

Minnesota Attorney General: Administrative Rules Proceedings

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Version 3
August 20, 2018

DEPARTMENT: Office of the Attorney General

STATE OF MINNESOTA

OFFICE MEMORANDUM

DATE: April 16, 1991

TO: BRUCE NELSON
Department of Public Service

FROM: MARTHA J. CASSERLY
Special Assistant
Attorney General

PHONE: 296-6839

SUBJECT: In the Matter of the Adopted Rule Relating to Minnesota Energy Code

The above-referenced rule has been approved as to its legality by the Attorney General on April 10, 1991.

Enclosed is your copy of the approved rule. This office has already filed two copies with the Secretary of State, who will forward one copy to the Revisor of Statutes. The fourth is being retained by this division of the Attorney General's Office for its records.

Also enclosed are any petitions, requests, submissions or comments along with any extra copies of documents which you submitted to the Attorney General.

Your next step is to arrange for publication of the Notice of Adoption in the State Register. In a day or two, you should receive from the Revisor's Office three copies of the notice of adoption of your rule. You should submit two copies of the Notice of Adoption to the State Register for publication. A permanent rule without a hearing does not become effective until five days after a notice of adoption is published in the State Register in accordance with Minn. Stat. § 14.27. An emergency rule becomes effective five working days after approval by the Attorney General; however, the agency must publish a notice in the State Register in accordance with Minn. Stat. § 14.34.

If you have any questions in this regard, please contact me.

MJC:sc

cc: Eric Swanson
William Brown, Chief Judge
MaryAnn Hruby

MJC
3/27

RULE REVIEW CHECKLIST

File No. 1815
DATE RECEIVED 3-27-91
REVIEW DATE 4-5-91
DUE DATE 4-10-91
(DIS)APPROVED mjc-4-10-91
WITHDRAWN

Docket No. 05.0009.0730
ADOPTED W/O HEARING
EMERGENCY RULE
TO REVISOR ON 3-28-91
REVISOR (DIS)APPROVED
FILED W/SEC. OF STATE 4-12-91
RETURNED TO AGENCY 4-16-91

✓ Rule as adopted (4 copies)

✓ Notice to Solicit Outside Information/Opinion (if applicable)
June 19, 1989 Date published in State Register
Comments

~~Petition for Adoption of a~~ Rule

Board's Authorizing Resolution
Date adopted

✓ Proposed Rule
✓ Revisor's Certificate

✓ Notice of Intent to Adopt Rule
216C.19 and 8 Statutory Authority
✓ Statement Small Business Statement
Expenditure of public money statement
2-1-91 Signature

✓ Statement of Need and Reasonableness (if applicable)
✓ Small Business Statement
NA Fees - § 16A.128

✓ Affidavit of Mailing Notice of Intent to Adopt Rule Feb 14, 1991
February 13, 1991 Dated (30/25 days before adoption)
✓ Notice attached indicates it is attached
Copy of rule or summary attached

✓ Publication in State Register
February 19, 1991 Date (30/25 days before adoption)

✓ 180-day deadline from:
Effective date of ~~law requiring~~ rule (14.12) (both rules) (amendments don't apply)
✓ end of ~~comment period (§ 14.26)~~ (rules without hearing)
effective date of statutory authority (§ 14.29) (emergency rules)

Resolution Adopting
Date adopted

✓ Findings of Fact, Conclusions & Order Adopting
March 25, 1991 Date

~~Written Requests, Submissions~~ or Comments

Declaration of Attorney
Eric Swanson Name of SAAG representing agency

Department of Public Service

Adopted Permanent Rules Relating to Minnesota Energy Code

RECEIVED
FEB 21 1991
DEPT. OF PUBLIC SERVICE

Rules as Adopted

GENERAL

7670.0100 AUTHORITY; SCOPE; APPLICABILITY.

Subpart 1. **Authority.** This chapter is adopted pursuant to Minnesota Statutes, section 216C.19, subdivision 8.

Subp. 2. **Scope.** Under Minnesota Statutes, section 216C.19, subdivision 8, this chapter is a part of the State Building Code, adopted according to Minnesota Statutes, sections 16B.59 to 16B.73.

Subp. 3. **Applicability.** Buildings covered by this chapter must comply with the Model Energy Code as amended by parts 7670.0260 to 7670.1000.

EXCEPTION: Relocated residential buildings need not comply with this chapter, except that, where available, an energy audit must be conducted on the relocated building.

7670.0125 LEGISLATIVE MANDATES CONCERNING MINNESOTA ENERGY CODE.

An enclosed structure or portion of an enclosed structure constructed after January 1, 1978, and used primarily as a commercial parking facility for three or more motor vehicles may not be heated. Incidental heating resulting from building exhaust air passing through a parking facility is not prohibited if substantially all useful heat previously has been removed from the air.

EXCEPTION: Parking facilities that are appurtenant to dwelling unit occupancies.

7670.0130 INCORPORATIONS BY REFERENCE.

Subpart 1. **Incorporated items.** The following standards and references are incorporated by reference:

A. The Model Energy Code, 1989 Edition, as published by the Council of American Building Officials (Falls Church,

Virginia), as amended by parts 7670.0260 to 7670.1000.

B. Code of Federal Regulations, title 10, part 435, Energy Conservation Voluntary Performance Standards for New Commercial and Multi-Family High Rise Residential Buildings; Mandatory for New Federal Buildings.

C. Code of Federal Regulations, title 10, part 430, National Appliance Energy Conservation Act of 1987.

D. LTGSTD, lighting prescriptive and system performance compliance calculation program, a computer program developed by Battelle Pacific Northwest Laboratories.

E. ANSI/ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings.

F. AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

G. ASTM C 236-87, Standard Test Method for Steady State Thermal Performance of Building Assemblies by means of a Guarded Hot Box.

H. ASTM C 976-82, Standard Test Method for Thermal Performance of Building Assemblies by means of a Calibrated Hot Box.

I. WINDOW, a computer program developed by the Windows and Daylighting Group at Lawrence Berkeley Laboratory.

Subp. 2. **Availability.** All standards and documents incorporated by reference are available for public inspection at the Minnesota State Law Library and through the Minitex interlibrary loan system. In addition:

A. ASHRAE and ANSI/ASHRAE documents and standards are available from the American Society of Heating, Refrigerating and Air-Conditioning Engineers - Publication Sales, 1791 Tullie Circle NE, Atlanta, GA 30329;

B. AAMA standards are available from the American Architectural Manufacturers Association, 2700 River Road, Des Planes, IL 60018;

C. ASTM standards are available from ASTM, 1916 Race Street, Philadelphia, PA 19103; and

D. The WINDOW computer program is available from Bostik Construction Products, 1740 County Line, Huntington Valley, PA 19006.

7670.0260 MATERIALS AND EQUIPMENT.

Section 102 of the Model Energy Code is amended by adding a paragraph to read:

102.3 Thermal Insulation. Thermal insulation used in residential buildings three stories or less in height must conform to chapter 7640, Minnesota Thermal Insulation Standards, adopted by the Department of Public Service.

7670.0325 AMENDMENTS TO SECTION 201: DEFINITIONS.

Subpart 1. **Thermal transmittance (U).** In section 201 of the Model Energy Code, the definition of "Thermal transmittance (U)" is amended to read:

THERMAL TRANSMITTANCE (U). The coefficient of heat transmission (air to air). It is the time rate of heat flow per unit area and unit temperature differential between the warm side and cold side air films (Btu/h ft^2 F).

Thermal transmittance of opaque wall components (U_w) and roof/ceiling components (U_r) calculation methods are defined in the references indicated:

(1) Parallel heat flow method: Model Energy Code, chapter 5, equations 1 and 2, substituting the framing and insulated cavity components of the opaque wall or roof/ceiling for the elements designated by subscripts in these equations.

(2) Series-parallel method: Page 20.8 of Standard RS-1 listed in chapter 7.

(3) Parallel path correction factor method: Standard RS-24 listed in chapter 7.

(4) Thermal bridges in sheet metal construction method: Standard RS-25 listed in chapter 7.

(5) Zone method: Pages 22.10 and 22.11 of Standard RS-1 listed in chapter 7.

Subp. 2. **Vapor retarder.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

VAPOR RETARDER. A material to retard air and water vapor passage designed to meet a maximum perm rating of 1.0 grain per hour per ft^2 per inch Hg pressure differential. Polyethylene material that is not cross laminated which is used to meet the requirements of this paragraph must be designed to have a minimum thickness of four mills.

Subp. 3. **Wind wash.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

WIND WASH. Wind wash is the passage of unconditioned air through thermal insulation of the building envelope.

Subp. 4. **Window area.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

WINDOW AREA. Window area, or glazing area, is either the area of glazing and sash, or the area used by the manufacturer to determine the window thermal transmittance.

7670.0400 AMENDMENT TO SECTION 302: DESIGN CONDITIONS.

Footnote 1 of section 302.1 of the Model Energy Code is amended to read:

[1]The exterior design temperature must be selected from the "Design Conditions" columns shown in Table 302.1.

EXCEPTION: Where necessary to assure the prevention of damage to the building or to material and equipment within the building, the values listed in Table 302.1 under "extreme conditions" may be used.

TABLE 302.1 Exterior Design Temperatures

	DESIGN CONDITIONS		EXTREME CONDITIONS	
CITY	SUMMER DB/WB	WINTER DB	SUMMER DB/WB	WINTER DB
Albert Lea	87/72	-17	90/74	
Alexandria	88/72	-22	90/72	-28.0
Bemidji	85/69	-31	88/69	-36.9
Brainerd	87/71	-20	90/73	
Duluth	82/68	-21	85/70	-27.4
Faribault	88/72	-17	91/74	-24.3
Fergus Falls	88/72	-21	91/72	-27.8
International Falls	83/68	-29	85/68	-36.5
Mankato	88/72	-17	91/72	
Minneapolis	89/73	-16	92/75	-22.0
Rochester	87/72	-17	90/74	
St. Cloud	88/72	-15	91/74	
St. Paul	89/73	-16	92/75	-22.0
Virginia	83/68	-25	85/69	-33.0
Willmar	88/72	-15	91/74	-24.3
Winona	88/73	-14	91/75	

"DB" = dry bulb temperature, degrees Fahrenheit

"WB" = wet bulb temperature, degrees Fahrenheit

Heating degree days must be selected from Standard RS-23 listed in chapter 7. Adjustments may be made as determined by the building official to reflect local climates which differ from the tabulated temperatures or local weather experience.

7670.0450 AMENDMENT TO SECTION 303: VENTILATION.

Section 303.1 of the Model Energy Code is amended to read:

303.1 Ventilation. Ventilation systems must be designed to conform with Standard RS-3 listed in chapter 7.

7670.0470 AMENDMENT TO SECTION 502: ENVELOPE THERMAL TRANSMITTANCE.

Subpart 1. Section 502.2.1 of the Model Energy Code is amended by adding a paragraph to read:

502.1.4 Thermal transmittance of opaque wall components and roof/ceiling components. Thermal transmittance of opaque wall components (U_w) and roof/ceiling components (U_r) must be calculated using the following methods:

(1) Wood frame: Parallel heat flow method.

(2) Masonry blocks with insulation inserts or filled cores and other envelope assemblies containing nonmetal framing: Series-parallel method.

(3) Metal framing bonded on one or both sides to a metal skin or covering: Thermal bridges in sheet metal construction method.

(4) Nonmetal surface with metal framing:

(a) For elements identified in Standard RS-24 listed in chapter 7, the parallel path correction factor method.

(b) For elements not identified in Standard RS-24 listed in chapter 7, the zone method.

Subp. 2. Section 502.1 of the Model Energy Code is amended by adding a paragraph to read:

502.1.5 Thermal transmittance of window area and skylight elements. Thermal transmittance of window area (U_g) and

skylight elements (U_S) must be determined in accordance with one of the following methods:

(1) Representative U-values for fenestration products, pages 27.16 to 27.18 of Standard RS-1 listed in chapter 7;

(2) Standard RS-26 listed in chapter 7;

(3) Standard RS-27 or RS-28 listed in chapter 7 using design conditions specified in footnote (a) of table 13, chapter 27 of Standard RS-1; or

(4) Standard RS-29 listed in chapter 7 using design conditions specified in footnote (a) of table 13, chapter 27 of Standard RS-1.

Subp. 3. Section 502.2.1 of the Model Energy Code is amended by adding a new section to read:

502.2.1.7 Alternative compliance. Alternative methods of compliance with sections 502.2.1.1, 502.2.1.2, and 502.2.1.3 for one- and two-family residential buildings.

Minimum performance for Type A-1 (one- and two-family) buildings:

Ceilings	Walls	Floors	Windows	Doors
R-38	R-20[1]	R-20[1]	Maximum U-0.49[2]	R-3

(1) For the insulated cavity of opaque walls, floors, and rim joists.

(2) Maximum window area must not exceed 12 percent of the area of exterior walls, not including foundation walls.

Site-built fixed glazing must be installed in either an aluminum or steel frame having a minimum 0.25 inch low conductance thermal break or in wood or vinyl framing. The glazing must be either double-glazed with a dead air space between panes of nominal one-half inch spacing or triple-glazed with a dead air space between panes of not less than one-fourth inch.

7670.0480 AMENDMENT TO SECTION 502: EFFECTIVENESS OF REQUIRED THERMAL INSULATION.

Section 502.2 of the Model Energy Code is amended by adding paragraphs to read:

502.2.1.8 Cold weather vapor condensation. Building assemblies are required to maintain the thermal performance of required insulation and the integrity of building materials against cold weather water vapor condensation.

502.2.1.8.1 Vapor retarder. A vapor retarder must be installed between the interior surface and the winter design condition dew point location within each building envelope surface. The vapor retarder must be continuous and joints in the vapor retarder must be sealed between solid blocking.

EXCEPTION: A vapor barrier need not be installed on the rim joist insulation.

502.2.1.8.2 Air leakage barrier. A barrier against air leakage must be installed to prevent the leakage of moisture-laden air from the house into the building envelope. An air barrier must be continuous at all plumbing and heating penetrations of interior surface of the building exterior envelope. If a tub or shower is located on an exterior wall, an air barrier must be provided at the interior surface of the building exterior envelope behind the tub or shower.

502.2.1.9 Preventing wind wash. A barrier must be provided at the following locations to mitigate wind wash:

A. the exterior edge of attic insulation; and

B. cantilevered floors and bay windows, including corners with adjoining vertical walls above and below.

7670.0500 AMENDMENT TO SECTION 502: SLAB ON GRADE FLOORS.

Section 502.2.1.4 of the Model Energy Code is amended to read:

502.2.1.4 Slab on grade floors. For slab on grade floors, the thermal resistance of the insulation around the perimeter of the floor must be not less than the value given in Table No. 502.2.1. The insulation must extend downward from the top of the slab to the design frost line or downward to the bottom of the slab then horizontally beneath the slab for an equivalent distance, and must be an approved type.

7670.0510 AMENDMENT TO SECTION 502: FOUNDATION WALLS.

Section 502.2.1.6 of the Model Energy Code is amended to read:

502.2.1.6 Foundation walls. Foundation walls enclosing heated or conditioned spaces must be insulated.

Either the thermal resistance (R) of the insulation on the entire opaque foundation wall must be not less than R-5, or the thermal resistance (R) of the insulation on the opaque foundation wall must be not less than R-10 from the top of the wall down to the design frost line. If the top of the footing is at or above the design frost line, the thermal resistance (R) of the insulation on the wall must not be less than R-5 from the top of the wall to the top of the footing.

All insulation used in or on foundation walls must be approved for the intended use. The insulation must be installed in accordance with the approved manufacturer's specifications.

If the foundation wall insulation is on the exterior, the portion from the top of the foundation wall to six inches below grade must be covered by an approved protective coating finish to protect the insulation from deterioration due to sunlight and physical abuse.

7670.0550 AMENDMENT TO SECTION 502: AIR LEAKAGE.

Subpart 1. **Alternative.** Section 502.4.3 of the Model Energy Code is amended by adding an exception as follows:

EXCEPTION: As an alternative to the prescriptive requirements of section 502.4.3 for detached single-family residential buildings, air tightness must comply with air leakage class A, B, C, or D of Standard RS-30 listed in chapter 7. In addition, this alternative requires that the ventilation system must provide a ventilation rate of not less than 0.35 air changes per hour (determined in accordance with Standard RS-3, Table 2.3) or 15 cfm per person, whichever is greater. This ventilation rate must be verified by measurement. If this alternative is not chosen, this ventilation rate requirement applies only if required by Standard RS-3.

Subp. 2. **Fire stops.** Section 502 is amended by adding a

section as follows:

502.4.4 Fire stops. Fire stops must be installed in accordance with the State Building Code. When mineral fiber or glass fiber materials are used as fire stop construction at ceilings and wall cavities separating conditioned and nonconditioned spaces, the fire stop must be installed to block air movement.

EXCEPTIONS: A fire stop need not block air movement if its installation would conflict with any other part of the State Building Code.

7670.0610 AMENDMENTS TO SECTION 503: BUILDING MECHANICAL SYSTEMS.

Subpart 1. **Calculation procedures.** Section 503.2.1 of the Model Energy code is amended to read:

503.2.1 Calculation procedures. Heating and cooling system design loads for the purpose of sizing systems and equipment must be determined in accordance with the procedures described in Standard RS-1 listed in chapter 7.

503.2.1.1 Safety factor. Design loads may at the designer's option be increased by as much as ten percent to account for unexpected loads or changes in space usage.

503.2.1.2 Pick-up loads. Transient loads such as warm-up or cool-down loads that occur after off-hour setback or shutoff may be calculated from principles based on the heat capacity of the building and its contents, the degree of setback, and desired recovery time; or may be assumed to be up to 30 percent for heating and ten percent for cooling of the steady-state design loads. The steady-state load may include a safety factor in accordance with section 503.2.1.1.

Subp. 2. **System and equipment sizing.** Section 503.2 of the Model Energy Code is amended by adding a paragraph to read:

503.2.3 System and equipment sizing. HVAC systems and equipment must be sized to provide no more than the space and system loads calculated in accordance with 503.2.1.

Exceptions:

(a) Equipment capacity may exceed the design load if the equipment selected is the smallest size needed to meet the load within available options of the desired equipment line.

(b) Equipment whose capacity exceeds the design load may be specified if oversizing the equipment can be shown to not increase the overall annual energy costs.

(c) Stand-by equipment may be installed if controls and devices are provided that allow stand-by equipment to operate automatically only when the primary equipment is not operating.

(d) Multiple units of the same equipment type, such as multiple chillers and boilers, with combined capacities exceeding the design load may be specified to operate concurrently only if controls are provided that sequence or otherwise optimally control the operation of each unit based on load.

(e) For a single piece of equipment that has both heating and cooling capability, only one function, either the heating or the cooling, need meet the requirements of this section. Capacity for the other function must be, within available equipment options, the smallest size necessary to meet the load.

7670.0660 AMENDMENT TO SECTION 503: EQUIPMENT EFFICIENCY.

Subpart 1. **Table No. 503.4.3.** Table No. 503.4.3 of the Model Energy Code "HVAC System Heating Equipment - Gas- and Oil-Fired Minimum Steady State Combustion Efficiency" is amended by changing the requirement for forced-air furnaces and low-pressure steam or hot-water boilers for all other commercial or industrial furnaces and boilers to 80 percent.

Subp. 2. **Table No. 503.4.8.** Section 503 of the Model Energy Code is amended by adding a table to read:

Table No. 503.4.8 -- Minimum EER and COP for Electrically Driven Water Source Hydronic Heat Pumps[1]

Size	under 19 kW (65,000 Btu/h)	19 kW (65,000 Btu/h) and over
EER	9.0	9.4
COP	2.64	2.75

[1]When tested at the standard rating conditions specified in Table No. 503.4.6a.

Subp. 3. **Efficiency requirements.** HVAC system heating and cooling equipment regulated by the National Appliance Energy Conservation Act of 1987 must conform to the efficiency requirements of Standard RS-31 listed in chapter 7.

7670.0670 AMENDMENT TO SECTION 503.10: DUCT CONSTRUCTION.

Section 503.10.2 of the Model Energy Code is amended to read:

503.10.2. For low pressure supply and return air ducts located outside of the conditioned space, all transverse joints must be sealed using mastic, tape, or mastic and tape. For fibrous glass ductwork, pressure sensitive tape may be used.

7670.0710 AMENDMENTS TO SECTION 504: SERVICE WATER HEATING.

Subpart 1. **Time clocks.** Section 504.5 of the Model Energy Code is amended by deleting section 504.5.3.

Subp. 2. **Pipe insulation.** Section 504.7 of the Model Energy Code is amended by deleting the exception.

Subp. 3. **Devices to limit temperature.** Section 504.8.2 of the Model Energy Code is amended by deleting section 504.8.2.2.

Subp. 4. **Efficiency requirements.** Service water heating equipment regulated by the National Appliance Energy Conservation Act of 1987 must conform to the efficiency requirements of Standard RS-31 listed in chapter 7.

7670.0800 AMENDMENTS TO SECTION 505: ELECTRIC POWER AND LIGHTING.

Subpart 1. **Electric energy determination.** The exception to section 505.2 of the Model Energy Code is amended to read:

EXCEPTION: Motels, hotels, college dormitories, other transient facilities, and buildings intended for occupancy primarily by persons who are 62 years of age or older or handicapped, or which contain a majority of units not equipped with complete kitchen facilities.

Subp. 2. **Lighting power budget.** The lighting requirements of sections 505.3 and 505.4 of the Model Energy Code are amended to read:

The lighting power budget must be the upper limit of the power to provide the lighting needs in accordance with the 1988 and 1989 criteria and calculation procedure specified in Standard RS-32 listed in chapter 7 (excluding section 3.2, referencing equation 3.4-1 in section 3.1.6.2, and correcting the units of Interior Lighting Power Allowance in equation 3.5-3 to Watts), or using Standard RS-33 listed in chapter 7.

EXCEPTION: One- and two-family detached dwellings and the dwelling portion of multifamily buildings.

7670.0850 AMENDMENT TO SECTION 600: DESIGN BY ACCEPTABLE PRACTICE.

Section 601.1 of the Model Energy Code is amended by adding a paragraph to read:

Buildings constructed in accordance with this section must also comply with parts 7670.0470 to 7670.0800 as indicated below:

Model Energy Code	Minnesota Rules Part
602.2	7670.0470, 7670.0480
602.2.4	7670.0500
602.2.6	7670.0510
602.3.2	7670.0550
603.1	7670.0610
603.2.1	7670.0660
603.4	7670.0670
604	7670.0710
605	7670.0800

7670.1000 AMENDMENTS TO SECTION 701: STANDARDS.

Section 701.1 of the Model Energy Code is amended by replacing and adding the following code standard numbers to read:

A. RS-1, 1989 ASHRAE Handbook of Fundamentals.

B. RS-3, ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality.

C. RS-4, ASHRAE Standard 55-1981 Thermal Environment Conditions for Human Occupancy.

D. RS-17 and RS-18, SMACNA HVAC Duct Construction Standards: Metal and Flexible, First Edition, 1985.

E. RS-23, Monthly Normals of Temperature, Precipitation, andHeating and Cooling Degree Days 1951-80 Minnesota. National Oceanic and Atmospheric Administration September 1982.

F. RS-24, Code of Federal Regulations, title 10, part 435.105, section 5.3.3.2.1(b), Calculation procedures for parallel path correction factor method.

G. RS-25, Code of Federal Regulations, title 10, part 435.105, section 5.3.3.2.1(d), Calculation procedures for thermal bridges in Sheet Metal Construction.

H. RS-26, AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation of Windows, Doors and Glazed Wall Sections.

I. RS-27, ASTM C 236-87, Standard Test Method for Steady State Performance of Building Assemblies by means of a Guarded Hot Box.

J. RS-28, ASTM C 976-82, Standard Test Method for Steady State Performance of Building Assemblies by means of a Calibrated Hot Box.

K. RS-29, WINDOW computer program.

L. RS-30, ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings.

M. RS-31, Code of Federal Regulations, title 10, part 430.32, Energy Conservation Standards.

N. RS-32, Code of Federal Regulations, title 10, part 435.103, lighting.

O. RS-33, LTGSTD, lighting prescriptive and system performance compliance calculation program.

REPEALER. Minnesota Rules, parts 7670.0110; 7670.0120; 7670.0200; 7670.0210; 7670.0220; 7670.0300; 7670.0310; 7670.0320; 7670.0330; 7670.0340; 7670.0520; 7670.0540; 7670.0600; 7670.0620; 7670.0630; 7670.0640; 7670.0650; 7670.0700; 7670.0720; 7670.0730; 7670.0900; 7670.0910; 7670.0920; 7670.0930; 7670.0940; 7670.0950; 7670.0960; 7670.0970; 7670.1010; 7670.1020; 7670.1030; 7670.1100; and 7670.1110 are repealed.

APPROVED AS TO FORM AND LEGALITY

April 10 19 91

HUBERT H. HUMPHREY, III
ATTORNEY GENERAL

BY MJ Cassedy

SPECIAL ASSISTANT ATTORNEY GENERAL

STATE OF MINNESOTA
DEPARTMENT OF STATE
FILED
APR 15 1991

Joan Anderson Growe

Secretary of State

4:11 P.M. - M

Department of Public Service

Proposed Permanent Rules Relating to Minnesota Energy Code

Rules as Proposed

GENERAL

7670.0100 AUTHORITY; SCOPE; APPLICABILITY.

Subpart 1. **Authority.** This chapter is adopted pursuant to Minnesota Statutes, section 216C.19, subdivision 8 ~~and constitute amendments to~~.

Subp. 2. **Scope.** Under Minnesota Statutes, section 216C.19, subdivision 8, this chapter is a part of the State Building Code, adopted according to Minnesota Statutes, sections 16B.59 to 16B.73. ~~In cases of conflict with the State Building Code, this chapter governs in all cases not affecting safety and health requirements.~~

~~Additionally, this chapter is intended to serve as standards for conducting maxi audits of existing buildings owned by the state, the University of Minnesota, cities, counties, and school districts as specified in Minnesota Statutes, section 216C.20.~~

Subp. 3. **Applicability.** Buildings covered by this chapter must comply with the Model Energy Code as amended by parts 7670.0260 to 7670.1000.

EXCEPTION: Relocated residential buildings need not comply with this chapter, except that, where available, an energy audit must be conducted on the relocated building.

7670.0125 LEGISLATIVE MANDATES CONCERNING MINNESOTA ENERGY CODE.

An enclosed structure or portion of an enclosed structure constructed after January 1, 1978, and used primarily as a commercial parking facility for three or more motor vehicles may not be heated. Incidental heating resulting from building exhaust air passing through a parking facility is not prohibited if substantially all useful heat previously has been removed from the air.

Approved by Revisor

EXCEPTION: Parking facilities that are appurtenant to dwelling unit occupancies.

7670.0130 ~~ADOPTION~~ INCORPORATIONS BY REFERENCE ~~OF THE MODEL ENERGY CODE WITH AMENDMENTS~~.

Subpart 1. **Incorporated items.** The following standards and references are incorporated by reference:

A. The Model Energy Code, ~~1983~~ 1989 Edition, as published by the Council of American Building Officials (Falls Church, Virginia), ~~is incorporated by reference and made a part of the State Building Code, subject to the amendments in this chapter~~ as amended by parts 7670.0260 to 7670.1000.

B. Code of Federal Regulations, title 10, part 435, Energy Conservation Voluntary Performance Standards for New Commercial and Multi-Family High Rise Residential Buildings; Mandatory for New Federal Buildings.

C. Code of Federal Regulations, title 10, part 430, National Appliance Energy Conservation Act of 1987.

D. LTGSTD, lighting prescriptive and system performance compliance calculation program, a computer program developed by Battelle Pacific Northwest Laboratories.

E. ANSI/ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings.

F. AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

G. ASTM C 236-87, Standard Test Method for Steady State Thermal Performance of Building Assemblies by means of a Guarded Hot Box.

H. ASTM C 976-82, Standard Test Method for Thermal Performance of Building Assemblies by means of a Calibrated Hot Box.

I. WINDOW, a computer program developed by the Windows and Daylighting Group at Lawrence Berkeley Laboratory.

Subp. 2. **Availability.** All standards and documents incorporated by reference are available for public inspection at

Approved by Revisor _____

the Minnesota State Law Library and through the Minitex interlibrary loan system. In addition:

A. ASHRAE and ANSI/ASHRAE documents and standards are available from the American Society of Heating, Refrigerating and Air-Conditioning Engineers - Publication Sales, 1791 Tullie Circle NE, Atlanta, GA 30329;

B. AAMA standards are available from the American Architectural Manufacturers Association, 2700 River Road, Des Planes, IL 60018;

C. ASTM standards are available from ASTM, 1916 Race Street, Philadelphia, PA 19103; and

D. The WINDOW computer program is available from Bostik Construction Products, 1740 County Line, Huntington Valley, PA 19006.

7670.0260 MATERIALS AND EQUIPMENT.

Section 102 of the Model Energy Code is amended by adding a paragraph to read:

102.3 Thermal Insulation. Thermal insulation used in residential buildings three stories or less in height must conform to chapter 7640, Minnesota Thermal Insulation Standards, adopted by the Department of Public Service.

7670.0325 AMENDMENTS TO SECTION 201: DEFINITIONS.

Subpart 1. **Thermal transmittance (U).** In section 201 of the Model Energy Code, the definition of "Thermal transmittance (U)" is amended to read:

THERMAL TRANSMITTANCE (U). The coefficient of heat transmission (air to air). It is the time rate of heat flow per unit area and unit temperature differential between the warm side and cold side air films (Btu/h ft^2 F).

Thermal transmittance of opaque wall components (U_w) and roof/ceiling components (U_r) calculation methods are defined in the references indicated:

(1) Parallel heat flow method: Model Energy Code, chapter 5, equations 1 and 2, substituting the framing and insulated cavity components of the opaque wall or roof/ceiling

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for the elements designated by subscripts in these equations.

(2) Series-parallel method: Page 20.8 of Standard RS-1 listed in chapter 7.

(3) Parallel path correction factor method: Standard RS-24 listed in chapter 7.

(4) Thermal bridges in sheet metal construction method: Standard RS-25 listed in chapter 7.

(5) Zone method: Pages 22.10 and 22.11 of Standard RS-1 listed in chapter 7.

Subp. 2. **Vapor retarder.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

VAPOR RETARDER. A material to retard air and water vapor passage designed to meet a maximum perm rating of 1.0 grain per hour per ft^2 per inch Hg pressure differential. Polyethylene material that is not cross laminated which is used to meet the requirements of this paragraph must be designed to have a minimum thickness of four mills.

Subp. 3. **Wind wash.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

WIND WASH. Wind wash is the passage of unconditioned air through thermal insulation of the building envelope.

Subp. 4. **Window area.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

WINDOW AREA. Window area, or glazing area, is either the area of glazing and sash, or the area used by the manufacturer to determine the window thermal transmittance.

7670.0400 AMENDMENT TO ~~302.1~~ SECTION 302: ~~FOOTNOTE 1~~ DESIGN CONDITIONS.

~~On page 12 of the code,~~ Footnote 1 ~~to~~ of section 302.1 of the Model Energy Code is amended to read:

[1]The ~~outdoor~~ exterior design temperature ~~shall~~ must be selected from the ~~columns of 99 percent values for winter and one percent values for summer from tables in Standard RS-1~~ "Design Conditions" columns shown in Table 302.1.

EXCEPTION: Where necessary to assure the prevention of

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damage to the building or to material and equipment within the building, the values listed in Table 302.1 under "extreme conditions" may be used.

TABLE 302.1 Exterior Design Temperatures

CITY	DESIGN CONDITIONS SUMMER DB/WB	DESIGN CONDITIONS WINTER DB	EXTREME CONDITIONS SUMMER DB/WB	EXTREME CONDITIONS WINTER DB
Albert Lea	87/72	-17	90/74	
Alexandria	88/72	-22	90/72	-28.0
Bemidji	85/69	-31	88/69	-36.9
Brainerd	87/71	-20	90/73	
Duluth	82/68	-21	85/70	-27.4
Faribault	88/72	-17	91/74	-24.3
Fergus Falls	88/72	-21	91/72	-27.8
International Falls	83/68	-29	85/68	-36.5
Mankato	88/72	-17	91/72	
Minneapolis	89/73	-16	92/75	-22.0
Rochester	87/72	-17	90/74	
St. Cloud	88/72	-15	91/74	
St. Paul	89/73	-16	92/75	-22.0
Virginia	83/68	-25	85/69	-33.0
Willmar	88/72	-15	91/74	-24.3
Winona	88/73	-14	91/75	

"DB" = dry bulb temperature, degrees Fahrenheit

"WB" = wet bulb temperature, degrees Fahrenheit

Heating degree days ~~heating shall~~ must be selected from Standard ~~RS-22~~ RS-23 listed in chapter 7. Adjustments may be made as determined by the building official to reflect local climates which differ from the tabulated temperatures or local weather experience ~~as determined by the building official~~.

7670.0450 AMENDMENT TO SECTION 303: VENTILATION.

Section 303.1 of the Model Energy Code is amended to read:

303.1 Ventilation. Ventilation systems must be designed to conform with Standard RS-3 listed in chapter 7.

7670.0470 AMENDMENT TO SECTION 502: ENVELOPE THERMAL TRANSMITTANCE.

Subpart 1. Section 502.2.1 of the Model Energy Code is amended by adding a paragraph to read:

502.1.4 Thermal transmittance of opaque wall components and roof/ceiling components. Thermal transmittance of opaque wall components (U_w) and roof/ceiling components (U_r) must be calculated using the following methods:

(1) Wood frame: Parallel heat flow method.

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(2) Masonry blocks with insulation inserts or filled cores and other envelope assemblies containing nonmetal framing: Series-parallel method.

(3) Metal framing bonded on one or both sides to a metal skin or covering: Thermal bridges in sheet metal construction method.

(4) Nonmetal surface with metal framing:

(a) For elements identified in Standard RS-24 listed in chapter 7, the parallel path correction factor method.

(b) For elements not identified in Standard RS-24 listed in chapter 7, the zone method.

Subp. 2. Section 502.1 of the Model Energy Code is amended by adding a paragraph to read:

502.1.5 Thermal transmittance of window area and skylight elements. Thermal transmittance of window area (U_g) and skylight elements (U_s) must be determined in accordance with one of the following methods:

(1) Representative U-values for fenestration products, pages 27.16 to 27.18 of Standard RS-1 listed in chapter 7;

(2) Standard RS-26 listed in chapter 7;

(3) Standard RS-27 or RS-28 listed in chapter 7 using design conditions specified in footnote (a) of table 13, chapter 27 of Standard RS-1; or

(4) Standard RS-29 listed in chapter 7 using design conditions specified in footnote (a) of table 13, chapter 27 of Standard RS-1.

Subp. 3. Section 502.2.1 of the Model Energy Code is amended by adding a new section to read:

502.2.1.7 Alternative compliance. Alternative methods of compliance with sections 502.2.1.1, 502.2.1.2, and 502.2.1.3 for one- and two-family residential buildings.

Minimum performance for Type A-1 (one- and two-family) buildings:

Ceilings	Walls	Floors	Windows	Doors
R-38	R-20[1]	R-20[1]	Maximum U-0.49[2]	R-3

(1) For the insulated cavity of opaque walls, floors, and

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rim joists.

(2) Maximum window area must not exceed 12 percent of the area of exterior walls, not including foundation walls.

Site-built fixed glazing must be installed in either an aluminum or steel frame having a minimum 0.25 inch low conductance thermal break or in wood or vinyl framing. The glazing must be either double-glazed with a dead air space between panes of nominal one-half inch spacing or triple-glazed with a dead air space between panes of not less than one-fourth inch.

