CR 85-164

RULES CERTIFICATE

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STATE OF WISCONSIN)
) SS
DEPT. OF INDUSTRY,)
LABOR & HUMAN RELATIONS)

TO ALL TO WHOM THESE PRESENTS SHALL COME, GREETINGS:

I, Howard S. Bellman, Secretary of the Department of Industry, Labor and Human Relations, and custodian of the official records of said department, do hereby certify that the annexed rule(s) relating to Energy conservation standards for electrically heated homes (Subject) were duly approved and adopted by this department on 5/6/86 (Date).

I further certify that said copy has been compared by me with the original on file in this department and that the same is a true copy thereof, and of the whole of such original.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the official seal of the department at 1013D in the city of Madison, this 6th day of May A.D. 1986.

Howard S. Bellman
Secretary

DILHR-ADM-6056(N.04/80)

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ORDER OF ADOPTION

Pursuant to authority vested in the Department of Industry, Labor and Human Relations by section(s) 101.02(1), 101.63(1) and (1m), 101.64(3) 101.73(1) and (1m) and 101.74 Stats., the Department of Industry, Labor and Human Relations hereby [X] creates; [X] amends; [X] repeals and recreates; and [X] repeals and adopts rules of Wisconsin Administrative Code chapter(s):

Ind. ILHR 22 *(Number)* Energy Conservation *(Title)*

The attached rules shall take effect on January 1, 1987 _____, pursuant to section 227.026, Stats.

Adopted at Madison, Wisconsin, this 6th day of May, A.D., 1986.

DEPARTMENT OF INDUSTRY, LABOR AND HUMAN RELATIONS

Howard S. Bellman
Secretary

State of Wisconsin \ Department of Industry, Labor and Human Relations

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RULES in FINAL DRAFT FORM

Rule: Ch. ILHR 22

Relating to: Energy Conservation Standards for Electrically Heated Homes

Clearinghouse Rule No.: 85-164

AN ORDER to repeal ILHR 22.06 (6a); to renumber ILHR 22.03 (1), subchapter VI, ILHR 22.14 and 22.15, subchapter V and ILHR 22.08 to 22.12; to renumber and amend ILHR 20.24 (2m), ILHR 22.06 (5a), ILHR 22.06 (6b), and ILHR 22.13; to amend subchapter III (title); ILHR 22.04, subchapter VI (title), ILHR 22.06 (intro.) and ILHR 22.07 (title); to repeal and recreate ILHR 21.05 (3) and (5), ILHR 22.05 (3), ILHR 22.19 (1) (a), and ILHR 22.19 (2); and to create ILHR 20.24 (2m), ILHR 22.03 (1), ILHR 22.03 (4m), ILHR 22.03 (5m), ILHR 22.03 (7m), ILHR 22.03 (7r), ILHR 22.03 (9m), ILHR 22.05 (intro.), ILHR 22.07 (intro.), subchapter V (title), ILHR 22.08 to 22.13, ILHR 22.14, ILHR 22.21, and ILHR 25.05, relating to energy conservation in one- and 2-family dwellings.

* *

ANALYSIS OF RULES

In 1983, Wisconsin Act 27 created s. 101.63 (1m) and 101.73 (1m), Stats., which requires the Department of Industry, Labor and Human Relations to develop superinsulation standards for new electrically heated one- and 2-family dwellings, including maufactured dwellings.

A committee comprised of representatives of the Public Service Commission, the Division of State Energy and Costal Management and the department performed the research on energy conservation methodologies regarding electrically heated homes and developed the rules.

Input concerning energy efficient construction practices was obtained from builders, manufacturers and other members of the building trades early in the development process by means of surveys and later from members of the Dwelling Code Council.

The superinsulation standards will apply only to electrically heated one- and 2-family dwellings. The rules are proposed to be inserted into chapter ILHR 22 which deals with energy conservation standards for one- and 2-family dwellings. A few changes in the requirements which pertain to non-electrically heated dwellings have also been proposed. This was done to update the appliance efficiency standards to keep up with available technology.

A new subchapter is proposed to be inserted in chapter ILHR 22 to accommodate the new insulation and infiltration standards for electrically heated homes. The current insulation and infiltration standards are retained and will apply to all other fuel types.

INSULATION STANDARDS FOR ELECTRICALLY HEATED HOMES.

Under the current rules, the insulation requirements may be met by complying with either performance standards using the system design method, or by complying with specification standards using the component or acceptable practice method. Under the acceptable practice method, compliance may be achieved by insulating various building components such as exterior walls, ceilings, and floors to the level specified for each building element.

The system design method involves calculating the total heat loss of all the building elements. Under this method, the level of insulation in various building elements may be decreased as long as the insulation levels in other components are increased by an equivalent amount. To comply, the building must be insulated in such a way that the total heat loss of the entire building does not exceed the heat loss which would occur if the dwelling was insulated to levels specified in the code.

The proposed insulation standards for electrically heated homes may still be met using either method, but the insulation levels have been increased for electrically heated homes. The insulation standards for non-electrically heated homes remain the same as they are under the current code.

Table A shows ways in which wall sections of a 65' x 25' (1625 sq ft) single story dwelling with a full basement could be built to meet the proposed code using the acceptable practice, component method. Note, the exterior above grade walls are considered to be one component.

The proposed standard for walls of electrically heated homes is U=0.080. Any combination of wall insulating and building materials may be used to meet the standard. Table A shows just two ways in which this could be accomplished.

TABLE A

Wall Insulation Combinations to Meet Current and Proposed Codes

Component Method

	AREA (Sq. Ft.)	CURRENT CODE (2 x 4 Wall) R-Value	CURRENT CODE (2 x 4 Wall) UA[3]	CURRENT CODE (2 x 6 Wall) R-Value	CURRENT CODE (2 x 6 Wall) UA	PROPOSED CODE (2 x 4 Wall) R-Value	PROPOSED CODE (2 x 4 Wall) UA	PROPOSED CODE (2 x 6 Wall) R-Value	PROPOSED CODE (2 x 6 Wall) UA
Insulated Cavity Opaque Wall	1063	20.0[1]	53.15	26.0[5]	40.88	25.0[6]	42.52	26.0[5]	40.88
Framing (12%)	145	11.4[2]	12.72	13.9	10.43	16.4	8.84	13.9	10.43
Windows	190	1.7	111.76	1.7	111.76	3.3	57.57	3.3	57.57
Doors	42	10.0	4.20	10.0	4.20	10.0	4.20	10.0	4.20
Box Sill	149	21.43	6.95	8.42	17.69	26.4	5.63	27.4	5.44
Foundation (12" exp)	158	6.5	24.31	6.5	24.31	11.5	13.74	11.5	13.74
Bsmt Windows	22	1.7	12.94	1.7	12.94	3.3	6.66	2.8	7.86
Actual Total	1769		226.03		222.21		139.16		140.12
Required Total UA[4]			229.97		229.97		141.52		141.52
Required Avg U			0.13		0.13		0.080		0.080

1. Includes R-value of R13 batt insulation, R5 sheathing, and R2 for finishes and air films.

2. Includes R-value of stud plus sheathing and wall finishes and air films.

3. Since R=1/U UA=A/R.

4. When the actual total UA is less than or equal to the required total UA (=A x required average U) compliance is achieved.

5. Includes R-values of R19 batt insulation R5 insulating sheathing and R2 for finishes and air films.

6. Includes R13 batt insulation, R10 sheathing and R2 for finishes and air films.

The proposed maximum U-value for attics of electrically heated homes is 0.020 or insulation equivalent to R50. Table B shows the amounts of some insulating materials which could be used to meet the proposed standard using the component method.

Table B
Insulation Levels to Meet Proposed
Heat Loss Through Ceiling/Attic Assemblies U = 0.020

Fiberglass batts	2-R19 batts + 1-R11 batt
Cellulose (R=3.7/in)	13 inches loose fill
Expanded pearlite (R=2.7/in)	16 inches loose fill
Mineral fiber (R=3.3/in)	14 inches loose fill
Polystyrene beads (R=2.88/in)	16 inches loose fill

The proposed standard for below grade foundation walls of electrically heated homes is U = 0.100. Some of the ways to meet this standard would be to apply R10 polystyrene insulation on the exterior of a concrete wall, apply an R11 batt between furring attached to the interior of a basement wall, or use an all wood foundation with batt insulation. Another option which may be used is to insulate the basement or crawl space ceiling to R19.

If the system design method is used, insulation may be decreased in some walls or the attic if it is increased in other areas by a corresponding amount.

In the summer and fall of 1984, a statewide survey of one- and 2-family home builders was conducted to determine the amount of experience Wisconsin builders have with high levels of insulation. The survey results showed that in the 1983 building season, 59% of the respondents insulated electrically heated dwelling walls to R-24 or greater, 51% insulated foundation walls to R11 or greater, 27% insulated attics to R50 or greater and 68% used triple-glazed windows.

The impact of the increased insulation levels contained in the proposed rules on the building industry is expected to be minimal for two reasons: First, the rules reflect insulation techniques which are already employed by a large number of builders and second, the insulating and building materials which would be used to meet the proposed standards are the same as those currently used and are readily available.

AIR LEAKAGE IN ELECTRICALLY HEATED DWELLINGS.

One of the major factors affecting heat loss in dwellings is unheated air leaking into the dwelling from the outside through windows, doors and cracks.

A new technology is emerging that allows for measurement of air leakage and is known as blower door testing. The blower door test consists of a large fan with an air flow measurement device. The fan is installed in the doorway of a house and all sources of ventilation such as windows and ventilation ductwork are closed off. The fan is then turned on to blow air into or out of the house, pressurizing or depressurizing it and forcing air through openings. Thus, the blower door detects air leaks in the thermal envelope of the house in the same way that blowing up a balloon allows one to detect a pinhole in it.

