Electrical Tech Note — 385

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Building Materials R-Values

Determination of heat loss from a building involves calculating the heat loss for each portion of different building surface such as the wall, windows, doors, ceiling, and floors. If walls consist of different materials then a separate calculation is made for each type of material. The driving force for heat loss is the difference in temperature across the surface. This temperature difference is determined by deciding upon the desired inside temperature, and then from weather data, find the minimum outside temperature for the area. Usually this minimum temperature is a value below which the temperature is not expected more than 5% of the time. When the temperature goes below the design value it usually is not below that value for more than a few hours at most. Heat loss (Q) for a building material is determined by multiplying the temperature difference (ΔT) by the area (A) of the material and dividing by the total R-value for the material. Heat loss from a building material can be calculated using *Equation 385.1.* The heat loss for each building material is added together to determine the total heat loss from the building.

$$Q = \frac{A \times \Delta T}{R - value} \qquad \textbf{Eq. 385.1}$$

Example: Assume a one room building has dimensions 24 ft by 32 ft with a ceiling area of 768 ft^2 (R-value = 24), wall surface area of 856 ft^2 (R-value = 16), two insulated doors with storm door at 40 ft^2 (R-value = 12), and six windows at 90 ft^2 (R-value = 0.89). The total heat loss from the building is calculated to be 18,995 Bth.hr.

walls:	(856 x 100)/16	=	5,350 Btu/hr
ceiling:	(768 x 100)/24	=	3,200 Btu/hr
windows:	(90 x 100)/0.91	=	9,890 Btu/hr
doors:	(40 x 100)/12	=	333 Btu/hr
Total Heat Loss			**18,773 Btu/hr**

Building Heat Loss: Building heat loss is driven by the temperature difference between the inside and outside of the building surface. Obviously the larger the surface area of the building, the greater will be the heat loss. All materials will allow heat flow, but some will allow heat to pass faster than others. The opposite is the resistance to heat flow which is called R-value. *Table 385.2* gives the R-value for some common building materials. Heat flow is generally given in British thermal units per hour (Btu/hr). R-values for windows and doors are given in *Table 385.1.* All building surfaces are made up of a sandwich of materials each of which has a resistance to heat flow. Even a single pane of glass is a sandwich of three materials with an R-value for each. Two of the materials that are usually included in the determination of R-value for any building section is a very thin still layer of air next to the inside and outside surfaces of the material. This thin layer of air acts as an insulation and is usually included in the total R-value determination. The R-values for thin air films is given in *Table 385.3.* The single pane of glass has an R-value of 0.91 which is made up of an inside thin air film with a value of 0.68, the glass itself with a value of only 0.06, and the outside thin air film with a value of 0.17. Add these three values to get the total value for the single pane window (0.91). This is illustrated in

Figure 385.1. Double pane glass has a trapped air space between the glass which acts as in insulation. R-values for trapped air space are given in *Table 385.3.* If a storm door fits tightly it too will trap air between the main door and the storm door which will act as a layer of insulation. The total R-value for this window is simply the sum of the individual R-values (0.17 + 0.06 + 0.68) = 0.91)

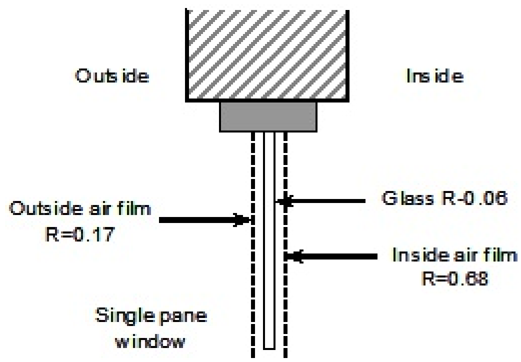

Figure 385.1 *Included in each calculation of the total R-value for a building material is a thin air film on the inside and outside of the material. These still air films next to the surface add to the total R-value of the material. In the case of window glass, these air films may be the most significant portion of the window R-value.*

To obtain the heat loss from a window use *Equation 385.1.* Multiply the area of the window by the expected temperature difference for the winter. How to select the outside design temperature difference is discussed later. In this case assume it is 70°F. Then divide by the R-value to get the total heat loss for the window. In this case assume the window is 12 square feet. The heat loss from this window would then be 923 Btu/hr.

$$HeatLoss = \frac{12\,ft^2 \times 70^\circ F}{0.91} = 923 Btu / hr$$

Here is another example that for a building wall section where the outside is vinyl lap siding, half inch sheathing, 3.5 inches of fiberglass blanket insulation, 5/8 in. wood particle board (OSB), and 1/16 in. vinyl inside surface. The wall section is shown in *Figure 385.2.* The individual R-values for each material through the wall section are added to obtain a total R-value of 15.33. Assuming a wall section that is 16 ft long, 8 ft high with one window with an area of 12 ft^2, the total area of the wall section is 128 ft^2 minus the 12 ft^2 for the window to get 116 ft^2. Using a temperature difference of 70°F, the heat loss through this wall section is 530 Btu/hr.

