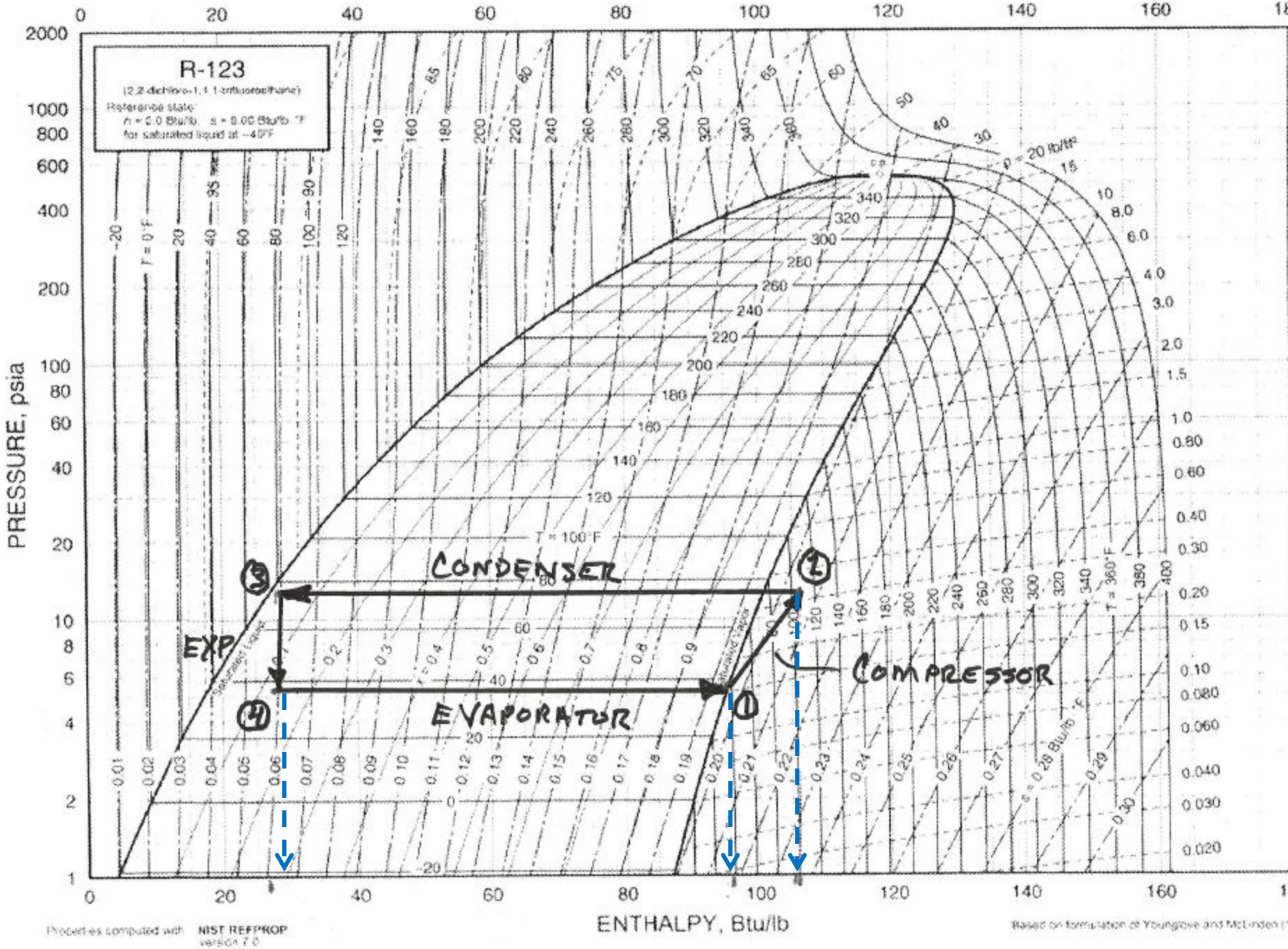
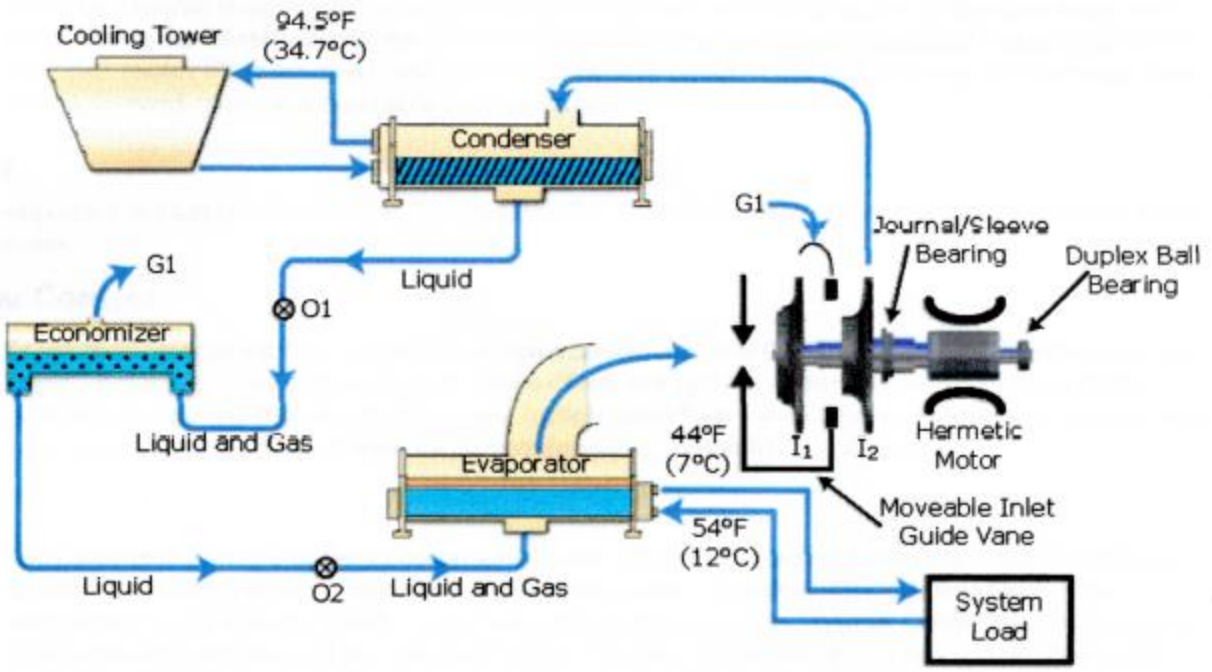


Fig. 5 Pressure-Enthalpy Diagram for Refrigerant 123

The CenTraVac Chiller Operating Cycle

Figure 1. Two-stage refrigerant flow



Lab X6 - Vapor Compression Refrigeration Cycle

MEEG346 site in Canvas will have:

- Lab instructions/AC fundamentals review
- Lab Procedures
- Data sheets
- Thermodynamic properties of refrigerant

What we will be doing:

- Report to Spencer Thermal Lab at usual team time.
  Safety glasses, ear plugs, toed/heeled shoes

- Walk over to the plant, brief tour of key parts by staff.
  (Behind New Sci&Tech Bldg)

- Obtain data on operating chiller, including cooling tower

- Calculate the COP from the data.

- Operations can change daily, according to weather, maintenance and repairs, etc. Each team may have a different experience.