Under the proposed rules, builders may choose to use a blower door test to demonstrate air tightness in lieu of following a rigorous list of prescriptive sealing requirements.

The proposed rules also allow the use of an exterior infiltration barrier to seal some openings in the thermal envelope.

To reflect improvements in the air leakage rates of manufactured windows and doors the maximum infiltration rates have been proposed to be updated for electrically heated dwellings. Information from window and door manufacturers indicates that the proposed standards may be met with currently available windows.

To address the problems of air quality and excess humidity in tightly-built homes, a ventilation system to provide 0.5 air changes per hour of fresh air is proposed to be required in new electrically heated homes. Because of the number of moisture problems which have been reported in homes built to the current code it was decided that in the new code, which would result in even more tightly built homes, a more extensive type of ventilation system should also be required. The ventilation system may consist of one or more exhaust fans. Operable windows or dampered openings may serve as fresh air inlets.

APPLIANCE EFFICIENCY STANDARDS FOR DWELLINGS OF ALL FUEL TYPES.

The appliance efficiency standards of the current rules were adopted in 1978. Since that time, improvements have been made in energy conservation technology so that the current standards now fall below cost effective minimums.

The efficiency standards for air conditioners and oil and gas fired heating equipment are proposed to be updated and a minimum standard for water heater efficiencies is also proposed.

Equipment manufacturers were contacted and equipment efficiency listings were consulted to affirm that appliances which meet the proposed efficiency standards are widely available. DSE analyses indicate that the proposed standards will provide positive life cycle cost savings to consumers.

* *

Pursuant to the authority vested in the state of Wisconsin, Department of Industry, Labor and Human Relations by ss. 101.02 (1), 101.63 (1) and (1m), 101.64 (3), 101.73 (1) and (1m) and 101.74, Stats., the department hereby repeals, renumbers, renumbers and amends, amends, repeals and recreates, and creates rules interpreting ss. 101.60, 101.63 (1) and (1m), 101.70 and 101.73 (1) and (1m), Stats., as follows:

SECTION 1. ILHR 20.24 (2m) is renumbered 20.24 (2k) and is amended to read:

ILHR 20.24 (2k) American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103, STANDARD SPECIFICATION FOR MORTAR FOR UNIT MASONRY, ASTM Designation C270-82; STANDARD PRACTICE FOR MEASURING AIR LEAKAGE BY THE FAN PRESSURIZATION METHOD, ASTM Designation E799-81.

SECTION 2. ILHR 20.24 (2m) is created to read:

ILHR 20.24 (2m) American Society of Heating, Refrigerating, and Air-conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, N.E. Atlanta, Georgia 30329, ENERGY CONSERVATION IN NEW BUILDING DESIGN, ASHRAE Standard 90A-80.

SECTION 3. ILHR 21.05 (3) and (4) are repealed and recreated to read:

ILHR 21.05 (3) ATTIC VENTILATION. Ventilation above the ceiling/attic insulation shall be provided as specified in either s. ILHR 22.05 (3) (a) or s. ILHR 22.11 (3) (a).

(4) CRAWL SPACE VENTING. Crawl spaces shall be vented in accordance with either s. ILHR 22.05 (3) (b) or s. ILHR 22.11 (3) (b). Unheated crawl spaces shall be provided with a concrete slab, roll roofing or plastic film vapor barrier.

SECTION 4. ILHR 22.03 (1) is renumbered 22.03 (1m).

SECTION 5. ILHR 22.03 (1) is created to read:

ILHR 22.03 (1) "Annual fuel utilization efficiency or AFUE" means the efficiency rating of the heating plant model determined on average usage conditions as set out in the U.S. Department of Energy test procedures.

Note: The higher the AFUE rating, the higher the heating plant efficiency will be.

SECTION 6. ILHR 22.03 (4m) is created to read:

ILHR 22.03 (4m) "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.

SECTION 7. ILHR 22.03 (5m) is created to read:

ILHR 22.03 (5m) "Equivalent leakage area or ELA" means the estimated area of a hole in the thermal envelope of a building which would exist if all the leakage openings were gathered into one location.

SECTION 8. ILHR 22.03 (7m) is created to read:

ILHR 22.03 (7m) "Infiltration Barrier" means a material which restricts the movement of air and liquid water, but is permeable to water vapor.

SECTION 9. ILHR 22.03 (7r) is created to read:

ILHR 22.03 (7r) "Overall thermal transmittance or Uo" means the area-weighted average of the thermal transmittance values of all materials, including framing and fenestration, which make up a building section.

Note: Additional explanatory material is contained in the appendix.

SECTION 10. ILHR 22.03 (9m) is created to read:

ILHR 22.03 (9m) "Thermal envelope" means the collective assemblies of the building which enclose the heated space and define the surface areas through which the design heating loss is calculated. The components which make up the thermal envelope form a continuous, unbroken surface.

SECTION 11. Subchapter III (title) and ILHR 22.04 are amended to read:

SUBCHAPTER III - DESIGN CRITERIA FOR DWELLINGS WHICH USE FUELS OTHER THAN ELECTRICITY FOR SPACE HEATING

ILHR 22.04 INDOOR AND OUTDOOR TEMPERATURES. The indoor temperatures listed in Table 22.04-A and the outdoor temperatures listed in Table 22.04-B shall be used to determine the total building heat loss or heat gain and to select the size of the heating or cooling equipment which is installed in dwellings which are not electrically heated.

Note to Revisor: Tables 22.04-A and 22.04-B are to remain.

SECTION 12. ILHR 22.05 (intro.) is created to read:

ILHR 22.05 MOISTURE CONTROL FOR NON-ELECTRICALLY HEATED DWELLINGS. The provisions of this section for moisture control shall apply to non-electrically heated dwellings.

SECTION 13. ILHR 22.05 (3) is repealed and recreated to read:

ILHR 22.05 (3) VENTILATION. (a) Attics. Ventilation above the ceiling/attic insulation shall be provided.

1. The free ventilating area shall be at least 1/300 of the horizontal area of the ceiling. At least 50% of the required free ventilating area shall be distributed at the low sides of the roof, the remainder of the vents shall be provided in the upper one-half of the roof or attic area.

2. If all the ventilating area is provided at one level, then the ventilating area shall be at least 1/150 of the horizontal area of the ceiling.

3. The ventilation space above any non-rigid insulation in a cathedral ceiling assembly shall be at least one inch in height.

(b) Crawl spaces. Ventilation shall be provided in crawl spaces which are outside the thermal 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.

SECTION 14. Subchapter IV (title) and ILHR 22.06 (intro.) are amended to read:

SUBCHAPTER IV - ~~BUILDING~~ THERMAL ENVELOPE REQUIREMENTS FOR DWELLINGS WHICH USE FUELS OTHER THAN ELECTRICITY FOR SPACE HEATING

ILHR 22.06 INSULATION STANDARDS FOR NON-ELECTRICALLY HEATED DWELLINGS. The ~~exterior~~ thermal envelope of ~~the building~~ dwellings which are not electrically heated shall be insulated to meet the requirements of this ~~part~~ section. ~~More stringent overall thermal transmittance (Uo values) will be phased in at time intervals as specified for the designated building components.~~

SECTION 15. ILHR 22.06 (5a) is renumbered 22.06 (5) and is amended to read:

ILHR 22.06 (5) ROOF/CEILINGS ~~(effective April 1, 1979)~~. The overall thermal transmittance (Uo value) through roof/ceiling assemblies shall not exceed .029 Btu per (hour) (square foot) (degree F).

SECTION 16. ILHR 22.06 (6a) is repealed.

SECTION 17. ILHR 22.06 (6b) is renumbered 22.06 (6) and the (intro.) is amended to read:

ILHR 22.06 (6) EXTERIOR WALLS ~~(effective April 1, 1980)~~. The exposed exterior walls above grade shall be insulated in accordance with par. (a) or (b) and (c).

SECTION 18. ILHR 22.07 (title) is amended and (intro.) is created to read:

ILHR 22.07 AIR LEAKAGE REQUIREMENTS FOR NON-ELECTRICALLY HEATED DWELLINGS. Provisions for the limitation of air leakage in dwellings which are not electrically heated shall be made in accordance with this section.

SECTION 19. Subchapter VI is renumberd subchapter VII and ILHR 22.14 and 22.15 are renumbered 22.22 and 22.23.

SECTION 20. Subchapter V is renumbered subchapter VI and ILHR 22.08 to 22.12 are renumbered 22.15 to 22.19.

SECTION 21. ILHR 22.13 is renumbered 22.20 and is amended to read:

ILHR 22.20 ELECTRONIC IGNITION AND AUTOMATIC FLUE DAMPERING (~~Effective April 1, 1979~~). Combustion space heating equipment shall be provided with ~~electronic~~ intermittent ignition devices and automatic flue ~~dampering~~ dampers ~~except sealed combustion equipment or equipment located in enclosures and provided with combustion air need not be provided with automatic flue dampering~~. Automatic flue dampers may be eliminated where:

1. Induced draft equipment is used;

2. Where equipment with a condensing secondary heat exchanger is used;

3. All combustion air is ducted to the furnace burner from the outside; or

4. Where combustion equipment is located in an enclosure and provided with combustion air from the outside.

SECTION 22. Subchapter V (title) and ILHR 22.08 to 22.13 are created to read:

SUBCHAPTER V - INSULATION AND INFILTRATION STANDARDS
FOR ELECTRICALLY HEATED DWELLINGS

ILHR 22.08 PURPOSE AND AUTHORITY. The purpose of this subchapter is to provide design requirements to improve energy efficiency of conventionally built and manufactured one- and 2-family dwellings which use electricity for space heating as required by ss. 101.63 (1m) and 101.73 (1m), Stats.

