Chapter Comm 22

Introduction

Wisconsin has a keen interest in conserving energy because we import about 95 percent of what we use. For our state's economic well-being, the legislature has enacted enabling legislation to set building code standards for energy conservation.

This chapter of the UDC sets minimum standards for energy conservation for new one- and two-family dwellings. It sets requirements for insulation and moisture protection of the building envelope and capacity and efficiency requirements for heating, ventilating and air conditioning systems.

The standards attempt to satisfy the human comfort needs of proper temperature, air movement and humidity as well as economical and building-preserving construction and operation. To assist you in better understanding these standards, we've included the following energy basics section. Following that is the code section-by-section commentary.

Note that the effective date of the original energy conservation standards was December 1, 1978, differing from the June 1, 1980, effective date of the other chapters of the UDC.

Special electrically heated dwelling standards were removed by March 2008 Legislative action.

Some Energy Basics

The following information is offered as background material to the intent and proper application of the Ch. Comm 22 requirements.

Chapter Comm 22 requirements can be put into the four categories of heat loss control, moisture control, ventilation design, and heating equipment requirements with some overlap between the four.

I. Heat Loss
   The heat loss control requirements of Ch. Comm 22 are meant to limit heat transfer. Heat transfer is the tendency of heat or energy to move from a warmer space to a cooler space until both spaces are the same temperature. Obviously, the greater the difference in temperatures, the greater the heat flow. There are three types of heat transfer:

   - Radiation - transfer of heat through space. An example is your body heat radiating out a closed window on a winter night. The glass is cold so there is no radiation to you and it is a poor reflector of your own heat back to you. Another example is sunshine coming in through a window.

- Conduction - transfer of heat through a material. An example is your warm hand held against the inside surface of a cold exterior wall.

- Convection - transfer of heat by moving masses of air. An example is heated air leaking out through door and window openings.

The code does not say much about radiative heat losses. It does say a lot about conductive and convective heat losses. Let's discuss these further.

A. Heat Loss By Conduction

1. C-Values and k-Values

A measure of a material's ability to Conduct heat is its "C"-value which is expressed in BTUs per (hour)(oF). A BTU is a British Thermal Unit which is the heat required to raise one pound (about a pint) of water by one degree Fahrenheit and is roughly equal to the heat given off by the burning of one kitchen match. A human body gives off about 400 BTUs per hour. Since a C-value is a flow rate of heat, it needs a per time unit similar to other rate measures such as speed, "55 miles per hour." An hourly rate is also used in the C-value. Finally, as you recall, heat flow is greater as the temperature difference increases. So the C-value needs to be expressed in terms of what the difference is. For simplicity, it is taken at 1 degree Fahrenheit difference.

Another term to be familiar with is a "k"-value which is merely the C-value for one inch of material.

Typically, building components such as walls or ceilings consist of a "series" or layers of different materials as you follow the heat flow path out. However, you cannot add C-values together because if you were to take two insulating materials with a C-value of .5 each and were to add them together, you get the result of a total C-value of 1.0. This would mean that the heat flow rate has increased with the addition of more insulating material. Obviously then you cannot add C-values to find the "series" value.

2. R-Values

Therefore, we now have to bring in the perhaps more familiar "R"-value which is a measure of a material's Resistance to heat flow and is the inverse or reciprocal of the material's C-value (R=1/C).

So if a material has a C-value of 0.5, it has an R-value of 2 (as 2 = 1/0.5). If you have to add two materials in series or layers, say each with a C-value of 0.5, you take the inverse of both to get an R-value for each of 2. These can be added together to get a total R-value of 4. Usually materials are labeled or tables are written so that the material's R-value is given [see Comm 22.20(5)(a)], which relieves you of finding the inverse of the material's C-value.

3. U-Values

For thermal heat loss calculations, we normally use "U"-values (U for Unrestrained heat flow or transmittance) which is a material's C-value but also includes the insulating effect of the air films on either side of the material. So it is, therefore, a smaller number (less heat flow).

A U-value can also refer to thermal transmittance of a series of materials in layers. To obtain a U-value for such an assembly, you add the individual R-values of the layers and the air films on either side of the assembly. Then you take the reciprocal of the total R-value to get the total U-value of the assembly (U = 1/R). (As with C-values discussed above, you can not add U-values for series calculations.)

4. Heat Loss Calculations

The purpose of these C-, k-, R- and U-values is to be able to calculate heat loss through a building component (wall, ceiling, floor). The basic equation is U x A x TD = Heat Loss or

U x Area (ft^2) x Temperature Difference (^oF) = Conduction Heat Loss (BTU/hr)

So to find the heat loss per hour through a building section of wall, you:

- determine its U-value by finding the inverse of the sum of individual R-values for each layer of material;
- decide on the inside and outside temperatures (in the case of the UDC, the winter design temperatures are mandated);
- measure the surface area of the building section;
- multiply these numbers together and get a result in BTUs per hour.

If you did this for every different building section (solid wall, window, ceiling, etc.), you could obtain the total heat loss through the envelope at design temperatures, which is the worst case situation. Normally this maximum figure along with the heat loss by infiltration (see discussion later) is used to size the furnace or other heating source. It is referred to as the heating load.

If you wanted to know the total envelope loss for a heating season, you do a degree-day calculation. A degree-day is the difference between 65°F and the average temperature for a day if it was below 65°F. If this calculation is done for each day of the heating season, you can find the total heating degree-days for the year. This can be plugged into a modified version of the heat loss calculation as follows:

U x Surface Area x Degree-days x $\frac{\text{24 hours/day}}{}$ = Season Heat Loss

5. U-Overall

   One more term to know is U-overall or U_o which refers to the overall U-value of a building component such as a wall or ceiling. For example, a wall will have different individual U-values for the windows, stud cavities and stud locations. The UDC sets a minimum U_o for each overall component surface. If a designer has a large window area, more insulation will need to be placed in the wall cavities or sheathing areas so that the overall or "average" wall surface U-value is acceptable.

   The U-overall value is calculated by taking the weighted average of the U-values (not R-values) of the different parallel paths through the same component (wall, ceiling or other) that you're dealing with.

6. System Design

   As an alternative, the system design method can be used so that more insulation is put in the ceiling to make up for the extra windows. However, it is not a one-for-one tradeoff because of the thermal transfer properties and mathematics of reciprocals involved. Let's say you have an R-10 (U = 0.1) wall and R-10 (U = 0.1) ceiling of equal area. If you transfer half of the wall insulation, to the ceiling, the wall becomes R-5 (U = 0.2) and the ceiling becomes R-15 (U = 0.07). However, you can see that the wall U-value increased by 0.1 and the ceiling U-value only decreased by 0.03. (Remember U-values are used to calculate heat losses.)

B. Heat Loss By Convection

As mentioned, the other mechanism of heat loss addressed by the UDC is convection, or heat loss by air movement. In homes, this is principally heat loss by exfiltration and infiltration. Exfiltration is the loss of heated air through building cracks and other openings. Infiltration is the introduction of outside cold air into the building. This air movement also causes discomfort (drafts) to occupants in addition to the heat loss itself.

The driving force for this exchange of air is the difference between indoor and outdoor air pressures. Air pressure differences are principally caused by wind pressures and the "stack" effect of warm inside air that tends to rise. Mechanically induced air pressure differences can also occur due to such things as exhaust fans and furnace venting.

To calculate the heat loss by convection, we go back to the general heat loss calculation and modify it to:

$$\text{Heat Loss} = \text{Air's Heat Capacity} \times \frac{\text{Air Volumed Exchanged}}{\text{Hour}} \times \text{Temp. Difference}$$

The volume exchanged can be determined by measuring or judging how many air changes that a house goes through in an hour. To do this, you calculate the volume of the heated space and multiply by an air change rate. For a UDC home, you can assume a rate between 0.2 and 0.5 air changes per hour [see Comm 22.30(2)], usually with a lower rate for basements with little outside air exposure, and higher rates for living areas or exposed basements. If you have a 1500 square foot house on a crawl space with 8-foot ceilings, the calculation of the volume exchanged can be:

$$1500 \text{ sq. ft.} \times 8 \text{ ft.} \times 0.5 \text{ Air Changes/hr} = 6{,}000 \text{ cu. ft./hr}$$

The heat capacity of air is a physical constant and is .018 BTU per (°F)(cu. ft.). The temperature difference, which varies by site location, used is the same as for heat loss by conduction. So the whole equation for this example is:

$$\frac{.018}{(^{o}F)(\text{cu. ft.})} \text{ BTU} \times 6{,}000 \text{ cu. ft./hr.} \times 90^{o} = 9{,}720 \text{ BTUs/hr}$$

This figure is the design or maximum heat loss by convection. If you wanted to figure the total seasonal infiltration heat loss, you would perform a degree day calculation as for the seasonal conduction heat loss calculation. You substitute the seasonal degree days and the 24-hour multiplier for the temperature difference figure in the infiltration heat loss equation above.

Another method of determining heat loss by convection is the crack method. For this method you obtain the air leakage rates in cubic feet per minute for the doors and windows from their manufacturers and multiply by the lineal feet of sash crack or square feet of door area. (A more exact analysis would multiply the door infiltration rates by 1 or 2 due to open/close cycles and add 0.07 cfm per lineal feet of foundation sill crack.) This gives an air change rate per minute. This has to be converted to an hourly rate by multiplying by 60. Then you substitute this figure for the air change rate in the infiltration heat loss equation above.

