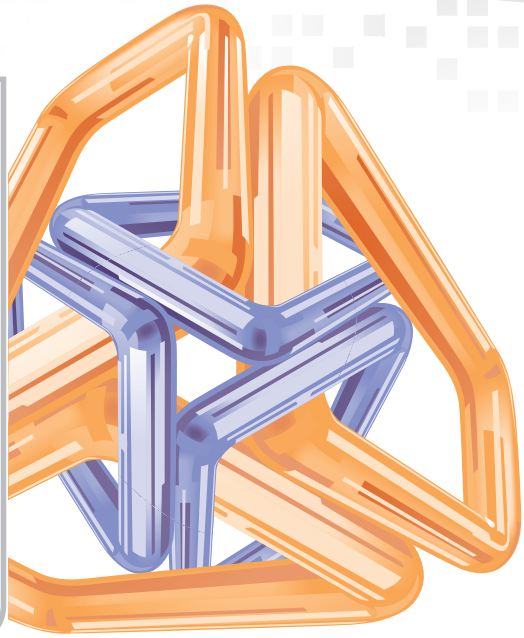
WARREN CONTROLS

Energy - Units, Terms, Formulas & Conversions



Electrical Systems

kWh = kW x Hours

Thermal Systems

One BTU is defined as the amount of energy required to raise one pound of water one degree F.

BTU = ((BTU/Hr.) x (Hours))

ENERGY CONVERSION FACTORS

1 kWh = 3,412 BTU

1 kW = 3,412 BTU/Hr

1 HP = 0.746 kW

1 Ton = 12,000 BTU/Hr

1 Boiler HP = 33,475 BTU/Hr

1 Lb Steam ≈ 1,100 BTU (approx.)

1 Therm = 100,000 BTU

1 CF (cubic Foot) ≈ 1,000 BTU (approx.)

1 CCF = 100 CF ≈ 1 Therm (approx.)

1 MCF = 1,000 CF ≈ 1 MMBTU (approx.)

1 MMBTU = 1,000,000 BTU

$$\text{Load Factor} = \frac{\text{kWh for the billing period}}{\text{Peak kW} \times \text{Total Hours in the billing period}}$$

$$\text{Heating Degree Day (HDD)} = 65°F - \frac{(T_{High} + T_{Low})}{2}$$

$$\text{Cooling Degree Day (CDD)} = \frac{(T_{High} + T_{Low})}{2} - 65°F$$

LIGHTING TERMS

Lumens – The amount of light that a bulb produces. Unit of output; technically, "Luminous Flux"

Footcandles – Units of light density striking a surface. One footcandle is defined as one lumen distributed uniformly over one square foot of surface.

Lux – The metric equivalent of footcandle, equals 1 Lumen / 1 Sq. Meter

CRI – Color Rendering Index, a rating system from 0 to 100 which describes how well a light source brings out the true color of an object under a reference light source. 100 = Sunlight.

CCT – Correlated Color Temperature, measured in degrees Kelvin, is the measure of color appearance for warmness or coolness. Cooler is a higher temperature, Warmer is a lower temperature.

LLD – Lamp Lumen Depreciation refers to the aging of a lamp and its reduction in light output. Typically referenced as a curve over time.

AIR CONDITIONING EFFICIENCY TERMS

SEER –Seasonal Energy Efficiency Ratio

**based on an outside air temp of 82°F and an indoor temp of 80°F @ 50% relative humidity (Ø)*

$$\textbf{SEER} = \frac{\text{BTU / Hr (cooling)}}{\text{Watts}}$$

This unit of efficiency is normally applied to most AC systems below 65,000 BTU/Hr

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EER –Energy Efficiency Ratio

**based on an outside air temp of 95°F and an indoor temp of 80°F @ 50% relative humidity (Ø)*

$$\textbf{EER} = \frac{\text{BTU / Hr}}{\text{Watts}}$$

This unit of efficiency is normally applied to most AC systems over 65,000 BTU/Hr. Electric driven chillers are sometimes rated by this method but more often by kW/ton.

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kW/Ton – Kilowatts per Ton of Cooling

$$\frac{\textbf{kW}}{\textbf{Ton}} = \frac{\textbf{Kilowatt Input}}{\textbf{Cooling Output (tons)}}$$

$$\textbf{kW}_{\text{air conditioner @95°F}} \approx \frac{\textbf{12 x Tons}}{\textbf{EER}} \qquad \textbf{kW}_{\text{air conditioner @82°F}} \approx \frac{\textbf{12 x Tons}}{\textbf{SEER}}$$

COP – Coefficient of Performance

$$\text{COP} = \frac{\text{Useful Heat BTU Output}}{\text{BTU Input}}$$

EER = COP x 3.412

RLA – Running Load Amps

FLA – Full Load Amps

Heat Transfer for Chilled Water Systems

q = m x c x ΔT

where:

q = BTU/Hr

m = mass of gallons of water in Lbs/Gallon

c = specific heat of water = 1 BTU/Lb. °F

ΔT = temperature difference in °F

One Ton of Chilled Water ≈ 500 x GPM x ΔT

Commercial Heating

$$\text{\$ / MMBTU} = \frac{\text{\$ / Fuel Unit}}{\text{MMBTU / Fuel Unit x Efficiency}}$$

Electric Motors

Motor Speed

$$\text{Synchronous Speed} = \frac{120 \times \text{Frequency}}{\text{Number of Poles}}$$

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2 Poles = 3,600 RPM

4 Poles = 1,800 RPM

6 Poles = 1,200 RPM

8 Poles = 900 RPM

Motor Load by Current & Voltage

$$\text{Load Factor \%} = \frac{\text{Load HP} \times 100\%}{\text{Nameplate HP}}$$

Power equation including power factor is:

W = Volts x Amps x Power Factor x 1.732 *….(√3)*

$$\text{kW} = \frac{\text{Volts} \times \text{Amps} \times \text{Power Factor} \times 1.732}{\text{1000 W / kW}}$$

**estimate Power Factor to be 0.8 or 0.9, otherwise use it from the nameplate if available.*

Motor Load by Slip

$$\text{Load Factor \%} = \frac{\text{(synchronous speed – measured operating speed) x 100\%}}{\text{Synchronous speed – Nameplate Speed}}$$

Power Factor – an indication of the amount of magnetized current required by the motor.

Power Factor = kW / kVA

Motor Demand & Energy Usage Calculations

$$\text{kW} = \frac{\text{(HP) x (.746 kW/HP) x (Motor Loading)}}{\text{Efficiency}}$$

Reasons for Using VFD's on Fans and Pumps have to do with Affinity Laws.

Where Flow rate of air or liquid is proportional to Speed, but…

Shaft HP is proportional to the flow % cubed.

Heat Pumps

HSPF – Heating Seasonal Performance Factor

$$\text{HSPF} = \frac{\text{BTU / Hr (heating)}}{\text{Watts x Hour}} \qquad \text{COP} = \frac{\text{HSPF}}{3.412}$$

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