ILHR 22.085 APPLICATIONS (1) NEW DWELLINGS. The provisions of this subchapter shall apply to any new electrically heated dwelling or dwelling unit for which a uniform building permit was issued on or after the effective date of this subchapter.

(2) DWELLINGS EXISTING BEFORE DECEMBER 1, 1978. The provisions of this subchapter shall not apply to any dwelling or dwelling unit for which a uniform building permit was issued before December 1, 1978, or to additions or alterations to such dwellings.

(3) ADDITIONS TO DWELLINGS OR DWELLING UNITS. (a) Additions to a dwelling or dwelling unit shall be constructed in compliance with the requirements of this subsection whenever one of the following conditions apply:

1. The uniform building permit for the original dwelling or dwelling unit was issued on or after the effective date of this subchapter and the dwelling or dwelling unit is electrically heated; or

2. The uniform building permit for the original dwelling or dwelling unit was issued on or after the effective date of this subchapter and the combined input capacity of permanently installed electrical space heating equipment of the original dwelling or dwelling unit and the new addition exceeds 3 kilowatts; or

3. The uniform building permit for the original dwelling or dwelling unit was issued on or after December 1, 1978, but before the effective date of this subchapter, and the addition is provided with permanently installed electrical space heating equipment with an input capacity of 3 kilowatts or more.

(b) An addition to a dwelling or dwelling unit to which one of the three conditions of par. (a) apply, shall be insulated to meet the requirements of s. ILHR 22.12 with one of the following methods:

1. The addition alone may be insulated in accordance with s. ILHR 22.12 (1) via the component method;

2. The addition alone may be insulated in accordance with s. ILHR 22.12 (2) via the system method; or

3. The entire dwelling, including the addition, may be insulated in accordance with s. ILHR 22.12 (2) via the system method.

(4) ALTERATIONS TO DWELLINGS OR DWELLING UNITS CONSTRUCTED AFTER THE EFFECTIVE DATE OF THIS SUBCHAPTER. (a) Electrically heated dwellings or dwelling units. Any alteration made to an electrically heated dwelling or dwelling unit for which a uniform building permit was issued on or after the effective date of this subchapter shall be made in accordance with the provisions of this subchapter which are in effect at the time the permit for the alteration is issued.

(b) Non-electrically heated dwellings and dwelling units. 1. Whenever an alteration to a non-electrically heated dwelling or dwelling unit for which a uniform dwelling permit was issued on or after the effective date of this subchapter results in the addition of permanently installed space heating equipment so that the combined input capacity of all sources of permanently installed electric space heating equipment in the dwelling or dwelling unit exceeds 3 kilowatts, the alteration shall be performed in accordance with the requirements of this subchapter which are in effect at the time that the permit for the alteration is issued.

2. Alterations which do not result in an increase in the electric space heating input capacity to over 3 kilowatts, shall be made in compliance with the provisions of subchapters III and IV which are in effect at the time the permit for alterations is issued.

(5) ALTERATIONS TO DWELLINGS OR DWELLING UNITS CONSTRUCTED AFTER DECEMBER 1, 1978, BUT BEFORE THE EFFECTIVE DATE OF THIS SUBCHAPTER. Any alteration which is made to a dwelling or dwelling unit for which a uniform building permit was issued on or after December 1, 1978, but before the effective date of this subchapter, shall be made in compliance with the requirements for non-electrically heated dwellings specified in this chapter which are in effect at the time the permit for the alteration is issued.

Note: The intent of this subsection is to assure that a dwelling which is built in accordance with this code continues to meet minimum health, safety and energy conservation standards whenever additions and alterations are made to the dwelling. It is not the intent of this section however, to require additional modifications beyond those necessary to achieve the intended alteration or addition. For example, if a window is being replaced the replacement window must meet the infiltration and thermal transmission requirements of the current code. If new windows are to be cut into the exterior wall, the new windows must meet code requirements and, because insulation had to be removed from the wall to put in the windows, the insulation requirements of the current code must be met by using either the component or system method. As another example, when electric heat is added to the basement area and the walls are not to be altered, insulation does not have to be installed. If insulation is removed from the basement ceiling, however, to create a heated basement, the insulation requirements of the current code must be met by the component or system method.

ILHR 22.09 ACCURACY OF CALCULATIONS. The thermal resistance or thermal transmittance values used in heat gain or loss calculations for electrically heated dwellings shall be supplied by the material manufacturer or as given in the ASHRAE Handbook of Fundamentals. The thermal transmittance values used in heat gain or loss calculations shall have a minimum decimal accuracy of 4 places, rounded to 3, thermal envelope areas shall have a minimum decimal accuracy of 3 places rounded to 2.

Note: ASHRAE is an acronym for the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. Copies of the ASHRAE Handbook of Fundamentals may be purchased from the ASHRAE Publications Sales Department, 1791 Tullie Circle, N.E. Atlanta, Georgia 30329. A list of R-values for most building materials reprinted from ASHRAE Fundamentals is given in Appendix A.

ILHR 22.10 INDOOR AND OUTDOOR TEMPERATURES. The indoor temperatures listed in Table 22.10-A and the outdoor temperatures listed in Table 22.04-B shall be used to determine the total building heat loss or gain and to select the size of the heating or cooling equipment which is installed in electrically heated dwellings in accordance with s. ILHR 22.15.

TABLE 22.10-A
Indoor Design Temperatures

Season	Temperature
Winter	70°F
Summer	78°F

ILHR 22.11 MOISTURE CONTROL FOR ELECTRICALLY HEATED DWELLINGS. Provisions for the control of moisture in electrically heated dwellings shall be made in accordance with this section. (1) VAPOR BARRIERS. A vapor barrier shall be installed to prevent water vapor from condensing within the insulated cavities of the thermal envelope. All joints in the vapor barrier shall be overlapped and secured or sealed. Rips and punctures in the vapor barrier shall be patched with vapor barrier materials and taped or sealed. Openings in the vapor barrier around electrical boxes and other utility services shall be taped or sealed. The transmission rate of the vapor barrier may not exceed 0.1 perm.

(2) RELATIVE HUMIDITY. Where a power humidifier is installed, the equipment shall be provided with a control to regulate the relative humidity.

(3) VENTILATION (a) Attics. Ventilation above the ceiling/attic insulation shall be provided.

1. The free ventilating area shall be at least 1/300 of the horizontal area of the ceiling. At least 50% of the required free ventilating area shall be distributed at the low sides of the roof, the remainder of the vents shall be provided in the upper one-half of the roof or attic area.

2. If all the ventilating area is provided at one level, then the ventilating area shall be at least 1/150 of the horizontal area of the ceiling.

3. The ventilation space above any non-rigid insulation in a cathedral ceiling assembly shall be at least one inch in height.

(b) Crawl spaces. Ventilation shall be provided in crawl spaces which are outside the thermal 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.

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

(4) AIR QUALITY. (a) General. All electrically heated dwellings shall be provided with mechanical ventilation equipment.

1. The equipment shall be capable of providing 0.5 air changes per hour upon demand to the living space within the thermal envelope, or shall be capable of providing 0.5 air changes per hour to individual rooms of the living area during periods of occupancy.

2. The mechanical ventilation equipment may consist of one or more exhaust fans.

3. The air intakes may be operable windows or dampered openings.

4. All exhaust vents shall terminate outside the building.

5. Habitable spaces within basements shall be considered to be part of the living space.

(b) Dwellings with combustion appliances and high ventilation rates. Dwellings which are provided with gas-fired, oil-fired, solid fuel burning appliances or fireplaces and are also provided with mechanical ventilation systems capable of providing one air change per hour or more to the living space shall be provided with dampered outside air intakes.

Note #1: Residences with low levels of infiltration or occupants who smoke or situations which release pollutants or large quantities of moisture to the air may require a more extensive mechanical system or a greater number of air changes to assure a sufficient level of air quality.

Note #2: Information on ventilation capacity calculations is contained in Appendix E.

ILHR 22.12 INSULATION STANDARDS. Electrically heated dwellings shall be insulated to meet the requirements specified in sub. (1) or (2).

(1) COMPONENT METHOD. Each component of the thermal envelope of an electrically heated dwelling shall meet the thermal performance values specified in Table 22.12-1.

Note: Additional explanatory material is contained in the appendix.

TABLE 22.12-1

INSULATION STANDARDS FOR ELECTRICALLY HEATED DWELLINGS

Component of Thermal Envelope	Maximum Overall Thermal Transmittances, Uo
Roof-Ceiling[a]	0.020
Walls:	
above grade[b]	0.080
below grade[c]	0.100
Floors:	
slab-on-grade[d]	0.100
over unconditioned spaces[e]	0.055

Note a: Roof-ceiling assemblies include attic access panels and skylites.

Note b: Walls include box sills, windows, doors, and those portions of the foundation wall above grade.

Note c: The thermal transmittance value applies to the surface area which extends from grade to the top of the footing. If insulation is to be applied to the exterior of the wall below grade the insulation shall be a type suitable for this application.

Note d: The thermal transmittance value applies to a surface area which extends from the top of a slab to 48 inches vertically downward or horizontally or a combination thereof with a total dimension of 48 inches.

Note e: Includes unheated crawl spaces, basements, garages and other spaces outside of the thermal envelope.

