Chapter Comm 22

ENERGY CONSERVATION

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Subchapter I — Scope and Application

Comm 22.01 Scope.

This chapter applies to all one- and 2-family dwellings covered by this code.

Comm 22.02 Application.

(1) This chapter is not intended to conflict with any safety or health requirements. Where such conflict occurs, the safety and health requirements shall govern.

(2) This chapter allows the designer the option of using Subchapters V and VI or Subchapter VII to demonstrate compliance with equipment and thermal performance requirements. The designer shall identify on the plan submittal form what method or subchapter is being used, and indicate the design criteria and how it is being applied. Requirements of all other subchapters apply regardless of choice.

(3) (a) Additions to dwellings may follow the energy code that was in effect at the time the current dwelling was originally constructed, provided the footprint of the addition has an area equal to 50% or less of the area of the footprint of the current dwelling.

(b) Portions of garages, porches and decks without living space directly above them are excluded from consideration under sub. (a).

Use of REScheck for Addition to Older Dwellings

You may use REScheck to determne compliance with this section. We will conservatively accept designs that fail to meet the current code by 12%. Alternatively, you can submit detailed calculations for greater deviations to show compliance.

Note: The UDC Energy Worksheet specifies the insulation requirements to apply to the dwelling envelope. A copy of the worksheet is in the appendix. Other code requirements apply to material and equipment identification, sealing of the building envelope, the heating and cooling system including ducts, and the hot water system. Copies of worksheets may be obtained from the Department of Commerce, Safety and Buildings Division P.O. Box 2509 Madison, WI 53701.

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.

There are separate thermal envelope, moisture control and ventilation requirements for nonelectrically and electrically heated dwellings. In this commentary, information that applies to both sets of standards will appear only in the nonelectric standards sections.

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 .5, it has an R-value of 2 (1/.5). If you have to add two materials in series or layers, say each with a C-value of .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, 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 x Temperature Difference (dF)
= 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:

$$U \times \text{Surface Area} \times \text{Degree-days} \times \frac{24 \text{ hours}}{\text{Day}} = \text{Season Heat Loss}$$

5. *U-Overall*

One more term to know is U-overall or Uo 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 Uo 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 = .1) wall and R-10 (U = .1) ceiling of equal area. If you transfer half of the wall insulation, to the ceiling, the wall becomes R-5 (U = .2) and the ceiling becomes R-15 (U = .07). However, you can see that the wall U-value increased by .1 and the ceiling U-value only decreased by .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:

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

The volume exchanged can be determined by measuring or judging how many air changes that a house goes through in an hour. For the UDC Energy Worksheet, this is the method used. 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 .25 and .50 air changes per hour, 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:

$$1500 \text{ sq. ft.} \times 8 \text{ ft.} \times .25 \text{ Air Changes/hr} = 3{,}000 \text{ cu. ft./hr}$$

The heat capacity of air is a physical constant and is .018 BTU per (°F)(cu. ft.). The temperature difference, which varies from 80° to 95° based on Table 22.04-B, used is the same as for heat loss by conduction. So the whole equation for this example is:

$$\frac{.018}{(dF)(cu.\ ft.)} \text{ BTU} \times 3{,}000 \text{ cu. ft./hr.} \times 90^{o} = 4{,}860 \text{ BTUs/hr}$$

This figure is the design or maximum heat loss. 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 .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 rotting and lessening of the insulation's R-value.

There are two 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 nonelectrically heated homes and .1 or lower for electrically heated homes.

For a vapor retarder to work properly, it must be placed on the warm 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.

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 creation of ice dams at the eaves in the winter. It also helps dissipate summertime attic heat.

III. Mechanical Ventilation

The next and perhaps more recently developed section of the UDC deals with mechanical ventilation. As the code has mandated tighter home construction, it has had to provide 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 electrically heated, superinsulated (and tightly built) homes.

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 Sizing and Efficiency Requirements

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

The code requirement is that heating and cooling equipment not exceed the calculated load by more than 15 percent except to satisfy the next manufacturer's model size. The reason for this size limitation is that most equipment designs are such that they are less efficient when used at less than their rated capacity.

In the case of a conventional forced air furnace, each time it shuts down some heat goes up the chimney between the time the furnace goes on and the fan goes on and between the time the fan goes off and the flue damper closes.

This concludes the energy basics section of this commentary chapter.

Subchapter II — Materials and Equipment.

Comm 22.03 Materials, equipment and systems installation.

Comm 22.03 (1) GENERAL. When available, information and values on thermal properties, performance of building envelope sections and components, and heat transfer shall be obtained from the ASHRAE Handbook of Fundamentals.

(2) LABORATORY OR FIELD TEST MEASUREMENTS. (a) *General thermal envelope materials*. When information specified under sub. (1) is not available, or when a different value is claimed, supporting data shall be obtained using one of the following test methods:

a. ASTM C177, Test method by guarded hot plate apparatus.

b. ASTM C236, Standard test method by means of a guarded hot box.

c. ASTM C335, Test method of horizontal pipe insulation.

d. ASTM C518, Test method by means of the heat flow meter apparatus.

e. ASTM C976, Standard test method by means of a calibrated hot box.