Exterior air film	0.17
Vinyl lap singing (traps an air space)	1.00
1/2 in. sheathing	1.32
3.5 in. fiberglass blanket (3.5 in. x 3.12/in)	10.92
5/8 in. particle board	1.14
1/16 in. vinyl inside covering	0.10
inside air film	0.68
Total R-Value	**15.33**

$$HeatLoss = \frac{116 ft^2 \times 70^\circ F}{15.33} = 530 Btu / hr$$

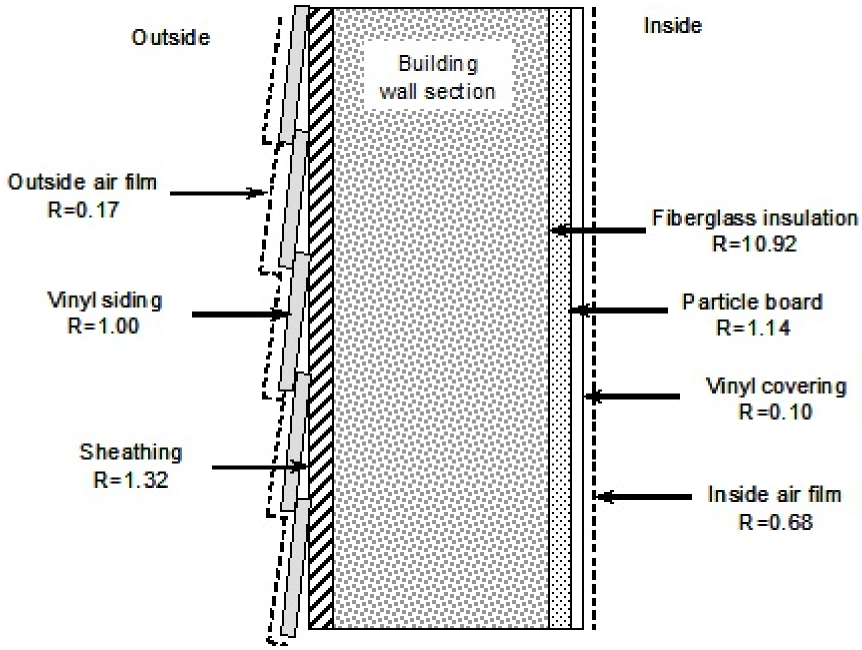

Figure 385.2 *R-value of a building section is the sum of the R-values of the individual materials. R-value of some materials is given in value per inch thickness and must be multiplied by the actual thickness of the material.*

Table 385.1 *Window and door typical R-values. Actual R-values may be available for other windows.*

Windows and Doors		**R-value**
Single glass window		0.06
Single glass window with storm		1.15
Double-pane with 3/16 in. air space		0.60
Double-pane with 1/2 in. air space		0.88
Triple-pane with 1/4 in. air space		1.71
Doors, solid wood 1-3/4 in.		2.17
Door, solid wood 1-3/4 plus storm door		3.23

Table 385.2 *Common building materials R-values. For R-values per inch, multiply by the thickness.*

Building Material	**R-value per inch**	**R-value for thickness**
Plaster board, 1/2 in.		0.32
Plaster board, 5/8 in.		0.45
Plywood, 1/4 in.		0.31
Plywood, 3/8 in.		0.47
Plywood, 1/2 in.		0.63
Plywood, 5/8 in.		0.78
Plywood, 3/4 in.		0.94
Sheathing, 1/2 in.		1.32
Wood fiber board	1.82	
Fiberglass blanket insulation	3.12	
Expanded urethane insulation board	5.88	
Expanded polystyrene insulation board	3.45	
Macerated paper, loose fill	3.57	
Sawdust or shavings, loose fill	2.22	
Vermiculite, loose fill	2.08	
Metal, any type any thickness		0.00
Asphalt roofing shingles		0.44
Wood roofing shingles		0.94
Wood, bevel, 1/2 in. by 8 in lapped		0.81
Hardwood	0.91	
Fir, pine,softwood	1.25	
Concrete block, 8 in., 3 core		1.11
Concrete block, 12 in., 3 core		1.89
Ordinary brick, 4 in.	0.11	0.44
Concrete	0.08	