7670.0480 AMENDMENT TO SECTION 502: EFFECTIVENESS OF REQUIRED THERMAL INSULATION.

Section 502.2 of the Model Energy Code is amended by adding paragraphs to read:

502.2.1.8 Cold weather vapor condensation. Building assemblies are required to maintain the thermal performance of required insulation and the integrity of building materials against cold weather water vapor condensation.

502.2.1.8.1 Vapor retarder. A vapor retarder must be installed between the interior surface and the winter design condition dew point location within each building envelope surface. The vapor retarder must be continuous and joints in the vapor retarder must be sealed between solid blocking.

EXCEPTION: A vapor barrier need not be installed on the rim joist insulation.

502.2.1.8.2 Air leakage barrier. A barrier against air leakage must be installed to prevent the leakage of moisture-laden air from the house into the building envelope. An air barrier must be continuous at all plumbing and heating penetrations of interior surface of the building exterior envelope. If a tub or shower is located on an exterior wall, an air barrier must be provided at the interior surface of the building exterior envelope behind the tub or shower.

502.2.1.9 Preventing wind wash. A barrier must be provided at the following locations to mitigate wind wash:

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A. the exterior edge of attic insulation; and

B. cantilevered floors and bay windows, including corners with adjoining vertical walls above and below.

7670.0500 AMENDMENT TO ~~502.2.1.4~~ SECTION 502: SLAB ON GRADE FLOORS.

~~On page 19 of the code,~~ Section 502.2.1.4 of the Model Energy Code is amended to read:

502.2.1.4 Slab on grade floors. For slab on grade floors, the thermal resistance of the insulation around the perimeter of the floor must be not less than the value given in Table No. ~~5-1~~ 502.2.1. The insulation must extend downward from the top of the slab to the design frost line or downward to the bottom of the slab then horizontally beneath the slab for an equivalent distance, and must be an approved type.

7670.0510 AMENDMENT TO ~~502.2.1~~ SECTION 502: FOUNDATION WALLS.

~~On page 19~~ Section 502.2.1.6 of the Model Energy Code, ~~502.2.1~~ is amended ~~by adding a paragraph~~ to read:

502.2.1.6 Foundation walls. Foundation walls enclosing heated or conditioned spaces must be insulated.

Either the thermal resistance (R) of the insulation on the entire opaque foundation wall must be not less than R-5, or the thermal resistance (R) of the insulation on the opaque foundation wall must be not less than R-10 from the top of the wall down to the design frost line. If the top of the footing is at or above the design frost line, the thermal resistance (R) of the insulation on the wall must not be less than R-5 from the top of the wall to the top of the footing.

All insulation used in or on foundation walls must be approved for the intended use. The insulation must be installed in accordance with the approved manufacturer's specifications.

If the foundation wall insulation is on the exterior, the portion from the top of the foundation wall to six inches below grade must be covered by an approved protective coating finish to protect the insulation from deterioration due to sunlight and physical abuse.

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7670.0550 AMENDMENT TO ~~502.4.3~~ SECTION 502: AIR LEAKAGE.

~~On page 23 of the code,~~ Subpart 1. **Alternative.** Section 502.4.3 of the Model Energy Code is amended by adding an exception as follows:

~~502.4.3.1 Exterior joints in the building envelope that are sources of air leakage, such as around window and door frames, between wall cavities and window or door frames, between walls and foundations, between walls and roofs or ceilings and between wall panels, openings at penetrations of utility services through walls, floors, and roofs, and all other similar openings in the building envelope must be caulked, gasketed, or otherwise sealed in an approved manner. A continuous air barrier must be provided at all electrical, mechanical, and plumbing penetrations.~~

EXCEPTION: As an alternative to the prescriptive requirements of section 502.4.3 for detached single-family residential buildings, air tightness must comply with air leakage class A, B, C, or D of Standard RS-30 listed in chapter 7. In addition, this alternative requires that the ventilation system must provide a ventilation rate of not less than 0.35 air changes per hour (determined in accordance with Standard RS-3, Table 2.3) or 15 cfm per person, whichever is greater. This ventilation rate must be verified by measurement. If this alternative is not chosen, this ventilation rate requirement applies only if required by Standard RS-3.

Subp. 2. **Fire stops.** Section 502 is amended by adding a section as follows:

502.4.4 Fire stops. Fire stops must be installed in accordance with the State Building Code. When mineral fiber or glass fiber materials are used as fire stop construction at ceilings and wall cavities separating conditioned and nonconditioned spaces, the fire stop must be installed to block air movement.

EXCEPTIONS: A fire stop need not block air movement if its installation would conflict with any other part of the State

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Building Code.

7670.0610 ~~AMENDMENT~~ AMENDMENTS TO ~~503.2~~ SECTION 503: BUILDING MECHANICAL SYSTEMS.

~~On page 24~~ Subpart 1. **Calculation procedures.** Section 503.2.1 of the Model Energy code~~, 503.2~~ is amended ~~by adding a paragraph~~ to read:

~~503.2.3 System design heating and cooling capacity. The rated capacity of the heating and cooling system at design conditions may not be greater than 115 percent for heating, 100 percent for cooling at design output load calculated in accordance with 503.2, whenever appropriate equipment is available.~~

~~Exceptions: 1. Equipment designed for standby purposes.~~
~~2. Cooling capacity of heat pumps.~~
~~3. Systems designed for pick up after automatic temperature setback when a registered professional engineer shows that the extra system design heating and cooling capacity is needed for pick up.~~

503.2.1 Calculation procedures. Heating and cooling system design loads for the purpose of sizing systems and equipment must be determined in accordance with the procedures described in Standard RS-1 listed in chapter 7.

503.2.1.1 Safety factor. Design loads may at the designer's option be increased by as much as ten percent to account for unexpected loads or changes in space usage.

503.2.1.2 Pick-up loads. Transient loads such as warm-up or cool-down loads that occur after off-hour setback or shutoff may be calculated from principles based on the heat capacity of the building and its contents, the degree of setback, and desired recovery time; or may be assumed to be up to 30 percent for heating and ten percent for cooling of the steady-state design loads. The steady-state load may include a safety factor in accordance with section 503.2.1.1.

Subp. 2. **System and equipment sizing.** Section 503.2 of the Model Energy Code is amended by adding a paragraph to read:

503.2.3 System and equipment sizing. HVAC systems and equipment must be sized to provide no more than the space and

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system loads calculated in accordance with 503.2.1.

Exceptions:

(a) Equipment capacity may exceed the design load if the equipment selected is the smallest size needed to meet the load within available options of the desired equipment line.

(b) Equipment whose capacity exceeds the design load may be specified if oversizing the equipment can be shown to not increase the overall annual energy costs.

(c) Stand-by equipment may be installed if controls and devices are provided that allow stand-by equipment to operate automatically only when the primary equipment is not operating.

(d) Multiple units of the same equipment type, such as multiple chillers and boilers, with combined capacities exceeding the design load may be specified to operate concurrently only if controls are provided that sequence or otherwise optimally control the operation of each unit based on load.

(e) For a single piece of equipment that has both heating and cooling capability, only one function, either the heating or the cooling, need meet the requirements of this section. Capacity for the other function must be, within available equipment options, the smallest size necessary to meet the load.

7670.0660 AMENDMENT TO ~~TABLE NO. 5-7~~ SECTION 503: EQUIPMENT EFFICIENCY.

Subpart 1. **Table No. 503.4.3.** Table No. 503.4.3 of the Model Energy Code "HVAC System Heating Equipment - Gas- and Oil-Fired Minimum Steady State Combustion Efficiency" is amended by changing the requirement for forced-air furnaces and low-pressure steam or hot-water boilers for all other commercial or industrial furnaces and boilers to 80 percent.

~~On page 29~~ Subp. 2. **Table No. 503.4.8.** Section 503 of the Model Energy Code~~, Table No. 5-7~~ is amended by adding a table to read:

Table No. ~~5-7~~ 503.4.8 -- Minimum EER and COP for Electrically Driven ~~HVAC System Components~~ Water Source Hydronic

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Heat Pumps[1]

Component	Type of Compressor	Condensing Means: Air EER	Air COP	Water EER	Water COP	Evaporative EER	Evaporative COP
Self-contained water-chillers	Centrifugal	8.00	2.34	13.80	4.04		
	Positive displacement	8.40	2.46	12.00	3.51		
Condenserless water-chillers	Positive displacement	9.90	2.9	12.00	3.51		
Compressor-and condenser units-65,000 Btu/h (19,050-watts) and over[2]	Positive displacement	9.50	2.78	12.50	3.66	12.50	3.66

Water-Source Hydronic Heat-Pump	Size	under 19 kW (65,000 Btu/h) EER	under 19 kW (65,000 Btu/h) COP	19 kW (65,000 Btu/h) and over EER	19 kW (65,000 Btu/h) and over COP
	Centrifugal	9.0	2.64	9.4	2.75
	EER	9.0		9.4	
	COP	2.64		2.75	

[1]When tested at the standard rating conditions specified in Table No. 5-10C 503.4.6a.

[2]Ratings in accordance with Standard RS-14 as applicable. COP based on condensing unit standard rating capacity and energy input to the unit, all at sea level.

Subp. 3. **Efficiency requirements.** HVAC system heating and cooling equipment regulated by the National Appliance Energy Conservation Act of 1987 must conform to the efficiency requirements of Standard RS-31 listed in chapter 7.

7670.0670 AMENDMENT TO 503.10.2 SECTION 503.10: DUCT CONSTRUCTION.

On page 33 of the code, Section 503.10.2 of the Model Energy Code is amended to read:

503.10.2. For low pressure supply and return air ducts located outside of the conditioned space, all transverse joints must be sealed using mastic, tape, or mastic plus and tape. For fibrous glass ductwork, pressure sensitive tape may be used.

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7670.0710 ~~DELETION OF 504.5.3~~ AMENDMENTS TO SECTION 504: SERVICE WATER HEATING.

~~On page 38~~ Subpart 1. **Time clocks.** Section 504.5 of the Model Energy Code~~, 504.5.3~~ is ~~deleted~~ amended by deleting section 504.5.3.

Subp. 2. **Pipe insulation.** Section 504.7 of the Model Energy Code is amended by deleting the exception.

Subp. 3. **Devices to limit temperature.** Section 504.8.2 of the Model Energy Code is amended by deleting section 504.8.2.2.

Subp. 4. **Efficiency requirements.** Service water heating equipment regulated by the National Appliance Energy Conservation Act of 1987 must conform to the efficiency requirements of Standard RS-31 listed in chapter 7.

7670.0800 ~~AMENDMENT OF 505.2~~ AMENDMENTS TO SECTION 505: ELECTRIC POWER AND LIGHTING.

~~On page 39~~ Subpart 1. **Electric energy determination.** The exception to section 505.2 of the Model Energy Code~~, 505.2~~ is amended to read:

~~505.2 Electric energy determination.~~

~~In any multi tenant residential building, provisions shall be made to separately determine the electric energy consumed by each tenant. Electrical service to individual dwelling units in buildings containing two or more units shall be separately metered, with individual metering readily accessible to the individual occupants.~~

EXCEPTION: Motels, hotels, college dormitories, other transient facilities, and buildings intended for occupancy primarily by persons who are 62 years of age or older or handicapped, or which contain a majority of units not equipped with complete kitchen facilities.

Subp. 2. **Lighting power budget.** The lighting requirements of sections 505.3 and 505.4 of the Model Energy Code are amended to read:

The lighting power budget must be the upper limit of the power to provide the lighting needs in accordance with the 1988

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and 1989 criteria and calculation procedure specified in Standard RS-32 listed in chapter 7 (excluding section 3.2, referencing equation 3.4-1 in section 3.1.6.2, and correcting the units of Interior Lighting Power Allowance in equation 3.5-3 to Watts), or using Standard RS-33 listed in chapter 7.

EXCEPTION: One- and two-family detached dwellings and the dwelling portion of multifamily buildings.

7670.0850 AMENDMENT TO SECTION 600: DESIGN BY ACCEPTABLE PRACTICE.

Section 601.1 of the Model Energy Code is amended by adding a paragraph to read:

Buildings constructed in accordance with this section must also comply with parts 7670.0470 to 7670.0800 as indicated below:

Model Energy Code	Minnesota Rules Part
602.2	7670.0470, 7670.0480
602.2.4	7670.0500
602.2.6	7670.0510
602.3.2	7670.0550
603.1	7670.0610
603.2.1	7670.0660
603.4	7670.0670
604	7670.0710
605	7670.0800

7670.1000 ~~AMENDMENT~~ AMENDMENTS TO ~~7011.1~~ SECTION 701: STANDARDS.

~~On page 54 of the code,~~ Section 701.1~~, Code Standard No. RS-4,~~ of the Model Energy Code is amended by replacing and adding the following code standard numbers to read:

A. RS-1, 1989 ASHRAE Handbook of Fundamentals.

B. RS-3, ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality.

C. RS-4, ASHRAE Standard 55-1981 Thermal Environment Conditions for Human Occupancy.

D. RS-17 and RS-18, SMACNA HVAC Duct Construction Standards: Metal and Flexible, First Edition, 1985.

E. RS-23, Monthly Normals of Temperature, Precipitation, andHeating and Cooling Degree Days 1951-80 Minnesota. National Oceanic and Atmospheric Administration September 1982.

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F. RS-24, Code of Federal Regulations, title 10, part 435.105, section 5.3.3.2.1(b), Calculation procedures for parallel path correction factor method.

G. RS-25, Code of Federal Regulations, title 10, part 435.105, section 5.3.3.2.1(d), Calculation procedures for thermal bridges in Sheet Metal Construction.

H. RS-26, AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation of Windows, Doors and Glazed Wall Sections.

I. RS-27, ASTM C 236-87, Standard Test Method for Steady State Performance of Building Assemblies by means of a Guarded Hot Box.

J. RS-28, ASTM C 976-82, Standard Test Method for Steady State Performance of Building Assemblies by means of a Calibrated Hot Box.

K. RS-29, WINDOW computer program.

L. RS-30, ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings.

M. RS-31, Code of Federal Regulations, title 10, part 430.32, Energy Conservation Standards.

N. RS-32, Code of Federal Regulations, title 10, part 435.103, lighting.

O. RS-33, LTGSTD, lighting prescriptive and system performance compliance calculation program.

REPEALER. Minnesota Rules, parts 7670.0110; 7670.0120; 7670.0200; 7670.0210; 7670.0220; 7670.0300; 7670.0310; 7670.0320; 7670.0330; 7670.0340; 7670.0520; 7670.0540; 7670.0600; 7670.0620; 7670.0630; 7670.0640; 7670.0650; 7670.0700; 7670.0720; 7670.0730; 7670.0900; 7670.0910; 7670.0920; 7670.0930; 7670.0940; 7670.0950; 7670.0960; 7670.0970; 7670.1010; 7670.1020; 7670.1030; 7670.1100; and 7670.1110 are repealed.

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Office of the Revisor of Statutes

Administrative Rules

TITLE: Proposed Permanent Rules Relating to Minnesota Energy Code

AGENCY: Department of Public Service

MINNESOTA RULES: Chapter 7670

INCORPORATIONS BY REFERENCE:

Part 7670.0130: Model Energy Code, 1989 Edition, published by Council of American Building Officials, Falls Church, Virginia, as amended by parts 7670.0260 to 7670.1000; LTGSTD, lighting prescriptive and system performance compliance calculation program, a computer program developed by Battelle Pacific Northwest Laboratories; ANSI/ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings; AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; ASTM C 236-87, Standard Test Method for Steady State Thermal Performance of Building Assemblies by means of a Guarded Hot Box; ASTM C 976-82, Standard Test Method for Thermal Performance of Building Assemblies by means of a Calibrated Hot Box; WINDOW, a computer program developed by the Windows and Daylighting Group at Lawrence Berkeley Laboratory. Available at Minnesota State Law Library and through Minitex interlibrary loan system.

The attached rules are approved for publication in the State Register

Craig E. Lindeke
Senior Assistant Revisor

STATE OF MINNESOTA

OFFICE OF THE ATTORNEY GENERAL

HUBERT H. HUMPHREY, III
ATTORNEY GENERAL

BUSINESS REGULATION SECTION
1100 BREMER TOWER
SEVENTH PLACE & MINNESOTA ST.
ST. PAUL, MN 55101
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March 27, 1991

Patricia Nolte
Legal Assistant
Public Finance Division
404 Capitol Office Building
525 Park Street
St. Paul, MN 55103

Re: In the matter of the Proposed Amendments to Rules of the Minnesota Department of Public Service Amending the State Building Code regarding Heat Loss, Illumination, and Climate Control (Minn. Rules ch. 7670)

Dear Ms. Nolte:

On March 25, 1991, the Minnesota Department of Public Service (Department) adopted the above-captioned rules governing thermal insulation standards. Enclosed for your review are the following:

1. Rule as adopted (original and three copies).

2. Findings of Fact, Conclusions, and Order Adopting Rule Amendments (two copies).

3. Notice of Intent to Solicit Outside Opinion (13 S.R. 2991, June 19, 1989).

4. Notice of Intent to Amend Rules Without a Public Hearing and Rules as Proposed (15 S.R. 1831, 19 February, 1991).

5. Notice of Intent to Amend Rules Without a Public Hearing, and Notice of Intent to Adopt a Rule With a Public Hearing if Twenty-Five or More Persons Request a Hearing as mailed.

6. Mailing list, Certificate of Mailing List and Affidavit of Mailing.

7. Affidavit of Additional Discretionary Notice.

8. Rules as proposed.

9. Statement of Need and Reasonableness.

10. Declaration of Counsel.

I previously forwarded to your office on December 5, 1990, all written comments received pursuant to the notice of intent to solicit outside opinion. Further, the Department received no comments pursuant to the notice of intent to adopt rule amendments without a public hearing. Finally, since the Department had earlier proposed rules on this subject and then withdrew and renoticed the rules in a modified form, I have included a copy of the notice of withdrawal dated February 4, 1991 (15 S.R. 1850, 19 February, 1991). If you have any questions on this matter, please feel free to contact me.

Very truly yours,

ERIC F. SWANSON
Special Assistant
Attorney General

Telephone: (612) 296-8703

ES:li.ak5

cc: Bruce Nelson

56,977-57,877	4,749-4,823	1,000	6,000
57,878-58,778	4,824-4,898	1,066	6,396
58,779-59,679	4,899-4,973	1,134	6,804
59,680-60,851	4,974-5,070	1,203	7,218

This fee schedule is based on the Minnesota State Median Income of $36,746 for a four-person household in federal fiscal year 1989. The Bureau of the Census developed the median income estimates for each state from three sources of data: the March 1987 Current Population Survey; the 1980 Census of Population; and 1986 per capita income estimates from the Bureau of Economic Analysis. These median income estimates were published in the *Federal Register*, Volume 53, No. 64/Monday, April 4, 1988, pages 10947 and 10948.

The department shall adjust the fee schedule annually, and publish the adjustments in the *State Register* on the last Monday in June. The adjustments shall be based on the most recent annual state median income as published in the *Federal Register* by the Department of Health and Human Services.

Department of Human Services

Health Care Programs Division

Notice of Solicitation of Outside Information or Opinions Regarding Proposed Amendments to Rules Governing Preadmission Screening and Alternative Care Grants

NOTICE IS HEREBY GIVEN that the State Department of Human Services is seeking information or opinions from sources outside the agency in preparing to propose amendments to the rules governing the standards and procedures applicable to alternative care grants under the medical assistance program, *Minnesota Rules*, parts 9505.2455, subparts 5 and 8; 9505.2465, subpart 4; and 9505.2490, subparts 1 and 2.

The adoption of the rule is authorized by *Minnesota Statutes*, section 256B.091, subdivisions 8 and 9, which require the agency to establish procedures for employing or contracting for services and for determining the use of grants for payment of costs of providing care-related supplies, the limits on rates for payment of approved services, and the limits on the total cost of an alternative care grant to an alternative care grant client.

The State Department of Human Services requests information and opinions concerning the subject matter of the rule. Interested persons or groups may submit data or views on the subject matter of concern in writing or orally. Written statements should be addressed to:

Eleanor Weber
Rules Division
Minnesota Department of Human Services
444 Lafayette Road
St. Paul, MN 55101

Oral statements will be received during regular business hours over the telephone at (612) 297-4301 by Eleanor Weber and in person at the above address.

All statements of information and opinions shall be accepted until further notice. Any written material received by the State Department of Human Services shall become part of the rulemaking record to be submitted to the attorney general or administrative law judge in the event that the rule is adopted.

Department of Public Service

Energy Division

Notice of Solicitation of Outside Information or Opinions Regarding the Minnesota Energy Code

NOTICE IS HEREBY GIVEN that the Department of Public Service is seeking information or opinions from sources outside the agency in preparing to propose the amendment *Minnesota Rules* Chapter 4215 governing energy matters within the State Building Code. The adoption of the rule is authorized by *Minnesota Statutes*, section 216C.19 subdivision 8, to establish energy standards for building design and construction.

The Department requests information and opinions concerning the subject matter of the rule, including but not limited to, ventilation and other issues related to both residential and nonresidential requirements of the Energy Code. Interested persons or groups may submit data or views on the subject matter of concern in writing or orally. Written statements should be addressed to:

Bruce Nelson, Senior Engineer, Department of Public Service, Energy Division, 900 American Center Building, 150 East Kellogg Boulevard, St. Paul, Minnesota 55101, (612) 297-2313.

Oral statements will be received during regular business hours over the telephone and in person at the above address.

All statements of information and opinions shall be accepted until October 1, 1989. Any written material received by the State Department of Public Service shall become part of the rulemaking record to be submitted to the attorney general or administrative law judge in the event that the rule is adopted.

Dated: 12 June 1989

Burl W. Haar
Deputy Commissioner

Minnesota Public Utilities Commission

Notice of Intent to Solicit Outside Information Regarding Proposed Rule Governing Construction Plans for Major Utility Facilities, Docket No. G,E-999/R-89-386.

NOTICE IS HEREBY GIVEN that the Minnesota Public Utilities Commission (Commission) is seeking information or opinions from outside sources in preparing to propose the adoption of rules governing construction plans for major utility facilities. The adoption of the rule is authorized by *Minnesota Statutes* § 216B.08 (1988), which allows the Commission to adopt rules, and *Minnesota Statutes* § 216B.24 (1988), which allows the Commission to review utility plans for contemplated construction of major utility facilities.

The Commission requests information and opinions concerning the subject matter of the rule. Interested persons or groups may submit data or views in writing or orally. Written statements or comments should be directed to:

Caroline Heil
Minnesota Public Utilities Commission
780 American Center Building
150 East Kellogg Boulevard
St. Paul, MN 55101

Oral statements or comments should be directed to David Jacobson of the Commission Staff at (612) 297-4562. Oral statements or comments will be received during regular business hours, 8:00 a.m. to 4:30 pm., Monday through Friday.

All statements of information and opinion will be accepted until 4:30 p.m. on July 21, 1989. Any written materials received by the Commission shall become part of the rulemaking record in the event that the rule is adopted.

Mary Ellen Hennen
Executive Secretary

Draft Rules Governing Construction Plans for Major Utility Facilities

7841.0100 DEFINITIONS.

Subpart 1. **Scope.** The terms used in this chapter have the meanings given them in this part.

Subp. 2. **Commission.** "Commission" means the Minnesota Public Utilities Commission.

Subp. 3. **Construction.** "Construction" means significant physical alteration of a site to install or enlarge a major utility facility, but does not include activities incident to preliminary engineering or environmental studies.

Subp. 4. **Major utility facility.** "Major utility facility" has the meaning given the term in *Minnesota Statutes*, section 216B.24, subdivision 1.

Subp. 5. **Public utility.** "Public utility" has the meaning given the term in *Minnesota Statutes*, section 216B.02, subdivision 4.

7841.0200 PURPOSE AND SCOPE.

Subpart 1. **Purpose.** The purpose of parts 7841.0100 to 7841.0500 is to prescribe the contents of and procedures for Commission review of construction plans for major utility facilities.

F. National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269.

(1) 30, Flammable and Combustible Liquids Code (1987); and

(2) 385, Standard for Tank Vehicle for Flammable and Combustible Liquids (1985).

G. National Leak Prevention Association, 4090 Rosehill Avenue, Cincinnati, Ohio 45229.

631, Spill Prevention, Minimum 10-Year Life Extension of Existing Steel Underground Tanks by Lining Without the Addition of Cathodic Protection (1988).

H. Petroleum Equipment Institute, P.O. Box 2380, Tulsa, Oklahoma 74101.

RP100, Recommended Practices for Installation of Underground Liquid Storage Systems (1990).

I. Steel Tank Institute, 728 Anthony Trail, Northbrook, Illinois 60062.

(1) Specifications for STI-P, System of External Corrosion Protection of Underground Steel Storage Tanks (1987);

(2) Steel Tank Institute Standard for Dual Wall Underground Steel Storage Tanks (undated); and

(3) STI F894-89, Steel Tank Institute Specification for External Corrosion Protection of FRP Composite Steel Underground Storage Tanks (1989).

J. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, Illinois 60062.

(1) UL 58, Steel Underground Tanks for Flammable and Combustible Liquids (1986);

(2) UL 567, Pipe Connectors for Flammable and Combustible Liquids and LP-Gas (1989);

(3) UL 1316, Glass-Fiber-Reinforced Plastic Underground Storage Tanks for Petroleum Products (1983); and

(4) UL 1746, Corrosion Protection Systems for Underground Storage Tanks (1989).

K. Underwriters Laboratories of Canada, 7 Crouse Road, Scarborough, Ontario, Canada M1R 3A9.

(1) CAN4-S603.1-M85, Standard for Galvanic Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids (1985);

(2) CAN4-S603-M85, Standard for Steel Underground Tanks for Flammable and Combustible Liquids (1985);

(3) CAN4-S615-M83, Standard for Reinforced Plastic Underground Tanks for Petroleum Products (1983);

(4) CAN4-S631-M84, Standard for Isolating Bushings for Steel Underground Tanks Protected with Coatings and Galvanic Systems (1984);

(5) CAN4-S633-M84, Flexible Underground Hose Connectors for Flammable and Combustible Liquids (1984); and

(6) ULC Subject C107C-M1984, Guide for Glass Fibre Reinforced Plastic Pipe and Fittings for Flammable Liquids (1984).

Department of Public Service

Proposed Permanent Rules Relating to Minnesota Energy Code

Notice of Intent to Amend a Rule Without a Public Hearing and Notice of Intent to Adopt a Rule With a Public Hearing if Twenty-Five or More Persons Request a Hearing

NOTICE IS HEREBY GIVEN that the Minnesota Department of Public Service intends to adopt amendments to *Minnesota Rules* Chapter 7670, without a public hearing following the procedures set forth in the *Minnesota Statutes*, sections 14.22 to 14.28. Authority for the adoption of these rules is contained in *Minnesota Statutes*, section 216C.19, subdivision 8.

All persons have 30 days in which to submit comment in support of or in opposition to any part or subpart of the proposed amendments. Comment is encouraged. Each comment should identify the proposed amendment addressed, the reason for the comment, and any change proposed.

All persons may make a written request for a public hearing on the proposed amendments within the 30-day comment period. If

KEY: PROPOSED RULES SECTION — Underlining indicates additions to existing rule language. ~~Strike outs~~ indicate deletions from existing rule language. If a proposed rule is totally new, it is designated "all new material." **ADOPTED RULES SECTION** — Underlining indicates additions to proposed rule language. ~~Strike outs~~ indicate deletions from proposed rule language.

25 or more persons submit a written request for a public hearing within the 30-day comment period, a public hearing will be held unless a sufficient number withdraw their requests in writing. Any person requesting a public hearing must state his or her name and address and is encouraged to identify the portion of the proposed amendment addressed, the reason for the request, and any change proposed. If a public hearing is required, the agency will proceed pursuant to *Minnesota Statutes*, sections 14.131 to 14.20.

These rules were previously published in 15 S.R. 828 (October 1, 1990) and mailed on September 25, 1990. However, significant amendments are being proposed, so the rule is being re-noticed with a new comment period. If you requested a hearing in the previous rulemaking proceeding, and still desire a hearing on these rules, you must submit another request during this comment period.

PLEASE NOTE: that if twenty five or more persons submit written requests for a public hearing within the 30 day comment period, a public hearing will be held on March 29, 1991 unless a sufficient number withdraw their requests in accordance with the notice of hearing on these rules published in the *STATE REGISTER* and mailed to persons registered with the Department of Public Service. To verify whether a hearing will be held, please call the Department of Public Service, Energy Information Center on March 22, 1991 between the hours on 8:00 a.m. and 4:15 p.m. at 296-5175 or Minnesota toll free 800-652-9747 (ask for "Energy").

Comments or written requests for a public hearing must be submitted to:

Bruce Nelson, Senior Engineer
Department of Public Service, Energy Division
790 American Center Building
150 East Kellogg Boulevard
St. Paul, MN 55101
phone (612) 297-2313 fax (612) 297-1959

The proposed amendments may be modified if the modifications are supported by the data and views submitted to the Department and do not result in a substantial change in the proposed amendments as noticed.

A Copy of the proposed rule amendment is attached to this notice.

A STATEMENT OF NEED AND REASONABLENESS that describes the need for and reasonableness of each provision of the proposed amendments and identifies the data and information relied upon to support the proposed amendments has been prepared and is available by requesting a copy from Mr. Nelson at the address listed above.

The adoption of these rules will not result in additional spending by local bodies of government in excess of $100,000 per year in either of the first two years following their adoption.

Minnesota Statute § 14.115, subdivision 2 (1988) requires the department, when proposing rules which may affect small business, to consider five methods for reducing the impact on small businesses. The adoption of these rule amendments will affect small businesses in Minnesota. The department has evaluated the effect of the proposed rules on small businesses and has considered each of the methods listed above for reducing the impact of the rules on small busineses.

Minnesota Statutes § 14.115, subd. 2(a) (1988) requires the department to consider the establishment of less stringent compliance or reporting requirements for small business. The proposed amendments to part 7670.0470, subpart 2 (items 1 and 4) relating to determination of window thermal performance are less stringent because they require no costly physical testing to demonstrate compliance. Chapter 7670 contains no reporting requirements.

Since Chapter 7670 contains no scheduling, deadline or reporting requirements, *Minnesota Statutes* § 14.115, subd. 2(b) and (c) are not applicable.

The proposed rules include several significant performance standards in conformance with *Minnesota Statutes* § 14.115, subd. 2(d). Part 7670.0470, subpart 2, includes four performance options for determining the thermal performance of windows. The Model Energy Code chapter 4 (Building Design Systems Analysis) is entirely performance based. The Model Energy Code chapter 5 (Building Design by Component Performance Approach) is also performance based. Finally, the lighting criteria proposed in Part 7670.0800, subpart 2 are performance based.

Minnesota Statutes § 14.115, subd. 2(e) requires the department to consider exempting small businesses from any or all requirements of the rule. *Minnesota Statutes* § 16B.62 establishes the scope of application of the State Building Code. To exempt small businesses would be contrary to the latter statute. It would be inappropriate for the department to usurp statutory requirements by changing the applicability to exempt small business. In the proposed rule part 7670.0100, subpart 3, the applicability of the chapter is modified to exempt relocated residential buildings in conformance with *Minnesota Statutes* § 16B.61, subd. 3(i).

If no hearing is required, upon adoption of the rule, the rule and the required supporting documents will be submitted to the Attorney General for review as to legality and form to the extent that form relates to legality. Any person may request notification of the date of submission to the Attorney General. Persons who wish to be advised of the submission of this material to the Attorney General, or who wish to receive a copy of the adopted rules, must submit a written request for such to Mr. Nelson at the address listed above.

Dated: 1 February 1991

Kris Sanda, Commissioner
Department of Public Service

Notice of Hearing and Notice of Intent to Cancel Hearing if Fewer than Twenty-Five Persons Request a Hearing in Response to Notice of Intent to Adopt Rules without a Public Hearing

NOTICE IS HEREBY GIVEN that a public hearing on the above-entitled matter will be held on March 29, 1991 in Conference Room 4, 9th floor of the American Center Building, 150 East Kellogg Boulevard, St. Paul, Minnesota commencing at 9:00 a.m. and continuing until all interested or affected persons have an opportunity to participate. The proposed rules may be modified as a result of the hearing process. Therefore, if you are affected in any manner by the proposed rule, you are urged to participate in the rule hearing process.

These rules were previously published in 15 S.R. 828 (October 1, 1990) and mailed on September 25, 1990. However, significant amendments are being proposed, so the rule is being re-noticed with a new comment period. If you requested a hearing in the previous rulemaking proceeding, and still desire a hearing on these rules, you must submit another request during this comment period.

PLEASE NOTE, HOWEVER, that the hearing will be cancelled if fewer than twenty-five persons request a hearing in response to the notice of intent to adopt these same rules without a public hearing published in this *State Register* and mailed to persons registered with the Department of Public Service, Energy Division. To verify whether a hearing will be held, please call the Department of Public Service, Energy Information Center on March 22, 1991 between the hours of 8:00 a.m. and 4:15 p.m. at 296-5175 or Minnesota toll free 800-652-9747 (ask for "Energy").

Following the agency's presentation at the hearing, all interested or affected persons will have an opportunity to participate. Such persons may present their views either orally at the hearing or in writing at any time prior to the close of the hearing. All evidence presented should be pertinent to the matter at hand. Written material not submitted at the time of the hearing which is to be included in the hearing may be mailed to Peter C. Erickson, Administrative Law Judge, Office of Administrative Hearings, 310 Fourth Avenue South, Minneapolis, Minnesota 55415; telephone 612/341-7606, either before the hearing or within five working days after the public hearing ends. The Administrative Law Judge may at the hearing, order the record to be kept open for a longer period not to exceed 20 calendar days. The comments received during the comment period shall be available for review at the Office of Administrative Hearings. Following the close of the comment period the agency and all interested persons have three business days to respond in writing to any new information submitted during the comment period. During the three day period, the agency may indicate, in writing, whether there are amendments suggested by other persons which the agency is willing to adopt. No additional evidence may be admitted during the three day period. The written responses shall be added to the rulemaking record. Upon the close of the record the Administrative Law Judge will write a report as provided for in *Minnesota Statutes*, Sections 14.15 to 14.50. The rule hearing is governed by *Minnesota Statutes*, section 14.14 to 14.20 and by *Minnesota Rules*, parts 1400.0200 to 1400.1200. Questions about procedure may be directed to the Administrative Law Judge.

Authority for the adoption of these rules is contained in *Minnesota Statutes*, section 216C.19, subdivision 8.

The adoption of these rules will not result in additional spending by local bodies of government in excess of $100,000 per year in either of the first two years following their adoption.

Minnesota Statute § 14.115, subdivision 2 (1988) requires the department, when proposing rules which may affect small business, to consider five methods (a through e) for reducing the impact on small businesses. The adoption of these rule amendments will affect small businesses in Minnesota. The department has evaluated the effect of the proposed rules on small businesses and has considered each of the methods listed above for reducing the impact of the rules on small businesses.

Minnesota Statutes § 14.115, subd. 2(a) (1988) requires the department to consider the establishment of less stringent compliance or reporting requirements for small business. The proposed amendments to part 7670.0470, subpart 2 (items 1 and 4) relating to determination of window thermal performance are less stringent because they require no costly physical testing to demonstrate compliance. Chapter 7670 contains no reporting requirements.

Since Chapter 7670 contains no scheduling, deadline or reporting requirements, *Minnesota Statutes* § 14.115, subd. 2(b) and (c) are not applicable.

The proposed rules include several significant performance standards in conformance with *Minnesota Statutes* § 14.115, subd. 2(d). Part 7670.0470, subpart 2, includes four performance options for determining the thermal performance of windows. The Model Energy Code chapter 4 (Building Design Systems Analysis) is entirely performance based. The Model Energy Code chapter 5 (Building Design by Component Performance Approach) is also performance based. Finally, the lighting criteria proposed in Part 7670.0800, subpart 2 are performance based.