(b) *Foam plastic insulation.* 1. When information specified under sub. (1) is not available, or when a different value is claimed, foam plastic insulation that uses a gas other than

air as the insulating medium shall use laboratory or field tests conducted on representative samples that have been aged for the equivalent of 5 years or until the R–value has stabilized.

2. The tests shall be conducted by an independent third party using the standards listed under par. (a) and shall be submitted for department review and approval in accordance with s. Comm 20.18.

(c) *Concrete masonry units.* Systems using integrally-insulated concrete masonry units shall be evaluated for thermal performance in accordance with one of the following:

1. Default values as approved by the department with no extrapolations or interpolations.

2. Laboratory or field test measurements specified under par (a).

3. The material approval process specified in s. Comm 20.18.

(3) GENERAL INSTALLATION. (a) Materials, equipment and systems shall be identified in a manner that will allow a determination of their compliance with the applicable provisions of this chapter.

(b) All insulation materials, caulking and weatherstripping, fenestration assemblies, mechanical equipment and systems components, and water-heating equipment and system components shall be installed in accordance with the manufacturer's installation instructions.

(c) Manufacturer's installation instructions shall be available on the job site at the time of inspection.

(4) DWELLING ENVELOPE INSULATION. (a) Except as provided in par. (b), a thermal resistance identification mark shall be applied by the manufacturer to each piece of dwelling envelope insulation 12-inches or greater in width.

(b) Insulation without a thermal resistance identification mark may be used if the insulation installer provides a signed and dated certification for the insulation installed in each element of the building envelope, listing the type of insulation, the manufacturer and the R-value. For blown-in or sprayed insulation, the installer shall also provide the initial installed thickness, the calculated settled thickness, the coverage area and the number of bags installed. The installer shall post the certification in a readily accessible conspicuous place on the job site.

(5) INSULATION INSTALLATION. (a) Roof and ceiling, floor and wall cavity batt or board insulation shall be installed in a manner which will permit inspection of the manufacturer's R-value identification mark.

(b) The thickness of roof and ceiling insulation that is either blown in or sprayed shall be identified by thickness markings that are labeled in inches installed at least one for every 300 square feet through the attic space. The markers shall be affixed to trusses or joists marking

the minimum initial in-stalled thickness and minimum settled thickness with numbers a minimum of one-inch in height. Each marker shall face the attic access. The thickness of installed insulation shall meet or exceed the minimum initial installed thickness shown by the marker.

Comm 22.04 Protection of insulation.

(1) BLANKET INSULATION. Except in the box sill, insulating blankets or batts shall be held in place with a covering or other means of mechanical or adhesive fastening.

Note: Acceptable covering or fastening for interior or warm-side applications includes drywall, vapor retarder material, foil or kraft paper backing or other means of holding the blankets in place. Air barrier material may be used for cold-side support.

(2) FOAM PLASTIC INSULATION. Exterior foam plastic insulation shall be protected from physical damage and damage from ultraviolet light.

Note: For interior applications, a thermal barrier may be required under s. Comm 21.11.

Comm 22.05 Fenestration product rating certification and labeling.

(1) CERTIFIED PRODUCTS. Except as provided in sub. (2), fenestration product rating, certification and labeling, U-values of windows, doors and skylights shall be determined in accordance with the National Fenestration Rating Council standard 100, Procedures for Determining Fenestration Product Thermal Properties, by an accredited, independent laboratory. Fenestration products shall be labeled and certified by the manufacturer. Such certified and labeled values shall be accepted for purposes of determining compliance with the dwelling envelope requirements of this code.

(2) DEFAULT VALUES. When a manufacturer has not determined product U-value in accordance with NFRC 100 for a particular product line, compliance with the dwelling envelope requirements of the code shall be determined by assigning such products a default U-value in accordance with Tables 22.05-1 and 22.05-2. Product features must be verifiable for the product to qualify for the default value associated with those features. Where the existence of a particular feature cannot be determined with reasonable certainty, the product shall not receive credit for that feature. Where a composite of materials of two different product types is used, the product shall be assigned the higher U-value.

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.

TABLE 22.05-1

U-VALUE DEFAULT TABLE FOR WINDOWS, GLAZED DOORS AND SKYLIGHTS*

	Single Glazed	Double Glazed
METAL WITHOUT THERMAL BREAK		
Operable	1.27	0.87
Fixed	1.13	0.69
Garden Window	2.60	1.81
Curtain Wall	1.22	0.79
Door	1.26	0.80
Skylight	1.98	1.31
Site Assembled Skylight	1.36	0.82
METAL WITH THERMAL BREAK		
Operable	1.08	0.65
Fixed	1.07	0.63
Curtain Wall	1.11	0.68
Door	1.10	0.66
Skylight	1.89	1.11
Site Assembled Skylight	1.25	0.70
REINFORCED VINYL OR METAL-CLAD WOOD		
Operable	0.90	0.57
Fixed	0.98	0.56
Door	0.99	0.57
Skylight	1.75	1.05
WOOD/VINYL/FIBERGLASS		
Operable	0.89	0.55
Fixed	0.98	0.56
Garden Window	2.31	1.61
Door	0.98	0.56
Skylight	1.47	0.84

* Glass block assemblies shall have a default U-value of 0.60.

