FORMULAS AND MEASUREMENTS

FORMULAS

- Area of a square or rectangle = Length X Width (See the Summary of Standards to determine what is included in area measurements for NEAT and BTL calculations)
- Area of a circle = π X r squared or 3.1416 X radius X radius
- Area of a triangle = 1/2 B X H or 1/2 the length of the base X the highest point of the triangle
- Circumference of a circle = 2 X π X r or 2 X 3.1416 X radius
- Volume of a square or rectangle = length X width X height (See the Summary of Standards to determine what is included in volume measurement for NEAT and BTL calculations)
- Volume of a cylinder = π X r squared X h or 3.1416 X radius X radius X height
- Minimum ventilation level (MVL) for Iowa is .35 as set by ASHRAE
- 17 is the correlation factor used for Iowa in some of the following formulas
- Building Tightness Limit (BTL) = .35 X volume ÷ 60 X17
- Air changes per hour (ACH) = natural air changes per hour (NACH)
- NACH = CFM 50 ÷ volume X 60 ÷ 17 or
- NACH = ACH 50 ÷ 17
- Mechanical change rate (MCH) = .35 - NACH
- Ventilation capacity in CFM = mechanical change rate X house volume ÷ 60. This is used to determine the CFM of a ventilation fan that is needed for the BTL
- Air free carbon monoxide: A ÷ B = air free CO (A = carbon monoxide reading X 20.9 (oxygen in air), and B = 20.9 - oxygen content of flue gases.)
- U-value = 1 ÷ R-value
- R-value = 1 ÷ U-value
- Cost per million Btus by fuel type
  - Electric = fuel cost (KWh) X 292 ÷ efficiency of heating unit (1.0)
  - Natural gas = fuel cost (therm) X 10 ÷ efficiency of heating unit (steady state efficiency)
  - Oil = fuel cost (gallon) X 7.14 ÷ efficiency of heating unit (steady state efficiency)
  - Propane = fuel cost (gallon) X 11.1 ÷ efficiency of heating unit (steady state efficiency

  Efficiencies are represented as decimals with electric heating being 1.0 and gas and oil being under 1.0 such as .92 for a high efficiency unit. A geothermal heat pump would be 3.0 to 4.0 efficient, and an air to air heat pump would be 1.8 to 2.6 efficient.

- Cellulose insulation
  - .036 lbs. Of cellulose insulation per square foot, per R-value open blow (example. R-19 = .6816 lb. per square foot)
  - .296 lbs. Of cellulose insulation per square foot, per R-value dense pack (example 6 inch cavity = 1.7816 lb. per square foot)

- Cost effectiveness
  - Payback = cost in dollars divided by annual savings
  - Return on investment = annual savings in dollars divided by initial cost in dollars
  - Savings to investment ratio = life-cycle savings in current dollars divided by initial cost in dollars

- Heating input from a gas meter = gas flow rate in cubic feet per minute X the energy content of gas (usually 850 - 1100 Btus/cu. Ft.) X 60 (number of minutes per hour).

- Heating replacement savings (annual) = 1 - (efficiency of existing heater divided by efficiency of replacement heater) X annual heating cost of the existing heater.

MEASUREMENT CONVERSIONS

- Energy Conversions
  - 1 kilowatt = 1,000 watts
  - 1 kilowatt = 56.89 Btu per minute
  - 1 kilowatt = 1.34 horsepower
  - 1 kilowatt hour = 3413 Btu
  - 1 Btu = .2930 watt-hour
  - 1 Therm = 100,000 Btu
  - 1 ton = 12,000 Btu

- Btu Conversion Factors
  - Electricity = 3,412 Btu/kWh (kilowatthour)
  - Natural Gas = 100,000 Btu/therm or 100,000 Btu/CCF
  - Fuel Oil = 315,000 Btu/gallon
  - LPG (Propane) – 91,330 Btu/gallon
  - Wood – 20 million Btu/cord

- Metric Conversions
  - 1 meter = 3.281 feet
  - 1 micrometer = μm = micron = .000001 meter
  - 1 liter = 1.057 quart = .264 gallons
  - 1 kilogram = 2.205 lbs.
  - 1 gram = .0353 ounce

- Pressure Conversions
  - 1 Pascal = .004 inches of water column
  - 1 Kilopascal = .145 lbs. Per square inch (psi)
  - .1 inch water column = 25 Pascals
  - .2 inch water column = 50 Pascals
  - .5 inch water column = 125 Pascals
  - 1 inch water column = 250 Pascals

- Temperature Conversion
  - Celsius to Fahrenheit = 9/5 X Celsius reading + 32 or 1.8 X Celsius reading + 32
  - Fahrenheit to Celsius = Fahrenheit reading - 32 X 5/9 or Fahrenheit reading - 32 X .5556

- Fraction to Decimal Conversion
  - 1/16 = .0625
  - 1/8 = .1250
  - 3/16 = .1875
  - 1/4 = .2500
  - 5/16 = .3125
  - 3/8 = .3750
  - 7/16 = .4375
  - 1/2 = .5000