C. Total Dwelling Heat Loss

If you add the heat losses by conduction and convection, you arrive at the total dwelling heat loss for purposes of the UDC. Of course this figure is approximate and ignores other means of heat loss. However, it also ignores the major heat gain from secondary sources such as electric lights, human bodies, cooking, etc. So the figure tends to overstate the heat loss but this ensures an adequately sized heating plant.

II. Moisture Control

The second area of concern addressed by the UDC is control of moisture. The occupancy of a dwelling produces a large amount of water vapor. As you may recall from weather forecasts, warmer air can hold more moisture than cold air. In the winter, the inside air is warmer than the outside, so if moisture moving outside by convection or dispersion (similar to conduction) reaches too cold of air, it will "condense out." This occurs at the dew point for that water vapor/air mixture. This condensation can be damaging to the building if it happens inside part of the wall or ceiling construction. It can promote structural member decay and lessening of the insulation's effective R-value.

There are three methods of reducing the possibility of condensation--vapor retarders and cold-side venting.

A. Vapor Retarders

A vapor retarder (sometimes called as a vapor barrier) acts to resist the movement of moisture through a section of the building envelope. A vapor retarder's efficiency at doing so is measured by its permeability in "perms." A perm is one grain of water per (hour) (square foot) (inch of mercury vapor). The lower the number, the more resistant is the material to moisture flowing through it.

The UDC requires a perm rating of one or lower for vapor retarders in homes.

For a vapor retarder to work properly, it must be placed on the warm-in-Winter side of the building envelope so moisture does not gain entry into the wall or other building component. The barrier also needs to be continuous with seams and holes lapped or sealed. Otherwise, warm moist air will easily bypass the vapor retarder and enter the wall or ceiling through leaky joints or penetrations. This bypass effect can be substantial and leads to greater heat loss, structural member damage &/or mold growth.

The requirement for a vapor retarder in ceilings and walls prevents deterioration of the wood structural members caused by condensation within the wall cavities or ceiling cavity. Vapor condenses when it comes in contact with material that is at a temperature lower than its dew point. The vapor retarder is required to keep the moisture out of the insulated wall cavities where the dew point temperature is reached. This temperature typically occurs within the wall cavity and thus would condense out water vapor before it can escape from the dwelling. If condensation is occurring on the interior surfaces of the dwelling, it is occurring at points where the buildings materials are cooler than the vapor's dew point. This situation is usually first evident on windows where the glass provides a colder surface on which condensation can occur.

Additional areas where condensation occurs are generally at corners of rooms at the exterior walls. This area is subject to condensation for a number of reasons. The temperature at the corners is generally cooler due to the fact that it is difficult to insulate at this location due to the method of construction. The insulation may be further reduced due to the roof system allowing less insulation to be placed above the corner. Condensation also occurs in areas with poor air circulation such as closets.

Recent studies have shown that air exfiltration may be the greatest cause of condensation. At the corners of the walls is the area with the greatest potential to obtain air exfiltration if precautions are not taken at the time of construction. The vapor retarder installed may not be complete at the corners due to the meeting of the ceiling and wall area. This allows additional moisture to pass through the corners and to be subject to condensation.

When condensation occurs, an environment is now created that is conducive to the formation of mold. This could occur on the surface or with wall/ceiling cavities. Elimination of the vapor retarder requirements at the interior finish would only allow the condensation, mold formation and deterioration of the wood to occur within the structural elements of the dwelling. Proper precautions during the original construction stages are generally adequate to prevent condensation from occurring. In some cases where the lifestyle of the inhabitants of the dwelling is such that a large quantity of humidity is produced, an occasional airing out of the dwelling by exhaust fans or opening windows should be employed by the occupants. Such ventilation may also be necessary when homes are built especially tight and natural infiltration is low.

B. Cold-Side Venting

The other means of controlling moisture is cold-side venting. This is usually employed in attics and unheated crawlspaces. The venting removes excess moisture that bypassed the ceiling vapor retarders or comes out of the earth in the crawl space. This venting is usually done by natural means through the use of grills or louvers from the space to the outside. However, for that to work, there must be high and low venting in the case of the attic or cross ventilation in the case of the crawl space.

Cold-side attic venting also keeps the roof cooler so that there is less melting of snow and contributes to less creation of ice dams at the eaves in the winter. It also helps dissipate summertime attic heat, which increases comfort and reduces cooling costs.

C. Impervious Insulations

Thus use of closed-cell foam plastic insulation or similar non-absorbent insulating materials that are unaffected by moisure condensation is another effective method used for some designs of dwellings to deal with this issue.

D. Moisture Control During Construction

Unless proper construction techniques are utilized during construction, serious problems can occur as a result of water vapor that is trapped inside and then causes deterioration of gypsum wallboard.

Over the years we have seen many improvements in both materials and methods in home construction. Often times the use of a new material required the change in a technique or method of construction previously unheard of. Most building codes are only a reflection of our latest achievements in technology and engineering. The vapor retarder requirements in the Uniform Dwelling Code are a reflection of state of the art insulation techniques. Simply stated, the purpose of the vapor retarder is to prevent (as much as possible) water vapor from penetrating into the insulation and thereby reducing the effectiveness of the insulation. The problem is that builders who are not familiar with the use of vapor retarders, particularly during winter construction months, can inadvertently create problems for the homeowner if precautionary measures are not taken during construction. We offer the following suggestions to incorporate in construction procedures, especially during winter months:

1. Do not allow gypsum board to pick up excess moisture prior to installation.
2. Make sure attics are insulated prior to putting heat into the home for gypsum board taping and finishing. Many builders neglect to do this and create condensation problems when the water vapor condenses upon hitting the cold, attic air above the gypsum board. Gypsum board ceilings should be hung and insulated prior to putting heat into the home.
3. Make sure all heating appliances, i.e., furnaces, temporary heaters, salamanders, etc., are vented to the outside of the home. Builders who do not follow this warning are adding additional water vapor created by combustion of heating fuels.
4. Make sure all required attic ventilation is installed and operable to remove any water vapor trapped in the attic.
5. Provide a means for the water vapor in the home to escape; such as periodic opening of windows, doors, etc. Perhaps the installation of a humidistatically controlled exhaust fan is necessary, particularly where electric baseboard heat or heat pump systems are utilized.
6. Do not overload gypsum board ceilings with insulation beyond their capacity. See s. Comm 21.02 (1)(a) of this commentary.

Incorporation of these techniques will avoid major problems with condensation. These methods are not new and have been proven successful by many hundreds of builders operating in climates such as ours.

E. Post-Construction" Moisture Control Problems

As discussed in the basics section of this commentary chapter, moisture must be dealt with in all homes. The following is a general discussion of typical symptoms, causes and prevention techniques regarding moisture problems in homes. It is intended as background information to help explain some UDC requirements. Additional recommendations above and beyond the UDC minimums are included for homeowners who may experience more severe moisture problems.

1.How can you determine if a home has a moisture problem?

You can get a good idea of whether your home has an excess moisture problem that may lead to damage by checking for the following symptoms.

- Extensive condensation on windows during the heating season. Some condensation is normal. Condensation that streams off the window and puddles on the frame and sill when outside temperatures are 10°F or above and inside temperatures are above 65°F indicates humidity levels are probably too high.
  - If condensation is limited to the inside surface of storm windows, then your primary windows may be allowing moist interior air to leak by them. Because of the "stack" pressure effect, this problem may be worse on second floor windows.

    - If condensation is limited to the inside surface of the primary windows, then your storm windows may be allowing cold air to leak by them which then cools the primary window.
- Staining and mold on window frames.
- Mold or water spots in numerous locations on the inside surface of outside walls. Common trouble spots include closets on outside walls; corners between two outside walls or between an outside wall and ceiling; and outside walls behind furniture; or other areas where air circulation is limited.
- Soft or buckling interior wall surfaces. Gypsum board is a common interior surface. When dampened it may pull away from studs or ceiling rafters. Additional moisture may cause the gypsum board to crumble.
- Staining or warping of exterior siding.
- Paint peeling from exterior siding, especially extensive peeling of paint down to the primer.

If you have not experienced any of these symptoms, the home probably does not have a moisture problem. However, it may be a good idea to consider some of the measures in the following Section III to assure that future problems do not develop.

2. What are typical causes of moisture problems in homes?

Through breathing and normal daily activities, each member of a household produces about seven pounds of water vapor. Naturally this number varies greatly depending on living habits. This water vapor becomes part of the air. However, air can hold only a limited amount of water vapor. This amount depends on temperature. The higher the temperature the more moisture the air can hold. When more moisture is introduced into the air than it can hold, some of the moisture will condense on surfaces. If cold surfaces sufficiently cool the surrounding air, condensation will occur on that surface even though the remaining room air is not saturated with moisture. The frosted cold beverage glass in summer is an example.

In most older homes there is enough movement of air into and out of the house that moisture does not build up and only small amounts of condensation occurs. However, when air leaks into and out of a house it not only takes moisture but heat as well. In order to make homes more energy efficient, builders have been trying to seal cracks and cut air leaks.

