# Useful Formulas 200.E.03

## WATER HORSEPOWER:

\[
\text{Water Horsepower} = \frac{\text{GPM} \times 8.33 \times \text{Head}}{33000} = \frac{\text{GPM} \times \text{Head}}{3960}
\]

**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

\[
\text{Laboratory BHP} = \frac{\text{Head} \times \text{GPM} \times \text{Sp. Gr.}}{3960 \times \text{Eff.}}
\]

## FIELD BHP

\[
\text{Field BHP} = \text{Laboratory BHP} + \text{Shaft Loss}
\]

## TOTAL BHP

\[
\text{Total BHP} = \text{Field BHP} + \text{Thrust Bearing Loss}
\]

## INPUT HORSEPOWER

\[
\text{Input Horsepower} = \frac{\text{Total BHP}}{\text{Motor Eff.}}
\]

**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** = HP Loss in driver thrust bearings
- **Bearing Loss** = (See (1) below under Misc.)

## FIELD EFFICIENCY

\[
\text{Field Efficiency} = \frac{\text{Water Horsepower}}{\text{Total BHP}}
\]

**Water HP as determined above**

**Total BHP as determined above**

## OVERALL PLANT EFFICIENCY

\[
\text{Overall Plant Efficiency} = \frac{\text{Water Horsepower}}{\text{Input Horsepower}}
\]

**Water HP as determined above**

**Input HP as determined above**
## Useful Formulas

### ELECTRICAL

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

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

### 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

**Kilowatt input to Motor** = .746 x 1 HP = \[
\frac{1.732 \times E \times I \times PF}{1000}
\]

**KW-Hrs. Per 1000 Gallons of Cold Water Pumped Per Hour** = HD in ft. x 0.00315

\[
\text{Pump Eff.} \times \text{Mot. Eff.}
\]

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

**Velocity Head** = \[
\frac{V^2}{2G}
\]

\( V = \text{Velocity of Water} \)

\( G = \text{Acceleration Due to Gravity} \) 32.2 ft./sec²

---

Xylem Inc.

www.xyleminc.com/brands/gouldswatertechnology

Goulds is a registered trademark of Goulds Pumps, Inc. and is used under license.

© 2012 Xylem Inc.  D200E03    January 2009