Table 385.3 *Surface air film and trapped still air space R-values.*

Air Film or Trapped Still Air Space		R-value
Vertical interior air film		0.68
Vertical exterior air film		0.17
Horizontal interior ceiling air film		0.61
Floor top surface air film		0.92
Vertical air space (3/4 in. to 4 in.)		0.90
Vertical air space with outside reflector		2.17

Outside Design Temperature: The driving force for heating or cooling of a building is the difference in temperature between the inside and outside of the building. The actual heat loss will change as that difference in temperature changes. It is necessary to plan for the coldest part of the winter in order to have a heating plant that will be sufficient to maintain a comfortable inside temperature. The coldest outside temperature possible is not usually used as the design outside temperature. Generally the coldest outside temperature for a given area in which the temperature does not drop below more than 5% of the time is used as the outside design temperature for heating calculations. In the event the temperature does drop below the design temperature it will only mean that the inside temperature will drop. Generally it will only be a modist decline because the coldest outside temperature will only occur for a few hours, not continuously. The standard inside design temperature for human housing in winter heating is 70^{o}F. In many commercial buildings, the heat generated by lights and equipment must be figured in as a part of the building heating. Suggested outside design temperature for Michigan are given in *Figure 385.3.*

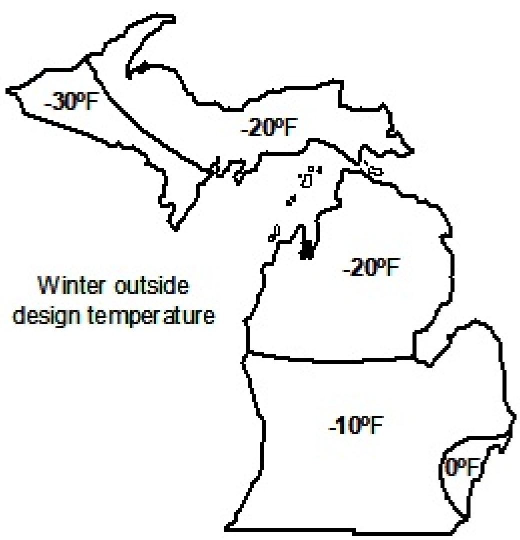

Figure 385.3 *Recommended outside design temperatures for Michigan to be used for calculating winter heating requirements.*

Fahrenheit and Celsius Temperature Scales: Sometimes temperatures listed on equipment may be in degrees Celsius (ºC). It is important to know how to make a conversion form degrees Celsius to degrees Fahrenheit. There are nine Fahrenheit degrees in five Celsius degrees. For example, if the inside to outside temperature difference (ΔT) is 70ºF, multiply by 5/9 (or divide by 1.8) to convert to the Celsius temperature difference. This is a temperature difference not the actual temperature. Note in *Figure 385.4* that the only place on the two scales where the two temperatures are the same is minus 40º. The temperature -40ºC is equal to -40ºF. To convert a temperature difference (ΔT) listed in Celsius to a Fahrenheit temperature difference, multiply the temperature difference in Celsius by 9 and divide by 5 (multiply by 1.8).

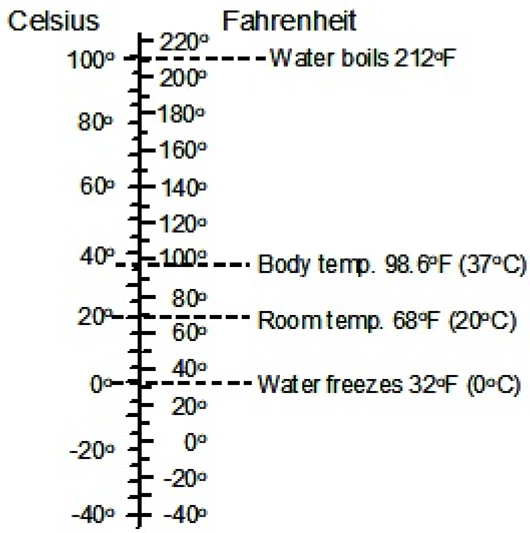

Figure 385.4 *The Celsius temperature scale is compared to the Fahrenheit temperature scale, and note they have the same reading at minus 40º.*

Ratings of Furnaces and Heaters: Furnaces and heaters are generally rated in Btu/hr. Electric heaters are generally rated in kilowatts (kW). The conversion is that one kilowatt is equal to 3413 Bth/hr. The metric unit of heat is the Joule. One kilowatt is equal to 1000 Joules per second or 3.6 million joules per hour. There is about 1055 Joules/hr. in one But/hr.