These efforts to tighten homes have meant that more moisture remains in the home. Unless controlled ventilation is added, moisture accumulates, and condensation occurs near the ceiling on outside walls or on outside walls of closets. These areas generally have cooler surfaces. If condensation persists on these surfaces, molds and mildews may develop. In addition, fungal growth and possible deterioration of material may occur when temperatures are at or above 50°F and the material remains wet. Such fungal growth could damage wood members in extreme circumstances.

3. Besides the UDC requirements, what measures can help prevent moisture problems?

- Reduce Moisture Production In The Home
  - One way to substantially reduce the chances that condensation will occur either on inside surfaces or within walls is to keep indoor moisture levels low. The first step is to reduce the amount of moisture produced in the home. Some major sources of moisture that can be controlled are listed below.
  - Prevent moisture from entering through basements. Many basements feel damp in the summer due to condensation of moisture from the air on cool basement surfaces. However, in some cases damp basements may be due to ground moisture entering the home through basement walls. Cracks or stains on basement walls and floors are signs of dampness entering through these surfaces.
    - You can check whether dampness is coming through walls by using a simple patch test. Tape a piece of plastic sheeting tightly against the basement wall where you suspect moisture penetration. After a couple of days pull the patch off and look for signs of moisture on the wall side of the patch. If you detect moisture, it means moisture is coming through the wall rather than condensing on the walls.
    - If you suspect a basement water problem, check the surface drainage around you home. Most basement water problems result from poor surface drainage. Make sure that the ground slopes away from the foundation. Consider installing gutters. If you have gutters, make sure they are clear of debris and functioning properly. Downspouts should direct water away from the foundation.
  - Do not store large amounts of firewood in the basement. Even seasoned wood can contain large amounts of moisture. It also may be a source for fungus.
  - Other ways you can reduce moisture generation:
    - Vent clothes dryers outdoors;
    - Don't line dry clothes indoors;
    - Limit the number of houseplants;
    - Cover kettles when cooking;
    - Limit the length of showers; and
    - Do not operate a humidifier in the wintertime unless your indoor relative humidity is below 25 percent.
    - Be sure any crawlspace floors have a vapor retarder covering.
  - If problems persist, you should also check for any blocked chimney flues that may be preventing moisture-laden flue gasses from exhausting out of the house.
  - Correct any plumbing and roof leaks. If ice dams are a problem, consider more attic ventilation and adding insulation.

- Add Mechanical Ventilation
  - A second way to reduce moisture levels is to add mechanical supply and exhaust ventilation. As an added benefit, ventilation will reduce concentrations of other possible air contaminants such as combustion by-products from heating, cooking and smoking.
  - A widely recommended ventilation rate for homes is one half air change per hour. In a 1,200-square-foot house with 8-foot high ceilings, there are about 9,600 cubic

feet of air. To meet the ventilation standard, half of that amount or 4,800 cubic feet of air must be exchanged every hour. This roughly equals 100 cubic feet per minute (cfm) of air exchange. Even in a tight house some of this air exchange occurs naturally.
    - However, in a house that is experiencing severe moisture problems, it can be assumed you are getting less than one half air change per hour. A balanced ventilation system should be used to make up the remaining necessary air exchange. A balanced system is one that not only exhausts stale air but provides a source of fresh replacement air. Currently the UDC per Comm 23.02(3)(b)2. only mandates that 40% of exhaust ventilation be made up through another means. Without proper replacement air the home could have what is known as negative air pressure.
    - Negative pressure could cause exhaust gases from your furnace or water heater, which should be going up your chimney or out a vent, to be sucked into the living space.
    - Additional ventilation is needed only during the heating season. When you provide controlled ventilation for your home, the heat lost is relatively small. For a 1,200-square-foot home, the cost of this lost energy and the electricity to run the fan would amount to about a dollar a day assuming you heat with the most expensive heat source, electric baseboard. This cost should be much less if you heat with gas or other fuels. Also, some ventilation systems can reclaim a portion of the heat (up to 80%) from the exhaust air by heat-recovery ventilators. This could help reduce energy costs.
- Stop Moisture At The Inside Wall Surface (In Addition To The Required Moisture Vapor Retarder)
    - In addition to reducing moisture levels of the interior air, carefully seal all openings in the inside surface of all exterior walls to prevent moist air penetration. This includes joints around window and door casings, baseboards, electrical outlets and switches and any other penetrations. Gaskets for electrical penetrations are now commonly available, be sure that they extend to the outside edge of the cover plate of electrical devices.

<u>Relative Humidity</u>

In winter, the ideal relative humidity range for <u>comfort</u> is 30 percent - 45 percent. A lower humidity may cause excessive skin evaporation which in turn will cause an undesired cooling effect. For the sake of protecting the structure from damage due to excessive moisture, an ideal relative humidity range of less than 45 percent is recommended. Therefore, to provide comfort and still protect the building, a relative humidity range between 30 percent to 45 percent is recommended.

In summer, the ideal comfort range is 30 percent - 50 percent. Higher humidity won't allow adequate skin evaporation and the resulting desired cooling effect.

III. Mechanical Ventilation

As the code has mandated tighter home construction, the UDC has had to provide increase of mechanical ventilation as an alternative to infiltration to maintain indoor air quality so excessive humidity or other pollutant levels are checked. This has taken the form of required exhaust ventilation for rooms with a toilet, tub or shower and for kitchen exhaust.

A designer may decide to use an air-to-air heat exchanger to satisfy the exhaust requirement, while at the same time recovering heat from the exhausted air. This is done by moving the exhausted air past the intake air with a heat exchanging barrier between the two air streams.

IV. Equipment Efficiency Requirements

The final area that Ch. Comm 22 regulates is heating and cooling equipment efficiencies.

Subchapter I — Scope and Application

22.01(3) Scope

Altough homes that are heated with renewable sources of fuel, such as wood, are exempt from the insulation requirements, they are still subject to the moisture control requirements for vapor retarders and ventilation. These are needed to protect framing and keep insulation dry and protected from degradation.

22.02(2) Demonstration Method of Compliance

As there are more than one method, submitters of plans & calculations should clearly communicate which method of compliance is being provided for the dwelling.

Subchapter III — Materials and Equipment.

22.20(4) Material Installation

This section requires all insulation, mechanical equipment and systems to be installed per the manufacturer's installation instructions which are to be available at job sites during inspection.

22.20(6) Building Certification

This section now requires that a permanent certificate of insulation R-values and fenestration U-factors be provided on or immediately adjacent to the electrical distribution panel. If REScheck or REM/Rate software program was used, that certificate print-out shall be provided. Otherwise, a copy of the prescriptive table (Table Comm 22.31-1 or Comm 22.31-4) may be used with the installed R-values highlighted. (Note that Rescheck also provides a method for sizing the heating plant as required by s. Comm 23.03. If some other method is chosed for demonstrating thermal envelope compliance, then Rescheck or an alternative means of showing proper heating plant sizing is still needed.)

22.21(1)&(1) Protection of Insulation

This section now requires blanket insulation to be held in place by a covering or mechanical fastening. Comm 22.21(2) adds cold-in-Winter side windwash protection of air-permeable insulation, thus keeping insulation in place and maintaining the R-value of that insulation. Normally the exterior sheating would do this, but where that is not present, some other vapor-permeable material, such as housewrap would be required.

Subchapter IV — Dwelling Thermal Envelope

22.31 Envelope Compliance

Envelope compliance may be by prescriptive method of Comm 22.31(1) by either complying with Table 22.31-1 or Table 22.31-4 or alternatively, per Comm 22.31(2) by showing the the overall envelope U-value times Area complies. The latter method may be done by hand calculation or more typically by the use of the free software program, Rescheck, available from the federal government at www.energycodes.gov . Rescheck also gives some additional credit for higher efficiency heating equipment. Finally, compliance may be shown per Comm 22.51 by calculations or software that models the whole house energy usage. Remrate is a type of acceptable software for that purpose.

Although the note here implies that Rescheck version 4.0 or higher would be acceptable, it would actually need to be high enough that “Wisconsin 2009” code is listed as an available code option.

22.32 (1) Ceilings With Attic Spaces.

This section permits the use of R-38 in the attic space in lieu of R-49 speicified in Table 21.23-1 as long as the R-38 inslulation covers the entire attic area including over the exterior wall top plates. This could be accomplished with the use of “energy heel” trusses. The height of the heel would depend on the type of insulation used to attain the R-38 insulation value.

22.33 Slab Floors

Shallow slabs less than 12" below grade must meet Table 22.31-1 or 22.31-4 for Unheated Slab R-value with perimeter insulation. Heated slabs of any depth with embedded, uninsulated heating ducts or pipes require slab insulation throughout, with additional insulation at the perimeter. Horizontal slab insulation that projects away from the building shall be protected by either pavement or a minimum of 10 inches of soil. See UDC Appendix drawings showing acceptable and unacceptable perimeter insulation in terms of ensuring the edge of the slab is properly insulated.

22.34 Crawl Spaces

Requirements for crawl space insulation protection, vapor retarders, and ventilation, which were formerly in various places of Comm 21 & 22, have been put into single place in Comm 22.34. Option of insulating the floor over crawl space and providing crawl space venting or else insulating the crawl space walls and not venting that space is made clear by code provisions.

22.35 Sunroom vs Screen Porch

This option for reduced insulation levels is only available to heated sunrooms with opague walls and glazing. It is not available to heated screen rooms with only screens for a portion of the walls.

