KNOWN PROPERTIES, VALUES AND PHYSICS

THERE ARE:
231 cubic inches in one gallon of water
One gallon of water weighs 8.34 pounds (lbs.)
One pound of water occupies 27.7 cubic inches or 0.016 cubic feet
One cubic foot holds 7.48 gallons or 62.39 lbs. of water

1 BTU
=1 lb. of water raised 1 degree Farenheit
=778 foot lbs. of energy (778 lbs. lifted 1 foot)

1 POUND OF WATER
requires 970.4 btu's added to water already at 212 degrees to convert to
212 degree steam (at atmospheric pressure, or 14.7 lbs. absolute).
...and when converted to steam will occupy 27 cubic feet at atmospheric pressure, 4.43 cubic feet at 100 lbs. pressure (absolute), and 1208 cubic feet in a 29.4 inch (mercury) vacuum.

WATER boils at 100 degrees in a 28 inch (mercury) vacuum, 40 degrees in a 29.67 inch (mercury) vacuum, and at 327.8 degrees at 100 lbs. (absolute) or 85.3 lbs. (guage).
STEAM at 100 psi (saturated) will gain...14% volume with 100 degrees of superheat added.

1 HORSEPOWER
=33,000 lbs. lifted 1 foot in 1 minute
=550 lbs. lifted 1 foot in 1 second
=750 watts electrical energy (746 true)
...and one killowatt (1000 watts) equals 1.34 horsepower

TO DETERMINE STEAM HORSEPOWER (constant); use the following formula:
P.L.A.N. / 33,000 = horsepower (then multiply by 2 for 'indicated'-not true hp)
whereas: **P**= pressure (average or 'mean' in cylinder)
L= length of stroke in feet
A= area in inches (") of piston or bore
N= Number of strokes per minute or RPM's
then divide **PLAN** by 33,000 to get constant horsepower. (actually is true kw)
example:
P= 100 psi, **L**= 6" (.5 feet), **A**= 19.6" (5" dia. piston), **N**= 500 rpm's
100 x **.5** x **19.6** x **500** = 490,000 490,000 / 33,000 = 14.85 horsepower (true kw)

TO DETERMINE PRONY BRAKE HORSEPOWER (common), use the following formula:
2 x pi x T x N / 33,000 = horsepower
whereas: pi = 3.1416
T= torque
N= Revolutions Per Minute

TO DETERMINE BOILER HORSEPOWER
divide the pounds of water evaporated into steam in one hour by 34.5 (old formula)
5 Square feet = 1hp = 34.5 Pounds per hour of steam

GRATE AREA FOR SOLID FUEL
figure in light draft- 1 square foot per horsepower (wood) [double that for coal]
if you double the air with forced draft, then reduce area by 50% to 60%.
(it is important to note that air requires a substantial amount of heat to be brought to the ignition temperature and that air can absorb
important heat from radiant surfaces)

CONDENSERS require about 1 square foot of cooling surface per horsepower w/60 degree water.
ENGINE EFFICIENCY may be determined by measuring the amount of condensate from the exhaust/hour and dividing it by constant horsepower.
Example: engine gives 200 lbs. of water (condensate) while producing constant 5 horsepower.
(200 / 5 = 40 lbs. per horsepower hour).....***AND*** in round #'s, 3 lbs. per horsepower/hour is 100% efficiency.

ABSOLUTE PRESSURE is the total pressure from a vacuum, (generally 14.7 lbs. or atmospheric pressure) more than **GUAGE PRESSURE**;
which is 0 lbs. at atmospheric pressure (14.7 absolute)

MEAN PRESSURE is the average of all the pressures as volumes increase due to the stroke of piston.
ENTROPY is simply a measure of disorder or randomness. In steam, it is used as a measurement of energy not available for work.

SUPERHEAT is the heat added to a gas that raises the temperature of the gas above the necessary temperature required to change state from a liquid to solid.
Example: steam at 14.7 lbs. absolute @ 312 degrees is steam containing 100 degrees superheat.

FINDING ENGINE HORSEPOWER OUTPUT
Determine actual watt output (E1) and divide by transmission and generator efficiency (E2)
and divide total by 746 watts (one electrical horsepower).
Example:
(watts = volts x amps)
(E1) 14.7 volts x 22 amps = 323.4
(E2) belt losses, alternator efficiency = 70% (estimated) or .70
E1 / E2 = 323.4 / .70 = 462 watts
462 watts / 746 =.62 horsepower

HARDWOOD ENERGY VALUES

Species	Density		Heat Value		
	lb/cu. ft.	**lb/cord**	**BTU/lb**	**Mil-BTUs/ton**	**Mil-BTUs/cord**
Willow	23.7	3,034	8,400	16.8	25.2
Sugar Maple	39.1	5,005	8,400	16.8	42.0
Red Maple	34.3	4,390	8,400	16.8	36.9
American Beach	39.1	5,005	8,600	17.2	43.0
Eastern Cottonwood	25.9	3,315	8,800	17.2	29.2
Red Oak	39.8	5,094	9,360	18.6	47.6

* all values are based on oven dry weight

- **One Full Cord = 128 cubic feet**
- **Willow Yields 5-8 tons / acre, non-irrigated**
- **Coal yields 20,974,000 BTUs / short ton**
- **One acre = 208.71' x 208.71'**

Using the same conversion rate for willow as exists for coal, 10,452 Btu's /KwH, one mean acre of willow yields 10,447 KwH's. One acre, 209' x 209', is sufficient to supply ~1.19 homes consuming 1Kw each hour for an entire year.