Methods of Heat Transfer: Heat from an animal, person or object can be transported by conduction, convection, or radiation. With *conduction*, heat energy is transferred through an object by passing from molecule to molecule. The material is fixed in place such as a solid wall. The rate at which heat travels through a material depends upon the material's heat conductivity. Generally that number is not known, but the resistance to heat movement or R-value is known. R-value is the reciprocal of the conductivity. The driving force for heat flow is the difference in temperature from one side of the material to the other. If the temperature on both sides of a material is the same, heat will not flow through the material. Heat flows from a high temperature to a lower temperature. The other factor involved in conductive heat flow is the area through which the heat must flow. The greater the area the greater will be the heat flow. The method of determining conductive heat flow is given in *Equation 385.1.*

Heat transfer by *convection* occurs when a fluid picks up heat and actually moves to another location. Generally the fluid picks up the heat by conduction and then either moves on it's own or is forced to move. A fan can move heat through ducts to another location or the fluid can move naturally. Gaseous fluids, such as air, take up more space when they take on heat.

The molecules get further apart. The result is a fluid with less density. Generally the weight of air is not noticed. For example, if the air in a room that is 20 ft wide, 40 ft long and 10 ft high is at a temperature of 65°F and 30% relative humidity at sea level, the air in the room will weigh 602 lbs. If the air is heated to 75°F, the air in the same room will weigh only 588 lbs. This is what makes a hot air balloon rise. A gaseous fluid will rise as it takes on heat. The air in a room next to a cold window will cool down as the heat from the air is conducted to the cold window surface. This cooling air will then fall to the floor and cause a draft. If a baseboard heater or warm air inlet is placed near the wall below a window, heat will be transferred to the air by conduction, then the warming air will rise up the wall past the window. The rising warm air will mix with the falling cool air. The fan of a forced air furnace in the basement will be assisted in forcing the heated air up to the rooms in the building because warm air rises. The cool air return will be assisted as the air naturally falls back to the basement through the cold air returns located at the base of the walls .

Radiation is another means of heat transfer in a building. Temperature is the driving force and heat radiates directly from a warm surface to a cold surface. In fact the rate of radiation heat flow is proportional to the fourth power of the temperature difference (ΔT^4). Heat flows directly from a warm object to a cooler object through a fluid or even through empty space. This is how heat is received from the sun, and why it gets real cold on a clear night. Outer space is very cold and heat radiates directly from objects on the earth to the coldness of outer space. Generally frost only forms on a clear night. Distance is another factor. Less heat will be transferred from one object to another if the objects are far apart. Radiation is also affected by the type of material, especially the surface of the material. It is important to understand that heat in a building can be moved by radiation. If a room has large windows that are very cold in winter, heat will radiate directly from a person's body to the cold window surface. Closing drapes or curtains will cut off the radiation path from the person to the cold window glass. A person can even feel warmer in a room at lower temperature if the drapes are pulled to prevent radiation to the cold windows. Increasing the R-values of walls and ceilings will raise the inside temperature of the ceiling and walls and can result in building occupants feeling more comfortable at a lower temperature because there will be less radiation to the cold walls and ceiling.

Building Heat Gain or Loss: The major heat loss during winter and heat gain in summer is generally due to conduction through building sections such as walls, windows, doors, ceilings, and floors. Another means of heat gain or loss from a building is by *infiltration*. Heat moves in or out of a building when doors are opened, and due to cracks between surfaces such as window and door frames. There will even be cracks between lapped board siding. This will be very obvious in winter when a draft is felt near window and door frames or outside wall receptacle outlets when the wind is blowing. This is heat transfer by convection and must be considered when figuring the heat loss for winter and heat gain in summer. This is called *infiltration*. It can be minimized by quality construction. Infiltration can be minimized to such a low level that normal building odors are not eliminated. Humidity may build to an excessive level in the building because moisture cannot escape. If infiltration is too low, a special vent may need to be added to insure adequate make-up air for a fuel fired furnace unless that fuel fired furnace or water heater receives combustion air direct from the outside. If a furnace cannot get enough air, carbon monoxide may build up in the building. For heating calculation purposes, infiltration is rated in air charges per hour. *Table 385.4* gives typical infiltration rates for buildings. Based upon a given infiltration rate in air changes per hour, *Table 385.5* gives the heat loss in Btu per hour per cubic foot of volume in the space. These are worst case values that can be used to determine the heating requirement for a building for a cold windy day. This table can also be used to evaluate the importance of each contributor to heat loss for a building. A heat loss analysis for a building will reveal the areas for heat loss improvements.

