#3983

UNDERSTANDING HEAT LOSS CALCULATIONS

FACTSHEET

WASHINGTON ENERGY EXTENSION SERVICE

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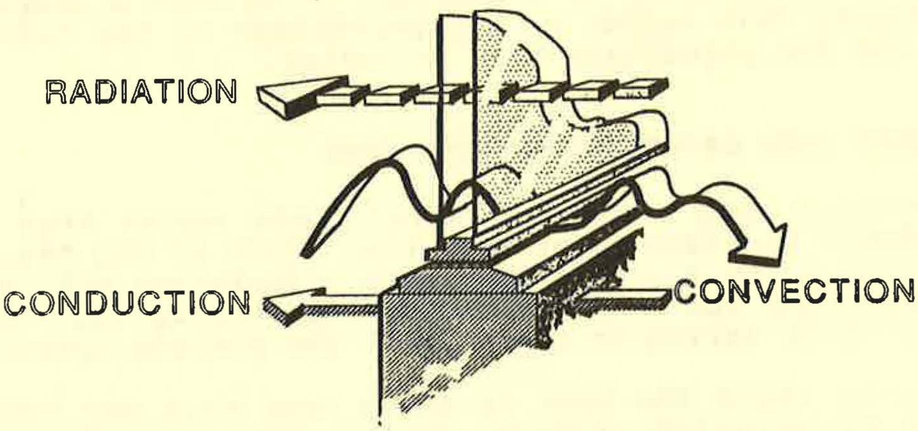
INTRODUCTION

Monthly heating bills get larger and larger as energy costs increase. To reduce costs without reducing comfort, energy conservation measures should be taken. In order to determine which measures should be taken -- adding additional insulation, storm windows, installing a new furnace, or other measures --you must first determine how much heat the house is currently losing and where it is being lost. To do this, a heat loss calculation is performed. This Factsheet will tell you what heat loss calculations are, and how they can help you. For information on how to perform heat loss calculations, ask for the factsheet titled "Performing Heat Loss Calculations (FS1201)."

WHAT ARE HEAT LOSS CALCULATIONS?

Heat loss calculations are a set of equations used to determine the overall heat loss from all or part of a building. This heat loss is typically expressed in British Thermal Units (Btu), a commonly accepted measurement of heat. A Btu is the amount of



heat required to raise the temperature of one pound of water one degree Fahrenheit, or about the amount of heat released from a common kitchen match.

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Heat losses from a building can be grouped into two categories: envelope, or skin, losses and, infiltration, or air leakage, losses. Envelope losses are due to the complex processes of convection, conduction and, radiation. Infiltration, which consists of cold air leaking in, heated air leaking out, and bathroom and kitchen fans exhausting warm air out , is more accurately described as infiltration/exfiltration/ventilation heat loss.

Because buildings are constructed of various materials with differing degrees of heat transfer, it is not always easy to calculate heat loss. Heat loss can be viewed in two ways, the material's resistance to heat flow, or R value, and the material's ability to transmit heat, or U value. The larger the R value, the higher the material's resistance to heat loss. The smaller the U value, the lower the heat flow through the material.

Heat loss through a building component can be measured even when the component is made up of different materials by adding the R values of the various materials together and then multiplying by the percentage of the component that is made of the material. Look at Example 1. Notice that the ceiling has two columns of numbers labeled "Solid" and "Cavity." These values represent the R values of the materials in the path of heat loss through the solid and open cavity portions of the ceiling. By adding these R values together, the total R value for that heat transfer path can be found. The solid portion of the ceiling has an R value of 32.99 while the cavity portion has an R value of 39.62. Because R values cannot be averaged, these values must be converted to U values before the ceiling component U value can be found. Since R and U values are related, if you have one number, you can find the other by using the formula $R = 1/U$, $U = 1/R$. Once the R value has been converted to a U value, it is then a simple matter of multiplying this number by the percentage of the ceiling that is solid and the percentage that is cavity.

HOW CAN HEAT LOSS CALCULATIONS HELP YOU?

- For economy and comfort, experts now agree that heating systems should be sized to no more than 150% of the heating load of the building. An accurate heat loss calculation will allow you to properly size the heating system, increasing the comfort of your house while saving on the cost of the heating system.

- By showing where the heat is being lost from the building, a heat loss calculation enables you to make wise decisions on energy conservation investments. Such a calculation will show how changes in insulation levels will impact the total heat load of the house, and therefore your energy bill. You can then invest your money on energy conservation measures that give you the greatest return.

• By showing how much heat is being lost from the building, a heat loss calculation enables you to predict future costs. This will help with budget decisions.

• If remodeling or adding to the house, heat loss calculations will show how much additional heat will be required by the new space.