22.36 Fenestration

Fenestration is an architectural term for windows and doors. The UDC requires generally requires them to be certified under the NFRC 100 standard for the values used, which is easily verified in the inspection of the window label on each unit. Where windows are not labeled, the conservative, default table values must be used for determining compliance. The code allows a single door and a single window to be exempt from door and window requirements which permits the installation of elements such as stained-glass windows

Different types of window operating hardware will produce different U-values for similar-sized windows. Therefore, a 3'-0" x 3'-0" double hung window would have a different U-value from a 3'-0" x 3'-0" fixed window sash. Similar size windows produced by two different manufacturers would most likely also have different U-values. Averaging of U-values is per Comm 22.36(1).

22.37 Air Leakage

Air leakage at fenestration and at other penetrations in the envelope are to be sealed properly per Comm 22.37(3) requirements. Comm 22.37(4) was added to the code to provide specific guidance on recessed lighting installed at envelope areas, without leading to overheating fires.

22.37 Air Infiltration Barrier

The UDC does not define materials to be used as an infiltration barrier. It does require them to:

1. Be installed on the interior face, typically as part of the vapor retarder, or on the exterior face of the wall, typically as a house wrap or caulked building panels.
2. Form a continuous barrierover the walls of the building from the bearing points of the roof to the top of the foundation.
3. Seal all seams, joints, tears, and punctures.

Additionally, the department has determined such infiltration barrier construction:p

1. Be water vapor permeable to prevent moisture problems within the wall if installed on the cold sid of the wall. The perm rating must be significantly higher than the interior vapor retarder.
2. Restrict infiltration to an appreciable extent.

These materials include:

- Spun bond polyolefin sheets, with taped joints. (Ex: Tyvek by Dupont.)
- Micro-perforated polyethylene (Valeron) film sheets, with taped joints. (Ex: Air Stop by Diversi-Foam Products.)
- Tongue and groove extruded polystyrene, with taped joints.
- Other building panel sheets such as foam sheathing or plywood sheathing with taped joints, regardless if the panels have butt or tongue and groove edges

<u>22.38(1) Paint as a Vapor Retarder</u>
Advances in paint chemistry have made certain paints available to contractors which, when appliid at conventional spread rates, provide a vapor retarder with a perm of 1 or lower.

This department has reviewed vapor retarder paints for application meeting the intent of Comm 22.38; however does not widely recommend them. The evaluation method used to determine the acceptability of the paint is based on the paint's:

1. Perm rating based on ASTM test E-96.
2. Scrubability as based on ASTM test D-2486.
3. Evaluation of manufacturer's recommendation for the paint's use.
4. Labeling of all paint containers.

All test results submitted shall be from recognized independent testing agencies. The department feels that the above assures that specifically reviewed manufacturer's products will perform and not break down when applied as instructed by the manufacturer. Such vapor retardant paints shall be installed per the testing of that paint, thus if it is applied to a smoother surface for test, that is required for the actual application.

Two coats of vapor retarder paints are typically required to take into account variances in field application. If no materials approval is provided, then the UDC inspector may require two coats and proper documentation of the paint perm rating. Also any texturing must be applied after the vapor retarder paint. Holes made in the wall surface after covering with vapor retarder paint should be treated with the same sealing and repair as one should use for holes in other vapor retarder materials typically installed behind the typical gypsum wallboard used on ceilings & walls.

In order to assure building officials and owners that a vapor retarder paint has in fact been installed and the intent of Comm 22.38 met, a certificate of compliance (see following sample certificate) may be filled out and submitted to the building official with a copy to the owner. In addition to the certificate, the contractor should provide the inspection agency with the labels from the paint cans that were used by the applicator.

The following is the recommended procedure to be followed by building inspection agencies to assure compliance with the vapor retarder requirement and yet to allow limited use of vapor retarder paint. Procedure to be followed:

1. At the time of plan submittal, the builder should state or have shown on the plans what type of vapor retarder is to be used in the dwelling. Either manufacturer's data or a Wisconsin Materials Evaluation number shall be presented to show compliance by the chosen paint.
2. At the time the plan is approved, the inspector should provide a blank Certificate of Application if one will be locally required.
3. At the time the insulation/rough energy inspection is made, the inspector will be able to determine where the standard vapor retarder was applied in the dwelling.

4. At the final inspection, the contractor should supply to the building inspector the completed certificate as well as the labels from the paint cans.
5. The inspector may then destroy the labels and the Certificate of Application can be filed with the building file.

VAPOR RETARDER PAINT
CERTIFICATE OF APPLICATION

THIS CERTIFIES THAT A VAPOR RETARDER PAINT HAVING A PERM RATING BELOW 1.0 WAS APPLIED TO THE FOLLOWING STRUCTURE:

____

____

PAINT MANUFACTURER: ____

COMMERCE MATERIAL APPROVAL NO. (If Applicable)

\-

SUPPLIER: ____

GALLONS USED: ____________________ LABELS SUBMITTED: ☐ YES ☐ NO

CEILINGS - TOTAL SQUARE FEET COVERED: ______________________________

WALLS - TOTAL SQUARE FEET COVERED: ________________________________

NUMBER OF GALLONS USED ON: 1st COAT ___________ 2nd COAT __________

APPLICATION MADE BY NAME: ____

ADDRESS: ____

SIGNATURE: ____

22.38(2) Vapor Retarders Not on Warm Side
Occasionally it occurs that a wall will have two materials orlayers that may act as vapor retarders. It is important in this situation that the better vapor retarder (lower perm rating) be placed closer to the warm side. Also, extreme care should be taken to make the interior vapor retarder continuous with good joint and penetration sealing. This will help avoid condensation of moisture in the wall.

In some other dwelling designs, double walls are constructed with insulation in both walls. Often this is to avoid making electrical box and other penetrations in the vapor retarder. A single vapor retarder is placed between the two walls. This conflicts with the requirements that vapor retarders be placed on the warm side of all insulation. However it may be acceptable depending on the distribution of the insulation between the two walls. If there is enough insulation on the exterior side of the vapor retarder, the air temperature in the insulation at the interior face of the vapor retarder may still be warm enough to prevent condensation.

A DEW POINT CALCULATION estimates expected temperatures throughout the thickness of the wall. Interior temperature, exterior temperature, and wall component R-values must be known. Additionally, a "design" interior air relative humidity must be assumed. Since typical wintertime reported indoor humidities range from 40 percent to 60 percent, the department will accept 50 percent as an average indoor relative humidity (RH) design value for such a calculation.

In order to do such a calculation, a person must have access to a psychrometric chart or table to determine dew points throughout the wall section given specific design temperatures, RH, and wall component R-values.

Example: Fictional Wall
R = 10, uniformly distributed across thickness of 4 inches
RH = 50% (interior)
Temp = 70°F interior and -10°F exterior

This would result in condensation if interior air was lowered in temperature or exposed to a surface temperature of approximately 50°F. In this wall, the 50°F dew point occurs at 1 inch from the interior surface. Therefore, a recessed vapor retarder must be to the inside of this 1-inch limit.

Detailed calculations shall be submitted for each specific project where a designer wishes to recess a vapor retarder into the wall cavity.

22.38(3) Vapor Retarders Under Concrete Floor
Although there is a requirement for turning the under-concrete floor vapor retarder up at the edges of slab and running it to the top of the slab, this will in most cases, for basements, ground floors and crawl spaces, be equivalently met by just extending the vapor retarder beneath the slab, over the foundation and to the basement/ground floor wall. For this case the the thickness of the concrete footer and foundation wall provides a 1.0 perm or better vapor retarder rating.

For a slab on grade installation the vapor retarder shall extend to the point at which the slab is thickened.

22.38(4) Vapor Retarders Prohibited on Concrete or Masonry Walls
The code now prohibits installing a vapor retarder of a 0.1 perm or less rating on or in front of masonry or concrete below grade foundation walls. This is avoid the potential for moisture from adjoining earth being trapped between an interior vapor retarder and the wall and possibly causing degradation and mold.

22.39 Attic Ventilation
Attic ventilation is generally required for air-permeable insulation is installed. This means that attic ventilation is not required above closed-cell foam insulation.

The code requirements of these sections for venting areas are based on effective venting area. Louvers and screening greatly decrease the effective venting of attic vents. Usually the effective venting area of a vent is indicated on it. Otherwise the following is a guide:

Obstruction in Ventilator (Louvers and Screens)	To Determine Total Free Area of Ventilator Multiply Gross Area by:
1/4 inch mesh hardware cloth	1
1/8 inch mesh screen	0.8
No. 16 mesh insect screen (with or without plain metal louvers)	0.5
Wood louvers and 1/4 inch mesh hardware cloth	0.5
Wood louvers and 1/8 inch mesh screen	0.44
Wood louvers and No. 16 mesh insect screen	0.33

Regarding turbine vents, the effective area is equal to the bottom opening area.

Regarding power vents, manufacturer's requirements should be followed. Otherwise an installed mechanical ventilation capacity of 0.25 cfm per square foot of attic floor area is acceptable. Additionally, adequate air intakes must be provided. Control of the fan must be provided by a humidistat or combination humidistat/thermostat. A humidistat setting of 90 percent is acceptable.