Table 385.4 *Typical infiltration rates for construction. This is the quantity of outside air that must be heated from the outside temperature to the inside temperature every hour.*

Construction	Air Changes per Hour
Very tight	1/2
Tight	3/4
Average	1
Old	2 or more

It can be difficult to estimate the infiltration rate for a building. One way is the feel for air flow on a windy day or feel for cold areas crated by infiltration. There are artificial smoke producing devices that can be used for this purpose. There is equipment available that can create a known pressure difference between the inside and outside of a building that can be used to more accurately determine the infiltration rate and heat loss from a confined space such as an entire building. This equipment should be operated by trained personnel who understand that older buildings may have been constructed with materials that now may be considered health hazards.

Table 385.5 *Heat loss by infiltration in Btu/hr per cubic foot of volume for the temperature difference given (Btu/hr/ft*^{3}*).*

Infiltration rate	70°F ΔT	80°F ΔT	90°F ΔT	100°F ΔT	110°F ΔT
1/2 air change/hr	0.631	0.722	0.812	0.902	0.992
3/4 air change/hr	0.956	1.092	1.229	1.365	1.502
1 air change/hr	1.263	1.443	1.624	1.804	1.984
1-1/2 air change/hr	1.911	2.184	2.457	2.730	3.003
2 air change/hr	2.526	2.886	3.247	3.608	3.969

Sources of Heat Within a Confined Space: Heat is added to a building by equipment and occupants. People moving about in an office building and doing desk work will generate heat at a rate of between 500 and 800 Btu/hr. Motors will produce heat at a rate of about 3000 Bth/hr for each horsepower. For more information on heat production rates for livestock, refer to *Tech Note 384.* Lights produce heat at a rate of about 3.4 Btu/hr per watt. For an office building, these factors must be considered and will reduce the heat load in winter, and will add to the cooling load in summer. This is why it is so important to keep unnecessary lights turned off in a building in the summer. In the winter it may be a toss-up as to whether heat loss through windows will be greater than heat gain due to radiation from the sun. In the summer, heat gain from the sun through windows will be significant and steps should be taken to prevent direct solar radiation.

Recommendations for Effective Building Heating: Window and door treatment is essential. Infiltration can be significantly reduced by installing weather stripping around doors. Window frames need to be caulked. Provide storm doors. Provide either storm windows or double pane windows. The actual window or door does not have a very high R-value by itself. Adding storm doors, storm windows, or double pane windows will provide an air space that by itself has a significant R-value. Fireplaces must also be fitted with tight dampers that will prevent heat loss up unused chimneys.

A *vapor barrier* is important to be installed on the inside surface of exterior walls, floors, and ceilings. A polyethylene vapor barrier with a 4 to 6 mil thickness (0.004 to 0.006 in.) should be installed on the inside surface of the wall studs, the bottom surface of the ceiling joists, and on the top surface of the floor joists before the inside finish surface is installed. Even though insulation may have a vapor barrier, it is not as effective as a polyethylene barrier installed over the entire inside surface. Without an effective vapor barrier, moisture in the air inside the building will migrate towards the outside of the building. If too much moisture gets into the insulation, it can condense into a liquid and ruin the insulation.

Attic ventilation is necessary to prevent condensation of moisture in the attic space. In cold weather, moisture will likely form on the underside of the roof as frost if sufficient roof ventilation is not provided. On sunny days this frost will melt and drip onto the ceiling and even into the upper part of the walls. The moisture will ruin the insulation. It is suggested that attic ventilation be provided with one square foot of ventilator for ever 300 square feet of ceiling area. Ridge ventilation can be provided by cutting an opening at the very top of the roof peak and installing shingle ridge ventilation. Air must be permitted to enter at the eves.