KEY: PROPOSED RULES SECTION — Underlining indicates additions to existing rule language. ~~Strike outs~~ indicate deletions from existing rule language. If a proposed rule is totally new, it is designated "all new material." **ADOPTED RULES SECTION** — Underlining indicates additions to proposed rule language. ~~Strike outs~~ indicate deletions from proposed rule language.

Minnesota Statutes § 14.115, subd. 2(e) requires the department to consider exempting small businesses from any or all requirements of the rule. *Minnesota Statutes* § 16B.62 establishes the scope of application of the State Building Code. To exempt small businesses would be contrary to the later statute. It would be inappropriate for the department to usurp statutory requirements by changing the applicability to exempt small business. In the proposed rule part 7670.0100, subpart 3, the applicability of the chapter is modified to exempt reloacted residential buildings in conformance with *Minnesota Statutes* § 16B.61, subd. 3(i).

A Copy of the proposed rule amendment is attached to this notice.

NOTICE: Any person may request notification of the date on which the Administrative Law Judge's report will be available, after which date the agency may not take final action on the rules for a period of five working days. If you desire to be notified, you may so indicate at the hearing. After the hearing, you may request notification by sending a written request to the Administrative Law Judge. Any person may request notification of the date on which the rules were adopted and filed with the secretary of state. The notice must be mailed on the same day the rules are filed. If you want to be so notified you may so indicate at the hearing or send a request in writing to the agency at any time prior to filing the rules with the secretary of state.

NOTICE IS HEREBY GIVEN that a Statement of Need and Reasonableness is now available for review at the Agency and at the Office of Administrative Hearings. The Statement of Need and Reasonableness includes a summary of all the evidence and argument which the agency anticipates presenting at the hearing justifying both the need for and reasonableness of the proposed rules. Copies of the Statement of Need and Reasonableness may be reviewed at the agency or the Office of Administrative Hearings and may be obtained from the Office of Administrative Hearings at the cost of reproduction.

Copies of the Statement of Need and Reasonableness are also available by submitting a request to:

Bruce Nelson, Senior Engineer
Department of Public Service, Energy Division
790 American Center Building
150 East Kellogg Boulevard
St. Paul, MN 55101
phone (612) 297-2313 fax (612) 297-1959

Minnesota Statutes, Chapter 10A requires each lobbyist to register with the State Ethical Practices Board within five days after he or she commences lobbying. A lobbyist is defined in *Minnesota Statutes*, section 10A.01, subdivision 11 as any individual:

(a) engaged for pay or other consideration, or authorized by another individual or association to spend money, who spends more than five hours in any month or more than $250.00, not including travel expenses and membership dues, in any year, for the purpose of attempting to influence legislative or administrative action by communication or urging others to communicate with public officials;

(b) who spends more than $250.00, not including his own traveling expenses and membership dues, in any year, for the purpose of attempting to influence legislative or administrative action by communicating or urging others to communicate with public officials.

The statute provides certain exceptions. Questions should be directed to the Ethical Practices Board, 625 North Robert Street, St. Paul, Minnesota 55101, telephone 612-296-5148.

Dated: 1 February 1991

Kris Sanda, Commissioner
Department of Public Service

Rules as Proposed

GENERAL

7670.0100 AUTHORITY; SCOPE; APPLICABILITY.

Subpart 1. **Authority.** This chapter is adopted pursuant to *Minnesota Statutes*, section 216C.19, subdivision 8 ~~and constitute amendments to~~.

Subp. 2. **Scope.** Under *Minnesota Statutes*, section 216C.19, subdivision 8, this chapter is a part of the State Building Code, adopted according to *Minnesota Statutes*, sections 16B.59 to 16B.73. ~~In cases of conflict with the State Building Code, this chapter governs in all cases not affecting safety and health requirements.~~

~~Additionally, this chapter is intended to serve as standards for conducting maxi audits of existing buildings owned by the state, the University of Minnesota, cities, counties, and school districts as specified in *Minnesota Statutes*, section 216C.20.~~

Subp. 3. **Applicability.** Buildings covered by this chapter must comply with the Model Energy Code as amended by parts 7670.0260 to 7670.1000.

EXCEPTION: Relocated residential buildings need not comply with this chapter, except that, where available, an energy audit must be conducted on the relocated building.

7670.0125 LEGISLATIVE MANDATES CONCERNING MINNESOTA ENERGY CODE.

An enclosed structure or portion of an enclosed structure constructed after January 1, 1978, and used primarily as a commercial parking facility for three or more motor vehicles may not be heated. Incidental heating resulting from building exhaust air passing through a parking facility is not prohibited if substantially all useful heat previously has been removed from the air.

EXCEPTION: Parking facilities that are appurtenant to dwelling unit occupancies.

7670.0130 ~~ADOPTION~~ INCORPORATIONS BY REFERENCE ~~OF THE MODEL ENERGY CODE WITH AMENDMENTS~~.

Subpart 1. **Incorporated items.** The following standards and references are incorporated by reference:

A. The Model Energy Code, ~~1983~~ 1989 Edition, as published by the Council of American Building Officials (Falls Church, Virginia), ~~is incorporated by reference and made a part of the State Building Code, subject to the amendments in this chapter~~ as amended by parts 7670.0260 to 7670.1000.

B. *Code of Federal Regulations*, title 10, part 435, Energy Conservation Voluntary Performance Standards for New Commercial and Multi-Family High Rise Residential Buildings; Mandatory for New Federal Buildings.

C. *Code of Federal Regulations*, title 10, part 430, National Appliance Energy Conservation Act of 1987.

D. LTGSTD, lighting prescriptive and system performance compliance calculation program, a computer program developed by Battelle Pacific Northwest Laboratories.

E. ANSI/ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings.

F. AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

G. ASTM C 236-87, Standard Test Method for Steady State Thermal Performance of Building Assemblies by means of a Guarded Hot Box.

H. ASTM C 976-82, Standard Test Method for Thermal Performance of Building Assemblies by means of a Calibrated Hot Box.

I. WINDOW, a computer program developed by the Windows and Daylighting Group at Lawrence Berkeley Laboratory.

Subp. 2. **Availability.** All standards and documents incorporated by reference are available for public inspection at the Minnesota State Law Library and through the Minitex interlibrary loan system. In addition:

A. ASHRAE and ANSI/ASHRAE documents and standards are available from the American Society of Heating, Refrigerating and Air-Conditioning Engineers - Publication Sales, 1791 Tullie Circle NE, Atlanta, GA 30329;

B. AAMA standards are available from the American Architectural Manufacturers Association, 2700 River Road, Des Planes, IL 60018;

C. ASTM standards are available from ASTM, 1916 Race Street, Philadelphia, PA 19103; and

D. The WINDOW computer program is available from Bostik Construction Products, 1740 County Line, Huntington Valley, PA 19006.

7670.0260 MATERIALS AND EQUIPMENT.

Section 102 of the Model Energy Code is amended by adding a paragraph to read:

102.3 Thermal Insulation. Thermal insulation used in residential buildings three stories or less in height must conform to chapter 7640, Minnesota Thermal Insulation Standards, adopted by the Department of Public Service.

7670.0325 AMENDMENTS TO SECTION 201: DEFINITIONS.

Subpart 1. **Thermal transmittance (U).** In section 201 of the Model Energy Code, the definition of "Thermal transmittance (U)" is amended to read:

THERMAL TRANSMITTANCE (U). The coefficient of heat transmission (air to air). It is the time rate of heat flow per unit area and unit temperature differential between the warm side and cold side air films (Btu/h ft^2 F).

Thermal transmittance of opaque wall components (U_w) and roof/ceiling components (U_r) calculation methods are defined in the references indicated:

KEY: PROPOSED RULES SECTION — Underlining indicates additions to existing rule language. ~~Strike outs~~ indicate deletions from existing rule language. If a proposed rule is totally new, it is designated "all new material." **ADOPTED RULES SECTION** — Underlining indicates additions to proposed rule language. ~~Strike outs~~ indicate deletions from proposed rule language.

(1) Parallel heat flow method: Model Energy Code, chapter 5, equations 1 and 2, substituting the framing and insulated cavity components of the opaque wall or roof/ceiling for the elements designated by subscripts in these equations.

(2) Series-parallel method: Page 20.8 of Standard RS-1 listed in chapter 7.

(3) Parallel path correction factor method: Standard RS-24 listed in chapter 7.

(4) Thermal bridges in sheet metal construction method: Standard RS-25 listed in chapter 7.

(5) Zone method: Pages 22.10 and 22.11 of Standard RS-1 listed in chapter 7.

Subp. 2. **Vapor retarder.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

VAPOR RETARDER. A material to retard air and water vapor passage designed to meet a maximum perm rating of 1.0 grain per hour per ft^2 per inch Hg pressure differential. Polyethylene material that is not cross laminated which is used to meet the requirements of this paragraph must be designed to have a minimum thickness of four mills.

Subp. 3. **Wind wash.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

WIND WASH. Wind wash is the passage of unconditioned air through thermal insulation of the building envelope.

Subp. 4. **Window area.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

WINDOW AREA. Window area, or glazing area, is either the area of glazing and sash, or the area used by the manufacturer to determine the window thermal transmittance.

7670.0400 AMENDMENT TO ~~302.1~~ SECTION 302: ~~FOOTNOTE~~ 1 DESIGN CONDITIONS.

~~On page 12 of the code.~~ Footnote 1 ~~to~~ of section 302.1 of the Model Energy Code is amended to read:

[1]The ~~outdoor~~ exterior design temperature ~~shall~~ must be selected from the ~~columns of 99 percent values for winter and one percent values for summer from tables in Standard RS-1~~ "Design Conditions" columns shown in Table 302.1.

EXCEPTION: Where necessary to assure the prevention of damage to the building or to material and equipment within the building, the values listed in Table 302.1 under "extreme conditions" may be used.

TABLE 302.1 Exterior Design Temperatures

	DESIGN CONDITIONS		EXTREME CONDITIONS	
CITY	SUMMER DB/WB	WINTER DB	SUMMER DB/WB	WINTER DB
Albert Lea	87/72	-17	90/74	
Alexandria	88/72	-22	90/72	-28.0
Bemidji	85/69	-31	88/69	-36.9
Brainerd	87/71	-20	90/73	
Duluth	82/68	-21	85/70	-27.4
Faribault	88/72	-17	91/74	-24.3
Fergus Falls	88/72	-21	91/72	-27.8
International Falls	83/68	-29	85/68	-36.5
Mankato	88/72	-17	91/72	
Minneapolis	89/73	-16	92/75	-22.0
Rochester	87/72	-17	90/74	
St. Cloud	88/72	-15	91/74	
St. Paul	89/73	-16	92/75	-22.0
Virginia	83/68	-25	85/69	-33.0
Willmar	88/72	-15	91/74	-24.3
Winona	88/73	-14	91/75	

"DB" = dry bulb temperature, degrees Fahrenheit

"WB" = wet bulb temperature, degrees Fahrenheit

Heating degree days ~~heating shall~~ must be selected from Standard ~~RS-22~~ RS-23 listed in chapter 7. Adjustments may be made as determined by the building official to reflect local climates which differ from the tabulated temperatures or local weather experience ~~as determined by the building official~~.

7670.0450 AMENDMENT TO SECTION 303: VENTILATION.

Section 303.1 of the Model Energy Code is amended to read:

303.1 Ventilation. Ventilation systems must be designed to conform with Standard RS-3 listed in chapter 7.

7670.0470 AMENDMENT TO SECTION 502: ENVELOPE THERMAL TRANSMITTANCE.

Subpart 1. Section 502.2.1 of the Model Energy Code is amended by adding a paragraph to read:

502.1.4 Thermal transmittance of opaque wall components and roof/ceiling components. Thermal transmittance of opaque wall components (U_w) and roof/ceiling components (U_r) must be calculated using the following methods:

(1) Wood frame: Parallel heat flow method.

(2) Masonry blocks with insulation inserts or filled cores and other envelope assemblies containing nonmetal framing: Series-parallel method.

(3) Metal framing bonded on one or both sides to a metal skin or covering: Thermal bridges in sheet metal construction method.

(4) Nonmetal surface with metal framing:

(a) For elements identified in Standard RS-24 listed in chapter 7, the parallel path correction factor method.

(b) For elements not identified in Standard RS-24 listed in chapter 7, the zone method.

Subp. 2. Section 502.1 of the Model Energy Code is amended by adding a paragraph to read:

502.1.5 Thermal transmittance of window area and skylight elements. Thermal transmittance of window area (U_w) and skylight elements (U_r) must be determined in accordance with one of the following methods:

(1) Representative U-values for fenestration products, pages 27.16 to 27.18 of Standard RS-1 listed in chapter 7;

(2) Standard RS-26 listed in chapter 7;

(3) Standard RS-27 or RS-28 listed in chapter 7 using design conditions specified in footnote (a) of table 13, chapter 27 of Standard RS-1; or

(4) Standard RS-29 listed in chapter 7 using design conditions specified in footnote (a) of table 13, chapter 27 of Standard RS-1.

Subp. 3. Section 502.2.1 of the Model Energy Code is amended by adding a new section to read:

502.2.1.7 Alternative compliance. Alternative methods of compliance with sections 502.2.1.1, 502.2.1.2, and 502.2.1.3 for one- and two-family residential buildings.

Minimum performance for Type A-1 (one- and two-family) buildings:

Ceilings	Walls	Floors	Windows	Doors
R-38	R-20[1]	R-20[1]	Maximum U-0.49[2]	R-3

(1) For the insulated cavity of opaque walls, floors, and rim joists.

(2) Maximum window area must not exceed 12 percent of the area of exterior walls, not including foundation walls.

Site-built fixed glazing must be installed in either an aluminum or steel frame having a minimum 0.25 inch low conductance thermal break or in wood or vinyl framing. The glazing must be either double-glazed with a dead air space between panes of nominal one-half inch spacing or triple-glazed with a dead air space between panes of not less than one-fourth inch.

7670.0480 AMENDMENT TO SECTION 502: EFFECTIVENESS OF REQUIRED THERMAL INSULATION.

Section 502.2 of the Model Energy Code is amended by adding paragraphs to read:

502.2.1.8 Cold weather vapor condensation. Building assemblies are required to maintain the thermal performance of required insulation and the integrity of building materials against cold weather water vapor condensation.

502.2.1.8.1 Vapor retarder. A vapor retarder must be installed between the interior surface and the winter design condition dew point location within each building envelope surface. The vapor retarder must be continuous and joints in the vapor retarder must be sealed between solid blocking.

EXCEPTION: A vapor barrier need not be installed on the rim joist insulation.

502.2.1.8.2 Air leakage barrier. A barrier against air leakage must be installed to prevent the leakage of moisture-laden air from the house into the building envelope. An air barrier must be continuous at all plumbing and heating penetrations of interior surface of the building exterior envelope. If a tub or shower is located on an exterior wall, an air barrier must be provided at the interior surface of the building exterior envelope behind the tub or shower.

KEY: PROPOSED RULES SECTION — Underlining indicates additions to existing rule language. ~~Strike outs~~ indicate deletions from existing rule language. If a proposed rule is totally new, it is designated "all new material." **ADOPTED RULES SECTION** — Underlining indicates additions to proposed rule language. ~~Strike outs~~ indicate deletions from proposed rule language.

502.2.1.9 Preventing wind wash. A barrier must be provided at the following locations to mitigate wind wash:

A. the exterior edge of attic insulation; and

B. cantilevered floors and bay windows, including corners with adjoining vertical walls above and below.

7670.0500 AMENDMENT TO ~~502.2.1.4~~ SECTION 502: SLAB ON GRADE FLOORS.

~~On page 19 of the code.~~ Section 502.2.1.4 of the Model Energy Code is amended to read:

502.2.1.4 Slab on grade floors. For slab on grade floors, the thermal resistance of the insulation around the perimeter of the floor must be not less than the value given in Table No. ~~5-1~~ 502.2.1. The insulation must extend downward from the top of the slab to the design frost line or downward to the bottom of the slab then horizontally beneath the slab for an equivalent distance, and must be an approved type.

7670.0510 AMENDMENT TO ~~502.2.1~~ SECTION 502: FOUNDATION WALLS.

~~On page 19~~ Section 502.2.1.6 of the Model Energy Code~~, 502.2.1~~ is amended ~~by adding a paragraph~~ to read:

502.2.1.6 Foundation walls. Foundation walls enclosing heated or conditioned spaces must be insulated.

Either the thermal resistance (R) of the insulation on the entire opaque foundation wall must be not less than R-5, or the thermal resistance (R) of the insulation on the opaque foundation wall must be not less than R-10 from the top of the wall down to the design frost line. If the top of the footing is at or above the design frost line, the thermal resistance (R) of the insulation on the wall must not be less than R-5 from the top of the wall to the top of the footing.

All insulation used in or on foundation walls must be approved for the intended use. The insulation must be installed in accordance with the approved manufacturer's specifications.

If the foundation wall insulation is on the exterior, the portion from the top of the foundation wall to six inches below grade must be covered by an approved protective coating finish to protect the insulation from deterioration due to sunlight and physical abuse.

7670.0550 AMENDMENT TO ~~502.4.3~~ SECTION 502: AIR LEAKAGE.

~~On page 23 of the code.~~ Subpart 1. **Alternative.** Section 502.4.3 of the Model Energy Code is amended by adding an exception as follows:

~~502.4.3.1 Exterior joints in the building envelope that are sources of air leakage, such as around window and door frames, between wall cavities and window or door frames, between walls and foundations, between walls and roofs or ceilings and between wall panels, openings at penetrations of utility services through walls, floors, and roofs, and all other similar openings in the building envelope must be caulked, gasketed, or otherwise sealed in an approved manner. A continuous air barrier must be provided at all electrical, mechanical, and plumbing penetrations.~~

EXCEPTION: As an alternative to the prescriptive requirements of section 502.4.3 for detached single-family residential buildings, air tightness must comply with air leakage class A, B, C, or D of Standard RS-30 listed in chapter 7. In addition, this alternative requires that the ventilation system must provide a ventilation rate of not less than 0.35 air changes per hour (determined in accordance with Standard RS-3, Table 2.3) or 15 cfm per person, whichever is greater. This ventilation rate must be verified by measurement. If this alternative is not chosen, this ventilation rate requirement applies only if required by Standard RS-3.

Subp. 2. **Fire stops.** Section 502 is amended by adding a section as follows:

502.4.4 Fire stops. Fire stops must be installed in accordance with the State Building Code. When mineral fiber or glass fiber materials are used as fire stop construction at ceilings and wall cavities separating conditioned and nonconditioned spaces, the fire stop must be installed to block air movement.

EXCEPTIONS: A fire stop need not block air movement if its installation would conflict with any other part of the State Building Code.

7670.0610 ~~AMENDMENT~~ AMENDMENTS TO ~~503.2~~ SECTION 503: BUILDING MECHANICAL SYSTEMS.

~~On page 24~~ Subpart 1. **Calculation procedures.** Section 503.2.1 of the Model Energy code~~, 503.2~~ is amended ~~by adding a paragraph~~ to read:

~~503.2.3 System design heating and cooling capacity. The rated capacity of the heating and cooling system at design conditions may not be greater than 115 percent for heating, 100 percent for cooling at design output load calculated in accordance with 503.2, whenever appropriate equipment is available.~~

~~Exceptions: 1. Equipment designed for standby purposes.~~
~~2. Cooling capacity of heat pumps.~~
~~3. Systems designed for pick up after automatic temperature setback when a registered~~

~~professional engineer shows that the extra system design heating and cooling capacity is needed for pick up.~~

503.2.1 Calculation procedures. Heating and cooling system design loads for the purpose of sizing systems and equipment must be determined in accordance with the procedures described in Standard RS-1 listed in chapter 7.

503.2.1.1 Safety factor. Design loads may at the designer's option be increased by as much as ten percent to account for unexpected loads or changes in space usage.

503.2.1.2 Pick-up loads. Transient loads such as warm-up or cool-down loads that occur after off-hour setback or shutoff may be calculated from principles based on the heat capacity of the building and its contents, the degree of setback, and desired recovery time; or may be assumed to be up to 30 percent for heating and ten percent for cooling of the steady-state design loads. The steady-state load may include a safety factor in accordance with section 503.2.1.1.

Subp. 2. **System and equipment sizing.** Section 503.2 of the Model Energy Code is amended by adding a paragraph to read:

503.2.3 System and equipment sizing. HVAC systems and equipment must be sized to provide no more than the space and system loads calculated in accordance with 503.2.1.

Exceptions:

(a) Equipment capacity may exceed the design load if the equipment selected is the smallest size needed to meet the load within available options of the desired equipment line.

(b) Equipment whose capacity exceeds the design load may be specified if oversizing the equipment can be shown to not increase the overall annual energy costs.

(c) Stand-by equipment may be installed if controls and devices are provided that allow stand-by equipment to operate automatically only when the primary equipment is not operating.

(d) Multiple units of the same equipment type, such as multiple chillers and boilers, with combined capacities exceeding the design load may be specified to operate concurrently only if controls are provided that sequence or otherwise optimally control the operation of each unit based on load.

(e) For a single piece of equipment that has both heating and cooling capability, only one function, either the heating or the cooling, need meet the requirements of this section. Capacity for the other function must be, within available equipment options, the smallest size necessary to meet the load.

7670.0660 AMENDMENT TO ~~TABLE NO. 5-7~~ SECTION 503: EQUIPMENT EFFICIENCY.

Subpart 1. **Table No. 503.4.3.** Table No. 503.4.3 of the Model Energy Code "HVAC System Heating Equipment - Gas- and Oil-Fired Minimum Steady State Combustion Efficiency" is amended by changing the requirement for forced-air furnaces and low-pressure steam or hot-water boilers for all other commercial or industrial furnaces and boilers to 80 percent.

~~On page 29~~ Subp. 2. **Table No. 503.4.8.** Section 503 of the Model Energy Code~~, Table No. 5-7~~ is amended by adding a table to read:

Table No. ~~5-7~~ 503.4.8 — Minimum EER and COP for Electrically Driven ~~HVAC System Components~~ Water Source Hydronic Heat Pumps[1]

~~Component~~	~~Type of Compressor~~	~~Condensing Means Air EER~~	~~Air COP~~	~~Water EER~~	~~Water COP~~	~~Evaporative EER~~	~~Evaporative COP~~
~~Self-contained water chillers~~	~~Centrifugal~~	~~8.00~~	~~2.34~~	~~13.80~~	~~4.04~~		
	~~Positive displacement~~	~~8.40~~	~~2.46~~	~~12.00~~	~~3.51~~		

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Heat Pumps[1]

Component	Type of Compressor	Condensing Means: Air EER	Air COP	Water EER	Water COP	Evaporative EER	Evaporative COP
Condenserless water chillers	Positive displacement	9.90	2.9	12.00	3.51		
Compressor and condenser units 65,000 Btu/h (19,050 watts) and over[2]	Positive displacement	9.50	2.78	12.50	3.66	12.50	3.66

Water Source Hydronic Heat Pump	Size	under 19 kW (65,000 Btu/h) EER	under 19 kW (65,000 Btu/h) COP	19 kW (65,000 Btu/h) and over EER	19 kW (65,000 Btu/h) and over COP
	Centrifugal	9.0	2.64	9.4	2.75
	EER	9.0		9.4	
	COP	2.64		2.75	

[1]When tested at the standard rating conditions specified in Table No. 5-10C 503.4.6a.

[2]Ratings in accordance with Standard RS-14 as applicable. COP based on condensing unit standard rating capacity and energy input to the unit, all at sea level.

Subp. 3. **Efficiency requirements.** HVAC system heating and cooling equipment regulated by the National Appliance Energy Conservation Act of 1987 must conform to the efficiency requirements of Standard RS-31 listed in chapter 7.

7670.0670 AMENDMENT TO 503.10.2 SECTION 503.10: DUCT CONSTRUCTION.

On page 33 of the code, Section 503.10.2 of the Model Energy Code is amended to read:

503.10.2. For low pressure supply and return air ducts located outside of the conditioned space, all transverse joints must be sealed using mastic, tape, or mastic plus and tape. For fibrous glass ductwork, pressure sensitive tape may be used.

7670.0710 DELETION OF 504.5.3 AMENDMENTS TO SECTION 504: SERVICE WATER HEATING.

On page 38 Subpart 1. **Time clocks.** Section 504.5 of the Model Energy Code, 504.5.3 is deleted amended by deleting section 504.5.3.

Subp. 2. **Pipe insulation.** Section 504.7 of the Model Energy Code is amended by deleting the exception.

Subp. 3. **Devices to limit temperature.** Section 504.8.2 of the Model Energy Code is amended by deleting section 504.8.2.2.

Subp. 4. **Efficiency requirements.** Service water heating equipment regulated by the National Appliance Energy Conservation Act of 1987 must conform to the efficiency requirements of Standard RS-31 listed in chapter 7.

7670.0800 AMENDMENT OF 505.2 AMENDMENTS TO SECTION 505: ELECTRIC POWER AND LIGHTING.

On page 39 Subpart 1. **Electric energy determination.** The exception to section 505.2 of the Model Energy Code, 505.2 is amended to read:

505.2 Electric energy determination.

In any multi tenant residential building, provisions shall be made to separately determine the electric energy consumed by each tenant. Electrical service to individual dwelling units in buildings containing two or more units shall be separately metered, with individual metering readily accessible to the individual occupants.

EXCEPTION: Motels, hotels, college dormitories, other transient facilities, and buildings intended for occupancy primarily by persons who are 62 years of age or older or handicapped, or which contain a majority of units not equipped with complete kitchen facilities.

Subp. 2. **Lighting power budget.** The lighting requirements of sections 505.3 and 505.4 of the Model Energy Code are amended to read:

The lighting power budget must be the upper limit of the power to provide the lighting needs in accordance with the 1988 and

1989 criteria and calculation procedure specified in Standard RS-32 listed in chapter 7 (excluding section 3.2, referencing equation 3.4-1 in section 3.1.6.2, and correcting the units of Interior Lighting Power Allowance in equation 3.5-3 to Watts), or using Standard RS-33 listed in chapter 7.

EXCEPTION: One- and two-family detached dwellings and the dwelling portion of multifamily buildings.

7670.0850 AMENDMENT TO SECTION 600: DESIGN BY ACCEPTABLE PRACTICE.

Section 601.1 of the Model Energy Code is amended by adding a paragraph to read:

Buildings constructed in accordance with this section must also comply with parts 7670.0470 to 7670.0800 as indicated below:

Model Energy Code	*Minnesota Rules* Part
602.2	7670.0470, 7670.0480
602.2.4	7670.0500
602.2.6	7670.0510
602.3.2	7670.0550
603.1	7670.0610
603.2.1	7670.0660
603.4	7670.0670
604	7670.0710
605	7670.0800

7670.1000 ~~AMENDMENT~~ AMENDMENTS TO ~~701.1~~ SECTION 701: STANDARDS.

~~On page 54 of the code,~~ Section 701.1~~, Code Standard No. RS-4,~~ of the Model Energy Code is amended by replacing and adding the following code standard numbers to read:

A. RS-1, 1989 ASHRAE Handbook of Fundamentals.

B. RS-3, ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality.

C. RS-4, ASHRAE Standard 55-1981 Thermal Environment Conditions for Human Occupancy.

D. RS-17 and RS-18, SMACNA HVAC Duct Construction Standards: Metal and Flexible, First Edition, 1985.

E. RS-23, Monthly Normals of Temperature, Precipitation, andHeating and Cooling Degree Days 1951-80 Minnesota. National Oceanic and Atmospheric Administration September 1982.

F. RS-24, *Code of Federal Regulations*, title 10, part 435.105, section 5.3.3.2.1(b), Calculation procedures for parallel path correction factor method.

G. RS-25, *Code of Federal Regulations*, title 10, part 435.105, section 5.3.3.2.1(d), Calculation procedures for thermal bridges in Sheet Metal Construction.

H. RS-26, AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation of Windows, Doors and Glazed Wall Sections.

I. RS-27, ASTM C 236-87, Standard Test Method for Steady State Performance of Building Assemblies by means of a Guarded Hot Box.

J. RS-28, ASTM C 976-82, Standard Test Method for Steady State Performance of Building Assemblies by means of a Calibrated Hot Box.

K. RS-29, WINDOW computer program.

L. RS-30, ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings.

M. RS-31, Code of Federal Regulations, title 10, part 430.32, Energy Conservation Standards.

N. RS-32, Code of Federal Regulations, title 10, part 435.103, lighting.

O. RS-33, LTGSTD, lighting prescriptive and system performance compliance calculation program.

REPEALER. *Minnesota Rules*, parts 7670.0110; 7670.0120; 7670.0200; 7670.0210; 7670.0220; 7670.0300; 7670.0310; 7670.0320; 7670.0330; 7670.0340; 7670.0520; 7670.0540; 7670.0600; 7670.0620; 7670.0630; 7670.0640; 7670.0650; 7670.0700; 7670.0720; 7670.0730; 7670.0900; 7670.0910; 7670.0920; 7670.0930; 7670.0940; 7670.0950; 7670.0960; 7670.0970; 7670.1010; 7670.1020; 7670.1030; 7670.1100; and 7670.1110 are repealed.

KEY: PROPOSED RULES SECTION — Underlining indicates additions to existing rule language. ~~Strike outs~~ indicate deletions from existing rule language. If a proposed rule is totally new, it is designated "all new material." **ADOPTED RULES SECTION** — Underlining indicates additions to proposed rule language. ~~Strike outs~~ indicate deletions from proposed rule language.

DEPARTMENT OF PUBLIC SERVICE
ENERGY DIVISION

Proposed Permanent Rules Amending the Minnesota State Building Code Regarding Heat Loss, Illumination and Climate Control

Notice of Intent to Amend a Rule Without a Public Hearing and Notice of Intent to Adopt a Rule With a Public Hearing if Twenty-Five or More Persons Request a Hearing

(1) Notice is hereby given that the Minnesota Department of Public Service intends to adopt amendments to Minnesota Rules Chapter 7670, without a public hearing following the procedures set forth in the Minnesota Statutes, sections 14.22 to 14.28. Authority for the adoption of these rules is contained in Minnesota Statutes, section 216C.19, subdivision 8.

(2) All persons have 30 days in which to submit comment in support of or in opposition to any part or subpart of the proposed amendments. Comment is encouraged (3) Each comment should identify the proposed amendment addressed, the reason for the comment, and any change proposed.

All persons may make a written request for a public hearing on the proposed amendments within the 30-day comment period. (4) If 25 or more persons submit a written request for a public hearing within the 30-day comment period, a public hearing will be held unless a sufficient number withdraw their requests in writing. (6) Any person requesting a public hearing must state his or her name and address and is encouraged to identify the portion of the proposed amendment addressed, the reason for the request, and any change proposed. (7) If a public hearing is required, the agency will proceed pursuant to Minnesota Statutes, sections 14.131 to 14.20.

These rules were previously published in 15 S.R. 828 (October 1, 1990) and mailed on September 25, 1990. However, significant amendments are being proposed, so the rule is being re-noticed with a new comment period. If you requested a hearing in the previous rulemaking proceeding, and still desire a hearing on these rules, you must submit another request during this comment period.

PLEASE NOTE: that if twenty five or more persons submit written requests for a public hearing within the 30 day comment period, a public hearing will be held on March 29, 1991 unless a sufficient number withdraw their requests in accordance with the notice of hearing on these rules published in the STATE REGISTER and mailed to persons registered with the Department of Public Service. To verify whether a hearing will be held, please call the Department of Public Service, Energy Information Center on March 22, 1991 between the hours on 8:00 a.m. and 4:15 p.m. at 296-5175 or Minnesota toll free 800-652-9747 (ask for "Energy").

Comments or written requests for a public hearing must be submitted to: (5)

Bruce Nelson, Senior Engineer
Department of Public Service, Energy Division
790 American Center Building
150 East Kellogg Boulevard
St. Paul, MN 55101
phone (612) 297-2313 fax (612) 297-1959.

(8) The proposed amendments may be modified if the modifications are supported by the data and views submitted to the Department and do not result in a substantial change in the proposed amendments as noticed.

(11) A Copy of the proposed rule amendment is attached to this notice.

(12) **A Statement of Need and Reasonableness** that describes the need for and reasonableness of each provision of the proposed amendments and identifies the data and information relied upon to support the proposed amendments has been prepared and is available by requesting a copy from Mr. Nelson at the address listed above.

The adoption of these rules will not result in additional spending by local bodies of government in excess of $100,000 per year in either of the first two years following their adoption.

(13) Minnesota Statue § 14.115, subdivision 2 (1988) requires the department, when proposing rules which may affect small business, to consider five methods for reducing the impact on small businesses. The adoption of these rule amendments will affect small businesses in Minnesota. The department has evaluated the effect of the proposed rules on small businesses and has considered each of the methods listed above for reducing the impact of the rules on small businesses.

Minn. Stat. § 14.115, subd. 2(a) (1988) requires the department to consider the establishment of less stringent compliance or reporting requirements for small business. The proposed amendments to part 7670.0470, subpart 2 (items 1 and 4) relating to determination of window thermal performance are less stringent because they require no costly physical testing to demonstrate compliance. Chapter 7670 contains no reporting requirements.

Since Chapter 7670 contains no scheduling, deadline or reporting requirements, Minn. Stat. § 14.115, subd. 2(b) and (c) are not applicable.

The proposed rules include several significant performance standards in conformance with Minn. Stat. § 14.115, subd. 2(d). Part 7670.0470, subpart 2, includes four performance options for determining the thermal performance of windows. The Model Energy Code chapter 4 (Building Design Systems Analysis) is entirely performance based. The Model Energy Code chapter 5 (Building Design by Component Performance Approach) is also performance based. Finally, the lighting criteria proposed in Part 7670.0800, subpart 2 are performance based.

Minn. Stat. § 14.115, subd. 2(e) requires the department to consider exempting small businesses from any or all requirements of the rule. Minn. Stat. § 16B.62 establishes the scope of application of the State Building Code. To exempt small businesses would be contrary to the latter statute, It would be inappropriate for the department to usurp statutory requirements by changing the applicability to exempt small business. In the proposed rule part 7670.0100, subpart 3, the applicability of the chapter is modified to exempt relocated residential buildings in conformance with Minn. Stat. § 16B.61, subd. 3(i).

(9) If no hearing is required, upon adoption of the rule, the rule and the required supporting documents will be submitted to the Attorney General for review as to legality and form to the extent that form relates to legality. Any person may request notification of the date of submission to the Attorney General. Persons who wish to be advised of the submission of this material to the Attorney General, or who wish to receive a copy of the adopted rules, must submit a written request for such to Mr. Nelson at the address listed above.

Kris L. Sanda

Kris Sanda, Commissioner
Department of Public Service

2-1-91

Dated

Notice of Hearing and Notice of Intent to Cancel Hearing if Fewer than Twenty-Five Persons Request a Hearing in Response to Notice of Intent to Adopt Rules without a Public Hearing

Notice is hereby given that a public hearing on the above-entitled matter will be held on March 29, 1991 in Conference Room 4, 9th floor of the American Center Building, 150 East Kellogg Boulevard, St. Paul, Minnesota commencing at 9:00 a.m. and continuing until all interested or affected persons have an opportunity to participate. The proposed rules may be modified as a result of the hearing process. Therefore, if you are affected in any manner by the proposed rule, you are urged to participate in the rule hearing process.

These rules were previously published in 15 S.R. 828 (October 1, 1990) and mailed on September 25, 1990. However, significant amendments are being proposed, so the rule is being re-noticed with a new comment period. If you requested a hearing in the previous rulemaking proceeding, and still desire a hearing on these rules, you must submit another request during this comment period.

PLEASE NOTE, HOWEVER, that the hearing will be cancelled if fewer than twenty-five persons request a hearing in response to the notice of intent to adopt these same rules without a public hearing published in this State Register and mailed to persons registered with the Department of Public Service, Energy Division. To verify whether a hearing will be held, please call the Department of Public Service, Energy Information Center on March 22, 1991 between the hours of 8:00 a.m. and 4:15 p.m. at 296-5175 or Minnesota toll free 800-652-9747 (ask for "Energy").