(2) SYSTEM METHOD. The overall thermal transmittance for any component of an electrically heated dwelling specified in sub. (1) may be exceeded if the calculated heat loss or gain for the entire thermal envelope does not exceed the total heat loss or gain calculated using the maximum overall thermal transmittances for all the components as specified in sub. (1).

Note: Additional explanatory material and examples of some methods which may be used to meet these requirements are contained in Appendices A through C.

ILHR 22.13 INFILTRATION CONTROL FOR ELECTRICALLY HEATED DWELLINGS. Provisions for the limitation of infiltration in electrically heated dwellings shall be made in accordance with this section.

(1) GENERAL. Windows and door assemblies and other portions of the thermal envelope shall be constructed and installed to minimize infiltration.

(2) WINDOWS AND DOORS. Manufactured windows and door assemblies which form a part of the thermal envelope of an electrically heated dwelling shall be constructed and installed to limit infiltration.

(a) Windows. Except as provided in par. (c), the air infiltration rate for manufactured windows of electrically heated dwellings may not exceed 0.20 cubic feet per minute per foot of sash crack.

(b) Sliding doors. Except as provided in par. (c), the air infiltration rate for manufactured sliding doors of electrically heated dwellings may not exceed 0.25 cubic feet per minute per square foot of door area.

(c) Exception. Windows with a maximum infiltration rate of 0.30 cubic feet per minute per foot of sash crack and sliding doors with a maximum infiltration rate of 0.30 cubic feet per minute per square foot of door area may be used in electrically heated dwellings where a blower door test, performed in accordance with sub. (4), indicates that the infiltration rate of the entire thermal envelope does not exceed 4.4 air changes per hour at 50 pascals (Pa) or does not exceed an equivalent leakage area (ELA) of 2 square inches per 100 square feet of above grade thermal envelope at 10 pascals (Pa).

(d) Swinging doors. The air infiltration rate for swinging door assemblies of electrically heated dwellings may not exceed 0.35 cubic feet per minute per square foot of door area.

Note: The department will allow the use of windows and doors meeting the requirements of this section when tested in accordance with ASTM E-283, Standard Method of Test for Rate of Air Leakage Through Exterior Curtain Walls and Doors.

(3) EXTERIOR OPENINGS IN THE THERMAL ENVELOPE. (a) Sealing of openings. Except as provided in par. (b) or as provided in par. (c), the following openings and all other similar openings in the thermal envelope shall be caulked, gasketed, weatherstripped, tightly packed with fiberglass, or otherwise sealed with a flexible material to limit air infiltration:

Note: Additional explanatory material is contained in Appendix D.

1. At the junction of exterior walls and the roof, including but not limited to the joints between:

a. Double top plates; and

b. The top plate and the siding or exterior finish, where extruded polystyrene is not placed behind the siding or exterior finish.

2. Between exterior walls and floors, including but not limited to the joints between:

a. The subfloor and the exterior header joist;

Note: The header joist is also known as a band joist or skirt.

b. The top plates of the exterior wall and the header joists of floors placed on wall;

c. The subfloor and bottom plates of exterior walls; and

d. The joints between double top plates or double bottom plates of exterior walls.

3. Between floors and foundation walls, including but not limited to the joints between:

a. The foundation and sill plate and between the sill plate and floor joist header; or

b. The foundation and floor joist header; and

c. Floor joist header and the subfloor.

4. Between exterior frame walls placed on foundations, including but not limited to the joint between foundation and sill plate and the joint between double bottom plates.

5. At openings in exterior walls, including but not limited to the joints between:

a. Window headers and top wall plates;

b. Window headers and plates at the heads of windows and doors;

c. Plates and the window sills; and

c. Plate and window frame.

d. Separate wall panels;

e. Siding or exterior finish joints at cantilevered floors, bay windows and at soffits; and

f. Siding and foundation where no sheathing is provided behind the siding.

6. At joints around window and door assemblies in the thermal envelope, including but not limited to the joints between:

a. Window and door assemblies and the wall framing;

b. Window and door assemblies and the exterior siding or finish; and

c. Door thresholds and the subfloor.

7. At the joint between the foundation wall and the sill plate or joist header of a floor or between the foundation wall and the bottom plate of a wall.

8. At penetrations through the thermal envelope at walls, floors and ceilings or insulated roof assemblies, including but not limited to:

a. Piping;

b. Hose bibbs;

c. Plumbing vent stacks;

d. Electrical wiring;

e. Chimney or vent penetrations;

f. Dryer vents;

g. Bathroom vents;

h. Kitchen vents;

i. Telephone wire entrances;

j. Through the wall air conditioners;

k. Refrigeration lines;

1. Air vents and inlets; and

m. Recessed light fixtures.

9. Attic access panels in the thermal envelope shall be weatherstripped or otherwise sealed.

10. Air exhaust or intake openings shall be provided with back draft dampers or automatic dampers to limit air leakage.

11. All receptacles, switches or other electric boxes which are set into the vapor barrier or infiltration barrier shall be gasketed or otherwise sealed to limit infiltration. Insulation shall be placed behind all electric boxes and around wires in cavities of the thermal envelope.

12. Fireplaces shall be provided with:

a. Closable metal or glass doors covering the opening of the fire box;

b. A combustion air intake to draw air from the outside of the building directly into the fire box. The air intake shall be at least 6 square inches in area, or more if required by the manufacturers listing or installation instructions. The air intake shall be equipped with an accessible manual or automatic back draft damper; and

c. A flue damper with an accessible control.

(b) Exception. The sealing of any or all of the openings as specified in subds. (a) 1. through 5. may be omitted if the openings are covered by an infiltration barrier installed as specified in this paragraph.

1. The infiltration barrier shall be installed on the exterior side of the insulation of the thermal envelope.

2. The infiltration barrier shall form a continuous surface over the walls of the building, extending from the bearing points of the roof to the top of the foundation.

3. All seams, joints, tears and punctures shall be sealed.

Note: Infiltration barriers include spun-bonded polyolefin sheets and tongue and groove extruded polystyrene.

(c) Exception. The sealing of any or all of the openings specified in subds. (a) 1. through 5. may be omitted if a blower door test is performed in accordance with sub. (4) and the test indicates that the infiltration rate of the entire thermal envelope does not exceed 4.4 air changes per hour at 50 pascals (Pa) or does not exceed air equivalent leakage area (ELA) of 2 square inches per 100 square feet of above grade thermal envelope at 10 pascals (Pa).

(4) BLOWER DOOR TESTING PROCEDURE. Blower door tests which are performed to meet the requirements of par. (2) (c) or par. (3) (c) shall be performed in accordance with this subsection:

1. The test shall be performed in accordance with ASTM E-799, "Standard Practice for Measuring Air Leakage by the Fan Pressurization Method".

Note: ASTM is an acronym for the American Society for Testing and Materials. Copies of ASTM Standards may be purchased from the ASTM Publications Sales Department, 1916 Race Street, Philadelphia, PA 19103.

2. The blower door test may not be conducted when the wind speed exceeds 10 miles per hour (mph).

3. The results of the test shall be provided to the purchaser.

SECTION 23. ILHR 22.14 is created to read:

ILHR 22.14 SCOPE. This subchapter shall apply to all newly constructed conventional and manufactured one- and 2-family dwellings.

SECTION 24. ILHR 22.19 (1) (a) is repealed and recreated to read:

ILHR 22.19 (1) (a) Air conditioning equipment. Air conditioning equipment shall have a minimum energy efficiency ratio (EER) of 7.8 or a COP of 2.3.

SECTION 25. ILHR 22.19 (2) is repealed and recreated to read:

ILHR 22.19 (2) COMBUSTION HEATING EQUIPMENT. (a) General. Except as provided in par. (b), all gas-fired and oil-fired heating equipment shall have a minimum annual fuel utilization efficiency (AFUE) of 80%. Where a vent damper is provided but not included in the AFUE rating of the equipment, the equipment, without the vent damper, shall have a minimum AFUE of 75%.

(b) Exception. All gas-fired and oil-fired copper fin and coil type boilers shall meet the minimum energy efficiency standards of ASHRAE 90A-80, "Energy Conservation in New Building Design".

Note: ASHRAE is an acronym for the American Socity of Heating, Regrigerating, and Air-Conditioning Engineers, Inc. Copies of the ASHRAE standards may be purchased from the ASHRAE Publications Sales Department, 1719 Tullie Circle, N.E. Atlanta, Georgia 30329.

SECTION 26. ILHR 22.21 is created to read:

ILHR 22.21 SCOPE. This subchapter shall apply to all newly constructed conventional and manufactured one- and 2-family dwellings.

SECTION 27. ILHR 25.05 is created to read:

ILHR 25.05 WATER HEATING EQUIPMENT. (1) GENERAL. Except as provided by sub. (2), all residential water heaters shall meet the minimum energy efficiency standards of ASHRAE 90A-80, "Energy Conservation in New Building Design."

(2) EXCEPTION. Heat pump water heaters, solar water heaters and tankless water heaters are exempt from the requirements of sub. (1).

Note: ASHRAE is an acronym for the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. Copies of the ASHRAE Standards may be purchased from the ASHRAE Publications Sales Department, 1791 Tullie Circle, N.E. Atlanta, Georgia 30329.