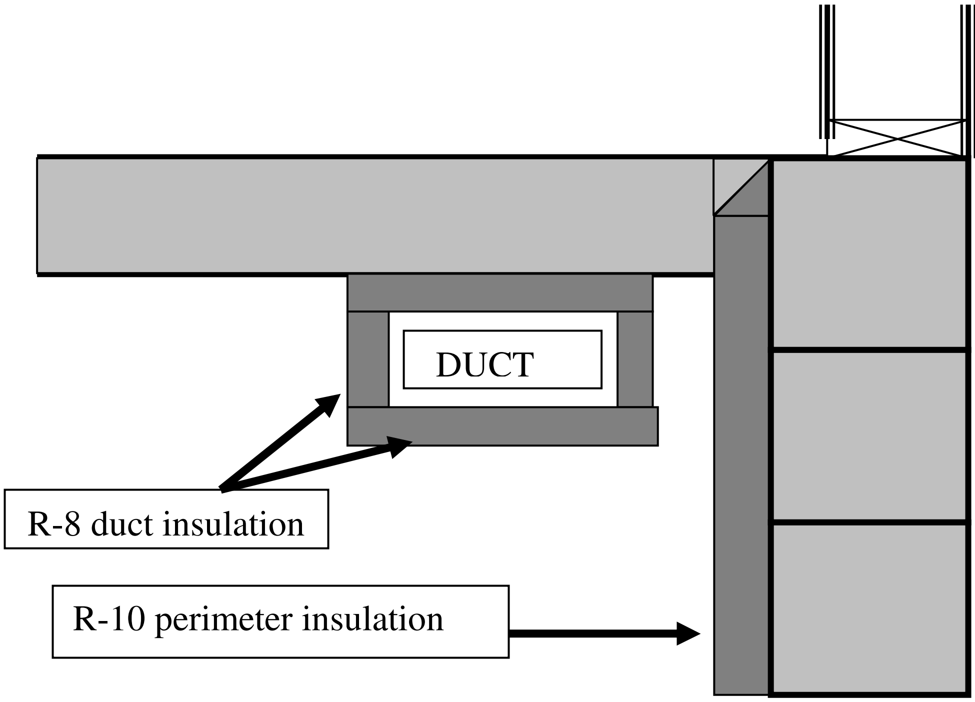
Subchapter V — Systems

22.40 Outdoor Design Temperatures
The design of heating equipment to satisfy the heating load is regulated by ss. Comm 23.02 and 23.03. Those sections refer to the UDC Appendix table for determining outdoor design temperatures.

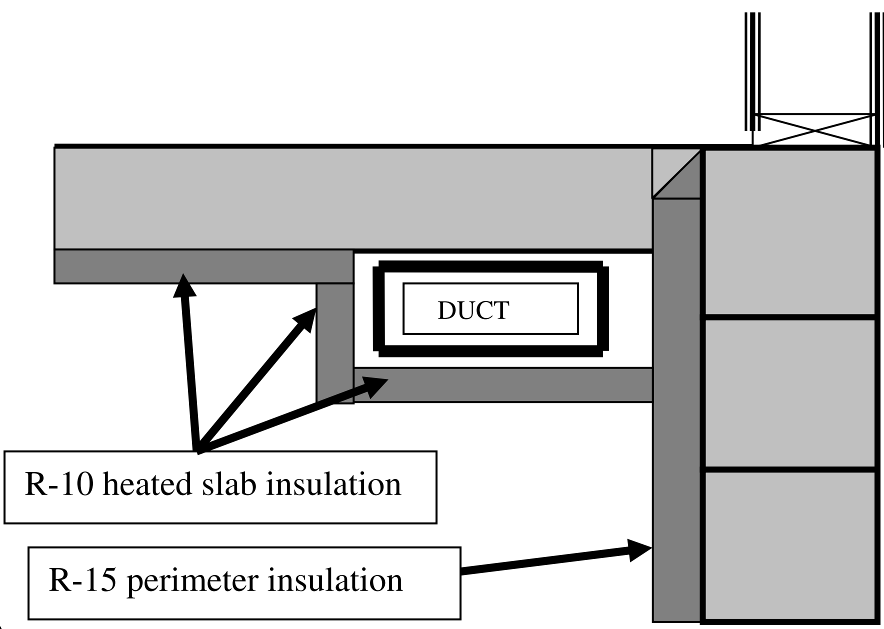
22.42 Insulation of Ducts Under Slabs-on-Grade

22.42

Section Comm 23.08 (4) states that the minimum insulation value for under ground ducts is R-5. As this section is more restrictive, the R-8 minimum is required. See following drawings.



Acceptable design for insulated duct outside building thermal envelope of an unheated slab on grade design



Acceptable design for heated slab-on-grade design as duct is within building thermal envelope

22.43(6) Tapes with Rubber-Based Adhesives Prohibited
Duct system joint sealing is required by Comm 22.43(1) where those ducts are not completely within the conditioned space. “Duck" or "duct" tape typically has rubber-based adhesives.

Comm 22.46 Replacement Furnace & Boiler Efficiencies
Normally replacement equipment may meet the code at the time of their original installation per s. Comm 20.07(61) definition of repair, as opposed to alterations that need to meet the current code. (Note that the federal government has evolving minimum heating appliance efficiencies that apply to all residential installations, new or replacement.) However, this section requires that replacement furnaces also comply with specified duct sealing criteria and that replacement boilers comply with circulating motor limits. Alternatively, the replacement equipment may instead just comply with the more stringent Wisconsin efficiency requirements of Table 22.31-3 (as for new construction that is permitted reduced thermal envelope insulation levels) without duct sealing or circulating motor limits.

Subchapter VI — Simulated Performance Alternative

22.51 Documentation of Simulated Performance Alternative
Compliance by Comm 22.52 is typically shown by REMrate software that models the whole house energy usage. REM/Rate software is proprietary to certain providers. The version available after April 1, 2009 must be used, thus any print-outs with version 12.6.0 or less is not acceptable to show compliance with the current code. Note that the example given on the following pages meet the Comm 22.52 documentation provisions of the code, including the inspection checklist of the components of that system.

SAMPLE

REM/Rate Home Energy Rating Tool

Rem/rate version 12.61 - Wisconsin

Uniform Dwelling Code Compliance Option Reports

For more information contact:
Homes Department
Focus on Energy
431 Charmany Dr
Madison, WI 53719
1-800-762-7077

SAMPLE

Wisconsin Uniform Dwelling Code Compliance By Dwelling Envelope Design

Date:	February 05, 2009	Rating No.:	SAMPLE
Building Name:	UDC2	Rating Org.:	
Owner's Name:		Phone No.:	
Property:		Rater's Name:	
Address:	, WI	Rater's No.:	
Builder's Name:			
Weather Site:	UDC Design Zone 2, WI	Rating Type:	Based On Plans
File Name:	SAMPLE.blg	Rating Date:	January 1, 2009

Elements	**Insulation Levels**	
	UDC	As Designed
Shell Uo Check		
Ceilings (U-Value):	0.031	0.022
Above-Grade Walls (U-Value):	0.130	0.092
Floors Over Ambient (U-Value):	0.039	0.033
Basement Walls (U-Value):	0.073	0.093
Overall Uo (Design must be lower):	0.095	0.076

This DESIGN meets the overall thermal performance requirements of the Wisconsin Uniform Dwelling Code. (COMM Chapter 22, Subchapter VI, Table 22.21.) The allowed Uo values were increased by18% as a furnace of at least 90 AFUE is installed (footnote g).

This REM/Rate report is a Department of Commerce approved method of showing compliance with the energy conservation standards of Chapter COMM 22 of the Uniform Dwelling Code.

Building Elements	**Type**	**U-Value**	**Area**
Ceilings			
Roof	R44 Attic *	0.022	1078.0
Above-Grade Walls			
Wall	R19 (2x6 16oc)*	0.063	1812.0
Wall	R19 (2x6 16oc)*	0.063	148.0
Wall	R19 (2x6 16oc)*	0.063	104.0
Joist	R1 Amb	0.059	119.0
Joist	R2 Gar	0.059	21.0
Joist	B1 Attic	0.059	35.0
Joist	B1 Amb	0.059	71.0
Window	NFRC .32 / .30*	0.320	25.0
Window	NFRC .32 / .30*	0.320	10.0
Window	NFRC .32 / .30*	0.320	45.0
Window	NFRC .32 / .30*	0.320	40.0
Window	NFRC .32 / .30*	0.320	25.0
Window	NFRC .32 / .30*	0.320	9.0
Window	NFRC .32 / .30*	0.320	25.0

REM/Rate - Residential Energy Analysis and Rating Software v12.6 Wisconsin

This information does not constitute any warranty of energy cost or savings.