TABLE 22.05-2
U-VALUE DEFAULT TABLE FOR NON-GLAZED DOORS

STEEL DOORS (1-3/4 inches thick)	**With Foam Core**	**Without Foam Core**
	0.35	0.60
WOOD DOORS (1-3/4 inches thick)	**Without Storm Door**	**With Storm Door**
Panel with 7/16-inch panels	0.54	0.36
Hollowcore flush	0.46	0.32
Panel with 1-1/8-inch panels	0.39	0.28
Solid core flush	0.40	0.26

Subchapter III — Definitions.

Comm 22.06 Definitions.

In ch. Comm 22:

(1) "Accessible", as applied to equipment, means admitting close approach to equipment not guarded by locked doors, elevation or other effective means.

Note: See "readily accessible".

(2) "Air conditioning" means the process of treating air to control simultaneously its temperature, humidity, cleanness, and distribution to meet the requirements of the conditioned space.

(3) "Automatic" means self-acting, operating by its own mechanism when actuated by some impersonal influence, such as a change in current strength, pressure, temperature or mechanical configuration.

(4) "Basement wall" is the opaque portion of a wall that encloses one side of a basement and is partially or totally below grade.

(5) "Conditioned space" means space within the dwelling envelope which is provided with heated or cooled air or surfaces to provide a heated space or a cooled space.

(6) "Cooled space" means a space directly or indirectly supplied with mechanical cooling to maintain air temperature within the space of 85°F or less at design conditions.

(7) "Crawl space wall" means the opaque portion of a wall which encloses a crawl space and is partially or totally below grade.

(8) "Deadband" means the range of values within which an input variable can be varied without initiating any noticeable change in the output variable.

(9) "Dwelling envelope" means the elements of a dwelling with enclosed conditioned space through which thermal energy may be transferred to or from the exterior.

(10) "Electrically heated" means provided with permanently installed electrical space heating equipment which has an input capacity of 3 kilowatts or more to meet all or part of the space heating requirements.

(11) "Energy" means the capacity for doing work, taking a number of forms which may be transformed from one form into another, such as thermal heat, mechanical work, electrical and chemical in customary units, measured in kilowatt-hours (kWh) or British thermal units (Btu).

Note: See "New energy".

(12) "Energy, Recovered". See "Recovered energy".

(13) "F-value" means the rate of heat loss through a slab per foot of perimeter measured in Btu/h • ft • °F.

(15) "Gross exterior wall area" means the normal projection of the dwelling envelope wall area bounding interior space which is conditioned by an energy-using system including opaque wall, window and door area. The gross area of exterior walls consists of all opaque wall areas, including between floor spandrels, box sills, window area including sash, and door areas when they are exposed to outdoor air or unconditioned spaces and enclosed heated or mechanically cooled space, including interstitial area between two such spaces. The gross exterior wall area includes the total basement wall area if it is less than 50 percent below grade. The gross exterior wall area includes non-opaque areas such as windows and doors of all basement walls. Any skylight shaft walls that are 12 inches or more in depth, measured from the ceiling plane to the roof deck, shall be considered in the gross area of exterior walls d are excluded from consideration in the roof assembly.

(16) "Gross floor area" means the sum of areas of all floors of the structure, including basements, cellars, and intermediate floored tiers measured from the exterior faces of exterior walls or from the center line of interior walls, excluding covered walkways, open roofed-over areas, porches, pipe trenches, exterior terraces or steps, chimneys, roof overhangs and similar features.

(17) "Heat" means energy that is transferred by virtue of a temperature difference or a change in state of a material.

(18) "Heated slab" means slab-on-grade construction in which the heating elements or hot air distribution system is in contact with or placed within the slab or the subgrade.

(19) "Heated space" means any enclosed space provided with a direct or indirect supply of heat to maintain the temperature of the space to at least 50° F at design conditions.

(20) "Humidistat" means a regulating device, actuated by changes in humidity, used for automatic control of relative humidity.

(21) "HVAC" means heating, ventilating and air conditioning.

(22) "HVAC system" means the equipment, distribution network, and terminals that provide either collectively or individually the processes of heating, ventilating, or air conditioning to a building.

(23) "Infiltration" means the uncontrolled inward air leakage through cracks and interstices in any dwelling element and around windows and doors of a dwelling caused by the pressure effects of wind, and the effect of differences in the indoor and outdoor air density.

(24) "Inherently protected type IC" means tested and listed by an independent testing laboratory as being suitable for installation in a cavity where the fixture may be in direct contact with thermal insulation or combustible materials and the fixture construction is such that, even without a thermal protector, the fixture cannot be overlamped or mislamped.

(25) "Manual" means capable of being operated by personal intervention.

Note: See "Automatic".

(26) "New energy" means energy other than recovered energy, utilized for the purpose of heating or cooling.

Note: See "Energy".

(27) "Opaque areas" means all exposed areas of a dwelling envelope which enclose conditioned space except openings for windows, skylights, doors and dwelling service systems.

(28) "Readily accessible" means capable of being reached quickly for operation, renewal or inspections, without requiring a person to climb over or remove obstacles or to resort to portable ladders or access equipment.

Note: See "Accessible".

(29) "Recovered energy" means energy utilized which would otherwise be wasted and would not contribute to a desired end use, from an energy utilization system.

(30) "Renewable energy sources" means sources of energy, excluding minerals, derived from incoming solar radiation, including natural daylighting and photosynthetic processes: from phenomena resulting therefrom, including wind, waves and tides, lake or pond thermal differences and from the internal heat of the earth, including nocturnal thermal exchanges.