Heating Degree Days: The way to compare the severity of the heating season in different parts of the country is to compare the number of heating degree days for the area. The map of Michigan in *Figure 385.5* gives the heating degree days for different parts of the state. Similar information for other areas of the country can be obtained over the internet from the National Weather Service, or from the Handbook of American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

A heating degree day (DD) is the number of degrees the daily mean temperature is below 65°F. If the outside temperature does not drop below 65°F, it will not be necessary to provide heat to the building to maintain a temperature of 70°F. The daily mean temperature is the simple average of the daily high temperature ($T_{dailyHigh}$) and the daily low temperature ($T_{DailyLow}$). That value is then subtracted from 65°F. The heating degree days for one day is added to those from the previous days of the heating season to provide an accumulated total. Heating degree days can be calculated using *Equation 385.2.* The National Weather Service can provide this data for any area in the U.S.

$$DD = 65^{\circ} - \frac{T_{DailyHigh} + T_{DailyLow}}{2}$$ **Eq. 385.2**

Example: Assume the daily high temperature was 42°F and the daily low temperature was 22°F. It does not matter how long the temperature during the day was at the various values. This is not the average temperature for the day, it is something called a daily mean temperature. Put these values into *Equation 385.2* to determine the heating degree days for that day. Accumulation of heating degree days starts in the Fall and continues through the spring. Assume up to the day of this example the total number of heating degree days is 1250 DD. Then the heating degree days for this day is 33 DD, and the total including this day is 1283 DD.

$$DD = 65^{\circ} - \frac{42^{\circ} + 22^{\circ}}{2} = 65^{\circ} - 32^{\circ} = 33DD$$

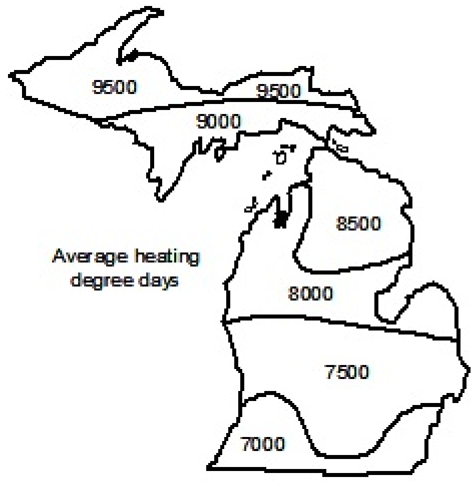

Figure 385.5 *Typical heating degree days for areas of Michigan which can be used to estimate the difference in severity of the heating season for different locations.*

Basement Wall and Floor Slab Heat Loss: Heat loss out through a solid concrete or concrete block basement wall can be significant. Significant heat loss also occurs to the outside through a concrete slab floor. Steps need to be taken to minimize concrete slab floor heat loss, although it can be more difficult and perhaps more expensive than insulating other parts of a building. For the portion of a basement wall that is just below grade level, the earth will be frozen and at a temperature of 32°F or slightly lower. If there is considerable snow cover, the temperature may not drop much below this level. If the ground generally is lacking snow cover and the temperature is sub-freezing for a considerable amount of the time, the frozen surface earth temperature may drop below 32°F. *Table 385.6* gives values for heat loss out through concrete basement walls to frozen earth. Heat loss out through concrete block basement walls is slightly less than for a solid concrete wall. When calculating heat loss to frozen earth assume the earth temperature to be approximately 30°F.

Table 385.6 *Heat loss through solid concrete and 8 in. concrete block basement walls below grade. For first 3 ft below grade assuming uniform earth temperature of 30°F.*

Basement wall heat loss (Btu/ft^2) (first 3 ft below grade)	ΔT=30°F	ΔT=35°F	ΔT=40°F	ΔT=45°F	ΔT=50°F
Concrete wall, 8 in., no insulation	22.73	26.52	30.30	34.09	37.88
Concrete wall, 8 in., 2 in. rigid insulation	3.65	4.26	4.87	5.47	6.08
Concrete block, 8"., no insulation	16.76	19.55	22.35	25.14	27.93
Concrete block, 8", 2 in. rigid insulation	3.45	4.03	4.60	5.18	5.75

Another place where insulation is often not present is in the joist space above the basement wall as illustrated in *Figure 385.6.* A portion of the basement wall is usually above grade exposed to changing outside air temperature, and some is below grade exposed to frozen earth. Still another part of the basement wall is exposed to unfrozen earth. A suggestion is to consider the frozen earth to extend down a depth of 3 ft below grade and than take the remainder of the outside basement wall at typical outside earth temperature. For most calculations in Michigan the earth temperature can be assumed to be approximately 45°F. Insulation materials used in above ground portions of a building may not be suitable in a basement because of potentially higher humidity and sometimes water leakage or even moisture migration through the concrete or concrete block. Basement walls in some older buildings are stone with rough inside surfaces. Rigid insulation that will not absorb moisture is recommended for basement wall insulation.