SAMPLE

Building Elements	Type	U-Value	Area
Window	NFRC .32 / .30*	0.320	25.0
Window	NFRC .32 / .30*	0.320	25.0
Window	NFRC .32 / .30*	0.320	25.0
Window	NFRC .32 / .30*	0.320	14.0
Window	NFRC .32 / .30*	0.320	28.0
Door	St 1.75" R7.5*	0.119	20.0
Door	St 1.75" R7.5*	0.119	20.0
Floors Over Ambient			
Floor	R30 / R0*	0.033	32.0
Basement Walls			
Wall	8-12"C R0 R5 F	0.088	600.0
Wall	8-12"C R0 R5 F	0.088	168.0
Wall	8-12"C R0 R5 F	0.117	176.0

SAMPLE

Wisconsin Uniform Dwelling Code Compliance By Annual Energy Analysis

Date:	February 05, 2009	Rating No.:	SAMPLE
Building Name:	UDC2	Rating Org.:	
Owner's Name:		Phone No.:	
Property:		Rater's Name:	
Address:	, WI	Rater's No.:	
Builder's Name:			
Weather Site:	UDC Design Zone 2, WI	Rating Type:	Based On Plans
File Name:	SAMPLE.blg	Rating Date:	January 1, 2009

Annual Energy Consumption (MMBtu)

	UDC	As Designed
Heating:	101.4	60.4
Cooling:	4.4	4.7
Water Heating:	19.8	19.8
Lights and Appliances:	37.6	37.6
Photovoltaics:	-0.0	-0.0
Total:	163.2	122.4 *

This DESIGN meets the annual energy consumption requirements of the Wisconsin Uniform Dwelling Code. (COMM Chapter 22, Subchapter VII.) Surpasses UDC requirements by 25.0%

This REM/Rate report is a Department of Commerce approved method of showing compliance with the energy conservation standards of Chapter COMM 22 of the Uniform Dwelling Code.

* Design consumption is based on the following systems:
  Heating: Fuel-fired air distribution, 70.0 kBtuh, 92.0 AFUE.
  Cooling: Air conditioner, 30.0 kBtuh, 13.0 SEER.
  Water Heating: Conventional, Gas, 0.62 EF.
  Blower door test: Htg: 1017 Clg: 1017 CFM50

In accordance with the Uniform Dwelling Code, building inputs such as setpoints, infiltration rates, and window shading may have been changed prior to calculating annual energy consumption.

REM/Rate - Residential Energy Analysis and Rating Software v12.6 Wisconsin

This information does not constitute any warranty of energy cost or savings.

SAMPLE

EQUIPMENT SIZING SUMMARY

Date:	February 05, 2009	Rating No.:	SAMPLE
Building Name:	UDC2	Rating Org.:	
Owner's Name:		Phone No.:	
Property:		Rater's Name:	
Address:	, WI	Rater's No.:	
Builder's Name:			
Weather Site:	UDC Design Zone 2, WI	Rating Type:	Based On Plans
File Name:	SAMPLE.blg	Rating Date:	January 1, 2009

	UDC2
HEATING	
Calculated Peak Load (kBtu/hr)	45.2
Infiltration	4.4
Envelope	40.8
Sizing Factor (%)	115.0
HEATING EQUIPMENT CAPACITY (kBtu/hr)	
Required	52.0
Specified	70.0
COOLING	
Calculated Peak Load (kBtu/hr)	17.3
Sensible	14.8
Latent	2.5
Sizing Factor (%)	100.0
COOLING EQUIPMENT CAPACITY (kBtu/hr)	
Required Total	17.3
Specified Total	30.0
Required Sensible	14.82
Specified Sensible	21.00
Required Latent	2.49
Specified Latent	9.00

Heating equipment capacity calculated using Wisconsin Uniform Dwelling Code ambient design temperature. (COMM Chapter 22, Subchapter IV, Table 22.07-2.) Indoor set points used: Heating 68.0 Cooling 78.00

REM/Rate - Residential Energy Analysis and Rating Software v12.6 Wisconsin

This information does not constitute any warranty of energy cost or savings.

SAMPLE

ENERGY CODE INSPECTION CHECKLIST

Date:	February 05, 2009	Rating No.:	SAMPLE
Building Name:	UDC2	Rating Org.:	
Owner's Name:		Phone No.:	
Property:		Rater's Name:	
Address:	, WI	Rater's No.:	
Builder's Name:			
Weather Site:	UDC Design Zone 2, WI	Rating Type:	Based On Plans
File Name:	SAMPLE.blg	Rating Date:	January 1, 2009

Building Information:

Conditioned Area (sq ft):	3162
Conditioned Volume (cubic ft):	25296
Insulated Shell Area (sq ft):	5746

The items below will be inspected for energy code certification. Any deviation from these specifications should be brought to the attention of , as soon as possible to assure that the project will still comply with energy code requirements.

Ceilings:

[ ] 1. Attic: R44 Attic * (1078 s.f.)
R-33.0 continuous insulation, R-11.0 cavity insulation.
Name: C1 Insulation Grade: I II III Face / Inset

Comments/Location____

Above-Grade Walls:

[ ] 1. Wall: R19 (2x6 16oc)* (2128 s.f.), Between conditioned space and ambient
R-0.0 continuous insulation, R-19.0 cavity insulation.
Name: AG1 Insulation Grade: I II III Face / Inset

Comments/Location____

[ ] 2. Wall: R19 (2x6 16oc)* (168 s.f.), Between conditioned space and garage
R-0.0 continuous insulation, R-19.0 cavity insulation.
Name: AG2 Insulation Grade: I II III Face / Inset

Comments/Location____

[ ] 3. Wall: R19 (2x6 16oc)* (104 s.f.), Between conditioned space and attic
R-0.0 continuous insulation, R-19.0 cavity insulation.
Name: AG3 Insulation Grade: I II III Face / Inset

SAMPLE

ENERGY CODE INSPECTION CHECKLIST

Comments/Location____

Windows and Skylights:

Window-to-Wall Area Ratio: 0.12

[ ] 1. Window: NFRC .32 / .30* (25 s.f., Northeast), U-Value: 0.320, SHGC: 0.300
For windows without labeled U-factors, describe features:
Name: AG1 Orientation: Northeast

Comments/Location____

[ ] 2. Window: NFRC .32 / .30* (10 s.f., Northeast), U-Value: 0.320, SHGC: 0.300
For windows without labeled U-factors, describe features:
Name: AG1 Orientation: Northeast

Comments/Location____

[ ] 3. Window: NFRC .32 / .30* (45 s.f., Southwest), U-Value: 0.320, SHGC: 0.300
For windows without labeled U-factors, describe features:
Name: AG1 Orientation: Southwest

Comments/Location____

[ ] 4. Window: NFRC .32 / .30* (40 s.f., Southwest), U-Value: 0.320, SHGC: 0.300
For windows without labeled U-factors, describe features:
Name: AG1 Orientation: Southwest

Comments/Location____

[ ] 5. Window: NFRC .32 / .30* (25 s.f., Southeast), U-Value: 0.320, SHGC: 0.300
For windows without labeled U-factors, describe features:
Name: AG1 Orientation: Southeast

Comments/Location____

[ ] 6. Window: NFRC .32 / .30* (9 s.f., Southeast), U-Value: 0.320, SHGC: 0.300
For windows without labeled U-factors, describe features:
Name: AG1 Orientation: Southeast

Comments/Location____

[ ] 7. Window: NFRC .32 / .30* (25 s.f., Northeast), U-Value: 0.320, SHGC: 0.300

For windows without labeled U-factors, describe features:
Name: AG1 Orientation: Northeast

Comments/Location____

[ ] 8. Window: NFRC .32 / .30* (25 s.f., Southwest), U-Value: 0.320, SHGC: 0.300
For windows without labeled U-factors, describe features:
Name: AG1 Orientation: Southwest

Comments/Location____

[ ] 9. Window: NFRC .32 / .30* (25 s.f., Southwest), U-Value: 0.320, SHGC: 0.300
For windows without labeled U-factors, describe features:
Name: AG1 Orientation: Southwest

Comments/Location____

[ ] 10. Window: NFRC .32 / .30* (25 s.f., Southeast), U-Value: 0.320, SHGC: 0.300
For windows without labeled U-factors, describe features:
Name: AG1 Orientation: Southeast

Comments/Location____

[ ] 11. Window: NFRC .32 / .30* (14 s.f., Southwest), U-Value: 0.320, SHGC: 0.300
For windows without labeled U-factors, describe features:
Name: Bsmt Orientation: Southwest

Comments/Location____

[ ] 12. Window: NFRC .32 / .30* (28 s.f., Southeast), U-Value: 0.320, SHGC: 0.300
For windows without labeled U-factors, describe features:
Name: Bsmt Orientation: Southeast

Comments/Location____

Doors:

[ ] 1. Door: St 1.75" R7.5* (20 s.f.), R-Value 7.5

Comments/Location____

[ ] 2. Door: St 1.75" R7.5* (20 s.f.), R-Value 7.5

Comments/Location____

Frame Floors:

[ ] 1. Floor: R30 / R0* (32 s.f.), Between conditioned space and ambient conditions
R-0.0 continuous insulation, R-30.0 cavity insulation.
Name: FF1 Insulation Grade: I II III Face / Inset

Comments/Location____

Foundation Walls:

[ ] 1. Wall: 8-12"C R0 R5 F (600 s.f.), Between conditioned space and ambient/ground
R-0.0 interior continuous insulation, R-0.0 interior cavity insulation, R-5.0 exterior insulation.
Name: FND1 Insulation Grade: I II III Face / Inset

Comments/Location____

[ ] 2. Wall: 8-12"C R0 R5 F (168 s.f.), Between conditioned space and garage/ground
R-0.0 interior continuous insulation, R-0.0 interior cavity insulation, R-5.0 exterior insulation.
Name: FND2 Insulation Grade: I II III Face / Inset