(31) "Roof assembly" means all components of the roof and ceiling envelope through which heat flows, thus creating a building transmission heat loss or gain, where such assembly is

exposed to outdoor air and encloses a heated or mechanically cooled space. The gross area of a roof assembly consists of the total interior surface of all roof or ceiling components, including opaque surfaces, dormer and bay window roofs, treyed ceilings, overhead portions of an interior stairway to an unconditioned attic, doors and hatches, glazing and skylights exposed to conditioned space, that are horizontal or sloped at an angle less than 60 degrees from the horizontal. A roof assembly, or portions thereof, having a slope of 60 degrees or greater from horizontal shall be considered in the gross area of exterior walls and shall be excluded from consideration in the roof assembly. Any skylight shaft walls less than 12 inches in depth, as measured from the ceiling plane to the roof deck, shall be considered in the roof assembly and are excluded from consideration in the gross area of exterior walls.

(32) "Sequence" means a consecutive series of operations.

(33) "Service systems" means all energy-using systems in a dwelling that are operated to provide services for the occupants or processes housed therein, including HVAC, service water heating, illumination, transportation, cooking or food preparation, laundering and similar functions.

(34) "Service water heating" means a supply of hot water for purposes other than comfort heating.

(35) "Service water heating demand" means the maximum design rate of energy withdrawal from a service water heating system in a designated period of time; usually an hour or a day.

(36) "Slab-on-grade floor insulation" means insulation around the perimeter of the floor slab or its supporting foundation.

(37) "Solar energy source" means a source of natural daylighting and of thermal, chemical or electrical energy derived directly from conversion of incident solar radiation.

(38) "System" means a combination of central or terminal equipment and their components, controls, accessories, interconnecting means, and terminal devices by which energy is transformed so as to perform a specific function such as, HVAC, service water heating or illumination.

(39) "Thermal conductance" means the time rate of heat flow through a body, frequently per unit area, from one of its bounding surfaces to the other for a unit temperature difference between the two surfaces, under steady state conditions. It is expressed as Btu/h • ft^2 • °F.

(40) "Thermal resistance" or "R" means a measure of the ability to retard the flow of heat. The R-value is the reciprocal of thermal transmittance or U-Value expressed as R= 1/U.

Note: The higher the R-value of a material, the more difficult it is for heat to be transmitted through the material.

(41) "Thermal resistance overall" or "R_o" means the reciprocal of overall thermal conductance expressed as Btu/h • ft^2 • °F. The overall thermal resistance of the gross area or individual component of the exterior dwelling envelope such as, roof and ceiling, exterior walls, floors, crawl space walls, foundation walls, windows, skylights, doors, and opaque walls, includes the weighted R-values of the component assemblies, including air-film, insulation, drywall, framing, and glazing.

(42) "Thermal transmittance" or "U" means the time rate of heat flow through a body or assembly which is located in between 2 different environments, expressed in Btu/h • $ft.^2$ • °F. The U-value applies to combinations of different materials used in series along the heat flow path and also to single materials that comprise a dwelling section, including cavity air spaces and air films on both sides of a dwelling element.

Note 1: The lower the U-value of a material, the more difficult it is for heat to be transmitted through the material.

Note 2: The thermal transmittance is also referred to as the coefficient of heat transfer or the coefficient of heat transmission.

(43) "Thermal transmittance overall" or "U_o" means the overall, average heat transmission of a gross area of the exterior dwelling envelope expressed as Btu/h • ft^2 • °F. The U_o-value applies to the combined effect of the time rate of heat flow through various paths, such as windows, doors and opaque construction areas, comprising the gross area of one or more exterior dwelling components, such as walls, floors or roof and ceilings.

(44) "Thermally protected type IC " means tested and listed by an independent testing laboratory as being suitable for installation in a cavity where thermal insulation will be in direct contact with the fixture.

(45) "Thermostat" means an automatic control device actuated by temperature and designed to be responsive to temperature.

(46) "Ventilation" means the process of supplying or removing air by natural or mechanical means to or from any space. Such air may or may not have been conditioned.

(47) "Zone" means a space or group of spaces within a dwelling with heating or cooling requirements sufficiently similar so that comfort conditions can be maintained throughout by a single controlling device.

Subchapter IV — Design Criteria

Comm 22.07 Indoor and outdoor temperatures.

(1) GENERAL. The indoor temperatures listed in sub. (2) and the outdoor temperatures listed in Table 22.07 shall be used to determine the total dwelling heat loss and to select the size of the of the heating equipment.

(2) INDOOR DESIGN TEMPERATURES. Unheated, non-habitable basement areas shall use a design temperature of less than 50°F. All other areas of a dwelling shall use a design temperature of 70°F.

TABLE 22.07
OUTDOOR DESIGN CONDITIONS BASED ON FIGURE 22.07

Zone 1	25° below zero F
Zone 2	20° below zero F
Zone 3	15° below zero F
Zone 4	10° below zero F

Note: See Figure 22.07 for zone boundaries.

