



Reasonably assume: A properly insulated standard building assembly will approximate the insulation R-value less 10%
 Uninsulated wall assembly: R-3 Uninsulated ceiling – no attic floor: R-1 Uninsulated ceiling – with attic floor: R-2

Surface Heat Loss

Heat loss is calculated in BTU per hour (Btuh) or seasonally (Btu/yr)

$$\frac{A \times \Delta T \times t}{R}$$

(Hourly)

A = area in ft²
 ΔT = temperature difference in ° F.
 t = time in hours (typically 1 – at design temp)
 R = R-value of assembly
 HDD = Heating degree days
 24 = Hours per day

$$\frac{A \times HDD \times 24}{R}$$

(Heating season)

Using U-factor, the formula can also be written: **A x ΔT x t x U** (hourly) or **A x HDD x 24 x U** (season)

Practice: A 40ft x 30ft (1200 ft²) home with 8' ceilings is located in Grand Rapids Michigan, which has an average of 6894 Heating Degree Days (HDD). The building has 980 net sq. Ft. of un-insulated 2x4 walls and R-19 fiberglass batts in the ceiling. What is the heat loss per hour for the net wall area and the ceiling area at a design temp of 0° F? Calculate from an indoor temp of 65°. Natural gas is the heating fuel at \$1.10/therm. See above for R-Value reasonable assumptions.

Btu/hr walls: _____ (**980 x 65 ÷ 3 = 21,233**) Btu/hr ceiling: _____ (**1200 x 65 ÷ 17.1 = 4,561.4**)

What is the yearly loss for the walls and ceiling? Assume a 92% furnace – what is the cost for each?

Btu/yr walls: _____ (**980 x 6894 x 24 ÷ 3 = 54,048,690**)
 Cost/yr walls: \$ _____ (**54,048,690 ÷ 100,000 = 540.5 therms ÷ .92 x 1.10 = \$646.25**)
 Btu/yr ceiling: _____ (**1200 x 6894 x 24 ÷ 17.1 = 11,610,947**)
 Cost/yr ceiling: \$ _____ (**11,610,947 ÷ 100,000 = 116.1 therms ÷ .92 x 1.10 = \$138.82**)

The walls have been dense-packed with cellulose to an R-13 and the attic has had an additional R-19 added. What is the new yearly heat loss for the walls and ceiling? What is the new cost?

Btu/yr walls: _____ (**980 x 6894 x 24 ÷ 11.7 = 13,858,708**)
 Cost/yr walls: \$ _____ (**13,858,708 ÷ 100,000 = 138.6 therms ÷ .92 x 1.10 = \$165.70**)
 Btu/yr ceiling: _____ (**1200 x 6894 x 24 ÷ 34.2 = 5,805,474**)
 Cost/yr ceiling: \$ _____ (**5,805,474 ÷ 100,000 = 58 therms ÷ .92 x 1.10 = \$69.41**)

The cost to add an additional R-19 to the attic above was \$1,620.00. What is the simple payback in years for the added insulation? Simple Payback: _____ yrs
(\$1620.00 cost ÷ \$69.41 savings = 23.3 years – there are times that it will not be cost effective)

Just for fun, what would the yearly heat loss have been through the ceiling had it been un-insulated?

Btu/yr ceiling : _____ (**1200 x 6894 x 24 ÷ 1 = 198,547,200**)
 Cost/yr ceiling: \$ _____ (**198,547,200 ÷ 100,000 = 1,985.5 ÷ .92 x 1.10 = \$2,373.96**)
 Add 2" of cellulose? Btu/yr: _____ (**1200 x 6894 x 24 ÷ 6.3 = 31,515,428**)
 Cost with minimal insulation? \$ _____ (**31,515,428 ÷ 100,000 = 315.15 ÷ .92 x 1.10 = \$376.81**)