Comments/Location____

[ ] 3. Wall: 8-12"C R0 R5 F (176 s.f.), Between conditioned space and ambient/ground
R-0.0 interior continuous insulation, R-0.0 interior cavity insulation, R-5.0 exterior insulation.
Name: FND3 Insulation Grade: I II III Face / Inset

Comments/Location____

Slab Floors:

[ ] 1. Slab: R5 Per, R0 Und* (717 s.f.)
R-5.0 perimeter insulation, R-0.0 under slab insulation.
Name: S1 Insulation Grade: I II III Face / Inset

Comments/Location____

[ ] 2. Slab: R5 Per, R0 Und* (329 s.f.)
R-5.0 perimeter insulation, R-0.0 under slab insulation.
Name: S2 Insulation Grade: I II III Face / Inset

Comments/Location____

SAMPLE

ENERGY CODE INSPECTION CHECKLIST

Rim and Band Joists:

[ ] 1. Joist: R1 Amb (119 s.f.), Between conditioned space and ambient
R-0.0 continuous insulation, R-19.0 cavity insulation.
Name: R1 Amb Insulation Grade: I II III Face / Inset

Comments/Location____

[ ] 2. Joist: R2 Gar (21 s.f.), Between conditioned space and garage
R-0.0 continuous insulation, R-19.0 cavity insulation.
Name: R2 Gar Insulation Grade: I II III Face / Inset

Comments/Location____

[ ] 3. Joist: B1 Attic (35 s.f.), Between conditioned space and attic
R-0.0 continuous insulation, R-19.0 cavity insulation.
Name: B1 Attic Insulation Grade: I II III Face / Inset

Comments/Location____

[ ] 4. Joist: B1 Amb (71 s.f.), Between conditioned space and ambient
R-0.0 continuous insulation, R-19.0 cavity insulation.
Name: B1 Amb Insulation Grade: I II III Face / Inset

Comments/Location____

Mechanical Equipment:

[ ] 1. Heating: Fuel-fired air distribution, Natural gas, 92.0 AFUE.

Make and Model Number:____

[ ] 2. Cooling: Air conditioner, Electric, 13.0 SEER.

Make and Model Number:____

[ ] 3. Water Heating: Conventional, Natural gas, 0.62 EF, 50.0 Gal.

Make and Model Number:____

Mechanical Ventilation System:

[ ] Mechanical ventilation system rated for, and capable of, providing continuous ventilation.
System shall include automatic timing controls.

SAMPLE

ENERGY CODE INSPECTION CHECKLIST

System type: Exhaust Only, 67 cfm, 8.0 hrs/day, 75.0 watts.

System description(make): ____

Air Leakage Control:

[ ] Joints, penetrations, and all other such openings in the building envelope that are sources of air leakage must be sealed.

[ ] Recessed lights must be type IC rated and installed with no penetrations; or, installed inside an appropriate air-tight assembly with a 0.5" clearance from combustible materials and 3" clearance from insulation.

Vapor Retarder:

[ ] Required on the warm-in-winter side of all non-vented framed ceilings, walls, and floors.

Materials Identification:

[ ] Materials and equipment must be identified so that compliance can be determined.

[ ] Manufacturer manuals for all installed heating and cooling equipment and service water heating equipment must be provided.

[ ] Insulation R-values and glazing U-factors must be clearly marked on the building plans or specifications.

Duct Insulation:

[ ] Ducts in conditioned basement must be insulated to R-0.0.

[ ] Ducts in conditioned basement must be insulated to R-0.0.

[ ] Ducts installed in exterior wall assemblies shall have at least 2" of rigid foam insulation with foil facing installed between sheathing and ducts.

Duct Construction:

[ ] All ducts must be sealed with mastic and fibrous backing tape. Pressure-sensitive tape may be used for fibrous ducts. Duct tape is not permitted.

[ ] The HVAC system must provide a means for balancing air and water systems.

Temperature Controls:

[ ] Thermostats are required for each separate HVAC system. A manual or automatic means to partially restrict or shut off the heating and/or cooling input to each zone or floor shall be provided.

[ ] Programmable Thermostat

Circulating Hot Water Systems:

[ ] Insulate circulating hot water pipes to the levels in Table 1.

Heating and Cooling Piping Insulation:

[ ] HVAC piping conveying fluids above 120 °F or chilled fluids below 55 °F must be insulated to the levels in Table 2.

SAMPLE

ENERGY CODE INSPECTION CHECKLIST

Table 1: Minimum Insulation Thickness for Circulating Hot Water Pipes.

Heated Water	Insulation Thickness in Inches by Pipe Sizes			
	Non-Circulating Runouts		Circulating Mains and Runouts	
Temperature (°F)	Up to 1"	Up to 1.25"	1.5" to 2.0"	Over 2"
170-180	0.5	1.0	1.5	2.0
140-160	0.5	0.5	1.0	1.5
100-130	0.5	0.5	0.5	1.0

Table 2: Minimum Insulation Thickness for HVAC Pipes.

	Fluid Temp.	Insulation Thickness in Inches by Pipe Sizes			
Piping System Types	Range(°F)	2" Runouts	1" and Less	1.25" to 2"	2.5" to 4"
Heating Systems					
Low Pressure/Temperature	201-250	1.0	1.5	1.5	2.0
Low Temperature	120-200	0.5	1.0	1.0	1.5
Steam Condensate(for feed water)	Any	1.0	1.0	1.5	2.0
Cooling Systems					
Chilled water, Refrigerant,	40-55	0.5	0.5	0.75	1.0
and Brine	Below 40	1.0	1.0	1.5	1.5

NOTES

SAMPLE

ENERGY COST AND FEATURE REPORT

Date:	February 05, 2009	Rating No.:	SAMPLE
Building Name:	UDC2	Rating Org.:	
Owner's Name:		Phone No.:	
Property:		Rater's Name:	
Address:	, WI	Rater's No.:	
Builder's Name:			
Weather Site:	UDC Design Zone 2, WI	Rating Type:	Based On Plans
File Name:	SAMPLE.blg	Rating Date:	January 1, 2009

ANNUAL ENERGY COSTS

		UDC2
Heating	$	778
Cooling	$	118
Water Heating	$	232
Lights & Appliances	$	1061
Photovoltaics	$	-0
Service Charges	$	119
Total	$	2308
Average Monthly	$	192

ENERGY FEATURES

Ceiling w/Attic:	R44 Attic * U=0.022
Vaulted Ceiling:	None
Above Grade Walls:	R19 (2x6 16oc)* U=0.063
Foundation Walls (Cond):	8-12"C R0 R5 F R=5.0
Found. Walls (Uncond):	None
Doors:	St 1.75" R7.5* U=0.119
Windows:	NFRC .32 / .30* U=0.320
Frame Floors:	R30 / R0* U=0.033
Slab Floors:	R5 Per, R0 Und* U=0.129
Infiltration:	Htg: 1017 Clg: 1017 CFM50
Infilt. Measure:	Blower door test
Mechanical Ventilation:	Exhaust Only: 67 cfm, 75.0 watts.
Interior Mass:	None
Mech Equip List:	Heating: Fuel-fired air distribution, 70.0 kBtuh, 92.0 AFUE.
	Cooling: Air conditioner, 30.0 kBtuh, 13.0 SEER.
	Water Heating: Conventional, Gas, 0.62 EF.
Programmable Thermostat:	Heat=Yes; Cool=Yes
Ducts:	Uninsulated Conditioned basement
Duct Leakage:	RESNET/HERS default

REM/Rate - Residential Energy Analysis and Rating Software v12.6 Wisconsin

This information does not constitute any warranty of energy cost or savings.

SAMPLE

ENERGY COST AND FEATURE REPORT

Lights/Appliances:	Defaults
Active Solar:	None
Photovoltaics:	None
Sunspace:	No

Notes: Where feature level varies in home, the dominant value is shown.

SAMPLE

Permit #
Checked by/Date

WIScheck COMPLIANCE REPORT

Wisconsin Uniform Dwelling Code
WIScheck Software Version 1.0

TITLE: UDC Chapter 22 Compliance Example

COUNTY: Dane
HEATING TYPE: Non-Electric
DATE: 1-4-1999
DATE OF PLANS: 1/4/99
PROJECT INFORMATION:
1500 ft2 house in Dane County

Sample Report

COMPANY INFORMATION:
Builder's Business Name

NOTES:
Windows are certified by NFRC. See attached manufacturer's specifications.

UDC COMPLIANCE: PASSES

Required UA = 373
Your Home = 349
6.5% Better Than Code

	Area or Perimeter	Cavity R-Value	Cont. R-Value	Glazing/Door U-Value	UA
CEILINGS	1500	19.0	19.0		39
WALLS: Wood Frame, 16" O.C.	1316	13.0	5.0		84
WALLS: Wood Frame, 16" O.C.	151	13.0	5.0		10
BSMT: Conc. 8.0' ht/7.0' bg/8.0' insul	1468	0.0	5.0		132
GLAZING: Windows or Doors, Above Grade	75			0.350	26
GLAZING: Windows or Doors, Above Grade	75			0.370	28
GLAZING: Windows, Basement/Foundation	20			0.870	17
DOORS	38			0.350	13
HVAC EQUIPMENT: Furnace, 90.0 AFUE					

COMPLIANCE STATEMENT: The proposed building design described here is consistent with the building plans, specifications, and other calculations submitted with the permit application. The proposed building has been designed to meet the requirements of the Wisconsin Uniform Dwelling Code.