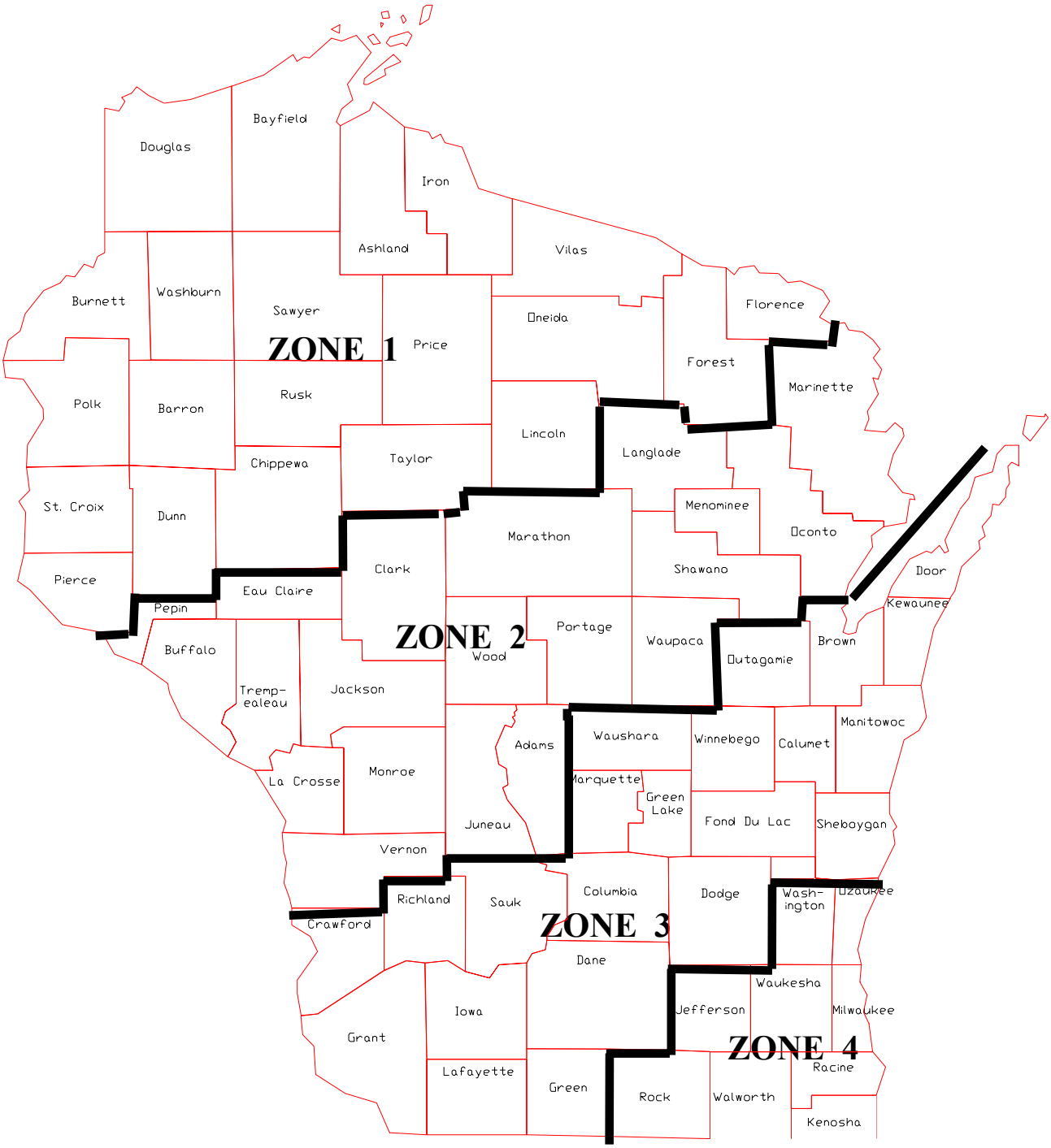
Douglas
Bayfield
Iron
Ashland
Vilas
Florence
Burnett
Washburn
Sawyer
Price
Oneida
ZONE 1
Forest
Marinette
Polk
Barron
Rusk
Lincoln
Langlade
Taylor
Chippewa
St. Croix
Dunn
Menominee
Oconto
Marathon
Clark
Shawano
Door
Pierce
Pepin
Eau Claire
Kewaunee
Portage
Waupaca
Brown
Buffalo
ZONE 2
Wood
Outagamie
Tremp-
ealeau
Jackson
Manitowoc
Adams
Waushara
Winnebago
Calumet
La Crosse
Monroe
Marquette
Green
Lake
Fond Du Lac
Sheboygan
Juneau
Vernon
Columbia
Dodge
Wash-
ington
Ozaukee
Richland
Sauk
Crawford
ZONE 3
Dane
Waukesha
Iowa
Jefferson
Milwaukee
Grant
ZONE 4
Racine
Lafayette
Green
Rock
Walworth
Kenosha

FIGURE 22.07

Comm 22.08 Ventilation and moisture control.

(1) ATTICS. (a) Ventilation shall be provided above the ceiling or attic insulation. At least 50% of the net free ventilating area shall be distributed at the low sides of the roof. The remainder of the net free ventilating area shall be distributed in the upper one-half of the roof or attic area.

1. If more than 50%, but less than 75% of the net free ventilating area is provided at the low sides of the roof, the total net free ventilating area shall be a minimum of 1/300 of the horizontal area of the ceiling.

2. If 75% or more of the net free ventilating area is provided at the low sides of the roof, the total net free ventilating area shall be at least 1/150 of the horizontal area of the ceiling.

