Useful Formulas
200.E.03

WATER HORSEPOWER: $= \frac{\text{GPM} \times 8.33 \times \text{Head}}{33000} = \frac{\text{GPM} \times \text{Head}}{3960}$	**WHERE:** **GPM** = Gallons per Minute **8.33** = Pounds of water per gallon **33000** = Ft. Lbs. per minute in one horsepower **Head** = Difference in energy head in feet (field head).
LABORATORY BHP $= \frac{\text{Head} \times \text{GPM} \times \text{Sp. Gr.}}{3960 \times \text{Eff.}}$ **FIELD BHP** = Laboratory BHP + Shaft Loss **TOTAL BHP** = Field BHP + Thrust Bearing Loss	**WHERE:** **GPM** = Gallons per Minute **Head** = Lab. Head (including column loss) **Efficiency** = Lab. Eff. of Pump Bowls (from price book curves) **Shaft Loss** = HP loss due to mechanical friction of lineshaft bearings **Thrust Bearing Loss** = HP Loss in driver thrust bearings (See (1) below under Misc.)
INPUT HORSEPOWER $= \frac{\text{Total BHP}}{\text{Motor Eff.}}$	**Motor Eff. from Motor mfg. (as a decimal)**
FIELD EFFICIENCY $= \frac{\text{Water Horsepower}}{\text{Total BHP}}$	**Water HP as determined above** **Total BHP as determined above**
OVERALL PLANT EFFICIENCY $= \frac{\text{Water Horsepower}}{\text{Input Horsepower}}$	**Water HP as determined above** **Input HP as determined above**

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200.E.03

ELECTRICAL

INPUT HORSEPOWER $= \frac{BHP}{Mot.\ Eff.} = \frac{4.826 \times K \times M \times R}{T} = \frac{1.732 \times E \times I \times PF}{746}$

BHP = Brake Horsepower as determined above
Mot. Eff. = Rated Motor Efficiency
K = Power Company Meter Constant
M = Power Company Meter Multiplier, or Ratio of Current and Potential Transformers connected with meter
R = Revolutions of meter disk
T = Time in Sec. for R
E = Voltage per Leg applied to motor
I = Amperes per Leg applied to motor
PF = Power factor of motor
1.732 = Factor for 3-phase motors. This reduces to 1 for single phase motors

Kilowatt input to Motor $= .746 \times 1\ HP = \frac{1.732 \times E \times I \times PF}{1000}$

KW-Hrs. Per 1000 Gallons of Cold Water Pumped Per Hour $= \frac{HD\ in\ ft. \times 0.00315}{Pump\ Eff. \times Mot.\ Eff.}$

MISC.

(1) **Thrust Bearing Loss** = .0075 HP per 100 RPM per 1000 lbs. thrust.*
(2) **Overall Plant Efficiency sometimes referred to as "Wire to Water" Efficiency**
***Thrust (in lbs.)** = (thrust constant (k) laboratory head) + (setting in feet x shaft wt. per ft.)
Note: Obtain thrust constant from curve sheets

Discharge Head (in feet of fluid pumped) $= \frac{Discharge\ Pressure\ (psi) \times 2.31}{Sp.\ Gr.\ of\ Fluid\ Pumped}$

Velocity Head $= \frac{V^2}{2G}$ V = Velocity of Water
G = Acceleration Due to Gravity 32.2 ft./sec^2

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