Following the agency's presentation at the hearing, all interested or affected persons will have an opportunity to participate. Such persons may present their views either orally at the hearing or in writing at any time prior to the close of the hearing. All evidence presented should be pertinent to the matter at hand. Written material not submitted at the time of the hearing which is to be included in the hearing may be mailed to Peter C. Erickson, Administrative Law Judge, Office of Administrative Hearings, 310 Fourth Avenue South, Minneapolis, Minnesota 55415; telephone 612/341-7606, either before the hearing or within five working days after the public hearing ends. The Administrative Law Judge may at the hearing, order the record to be kept open for a longer period not to exceed 20 calendar days. The comments received during the comment period shall be available for review at the Office of Administrative Hearings. Following the close of the comment period the agency and all interested persons have three business days to respond in writing to any new information submitted during the comment period. During the three day period, the agency may indicate, in writing, whether there are amendments suggested by other persons which the agency is willing to adopt. No additional evidence may be admitted during the three day period. The written responses shall be added to the rulemaking record. Upon the close of the record the Administrative Law Judge will write a report as provided for in Minnesota Statutes, Sections 14.15 to 14.50. The rule hearing is governed by Minnesota Statutes, section 14.14 to 14.20 and by Minnesota Rules, parts 1400.0200 to 1400.1200. Questions about procedure may be directed to the Administrative Law Judge.

Authority for the adoption of these rules is contained in Minnesota Statutes, section 216C.19, subdivision 8.

The adoption of these rules will not result in additional spending by local bodies of government in excess of $100,000 per year in either of the first two years following their adoption.

Minnesota Statue § 14.115, subdivision 2 (1988) requires the department, when proposing rules which may affect small business, to consider five methods (a through

e) for reducing the impact on small businesses. The adoption of these rule amendments will affect small businesses in Minnesota. The department has evaluated the effect of the proposed rules on small businesses and has considered each of the methods listed above for reducing the impact of the rules on small businesses.

Minn. Stat. § 14.115, subd. 2(a) (1988) requires the department to consider the establishment of less stringent compliance or reporting requirements for small business. The proposed amendments to part 7670.0470, subpart 2 (items 1 and 4) relating to determination of window thermal performance are less stringent because they require no costly physical testing to demonstrate compliance. Chapter 7670 contains no reporting requirements.

Since Chapter 7670 contains no scheduling, deadline or reporting requirements, Minn. Stat. § 14.115, subd. 2(b) and (c) are not applicable.

The proposed rules include several significant performance standards in conformance with Minn. Stat. § 14.115, subd. 2(d). Part 7670.0470, subpart 2, includes four performance options for determining the thermal performance of windows. The Model Energy Code chapter 4 (Building Design Systems Analysis) is entirely performance based. The Model Energy Code chapter 5 (Building Design by Component Performance Approach) is also performance based. Finally, the lighting criteria proposed in Part 7670.0800, subpart 2 are performance based.

Minn. Stat. § 14.115, subd. 2(e) requires the department to consider exempting small businesses from any or all requirements of the rule. Minn. Stat. § 16B.62 establishes the scope of application of the State Building Code. To exempt small businesses would be contrary to the later statute. It would be inappropriate for the department to usurp statutory requirements by changing the applicability to exempt small business. In the proposed rule part 7670.0100, subpart 3, the applicability of the chapter is modified to exempt relocated residential buildings in conformance with Minn. Stat. § 16B.61, subd. 3(i).

A Copy of the proposed rule amendment is attached to this notice.

NOTICE: Any person may request notification of the date on which the Administrative Law Judge's report will be available, after which date the agency may not take final action on the rules for a period of five working days. If you desire to be notified, you may so indicate at the hearing. After the hearing, you may request notification by sending a written request to the Administrative Law Judge. Any person may request notification of the date on which the rules were adopted and filed with the secretary of state, The notice must be mailed on the same day the rules are filed. If you want to be so notified you may so indicate at the hearing or send a request in writing to the agency at any time prior to filing the rules with the secretary of state.

NOTICE IS HEARBY GIVEN that a Statement of Need and Reasonableness is now available for review at the Agency and at the Office of Administrative Hearings. The Statement of Need and Reasonableness includes a summary of all the evidence and argument which the agency anticipates presenting at the hearing justifying both the need for and reasonableness of the proposed rules. Copies of the Statement of Need and Reasonableness may be reviewed at the agency or the Office of Administrative Hearings and may be obtained from the Office of Administrative Hearings at the cost of reproduction.

Copies of the Statement of Need and Reasonableness are also available by submitting a request to:

Bruce Nelson, Senior Engineer
Department of Public Service, Energy Division
790 American Center Building
150 East Kellogg Boulevard
St. Paul, MN 55101
phone (612) 297-2313 fax (612) 297-1959.

Minnesota Statutes, Chapter 10A requires each lobbyist to register with the State Ethical Practices Board within five days after he or she commences lobbying. A lobbyist is defined in Minnesota Statutes, section 10A.01, subdivision 11 as any individual:

(a) engaged for pay or other consideration, or authorized by another individual or association to spend money, who spends more than five hours in any month or more than $250.00, not including travel expenses and membership dues, in any year, for the purpose of attempting to influence legislative or administrative action by communication or urging others to communicate with public officials;

(b) who spends more than $250.00, not including his own traveling expenses and membership dues, in any year, for the purpose of attempting to influence legislative or administrative action by communicating or urging others to communicate with public officials.

The statute provides certain exceptions. Questions should be directed to the Ethical Practices Board, 625 North Robert Street, St. Paul, Minnesota 55101, telephone 612-296-5148.

Kris Sanda, Commissioner
Department of Public Service

2-1-91
Dated

Department of Public Service

Proposed Permanent Rules Relating to Minnesota Energy Code

Rules as Proposed

GENERAL

7670.0100 AUTHORITY; SCOPE; APPLICABILITY.

Subpart 1. Authority. This chapter is adopted pursuant to Minnesota Statutes, section 216C.19, subdivision 8 ~~and constitute amendments to~~.

Subp. 2. Scope. Under Minnesota Statutes, section 216C.19, subdivision 8, this chapter is a part of the State Building Code, adopted according to Minnesota Statutes, sections 16B.59 to 16B.73. ~~In cases of conflict with the State Building Code, this chapter governs in all cases not affecting safety and health requirements.~~

~~Additionally, this chapter is intended to serve as standards for conducting maxi audits of existing buildings owned by the state, the University of Minnesota, cities, counties, and school districts as specified in Minnesota Statutes, section 216C.20.~~

Subp. 3. Applicability. Buildings covered by this chapter must comply with the Model Energy Code as amended by parts 7670.0260 to 7670.1000.

EXCEPTION: Relocated residential buildings need not comply with this chapter, except that, where available, an energy audit must be conducted on the relocated building.

7670.0125 LEGISLATIVE MANDATES CONCERNING MINNESOTA ENERGY CODE.

An enclosed structure or portion of an enclosed structure constructed after January 1, 1978, and used primarily as a commercial parking facility for three or more motor vehicles may not be heated. Incidental heating resulting from building exhaust air passing through a parking facility is not prohibited if substantially all useful heat previously has been removed from the air.

Approved by Revisor

EXCEPTION: Parking facilities that are appurtenant to dwelling unit occupancies.

7670.0130 ~~ADOPTION~~ INCORPORATIONS BY REFERENCE ~~OF THE MODEL ENERGY CODE WITH AMENDMENTS~~.

Subpart 1. Incorporated items. The following standards and references are incorporated by reference:

A. The Model Energy Code, ~~1983~~ 1989 Edition, as published by the Council of American Building Officials (Falls Church, Virginia), ~~is incorporated by reference and made a part of the State Building Code, subject to the amendments in this chapter~~ as amended by parts 7670.0260 to 7670.1000.

B. Code of Federal Regulations, title 10, part 435, Energy Conservation Voluntary Performance Standards for New Commercial and Multi-Family High Rise Residential Buildings; Mandatory for New Federal Buildings.

C. Code of Federal Regulations, title 10; part 430, National Appliance Energy Conservation Act of 1987.

D. LTGSTD, lighting prescriptive and system performance compliance calculation program, a computer program developed by Battelle Pacific Northwest Laboratories.

E. ANSI/ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings.

F. AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

G. ASTM C 236-87, Standard Test Method for Steady State Thermal Performance of Building Assemblies by means of a Guarded Hot Box.

H. ASTM C 976-82, Standard Test Method for Thermal Performance of Building Assemblies by means of a Calibrated Hot Box.

I. WINDOW, a computer program developed by the Windows and Daylighting Group at Lawrence Berkeley Laboratory.

Subp. 2. Availability. All standards and documents incorporated by reference are available for public inspection at

the Minnesota State Law Library and through the Minitex interlibrary loan system. In addition:

A. ASHRAE and ANSI/ASHRAE documents and standards are available from the American Society of Heating, Refrigerating and Air-Conditioning Engineers - Publication Sales, 1791 Tullie Circle NE, Atlanta, GA 30329;

B. AAMA standards are available from the American Architectural Manufacturers Association, 2700 River Road, Des Planes, IL 60018;

C. ASTM standards are available from ASTM, 1916 Race Street, Philadelphia, PA 19103; and

D. The WINDOW computer program is available from Bostik Construction Products, 1740 County Line, Huntington Valley, PA 19006.

7670.0260 MATERIALS AND EQUIPMENT.

Section 102 of the Model Energy Code is amended by adding a paragraph to read:

102.3 Thermal Insulation. Thermal insulation used in residential buildings three stories or less in height must conform to chapter 7640, Minnesota Thermal Insulation Standards, adopted by the Department of Public Service.

7670.0325 AMENDMENTS TO SECTION 201: DEFINITIONS.

Subpart 1. Thermal transmittance (U). In section 201 of the Model Energy Code, the definition of "Thermal transmittance (U)" is amended to read:

THERMAL TRANSMITTANCE (U). The coefficient of heat transmission (air to air). It is the time rate of heat flow per unit area and unit temperature differential between the warm side and cold side air films (Btu/h ft^2 F).

Thermal transmittance of opaque wall components (U_w) and roof/ceiling components (U_r) calculation methods are defined in the references indicated:

(1) Parallel heat flow method: Model Energy Code, chapter 5, equations 1 and 2, substituting the framing and insulated cavity components of the opaque wall or roof/ceiling

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for the elements designated by subscripts in these equations.

(2) Series-parallel method: Page 20.8 of Standard RS-1 listed in chapter 7.

(3) Parallel path correction factor method: Standard RS-24 listed in chapter 7.

(4) Thermal bridges in sheet metal construction method: Standard RS-25 listed in chapter 7.

(5) Zone method: Pages 22.10 and 22.11 of Standard RS-1 listed in chapter 7.

Subp. 2. **Vapor retarder.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

VAPOR RETARDER. A material to retard air and water vapor passage designed to meet a maximum perm rating of 1.0 grain per hour per ft^2 per inch Hg pressure differential. Polyethylene material that is not cross laminated which is used to meet the requirements of this paragraph must be designed to have a minimum thickness of four mills.

Subp. 3. **Wind wash.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

WIND WASH. Wind wash is the passage of unconditioned air through thermal insulation of the building envelope.

Subp. 4. **Window area.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

WINDOW AREA. Window area, or glazing area, is either the area of glazing and sash, or the area used by the manufacturer to determine the window thermal transmittance.

7670.0400 **AMENDMENT TO ~~302.1~~ SECTION 302: ~~FOOTNOTE 1~~ DESIGN CONDITIONS.**

~~On page 12 of the code,~~ Footnote 1 ~~to~~ of section 302.1 of the Model Energy Code is amended to read:

[1]~~The outdoor~~ exterior design temperature ~~shall~~ must be selected from the ~~columns of 99 percent values for winter and one percent values for summer from tables in Standard RS-1~~ "Design Conditions" columns shown in Table 302.1.

EXCEPTION: Where necessary to assure the prevention of

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damage to the building or to material and equipment within the building, the values listed in Table 302.1 under "extreme conditions" may be used.

TABLE 302.1 Exterior Design Temperatures

CITY	DESIGN CONDITIONS SUMMER DB/WB	DESIGN CONDITIONS WINTER DB	EXTREME CONDITIONS SUMMER DB/WB	EXTREME CONDITIONS WINTER DB
Albert Lea	87/72	-17	90/74	
Alexandria	88/72	-22	90/72	-28.0
Bemidji	85/69	-31	88/69	-36.9
Brainerd	87/71	-20	90/73	
Duluth	82/68	-21	85/70	-27.4
Faribault	88/72	-17	91/74	-24.3
Fergus Falls	88/72	-21	91/72	-27.8
International Falls	83/68	-29	85/68	-36.5
Mankato	88/72	-17	91/72	
Minneapolis	89/73	-16	92/75	-22.0
Rochester	87/72	-17	90/74	
St. Cloud	88/72	-15	91/74	
St. Paul	89/73	-16	92/75	-22.0
Virginia	83/68	-25	85/69	-33.0
Willmar	88/72	-15	91/74	-24.3
Winona	88/73	-14	91/75	

"DB" = dry bulb temperature, degrees Fahrenheit

"WB" = wet bulb temperature, degrees Fahrenheit

Heating degree days ~~heating shall~~ must be selected from Standard ~~RS-22~~ RS-23 listed in chapter 7. Adjustments may be made as determined by the building official to reflect local climates which differ from the tabulated temperatures or local weather experience ~~as determined by the building official~~.

7670.0450 AMENDMENT TO SECTION 303: VENTILATION.

Section 303.1 of the Model Energy Code is amended to read:

303.1 Ventilation. Ventilation systems must be designed to conform with Standard RS-3 listed in chapter 7.

7670.0470 AMENDMENT TO SECTION 502: ENVELOPE THERMAL TRANSMITTANCE.

Subpart 1. Section 502.2.1 of the Model Energy Code is amended by adding a paragraph to read:

502.1.4 Thermal transmittance of opaque wall components and roof/ceiling components. Thermal transmittance of opaque wall components (U_w) and roof/ceiling components (U_r) must be calculated using the following methods:

(1) Wood frame: Parallel heat flow method.

(2) Masonry blocks with insulation inserts or filled cores and other envelope assemblies containing nonmetal framing: Series-parallel method.

(3) Metal framing bonded on one or both sides to a metal skin or covering: Thermal bridges in sheet metal construction method.

(4) Nonmetal surface with metal framing:

(a) For elements identified in Standard RS-24 listed in chapter 7, the parallel path correction factor method.

(b) For elements not identified in Standard RS-24 listed in chapter 7, the zone method.

Subp. 2. Section 502.1 of the Model Energy Code is amended by adding a paragraph to read:

502.1.5 Thermal transmittance of window area and skylight elements. Thermal transmittance of window area (U_g) and skylight elements (U_s) must be determined in accordance with one of the following methods:

(1) Representative U-values for fenestration products, pages 27.16 to 27.18 of Standard RS-1 listed in chapter 7;

(2) Standard RS-26 listed in chapter 7;

(3) Standard RS-27 or RS-28 listed in chapter 7 using design conditions specified in footnote (a) of table 13, chapter 27 of Standard RS-1; or

(4) Standard RS-29 listed in chapter 7 using design conditions specified in footnote (a) of table 13, chapter 27 of Standard RS-1.

Subp. 3. Section 502.2.1 of the Model Energy Code is amended by adding a new section to read:

502.2.1.7 Alternative compliance. Alternative methods of compliance with sections 502.2.1.1, 502.2.1.2, and 502.2.1.3 for one- and two-family residential buildings.

Minimum performance for Type A-1 (one- and two-family) buildings:

Ceilings	Walls	Floors	Windows	Doors
R-38	R-20[1]	R-20[1]	Maximum U-0.49[2]	R-3

(1) For the insulated cavity of opaque walls, floors, and

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rim joists.

(2) Maximum window area must not exceed 12 percent of the area of exterior walls, not including foundation walls.

Site-built fixed glazing must be installed in either an aluminum or steel frame having a minimum 0.25 inch low conductance thermal break or in wood or vinyl framing. The glazing must be either double-glazed with a dead air space between panes of nominal one-half inch spacing or triple-glazed with a dead air space between panes of not less than one-fourth inch.

7670.0480 AMENDMENT TO SECTION 502: EFFECTIVENESS OF REQUIRED THERMAL INSULATION.

Section 502.2 of the Model Energy Code is amended by adding paragraphs to read:

502.2.1.8 Cold weather vapor condensation. Building assemblies are required to maintain the thermal performance of required insulation and the integrity of building materials against cold weather water vapor condensation.

502.2.1.8.1 Vapor retarder. A vapor retarder must be installed between the interior surface and the winter design condition dew point location within each building envelope surface. The vapor retarder must be continuous and joints in the vapor retarder must be sealed between solid blocking.

EXCEPTION: A vapor barrier need not be installed on the rim joist insulation.

502.2.1.8.2 Air leakage barrier. A barrier against air leakage must be installed to prevent the leakage of moisture-laden air from the house into the building envelope. An air barrier must be continuous at all plumbing and heating penetrations of interior surface of the building exterior envelope. If a tub or shower is located on an exterior wall, an air barrier must be provided at the interior surface of the building exterior envelope behind the tub or shower.

502.2.1.9 Preventing wind wash. A barrier must be provided at the following locations to mitigate wind wash:

A. the exterior edge of attic insulation; and

B. cantilevered floors and bay windows, including corners with adjoining vertical walls above and below.

7670.0500 AMENDMENT TO ~~502.2.1.4~~ SECTION 502: SLAB ON GRADE FLOORS.

~~On page 19 of the code,~~ Section 502.2.1.4 of the Model Energy Code is amended to read:

502.2.1.4 Slab on grade floors. For slab on grade floors, the thermal resistance of the insulation around the perimeter of the floor must be not less than the value given in Table No. ~~5-1~~ 502.2.1. The insulation must extend downward from the top of the slab to the design frost line or downward to the bottom of the slab then horizontally beneath the slab for an equivalent distance, and must be an approved type.

7670.0510 AMENDMENT TO ~~502.2.1~~ SECTION 502: FOUNDATION WALLS.

~~On page 19~~ Section 502.2.1.6 of the Model Energy Code~~,~~ ~~502.2.1~~ is amended ~~by adding a paragraph~~ to read:

502.2.1.6 Foundation walls. Foundation walls enclosing heated or conditioned spaces must be insulated.

Either the thermal resistance (R) of the insulation on the entire opaque foundation wall must be not less than R-5, or the thermal resistance (R) of the insulation on the opaque foundation wall must be not less than R-10 from the top of the wall down to the design frost line. If the top of the footing is at or above the design frost line, the thermal resistance (R) of the insulation on the wall must not be less than R-5 from the top of the wall to the top of the footing.

All insulation used in or on foundation walls must be approved for the intended use. The insulation must be installed in accordance with the approved manufacturer's specifications.

If the foundation wall insulation is on the exterior, the portion from the top of the foundation wall to six inches below grade must be covered by an approved protective coating finish to protect the insulation from deterioration due to sunlight and physical abuse.

7670.0550 AMENDMENT TO ~~502.4.3~~ SECTION 502: AIR LEAKAGE.

~~On page 23 of the code,~~ Subpart 1. Alternative. Section 502.4.3 of the Model Energy Code is amended by adding an exception as follows:

~~502.4.3.1 Exterior joints in the building envelope that are sources of air leakage, such as around window and door frames, between wall cavities and window or door frames, between walls and foundations, between walls and roofs or ceilings and between wall panels, openings at penetrations of utility services through walls, floors, and roofs, and all other similar openings in the building envelope must be caulked, gasketed, or otherwise sealed in an approved manner. A continuous air barrier must be provided at all electrical, mechanical, and plumbing penetrations.~~

EXCEPTION: As an alternative to the prescriptive requirements of section 502.4.3 for detached single-family residential buildings, air tightness must comply with air leakage class A, B, C, or D of Standard RS-30 listed in chapter 7. In addition, this alternative requires that the ventilation system must provide a ventilation rate of not less than 0.35 air changes per hour (determined in accordance with Standard RS-3, Table 2.3) or 15 cfm per person, whichever is greater. This ventilation rate must be verified by measurement. If this alternative is not chosen, this ventilation rate requirement applies only if required by Standard RS-3.

Subp. 2. **Fire stops.** Section 502 is amended by adding a section as follows:

502.4.4 Fire stops. Fire stops must be installed in accordance with the State Building Code. When mineral fiber or glass fiber materials are used as fire stop construction at ceilings and wall cavities separating conditioned and nonconditioned spaces, the fire stop must be installed to block air movement.

EXCEPTIONS: A fire stop need not block air movement if its installation would conflict with any other part of the State

Building Code.

7670.0610 ~~AMENDMENT~~ AMENDMENTS TO ~~503.2~~ SECTION 503: BUILDING MECHANICAL SYSTEMS.

~~On page 24~~ Subpart 1. Calculation procedures. Section 503.2.1 of the Model Energy code~~, 503.2~~ is amended ~~by adding a~~ paragraph to read:

~~503.2.3 System design heating and cooling capacity. The rated capacity of the heating and cooling system at design conditions may not be greater than 115 percent for heating, 100 percent for cooling at design output load calculated in accordance with 503.2, whenever appropriate equipment is available.~~

~~Exceptions: 1. Equipment designed for standby purposes.~~
~~2. Cooling capacity of heat pumps.~~
~~3. Systems designed for pick up after automatic temperature setback when a registered professional engineer shows that the extra system design heating and cooling capacity is needed for pick up.~~

503.2.1 Calculation procedures. Heating and cooling system design loads for the purpose of sizing systems and equipment must be determined in accordance with the procedures described in Standard RS-1 listed in chapter 7.

503.2.1.1 Safety factor. Design loads may at the designer's option be increased by as much as ten percent to account for unexpected loads or changes in space usage.

503.2.1.2 Pick-up loads. Transient loads such as warm-up or cool-down loads that occur after off-hour setback or shutoff may be calculated from principles based on the heat capacity of the building and its contents, the degree of setback, and desired recovery time; or may be assumed to be up to 30 percent for heating and ten percent for cooling of the steady-state design loads. The steady-state load may include a safety factor in accordance with section 503.2.1.1.

Subp. 2. System and equipment sizing. Section 503.2 of the Model Energy Code is amended by adding a paragraph to read:

503.2.3 System and equipment sizing. HVAC systems and equipment must be sized to provide no more than the space and

system loads calculated in accordance with 503.2.1.

Exceptions:

(a) Equipment capacity may exceed the design load if the equipment selected is the smallest size needed to meet the load within available options of the desired equipment line.

(b) Equipment whose capacity exceeds the design load may be specified if oversizing the equipment can be shown to not increase the overall annual energy costs.

(c) Stand-by equipment may be installed if controls and devices are provided that allow stand-by equipment to operate automatically only when the primary equipment is not operating.

(d) Multiple units of the same equipment type, such as multiple chillers and boilers, with combined capacities exceeding the design load may be specified to operate concurrently only if controls are provided that sequence or otherwise optimally control the operation of each unit based on load.

(e) For a single piece of equipment that has both heating and cooling capability, only one function, either the heating or the cooling, need meet the requirements of this section. Capacity for the other function must be, within available equipment options, the smallest size necessary to meet the load.

7670.0660 AMENDMENT TO ~~TABLE NO. 5-7~~ SECTION 503: EQUIPMENT EFFICIENCY.

Subpart 1. **Table No. 503.4.3.** Table No. 503.4.3 of the Model Energy Code "HVAC System Heating Equipment - Gas- and Oil-Fired Minimum Steady State Combustion Efficiency" is amended by changing the requirement for forced-air furnaces and low-pressure steam or hot-water boilers for all other commercial or industrial furnaces and boilers to 80 percent.

~~On page 29~~ Subp. 2. **Table No. 503.4.8.** Section 503 of the Model Energy Code~~, Table No. 5-7~~ is amended by adding a table to read:

Table No. ~~5-7~~ 503.4.8 -- Minimum EER and COP for Electrically Driven ~~HVAC System Components~~ Water Source Hydronic

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Heat Pumps[1]

Component	Type of Compressor	Condensing Means: Air EER	Air COP	Water EER	Water COP	Evaporative EER	Evaporative COP
Self-contained water-chillers	Centrifugal	8.00	2.34	13.00	4.04		
	Positive displacement	8.40	2.46	12.00	3.51		
Condenserless water-chillers	Positive displacement	9.90	2.9	12.00	3.51		
Compressor and condenser units 65,000 Btu/h (19,050 watts) and over[2]	Positive displacement	9.50	2.78	12.50	3.66	12.50	3.66

Water-Source Hydronic Heat Pump	Size	under 19 kW (65,000 Btu/h) EER	under 19 kW (65,000 Btu/h) COP	19 kW (65,000 Btu/h) and over EER	19 kW (65,000 Btu/h) and over COP
	Centrifugal	9.0	2.64	9.4	2.75
	EER	9.0		9.4	
	COP	2.64		2.75	

[1]When tested at the standard rating conditions specified in Table No. 5-10C 503.4.6a.

[2]Ratings in accordance with Standard RS-14 as applicable; COP based on condensing unit standard rating capacity and energy input to the unit, all at sea level.

Subp. 3. Efficiency requirements. HVAC system heating and cooling equipment regulated by the National Appliance Energy Conservation Act of 1987 must conform to the efficiency requirements of Standard RS-31 listed in chapter 7.

7670.0670 AMENDMENT TO 503.10.2 SECTION 503.10: DUCT CONSTRUCTION.

On page 33 of the code, Section 503.10.2 of the Model Energy Code is amended to read:

503.10.2. For low pressure supply and return air ducts located outside of the conditioned space, all transverse joints must be sealed using mastic, tape, or mastic plus and tape. For fibrous glass ductwork, pressure sensitive tape may be used.

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7670.0710 ~~DELETION OF 504.5.3~~ AMENDMENTS TO SECTION 504: SERVICE WATER HEATING.

~~On page 38~~ Subpart 1. Time clocks. Section 504.5 of the Model Energy Code~~, 504.5.3~~ is ~~deleted~~ amended by deleting section 504.5.3.

Subp. 2. **Pipe insulation.** Section 504.7 of the Model Energy Code is amended by deleting the exception.

Subp. 3. **Devices to limit temperature.** Section 504.8.2 of the Model Energy Code is amended by deleting section 504.8.2.2.

Subp. 4. **Efficiency requirements.** Service water heating equipment regulated by the National Appliance Energy Conservation Act of 1987 must conform to the efficiency requirements of Standard RS-31 listed in chapter 7.

7670.0800 ~~AMENDMENT OF 505.2~~ AMENDMENTS TO SECTION 505: ELECTRIC POWER AND LIGHTING.

~~On page 39~~ Subpart 1. **Electric energy determination.** The exception to section 505.2 of the Model Energy Code~~, 505.2~~ is amended to read:

~~505.2 Electric energy determination.~~

~~In any multi-tenant residential building, provisions shall be made to separately determine the electric energy consumed by each tenant. Electrical service to individual dwelling units in buildings containing two or more units shall be separately metered, with individual metering readily accessible to the individual occupants.~~

EXCEPTION: Motels, hotels, college dormitories, other transient facilities, and buildings intended for occupancy primarily by persons who are 62 years of age or older or handicapped, or which contain a majority of units not equipped with complete kitchen facilities.

Subp. 2. **Lighting power budget.** The lighting requirements of sections 505.3 and 505.4 of the Model Energy Code are amended to read:

The lighting power budget must be the upper limit of the power to provide the lighting needs in accordance with the 1988

and 1989 criteria and calculation procedure specified in Standard RS-32 listed in chapter 7 (excluding section 3.2, referencing equation 3.4-1 in section 3.1.6.2, and correcting the units of Interior Lighting Power Allowance in equation 3.5-3 to Watts), or using Standard RS-33 listed in chapter 7.

EXCEPTION: One- and two-family detached dwellings and the dwelling portion of multifamily buildings.

7670.0850 **AMENDMENT TO SECTION 600: DESIGN BY ACCEPTABLE PRACTICE.**

Section 601.1 of the Model Energy Code is amended by adding a paragraph to read:

Buildings constructed in accordance with this section must also comply with parts 7670.0470 to 7670.0800 as indicated below:

Model Energy Code	Minnesota Rules Part
602.2	7670.0470, 7670.0480
602.2.4	7670.0500
602.2.6	7670.0510
602.3.2	7670.0550
603.1	7670.0610
603.2.1	7670.0660
603.4	7670.0670
604	7670.0710
605	7670.0800

7670.1000 ~~AMENDMENT~~ AMENDMENTS TO ~~701.1~~ SECTION 701: STANDARDS.

~~On page 54 of the code,~~ Section 701~~/17 Code Standard No. RS-4,~~ of the Model Energy Code is amended by replacing and adding the following code standard numbers to read:

A. RS-1, 1989 ASHRAE Handbook of Fundamentals.

B. RS-3, ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality.

C. RS-4, ASHRAE Standard 55-1981 Thermal Environment Conditions for Human Occupancy.

D. RS-17 and RS-18, SMACNA HVAC Duct Construction Standards: Metal and Flexible, First Edition, 1985.

E. RS-23, Monthly Normals of Temperature, Precipitation, andHeating and Cooling Degree Days 1951-80 Minnesota. National Oceanic and Atmospheric Administration September 1982.

F. RS-24, Code of Federal Regulations, title 10, part 435.105, section 5.3.3.2.1(b), Calculation procedures for parallel path correction factor method.

G. RS-25, Code of Federal Regulations, title 10, part 435.105, section 5.3.3.2.1(d), Calculation procedures for thermal bridges in Sheet Metal Construction.

H. RS-26, AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation of Windows, Doors and Glazed Wall Sections.

I. RS-27, ASTM C 236-87, Standard Test Method for Steady State Performance of Building Assemblies by means of a Guarded Hot Box.

J. RS-28, ASTM C 976-82, Standard Test Method for Steady State Performance of Building Assemblies by means of a Calibrated Hot Box.

K. RS-29, WINDOW computer program.

L. RS-30, ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings.

M. RS-31, Code of Federal Regulations, title 10, part 430.32, Energy Conservation Standards.

N. RS-32, Code of Federal Regulations, title 10, part 435.103, lighting.

O. RS-33, LTGSTD, lighting prescriptive and system performance compliance calculation program.

REPEALER. Minnesota Rules, parts 7670.0110; 7670.0120; 7670.0200; 7670.0210; 7670.0220; 7670.0300; 7670.0310; 7670.0320; 7670.0330; 7670.0340; 7670.0520; 7670.0540; 7670.0600; 7670.0620; 7670.0630; 7670.0640; 7670.0650; 7670.0700; 7670.0720; 7670.0730; 7670.0900; 7670.0910; 7670.0920; 7670.0930; 7670.0940; 7670.0950; 7670.0960; 7670.0970; 7670.1010; 7670.1020; 7670.1030; 7670.1100; and 7670.1110 are repealed.

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Office of the Revisor of Statutes

Administrative Rules

TITLE: Proposed Permanent Rules Relating to Minnesota Energy Code

AGENCY: Department of Public Service

MINNESOTA RULES: Chapter 7670

INCORPORATIONS BY REFERENCE:

Part 7670.0130: Model Energy Code, 1989 Edition, published by Council of American Building Officials, Falls Church, Virginia, as amended by parts 7670.0260 to 7670.1000; LTGSTD, lighting prescriptive and system performance compliance calculation program, a computer program developed by Battelle Pacific Northwest Laboratories; ANSI/ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings; AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; ASTM C 236-87, Standard Test Method for Steady State Thermal Performance of Building Assemblies by means of a Guarded Hot Box; ASTM C 976-82, Standard Test Method for Thermal Performance of Building Assemblies by means of a Calibrated Hot Box; WINDOW, a computer program developed by the Windows and Daylighting Group at Lawrence Berkeley Laboratory. Available at Minnesota State Law Library and through Minitex interlibrary loan system.

The attached rules are approved for publication in the State Register

Craig E. Lindeke
Senior Assistant Revisor

STATE OF MINNESOTA
DEPARTMENT OF PUBLIC SERVICE

In the Matter of the Proposed Amendments to Rules of the Minnesota Department of Public Service Amending the State Building Code Regarding Heat Loss, Illumination and Climate Control, (Minn. Rules Ch. 7670)

AFFIDAVIT OF CERTIFICATION OF MAILING LIST FOR NOTICE OF INTENT TO ADOPT A RULE WITHOUT A PUBLIC HEARING AND NOTICE OF INTENT TO ADOPT A RULE WITH A PUBLIC HEARING IF TWENTY-FIVE OR MORE PERSONS REQUEST A HEARING

STATE OF MINNESOTA)
) ss.
COUNTY OF RAMSEY)

Judith Schmidt, being first duly sworn deposes and says:

I hereby certify that the list of persons and associations who have requested, pursuant to Minnesota Statutes, sections 14.14, subdivision 1a and 14.22 or 14.30, that their names be placed on the state Department of Public Service, Energy Division, rulemaking mailing list is accurate, complete, and current as of this 13th day of February, 1991.

Judith Schmidt
(name)

Data Processing Coordinator
(title)

Subscribed and sworn to before me
this 13th day of FEBRUARY, 1991.

