Plant Assignments: Evaluating Refrigerant Options for Use on the MSU Campus

The Task in Perspective
The Minnesota State University campus in Mankato employs three centrifugal chillers. These chillers produce cold water which is used for air conditioning across campus. With the building expansions currently planned these three chillers may prove to be insufficient to produce enough chilled water. Therefore, the MNSU Facilities Department is currently considering the addition of a fourth chiller. These are referred to as high/medium and low pressure chillers, respectively. Typically a bidding process is used where possible vendors propose units which will satisfy the stated needs. However, it is the Facility staff’s responsibility to critically evaluate the bids and determine which is actually best for the University.

Work Assignment
The existing equipment includes chillers which use R-134a (HFC-134a) or R-123 (HCFC-123) as the refrigerant. Assume the Chief Engineer has determined that a R-134a chiller is preferable. Prepare a report for the Physical Plant Director which evaluates the two refrigerant options (i.e. a R-134a or R-123 based chiller) and justifies this recommendation based on the positive and negative considerations of 1) environmental impact, 2) refrigerant availability, and 3) thermodynamics. For item #3 produce a system schematic, a Pressure-Enthalpy (P-h) process diagram, and calculate generic motor horsepower for the two possible chillers.

Additional Information
Typical coefficients of performance for R-134a and R-123 chillers are 6.28 and 6.76 respectively. In both cases subcooling and superheating are ignored (i.e. the quality out of the condenser is zero and the quality out of the evaporator is unity). An equipment life of 30 years and a nominal refrigeration capacity of 1000 tons can be assumed. A table of thermodynamic properties for R-123 is available in the Engaged in Thermodynamics Additional Documents section. Information on the existing Trane and McQuay chillers is also included. Typical pressures for each refrigerant can be found in the Centrifugal Chillers and Centrifugal Chillers Advanced sections of the Background Information.