(b) As an exception to par (a), the ventilation space above any non-rigid insulation in a cathedral ceiling assembly shall be at least one inch in height.

(c) Engineered systems that provide equivalent ventilation to that specified in par. (a) may be used.

(d) The ventilation area required in par. (a) shall be maintained after the installation of insulation.

(2) CRAWL SPACES. Ventilation shall be provided in crawl spaces which are outside the dwelling envelope. The area of ventilation shall be at least 1/1500 of the floor space. At least 50% of the ventilating area shall be provided at opposite sides of the crawl space or as far apart as possible.

(3) CLOTHES DRYERS. If clothes dryers are provided, the dryers shall be vented to the outside of the dwelling. The dryer vents may not terminate in an attic space or crawl space or basement.

Note: See s. Comm 23.14 for vent material requirements.

Subchapter V — Heating and Air Conditioning Equipment and Systems

Comm 22.09 Scope.

This subchapter covers the determination of system heating and cooling loads, design requirements, system and component performance, control requirements, and distribution system construction and insulation.

Comm 22.10 Calculating heating and cooling loads.

The design requirements specified in Subchapter IV shall apply for all computations.

Comm 22.11 Calculation procedures.

(1) Heating and cooling design loads including ventilation loads for the purpose of sizing systems shall be determined in accordance with one of the procedures described in Chapter 25 of ASHRAE Handbook of Fundamentals.

(2) Infiltration for heating and cooling design loads shall be calculated based on a maximum of 0.5 air change per hour in the heated or cooled space.

Comm 22.12 Selection of equipment.

(1) GENERAL. Except as provided in sub. (2), the output capacity of the mechanical heating equipment shall not exceed the calculated heating load by more than 15%, except to satisfy the manufacturer's next closest nominal size.

(2) WATER HEATERS USED FOR SPACE HEATING. The output capacity of water heaters that are used for simultaneous space heating shall exceed the calculated space heating load by at least 43%, but by no more than 49%. Other sizing methods may be used if approved by the department for water heaters providing simultaneous space and domestic water heating.

Note: Heat exchanger units that are part of the plumbing system shall meet the requirements of Chs. Comm 81-84.

(3) The efficiency of equipment installed in a dwelling shall match the efficiency used to claim any credit under the method of design by system analysis or other approved compliance method.

Comm 22.13 Supplementary heater for heat pumps.

(1) If a heat pump is installed, it shall include a control to prevent supplementary heater operation when the operating load can be met by the heat pump alone.

(2) Supplementary heater operation is permitted during transient periods, such as start-up periods, following room thermostat set-point advance, and during defrost periods.

(3) A two-stage thermostat, which controls the supplementary heat on its second stage, shall be accepted as meeting this requirement. The cut-on temperature for the compression heating shall be higher than the cut-on temperature for the supplementary heat. Supplementary heat may be derived from any source including, electric resistance, combustion heating, and solar stored-energy heating.

Comm 22.14 Mechanical ventilation.

(1) Mechanical ventilation system supply and exhaust shall be equipped with a readily accessible means for shutoff when ventilation is not required.

(2) Automatic or gravity dampers that close when the system is not operating shall be provided for outdoor air intake and exhaust.

Comm 22.15 Temperature control

(1) A readily accessible manual or automatic means shall be provided to restrict or shut off the heating or cooling input to each zone or floor.

(2) Each system shall be provided with an adjustable thermostat for the regulation of temperature. A thermostat shall be capable of being set by adjustment or selection of sensors as follows:

(a) When used to control heating only, the thermostat shall be capable of being set from 55°F to 75°F.

(b) When used to control cooling only, the thermostat shall be capable of being set from 70°F to 85°F.

(c) When used to control both heating and cooling, the thermostat shall be capable of being set from 55°F to 85°F and shall be capable of operating the system heating and cooling in sequence. The thermostat or control system shall have an adjustable deadband of at least 10°F.

Comm 22.16 Humidity control.

If a system is equipped with a means for adding or removing moisture to maintain a selected relative humidity in spaces or zones, a humidistat shall be provided.

(1) Humidistats of humidifiers shall be capable of being set to prevent new energy from being used to produce a space or zone relative humidity above 30 percent.

(2) Humidistats of dehumidifiers shall be capable of being set to prevent new energy from being used to produce a space or zone relative humidity of less than 60 percent.

Note: This requirement does not restrict the actual operation of the equipment. The only requirement is that the specified setpoints be available to the occupants so that they can minimize energy consumption. The controls are not limited to the specified settings alone.

Comm 22.17 Duct system insulation.

(1) Except as provided in sub. (4), all heating and cooling duct systems, or portions thereof, that are located in unheated or uncooled spaces respectively, shall be provided with insulation with a thermal resistance of at least R-5.

Note: Where control of condensation is required for compliance with s. Comm 22.22, additional insulation, vapor retarders, or both, may need to be provided to limit vapor transmission and condensation.

(2) Where exterior walls are used as plenum walls, wall insulation shall be as required by the most restrictive condition of this section or s. Comm 22.21.

(3) Insulation resistance shall be measured on a horizontal plane in accordance with ASTM standard C 518 at a mean temperature of 75°F at the installed thickness

(4) Duct insulation, except as required to prevent condensation, is not required on any of the following ducts:

(a) Supply-air or return-air ducts that are installed in basements, cellars or unventilated crawl spaces having insulated walls.

