SHIPBOARD AC&R PLANT REMOVES $3.24 \times 10^6 \frac{Btu}{HR}$ FROM VARIOUS SPACES. PLANT HAS 3 IDENTICAL REFRIGERATING UNITS TO REMOVE THIS MUCH HEAT. EACH UNIT HAS A COMPRESSOR (RATED AT 125 HP, EFFICIENCY 75.43%), CONDENSER, AND CHILLER. R-12 FLOW RATE IN EACH UNIT IS 345 LBm/MIN.

a) CAP FOR ONE UNIT IN [R.TONS]:

$$CAP = \frac{1}{3}\left(3.24 \times 10^6 \frac{Btu}{HR}\right)\left(\frac{1\ R.TON}{12{,}000\ Btu/HR}\right)$$

$$\boxed{CAP = 90\ R.TONS}$$

b) RE FOR ONE UNIT IN $\left[\frac{Btu}{LBm}\right]$

$$RE = \frac{CAP}{\dot{m}_{REF}} = \frac{90\ R.TON\left(12{,}000\ \frac{Btu/HR}{R.TON}\right)}{345\ \frac{LBm}{MIN}\left(\frac{60\ MIN}{1\ HR}\right)}$$

$$\boxed{RE = 52.2\ \frac{Btu}{LBm}}$$

c) COP FOR ONE UNIT:

$$COP = \frac{CAP}{PWR}, \quad PWR = (ihp)_c, \quad \text{BUT } bhp = 125\ HP \text{ ("RATED AT")}$$

$$\eta_c = \frac{ihp}{bhp}$$

$$.7543 = ihp / 125\ HP$$

$$ihp = 94.3\ HP$$

$$COP = \frac{90\ R.TON\left(\frac{12{,}000\ Btu/HR}{1\ R.TON}\right)}{94.3\ HP\left(\frac{2545\ Btu/HR}{HP}\right)}$$

$$\boxed{COP = 4.5}$$

d) TOTAL HEAT REJECTED BY <u>ENTIRE</u> PLANT IN $\left[\frac{Btu}{HR}\right]$:

$$q_R = q_S + W_{IN}, \quad \text{MULTIPLY BOTH SIDES BY } \dot{m}_{REF}$$

WHERE $q_S = RE$ AND $W_{IN} = W_c$

PER UNIT → $\dot{Q}_R = CAP + (ihp)_c$

$$= 90\ R.TONS\left(\frac{12{,}000\ Btu/HR}{1\ R.TON}\right) + 94.3\ HP\left(\frac{2545\ Btu/HR}{HP}\right)$$

$$\dot{Q}_R = 1.32 \times 10^6\ \frac{Btu}{HR}\ \underline{\text{PER UNIT}}$$

SO, ENTIRE PLANT REJECTS:

TOTAL → $\dot{Q}_R = 3\left(1.32 \times 10^6\ \frac{Btu}{HR}\right)$

$$\boxed{\dot{Q}_R = 3.96 \times 10^6\ \frac{Btu}{HR}}$$

← MUST REJECT MORE HEAT THAN REMOVED DUE TO ADDITION OF COMPRESSOR WORK