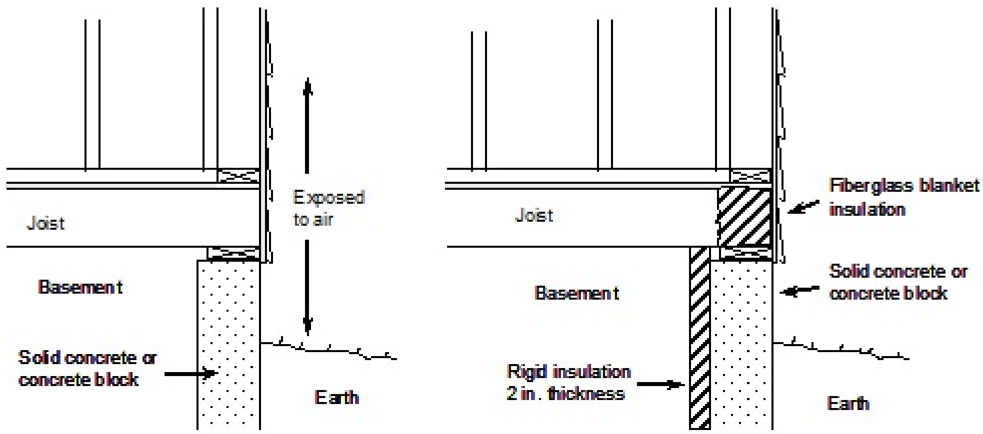

Figure 385.6 *Uninsulated basement walls, especially above grade level, can contribute to a significant loss of heat from a building. An area easy to insulate and often omitted is the joist space above the basement wall.*

Heat loss through solid concrete basement walls and through concrete block basement walls to the unfrozen earth is given in *Table 385.7.* It is suggested that the earth basement wall below 3 ft from grade level will be at an average earth temperature of 45°F. The table provides heat loss for various temperature differences. Based upon the expected basement air temperature, the temperature difference can be figured for an outside earth temperature of 45°F.

Table 385.8 provides heat loss values for basement floors. Usually the basement floor is not insulated. If it is insulated the type to use is a rigid insulation that will not absorb moisture. There becomes a question of strength of the floor from weight above. Insulation should not be placed below concrete floors that will be expected to support significant weight.

Table 385.7 *Heat loss through solid concrete and 8 in. concrete block basement walls below grade. More than 3 ft below grade assuming earth temperature of 45°F.*

Basement wall heat loss (Btu/ft^2) (first 3 ft below grade)	ΔT=15°F	ΔT=20°F	ΔT=25°F	ΔT=30°F	ΔT=35°F
Concrete wall, 8 in., no insulation	11.36	15.15	18.94	22.73	26.52
Concrete wall, 8 in., 2 in. rigid insulation	1.82	2.43	3.04	3.65	4.26
Concrete block, 8"., no insulation	8.38	11.17	13.97	16.76	19.55
Concrete block, 8", 2 in. rigid insulation	1.73	2.30	2.88	3.45	4.03

Table 385.8 *Heat loss through solid concrete basement floors assuming 45°F earth temperature.*

Concrete basement floor, 4 in.	ΔT=15°F	ΔT=20°F	ΔT=25°F	ΔT=30°F
no insulation beneath floor	10.27	13.70	17.12	20.55
rigid insulation, 2 in.	1.54	2.05	2.56	3.07

Some heated buildings will not have a basement, but an unheated crawl space. These spaces have ventilators to control moisture, but in Michigan the temperature in these spaces generally do not drop below freezing except in extreme conditions. The temperature of the air in a closed crawl space for many areas is assumed to be approximately 35°F in the winter. If air is permitted to circulate freely through such a space, then the temperature is generally assumed to be similar to the outside air temperature. *Table 385.9* gives approximate heat loss through floors to a closed unheated crawl space below.

Table 385.9 *Heat loss through floors over closed air space assuming the minimum air space temperature to be 35°F with an outside air temperature of 0°F.*

Floor construction over crawl space	**ΔT=25°F**	**ΔT=30°F**	**ΔT=35°F**	**ΔT=40°F**	**ΔT=45°F**
Double wood floor, no insulation	8.50	10.20	11.90	13.61	15.31
Double wood floor, 3.5 in. insulation	1.46	1.75	2.05	2.34	2.63
Double wood floor, 5.5 in. insulation	1.23	1.47	1.72	1.96	2.21