(b) Ducts for which heat gain or loss, without insulation, will not increase the energy requirements of the building.

(c) Ducts located within HVAC equipment.

(d) Exhaust air ducts.

Comm 22.18 Duct and plenum sealing.

(1) Sections of supply and return ducts not located entirely within the conditioned space and the unconditioned side of enclosed stud bays or joist cavities or spaces used to transport air shall be sealed.

(2) Sealing shall be accomplished using welds, gaskets, mastics, mastic-plus-embedded-fabric systems or tapes installed in accordance with the manufacturer's instructions.

(3) Insulation that provides a continuous air barrier may be used in lieu of sealing metal ducts.

(4) Tapes and mastics used with rigid fibrous glass ducts shall be listed and labeled as complying with UL 181A.

(5) Tapes and mastics used with flexible air ducts shall be listed and labeled as complying with UL 181B.

(6) Tapes with rubber-based adhesives may not be used.

Note: Standard duct tape has a rubber-based adhesive and does not comply with the requirements of this section.

Comm 22.19 Pipe insulation.

(1) Except as provided in sub. (2), all heating pipes in unheated spaces and all cooling pipes in uncooled spaces shall be insulated with material providing a minimum thermal resistivity of R-4 as measured on a flat surface in accordance with ASTM standard C 335 at a mean temperature of 75 °F.

(2) Piping insulation is not required in any of the following cases:

(a) Pipes installed within heating and air conditioning equipment, installed in conditioned spaces.

(b) Piping at fluid temperatures between 55°F and 120°F when not required for energy conservation purposes.

(c) When the heat loss or gain of the piping without insulation does not increase the energy requirements of the dwelling.

(d) When piping is installed in basements, cellars or unventilated crawl spaces having insulated walls.

Note: Additional insulation and vapor retarders may be necessary to prevent condensation in accordance with s. Comm 22.22.

Subchapter VI — Dwelling Envelope Design

Comm 22.20 General.

(1) APPLICATION. The dwelling envelope of all 1- and 2-family dwellings shall comply with this subchapter, unless the requirements of system analysis design of subch. VII are met.

(2) PRESCRIPTIVE PATH FOR ADDITIONS. (a) As an alternative to demonstrating compliance with ss. Comm 22.23 to 22.28, dwelling additions with a conditioned floor area less than 500 square feet shall meet the prescriptive envelope component criteria in Table 22.20.

(b) The U-factor of each individual fenestration product shall be used to calculate an area-weighted average fenestration product U-factor for the addition, which may not exceed the listed values in Table 22.20.

(c) The total area of fenestration products may not exceed 25 percent of the gross exterior wall area of the addition.

(d) The R-values for opaque thermal envelope components shall be equal to or greater than the applicable listed values in Table 22.20.

TABLE 22.20
PRESCRIPTIVE ENVELOPE COMPONENT CRITERIA FOR ADDITIONS TO AND REPLACEMENT WINDOWS FOR EXISTING SINGLE-FAMILY DWELLINGS

DESIGN ZONE [a]	MAXIMUM	MINIMUM					
	Fenestration U-factor [b, c]	Ceiling R-value [d]	Wall R-value	Floor R-value [d]	Basement wall R-value [e]	Slab perimeter R-value and depth [f]	Crawl space wall R-value [g]
2-4	0.35	R-38	R-21	R-21	R-11	R-13,4 ft.	R-20
1	0.35	R-38	R-21	R-21	R-19	R-18, 4 ft.	R-20

a. Refer to Figure 22.07 for design zone boundaries.
b. Exception: replacement skylights shall have a maximum U-factor of 0.50.
c. Fenestration shall meet s. Comm 22.05.
d. Floors over outside air shall meet Ceiling R-value requirements.
e. Basement wall insulation shall be installed in accordance with s. Comm 22.28.
f. Slab perimeter insulation shall be installed in accordance with s. Comm 22.26. An additional R-2 shall be added to Slab perimeter R-value in the table if the slab is heated.
g. Crawl space wall R-value shall apply to unventilated crawl spaces only. Crawl space insulation shall be installed in accordance with s. Comm 22.27.

Note: See appendix for a copy of the UDC Energy Worksheet used to show compliance with the envelope insulation requirements of ss. Comm 22.21 to 22.28. Copies of the worksheets may be obtained from the Department of Commerce, Safety & Buildings Division, P.O. Box 2509, Madison, WI 53701. Other forms or software may be used when approved by the department. WIScheck software may be used to show compliance and is available from the Safety & Buildings page on the Department of Commerce Website www.commerce.state.wi.us.

Comm 22.21 Envelope requirements.

(1) GENERAL. (a) The stated U_o- , U- or R-value of an assembly may be increased or decreased, provided the total thermal transmission heat gain or loss for the entire dwelling does not exceed the total U_o- ,U- or R-value of an assembly resulting from conformance to the values specified in ss. Comm 22.23 to 22.28.

(b) Where basement and crawl space walls are part of the building envelope, their U-factors shall be based on the wall components and surface air films. Adjacent soil may not be considered in the determination.

Note: Foundation insulation techniques can be found in the DOE Building Foundation Design Handbook.