WHO SHOULD DO HEAT LOSS CALCULATIONS?

Builders. The Washington State Energy Code requires heat loss calculations be submitted when applying for a building permit to ensure that the heating system is properly sized for the house. These calculations also help the builder estimate the cost of the heating system.

Homeowners. Heat loss calculations enable homeowners to optimize energy conservation investments.

Heating system professionals. These professionals use heat loss calculations to correctly size the heating equipment for the job.

Architects, designers and energy analysts. Heat loss calculations enable these professionals to incorporate features into their design which will make the building as energy efficient as possible.

WHAT SHOULD BE INCLUDED IN A GOOD HEAT LOSS CALCULATION?

Whether you decide to attempt a heat loss calculation yourself or you have someone else do it for you, there are things you should always look for in good heat loss calculations.

• **Are the measurements accurate?**

Make sure that the measurements used to compute the heat loss are accurate. If the areas used are too large or small, the heat loss is going to look too high or too low. This may affect both comfort and heating system efficiency.

• **Are the component U values reasonable?**

The component U value (as stated earlier) is a measure of the transmittance of heat through a building component, and is essential to the accuracy of the calculations. Look at Figure 2. This Figure is an example of a complete heat loss calculation. Notice that each component of the building has a component U value which is then multiplied by the area of the component to find the heat loss through that portion of the building. Some component U values can misrepresent the heat loss through a component by not taking into consideration the structural framing. A simple way to check whether the framing is represented in the U value is to convert this value into an R value (divide 1 by the component U value (1/U)). If the component R value is less than the R value of the insulation, then you can assume that the component U value takes into account the framing. Using the example in Figure 1, the component U value for the wall is .0576, which means the R value is R-17.36 (1/.0576). Because the nominal insulation value of the wall is R-19, you may assume that the wall framing was taken into consideration.

- **Has heat loss due to air leakage or duct losses been included in the calculation?**

Two areas that are occasionally overlooked in heat loss calculations are the losses from air leakage and duct work. In well insulated houses the heat lost to air leakage can reach 50% of the total building loss. Losses from leaking and poorly insulated duct work must be considered to ensure adequate furnace sizing.

WHERE CAN YOU GET MORE HELP?

The Washington Energy Extension Service offers a factsheet titled "Performing Heat Loss Calculations" (FS1201), that may help those interested in actually performing heat loss calculations. Staff members are also available to answer specific questions.

WEES PUBLICATIONS:

Home Insulation (FS1102)
Performing Heat Loss Calculations (FS1201)
Reducing Home Air Leakage With A Door Fan (FS1105)
The Warm Room (FS1204)
Zone Heating (FS1205)

REFERENCES

Ashrae Handbook 1985 Fundamentals, American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. 1791 Tullie Circle, N.E., Atlanta, GA, 30329.

Super Good Cents Technical Reference Manual, Bonneville Power Administration, Office of Conservation, P.O. Box 3621, Portland, OR, 97208, 1987.

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Figure 1.