Grade Level Concrete Slab Floors: When a building has a concrete slab floor at approximately grade level, heat loss out through the perimeter of the wall to the outside will be much greater than from the room down to the earth in the center of the building. It is recommended that rigid insulation that will not absorb moisture be either placed around the perimeter of the building before the concrete floor is poured, or installed vertically around the outside of the building. Several methods of installing rigid perimeter insulation are illustrated in *Figure 385.7.* For an existing building installing rigid insulation around the exterior perimeter is about the only effective way to reduce this heat loss. It is recommended the rigid insulation have a minimum thickness of 2 in. and either extend back under the floor 2 ft from the outside edge of the building, or start at the surface and extend down 2 ft into the earth. Typical values or perimeter heat loss are given in *Table 385.9.* These heat loss values are for a 2 ft outside perimeter of concrete floor at the inside temperature stated assuming the heat loss is to frozen earth at a temperature of 30°F and some of the heat loss below the floor to unfrozen earth at a temperature of 45°F. The values in *Table 385.10* point out the importance of effectively cutting-off the heat loss to the outside frozen earth. These values do not include the heat loss to earth through the interior concrete floor that is more than 2 ft from an outside wall.

Table 385.10 *Heat loss from concrete slab floor perimeter with floor at approximately grade level. Heat loss is for a 2 ft strip of concrete slab at the outside wall perimeter of the heated space. Estimated values for upper Midwest. Heat loss is in Btu per linear foot of exterior wall.*

Concrete slab floor heat loss (Btu/linear ft) (see Figure 385.7)	**Inside 50°F**	**Inside 60°F**	**Inside 70°F**	**Inside 80°F**
No perimeter insulation (Figure 385.7A)	11.8	27.9	44.1	60.2
Perimeter insulation, (Figure 385.7B)	1.8	4.3	6.7	9.1
Perimeter insulation, (Figure 385.7C)	5.9	10.4	14.9	19.4
Perimeter insulation, (Figure 385.7D)	7.6	21.7	35.8	49.9

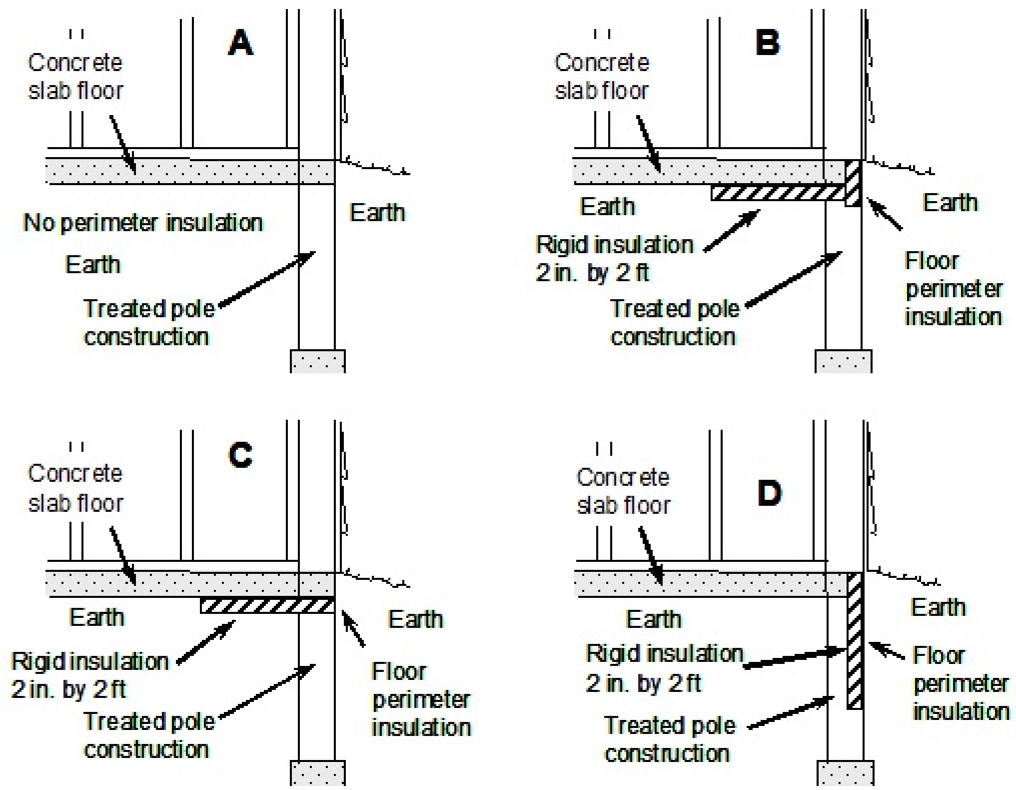

Figure 385.7 *Methods of installing rigid floor perimeter insulation for a building of treated pole construction where the concrete floor is not weight bearing. Refer to Table 385.10 for estimated heat loss for each wall installation technique.*