(END)

* *

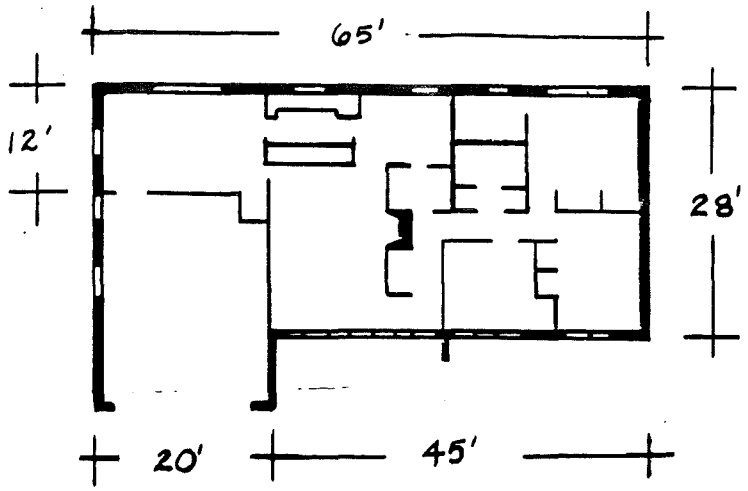
Pursuant to s. 227.026 (1) (b), Stats., these rules shall take effect on January 1, 1987.

* *

(1385k)

APPENDIX A
CHAPTER ILHR 22
DETERMINING THE LEVEL OF INSULATION

Two methods are outlined for determining the level of insulation, required by section ILHR 22.06 for non-electrically heated dwellings and by section ILHR 22.12 for electrically heated dwellings, using the following sample dwelling:



Sample dwelling: 1,500 square feet (186 lineal feet)

Gross wall area = 8.13' x 186 lineal feet = 1,512.18 square feet
Framed wall area = 1,301.69 square feet (20% framing, 80% cavity)
(does not include box sill)
Wall window area = 172.67 square feet
Box sill area = .81' x 186 lineal feet = 150.66 square feet
Gross exposed foundation wall area = 124.62 square feet
Opaque exposed foundation area = 108.97 square feet
Basement window area = 15.65 square feet
Door area = 37.82 square feet
Ceiling area = 1,500 square feet (10% framing, 90% cavity)

METHOD I - COMPONENT METHOD

The component method outlined below can be used with minimum calculations for determining the acceptable level of insulation. The first example shows how to determine the level of insulation for non-electrically heated dwellings. The second example shows how to determine the level of insulation for electrically heated dwellings.

EXAMPLE I - NON-ELECTRICALLY HEATED DWELLING

Problem: Using the component method determine the level of insulation required for the 1,500 square foot dwelling.

Step 1: Determine the percentage window and door area in the wall above the foundation.

$$\text{Percent opening area} = \frac{\text{Window area + Door area}}{\text{Gross wall area + Box sill area}} \times 100\%$$

$$= \frac{172.67 \text{ sq. ft.} + 37.82 \text{ sq. ft.}}{1512.18 \text{ sq. ft.} + 150.66 \text{ sq. ft.}} \times 100\%$$

$$= \frac{210.49 \text{ sq. ft.}}{1{,}662.84 \text{ sq. ft.}} \times 100\% = 12.66\%$$

Step 2: Determine level of insulation required for the box sill and sidewalls for the given window and door area from Table A-1.

Using backed aluminum siding, the table shows that an R-11 Batt with R-5.27 extruded polystyrene will allow up to 13% window and door area.

Step 3: Determine the percentage window area for the exposed foundation wall.

$$\text{Percent opening area} = \frac{\text{Window area}}{\text{Gross exposed foundation area}} \times 100\%$$

$$= \frac{15.65 \text{ sq. ft.}}{124.62 \text{ sq. ft.}} \times 100\%$$

$$= 12.6\%$$

Step 4: Determine the amount of exposed foundation wall: If there is 8" of wall exposed and the wall height is 8',

$$\text{Percent exposed wall} = \frac{8"/(12" \text{ per foot})}{8'} \times 100\% = 8.3\%$$

Step 5: Refer to Table A-2 to determine the level of insulation required for the foundation.

Using the requirements for less than 25% exposed foundation wall the table shows that an R-5.27 insulation can be used for up to 24.8% double glazed windows.

Step 6: Select the level of insulation required for the ceiling from Table A-3.

TABLE A-1
WALL INSULATION GUIDE
(Based on U_o requirements above the foundation wall
for non-electrically heated dwellings)

Insulation Type	Maximum Percent Window and Door area Allowable for Insulation Type	
	Uo = .12	
	5/8 inch Plywood Siding	Backed Aluminum Siding
R-11 Batt	6.8	8.4
R-11 Batt, R-1.22 Fiberboard	8.7	9.9
R-11 Batt, R-5.27 Extruded Polystyrene	12.4	13.0
R-11 Batt, R-10.54 Extruded Polystyrene	14.9	15.3
R-13 Batt	8.3	9.8
R-13 Batt, R-1.22 Fiberboard	10.3	11.2
R-13 Batt, R-5.27 Extruded Polystyrene	13.1	13.6
R-13 Batt, R-10.54 Extruded Polystyrene	15.3	15.6
R-19 Batt	11.2	12.2
R-19 Batt, R-1.22 Fiberboard	12.3	13.1
R-19 Batt, R-5.27 Extruded Polystyrene	14.7	15.1
R-19 Batt, R-10.54 Extruded Polystyrene	16.3	16.6

Note: The following assumptions were used to derive this table:

1. Door area = 2% of wall and box sill area.
2. Doors are used with a U-value of .47.
3. Windows are used with a U-value of .56.
4. The insulation type is carried down through the box sill.

TABLE A-2
EXPOSED FOUNDATION INSULATION
NON-ELECTRICALLY HEATED DWELLINGS

Foundation exposure	Requirement	Insulation type	Maximum percent window area Single Glazed	Double Glazed
Less than 25% of foundation exposed	U_o = .25	R-5.27	10.4	24.8
		R-11 batt	15.5	34.2
		Multi-cell insul. block (R-12.06)	16.0	35.0
More than 25% of foundation exposed	U_o = .13	R-11 batt	3.9	8.7
		R-13 batt	4.8	10.6
		Multi-cell insul. block (R-12.06)	4.5	9.9
	U_o = .12	R-11 batt	3.0	6.7
		R-13 batt	3.9	8.5
		Multi-cell insul. block (R-12.06)	3.5	7.8

TABLE A-3
INSULATION LEVELS REQUIRED TO MEET CEILING U VALUES
FOR NON-ELECTRICALLY HEATED DWELLINGS

Uo Value	Insulation	R-Value Required In Cavity	Over Framing
.029	Fiber glass batt	R-38	R-19
	Fiber glass blown	13.6 in. (R-34)	8.1 in. (R-20)
	Rock wool	10.9 in. (R-33)	5.4 in. (R-16)
	Cellulose	9.5 in. (R-35)	4.0 in. (R-15)

Note: The following assumptions are used:

1. Fiber glass blown = R-2.5 per inch
2. Rock wool = R-3.0 per inch
3. Cellulose = R-3.7 per inch

EXAMPLE II - ELECTRICALLY HEATED DWELLING

OPAQUE WALL AND BOX SILL:

Problem: Using the component method, determine the level of insulation required for the walls and box sill of the 1500 square foot dwelling.

Solution #1: Using Tables E-1 and E-2.

Step 1: Determine the composition of the above grade wall by calculating the percent of the area which is made up by windows, doors and foundation.

$$\text{Percent window area} = \frac{\text{Window area + foundation window area}}{\text{Total above grade wall area}} \times 100\%$$

Total above grade wall area =

Gross wall area + box sill area + Gross exposed foundation area

(Note that the total above grade wall area includes the exposed foundation wall area. However, if the basement or crawl space ceiling is insulated instead of the foundation, the exposed foundation area is set equal to zero because it is not a part of the thermal envelope.)

Total above grade wall area = 1512.18 sq. ft. + 150.66 sq. ft. + 124.62 sq. ft.
= 1787.46 sq. ft.

$$\% \text{ Window area} = \frac{172.67 \text{ sq. ft.} + 15.65 \text{ sq. ft.}}{1787.46 \text{ sq. ft.}} \times 100\% = 10.53\%$$

The %'s of other components are calculated in a similar manner:

$$\% \text{ Door area} = \frac{\text{door area}}{\text{Total wall area}} \times 100\% = \frac{37.82 \text{ sq. ft.}}{1787.46 \text{ sq. ft.}} \times 100\% = 2.12\%$$

$$\% \text{ Opaque foundation area} = \frac{\text{opaque foundation area}}{\text{total wall area}} \times 100\% = \frac{108.97 \text{ sq. ft.}}{1787.46 \text{ sq. ft.}} \times 100\%$$
$$= 6.10\%$$

$$\% \text{ Frame wall \& box sill area} = \frac{\text{frame wall area + box sill area}}{\text{total wall area}} \times 100\% = \frac{1301.69 \text{ sq. ft.} + 150.66}{1787.46 \text{ sq. ft.}} \times 100\%$$
$$= 81.25\%$$

Step #2: Use Tables E-1 to determine the opaque wall and boxsill U-value and Table E-2 to determine the insulation levels for electrically heated dwellings.

Table E-1 was formulated with the following assumptions:

-- The doors have R-values of at least R-8 and form 2% or less of the above-foundation wall.

$$\frac{\text{door area}}{\text{gross wall area + box sill area}} \times 100, \text{ in this case} =$$

$$\frac{37.82}{1512.18 = 150.66} \times 100 = 2\%$$

-- Windows with an R-value of at least 2.7 (triple glazed) are used, including the foundation windows.

-- The exposed foundation area is insulated to a level of R-10.54

If these assumptions are not valid for your case, calculate the required U-value as shown in solution #2.

For this example:

% Opaque foundation area = 6%
% Window area = 11%

From table E-1, the maximum above-foundation wall U-value
= 0.044 Btu/hr. sq. ft.°F.

For compliance, insulation materials and framing type should be used which produce a U-value which is <u>less than or equal to</u> the maximum U-value determined from Table E-1, as above. Table E-2 shows the U-values obtainable from different insulation material combinations and framing types.