Builder/Designer______________________________ Date______________

WIScheck Report Sample

TITLE: UDC Chapter 22 Compliance Example

Heating Equipment Sizing Summary

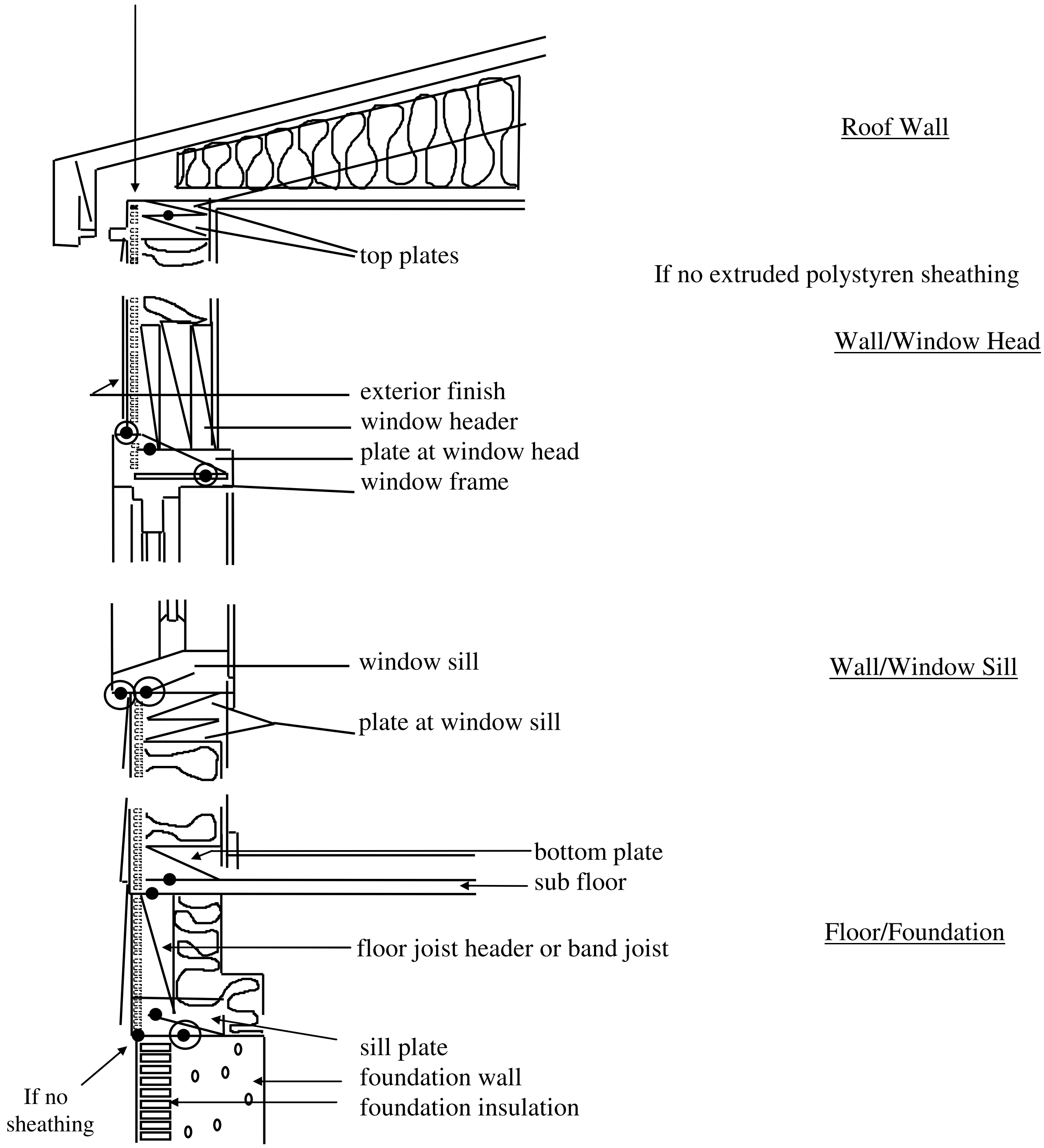
General Information

Outdoor Design Temperature:	-15	deg
Conditioned Floor Area:	1500	ft2
Average Ceiling Height:	8.0	ft
Infiltration Rate:	0.50	Normalized ACH
Equipment Oversizing Factor:	15.0	%

Loads Summary

Conductive Losses:	29725	Btu/hr
Infiltration Losses:	9180	Btu/hr
Oversizing Factor Losses:	5836	Btu/hr
Total Building Heating Load:	44741	Btu/hr

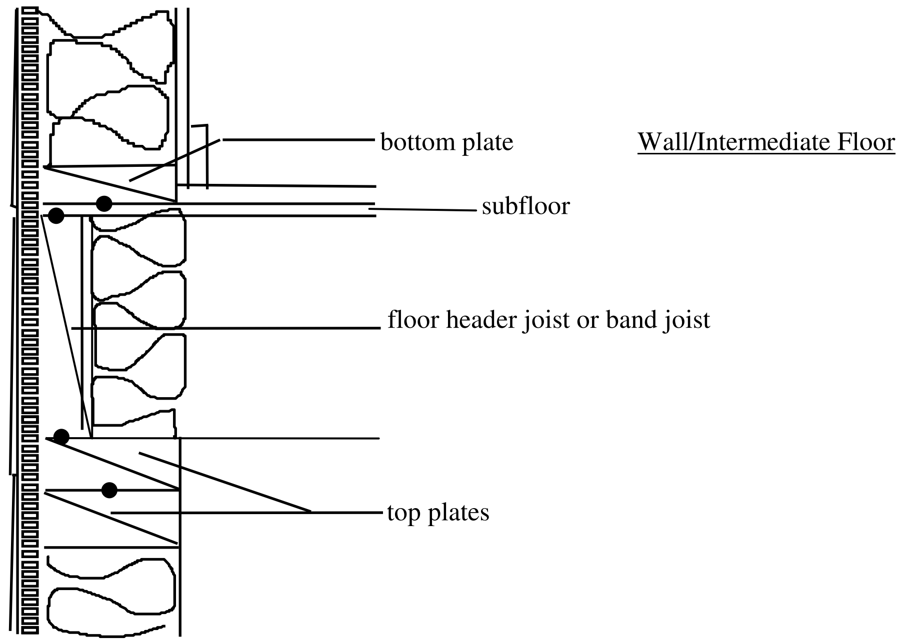
WIScheck Report Sample

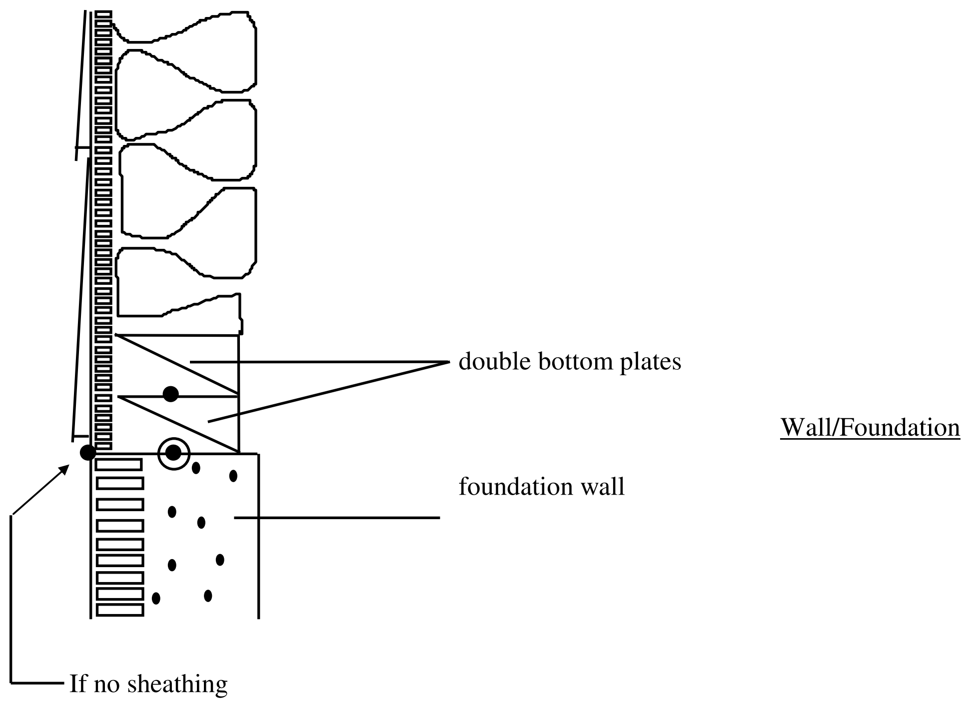


Caulk, Gasket or Seal:

Mandatory; also (not shown):

- All utility penetrations
- Between door thresholds and subfloor
- Between joist header and foundation
- Exterior joints at cantilevered floors, bay windows and soffitts (floor to wall, wall to roof, but not wall to wall joints)
- Separate wall panels in panelized construction


bottom plate
Wall/Intermediate Floor
subfloor
floor header joist or band joist
top plates


double bottom plates
Wall/Foundation
foundation wall
If no sheathing