Dennis M. Devereaux
Notary Public

DENNIS M. DEVEREAUX
NOTARY PUBLIC-MINNESOTA
RAMSEY COUNTY
My Comm. Expires Apr. 1, 1994

<<<< R U L E S >>>>

People receiving information on rule changes

Company / Person	Street / City, State, Zip	Code
DAVID DURENBERGER	RUSSELL BLDG-RM 154 WASHINGTON, DC 20510	MCD
WILLIAM FRENZEL	LONGWORTH OFFICE BLDG-RM 1026 WASHINGTON, DC 20515	MCD
MICHAEL JOHNSON	117 FIFTH ST W - BOX 95 BLUE EARTH, MN 56013	RULES
RALPH T KEYES	2240 MIDLAND GRV RD ST PAUL, MN 55113	RULES
JAMES L OBERSTAR	RAYBURN OFFICE BLDG-RM 2351 WASHINGTON, DC 20515	MCD
RONALD E OLSON	5416 70TH ST W EDINA, MN 55435	RULES
TIMOTHY PENNY	CANNON OFFICE BLDG-RM 436 WASHINGTON, DC 20515	MCD
ALFRED J ROSS	6356 WARE RD LINO LAKES, MN 55014	RULES
MARTIN O SABO	RAYBURN OFFICE BLDG. - RM 2201 WASHINGTON, DC 20515	MCD
ARLAN STANGELAND	RAYBURN OFFICE BLDG. - RM 2245 WASHINGTON, DC 20515	MCD
BRUCE F VENTO	RAYBURN OFFICE BLDG. - RM 2304 WASHINGTON, DC 20515	MCD
VIN WEBER	CANNON OFFICE BLDG. - RM 106 WASHINGTON, DC 20515	MCD
PAUL WELLSTONE	HART STATE OFFICE BLDG-RM SH506 WASHINGTON, DC 20510	MCD
ADMIN HEARING OFFICE SAM RUHLE	310 FOURTH AVE - RM 400 MINNEAPOLIS, MN 55415	RULES
ALABAMA DEPT OF ENERGY & COMM AFFR THOMAS HOLMES	3465 NORMAN BRIDGE RD PO BOX 250347 MONTGOMERY, AL 36125	SEO
ALASKA ENERGY OFFICE	949 E. 36TH AVE - RM 400 ANCHORAGE, AK 99508	SEO

<<<< R U L E S >>>>

People receiving information on rule changes

Company / Person	Street / City, State, Zip	Code
ARIZONA ENERGY OFFICE MARK GINSBERG	1700 WASHINGTON ST W PHOENIX, AZ 85007	SEO
ARKANSAS ENERGY OFFICE-ECON PLAN	1 CAPITOL MALL-RM 2C 105 LITTLE ROCK, AR 72201	SEO
BEMIDJI CHAMBER OF COMMERCE	BOX 850 BEMIDJI, MN 56601	RULES
BRAINERD WATER & LIGHT DEPT WALTER C SJOLUND	501 LAUREL ST-BOX 373 BRAINERD, MN 56401	RULES
BROEKER GEER LMTD. JOHN M BROEKER	8500 NORMANDALE LK BLVD #1510 MINNEAPOLIS, MN 55437	RULES
CALIFORNIA ENERGY COMMISSION	1516 NINTH ST SACRAMENTO, CA 95814	SEO
CARLTON COUNTY HUMAN SERVICES WILLIAM K. PINSONNAULT	BOX 316, 1215 AVENUE C CLOQUET, MN 55720	RULES
CITY OF BELLE PLAINE DAVID J UNMACHT	420 MAIN ST E BELLE PLAINE, MN 56011	RULES
CITY OF CIRCLE PINES JAMES KEINATH	200 CIVIC HEIGHTS CIRCLE CIRCLE PINES, MN 55014	RULES
CLOQUET CITY OF WILLIAM SCHLENVOGT	508 CLOQUET AVE CLOQUET, MN 55720	RULES
COLORADA OFFICE OF ENERGY CONSERV ROLAND RIVERA	112 14TH AVE E DENVER, CO 80203	SEO
COLUMBIA DIST OF ENERGY UNIT	613 G ST. N.W. WASHINGTON, DC 20001	SEO
CONNECTICUT ENERGY DIVISION BRADFORD S. CHASE	80 WASHINGTON ST HARTFORD, CT 06106	SEO
COOPERATIVE POWER ASSN ROBERT P AMBROSE	14615 LONE OAK RD EDEN PRAIRIE, MN 55344	RULES
COOPERATIVE POWER ASSN ADE MUSSELL	14615 LONE OAK ROAD EDEN PRAIRE, MN 55344	RULES
COTTONWOOD CO OFFICES FARLEY GRUNIG	COURTHOUSE WINDOM, MN 56101	RULES

<<<< R U L E S >>>>

People receiving information on rule changes

Company / Person	Street / City, State, Zip	Code
DAIRYLAND POWER COOPERATIVE ALBERT D DIAL	BOX 817 LACROSSE, WI 54602	RULES
DELAWARE ENERGY OFFICE	FEDERAL ST-BOX 1401 DOVER, DE 19903	SEO
DONOVAN CO INC JAMES A SMITH	100 OWASSO BLVD E ST PAUL, MN 55117	RULES
DORSEY AND WHITNEY BECKY A COMSTOCK	220 SIXTH ST S-RM 2300 MINNEAPOLIS, MN 55402	RULES
DORSEY AND WHITNEY WILLIAM J. KEPPEL	2200 FIRST BANK PL E MINNEAPOLIS, MN 55402	RULES
E W A INC	133 FIRST AVE NORTH MINNEAPOLIS, MN 55401	RULES
ENERGY PROGRAM DEPT OF CONS AFFAIRS NELSON ESPINELL	PO BOX 41059-MINILLAS STATION SANTRUCE, PR 00940	SEO
ENERGY RESOURCE CENTER VALDI STEFANSON	427 ST CLAIR AVE ST PAUL, MN 55102	RULES
FARIBAULT AREA CHAMBER OF COMMERCE ELAINE KENOW	228 CENTRAL AVE -- P. O. BOX 434 FARIBAULT, MN 55021	RULES
FLORIDA ENERGY OFFICE	BRYANT BLDG-RM 301 TALLAHASEE, FL 32301	SEO
FRIDLEY CITY OF JIM ROBINSON	6431 UNIVERSITY AVE NE FRIDLEY, MN 55432	RULES
GEO. A. HORMEL & CO DOUGLAS D. HAHN, P.E.	BOX 800 AUSTIN, MN 55912	RULES
GEORGIA OFFICE OF ENERGY RESOURCES	270 WASHINGTON ST SW-STE 615 ATLANTA, GA 30334	SEO
GUAM ENERGY OFFICE	BOX 2950 AGANA, GM 96910	SEO
HASTINGS CITY OF THOMAS HARMENING	100 SIBLEY ST HASTINGS, MN 55033	RULES
HAWAII ENERGY OFFICE	335 MERCHANT ST. RM 110 HONOLULU, HI 96813	SEO

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People receiving information on rule changes

Company / Person	Street / City, State, Zip	Code
HENN CNTY ENVIRONMENT & ENERGY OFF BEN KERMMOADE	822 SOUTH 3RD ST. SUITE 300 MINNEAPOLIS, MN 55415	RULES
HENN CNTY ENVIRONMENT & ENERGY OFF LUTHER D. NELSON	822 SOUTH 3RD ST. SUITE 300 MINNEAPOLIS, MN 55415	RULES
HENNEPIN CO PROPERTY MANAGEMENT JOHN G MCMILLAN	HENN CNTY GOVT CNTR.BLDG OFC-A LEVL MINNEAPOLIS, MN 55487	RULES
HESSIAN, MCKABY AND SODERBERG JEROME M. SODERBERG	4700 IDS Center Minneapolis, MN 55402	RULES
HONEYWELL INC W C VIITALA	HONEYWELL PLAZA-BOX 524 MINNEAPOLIS, MN 55440	RULES
IDAHO OFFICE OF ENERGY	450 STATE ST. W BOISE, ID 83720	SEO
ILLINOIS INST OF NAT RESOURCES	325 ADAMS ST W-RM 300 SPRINGFIELD, IL 62704	SEO
INDIANA ENERGY OFFICE	1 CAPITOL ST N-STE 700 INDIANAPOLIS, IN 46204	SEO
IOWA DEPT OF NATURAL RESOURCES ENERGY BUREAU	WALLACE STATE OFFICE BLDG DES MOINES, IA 50319	SEO
KANSAS CORP COMM-RESEARCH & ENERGY	STATE OFFICE BLDG-FOURTH FLR TOPEKA, KS 66612	SEO
KENTUCKY ENERGY CABINET LANA ROGERS	P.O. BOX 3249 FRANKFORT, KY 40603	SEO
LAKE SUPERIOR INDUSTRIAL BUREAU ALFRED E FRANCE	306 SUPERIOR ST W-#1408 ALWORTH DULUTH, MN 55802	RULES
LEFEVERE AND LEFLER JOHN E DRAWZ	2000 FIRST BANK PLACE WEST MINNEAPOLIS, MN 55402	RULES
LEHMANN & ASSOC INC ERNEST K LEHMANN	430 FIRST AVE N. - RM 790 MINNEAPOLIS, MN 55401	RULES
LEVANDER GILLEN MILLER & MAGNUSON ROGER C MILLER	633 CONCORD ST-RM 402-BOX 298 S ST PAUL, MN 55075	RULES
LINDBERG ASSOCIATES CLARENCE P LINDBERG	750 PLAZA DR S MENDOTA HTS, MN 55120	RULES

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People receiving information on rule changes

Company / Person	Street / City, State, Zip	Code
LOUISIANA DEPT OF NAT RESOURCES	BOX 94396 BATON ROUGE, LA 70804	SEO
LUVERNE CITY OF STEVEN L. PERKINS	203 MAIN ST E - BOX 348 LUVERNE, MN 56156	RULES
LYMAN LUMBER CO JUDITH A. JANICKE	300 MORSE AVE - BOX 40 EXCELSIOR, MN 55331	RULES
MAINE OFFICE OF ENERGY RESOURCES	STATE HOUSE-STN 53 AUGUSTA, ME 04333	SEO
MANKATO AREA CHAMBER OF COMMERCE	BOX 999 MANKATO, MN 56002	RULES
MARYLAND ENERGY OFFICE JAN SHOREY	45 CALVERT ST. ANNAPOLIS, MD 21401	SEO
MASSACHUSETTS ENERGY POLICY OFFICE	100 CAMBRIDGE ST-RM 1500 BOSTON, MA 02202	SEO
MICHIGAN ENERGY ADMINISTRATION	BOX 30228 LANSING, MI 48909	SEO
MINN ASSN OF TOWNSHIPS DAVID FRICKE	BOX 267 - 705 CENTRAL AVE. E. ST MICHAEL, MN 55376	RULES
MINN ATTORNEY GEN OFC-ANTITRUST DIV THOMAS F PURSELL	117 UNIV AVE - SECOND FLR ST PAUL, MN 55155	RULES
MINN AUTO DEALERS ASSN LOUIS W CLAESON JR	277 UNIVERSITY AVE ST PAUL, MN 55103	RULES
MINN COOPERATIVES ASSN OF ALLEN GERBER	480 CEDAR ST - RM 580 ST PAUL, MN 55101	RULES
MINN GOVERMENT REPORT JEAN DAWSON	STATE CAPITAL BLDG - PRESS RM B2 ST PAUL, MN 55155	RULES
MINN HOUSING FINANCE AGENCY HEIDE E. WHITNEY	400 SIBLEY ST - STE 300 ST PAUL, MN 55101	RULES
MINN LEGIS COMM TO REVIEW ADMIN RUL MARYANNE V HRUBY	STATE OFFICE BLDG - RM 55 ST PAUL, MN 55155	RULES
MINN MULTI HOUSING ASSN JOHN HORNER	4740 PARK GLEN RD MINNEAPOLIS, MN 55416	RULES

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People receiving information on rule changes

Company / Person	Street / City, State, Zip	Code
MINN PETROLEUM COUNCIL DARREL BUNGE	350 ST. PETER ST. - RM 1025 ST PAUL, MN 55102	RULES
MINN POLLUTION CONTROL AGENCY Gerald Willet	520 LAFAYETTE RD. N. ST. PAUL, MN 55155	RULES
MINN POWER CO ELAINE DEBEIR	30 SUPERIOR ST W DULUTH, MN 55802	RULES
MINN POWER CO JAMES A ROBERTS	30 SUPERIOR ST W DULUTH, MN 55802	RULES
MINN STATE UNIV SYSTEM MARY E STANTON	555 PARK ST-STE 230 ST PAUL, MN 55105	RULES
MINNEGASCO TRACY BRIDGE	201 SEVENTH ST S MINNEAPOLIS, MN 55402	RULES
MINNEGASCO INC. GEORGE H. LOFGREN	P.O. BOX 1165 MINNEAPOLIS, MN 55440	RULES
MINNESOTA SENATE DONALD J FRANK	STATE CAPITOL BLDG-RM G10 ST PAUL, MN 55155	RULES
MISSISSIPPI DEPT OF ENERGY	510 GEORGE ST-STE 300 JACKSON, MS 39202	SEO
MISSOURI DIV OF ENERGY	BOX 176 JEFFERSON CITY, MO 65102	SEO
MONTANA ENERGY DIV	1520 E. 6TH AVE HELENA, MT 59620	SEO
MONTEVIDEO CITY OF A.J. JOHNSON	BOX 676 MONTEVIDEO, MN 56265	RULES
MONTICELLO CITY OF	250 BROADWAY ST E MONTICELLO, MN 55362	RULES
MPLS BLDG OWNERS & MGRS ASSN INC. ARTHUR W OLOFSON	927 SOO LINE BLDG-105 5TH ST S. MINNEAPOLIS, MN 55402	RULES
NEBRASKA ENERGY OFFICE ANN BROCKHOFF	BOX 95085 LINCOLN, NB 68509	SEO
NEVADA COMM SERVICES-ENERGY OFFICE	1100 WILLIAM ST E RM 117 CARSON CITY, NV 89710	SEO

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People receiving information on rule changes

Company / Person	Street / City, State, Zip	Code
NEW HAMPSHIRE GOV COUNCIL ON ENERGY MALTZIE SCOTT	2 1/2 BEACON ST CONCORD, NH 03301	SEO
NEW JERSEY DEPT OF COMM & ECON DEV ROBERT J. GOLDEN JR.	101 COMMERCE ST RM 204 NEWARK, NJ 07102	SEO
NEW MEXICO DEPT OF ENERGY &MINERALS	2040 PACHECO ST SANTA FE, NM 87505	SEO
NEW YORK STATE ENERGY OFFICE CHARLES STUBER	2 ROCKEFELLER PLAZA-10TH FLR ALBANY, NY 12223	SEO
NORTH CAROLINA ENERGY DIV	BOX 25249 RALEIGH, NC 27611	SEO
NORTH DAKOTA OFFICE OF ENERGY	STATE CAPITOL BLDG-14TH FL BISMARCK, ND 58505	SEO
NORTH MARIANA ISLANDS ENERGY PLANNR	P.O. BOX 340 SAIPAN, MR 96950	SEO
NORTHERN PRODUCTS LOG HOMES, INC. Allison T. Beaulieu	P.O. BOX 616 BANGOR, ME 04401	RULES
NORTHERN STATES POWER C. GARY ANDERSON	414 NICOLLET MALL MINNEAPOLIS, MN 55401	RULES
NORTHERN STATES POWER - LAW DEPT. JOSEPH D. BIZZANO JR.	414 NICOLLET MALL MINNEAPOLIS, MN 55401	RULES
NORTHERN STATES POWER CO KEITH H WIETECKI	414 NICOLLET MALL MINNEAPOLIS, MN 55401	RULES
NORTHERN SUN ALLIANCE JOAN VANHALA	1519 FRANKLIN AVE E MINNEAPOLIS, MN 55404	RULES
OHIO DEPT OF ENERGY	30 BROAD ST E-24TH FLOOR COLUMBUS, OH 43266	SEO
OKLAHOMA DEPT OF ENERGY	2101 N. LINCOLN BLVD. OKLAHOMA CITY, OK 73105	SEO
OREGON DEPT OF ENERGY	625 MARION ST NE SALEM, OR 97310	SEO
OWATONNA PUBLIC UTILITIES DAVID M. MARTIN	P.O. BOX 800 OWATONNA, MN 55060	RULES

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People receiving information on rule changes

Company / Person	Street / City, State, Zip	Code
PEPIN DAYTON HERMAN JOHN H HERMAN	150 FIFTH ST-STE 2300 MINNEAPOLIS, MN 55402	RULES
PHILLIPS LEGISLATIVE SERVICE INC WILLIAM L PHILLIPS	459 RICE ST - 3RD FLOOR ST PAUL, MN 55103	RULES
POPHAM HAIK LAW FIRM ROBERT S BURK	3300 PIPER JAFFERY TOWER MINNEAPOLIS, MN 55402	RULES
Q S S INC CHARLES KROEGER	BOX 838 FARIBAULT, MN 55021	RULES
REGION FIVE REG DEVEL COMM DAVE WEIRENS	611 IOWA AVE STAPLES, MN 56479	RULES
RHODE ISLAND ENERGY OFFICE	275 WESTMINISTER MALL PROVIDENCE, RI 02903	SEO
RICHFIELD CITY OF BRUCE NORDQUIST	6700 PORTLAND AVE S RICHFIELD, MN 55423	RULES
SAAG CHRISTOPHER K. SANDBERG	BREMER TOWER-RM 1100 ST PAUL, MN 55101	RULES
SAMOA ENERGY OFFICE MATT Le'i	TERRITORIAL ENERGY OFFICE PAGO PAGO, SM 96799	SEO
SIERRA CLUB	1313 - 5TH ST. S.E. RM 323 MINNEAPOLIS, MN 55414	RULES
SMITH ARCHITECTURE & PLANNING RALPH SMITH	117 GLENWOOD AVE SUITE #204 RALEIGH, NC 27603	
SOUTH CAROLINA ENERGY OFFICE	1201 MAIN ST #1710 COLUMBIA, SC 29201	SEO
SOUTH DAKOTA OFFICE-ENERGY POLICY STEVE WEGMAN	217 1/2 W. MISSOURI PIERRE, SD 57501	SEO
ST CLOUD AREA CHAMBER OF COMMERCE THOMAS MOORE	26 N. SIXTH AVE ST CLOUD, MN 56302	RULES
ST LOUIS CO PLANNING & ZONING OFF MARK JOHNSON	COURTHOUSE DULUTH, MN 55802	RULES
ST PAUL CITY OF JAN GAFTERLAND	445 CITY HALL ST PAUL, MN 55102	RULES

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People receiving information on rule changes

Company / Person	Street / City, State, Zip	Code
STATE GOVERNMENT AFFAIRS 3M CO WILLIAM J. LANGLOIS	BLDG 225-5N-04 3M CENTER ST PAUL, MN 55144	RULES
TENNESSEE ENERGY OFFICE	320 - 6TH AVE. N. NASHVILLE, TN 37219	SEO
TEXAS ENERGY OFFICE	1700 NO. CONGRESS AVE SUITE 640 AUSTIN, TX 78701	SEO
THE ENERGY CONSERVATORY ROBERT NEVITT	5158 BLOOOMINGTON AVE S MINNEAPOLIS, MN 55417	RULES
TRI COUNTY COMM ACTION PROG MARK G SEXTON	404 SECOND AVE NE LITTLE FALLS, MN 56345	RULES
U OF M ROBERT W SNYDER	1994 BUFORD AVE-RM 248COB ST PAUL, MN 55108	RULES
U S DEPT OF INTERIOR-FISH &WILDLIFE ROBERT F. WELFORD	400 SIBLEY ST-STE 50 ST PAUL, MN 55101	RULES
U.S. HOUSE OF REPRESENTATIVES GERRY SIKORSKI	CANNON OFFICE BLDG-RM 414 WASHINGTON, DC 20515	MCD
UNITED POWER ASSN BRUCE HAUSCHULZ	HIGHWAY 10 ELK RIVER, MN 55330	RULES
UNITED POWER ASSN REYNOLD S RAHKO	HWY 10 E ELK RIVER, MN 55330	RULES
UNOCAL CORP DAVE HENDERSON	1650 GOLF RD E SCHAUMBURG, IL 60196	RULES
UPPER MINN VALLEY REG DEVEL COMM OTTO SCHMID	323 SCHLIEMAN AVE W APPLETON, MN 56208	RULES
UTAH ENERGY OFFICE - 3 TRAID CENTER MICHAEL JOHNSON	355 WEST NORTH TEMPLE - Room 450 SALT LAKE CITY, UT 84180	SEO
VERMONT STATE ENERGY OFFICE	STATE OFFICE BLDG MONTPELIER, VT 05602	SEO
VIRGIN ISLANDS ENERGY OFFICE	BOX 2996 ST THOMAS, VI 00801	SEO
VIRGINIA ENERGY OFFICE JENNIFER SNEAD	2201 W. BROAD ST. RICHMOND, VA 23220	SEO

<<<< R U L E S >>>>

People receiving information on rule changes

Company / Person	Street / City, State, Zip	Code
WALDORF CORP GARY KAZUIKEWICA	2250 WABASHA ST ST PAUL, MN 55114	RULES
WASHINGTON CO HRA SAM GRIFFITH	455 BROADWAY AVE ST PAUL PK, MN 55071	RULES
WASHINGTON STATE ENERGY OFFICE	400 UNION ST E-FIRST FL OLYMPIA, WA 98504	SEO
WINTHROP AND WEINSTINE JOHN A KNAPP	30 E 7TH ST #3200 WLD TRD CTR ST PAUL, MN 55101	RULES
WISCONSIN STATE PLANNING&ENERGY DIV	BOX 7868 MADISON, WI 53707	SEO
WYOMING ENERGY CONSERVATION OFFICE	2301 CENTRAL AVE CHEYENNE, WY 82002	SEO
YAGGY, COLBY ASSOCIATES	717 THIRD AVE SE BOX 7038 ROCHESTER, MN 55903	RULES
ZENK, READ, TYPSTAD & ASSOC. LARRY A READ	BOX 689-OLD HIGHWAY 65 N. ALBERT LEA, MN 56007	RULES

STATE OF MINNESOTA
DEPARTMENT OF PUBLIC SERVICE

In the Matter of the Proposed Amendments to Rules of the Minnesota Department of Public Service Amending the State Building Code Regarding Heat Loss, Illumination and Climate Control, Minn. Rules Ch. 7670

AFFIDAVIT OF MAILING THE NOTICE OF INTENT TO ADOPT A RULE WITHOUT A PUBLIC HEARING AND NOTICE OF INTENT TO ADOPT A RULE WITH A PUBLIC HEARING IF TWENTY-FIVE OR MORE PERSONS REQUEST A HEARING

STATE OF MINNESOTA)
) ss.
COUNTY OF RAMSEY)

Marlene Odeen, being first duly sworn deposes and says:

I hereby certify that on the 14 day of February, 1991, at the City of St. Paul, County of Ramsey, State of Minnesota, I mailed the attached Notice of Intent to Adopt a Rule Without a Public Hearing and Notice of Intent to Adopt a Rule with a Public Hearing if Twenty-five or More Persons Request a Hearing by depositing in the State of Minnesota Central Mail System, a copy thereof, with postage prepaid, to all persons and associations who have requested, pursuant to Minnesota Statutes, sections 14.14, subdivision 1a and 14.22 or 14.30, that their names be placed on the state Department of Public Service, Energy Division, rulemaking mailing list.

Marlene Odeen
(name)

Secretary
(title)

Subscribed and sworn to before me this 14th day of February, 1991.

Dennis M. Devereaux
Notary Public

DENNIS M. DEVEREAUX
NOTARY PUBLIC-MINNESOTA
RAMSEY COUNTY
My Comm. Expires Apr. 1, 1994

DEPARTMENT OF PUBLIC SERVICE
ENERGY DIVISION

Proposed Permanent Rules Amending the Minnesota State Building Code Regarding Heat Loss, Illumination and Climate Control

Notice of Intent to Amend a Rule Without a Public Hearing and Notice of Intent to Adopt a Rule With a Public Hearing if Twenty-Five or More Persons Request a Hearing

Notice is hereby given that the Minnesota Department of Public Service intends to adopt amendments to Minnesota Rules Chapter 7670, without a public hearing following the procedures set forth in the Minnesota Statutes, sections 14.22 to 14.28. Authority for the adoption of these rules is contained in Minnesota Statutes, section 216C.19, subdivision 8.

All persons have 30 days in which to submit comment in support of or in opposition to any part or subpart of the proposed amendments. Comment is encouraged. Each comment should identify the proposed amendment addressed, the reason for the comment, and any change proposed.

All persons may make a written request for a public hearing on the proposed amendments within the 30-day comment period. If 25 or more persons submit a written request for a public hearing within the 30-day comment period, a public hearing will be held unless a sufficient number withdraw their requests in writing. Any person requesting a public hearing must state his or her name and address and is encouraged to identify the portion of the proposed amendment addressed, the reason for the request, and any change proposed. If a public hearing is required, the agency will proceed pursuant to Minnesota Statutes, sections 14.131 to 14.20.

These rules were previously published in 15 S.R. 828 (October 1, 1990) and mailed on September 25, 1990. However, significant amendments are being proposed, so the rule is being re-noticed with a new comment period. If you requested a hearing in the previous rulemaking proceeding, and still desire a hearing on these rules, you must submit another request during this comment period.

PLEASE NOTE: that if twenty five or more persons submit written requests for a public hearing within the 30 day comment period, a public hearing will be held on March 29, 1991 unless a sufficient number withdraw their requests in accordance with the notice of hearing on these rules published in the STATE REGISTER and mailed to persons registered with the Department of Public Service. To verify whether a hearing will be held, please call the Department of Public Service, Energy Information Center on March 22, 1991 between the hours on 8:00 a.m. and 4:15 p.m. at 296-5175 or Minnesota toll free 800-652-9747 (ask for "Energy").

Comments or written requests for a public hearing must be submitted to:

Bruce Nelson, Senior Engineer
Department of Public Service, Energy Division
790 American Center Building
150 East Kellogg Boulevard
St. Paul, MN 55101
phone (612) 297-2313 fax (612) 297-1959.

The proposed amendments may be modified if the modifications are supported by the data and views submitted to the Department and do not result in a substantial change in the proposed amendments as noticed.

A Copy of the proposed rule amendment is attached to this notice.

A Statement of Need and Reasonableness that describes the need for and reasonableness of each provision of the proposed amendments and identifies the data and information relied upon to support the proposed amendments has been prepared and is available by requesting a copy from Mr. Nelson at the address listed above.

The adoption of these rules will not result in additional spending by local bodies of government in excess of $100,000 per year in either of the first two years following their adoption.

Minnesota Statue § 14.115, subdivision 2 (1988) requires the department, when proposing rules which may affect small business, to consider five methods for reducing the impact on small businesses. The adoption of these rule amendments will affect small businesses in Minnesota. The department has evaluated the effect of the proposed rules on small businesses and has considered each of the methods listed above for reducing the impact of the rules on small businesses.

Minn. Stat. § 14.115, subd. 2(a) (1988) requires the department to consider the establishment of less stringent compliance or reporting requirements for small business. The proposed amendments to part 7670.0470, subpart 2 (items 1 and 4) relating to determination of window thermal performance are less stringent because they require no costly physical testing to demonstrate compliance. Chapter 7670 contains no reporting requirements.

Since Chapter 7670 contains no scheduling, deadline or reporting requirements, Minn. Stat. § 14.115, subd. 2(b) and (c) are not applicable.

The proposed rules include several significant performance standards in conformance with Minn. Stat. § 14.115, subd. 2(d). Part 7670.0470, subpart 2, includes four performance options for determining the thermal performance of windows. The Model Energy Code chapter 4 (Building Design Systems Analysis) is entirely performance based. The Model Energy Code chapter 5 (Building Design by Component Performance Approach) is also performance based. Finally, the lighting criteria proposed in Part 7670.0800, subpart 2 are performance based.

Minn. Stat. § 14.115, subd. 2(e) requires the department to consider exempting small businesses from any or all requirements of the rule. Minn. Stat. § 16B.62 establishes the scope of application of the State Building Code. To exempt small businesses would be contrary to the latter statute, It would be inappropriate for the department to usurp statutory requirements by changing the applicability to exempt small business. In the proposed rule part 7670.0100, subpart 3, the applicability of the chapter is modified to exempt relocated residential buildings in conformance with Minn. Stat. § 16B.61, subd. 3(i).

If no hearing is required, upon adoption of the rule, the rule and the required supporting documents will be submitted to the Attorney General for review as to legality and form to the extent that form relates to legality. Any person may request notification of the date of submission to the Attorney General. Persons who wish to be advised of the submission of this material to the Attorney General, or who wish to receive a copy of the adopted rules, must submit a written request for such to Mr. Nelson at the address listed above.

Kris Sanda, Commissioner
Department of Public Service

2-1-91
Dated

Notice of Hearing and Notice of Intent to Cancel Hearing if Fewer than Twenty-Five Persons Request a Hearing in Response to Notice of Intent to Adopt Rules without a Public Hearing

Notice is hereby given that a public hearing on the above-entitled matter will be held on March 29, 1991 in Conference Room 4, 9th floor of the American Center Building, 150 East Kellogg Boulevard, St. Paul, Minnesota commencing at 9:00 a.m. and continuing until all interested or affected persons have an opportunity to participate. The proposed rules may be modified as a result of the hearing process. Therefore, if you are affected in any manner by the proposed rule, you are urged to participate in the rule hearing process.

These rules were previously published in 15 S.R. 828 (October 1, 1990) and mailed on September 25, 1990. However, significant amendments are being proposed, so the rule is being re-noticed with a new comment period. If you requested a hearing in the previous rulemaking proceeding, and still desire a hearing on these rules, you must submit another request during this comment period.

PLEASE NOTE, HOWEVER, that the hearing will be cancelled if fewer than twenty-five persons request a hearing in response to the notice of intent to adopt these same rules without a public hearing published in this State Register and mailed to persons registered with the Department of Public Service, Energy Division. To verify whether a hearing will be held, please call the Department of Public Service, Energy Information Center on March 22, 1991 between the hours of 8:00 a.m. and 4:15 p.m. at 296-5175 or Minnesota toll free 800-652-9747 (ask for "Energy").

Following the agency's presentation at the hearing, all interested or affected persons will have an opportunity to participate. Such persons may present their views either orally at the hearing or in writing at any time prior to the close of the hearing. All evidence presented should be pertinent to the matter at hand. Written material not submitted at the time of the hearing which is to be included in the hearing may be mailed to Peter C. Erickson, Administrative Law Judge, Office of Administrative Hearings, 310 Fourth Avenue South, Minneapolis, Minnesota 55415; telephone 612/341-7606, either before the hearing or within five working days after the public hearing ends. The Administrative Law Judge may at the hearing, order the record to be kept open for a longer period not to exceed 20 calendar days. The comments received during the comment period shall be available for review at the Office of Administrative Hearings. Following the close of the comment period the agency and all interested persons have three business days to respond in writing to any new information submitted during the comment period. During the three day period, the agency may indicate, in writing, whether there are amendments suggested by other persons which the agency is willing to adopt. No additional evidence may be admitted during the three day period. The written responses shall be added to the rulemaking record. Upon the close of the record the Administrative Law Judge will write a report as provided for in Minnesota Statutes, Sections 14.15 to 14.50. The rule hearing is governed by Minnesota Statutes, section 14.14 to 14.20 and by Minnesota Rules, parts 1400.0200 to 1400.1200. Questions about procedure may be directed to the Administrative Law Judge.

Authority for the adoption of these rules is contained in Minnesota Statutes, section 216C.19, subdivision 8.

The adoption of these rules will not result in additional spending by local bodies of government in excess of $100,000 per year in either of the first two years following their adoption.

Minnesota Statue § 14.115, subdivision 2 (1988) requires the department, when proposing rules which may affect small business, to consider five methods (a through

e) for reducing the impact on small businesses. The adoption of these rule amendments will affect small businesses in Minnesota. The department has evaluated the effect of the proposed rules on small businesses and has considered each of the methods listed above for reducing the impact of the rules on small businesses.

Minn. Stat. § 14.115, subd. 2(a) (1988) requires the department to consider the establishment of less stringent compliance or reporting requirements for small business. The proposed amendments to part 7670.0470, subpart 2 (items 1 and 4) relating to determination of window thermal performance are less stringent because they require no costly physical testing to demonstrate compliance. Chapter 7670 contains no reporting requirements.

Since Chapter 7670 contains no scheduling, deadline or reporting requirements, Minn. Stat. § 14.115, subd. 2(b) and (c) are not applicable.

The proposed rules include several significant performance standards in conformance with Minn. Stat. § 14.115, subd. 2(d). Part 7670.0470, subpart 2, includes four performance options for determining the thermal performance of windows. The Model Energy Code chapter 4 (Building Design Systems Analysis) is entirely performance based. The Model Energy Code chapter 5 (Building Design by Component Performance Approach) is also performance based. Finally, the lighting criteria proposed in Part 7670.0800, subpart 2 are performance based.

Minn. Stat. § 14.115, subd. 2(e) requires the department to consider exempting small businesses from any or all requirements of the rule. Minn. Stat. § 16B.62 establishes the scope of application of the State Building Code. To exempt small businesses would be contrary to the later statute. It would be inappropriate for the department to usurp statutory requirements by changing the applicability to exempt small business. In the proposed rule part 7670.0100, subpart 3, the applicability of the chapter is modified to exempt relocated residential buildings in conformance with Minn. Stat. § 16B.61, subd. 3(i).

A Copy of the proposed rule amendment is attached to this notice.

NOTICE: Any person may request notification of the date on which the Administrative Law Judge's report will be available, after which date the agency may not take final action on the rules for a period of five working days. If you desire to be notified, you may so indicate at the hearing. After the hearing, you may request notification by sending a written request to the Administrative Law Judge. Any person may request notification of the date on which the rules were adopted and filed with the secretary of state, The notice must be mailed on the same day the rules are filed. If you want to be so notified you may so indicate at the hearing or send a request in writing to the agency at any time prior to filing the rules with the secretary of state.

NOTICE IS HEARBY GIVEN that a Statement of Need and Reasonableness is now available for review at the Agency and at the Office of Administrative Hearings. The Statement of Need and Reasonableness includes a summary of all the evidence and argument which the agency anticipates presenting at the hearing justifying both the need for and reasonableness of the proposed rules. Copies of the Statement of Need and Reasonableness may be reviewed at the agency or the Office of Administrative Hearings and may be obtained from the Office of Administrative Hearings at the cost of reproduction.

Copies of the Statement of Need and Reasonableness are also available by submitting a request to:

Bruce Nelson, Senior Engineer
Department of Public Service, Energy Division
790 American Center Building
150 East Kellogg Boulevard
St. Paul, MN 55101
phone (612) 297-2313 fax (612) 297-1959.

Minnesota Statutes, Chapter 10A requires each lobbyist to register with the State Ethical Practices Board within five days after he or she commences lobbying. A lobbyist is defined in Minnesota Statutes, section 10A.01, subdivision 11 as any individual:

(a) engaged for pay or other consideration, or authorized by another individual or association to spend money, who spends more than five hours in any month or more than $250.00, not including travel expenses and membership dues, in any year, for the purpose of attempting to influence legislative or administrative action by communication or urging others to communicate with public officials;

(b) who spends more than $250.00, not including his own traveling expenses and membership dues, in any year, for the purpose of attempting to influence legislative or administrative action by communicating or urging others to communicate with public officials.

The statute provides certain exceptions. Questions should be directed to the Ethical Practices Board, 625 North Robert Street, St. Paul, Minnesota 55101, telephone 612-296-5148.

Kris Sanda, Commissioner
Department of Public Service

2-1-91
Dated

Department of Public Service

Proposed Permanent Rules Relating to Minnesota Energy Code

Rules as Proposed

GENERAL

7670.0100 AUTHORITY; SCOPE; APPLICABILITY.

Subpart 1. Authority. This chapter is adopted pursuant to Minnesota Statutes, section 216C.19, subdivision 8 and ~~constitute amendments to~~.

Subp. 2. Scope. Under Minnesota Statutes, section 216C.19, subdivision 8, this chapter is a part of the State Building Code, adopted according to Minnesota Statutes, sections 16B.59 to 16B.73. ~~In cases of conflict with the State Building Code, this chapter governs in all cases not affecting safety and health requirements.~~

~~Additionally, this chapter is intended to serve as standards for conducting maxi-audits of existing buildings owned by the state, the University of Minnesota, cities, counties, and school districts as specified in Minnesota Statutes, section 216C.20.~~

Subp. 3. Applicability. Buildings covered by this chapter must comply with the Model Energy Code as amended by parts 7670.0260 to 7670.1000.

EXCEPTION: Relocated residential buildings need not comply with this chapter, except that, where available, an energy audit must be conducted on the relocated building.

7670.0125 LEGISLATIVE MANDATES CONCERNING MINNESOTA ENERGY CODE.

An enclosed structure or portion of an enclosed structure constructed after January 1, 1978, and used primarily as a commercial parking facility for three or more motor vehicles may not be heated. Incidental heating resulting from building exhaust air passing through a parking facility is not prohibited if substantially all useful heat previously has been removed from the air.

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EXCEPTION: Parking facilities that are appurtenant to dwelling unit occupancies.

7670.0130 ~~ADOPTION~~ INCORPORATIONS BY REFERENCE ~~OF THE MODEL ENERGY CODE WITH AMENDMENTS~~.

Subpart 1. Incorporated items. The following standards and references are incorporated by reference:

A. The Model Energy Code, ~~1983~~ 1989 Edition, as published by the Council of American Building Officials (Falls Church, Virginia), ~~is incorporated by reference and made a part of the State Building Code, subject to the amendments in this chapter~~ as amended by parts 7670.0260 to 7670.1000.

B. Code of Federal Regulations, title 10, part 435, Energy Conservation Voluntary Performance Standards for New Commercial and Multi-Family High Rise Residential Buildings; Mandatory for New Federal Buildings.

C. Code of Federal Regulations, title 10, part 430, National Appliance Energy Conservation Act of 1987.

D. LTGSTD, lighting prescriptive and system performance compliance calculation program, a computer program developed by Battelle Pacific Northwest Laboratories.

E. ANSI/ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings.

F. AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

G. ASTM C 236-87, Standard Test Method for Steady State Thermal Performance of Building Assemblies by means of a Guarded Hot Box.