TABLE E-1
MAXIMUM ABOVE-FOUNDATION WALL U-VALUES FOR ELECTRICALLY HEATED HOMES

PERCENT WINDOW AREA

PERCENT OPAQUE FOUNDATION AREA	5	6	7	8	9	10	11	12	13	14	15	16
0	.065	.062	.059	.056	.053	.050	.046	.043	.040	.036	.032	.029
5	.065	.061	.058	.055	.051	.048	.044	.041	.037	.033	.029	.025
6	.064	.061	.058	.055	.051	.048	.044	.040	.037	.033	.029	.025
7	.064	.061	.058	.054	.051	.047	.044	.040	.036	.032	.029	
8	.064	.061	.057	.054	.050	.047	.043	.039	.035	.031	.027	
9	.064	.061	.057	.054	.050	.046	.043	.039	.035	.031	.027	
10	.064	.060	.057	.053	.050	.046	.042	.038	.034	.030	.026	
11	.064	.060	.057	.053	.049	.046	.042	.038	.034	.030	.025	
12	.063	.060	.056	.053	.049	.045	.041	.037	.033	.029	.025	
13	.063	.060	.056	.052	.049	.045	.041	.037	.033	.028		
14	.063	.059	.056	.052	.048	.044	.040	.036	.032	.027		
15	.063	.059	.055	.052	.048	.044	.040	.036	.031	.027		
16	.063	.059	.055	.051	.047	.043	.039	.035	.031	.026		
17	.062	.059	.055	.051	.047	.043	.039	.034	.030	.025		
18	.062	.058	.055	.051	.047	.042	.038	.034	.029			
19	.062	.058	.054	.050	.046	.042	.037	.033	.028			
20	.062	.058	.054	.050	.046	.041	.037	.032	.028			
21	.061	.057	.053	.049	.045	.041	.036	.032	.027			
22	.061	.057	.053	.049	.045	.040	.036	.031	.026			
23	.061	.057	.053	.048	.044	.040	.035	.030	.025			
24	.061	.057	.052	.048	.044	.039	.034	.029				
25	.060	.056	.052	.048	.043	.038	.034	.029				

TABLE E-2
FRAME WALL & BOX SILL U-VALUES FROM DIFFERENT
BUILDING MATERIALS AND METHODS

	2 x 4 FRAMING 16" O.C.[1]	2 x 6 FRAMING 16" O.C.	2 x 6 FRAMING 24" O.C.[2]	Double 2 x 4 o: 2 x 8 FRAMING 24" O.C.
R-11 Batt	0.091			
R-11 Batt, R1.22 Fiberboard	0.081			
R-11 Batt, R5.27 Polystyrene	0.060			
R-11 Batt, R10.54 Polystyrene	0.045			
R-11 Batt, R7.21 Isocyanurate	0.054			
R-11 Batt, R14.4 Isocyanurate	0.038			
R-13 Batt	0.083			
R-13 Batt, R1.22 Fiberboard	0.074			
R-13 Batt, R5.27 Polystyrene	0.056			
R-13 Batt, R10.54 Polystyrene	0.043			
R-13 Batt, R7.2 Isocyanurate	0.050			
R-13 Batt, R14.4 Isocyanurate	0.036			
R-19 Batt		0.060	0.058	0.056
R-19 Batt, R1.22 Fiberboard		0.055	0.053	0.052
R-19 Batt, R5.27 Polystyrene		0.044	0.043	0.042
R-19 Batt, R10.54 Polystyrene		0.036	0.035	0.034
R-19 Batt, R7.2 Isocyanurate		0.040	0.039	0.039
R-19 Batt, R14.4 Isocyanurate		0.031	0.030	0.030
Two R-11 Batts				0.053
" , R-1.22 Fiberboard				0.049
" , R5.27 Polystyrene				0.040
" , R10.54 Polysturene				0.033
" , R7.2 Isocyanurate				0.037
" , R14.4 Isocyanurate				0.029
Two R-13 Batts				0.048
" , R1.22 Fiberboard				0.045
" , R5.27 Polystyrene				0.037
" , R10.54 Polystyrene				0.030
" , R7.2 Isocyanurate				0.034
" , R14.4 Isocyanurate				0.027

1 Assumes 20% framing, 80% cavity.

2 Assumes 17% framing, 83% cavity.

Solution #2: To calculate the required wall U-value without using Tables E-1 and E-2, use the method outlined below:

Step 1: Calculate the above grade wall composition as illustrated in Step 1 of Solution #1.

% Window area = 10.53%
% Door area = 2.12%
% Opaque foundation area = 6.10%
% Opaque wall & box sill area = 82.25%

Step 2: Use the following formula to calculate the maximum allowable U-value for the opaque wall and box sill.

$$\frac{Uo - (Uw \times \%w) - (Ud \times \%d) - Uf \times \%f)}{\%wall} = U_{wall}$$

Where:

U_o = Required overall above grade wall U-value, use 0.080 for an electrically heated home

U_w = The U-value of the windows (= 1/R-value)

$\%_w$ = The fraction of window area calculated in Step 1

U_d = The U-value of the doors (= 1/R-value)

$\%_d$ = The fraction of door area calculated in Step 1

U_f = The U-Value of the insulated foundation

$\%_f$ = The fraction of exposed foundation calculated in Step 1

$\%_{wall}$ = The fraction of opaque wall and box sill area as calculated in Step 1

U_{wall} = The maximum U-value of the opaque wall and box sill to be calculated

In our example:

The window R-value = R-2.78 U = 1/2.78 = 0.341
The door R-value = R-8.85 U = 1/8.85 = 0.113
The foundation R-value = R-12.4 U - 1/12.4 = 0.080

$$U_{wall} = \frac{0.080-(0.341 \times 0.1053)-(0.113 \times 0.0212)-(0.080 \times 0.0610)}{0.8225} = 0.045$$

In this case, the maximum U-value of the opaque wall and box sill is 0.045 Btu/hr. sq. ft. °F. For compliance, the insulation which is installed in the wall and box sill must provide a U-value which is less than or equal to 0.045. Table E-3 shows the U-values obtainable from different insulation materials and framing types.

CEILING:

Problem: Using the component method, determine the level of insulation required for the ceiling of the 1500 sq. ft. dwelling.

Solution #1 Use Table E-3

Table E-3 gives the amount of installed insulation which would be necessary to achieve a required U-value in the ceiling or attic.

Table E-3 was formulated with the following assumptions:

-- The loose fill insulation, if used, is installed to provide the following R-values:

Cellulose	R = 3.7/in
Expanded pearlite	R = 2.7/in
Mineral Fiber (rock, slag, or glass)	R = 3.3/in
Polystyrene beads	R = 2.9/in
Fiber glass, blown	R = 2.5/in

-- The insulated area is 90% cavity and 10% 2 x 6 framing

-- There are no skylights in the ceiling/attic assembly

-- The R-value of the ceiling finish materials plus air films is R-1.2

-- The attic hatch is insulated to the same level as the rest of the attic floor, if it is a part of the thermal envelope.

If these assumptions are not valid for your case, calculate the required U-value as shown in solution #2.

TABLE E-3
INSULATION LEVELS REQUIRED TO MEET CEILING U_o VALUES

Dwelling Fuel Type	U_o	Insulation Type	Amount Required Depth (R-value) in cavity
Electrically Heated	0.020	Fiber glass Batts	R-54
		Cellulose	14.1 in (R-52)
		Expanded Pearlite	18.6 in (R-50)
		Mineral Fiber	15.6 in (R-51)
		Polystyrene Beads	17.5 in (R-52)
		Blown Fiber glass	20.0 in (R-50)

Solution #2: To calculate the required ceiling insulation level for ceiling/attic assemblies, use the following method.

Step 1: Calculate the required U-value for the attic floor, U_F, with the following formula.

$$U_F = \frac{UoAo - UsAs - Uh\ Ah}{A_F}$$

Where:

U_F = The required U-value for the attic floor

U_o = The overall U-value set by the code, use 0.020 for an electrically heated dwelling

A_o = The overall attic/ceiling area including the attic floor, any skylights and the attic hatch or access panel.

U_s = The U-value of the skylights including the frame

A_s = The area of skylights, including the frame (if there are no skylights, set equal to zero)

U_h = The U-value of the attic hatch or access panel

A_h = The area of the attic hatch or access panel (If the hatch is to be insulated to the same level as the attic floor, add the area to the floor area, A_F, and set A_h equal to zero. If the attic hatch or access panel is not a part of the thermal envelope, set A_h equal to zero.)

A_F = The area of the insulated attic floor, equal to the overall attic/ceiling area minus the attic hatch and skylight areas, if any.

Example: For the attic of an electrically heated dwelling with an overall attic area of 1500 sq. ft. The attic hatch is 14" x 24" and is to be insulated with two R-19 fiber glass batts, the rest of the attic is to be insulated with blown mineral fiber with an R-value of 3.3-R/inch. There are two skylights, each 6 square feet with R-values of 1.8.

The R-value of the attic hatch is the sum of the R-values of the batts plus R-2 for the finish materials and air films.

$R = 19 + 19 + 2 = 40$

The U-value of the hatch is $U_H = 1/40 = 0.025$

The U-value of the skylights $U_S = 1/1.8 = 0.56$

The area of the hatch = 2 ft x 1.17 ft = 2.3 sq. ft.