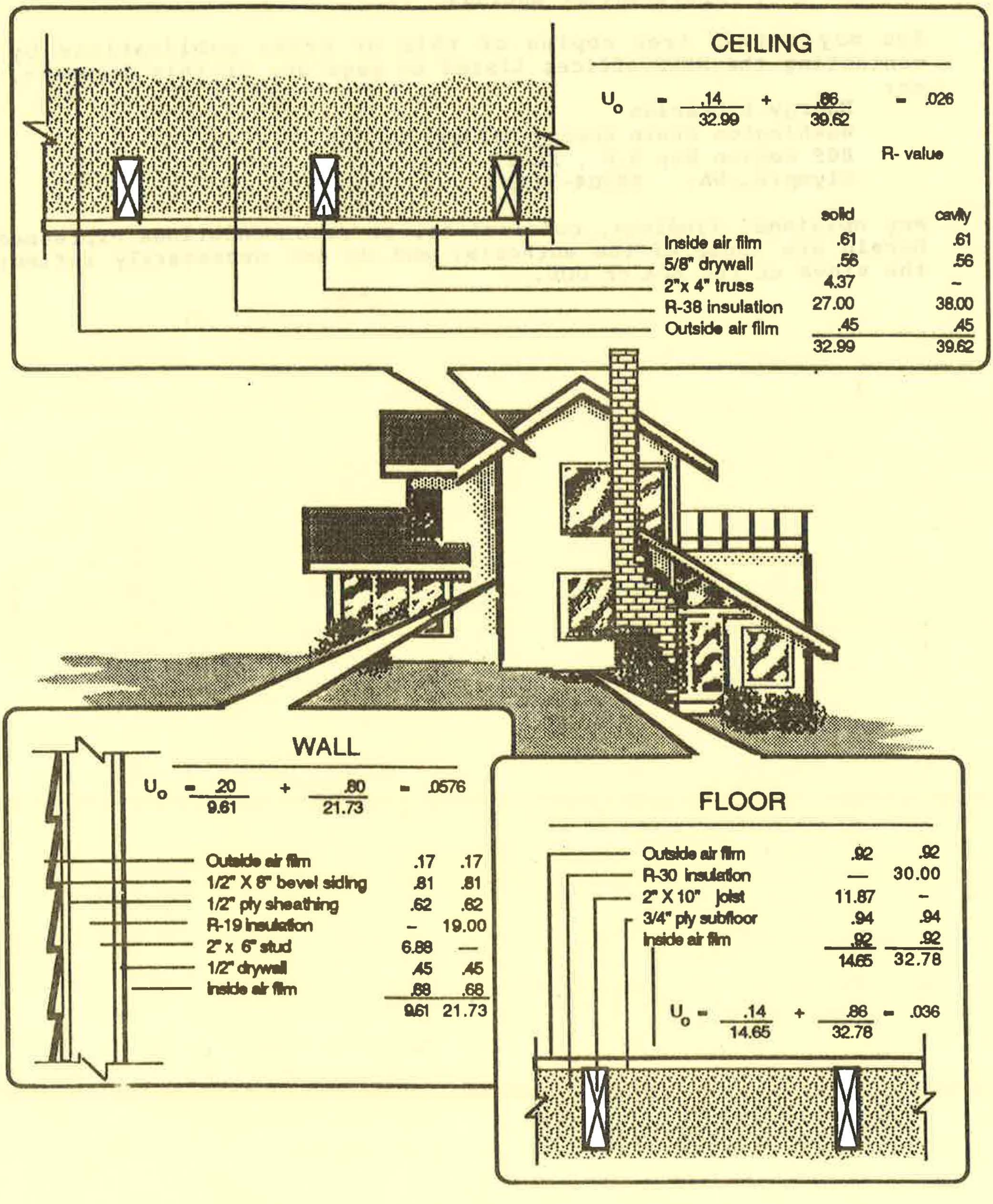
CEILING
U_o = .14/32.99 + .86/39.62 = .026
R- value
solid cavity
Inside air film .61 .61
5/8" drywall .56 .56
2"x 4" truss 4.37 –
R-38 insulation 27.00 38.00
Outside air film .45 .45
32.99 39.62
WALL
U_o = .20/9.61 + .80/21.73 = .0576
Outside air film .17 .17
1/2" X 8" bevel siding .81 .81
1/2" ply sheathing .62 .62
R-19 insulation – 19.00
2" x 6" stud 6.88 —
1/2" drywall .45 .45
Inside air film .68 .68
9.61 21.73
FLOOR
Outside air film .92 .92
R-30 insulation — 30.00
2" X 10" joist 11.87 –
3/4" ply subfloor .94 .94
Inside air film .92 .92
14.65 32.78
U_o = .14/14.65 + .86/32.78 = .036

Figure 2

The Following Example Is Of A Typical Heat Loss Calculation.

Qc = U x A

Component	U value	Area/Sq. Ft.		UA/btu/hr/F^{o}
Floor	.036	1120	=	40.32
Walls	.0576	1672	=	96.31
Windows	.70	270	=	189.00
Doors	.46	56	=	25.76
Ceilings	.026	1104	=	28.70
Skylights	.90	16	=	14.40

Qi = .018 x V x Ach

Infiltration .018 14840 .5 = 133.56

528.05 btu/hr/f^{o}

The value calculated above is a measure of the amount of heat leaving the house on an hourly basis for every 1 degree of temperature difference between the inside and outside. To calculate the heating system size, some measure of the local winter climate must be taken into consideration. This number is the winter design temperature. Based on historical weather data, the winter outside temperature will drop below this design temperature only 3% of the time.

Design Temperature = 19F^{o} Temp. Difference = 65^{o} - 19^{o} = 46^{o}

Qs = UA x *T 528.05 x 46^{o} = 24,290 btu/hr

Duct Work Losses: ducts in crawlspace, insulated to R-5

Qd = dlm* x Qs .10 x 24,290 = 2,429 btu/hr

Q = Qs + Qd 24,290 + 2,429 = 26,719 btu/hr

dlm* = Duct loss multiplier, ACCA, Manual J, Table 7A
Q = Total Heat Loss
Qs = Structural Heat Loss Qc = Conductive Heat Loss
Qi = Convective Heat Loss
V = Volume UA = Thermal Transmittance for an Area
Ach = Air change Rate
T = Temperature Difference
Qd = Duct loss