H. ASTM C 976-82, Standard Test Method for Thermal Performance of Building Assemblies by means of a Calibrated Hot Box.

I. WINDOW, a computer program developed by the Windows and Daylighting Group at Lawrence Berkeley Laboratory.

Subp. 2. Availability. All standards and documents incorporated by reference are available for public inspection at

the Minnesota State Law Library and through the Minitex interlibrary loan system. In addition:

A. ASHRAE and ANSI/ASHRAE documents and standards are available from the American Society of Heating, Refrigerating and Air-Conditioning Engineers - Publication Sales, 1791 Tullie Circle NE, Atlanta, GA 30329;

B. AAMA standards are available from the American Architectural Manufacturers Association, 2700 River Road, Des Planes, IL 60018;

C. ASTM standards are available from ASTM, 1916 Race Street, Philadelphia, PA 19103; and

D. The WINDOW computer program is available from Bostik Construction Products, 1740 County Line, Huntington Valley, PA 19006.

7670.0260 MATERIALS AND EQUIPMENT.

Section 102 of the Model Energy Code is amended by adding a paragraph to read:

102.3 Thermal Insulation. Thermal insulation used in residential buildings three stories or less in height must conform to chapter 7640, Minnesota Thermal Insulation Standards, adopted by the Department of Public Service.

7670.0325 AMENDMENTS TO SECTION 201: DEFINITIONS.

Subpart 1. Thermal transmittance (U). In section 201 of the Model Energy Code, the definition of "Thermal transmittance (U)" is amended to read:

THERMAL TRANSMITTANCE (U). The coefficient of heat transmission (air to air). It is the time rate of heat flow per unit area and unit temperature differential between the warm side and cold side air films (Btu/h ft^2 F).

Thermal transmittance of opaque wall components (U_w) and roof/ceiling components (U_r) calculation methods are defined in the references indicated:

(1) Parallel heat flow method: Model Energy Code, chapter 5, equations 1 and 2, substituting the framing and insulated cavity components of the opaque wall or roof/ceiling

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for the elements designated by subscripts in these equations.

(2) Series-parallel method: Page 20.8 of Standard RS-1 listed in chapter 7.

(3) Parallel path correction factor method: Standard RS-24 listed in chapter 7.

(4) Thermal bridges in sheet metal construction method: Standard RS-25 listed in chapter 7.

(5) Zone method: Pages 22.10 and 22.11 of Standard RS-1 listed in chapter 7.

Subp. 2. **Vapor retarder.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

VAPOR RETARDER. A material to retard air and water vapor passage designed to meet a maximum perm rating of 1.0 grain per hour per ft^2 per inch Hg pressure differential. Polyethylene material that is not cross laminated which is used to meet the requirements of this paragraph must be designed to have a minimum thickness of four mills.

Subp. 3. **Wind wash.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

WIND WASH. Wind wash is the passage of unconditioned air through thermal insulation of the building envelope.

Subp. 4. **Window area.** Section 201 of the Model Energy Code is amended by adding a new definition to read:

WINDOW AREA. Window area, or glazing area, is either the area of glazing and sash, or the area used by the manufacturer to determine the window thermal transmittance.

7670.0400 **AMENDMENT TO ~~302.1~~ SECTION 302: ~~FOOTNOTE 1~~ DESIGN CONDITIONS.**

~~On page 12 of the code,~~ Footnote 1 ~~to~~ of section 302.1 of the Model Energy Code is amended to read:

[1]The ~~outdoor~~ exterior design temperature ~~shall~~ must be selected from the ~~columns of 99 percent values for winter and one percent values for summer from tables in Standard RS-1~~ "Design Conditions" columns shown in Table 302.1.

EXCEPTION: Where necessary to assure the prevention of

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damage to the building or to material and equipment within the building, the values listed in Table 302.1 under "extreme conditions" may be used.

TABLE 302.1 Exterior Design Temperatures

CITY	DESIGN CONDITIONS SUMMER DB/WB	DESIGN CONDITIONS WINTER DB	EXTREME CONDITIONS SUMMER DB/WB	EXTREME CONDITIONS WINTER DB
Albert Lea	87/72	-17	90/74	
Alexandria	88/72	-22	90/72	-28.0
Bemidji	85/69	-31	88/69	-36.9
Brainerd	87/71	-20	90/73	
Duluth	82/68	-21	85/70	-27.4
Faribault	88/72	-17	91/74	-24.3
Fergus Falls	88/72	-21	91/72	-27.8
International Falls	83/68	-29	85/68	-36.5
Mankato	88/72	-17	91/72	
Minneapolis	89/73	-16	92/75	-22.0
Rochester	87/72	-17	90/74	
St. Cloud	88/72	-15	91/74	
St. Paul	89/73	-16	92/75	-22.0
Virginia	83/68	-25	85/69	-33.0
Willmar	88/72	-15	91/74	-24.3
Winona	88/73	-14	91/75	

"DB" = dry bulb temperature, degrees Fahrenheit

"WB" = wet bulb temperature, degrees Fahrenheit

Heating degree days ~~heating shall~~ must be selected from Standard ~~RS-22~~ RS-23 listed in chapter 7. Adjustments may be made as determined by the building official to reflect local climates which differ from the tabulated temperatures or local weather experience ~~as determined by the building official~~.

7670.0450 AMENDMENT TO SECTION 303: VENTILATION.

Section 303.1 of the Model Energy Code is amended to read:

303.1 Ventilation. Ventilation systems must be designed to conform with Standard RS-3 listed in chapter 7.

7670.0470 AMENDMENT TO SECTION 502: ENVELOPE THERMAL TRANSMITTANCE.

Subpart 1. Section 502.2.1 of the Model Energy Code is amended by adding a paragraph to read:

502.1.4 Thermal transmittance of opaque wall components and roof/ceiling components. Thermal transmittance of opaque wall components (U_w) and roof/ceiling components (U_r) must be calculated using the following methods:

(1) Wood frame: Parallel heat flow method.

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(2) Masonry blocks with insulation inserts or filled cores and other envelope assemblies containing nonmetal framing: Series-parallel method.

(3) Metal framing bonded on one or both sides to a metal skin or covering: Thermal bridges in sheet metal construction method.

(4) Nonmetal surface with metal framing:

(a) For elements identified in Standard RS-24 listed in chapter 7, the parallel path correction factor method.

(b) For elements not identified in Standard RS-24 listed in chapter 7, the zone method.

Subp. 2. Section 502.1 of the Model Energy Code is amended by adding a paragraph to read:

502.1.5 Thermal transmittance of window area and skylight elements. Thermal transmittance of window area (U_g) and skylight elements (U_s) must be determined in accordance with one of the following methods:

(1) Representative U-values for fenestration products, pages 27.16 to 27.18 of Standard RS-1 listed in chapter 7;

(2) Standard RS-26 listed in chapter 7;

(3) Standard RS-27 or RS-28 listed in chapter 7 using design conditions specified in footnote (a) of table 13, chapter 27 of Standard RS-1; or

"

(4) Standard RS-29 listed in chapter 7 using design conditions specified in footnote (a) of table 13, chapter 27 of Standard RS-1.

Subp. 3. Section 502.2.1 of the Model Energy Code is amended by adding a new section to read:

502.2.1.7 Alternative compliance. Alternative methods of compliance with sections 502.2.1.1, 502.2.1.2, and 502.2.1.3 for one- and two-family residential buildings.

Minimum performance for Type A-1 (one- and two-family) buildings:

Ceilings	Walls	Floors	Windows	Doors
R-38	R-20[1]	R-20[1]	Maximum U-0.49[2]	R-3

(1) For the insulated cavity of opaque walls, floors, and

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rim joists.

(2) Maximum window area must not exceed 12 percent of the area of exterior walls, not including foundation walls.

Site-built fixed glazing must be installed in either an aluminum or steel frame having a minimum 0.25 inch low conductance thermal break or in wood or vinyl framing. The glazing must be either double-glazed with a dead air space between panes of nominal one-half inch spacing or triple-glazed with a dead air space between panes of not less than one-fourth inch.

7670.0480 AMENDMENT TO SECTION 502: EFFECTIVENESS OF REQUIRED THERMAL INSULATION.

Section 502.2 of the Model Energy Code is amended by adding paragraphs to read:

502.2.1.8 Cold weather vapor condensation. Building assemblies are required to maintain the thermal performance of required insulation and the integrity of building materials against cold weather water vapor condensation.

502.2.1.8.1 Vapor retarder. A vapor retarder must be installed between the interior surface and the winter design condition dew point location within each building envelope surface. The vapor retarder must be continuous and joints in the vapor retarder must be sealed between solid blocking.

EXCEPTION: A vapor barrier need not be installed on the rim joist insulation.

502.2.1.8.2 Air leakage barrier. A barrier against air leakage must be installed to prevent the leakage of moisture-laden air from the house into the building envelope. An air barrier must be continuous at all plumbing and heating penetrations of interior surface of the building exterior envelope. If a tub or shower is located on an exterior wall, an air barrier must be provided at the interior surface of the building exterior envelope behind the tub or shower.

502.2.1.9 Preventing wind wash. A barrier must be provided at the following locations to mitigate wind wash:

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A. the exterior edge of attic insulation; and

B. cantilevered floors and bay windows, including corners with adjoining vertical walls above and below.

7670.0500 AMENDMENT TO ~~502.2.1.4~~ SECTION 502: SLAB ON GRADE FLOORS.

~~On page 19 of the code,~~ Section 502.2.1.4 of the Model Energy Code is amended to read:

502.2.1.4 Slab on grade floors. For slab on grade floors, the thermal resistance of the insulation around the perimeter of the floor must be not less than the value given in Table No. ~~5-1~~ 502.2.1. The insulation must extend downward from the top of the slab to the design frost line or downward to the bottom of the slab then horizontally beneath the slab for an equivalent distance, and must be an approved type.

7670.0510 AMENDMENT TO ~~502.2.1~~ SECTION 502: FOUNDATION WALLS.

~~On page 19~~ Section 502.2.1.6 of the Model Energy Code~~,~~ ~~502.2.1~~ is amended ~~by adding a paragraph~~ to read:

502.2.1.6 Foundation walls. Foundation walls enclosing heated or conditioned spaces must be insulated.

Either the thermal resistance (R) of the insulation on the entire opaque foundation wall must be not less than R-5, or the thermal resistance (R) of the insulation on the opaque foundation wall must be not less than R-10 from the top of the wall down to the design frost line. If the top of the footing is at or above the design frost line, the thermal resistance (R) of the insulation on the wall must not be less than R-5 from the top of the wall to the top of the footing.

All insulation used in or on foundation walls must be approved for the intended use. The insulation must be installed in accordance with the approved manufacturer's specifications.

If the foundation wall insulation is on the exterior, the portion from the top of the foundation wall to six inches below grade must be covered by an approved protective coating finish to protect the insulation from deterioration due to sunlight and physical abuse.

7670.0550 AMENDMENT TO ~~502.4.3~~ SECTION 502: AIR LEAKAGE.

~~On page 23 of the code,~~ Subpart 1. Alternative. Section 502.4.3 of the Model Energy Code is amended by adding an exception as follows:

~~502.4.3.1 Exterior joints in the building envelope that are sources of air leakage, such as around window and door frames, between wall cavities and window or door frames, between walls and foundations, between walls and roofs or ceilings and between wall panels, openings at penetrations of utility services through walls, floors, and roofs, and all other similar openings in the building envelope must be caulked, gasketed, or otherwise sealed in an approved manner. A continuous air barrier must be provided at all electrical, mechanical, and plumbing penetrations.~~

EXCEPTION: As an alternative to the prescriptive requirements of section 502.4.3 for detached single-family residential buildings, air tightness must comply with air leakage class A, B, C, or D of Standard RS-30 listed in chapter 7. In addition, this alternative requires that the ventilation system must provide a ventilation rate of not less than 0.35 air changes per hour (determined in accordance with Standard RS-3, Table 2.3) or 15 cfm per person, whichever is greater. This ventilation rate must be verified by measurement. If this alternative is not chosen, this ventilation rate requirement applies only if required by Standard RS-3.

Subp. 2. Fire stops. Section 502 is amended by adding a section as follows:

502.4.4 Fire stops. Fire stops must be installed in accordance with the State Building Code. When mineral fiber or glass fiber materials are used as fire stop construction at ceilings and wall cavities separating conditioned and nonconditioned spaces, the fire stop must be installed to block air movement.

EXCEPTIONS: A fire stop need not block air movement if its installation would conflict with any other part of the State

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Building Code.

7670.0610 ~~AMENDMENT~~ AMENDMENTS TO ~~503.2~~ SECTION 503: BUILDING MECHANICAL SYSTEMS.

~~On page 24~~ Subpart 1. Calculation procedures. Section 503.2.1 of the Model Energy code~~, 503.2~~ is amended ~~by adding a~~ paragraph to read:

~~503.2.3 System design heating and cooling capacity. The rated capacity of the heating and cooling system at design conditions may not be greater than 115 percent for heating, 100 percent for cooling at design output load calculated in accordance with 503.2, whenever appropriate equipment is available.~~

~~Exceptions: 1. Equipment designed for standby purposes.~~
~~2. Cooling capacity of heat pumps.~~
~~3. Systems designed for pick up after automatic temperature setback when a registered professional engineer shows that the extra system design heating and cooling capacity is needed for pick up.~~

503.2.1 Calculation procedures. Heating and cooling system design loads for the purpose of sizing systems and equipment must be determined in accordance with the procedures described in Standard RS-1 listed in chapter 7.

503.2.1.1 Safety factor. Design loads may at the designer's option be increased by as much as ten percent to account for unexpected loads or changes in space usage.

503.2.1.2 Pick-up loads. Transient loads such as warm-up or cool-down loads that occur after off-hour setback or shutoff may be calculated from principles based on the heat capacity of the building and its contents, the degree of setback, and desired recovery time; or may be assumed to be up to 30 percent for heating and ten percent for cooling of the steady-state design loads. The steady-state load may include a safety factor in accordance with section 503.2.1.1.

Subp. 2. System and equipment sizing. Section 503.2 of the Model Energy Code is amended by adding a paragraph to read:

503.2.3 System and equipment sizing. HVAC systems and equipment must be sized to provide no more than the space and

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system loads calculated in accordance with 503.2.1.

Exceptions:

(a) Equipment capacity may exceed the design load if the equipment selected is the smallest size needed to meet the load within available options of the desired equipment line.

(b) Equipment whose capacity exceeds the design load may be specified if oversizing the equipment can be shown to not increase the overall annual energy costs.

(c) Stand-by equipment may be installed if controls and devices are provided that allow stand-by equipment to operate automatically only when the primary equipment is not operating.

(d) Multiple units of the same equipment type, such as multiple chillers and boilers, with combined capacities exceeding the design load may be specified to operate concurrently only if controls are provided that sequence or otherwise optimally control the operation of each unit based on load.

(e) For a single piece of equipment that has both heating and cooling capability, only one function, either the heating or the cooling, need meet the requirements of this section. Capacity for the other function must be, within available equipment options, the smallest size necessary to meet the load.

7670.0660 AMENDMENT TO ~~TABLE NO. 5-7~~ SECTION 503: EQUIPMENT EFFICIENCY.

Subpart 1. **Table No. 503.4.3.** Table No. 503.4.3 of the Model Energy Code "HVAC System Heating Equipment - Gas- and Oil-Fired Minimum Steady State Combustion Efficiency" is amended by changing the requirement for forced-air furnaces and low-pressure steam or hot-water boilers for all other commercial or industrial furnaces and boilers to 80 percent.

~~On page 29~~ Subp. 2. **Table No. 503.4.8.** Section 503 of the Model Energy Code~~, Table No. 5-7~~ is amended by adding a table to read:

Table No. ~~5-7~~ 503.4.8 -- Minimum EER and COP for Electrically Driven ~~HVAC System Components~~ Water Source Hydronic

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Heat Pumps[1]

Component	Type of Compressor	Condensing Means: Air EER	Air COP	Water EER	Water COP	Evaporative EER	Evaporative COP
Self-contained water-chillers	Centrifugal	8.00	2.34	13.00	4.04		
	Positive displacement	8.40	2.46	12.00	3.51		
Condenserless water-chillers	Positive displacement	9.90	2.9	12.00	3.51		
Compressor and condenser units 65,000 Btu/h (19,050 watts) and over[2]	Positive displacement	9.50	2.78	12.50	3.66	12.50	3.66

Water-Source Hydronic Heat Pump	Size	under 19 kW (65,000 Btu/h) EER	under 19 kW (65,000 Btu/h) COP	19 kW (65,000 Btu/h) and over EER	19 kW (65,000 Btu/h) and over COP
	Centrifugal	9.0	2.64	9.4	2.75
	EER	9.0		9.4	
	COP	2.64		2.75	

[1]When tested at the standard rating conditions specified in Table No. 5-10C 503.4.6a.

[2]Ratings in accordance with Standard RS-14 as applicable, COP based on condensing unit standard rating capacity and energy input to the unit, all at sea level.

Subp. 3. **Efficiency requirements.** HVAC system heating and cooling equipment regulated by the National Appliance Energy Conservation Act of 1987 must conform to the efficiency requirements of Standard RS-31 listed in chapter 7.

7670.0670 AMENDMENT TO 503.10.2 SECTION 503.10: DUCT CONSTRUCTION.

On page 33 of the code, Section 503.10.2 of the Model Energy Code is amended to read:

503.10.2. For low pressure supply and return air ducts located outside of the conditioned space, all transverse joints must be sealed using mastic, tape, or mastic plus and tape. For fibrous glass ductwork, pressure sensitive tape may be used.

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7670.0710 ~~DELETION OF 504.5.3~~ AMENDMENTS TO SECTION 504: SERVICE WATER HEATING.

~~On page 38~~ Subpart 1. Time clocks. Section 504.5 of the Model Energy Code~~, 504.5.3~~ is ~~deleted~~ amended by deleting section 504.5.3.

Subp. 2. **Pipe insulation.** Section 504.7 of the Model Energy Code is amended by deleting the exception.

Subp. 3. **Devices to limit temperature.** Section 504.8.2 of the Model Energy Code is amended by deleting section 504.8.2.2.

Subp. 4. **Efficiency requirements.** Service water heating equipment regulated by the National Appliance Energy Conservation Act of 1987 must conform to the efficiency requirements of Standard RS-31 listed in chapter 7.

7670.0800 ~~AMENDMENT OF 505.2~~ AMENDMENTS TO SECTION 505: ELECTRIC POWER AND LIGHTING.

~~On page 39~~ Subpart 1. **Electric energy determination.** The exception to section 505.2 of the Model Energy Code~~, 505.2~~ is amended to read:

~~505.2 Electric energy determination.~~

~~In any multi-tenant residential building, provisions shall be made to separately determine the electric energy consumed by each tenant. Electrical service to individual dwelling units in buildings containing two or more units shall be separately metered, with individual metering readily accessible to the individual occupants.~~

EXCEPTION: Motels, hotels, college dormitories, other transient facilities, and buildings intended for occupancy primarily by persons who are 62 years of age or older or handicapped, or which contain a majority of units not equipped with complete kitchen facilities.

Subp. 2. **Lighting power budget.** The lighting requirements of sections 505.3 and 505.4 of the Model Energy Code are amended to read:

The lighting power budget must be the upper limit of the power to provide the lighting needs in accordance with the 1988

and 1989 criteria and calculation procedure specified in Standard RS-32 listed in chapter 7 (excluding section 3.2, referencing equation 3.4-1 in section 3.1.6.2, and correcting the units of Interior Lighting Power Allowance in equation 3.5-3 to Watts), or using Standard RS-33 listed in chapter 7.

EXCEPTION: One- and two-family detached dwellings and the dwelling portion of multifamily buildings.

7670.0850 AMENDMENT TO SECTION 600: DESIGN BY ACCEPTABLE PRACTICE.

Section 601.1 of the Model Energy Code is amended by adding a paragraph to read:

Buildings constructed in accordance with this section must also comply with parts 7670.0470 to 7670.0800 as indicated below:

Model Energy Code	Minnesota Rules Part
602.2	7670.0470, 7670.0480
602.2.4	7670.0500
602.2.6	7670.0510
602.3.2	7670.0550
603.1	7670.0610
603.2.1	7670.0660
603.4	7670.0670
604	7670.0710
605	7670.0800

7670.1000 ~~AMENDMENT~~ AMENDMENTS TO ~~701.1~~ SECTION 701: STANDARDS.

~~On page 54 of the code,~~ Section 701~~/1~~ ~~Code Standard No. RS-4,~~ of the Model Energy Code is amended by replacing and adding the following code standard numbers to read:

A. RS-1, 1989 ASHRAE Handbook of Fundamentals.

B. RS-3, ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality.

C. RS-4, ASHRAE Standard 55-1981 Thermal Environment Conditions for Human Occupancy.

D. RS-17 and RS-18, SMACNA HVAC Duct Construction Standards: Metal and Flexible, First Edition, 1985.

E. RS-23, Monthly Normals of Temperature, Precipitation, andHeating and Cooling Degree Days 1951-80 Minnesota. National Oceanic and Atmospheric Administration September 1982.

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F. RS-24, Code of Federal Regulations, title 10, part 435.105, section 5.3.3.2.1(b), Calculation procedures for parallel path correction factor method.

G. RS-25, Code of Federal Regulations, title 10, part 435.105, section 5.3.3.2.1(d), Calculation procedures for thermal bridges in Sheet Metal Construction.

H. RS-26, AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation of Windows, Doors and Glazed Wall Sections.

I. RS-27, ASTM C 236-87, Standard Test Method for Steady State Performance of Building Assemblies by means of a Guarded Hot Box.

J. RS-28, ASTM C 976-82, Standard Test Method for Steady State Performance of Building Assemblies by means of a Calibrated Hot Box.

K. RS-29, WINDOW computer program.

L. RS-30, ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings.

M. RS-31, Code of Federal Regulations, title 10, part 430.32, Energy Conservation Standards.

N. RS-32, Code of Federal Regulations, title 10, part 435.103, lighting.

O. RS-33, LTGSTD, lighting prescriptive and system performance compliance calculation program.

REPEALER. Minnesota Rules, parts 7670.0110; 7670.0120; 7670.0200; 7670.0210; 7670.0220; 7670.0300; 7670.0310; 7670.0320; 7670.0330; 7670.0340; 7670.0520; 7670.0540; 7670.0600; 7670.0620; 7670.0630; 7670.0640; 7670.0650; 7670.0700; 7670.0720; 7670.0730; 7670.0900; 7670.0910; 7670.0920; 7670.0930; 7670.0940; 7670.0950; 7670.0960; 7670.0970; 7670.1010; 7670.1020; 7670.1030; 7670.1100; and 7670.1110 are repealed.

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Office of the Revisor of Statutes

Administrative Rules

TITLE: Proposed Permanent Rules Relating to Minnesota Energy Code

AGENCY: Department of Public Service

MINNESOTA RULES: Chapter 7670

INCORPORATIONS BY REFERENCE:

Part 7670.0130: Model Energy Code, 1989 Edition, published by Council of American Building Officials, Falls Church, Virginia, as amended by parts 7670.0260 to 7670.1000; LTGSTD, lighting prescriptive and system performance compliance calculation program, a computer program developed by Battelle Pacific Northwest Laboratories; ANSI/ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings; AAMA Standard 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; ASTM C 236-87, Standard Test Method for Steady State Thermal Performance of Building Assemblies by means of a Guarded Hot Box; ASTM C 976-82, Standard Test Method for Thermal Performance of Building Assemblies by means of a Calibrated Hot Box; WINDOW, a computer program developed by the Windows and Daylighting Group at Lawrence Berkeley Laboratory. Available at Minnesota State Law Library and through Minitex interlibrary loan system.

The attached rules are approved for publication in the State Register

Craig E. Lindeke
Senior Assistant Revisor

STATE OF MINNESOTA
DEPARTMENT OF PUBLIC SERVICE

In the Matter of the Proposed Amendments to Rules of the Minnesota Department of Public Service Amending the State Building Code Regarding Heat Loss, Illumination and Climate Control, Minn. Rules Ch. 7670

AFFIDAVIT OF ADDITIONAL DISCRETIONARY NOTICE

STATE OF MINNESOTA)
) SS.
COUNTY OF RAMSEY)

Marlene Odeen, being duly sworn, deposes and says:

1. That in addition to giving the statutorily required rulemaking notice in the above-captioned matter, the Department of Public Service provided additional discretionary notice to the persons on the attached mailing list. The persons on the mailing list include home builders, home energy contractors, building officials and housing researchers, some of whom are small businesses within the meaning of Minn. Stat. Subd. 14.115 (1988). The Department has given this notice in accordance with Minn. Stat. Subd. 14.115, subp. 4 (1988) in order to provide an opportunity for small businesses to participate in the rulemaking process.

2. This additional discretionary notice was given on the 14th day of February, 1991, when the Department of Public Service served its "Notice of Intent to Adopt a Rule Without a Public Hearing and Notice of Intent to Adopt a Rule With a Public Hearing if Twenty-five or More Persons Request a Hearing" on the persons on the mailing list referred to in paragraph 1 above by depositing in the State of Minnesota Central Mail system or in the United States mail for first class mailing at said City of St. Paul, a copy thereof, properly enveloped, with postage prepaid, and addressed to said persons.

Marlene Odeen
(name)

Secretary
(title)

Subscribed and sworn to before me this 14th day of February 1991.

DENNIS M. DEVEREAUX
NOTARY PUBLIC-MINNESOTA
RAMSEY COUNTY
My Comm. Expires Apr. 1, 1994

Dennis M. Devereaux
Notary Public

LIST OF PERSONS WHO WERE MAILED
ADDITIONAL DISCRETIONARY NOTICE ON FEBRUARY 13, 1991

Joan Archer
Builders Association of MN
2469 University Avenue
St. Paul, MN 55114

Steve Klossner
Advanced Certified Thermography
672 Quixote Ave.
Lakeland, MN 55043

Mike Nobel
ENERGY OUTFITTERS LTD.
245 ALDRICH AVE N #301
MINNEAPOLIS, MN 55405

Doug Gilbertson
Celotex Corp.
300 Dakota Ave So.
Minneapolis, MN 55416

Ed Werner
House IR Research
State Ofc. Bldg. 2nd fl., E corridor
100 Constitution Ave.
Saint Paul, MN 55155

Dave Prokop
2990 Janero Ave. N.
Lake Elmo, MN 55042

Tim Larson
Cold Climate Housing Center
Kaufert Laboratory Bldg.
2004 Folwell Ave
Saint Paul, MN 55108

Al Kleinback
State Building Codes Div.
408 Metro Square Bldg.
St. Paul, MN 55101

David Grimsrud
Cold Climate Hsg. Research
86 Pleasant Street SE 330 Welling
Minneapolis, MN 55455

David Morris
220 West King
Stant Paul, MN 55107

Dick Arey
Ctr. for Energy & Urban Environment
510 First Ave. N # 500
Minneapolis, MN 55403

Gary Nelson
4723 Upton Ave. So.
Minneapolis, MN 55410

Wanda Olson
U of M Ag. Extension
360 McNeal Hall
1985 Buford Ave
Saint Paul, MN 55108

ATTACHMENT 1

DEPARTMENT: ATTORNEY GENERAL

STATE OF MINNESOTA

OFFICE MEMORANDUM

DATE: December 26, 1990

TO: BRUCE NELSON
Senior Engineer
Department of Public Service

RECEIVED
DEC 28 1990
DEPT. OF PUBLIC SERVICE

FROM: MARTHA J. CASSERLY
Special Assistant
Attorney General

PHONE: 296-6839

SUBJECT: **Rules Relating to Minnesota Energy Code**

The above-referenced rule has not been approved by the Attorney General because the Department of Public Service did not provide a 30-day comment period as required by Minn. Stat. §§ 14.22 and 14.25.

The Department's Notice of Intent to amend a rule without a public hearing expressly stated that "comments or requests for a public hearing must be received no later than 4:30 p.m. on October 30, 1990." While the affidavit of mailing indicates that the Notice was mailed September 25, 1990, the Notice was not published in the State Register until October 1, 1990. Under the method of calculation of the number of days pursuant to Minn. Stat. § 645.15, the 30-day comment period after the date of publication ended October 31, not October 30. Consequently, the Department provided a 29-day comment period, rather than 30 days.

To correct this deficiency, you must re-publish and re-mail the Notice of Intent and expressly provide a complete 30-day comment period. After the close of the 30-day comment period, assuming you do not get a total of 25 or more requests for a public hearing,[1] the rule may be resubmitted to the Attorney General for review. Attorney General Rule 2010.1300 provides the procedures for re-submitting the rule. In addition to the documents listed in subpart 1 of that rule, the following documents must also be submitted:

1. A copy of the Notice of Intent as signed and mailed;
2. A copy of the Notice of Intent as published in the State Register;
3. An affidavit of mailing the subsequent Notice of Intent; and
4. Any additional comments or requests received.

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1. In counting the number of requests for a public hearing, you must include the requests received during the initial comment period, unless the requests have been withdrawn in writing.

In resubmitting the rule to our office, please enclose a cover memo specifying that the rule is being resubmitted and refer to our file number 1771, so that we may obtain our initial file in this matter.

As I stated on the phone, if you wish, I will review your Notice of Intent before it is mailed/published. Please contact me or Patty Nolte if you have additional questions.

MJC:cy.bm1

cc: William Brown, Office of Administrative Hearings
Mary Ann Hruby, Legislative Commission to Review Administrative Rules
Paul Marinac, Revisors Office
Eric Swanson, Attorney General's Office

Chemical action, dust or oil accumulations, or the presence of condensation or frost can change a reflective surface enough to reduce its reflectance and increase its emittance. Chemical changes include oxidation, corrosion, or tarnishing caused by air, moisture, wet plaster, or the chemical treatment of wood spacing strips or other adjoining structural members. Surface emittance values should be obtained by tests, such as described in ASTM *Standard* C445. Low emittance windows have significantly greater thermal resistance, for example.

CALCULATING OVERALL THERMAL RESISTANCES

Using the principles of heat flow in Chapter 3, calculating heat flow by the overall thermal resistance method is preferred.

The total resistance to heat flow through building constructions such as flat ceiling, floor, or wall (or curved surface if the curvature is small) is the numerical sum of the resistances (R-values) of all parts of the construction in series.

$$R = R_1 + R_2 + R_3 + R_4 + \ldots + R_n \quad (1)$$

where R_1, R_2, etc., are the individual resistances of the parts and R is the resistance of the construction from inside surface to outside surface. However, in buildings, an inside air film and an outside air film both having some thermal resistance. To obtain the overall resistance of the building construction, R_T, the air film resistances R_i and R_0 must be added from Table 1, Chapter 22.

$$R_T = R_i + R + R_0 \quad (2)$$

The U-factor is the reciprocal of R_T.

$$U = 1/R_T \quad (3)$$

With the use of higher values of R_T, the corresponding values of U become very small. This is one reason why it is sometimes preferable to specify resistance rather than transmittance. Also, a whole number is more understandable to an insulation buyer rather than a decimal or fraction.

An example of former calculations for a wall with air space construction, consisting of two homogeneous materials of conductivities k_1 and k_2 and thickness x_1 and x_2, respectively, separated by an air space of conductance.

$$R_T = 1/h_i + x_1/k_1 + 1/C + x_2/k_2 + 1/h_0 \quad (4)$$

Series and Parallel Heat Flow Paths

In many installations, components are arranged so heat flows in parallel paths of different conductances. If no heat flows between lateral paths, heat flow in each path may be calculated using Equations 1 and 2. The average transmittance is then:

$$U_{av} = a\,U_a + b\,U_b + \cdots + n\,U_n \quad (5)$$

where $a, b, \cdots, n$ are respective fractions of a typical basic area composed of several different paths with transmittance U_a, $U_b, \cdots, U_n$.

If heat can flow laterally in any continuous layer so that transverse isothermal planes result, total average resistance $R_{T(av)}$ will be the sum of the resistance of the layers between such planes, each layer being calculated by the appropriate Equation 1 or modification of Equation 4, using the resistance values. This is a series combination of layers, of which one (or more) provides parallel paths.

The calculated heat flow, assuming parallel heat flow only, is usually considerably lower than that calculated with the assumption of combined series-parallel heat flow. The actual heat flow will be some value between the two calculated values. In the absence of test values for the combination, an intermediate value should be used; examination of the construction will usually reveal whether a value closer to the higher or lower calculated value should be used. Generally, if the construction contains any highly conductive layer in which lateral conduction is very high compared to heat flow through the wall, a value closer to the series parallel calculation should be used. If, however, there is no layer of high lateral conductance, a value closer to the parallel heat flow calculation should be used.

CALCULATING SURFACE TEMPERATURES

The temperature at any interface can be calculated, since the temperature drop through any component of the wall is proportional to its resistance. Thus, the temperature drop, Δt, through R_1 in Equation (1) is:

$$\Delta t_1 = R_1 (t_i - t_o)/R_T \quad (6)$$

where t_i and t_o are the indoor and outdoor temperatures, respectively. Hence, the temperature at the interface between R_1 and R_2 is:

$$\Delta t_{1-2} = t_i - t_1 \quad (7)$$

For types of building materials having nonuniform or irregular sections such as hollow clay tile or concrete blocks, it is necessary to use the R-value of the unit as manufactured.

If the resistances of materials in a wall are highly dependent on temperature, the mean temperature must be known to assign the correct value. In such cases, it is perhaps most convenient to use a trial and error procedure for the calculation of the total resistance, R_T. First, the mean operating temperature for each layer is estimated and R values for the particular materials are selected. The total resistance R_T is then calculated as in Equation (4), and the temperature at each interface is calculated using Equations (6) and (7).

The mean temperature of each component (arithmetic mean of its surface temperatures) can then be used to obtain second generation R-values. This procedure can then be repeated until the R-values have been correctly selected for the resulting mean temperatures. Generally, this can be done in two or three trial calculations.

In many heating and cooling load calculations, it is necessary to determine the inside surface temperature or the temperature of the surfaces within the structure. The resistances through any two paths of heat flow are proportional to the temperature drops through these paths and can be expressed as:

$$R_1/R_2 = (t_i - t_x) / (t_i - t_o) \quad (8)$$

where

R_1 = resistance from the indoor air to any point in the structure at which the temperature is to be determined
R_2 = overall resistance of the wall from indoor air to outdoor air
t_i = indoor air temperatures
t_x = temperature to be determined
t_o = outdoor air temperature

HEAT FLOW CALCULATIONS

Equation (9) is used to calculate heat flow through flat surfaces; Equation (10) is used for cylindrical surfaces (Figure 5).

$$q_s = (t_{is} - t_{os})/R \quad (9)$$

and

$$q_s = \frac{t_{is} - t_{os}}{r_s \ln(r_1/r_i)]/k_1 + [r_s \ln(r_s/r_1)]/k_2} \quad (10)$$

graded to drain the crawl space so that surface water will not rise above the vapor retarder. Floor insulation eliminates the need for dampers on crawl space vent openings, but does not allow these spaces to be used for utilities or a heating distribution system unless it is efficiently insulated.

Floor construction with joists can be insulated between the joists (Figure 12). Insulation between joists must have supplemental support. Material with an integral vapor retarder, installed with the vapor retarder up, can be secured by the flange provided for this purpose. Laced wires, barbed-end wires spanning the joist space, wire mesh, screening, or ceiling finish will support loose-fill insulation. Floor construction can also be insulated by placing flexible blanket material over the joists before laying the subfloor.

Another floor insulation method uses double-sided, perforated aluminum foil draped and stapled over floor joists (BRANZ 1983). For about a 4-in. sag depth, laboratory R-values were 5.7 to 14.2 °F · ft² · h/Btu with a mean of 6.8, depending on the humidity above the floor space. Field measurements have shown R-values up to 14 °F · ft² · h/Btu for carpeted floors over good installations with a 4 in. sag.

Roof Deck Construction

Almost all structural roof deck construction systems require thermal insulation to economically maintain the design indoor environment. For level or nearly level roofed structures, insulation should be placed on top of the deck, on the outside of the structure. This location moderates the deck temperature, which reduces thermal movement of the deck and the potential for underdeck condensation. Traditionally, the insulation is placed under the roof membrane so it functions as a base for the built-up roof (BUR) membrane. For a stable base, a good bond must be established between the insulation, through the vapor retarder, to the roof deck, and between the insulation and the BUR. Ineffective bonds that allow the BUR to move in reaction to stresses from temperature changes often cause the roof to fail.