(2) APPLICATION OF STANDARDS FOR ELECTRICALLY HEATED DWELLINGS. (a) New dwellings. New dwellings that are electrically heated shall meet the thermal performance standards of this subchapter for electrically heated dwellings.

(b) Additions. If the combined input capacity of permanently installed electrical space heating equipment of the original dwelling and a new addition exceeds 3 kilowatts, either the addition shall meet the thermal performance standards of this subchapter for electrically heated dwellings or the entire dwelling and addition shall meet the thermal performance standards of this subchapter for electrically heated dwellings.

(c) Alterations. If an alteration results in the addition of permanently installed electrical space heating equipment with a combined input capacity of permanently installed electrical space heating equipment of the altered dwelling exceeds 3 kilowatts, either the area served by the new electrical space heating equipment shall meet the thermal performance standards of this subchapter for electrically heated dwellings or the entire dwelling, and the addition shall meet the thermal performance standards of this sub-chapter for electrically heated dwellings.

(3) APPLIANCE CREDITS. The maximum overall heat loss allowance may be increased when an equivalent amount of energy savings is provided by the following types of high efficiency heating equipment:

(a) A furnace with an AFUE of 90% or greater.

(b) A boiler with an AFUE of 81% or greater.

Note: AFUE means annual fuel utilization efficiency.

(c) An air-source heat pump with an HSPF of 7.8 or greater.

Note: HSPF means heating seasonal performance factor.

(d) A geothermal heat pump.

(e) A radiant electric heat panel that meets all of the following requirements:

1. The panel delivers at least 50% of its heat output by radiation.

2. The panel reaches its operating temperature in 15 minutes or less.

3. a. The panel is surface mounted.

b. The panel is not located behind finish material, such as paneling or carpeting and is not located within a wall, floor or ceiling assembly.

Note: The UDC Energy Worksheet and WIScheck software will determine the amount of credit available.

TABLE 22.21
HEATING AND COOLING CRITERIA [g]

Component of Dwelling Envelope	Maximum Overall Thermal Transmittance, U_0 or Minimum Thermal Resistance, R: Non-electrically Heated	Electrically Heated
Roof and Ceiling[a]	$U_0 = 0.026$	$U_0 = 0.020$
Walls:		
crawl space[c, f]	$U_0 = 0.060$	$U_0 = 0.060$
basement[c, f]	$U_0 = 0.091$	$U_0 = 0.091$
walls[b]	$U_0 = 0.110$	$U_0 = 0.080$
Floors:		
heated slab-on-grade[c, d,f].	R = 8.5	R = 10
over unheated space[e]	$U_0 = 0.050$	$U_0 = 0.050$
unheated slab-on-grade[c, d,f]	R = 6.5	R = 10
over outside air (overhang)	$U_0 = 0.033$	$U_0 = 0.033$

[a] Roof and ceiling assemblies include attic access panels and skylights.
[b] See definition of gross exterior wall area.
[c] Insulation installed below grade shall be suitable for that application.
[d] "Heated slab" means slab-on-grade construction in which the heating elements or hot air distribution system is in contact with or placed within the slab or the subgrade. The required U-value refers to the insulation only.
[e] Includes unheated crawl spaces, basements, garages, and other spaces outside of the dwelling envelope.
[f] The required U-value applies to the floor or wall assembly only, excluding the effect of soil.

Comm 22.22 Vapor retarders.

(1) GENERAL. (a) Designs shall prevent deterioration from moisture condensation.

(b) Vapor retarders shall have a rating of 1.0 perm or less when tested in accordance with ASTM standard E 96, Procedure A.

(c) The vapor retarder shall be continuous. All joints in the vapor retarder shall be overlapped and secured or sealed. Rips and punctures in the vapor retarder shall be patched with vapor retarder materials and taped or sealed.

(2) FRAME ASSEMBLIES. In all frame walls, floors and ceilings, the vapor retarder shall be installed on the warm side of the thermal insulation. The vapor retarder shall cover the exposed insulation and the interior face of studs, joists and rafters. No vapor retarder is required in the box sill.

(3) CONCRETE FLOORS. A vapor retarder shall be installed under the slab or under the base course of slabs and basement floors unless the slab is in an unheated attached garage

(4) CONCRETE OR MASONRY BASEMENT WALLS. A vapor retarder is not required in concrete or masonry basement wall below-ground applications.

(5) CRAWL SPACES. A vapor retarder shall be provided over crawl space floors in accordance with s. Comm 21.05 (4).

(6) WOOD FOUNDATIONS. Vapor retarders for wood foundations shall be in accordance with the standards adopted under s. Comm 20.24, Table 20.24-2 2.

Vapor Retarders

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 infiltration may be the greatest cause of condensation. At the corners of the walls is the area with the greatest potential to obtain air infiltration 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.

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 dry wall.

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 drywall to pick up excess moisture prior to installation.*

2. *Make sure attics are insulated prior to putting heat into the home for drywall 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 dry wall. Drywall 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 drywall 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.

"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.

I. 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.

A. 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.

1. 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.

B. Staining and mold on window frames.

C. 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.

D. Soft or buckling interior wall surfaces. Drywall is a common interior surface. When dampened it may pull away from studs or ceiling rafters. Additional moisture may cause the drywall to crumble.

E. Staining or warping of exterior siding.

F. 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.