The area of the skylights is 12 square feet

The area of the floor is 1500 - 12 - 2.3 = 1486 sq. ft.

$$U_F = \frac{(0.020)(1500) - (0.56)(12) - (0.025)(2.3)}{1486} = 0.0156$$

Step #2: To calculate the amount of insulation needed over the framing and cavity areas, d, of the attic floor use the following formula:

$$d = \frac{1}{U_F\ (R/in)} - \frac{(RW/in)\ h}{(\%C)(RW/in) + (\%W)(R/in)} - \frac{Rfin}{(R/in)} + h$$

Where:

d = depth of insulation at cavity in inches

U_F = required U-value of floor calculated in Step #1

R/in = R-value per inch of insulating material obtained from manufacturer or Table A4

h = height of framing, 5-1/2" for 2 x 6 framing or 7-1/4" for 2 x 8 framing, for example.

%C = fraction of floor which is cavity (usually assume 0.9)

$\%_W$ = fraction of floor which is framing (usually assume .1)

RW/in = R-value per inch of wood framing (usually assume 1.25 R/inch)

R_{fin} = R-value of interior ceiling finish materials, including air films (usually assume R-1.2)

$$d = \frac{1}{(0.0156)(3.3)} + 5.5 - \frac{(1.25)(5.5)}{(0.9)(1.25) + (0.1)(3.3)} - \frac{1.2}{3.3} = 19.59 \text{ inches}$$

The floor of the attic is to be covered with insulation so that the depth in the cavities is equal to 19.59 inches.

Note to Revisor:

Reprint Method II - System Design Method.

Amend a portion of Table A-4
"Common Construction Materials R-Values" as follows:

After the last entry under Boards and Slabs add the following information:

	Density	R/in	R
Foil faced, glass fiber - reinforced cellular polisocyanurate	2	7.04	--
Nominal 0.5 in	2	--	3.6
Nominal 1.0 in	2	--	7.2
Nominal 2.0 in	2	--	14.4

Replace Table A-6 with this amended table:

TABLE A-6

COEFFICIENTS OF TRANSMISSION (U) FOR SLAB DOORS*
Btu per (hr)(sq ft)(F Deg)

Thickness[1]	Winter			Summer,
	Solid Wood, No Storm Door	With Storm Door		
		Wood	Metal	No Storm Door
1 in.	0.64	0.30	0.39	0.61
1-1/4 in.	0.55	0.28	0.34	0.53
1-1/2 in.	0.49	0.27	0.33	0.47
2 in.	0.43	0.24	0.29	0.42
Steel Door				
1-3/4 in.				
A[3]	0.59	--	--	0.58
B[4]	0.19	--	--	0.18
C[5]	0.47	--	--	0.46

1 Nominal thickness.
2 Values for wood storm doors are for approximately 50% glass; for metal storm doors values apply for any percent of glass.
3 A = Mineral fiber core (2 lb/cu ft).
4 B = Solid urethane foam core with thermal break.
5 C = Solid polystyrene core with thermal break.

Note: Hollow core doors 1-3/8 in. thick - R = 2.17; U = 0.46
1-3/4 in. thick - R = 2.22; U = 0.45

*Reprinted with permission from ASHRAE Handbook of Fundamentals.

Replace Appendix B with the following:

APPENDIX B

FORMULA FOR DETERMINING THE OVERALL U_0 OF THE WALL

$$U_o = \frac{U_{cav}A_{cav} + U_{sol}A_{sol} + U_{win}A_{win} + U_{door}A_{door} + U_{box}A_{box} + U_{found}A_{found}}{A_o}$$

Where:

U_o = Overall thermal transmittance of gross wall area
A_o = Gross area of exterior walls.
U_{cav} = Thermal transmittance of cavity area (usually assume 80%).
A_{cav} = Area between wall framing where insulation may be placed.
U_{sol} = Thermal transmittance of wood framing area.
A_{sol} = Area of wood framing (usually assume 20%)
U_{box} = Thermal transmittance of box sill area.
A_{box} = Area of box sill.
U_{found} = Thermal transmittance of foundation area.
A_{found} = Area of above grade exposed concrete.
U_{win} = Thermal transmittance of window.
A_{win} = Total glass area.
U_{door} = Thermal transmittance of door.
A_{door} = Total door area.

FORMULA FOR DETERMINING THE OVERALL U_o OF THE CEILING

$$U_o = \frac{U_{cav}A_{cav} + U_{sol}A_{sol} + U_{skylight}A_{skylight}}{A_o}$$

Where:

U_o = Overall thermal transmittance of gross roof/ceiling.
A_o = Gross area of roof/ceiling assembly.
U_{cav} = Thermal transmittance of cavity area.
A_{cav} = Area between wood framing.
U_{sol} = Thermal transmittance of framing.
A_{sol} = Area of wood framing (usually assume 10%).
$U_{skylight}$ = Thermal transmittance of skylight elements.
$A_{skylight}$ = Area of skylight (including frame).

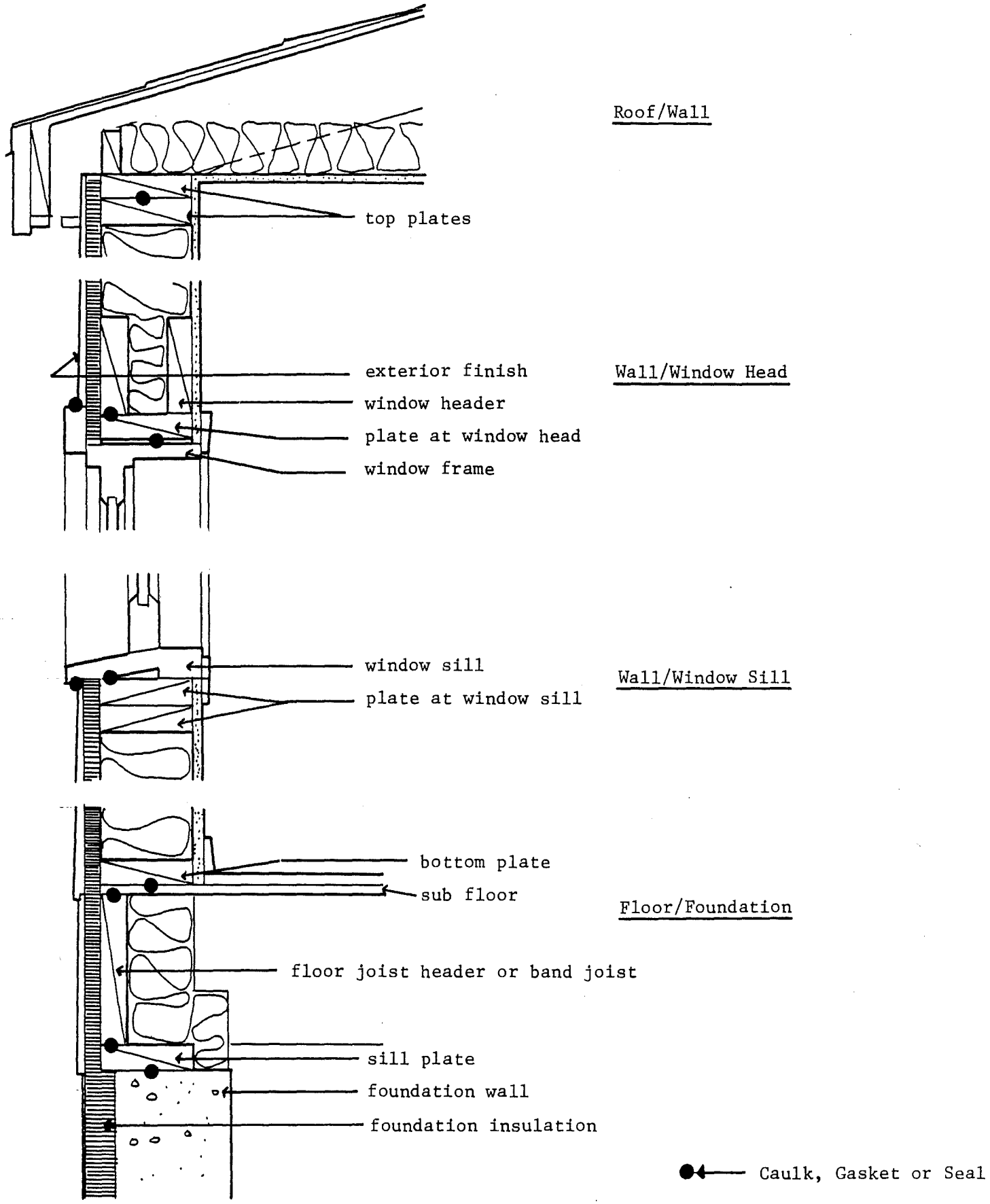
Create Appendix D after Appendix C:

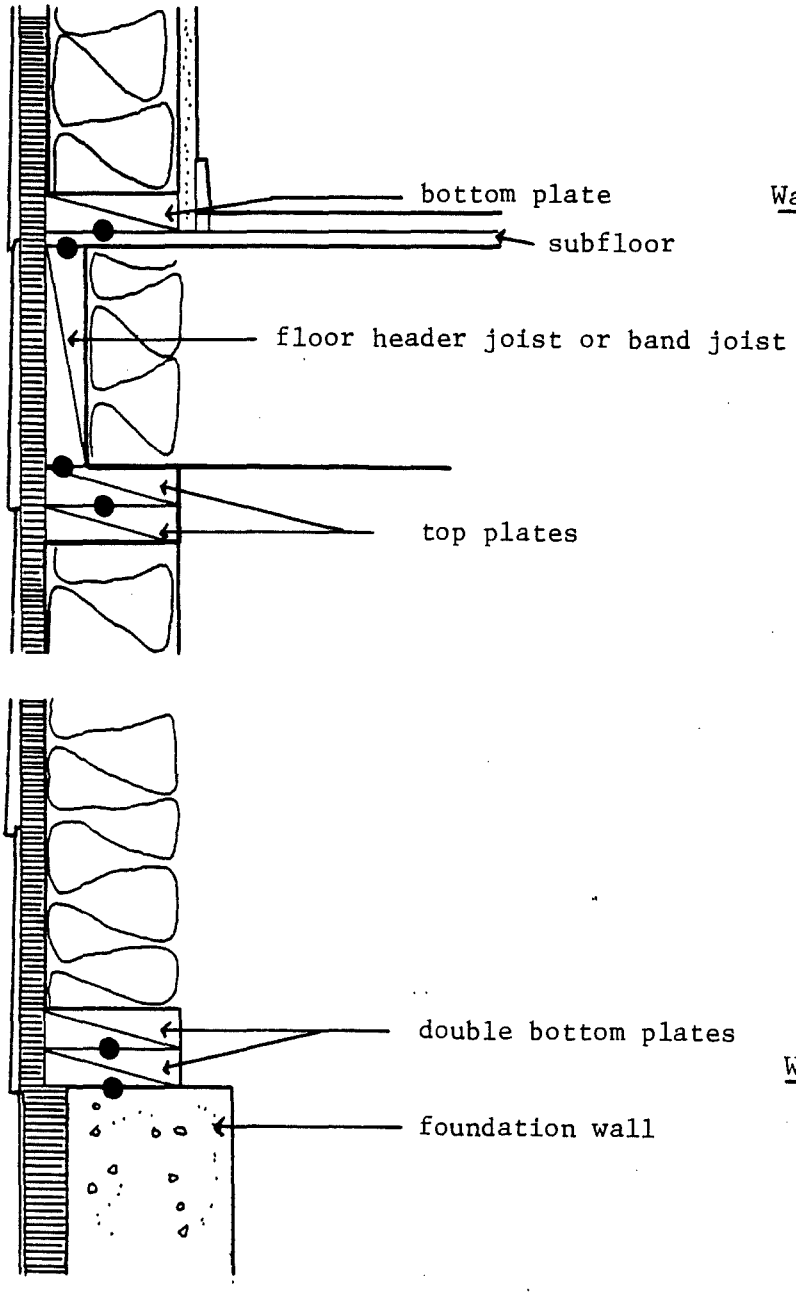
APPENDIX D

ILLUSTRATIONS OF EXTERIOR OPENINGS IN THE THERMAL ENVELOPE

The following illustrations show some exterior openings in the thermal envelope which may be sealed to control infiltration. A detailed list of sealing requirements for electrically heated homes is given in s. ILHR 22.13 (3).

ILHR 22.13 Infiltration Control For Electrically Heated Homes





Wall/Intermediate Floor

Wall/Foundation

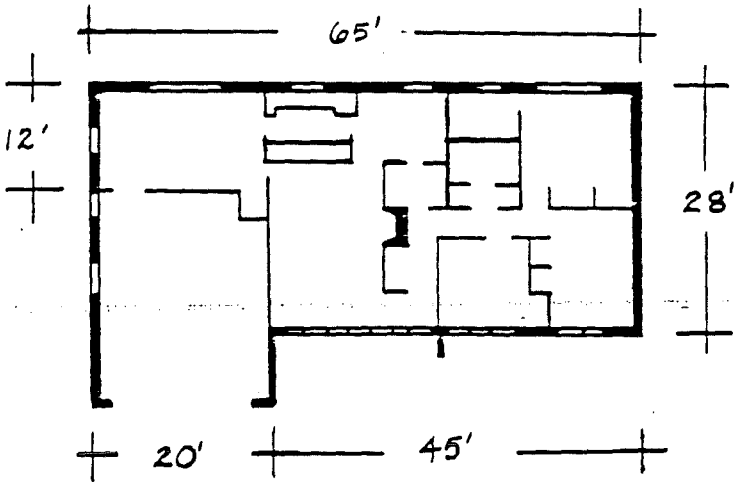
Create Appendix E after Appendix D.

APPENDIX E

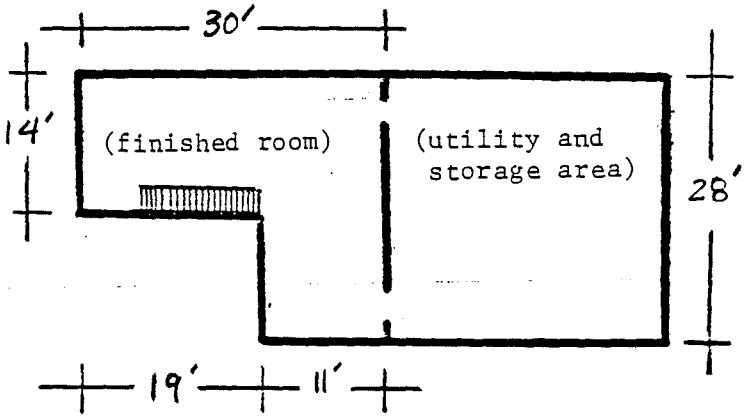
CALCULATION OF VENTILATION REQUIREMENTS

The following examples show one way to calculate the cubic feet per minute (CFM) ventilation capacity necessary to meet the requirements of s. ILHR 22.11 (4) for electrically heated homes, and how to calculate the number of air changes delivered by a system.

Example problem #1: Calculate the minimum necessary CFM ventilating capacity for the sample dwelling. The thermal envelope of the sample dwelling encloses the following areas, excluding the garage:



FIRST FLOOR



BASEMENT LEVEL

Step #1: Calculate the volume of air contained in the living space

FIRST STORY

The first story interior has 1556 square feet of floor area and 8 foot ceilings. The first floor volume is the floor area multiplied by the ceiling height:

Volume = 1556 sq. ft. x 8 ft. = 12448 cu. ft.

Next, calculate the volumes (= length x width x height) of spaces which are not living spaces.

Closets	1050 cu. ft.
Utility Room	308 cu. ft.
Vanity in bath	14 cu. ft.
Storage cabinets	58 cu. ft.
Book shelves	22 cu. ft.
Kitchen cabinets	176 cu. ft.
China cabinets	24 cu. ft.
fire place	112 cu. ft.
Interior walls	399 cu. ft.
TOTAL	2163 cu. ft.

Subtracting these volumes from the first floor volume gives the volume to be ventilated.

12448 cu. ft. - 2163 cu. ft. = 10285 cu. ft.

BASEMENT

The basement has one habitable room which must be ventilated. The room is 575 square feet, the ceiling height is 8 feet.

Volume = 575 sq. ft. x 8 ft. = 4600 cu. ft.

The total living space volume is the sum of the volumes on each story.

Total volume = 10285 cu. ft. + 4600 cu. ft. = 14885 cu. ft.

This is the volume of the air which must be exhausted to provide one air change to the living space.

Step #2: Calculate the required CFM capacity.

Use the following formula:

$$CFM = \frac{V \times ach}{60}$$

Where:

CFM = the required exhaust capacity in cubic feet per minute.

V = the volume of air in the space to be ventilated, in cubic feet.

ach = the desired number of air changes per hour, ILHR 22.11 (4) requires a minimum of 0.5 air changes per hour for electrically heated homes.

In this case:

$$CFM = \frac{14885 \text{ cu. ft.} \times 0.5 \text{ ach}}{60} = 124 \text{ CFM}$$

A fan or fans with a total effective exhaust capacity of 124 CFM or more would provide 0.5 air changes per hour. The effective capacity is the amount of ventilation actually delivered by the installed system, taking into account any resistance to air flow due to duct work.

Example problem #2: Calculate the number of air changes per hour (ach) which are delivered by an installed ventilation system. If two bathroom fans, each with an effective exhaust rate of 50 cfm, and a kitchen fan with an effective exhaust rate of 200 cfm are installed in the sample dwelling, how many air changes per hour is the system capable of providing?

Step #1, calculate the volume of the living space as in step #1 of Example #1. The volume of the living space is 14,885 cubic feet.

Step #2, calculate the capacity in air changes per hour with the following formula:

$$ach = \frac{CFM \times 60}{V}$$

Where:

ach = the number of air changes per hour that the system is capable of providing.

CFM = the total effective exhaust capacity of the system, in cubic feet per minute.

V = the volume of the space which is ventilated, in cubic feet.

In this case, CFM equals the total effective capacity of the three fans in the kitchen and bathes:

$$CFM = 200 + 50 + 50 = 300 \text{ CFM}$$

$$\text{ach} = \frac{300 \times 60}{14885} = 1.2 \text{ air changes per hour}$$

The ventilation system is capable of providing 1.2 air changes per hour to the living space.

(1426k)

State of Wisconsin \ Department of Industry, Labor and Human Relations

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May 6, 1986 MAY 6 1986

Revisor of Statutes Bureau

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Douglas LaFollette
Secretary of State
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Madison, Wisconsin 53702

Dear Messrs. Poulson and LaFollette:

TRANSMITTAL OF RULE ADOPTION

CLEARINGHOUSE RULE NO. 85-164

RULE NO. Ch ILHR 22

RELATING TO Energy conservation standards for electrically heated homes

Pursuant to section 227.023, Stats., agencies are required to file a certified copy of every rule adopted by the agency in the offices of the Secretary of State and the Revisor of Statutes.

At this time, the following material is being submitted to you.

1. Order of Adoption.
2. Rules Certificate Form.
3. Rules in Final Draft Form.

Pursuant to section 227.016 (6), Stats., a summary of the final regulatory flexibility analysis is also included.

Respectfully submitted,

Howard S. Bellman

Howard S. Bellman
Secretary

cc: Agency Contact Person

ADM-7239(R.03/86)