In this configuration, a vapor retarder should be placed between the deck and the insulation when required by interior environmental conditions. An alternate method for obtaining the required vapor retarder for a solid-shaped metal deck is to seal the deck at all overlaps and joints.

Single-ply membrane roofs are frequently installed with ballasted or loose-laid systems. Adhesion to the insulation is usually not desirable.

Insulation can also be placed above the membrane in a Protected Membrane Roof (PMR) system. With this approach, the roof membrane is installed on the deck, where it functions as a water and vapor retarder. Insulation can be placed above and below membranes to function both as the base for the membrane and the membrane protector, as well as for the insulator. An insulation with the required structural and/or water resistance properties required for a particular application can reduce the severity of moisture effects. Some insulation can be wetted and then successfully dried; while wet, however, it has a greatly reduced insulation value.

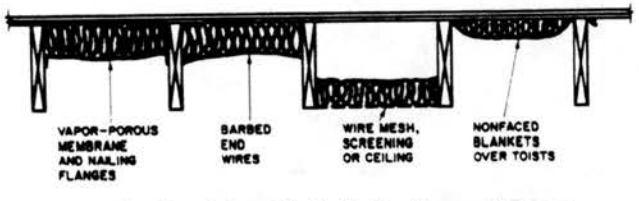


Fig. 12 Insulation Methods for Framed Floors

Roof systems designed for continual heavy traffic should have a secondary structure, supported on a curb system, above the water membrane of the roof system.

Insulation for pitched roofs covered with shingles, tile, or similar mechanically fastened watershedding materials should be placed above the ceiling directly on the attic floor. A vapor retarder should be placed on the winter warm side of the insulation, and the attic space must be adequately ventilated.

If the undersurface of the pitched roof is exposed to the interior, the winter warm side vapor retarder and insulation can be applied over the roof framing or decking. The insulation is then covered with a nailing base for the roofing application. Prefinished roof planks with the required thermal resistance can also be placed over the rafters.

Ventilation may be needed between the insulation and the roofing nailing base depending on the influence the permeance of the insulation and vapor retarder has on interior environmental conditions.

If insulation must be placed on a suspended ceiling, the space between the insulation and roof deck must be adequately ventilated for condensation control. Power-driven ventilators are usually necessary for flat decks, and shallow concealed spaces and inlet vents should be located to provide the desired air movement.

INSULATION FIELD PERFORMANCE CHARACTERISTICS

Convection and air infiltration in some insulation systems may increase the heat transfer across them. Low density loose-fill, large open-cell, and fibrous insulations and poorly designed or installed reflective systems are most susceptible to increased heat transfer caused by natural and forced convection (air infiltration). A change of temperature differential across an insulation, as well as the height, thickness, or width of the insulated space, influences the amount of convection. When an impermeable membrane is applied to one surface or when the cavity is filled with insulation, natural convection is reduced significantly and apparent thermal conductivities measured by standard test methods apply.

The effectiveness of thermal insulation is seriously impaired when it is installed incorrectly. For example, a 4% void area in R-2 wall insulation increases heat loss by 15%. A 4% void in R-3.3 ceiling insulation causes a 50% increase in heat loss. When insulation is properly installed, the wall or ceiling system performs as shown in Table 4, Chapter 22. Verschoor (1977) found that air interchange around thin wall insulation installed vertically with air spaces on both sides increases heat loss by 60%. Other factors, including vibration, temperature cycling, and other mechanical forces, can affect thermal performance by causing settling or other dimensional changes. Section A3 of the CIBSE Guide (1986) gives more information on the effect of moisture on thermal properties of building structures.

MOISTURE IN BUILDINGS

MIGRATION OF WATER VAPOR

Importance of Air Leakage

Vapor retarders have been advocated to avoid condensation problems in buildings, since water vapor migrates by diffusion through the building envelope materials because of a vapor pressure difference. Wilson and Garden (1965), Dickens and Hutcheon (1965), Latta (1976), Handegord (1979), Tamura (1975) and Chapter 23 showed that air movement carrying the water vapor with it is far more powerful in transporting water vapor

within the building envelope. Condensation will occur if the air/vapor mixture is cooled to its dew point and latent heat is removed.

Air passing quickly on a direct path through a wall may not be cooled sufficiently to condense until it mingles with and is diluted by the outdoor air. Air following a longer path on the cold side of the insulation (for example, when it flows down an air space to escape at weep holes) may deposit water on the back of a cold cladding or sheathing.

The relative amounts of water deposited in a wall or roof by vapor diffusion or by a current of air cannot be calculated with certainty. Under one set of conditions, six or seven times as much water can be deposited as a result of air leakage as by vapor diffusion through a wall without a vapor retarder. Under different circumstances, the rates could be 100:1 or higher.

A good quality vapor retarder eliminates condensation by vapor diffusion, but even an excellent vapor retarder is of little benefit if it can be bypassed by a current of air. Therefore, the first defense against condensation is control of humid air movement within a building structure by airtight construction. The section on concealed condensation in this chapter and the section on water vapor retarders in Chapter 20 include further details.

In many buildings, moist air leaking outward into a wall in winter is a major problem; rarely is vapor diffusion a major factor. Water entering between two layers with high resistance to vapor diffusion may damage the construction if it does not dry out again. As a result, the double vapor retarder compounds the problem initiated by the defect that allowed the water to enter. Walls and roofs should be designed so any water that enters can be removed by ventilation or by drainage to the outdoors or to a location capable of withstanding the water. Drainage may not be sufficient in low-slope roofs and is addressed in the section on membrane roof systems.

Controlling Air Movement

A controlled amount of ventilation air must be provided to disperse moisture, but dispersion should not be left to uncontrolled air leakage. To control air leakage, either the holes through which the air passes or the driving pressure difference must be eliminated. Since the pressure differences arise from the natural phenomena of wind, air, and temperature differences, they can only be balanced by changing the pressure inside the building. But the complex controls and equipment needed to sense and balance the pressure difference under constantly changing conditions make this solution impractical. The most practical approach is to minimize the size and number of holes.

It may be simple to design a satisfactory wall or roof construction for clear uninterrupted areas, but intersections with other building components require planning to link the airtightness of a wall section to the airtight glass in a window or an airtight membrane in the roof or ceiling. Leakage paths are often found in the inside of the outer wall where a partition wall joins it. Similar leakage paths can be found in electrical outlet boxes, at openings for piping, up through the hollow core of a partition wall, and through the ceiling, if ceiling airtightness is not carried across the top of the partition. A designer should work closely with construction workers to find practical solutions to construction problems, but in considering alternatives, airtightness of the envelope must be maintained.

Airtightness and Location of Air Barriers

In striving to eliminate air leaks, but realizing that perfection is not attainable, construction should include drainage or ventilation to carry away unwanted water. Ventilation or drainage must go to the outside of the airtight layer of construction or it will increase air leakage of the building. To avoid condensation on the airtight layer, the layer must either be kept above dewpoint by locating it on the warm side of the insulation or be of adequate permeance to permit vapor to move to the outside.

There must be no gaps between the airtight layer and the insulation, or cold air will penetrate the ventilation or drainage openings into the warm side of the insulation and reduce its effectiveness. Generally, the air barrier is placed on the warm side of, and in contact with, the insulation. The air barrier must be sufficiently strong and well supported to resist wind loads.

Air leakage through the building envelope does not necessarily occur at doors and windows. Tamura and Wilson (1964) showed that leakage from windows and doors in houses constitute only about 20% of the total leakage. Leakage cracks and openings in walls and ceilings, especially at intersections of walls, floors, and ceilings, make a far greater contribution to total leakage. Depending on the particular house, up to 70% of the total leakage openings was in walls, and up to 67% was through the ceiling.

Holes for wiring or plumbing in upper plates of exterior walls and interior partitions may cause about 50% of the total leakage through the ceiling. An equivalent leakage area may develop from shrinkage of upper wall plates after construction. Substantial leakage openings can be caused by wood shrinkage or cantilevering of floor constructions at the foundation wall or second-floor level. Chimney or plumbing stack penetrations and access hatches or fans are also likely leakage locations. In some residential construction, more leakage has been found between a window frame and wall than between a window frame and sash. Unsealed joints in ductwork and around exhaust fan openings are also common leakage areas.

Not all cracks and openings can be sealed in existing houses, nor is absolutely tight construction achieved in new housing. However, an effort should be made to provide as tight an enclosure as possible to reduce leakage and so minimize potential condensation within the envelope. Such measures also reduce energy loss.

Air Leakage in Buildings

The direction and rate of air leakage through cracks and holes depends on the direction and magnitude of air pressure differences created by stack effect and wind, and by the action of chimneys, fans, and blowers. Most significant is the stack effect from the winter temperature difference between inside and outside. Warm inside air, lighter than cold outside air, rises and flows outward through cracks and openings in the upper walls and ceilings. Condensation occurs on contact with cold surfaces below the dew point. The magnitude of the pressures depends on the height of the heated space and the temperature difference, as indicated by Equation (9) and Figures 1 and 2, Chapter 23.

Air pressure differences created by wind may be of the same magnitude as those of stack effect for low-rise buildings in cold climates (see Figure 3, Chapter 23). Wind pressure acts inward over the windward walls and outward over leeward walls and walls parallel to the wind. Although suction pressures are generally created over all flat or sloped roofs, the sustained pressure difference from wind across the ceiling in a ventilated roof space is usually near zero.

Electrically Heated and Fuel-heated Houses

In electrically heated houses or houses without a chimney, the midwinter pattern of pressure differences from average wind and stack effect is likely to be similar to that shown in Figure 13. Out-

Table 2 Thermal Resistances of Plane Airspaces[a,b,c], °F · ft² · h/Btu (*Concluded*)

Position of Airspace	Direction of Heat Flow	Airspace Mean Temp.[d], °F	Airspace Temp. Diff.[d], °F	1.5-in. Airspace[c] Effective Emittance, E[d,e] 0.03	0.05	0.2	0.5	0.82	3.5-in. Airspace[c] Effective Emittance, E[d,e] 0.03	0.05	0.2	0.5	0.82
Horiz.	Up ↑	90	10	2.55	2.41	1.71	1.08	0.77	2.84	2.66	1.83	1.13	0.80
		50	30	1.87	1.81	1.45	1.04	0.80	2.09	2.01	1.58	1.10	0.84
		50	10	2.50	2.40	1.81	1.21	0.89	2.80	2.66	1.95	1.28	0.93
		0	20	2.01	1.95	1.63	1.23	0.97	2.25	2.18	1.79	1.32	1.03
		0	10	2.43	2.35	1.90	1.38	1.06	2.71	2.62	2.07	1.47	1.12
		−50	20	1.94	1.91	1.68	1.36	1.13	2.19	2.14	1.86	1.47	1.20
		−50	10	2.37	2.31	1.99	1.55	1.26	2.65	2.58	2.18	1.67	1.33
45° Slope	Up ↗	90	10	2.92	2.73	1.86	1.14	0.80	3.18	2.96	1.97	1.18	0.82
		50	30	2.14	2.06	1.61	1.12	0.84	2.26	2.17	1.67	1.15	0.86
		50	10	2.88	2.74	1.99	1.29	0.94	3.12	2.95	2.10	1.34	0.96
		0	20	2.30	2.23	1.82	1.34	1.04	2.42	2.35	1.90	1.38	1.06
		0	10	2.79	2.69	2.12	1.49	1.13	2.98	2.87	2.23	1.54	1.16
		−50	20	2.22	2.17	1.88	1.49	1.21	2.34	2.29	1.97	1.54	1.25
		−50	10	2.71	2.64	2.23	1.69	1.35	2.87	2.79	2.33	1.75	1.39
Vertical	Horiz. →	90	10	3.99	3.66	2.25	1.27	0.87	3.69	3.40	2.15	1.24	0.85
		50	30	2.58	2.46	1.84	1.23	0.90	2.67	2.55	1.89	1.25	0.91
		50	10	3.79	3.55	2.39	1.45	1.02	3.63	3.40	2.32	1.42	1.01
		0	20	2.76	2.66	2.10	1.48	1.12	2.88	2.78	2.17	1.51	1.14
		0	10	3.51	3.35	2.51	1.67	1.23	3.49	3.33	2.50	1.67	1.23
		−50	20	2.64	2.58	2.18	1.66	1.33	2.82	2.75	2.30	1.73	1.37
		−50	10	3.31	3.21	2.62	1.91	1.48	3.40	3.30	2.67	1.94	1.50
45° Slope	Down ↘	90	10	5.07	4.55	2.56	1.36	0.91	4.81	4.33	2.49	1.34	0.90
		50	30	3.58	3.36	2.31	1.42	1.00	3.51	3.30	2.28	1.40	1.00
		50	10	5.10	4.66	2.85	1.60	1.09	4.74	4.36	2.73	1.57	1.08
		0	20	3.85	3.66	2.68	1.74	1.27	3.81	3.63	2.66	1.74	1.27
		0	10	4.92	4.62	3.16	1.94	1.37	4.59	4.32	3.02	1.88	1.34
		−50	20	3.62	3.50	2.80	2.01	1.54	3.77	3.64	2.90	2.05	1.57
		−50	10	4.67	4.47	3.40	2.29	1.70	4.50	4.32	3.31	2.25	1.68
Horiz.	Down ↓	90	10	6.09	5.35	2.79	1.43	0.94	10.07	8.19	3.41	1.57	1.00
		50	30	6.27	5.63	3.18	1.70	1.14	9.60	8.17	3.86	1.88	1.22
		50	10	6.61	5.90	3.27	1.73	1.15	11.15	9.27	4.09	1.93	1.24
		0	20	7.03	6.43	3.91	2.19	1.49	10.90	9.52	4.87	2.47	1.62
		0	10	7.31	6.66	4.00	2.22	1.51	11.97	10.32	5.08	2.52	1.64
		−50	20	7.73	7.20	4.77	2.85	1.99	11.64	10.49	6.02	3.25	2.18
		−50	10	8.09	7.52	4.91	2.89	2.01	12.98	11.56	6.36	3.34	2.22

[a]See Chapter 20, section on "Factors Affecting Heat Transfer Across Airspaces." Thermal resistance values were determined from the relation, $R = 1/C$, where $C = h_c + Eh_r$; h_c is the conduction-convection coefficient, Eh_r is the radiation coefficient $\equiv 0.00686E[(t_m + 460)/100]^3$, and t_m is the mean temperature of the airspace. Values for h_c were determined from data developed by Robinson *et al.* (1954). Equations 5 through 7 in Yarbrough (1983) show the data in Table 2 in analytic form. For extrapolation from Table 2 to airspaces less than 0.5 in. (as in insulating window glass), assume

$$h_c = 0.159(1 + 0.0016\,t_m)/l$$

where l is the airspace thickness in in., and h_c is heat transfer through the airspace only.

[b]Values are based on data presented by Robinson *et al.* (1954). (Also see Chapter 3, Tables 3 and 4, and Chapter 39). Values apply for ideal conditions, *i.e.*, airspaces of uniform thickness bounded by plane, smooth, parallel surfaces with no air leakage to or from the space. When accurate values are required, use overall U-factors determined through calibrated hot box (ASTM C 976) or guarded hot box (ASTM C 236) testing. Thermal resistance values for multiple airspaces must be based on careful estimates of mean temperature differences for each airspace.

[c]A single resistance value cannot account for multiple airspaces; each airspace requires a separate resistance calculation that applies only for the established boundary conditions. Resistances of horizontal spaces with heat flow downward are substantially independent of temperature difference.

[d]Interpolation is permissible for other values of mean temperature, temperature difference, and effective emittance E. Interpolation and moderate extrapolation for airspaces greater than 3.5 in. are also permissible.

[e]Effective emittance E of the airspace is given by $1/E = \epsilon_1 + 1/\epsilon_2 - 1$ where ϵ_1 and ϵ_2 are the emittances of the surfaces of the airspace (see Table 3).

Wood Frame Walls

The average overall R-values and U-factors of wood frame walls can be calculated by assuming parallel heat flow paths through areas with different thermal resistances. Equations (1) through (5) from Chapter 20 are used.

For simple stud walls 16 in. on center (OC), the fraction of framing is assumed to be approximately 0.15; for studs 24 in. OC, approximately 0.12. These fractions contain an allowance for multiple studs, plates, sills, and extra framing around windows and doors but do not allow for headers or band joists.

Example 1. Calculate the U-factor of the 2 by 4 stud wall shown in Figure 2. The studs are at 16 in. OC. There is a 3.5- in. mineral fiber batt insulation (R-11) in the stud space. The inside finish is 0.5-in. gypsum board; the outside is finished with 0.5-in. vegetable fiber board sheathing and 0.5-in. by 8-in. wood lapped siding. The framing occupies approximately 15% of the transmission area.

Solution: Obtain the R-value of the various building elements from Tables 1 and 4.

Element	R(Insulation)	R(Framing)
1. Outside surface (15 mph wind)	0.17	0.17
2. Wood bevel lapped siding	0.81	0.81
3. 0.5-in. sheathing	1.32	1.32
4. 3.5-in. mineral fiber batt insulation	11	—
5. Nominal 2 by 4 wood stud	—	4.38
6. 0.5-in. gypsum wallboard	0.45	0.45
7. Inside surface (still air)	0.68	0.68
	$R_1 = 14.43$	$R_2 = 7.81$

Therefore $U_1 = 0.069$; $U_2 = 0.128$ Btu/h · ft² · °F.

If the wood framing (*i.e.*, thermal bridging) is not included, Equation (3) from Chapter 20 may be used to calculate the U-factor of the wall as follows:

$$U_{av} = U_1 = 1/R_1 = 0.069 \text{ Btu/h} \cdot \text{ft}^2 \cdot ^\circ\text{F}$$

If the wood framing is accounted for using the parallel flow method, the U-factor of the wall is determined using Equation (5) from Chapter 20 as follows:

$$U_{av} = (0.85 \times 0.069) + (0.15 \times 0.128) = 0.078 \text{ Btu/h} \cdot \text{ft}^2 \cdot ^\circ\text{F}$$

If the wood framing is included using the isothermal planes method, the U-factor of the wall is determined using Equations (2) and (3) from Chapter 20 as follows:

$$R_{T(av)} = 2.30 + 1/[(0.85/11.00) + (0.15/4.38)] + 1.13$$
$$= 12.44 \text{ F} \cdot \text{ft}^2 \cdot \text{h/Btu}$$
$$U_{av} = 0.080 \text{ Btu/h} \cdot \text{ft}^2 \cdot \text{°F}$$

For a frame wall with a 24 in. OC stud space, the average overall R-value becomes 13.16 °F· ft²· h/Btu. Similar calculation procedures can be used to evaluate other wall designs.

Masonry Walls

The average overall R-values of masonry walls can be estimated by assuming a combination of layers in series, one or more of which provides parallel paths. This method is used because heat flows laterally through block face shells so that transverse isothermal planes result. Average total resistance $R_{T(av)}$ is the sum of the resistances of the layers between such planes, each layer calculated as shown in Example 2.

Example 2. Calculate the overall thermal resistance and average U-factor of the 7-5/8-in. thick insulated concrete block wall shown in Figure 3. The two-core block has an average web thickness of 1-in. and a face shell thickness of 1-1/4-in. Overall block dimensions are 7-5/8 by 7-5/8 by 15-5/8 in. Thermal resistances of 112 lb/ft³ concrete and 5 lb/ft³ expanded perlite insulation are 0.10 and 2.90 °F· ft²· h/Btu per in., respectively.

Solution: The equation used to determine the overall thermal resistance of the insulated concrete block wall is derived from Equations (2) and (5) from Chapter 20 and is given below:

$$R_{T(av)} = R_i + R_f + \frac{R_w R_c}{a_c R_w + a_w R_c} + R_o$$

where

$R_{T(av)}$ = overall thermal resistance based on the assumption of isothermal planes
R_i = thermal resistance of inside air surface film (still air)
R_o = thermal resistance of outside air surface film (15 mph wind)
R_f = total thermal resistance of face shells
R_c = thermal resistance of cores between face shells
R_w = thermal resistance of webs between face shells
a_w = fraction of total area transverse to heat flow represented by webs of blocks
a_c = fraction of total area transverse to heat flow represented by cores of blocks

From the information given and the data in Table 1, determine the values needed to compute the overall thermal resistance.

$R_i = 0.68$
$R_o = 0.17$
$R_f = (2)(1.25)(0.10) = 0.25$
$R_c = (5.125)(2.90) = 14.86$
$R_w = (5.125)(0.10) = 0.51$
$a_w = 3/15.625 = 0.192$
$a_c = 12.625/15.625 = 0.808$

Using the equation given, the overall thermal resistance and average U-factor are calculated as follows:

$$R_{T(av)} = 0.68 + 0.25 + (0.51)(14.86)/[(0.808)(0.51) + (0.192)(14.86)] + 0.17$$
$$= 0.68 + 0.25 + 2.33 + 0.17 = 3.43 \text{ °F} \cdot \text{ft}^2 \cdot \text{h/Btu}$$
$$U_{av} = 1/3.43 = 0.292 \text{ Btu/h} \cdot \text{ft}^2 \cdot \text{°F}$$

Based on guarded hot box tests, Van Geem (1985) measured the average R-value for this insulated concrete block wall as 3.13 °F· ft²· h/Btu.

Assuming parallel heat flow only, the calculated resistance is usually higher than that calculated on the assumption of isothermal planes. The actual resistance generally is some value between the two calculated values. In the absence of test values, examination of the construction usually reveals whether a value closer to the higher or lower calculated R-value should be used. Generally, if the construction contains a layer in which lateral conduction is high compared with transmittance through the construction, the calculation with isothermal planes should be used. If the construction has no layer of high lateral conductance, the parallel heat flow calculation should be used.

Hot box tests of insulated and uninsulated masonry walls constructed with block of conventional configuration show that thermal resistances calculated using the isothermal planes heat flow

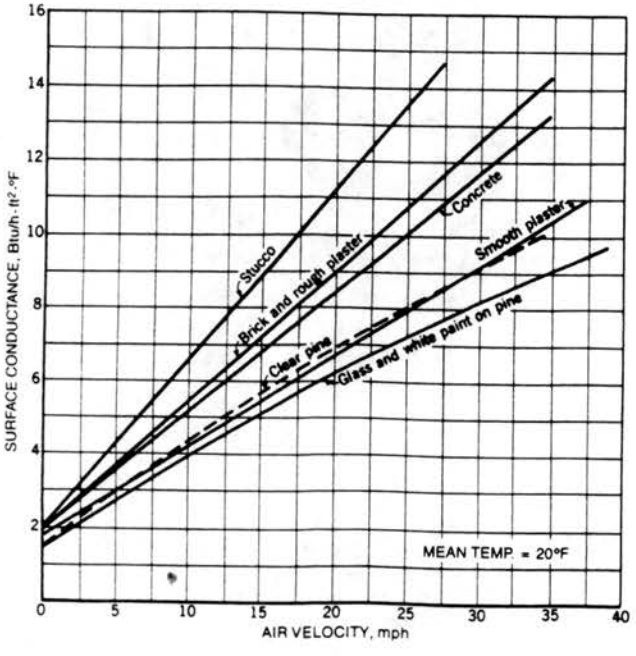
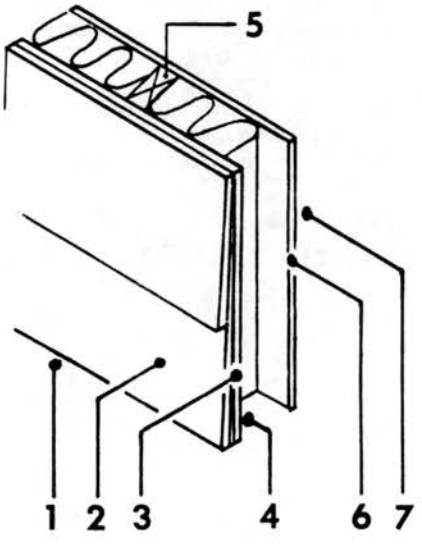


Fig. 1 Surface Conductance for Different 12-Inch-Square Surfaces as Affected by Air Movement



1. Outside surface (15 mph wind)
2. Wood siding, 0.5 in. by 8 in. lapped
3. Sheating, 0.5 in. vegetable fiber board
4. Mineral fiber batt insulation, 3.5 in.
5. Nominal 2 by 4 wood stud
6. Gypsum wallboard, 0.5 in.
7. Inside surface (still air)

Fig. 2 Insulated Wood Frame Wall (Example 1)

method agree well with measured values (see Van Geem 1985, Valore 1980, Shu *et al.* 1979). Neglecting horizontal mortar joints can result in thermal transmittance values up to 16% lower than actual, depending on the density and thermal properties of the masonry, and 1 to 6% lower depending on the core insulation material (Van Geem 1985, McIntyre 1984). Horizontal mortar joints usually found in concrete block wall construction are neglected in Example 2.

Panels Containing Metal

Curtain wall constructions often include metallic and other thermal bridges. Thermal resistance of panels can be significantly reduced by metallic thermal bridges. However, the capacity of the adjacent facing materials to transmit heat transversely to the metal is limited, and some contact resistance between all materials in contact limits the reduction. Contact resistances in building structures are only 0.06 to 0.6 °F·ft²·h/Btu which are too small to be of concern in many cases. However, the contact resistances of steel framing members are important to consider. Also, in many cases (as illustrated in Example 3) the area of metal in contact with the facing greatly exceeds the thickness of the metal which mitigates the influence.

Thermal characteristics for panels of sandwich construction can be computed by combining the thermal resistances of the various layers. However, few panels are true sandwich constructions; many have ribs and stiffeners that create complicated heat flow paths. R-values for the assembled sections should be determined on a representative sample by using a hot box method. If the sample is a wall section with air cavities on both sides of fibrous insulation, the sample must be of representative height since convective airflow can contribute significantly to heat flow through the test section. Computer modeling can also be useful, but all heat transfer mechanisms must be considered.

In Example 3, the metal member is only 0.020 in. thick, but it is in contact with adjacent facings over a 1.25 in.-wide area. The steel member is 3.50 in. deep, has a thermal resistance of approximately 0.011 °F·ft²·h/Btu, and is virtually isothermal. The calculation involves careful selection of the appropriate thickness for the steel member. If the member is assumed to be 0.020 in. thick, the fact that the flange transmits heat to the adjacent facing is ignored. If the member is assumed to be 1.25 in. thick, the heat flow through the steel is overestimated. In Example 3, the steel member behaves in much the same way as a rectangular member 1.25 in. thick and 3.50 in. deep with a thermal resistance of 0.69 °F·ft²·h/Btu [(1.25/0.020) × 0.011] does. The Building Research Association of New Zealand (BRANZ) commonly uses this approximation.

Table 3 Emittance Values of Various Surfaces and Effective Emittances of Airspaces[a]

Surface	Average Emittance ϵ	Effective Emittance, E of Airspace: One surface emittance ϵ; the other 0.9	Effective Emittance, E of Airspace: Both surfaces emittance ϵ
Aluminum foil, bright	0.05	0.05	0.03
Aluminum foil, with condensate just visible (> 0.7gr/ft²)	0.30[b]	0.29	—
Aluminum foil, with condensate clearly visible (> 2.9 gr/ft²)	0.70[b]	0.65	—
Aluminum sheet	0.12	0.12	0.06
Aluminum coated paper, polished	0.20	0.20	0.11
Steel, galvanized, bright	0.25	0.24	0.15
Aluminum paint	0.50	0.47	0.35
Building materials: wood, paper, masonry, nonmetallic paints	0.90	0.82	0.82
Regular glass	0.84	0.77	0.72

[a]These values apply in the 4 to 40 μm range of the electromagnetic spectrum.
[b]Values are based on data presented by Bassett and Trethowen (1984).

Example 3. Calculate the C-factor of the insulated steel frame wall shown in Figure 4. Assume that the steel member has an R-value of 0.69 °F·ft²·h/Btu and that the framing behaves as though it occupies approximately 8% of the transmission area.

Solution: Obtain the R-values of the various building elements from Table 4.

Element	R(Insulation)	R(Framing)
1. 0.5-in. gypsum wallboard	0.45	0.45
2. 3.5-in. mineral fiber batt insulation	11	—
3. Steel framing member	—	0.69
4. 0.5-in. gypsum wallboard	0.45	0.45
	R_1 = 11.90	R_2 = 1.59

Therefore, $C_1 = 0.084$; $C_2 = 0.629$ Btu/h·ft²·°F.

If the steel framing (*i.e.*, thermal bridging) is not considered, the C-factor of the wall is calculated using Equation (3) from Chapter 20 as follows:

$$C_{av} = C_1 = 1/R_1 = 0.084 \text{ Btu/h·ft}^2\text{·°F}$$

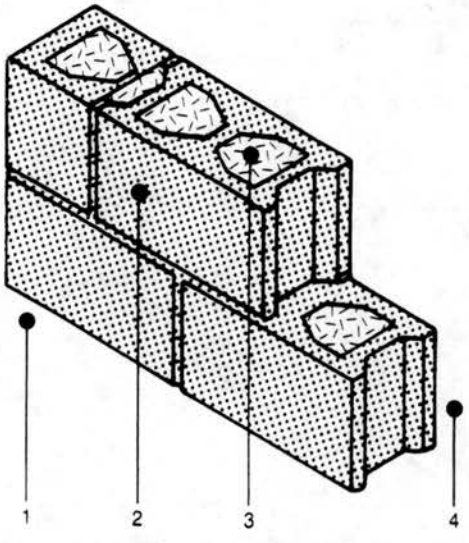
If the steel framing is accounted for using the parallel flow method, the C-factor of the wall is determined using Equation (5) from Chapter 20 as follows:

$$C_{av} = (0.92 \times 0.084) + (0.08 \times 0.629)$$
$$= 0.128 \text{ Btu/h·ft}^2\text{·°F}$$
$$R_{T(av)} = 7.81 \text{ °F·ft}^2\text{·h/Btu}$$

If the steel framing is included using the isothermal planes method, the C-factor of the wall is determined using Equations (2) and (3) from Chapter 20 as follows:

$$R_{T(av)} = 0.45 + 1/[(0.92/11.00) + (0.08/0.69)] + 0.45$$
$$= 5.91 \text{ °F·ft}^2\text{·h/Btu}$$
$$C_{av} = 0.169 \text{ Btu/h·ft}^2\text{·°F}$$

Farouk and Larson (1983) measured an average R-value of 6.61 °F·ft²·h/Btu for this insulated steel frame wall.



1. Outside surface (15 mph wind)
2. Concrete block
3. Expanded perlite insulation
4. Inside surface (still air)

Fig. 3 Insulated Concrete Block Wall (Example 2)

Table 4 Footnotes (*Concluded*)

$$k = 0.1791 + \frac{(1.874 \times 10^{-2} + 5.753 \times 10^{-4} M)\,\rho}{1 + 0.01M}$$

where ρ is density based on oven-dry mass in lb/ft^3 and M is the moisture content in percent.

[n]From Adams (1971), an empirical equation for the specific heat of moist wood at 75°F is as follows:

$$c_p = \frac{(0.299 + 0.01M)}{(1 + 0.01M)} + \Delta c_p$$

where Δc_p accounts for the heat of sorption and is denoted by

$$\Delta c_p = M\,(1.921 \times 10^{-3} - 3.168 \times 10^{-5} M)$$

where M is the moisture content in percent by mass.

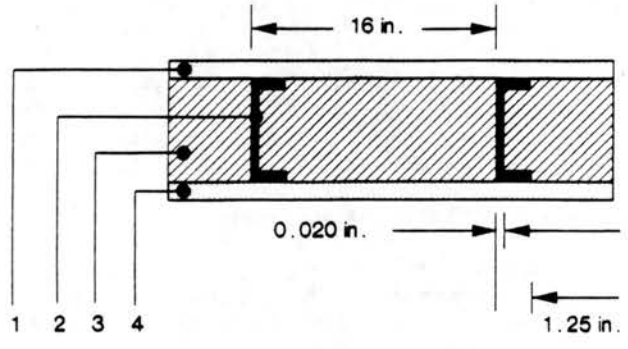


Fig. 4 Insulated Steel Frame Wall (Example 3)

The Zone Method of Calculation

For structures with widely spaced metal members of substantial cross-sectional area, calculation by the isothermal planes method can result in thermal resistance values that are too low. For these constructions, the Zone Method can be used. This method involves two separate computations—one for a chosen limited portion, Zone A, containing the highly conductive element; the other for the remaining portion of simpler construction, Zone B. The two computations are then combined using the parallel flow method, and the average transmittance per unit overall area is calculated. The basic laws of heat transfer are applied by adding the area conductances, CA, of elements in parallel, and adding area resistances, R/A, of elements in series.

The surface shape of Zone A is determined by the metal element. For a metal beam (see Figure 5), the Zone A surface is a strip of width W that is centered on the beam. For a rod perpendicular to panel surfaces, it is a circle of diameter W. The value of W is calculated from Equation (1), which is empirical. The value of d should not be less than 0.5 in. for still air.

$$W = m + 2d \qquad (1)$$

where

m = width or diameter of the metal heat path terminal, in.
d = distance from panel surface to metal, in.

Generally, the value of W should be calculated using Equation (1) for each end of the metal heat path; the larger value, within the limits of the basic area, should be used as illustrated in Example 4.

Example 4. Calculate transmittance of the roof deck shown in Figure 5. Tee-bars at 24 in. OC support glass fiber form boards, gypsum concrete, and built-up roofing. Conductivities of components are: steel, 314.4 Btu·in./h·ft^2·°F; gypsum concrete, 1.66 Btu·in./h·ft^2·°F; and glass fiber form board, 0.25 Btu·in./h·ft^2·°F. Conductance of built-up roofing is 3.00 Btu/h·ft^2·°F.

Solution: The basic area is 2 ft^2 (24 in. by 12 in.) with a tee-bar (12-in. long) across the middle. This area is divided into *Zones A* and *B*.

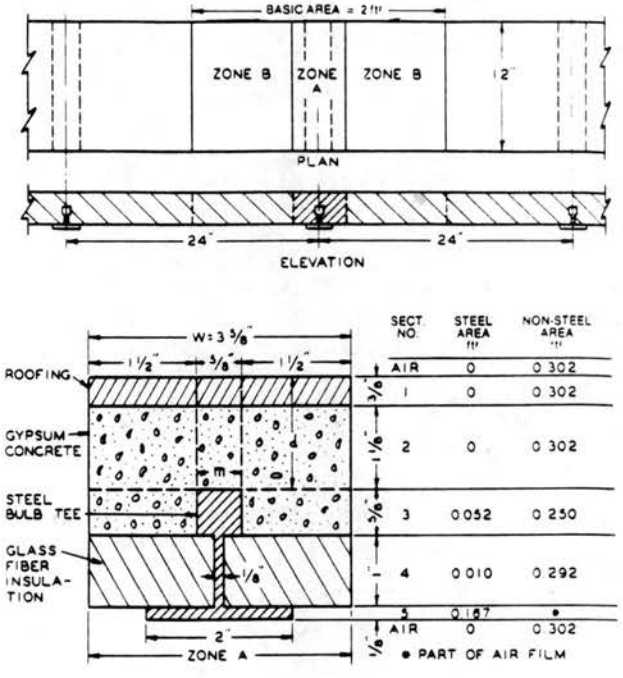


Fig. 5 Gypsum Roof Deck on Bulb Tees (Example 4)

Zone A is determined from Equation 1 as follows:

Top side $W = m + 2d = 0.625 + (2 \times 1.5) = 3.625$ in.
Bottom side $W = m + 2d = 2.0 + (2 \times 0.5) = 3.0$ in.

Using the larger value of W, the area of *Zone A* is $(12 \times 3.625)/144 = 0.302$ ft^2. The area of *Zone B* is $2.0 - 0.302 = 1.698$ ft^2.

To determine area transmittance for *Zone A*, divide the structure within the zone into five sections parallel to the top and bottom surfaces (Figure 5). The area conductance, CA, of each section is calculated by adding the area conductances of its metal and nonmetal paths. Area conductances of the sections are converted to area resistances, R/A, and added to obtain the total resistance of *Zone A*.

Section	Area × Conductance	= CA	$\frac{1}{CA} = \frac{R}{A}$
Air (outside, 15 mph)	0.302 × 6.00	1.81	0.55
No. 1, Roofing	0.302 × 3.00	0.906	1.10
No. 2, Gypsum concrete	0.302 × 1.66/1.125	0.446	2.24
No. 3, Steel	0.052 × 314.4/0.625	26.2	0.04
No. 3, Gypsum concrete	0.250 × 1.66/0.625	0.664	
No. 4, Steel	0.010 × 314.4/1.00	3.14	0.31
No. 4, Glass fiberboard	0.292 × 0.25/1.00	0.073	
No. 5 Steel	0.167 × 314.4/0.125	420.0	0.002
Air (inside)	0.302 × 1.63	0.492	2.03
			Total R/A = [illegible]

Area transmittance of *Zone A* = $1/(R/A) = 1/6.27 = 0.159$.

For *Zone B*, the unit resistances are added and then converted to area transmittance, as shown in the following table.

Section	Resistance, *R*
Air (outside, 15 mph)	1/6.00 = 0.17
Roofing	1/3.00 = 0.33
Gypsum concrete	1.75/1.66 = 1.05
Glass fiberboard	1.00/0.25 = 4.00
Air (inside)	1/1.63 = 0.61
Total resistance	= 6.16

Since unit transmittance = $1/R = 0.162$, the total area transmittance, *UA*, is calculated as follows:

Zone B = 1.698 × 0.162	= 0.275
Zone A =	0.159
Total area transmittance of basic area	= 0.434
Transmittance per ft² = 0.434/2.0	= 0.217
Resistance per ft²	= 4.61

Overall R-values of 4.57 and 4.85 °F·ft²·h/Btu have been measured in two guarded hot box tests of a similar construction.

When the steel member represents a relatively large proportion of the total heat flow path, as in Example 4, detailed calculations of resistance in sections 3, 4, and 5 of Zone A are unnecessary; if only the steel member is considered, the final result of Example 4 is the same. However, if the heat flow path represented by the steel member is small, as for a tie rod, detailed calculations for sections 3, 4, and 5 are necessary. A panel with an internal metallic structure and bonded on one or both sides to a metal skin or covering, presents special problems of lateral heat flow not covered in the zone method.

Ceilings and Roofs

The overall R-value for ceilings of wood frame flat roofs can be calculated using Equations (1) through (5) from Chapter 20. Properties of the materials are found in Tables 1, 2, 3, and 4. The fraction of framing is assumed to be 0.10 for joists at 16 in. OC and 0.07 for joists at 24 in. OC. The calculation procedure is similar to that shown in Example 1. Note that if the ceiling contains plane airspaces (see Table 2), the resistance depends on the direction of heat flow, *i.e.*, whether the calculation is for a winter (heat flow up) or summer (heat flow down) condition.

For ceilings of pitched roofs under winter conditions, calculate the R-value of the ceiling using the procedure for flat roofs. The heat loss from these ceilings can be obtained using a calculated attic temperature (see Chapter 25). Table 5 can be used to determine the effective resistance of the attic space under summer conditions for varying conditions of ventilation air temperature, airflow direction and rates, ceiling resistance, roof or sol-air temperatures, and surface emittances (Joy 1958).

Table 5 Effective Thermal Resistance of Ventilated Attics[a] (Summer Condition)

PART A. NONREFLECTIVE SURFACES

		No Ventilation[b]		Natural Ventilation				Power Ventilation[c]			
		Ventilation Rate, cfm/ft²									
		0		0.1[d]		0.5		1.0		1.5	
		Ceiling Resistance, R[e], °F·ft²·h/Btu									
Ventilation Air Temp., °F	Sol-Air[f] Temp., °F	10	20	10	20	10	20	10	20	10	20
80	120	1.9	1.9	2.8	3.4	6.3	9.3	9.6	16	11	20
	140	1.9	1.9	2.8	3.5	6.5	10	9.8	17	12	21
	160	1.9	1.9	2.8	3.6	6.7	11	10	18	13	22
90	120	1.9	1.9	2.5	2.8	4.6	6.7	6.1	10	6.9	13
	140	1.9	1.9	2.6	3.1	5.2	7.9	7.6	12	8.6	15
	160	1.9	1.9	2.7	3.4	5.8	9.0	8.5	14	10	17
100	120	1.9	1.9	2.2	2.3	3.3	4.4	4.0	6.0	4.1	6.9
	140	1.9	1.9	2.4	2.7	4.2	6.1	5.8	8.7	6.5	10
	160	1.9	1.9	2.6	3.2	5.0	7.6	7.2	11	8.3	13
PART B. REFLECTIVE SURFACES[g]											
80	120	6.5	6.5	8.1	8.8	13	17	17	25	19	30
	140	6.5	6.5	8.2	9.0	14	18	18	26	20	31
	160	6.5	6.5	8.3	9.2	15	18	19	27	21	32
90	120	6.5	6.5	7.5	8.0	10	13	12	17	13	19
	140	6.5	6.5	7.7	8.3	12	15	14	20	16	22
	160	6.5	6.5	7.9	8.6	13	16	16	22	18	25
100	120	6.5	6.5	7.0	7.4	8.0	10	8.5	12	8.8	12
	140	6.5	6.5	7.3	7.8	10	12	11	15	12	16
	160	6.5	6.5	7.6	8.2	11	14	13	18	15	20

[a] Although the term effective resistance is commonly used when there is attic ventilation, this table includes values for situations with no ventilation. The effective resistance of the attic, added to the resistance ($1/U$) of the ceiling yields the effective resistance of this combination based on sol-air (see Chapter 26) and room temperatures. These values apply to wood frame construction with a roof deck and roofing that has a conductance of 1.0 Btu/h·ft²·°F.

[b] This condition cannot be achieved in the field unless extreme measures are taken to tightly seal the attic.

[c] Based on air discharging outward from attic.

[d] When attic ventilation meets the requirements stated in Chapter 23, 0.1 cfm/ft² is assumed as the natural summer ventilation rate for design purposes.

[e] When determining ceiling resistance, do not add the effect of a reflective surface facing the attic, as it is accounted for in Table 5, Part B.

[f] Roof surface temperature rather than sol-air temperature (see Chapter 26) can be used if 0.25 is subtracted from the attic resistance shown.

[g] Surfaces with effective emittance *E* of 0.05 between ceiling joists facing the attic space.

TABLE 1 CLIMATIC CONDITIONS FOR THE UNITED STATES (*Continued*)

Col. 1	Col. 2	Col. 3	Col. 4	Winter,[b] °F Col. 5		Summer,[c] °F Col. 6			Col. 7	Col. 8			Prevailing Wind Col. 9		Temp. °F Col. 10	
State and Station[a]	Lat.	Long.	Elev.	Design Dry-Bulb		Design Dry-Bulb and Mean	Coincident	Wet-Bulb	Mean Daily	Design Wet-Bulb			Winter	Summer	Median of Annual Extr.	
	° ′	° ′	Feet	99%	97.5%	1%	2.5%	5%	Range	1%	2.5%	5%	Knots[d]		Max.	Min.
MICHIGAN																
Adrian	41 55	84 01	754	− 1	3	91/73	88/72	85/71	23	76	75	73			97.2	− 7.0
Alpena AP	45 04	83 26	610	− 11	− 6	89/70	85/70	83/69	27	73	72	70	W 5	SW	93.9	− 14.8
Battle Creek AP	42 19	85 15	941	1	5	92/74	88/72	85/70	23	76	74	73	SW 8	SW		
Benton Harbor AP	42 08	86 26	643	1	5	91/72	88/72	85/70	20	75	74	72	SSW 8	WSW		
Detroit	42 25	83 01	619	3	6	91/73	88/72	86/71	20	76	74	73	W 11	SW	95.1	− 2.6
Escanaba	45 44	87 05	607	− 11	− 7	87/70	83/69	80/68	17	73	71	69			88.8	− 16.1
Flint AP	42 58	83 44	771	− 4	1	90/73	87/72	85/71	25	76	74	72	SW 8	SW	95.3	− 9.9
Grand Rapids AP	42 53	85 31	784	1	5	91/72	88/72	85/70	24	75	74	72	WNW 8	WSW	95.4	− 5.6
Holland	42 42	86 06	678	2		88/72	86/71	83/70	22	75	73	72			94.1	− 6.8
Jackson AP	42 16	84 28	1020	1	5	92/74	88/72	85/70	23	76	74	73			96.5	− 7.8
Kalamazoo	42 17	85 36	955	1	5	92/74	88/72	85/70	23	76	74	73			95.9	− 6.7
Lansing AP	42 47	84 36	873	− 3	1	90/73	87/72	84/70	24	75	74	72	SW 12	W	94.6	− 11.0
Marquette Co	46 34	87 24	735	− 12	− 8	84/70	81/69	77/66	18	72	70	68			94.5	− 11.8
Mt Pleasant	43 35	84 46	796	0	4	91/73	87/72	84/71	24	76	74	72			95.4	− 11.1
Muskegon AP	43 10	86 14	625	2	6	86/72	84/70	82/70	21	75	73	72	E 8	SW		
Pontiac	42 40	83 25	981	0	4	90/73	87/72	85/71	21	76	74	73			95.0	− 6.8
Port Huron	42 59	82 25	586	0	4	90/73	87/72	83/71	21	76	74	73	W 8	S		
Saginaw AP	43 32	84 05	667	0	4	91/73	87/72	84/71	23	76	74	72	WSW 7	SW	96.1	− 7.6
Sault Ste. Marie AP (S)	46 28	84 22	721	− 12	− 8	84/70	81/69	77/66	23	72	70	68	E 7	SW	89.8	− 21.0
Traverse City AP	44 45	85 35	624	− 3	1	89/72	86/71	83/69	22	75	73	71	SSW 9	SW	95.4	− 10.7
Ypsilanti	42 14	83 32	716	1	5	92/72	89/71	86/70	22	75	74	72	SW 10	SW		
MINNESOTA																
Albert Lea	43 39	93 21	1220	− 17	− 12	90/74	87/72	84/71	24	77	75	73				
Alexandria AP	45 52	95 23	1430	− 22	− 16	91/72	88/72	85/70	24	76	74	72			95.1	− 28.0
Bemidji AP	47 31	94 56	1389	− 31	− 26	88/69	85/69	81/67	24	73	71	69	N 8	S	94.5	− 36.9
Brainerd	46 24	94 08	1227	− 20	− 16	90/73	87/71	84/69	24	75	73	71				
Duluth AP	46 50	92 11	1428	− 21	− 16	85/70	82/68	79/66	22	72	70	68	WNW 12	WSW	90.9	− 27.4
Fairbault	44 18	93 16	940	17	− 12	91/74	88/72	85/71	24	77	75	73			95.8	− 24.3
Fergus Falls	46 16	96 04	1210	− 21	− 17	91/72	88/72	85/70	24	76	74	72			96.9	− 27.8
International Falls AP	48 34	93 23	1179	− 29	− 25	85/68	83/68	80/66	26	71	70	68	N 9	S	93.4	− 36.5
Mankato	44 09	93 59	1004	− 17	− 12	91/72	88/72	85/70	24	77	75	73				
Minneapolis/St. Paul AP	44 53	93 13	834	− 16	− 12	92/75	89/73	86/71	22	77	75	73	NW 8	S	96.5	− 22.0
Rochester AP	43 55	92 30	1297	− 17	− 12	90/74	87/72	84/71	24	77	75	73	NW 9	SSW		
St. Cloud AP (S)	45 35	94 11	1043	− 15	− 11	91/74	88/72	85/70	24	76	74	72				
Virginia	47 30	92 33	1435	− 25	− 21	85/69	83/68	80/66	23	71	70	68			92.6	− 33.0
Willmar	45 07	95 05	1128	− 15	− 11	91/74	88/72	85/71	24	76	74	72			96.8	− 24.3
Winona	44 03	91 38	652	− 14	− 10	91/75	88/73	85/72	24	77	75	74				
MISSISSIPPI																
Biloxi, Keesler AFB	30 25	88 55	26	28	31	94/79	92/79	90/78	16	82	81	80	N 8	S	23	98
Clarksdale	34 12	90 34	178	14	19	96/77	94/77	92/76	21	80	79	78			100.9	13.2
Columbus AFB	33 39	88 27	219	15	20	95/77	93/77	91/76	22	80	79	78	N 7	W	101.6	12.7
Greenville AFB	33 29	90 59	138	15	20	95/77	93/77	91/76	21	80	79	78			99.5	14.9
Greenwood	33 30	90 05	148	15	20	95/77	93/77	91/76	21	80	79	78			100.6	15.3
Hattiesburg	31 16	89 15	148	24	27	96/78	94/77	92/77	21	81	80	79			99.9	18.2
Jackson AP	32 19	90 05	310	21	25	97/76	95/76	93/76	21	79	78	78	NNW 6	NW	99.8	16.0
Laurel	31 40	89 10	236	24	27	96/78	94/77	92/77	21	81	80	79			99.7	17.8
Mccomb AP	31 15	90 28	469	21	26	96/77	94/76	92/76	18	80	79	78				
Meridian AP	32 20	88 45	290	19	23	97/77	95/76	93/76	22	80	79	78	N 6	WSW	98.3	15.7
Natchez	31 33	91 23	195	23	27	96/78	94/78	92/77	21	81	80	79			98.4	18.4
Tupelo	34 16	88 46	361	14	19	96/77	94/77	92/76	22	80	79	78			100.7	11.8
Vicksburg Co	32 24	90 47	262	22	26	97/78	95/78	93/77	21	81	80	79			96.9	18.0
MISSOURI																
Cape Girardeau	37 14	89 35	351	8	13	98/76	95/75	92/75	21	79	78	77				
Columbia AP (S)	38 58	92 22	778	− 1	4	97/74	94/74	91/73	22	78	77	76	WNW 9	WSW	99.5	− 6.2
Farmington AP	37 46	90 24	928	3	8	96/76	93/75	90/74	22	78	77	75			99.9	− 2.1
Hannibal	39 42	91 21	489	− 2	3	96/76	93/76	90/76	22	80	78	77	NNW 11	SSW	98.4	− 7.6
Jefferson City	38 34	92 11	640	2	7	98/75	95/74	92/74	23	78	77	76			101.2	− 6.1
Joplin AP	37 09	94 30	980	6	10	100/73	97/73	94/73	24	78	77	76	NNW 12	SSW		
Kansas City AP	39 07	94 35	791	2	6	99/75	96/74	93/74	20	78	77	76	NW 9	S	100.2	− 4.3
Kirksville AP	40 06	92 33	964	− 5	0	96/74	93/74	90/73	24	78	77	76			98.3	− 10.8
Mexico	39 11	91 54	775	− 1	4	97/74	94/74	91/73	22	78	77	76			101.2	− 8.0
Moberly	39 24	92 26	850	− 2	3	97/74	94/74	91/73	23	78	77	76				
Poplar Bluff	36 46	90 25	380	11	16	98/78	95/76	92/76	22	81	79	78				
Rolla	37 59	91 43	1204	3	9	94/77	91/75	89/74	22	78	77	76			99.4	− 3.1
St. Joseph AP	39 46	94 55	825	− 3	2	96/77	93/76	91/76	23	81	79	77	NNW 9	S	100.6	− 8.0
St. Louis AP	38 45	90 23	535	2	6	97/75	94/75	91/74	21	78	77	76	NW 9	WSW		
St. Louis Co	38 39	90 38	462	3	8	98/75	94/75	91/74	18	78	77	76	NW 6	S	99.1	− 2.7
Sikeston	36 53	89 36	325	9	15	98/77	95/76	92/75	21	80	78	77				
Sedalia, Whiteman AFB	38 43	93 33	869	− 1	4	95/76	92/76	90/75	22	79	78	76	NNW 7	SSW	100.0	− 5.1
Sikeston	36 53	89 36	325	9	15	98/77	95/76	92/75	21	80	78	77				
Springfield AP	37 14	93 23	1268	3	9	96/73	93/74	91/74	23	78	77	75	NNW 10	S	97.2	− 2.4

Table 13 Overall Coefficients of Heat Transmission of Various Fenestration Products

Part A: U-Values for Vertical Installation[a], Btu/h·ft²·°F

Glazing Type[b]	Glass Only: Center of Glass	Glass Only: Edge[c] of Glass	Aluminum Frame no thermal break ($U_f = 1.9$): Product[d] Type R	Aluminum Frame no thermal break ($U_f = 1.9$): Product[d] Type C	Aluminum Frame thermal break ($U_f = 1.0$): Product[d] Type R	Aluminum Frame thermal break ($U_f = 1.0$): Product[d] Type C	Wood or Vinyl Frame ($U_f = 0.4$): Product[d] Type R	Wood or Vinyl Frame ($U_f = 0.4$): Product[d] Type C
Single glazing								
glass	(1.11)	(n/a)	1.31	1.23	1.09	1.10	0.90	0.98
1/8 in. acrylic	(1.03)	(n/a)	1.26	1.16	1.02	1.03	0.84	0.92
Double glass								
1/4 in. air space	(0.57)	(0.66)	0.92	0.78	0.70	0.65	0.54	0.55
3/8 in. air space	(0.52)	(0.62)	0.88	0.74	0.66	0.60	0.50	0.51
1/2 in. and greater air space	(0.49)	(0.59)	0.87	0.72	0.64	0.59	0.49	0.49
Double glass, $\varepsilon = 0.40$ on surface 2 or 3								
1/4 in. air space	(0.50)	(0.60)	0.87	0.73	0.65	0.59	0.49	0.50
3/8 in. air space	(0.43)	(0.55)	0.83	0.67	0.60	0.54	0.45	0.45
1/2 in. and greater air space	(0.41)	(0.54)	0.81	0.65	0.58	0.52	0.43	0.42
Double glass, $\varepsilon = 0.15$ on surface 2 or 3								
1/4 in. air space	(0.45)	(0.56)	0.84	0.68	0.61	0.55	0.46	0.46
3/8 in. air space	(0.36)	(0.51)	0.78	0.62	0.56	0.48	0.41	0.39
1/2 in. air space	(0.34)	(0.50)	0.76	0.60	0.54	0.46	0.39	0.37
Double glass								
1/4 in. argon space	(0.52)	(0.62)	0.88	0.74	0.66	0.61	0.50	0.51
3/8 in. argon space	(0.48)	(0.59)	0.86	0.71	0.63	0.57	0.48	0.48
1/2 in. and greater argon space	(0.46)	(0.57)	0.82	0.69	0.62	0.56	0.47	0.47
Double glass, $\varepsilon = 0.40$ on surface 2 or 3								
1/4 in. argon space	(0.43)	(0.55)	0.83	0.67	0.60	0.54	0.45	0.45
3/8 in. argon space	(0.38)	(0.52)	0.79	0.63	0.57	0.49	0.42	0.40
1/2 in. and greater argon space	(0.36)	(0.51)	0.78	0.62	0.56	0.48	0.41	0.39
Double glass, $\varepsilon = 0.15$ on surface 2 or 3								
1/4 in. argon space	(0.36)	(0.51)	0.78	0.62	0.56	0.48	0.41	0.39
3/8 in. argon space	(0.30)	(0.48)	0.74	0.57	0.51	0.43	0.37	0.34
1/2 in. and greater argon space	(0.28)	(0.47)	0.73	0.55	0.50	0.42	0.36	0.33
Double glazing, 1/8 in. acrylic or polycarbonate								
1/4 in. air space	(0.52)	(0.62)	0.89	0.74	0.67	0.61	0.51	0.51
3/8 in. air space	(0.48)	(0.59)	0.86	0.71	0.64	0.57	0.48	0.48
1/2 in. and greater air space	(0.46)	(0.57)	0.85	0.69	0.62	0.56	0.47	0.47
Double glazing, 1/4 in. acrylic or polycarbonate								
1/4 in. air space	(0.48)	(0.59)	0.86	0.71	0.64	0.57	0.48	0.48
3/8 in. air space	(0.44)	(0.56)	0.84	0.68	0.61	0.54	0.46	0.45
1/2 in. and greater air space	(0.42)	(0.54)	0.82	0.66	0.60	0.53	0.45	0.43
Triple glass								
1/4 in. air space	(0.38)	(0.52)	0.79	0.64	0.57	0.50	0.42	0.41
3/8 in. air space	(0.34)	(0.50)	0.76	0.60	0.54	0.46	0.39	0.38
1/2 in. and greater air space	(0.32)	(0.49)	0.75	0.58	0.53	0.45	0.38	0.36
Triple glass, $\varepsilon = 0.40$ on surface 2, 3, 4 or 5								
1/4 in. air spaces	(0.35)	(0.50)	0.77	0.61	0.55	0.48	0.40	0.39
3/8 in. air spaces	(0.30)	(0.48)	0.74	0.57	0.52	0.44	0.37	0.35
1/2 in. and greater air spaces	(0.28)	(0.47)	0.72	0.55	0.50	0.41	0.36	0.33
Triple glass or double glass with polyester film suspended in between, $\varepsilon = 0.15$ on surface 2, 3, 4, or 5								
1/4 in. air spaces	(0.33)	(0.49)	0.76	0.59	0.53	0.45	0.39	0.37
3/8 in. air spaces	(0.27)	(0.46)	0.72	0.54	0.50	0.41	0.35	0.32
1/2 in. and greater air spaces	(0.24)	(0.45)	0.70	0.52	0.48	0.39	0.34	0.30
Triple glass or double glass with polyester film suspended in between, $\varepsilon = 0.15$ on surfaces 2 or 3 and 4 or 5								
1/4 in. air spaces	(0.28)	(0.47)	0.73	0.55	0.53	0.42	0.36	0.33
3/8 in. air spaces	(0.22)	(0.45)	0.69	0.51	0.47	0.37	0.32	0.29
1/2 in. and greater air spaces	(0.19)	(0.44)	0.67	0.48	0.45	0.35	0.31	0.26
Triple glass								
1/4 in. argon spaces	(0.34)	(0.50)	0.77	0.60	0.54	0.46	0.39	0.38
3/8 in. argon spaces	(0.31)	(0.48)	0.74	0.57	0.52	0.44	0.37	0.35
1/2 in. and greater argon spaces	(0.29)	(0.47)	0.73	0.56	0.51	0.42	0.36	0.34
Triple glass, $\varepsilon = 0.40$ on surface 2, 3, 4 or 5								
1/4 in. argon spaces	(0.30)	(0.48)	0.74	0.57	0.52	0.44	0.37	0.35
3/8 in. argon spaces	(0.26)	(0.46)	0.72	0.54	0.49	0.41	0.35	0.32
1/2 in. and greater argon spaces	(0.25)	(0.46)	0.71	0.53	0.48	0.39	0.34	0.31

Table 13 Overall Coefficients of Heat Transmission of Various Fenestration Products (*Concluded*)

Part A: U-Values for Vertical Installation[a], Btu/h·ft²·°F

Glazing Type[b]	Glass Only		Aluminum Frame no thermal break ($U_f = 1.9$)		Aluminum Frame thermal break ($U_f = 1.0$)		Wood or Vinyl Frame ($U_f = 0.4$)	
	Center of Glass	Edge[c] of Glass	Product[d] Type		Product[d] Type		Product[d] Type	
			R	*C*	*R*	*C*	*R*	*C*
Triple glass or double glass with polyester film suspended in between, ε = 0.15 on surface 2, 3, 4, or 5								
1/4 in. argon spaces	(0.27)	(0.46)	0.72	0.54	0.50	0.41	0.35	0.32
3/8 in. argon spaces	(0.22)	(0.45)	0.69	0.51	0.47	0.37	0.33	0.29
1/2 in. and greater argon spaces	(0.20)	(0.44)	0.68	0.50	0.46	0.36	0.31	0.28
Triple glass or double glass with polyester film suspended in between, ε = 0.15 on surfaces 2 or 3 and 4 or 5								
1/4 in. argon spaces	(0.22)	(0.45)	0.69	0.51	0.47	0.37	0.32	0.29
3/8 in. argon spaces	(0.17)	(0.43)	0.66	0.47	0.44	0.34	0.30	0.25
1/2 in. and greater argon spaces	(0.15)	(0.43)	0.65	0.46	0.43	0.32	0.29	0.24

Part B: U-Value Conversion Table for Sloped and Horizontal Glazing for Upward Heat Flow

Slope	U-Value, Btu/h·ft²·°F												
90° (vertical)	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30
45°	0.14	0.25	0.36	0.47	0.57	0.68	0.79	0.90	1.00	1.11	1.22	1.33	1.44
0 (horiz.)	0.19	0.29	0.40	0.51	0.61	0.72	0.82	0.93	1.04	1.14	1.25	1.35	1.46

[a]All U-values are based on standard ASHRAE winter conditions of 70°F indoor and 0°F outdoor air temperature with 15 mph outdoor air velocity and zero solar flux. The outside surface coefficient at these conditions is approximately 5.1 Btu/hr·ft²·°F, depending on the glass surface temperature. With the exception of single glazing, small changes in the interior and exterior temperatures do not significantly affect overall U-values.

[b]Glazing layer surfaces are numbered from the outside to the inside. Double and triple refer to the number of glazing lites. All data are based on 1/8 in. glass unless otherwise noted. Thermal conductivities are: 0.53 Btu/h·ft·°F for glass, and 0.11 Btu/h·ft·°F for acrylic and polycarbonate.

[c]Based on aluminum spacers data (see Figure 6). Edge of glass effect assumed to extend over the 2.5 in. band around perimeter of each glazing unit as seen in Figure 7.

[d]Product types described in Figure 7.

edge-of-glass U-values as a function of the center-of-glass U-value. The spacer edge is assumed to be even with the line of sight of the glazing. Data are given for aluminum spacers with sealants and non-metal spacers including fiberglass, wood, and butyl. Values for glass edges and steel spacers fall between the aluminum and the non-metal spacers. This edge effect does not occur with single glazing. For highly insulating glazing, edge heat transfer can significantly increase overall U-value. Thus, test data or design-specific computations should account for this effect.

Estimation of the rate of heat transfer through the framing elements of a fenestration system is complicated by (1) the variety of frame configurations for operable windows, (2) the different combinations of materials used for sash and frames, and (3) the difference in sizes available in residential and commercial applications. Available windows are usually framed in either wood, aluminum, or vinyl; and many manufacturers combine materials for structural or aesthetic purposes. Some aluminum-framed units have *thermal breaks* that reduce the conductive heat transfer through the framing element. Standard methods for calculating frame heat transfer are not generally available, however Energy Mines and Resources Canada (1987) and Johnson (1985) have developed computer programs that analyze frame conduction.

Representative U-Values for Fenestration Products

Table 13 can be used to select a particular fenestration product to obtain a desired U-value. Part A of this table presents computed overall U-values for a wide range of glazing units and framing materials installed vertically and based on component U-values shown in parentheses. Part B presents approximate U-values for non-vertical installation. The overall U-values in part A are appropriate for calculating compliance with the requirements of ASHRAE Standard 90. However, the values apply only to the specific design conditions described in the footnotes and are typically used to determine peak load conditions for sizing heating equipment. While these U-values have been determined for winter conditions, they can be used to estimate heat gain during peak cooling conditions since conductive gain which is one of several factors, is usually a small portion of the total heat gain for windows in direct sunlight. Glazing designs and framing materials may be compared to choose a fenestration system that needs a specific winter design U-value.

The overall U-values in Table 13 are based on the rough opening area for representative generic glazing products. Test data, when available, may provide more accurate results for specific products. However, a wide range of measured U-values for similar products has been reported (Hogan 1988). Standard test methods for fenestration systems are still under development and different test methods sometimes give different U-values (McCabe *et al.* 1986).

The multiple glazing categories are appropriate for sealed glass units, acrylic domes, and the addition of storm sash to other glazing units. No distinction is made between flat and domed units such as skylights. For acrylic domes, use average airspace width to determine U-value. Unless otherwise noted, all multiple glazed units are filled with dry air. Argon units are assumed filled with 100% Argon. U-values for CO_2 filled units are similar to Argon fills. For spaces up to 0.5 in., Argon/SF_6 mixtures up to 70% SF_6 are generally the same as Argon fills. (A unit with 0.25 in. Krypton fill gas has about the same U-value as a unit with 0.5 in. Argon fill gas.)

Table 13, Part A lists data for three values of hemispherical emittance. Uncoated glass has an emittance of 0.84. Emittance of various low-emittance glasses vary considerably between manufacturers and processes. When the emittance is known to be between the listed values, interpolation is recommended. When manufacturers data are not available for low-emittance

glass, assume glass with a pyrolytic (hard) coating has an emittance of 0.40, and glass with a sputtered (soft) coating has an emittance of 0.15. Some coated glazings have lower values of emittance. The use of tinted glass does not change the winter U-value. Also some reflective glass may have an emittance less than 0.84.

Frame type refers to the primary unit. Thus, when storm sash is added over other glazing, use the values for the non-storm frame. For glazing with a steel frame, use aluminum frame values. The wood frame category represents wood frames with and without cladding as well as vinyl frames.

Product Types R (residential) and C (commercial) refer to the proportions of frame to glass area as shown in Figure 7. The U-values in Table 13 and the definition of these two products are based on frame sizes for operable windows. The Type R category is based on products in which the glazing units are about 6 ft² in area and the overall size corresponds to a 3 by 4 ft window. For aluminum windows, this corresponds to 25% frame area, 27% edge of glass, and 48% center of glass; for wood and vinyl, the frame, edge, and center of glass areas are 30%, 26%, and 44%, respectively. The Type C category is based on products in which the panes of glazing are about 24 ft² in area and the overall size corresponds to a 4 by 6 ft window. For aluminum windows, Type C category correspond to 15% frame, 15% edge, and 70% center of glass. For wood and vinyl, the breakdown is 18%, 15%, and 67%, respectively. In this case the key determinant for selecting the appropriate product is glazing unit size, *not* overall window size. For products with glazing unit sizes 16 ft² or less, use the Type R category. For products with glazing unit sizes greater than 16 ft², such as sliding glass doors, use the Type C category. For large sealed glass units with mullions or grilles that form a thermal bridge in the airspace between the glazing, use the Type R category.

Part B of Table 13 lists approximate U-values for simple single and double glazed units installed in non-vertical installations where heat flows upward. After determining a U-value for vertical installation from Part A, enter Part B on the 90° slope line (vertical) and find that value. Then read down and find the U-value corresponding to the desired slope. For simplicity, use the 90° value for products installed 60 to 90° above horizontal, the 45° value for installations 30 to 60° above horizontal, and the zero degree value (horizontal) for installations within 30° of horizontal.

Example 5. Calculate the U-value for a skylight that has a double-glazed, 0.125 in. acrylic dome with 0.75 in. airspace and a thermally-broken aluminum frame installed on a roof with a 4 in 12 slope.

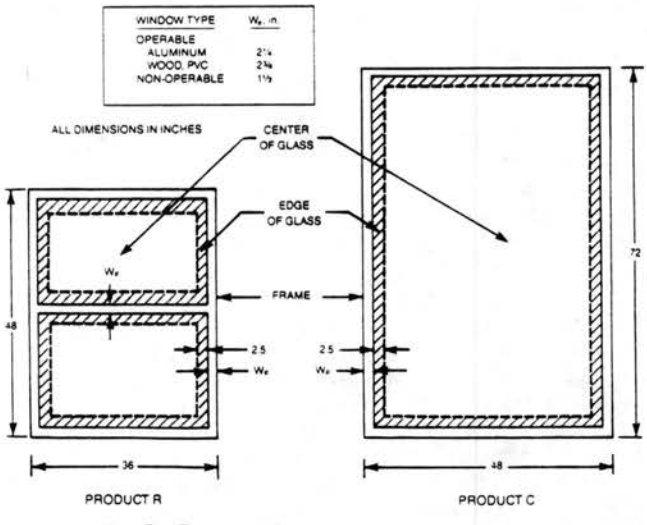


Fig. 7 R and C Category Frame Dimensions

Solution: Assume Product Type R. From Table 13, Part A, the U-value of a thermally-broken, aluminum-framed, double glazing, with 0.125 in. acrylic and 0.5 in. or greater airspace is 0.62 Btu/h·ft²·°F, if mounted vertically. From Part B, the U-value for a 4-in-12 slope (18°) is 0.74 Btu/h·ft²·°F.

To estimate the overall U-value of a fenestration product that differs significantly from the assumptions of Table 13, Figure 7, or both, first determine the percentage area that is frame/sash, center-of-glass, and edge-of-glass (based on a 2.5 in. band around the perimeter of each glazing unit). Next, determine the appropriate component U-values. These can be either from the standard values listed in parentheses in the table or from some other source such as test data or computed values. Finally, multiply the percent area and the component U-value and sum these products to obtain the overall U-value, U_o.

Example 6. Calculate the U-value for a wood-framed, 30 by 80 in., swinging French door with eight 11 by 16 in. panes, each consisting of clear double-glazing with a 0.5 in. airspace.

Solution: First calculate the areas and percentages that correspond to the frame, edge-of-glass, and center-of-glass. These are 41%, 37%, and 22%, respectively. Next, select the corresponding component U-values from the data in Table 13, Part A. These component U-values are 0.4, 0.59, and 0.49 Btu/h·ft²·°F respectively. The French door U-value is:

$$U_o = 0.41(0.4) + 0.37(0.59) + 0.22(0.49)$$
$$= 0.49 \text{ Btu/h·ft}^2\text{·°F}$$

Fenestration system performance is likely to be different than the data in Table 13, when products are installed in buildings, due to the combined effects of solar gain, wind, ambient temperature and cloud cover. Since all of these factors influence the rate of heat transfer through fenestration, seasonal or annual energy flows can not be accurately determined solely on the basis of the design-day U-values. Where it is desired to compare U-values at different wind speeds, Table 14 provides approximate data to convert the overall U-value data at one specific wind condition to a U-value at another wind condition. Performance data in Table 13, Part A is based on the assumption of an overcast sky, which implies that the effective sky temperature for radiative heat transfer is equal to the outdoor air temperature. That assumption gives reasonable results with 7.5 and 15 mph wind speeds, however, with a clear sky and nearly still wind conditions, significant heat transfer occurs by radiation and the data in Table 14 may underestimate the actual U-Values.

Air Infiltration

Air infiltration through fenestration products is significant in determinating a building's heating and cooling loads. It should

Table 14 Glazing U-Value Conversion from 15 mph Wind to 7.5 mph Wind and Still Air

Wind speed, mph		
15	7.5	0
U-Value, Btu/h·ft²·°F		
0.10	0.10	0.10
0.20	0.20	0.19
0.30	0.29	0.28
0.40	0.38	0.37
0.50	0.47	0.45
0.60	0.56	0.53
0.70	0.65	0.61
0.80	0.74	0.69
0.90	0.83	0.78
1.00	0.92	0.86
1.10	1.01	0.94
1.20	1.10	1.02
1.30	1.19	1.10

5.3.3 Thermal Transmittance (U_t) of an Envelope Assembly

5.3.3.1 The thermal transmittance of each envelope assembly shall be determined with due consideration of all major series and parallel heat flow paths through the elements of the assembly. Compression of insulation shall be considered in determining the thermal resistance.

5.3.3.2 The thermal transmittance of opaque assemblies U_t shall be determined using a series path procedure that corrects parallel paths, such as insulation and studs in a wall cavity or the roof assembly shown in Figure 5.3-1. Table 5.3-1 prescribes the procedure to be used for Subsections 5.3.3.2.1 and 5.3.3.2.2.

5.3.3.2.1 For envelope assemblies containing metal framing, the U_t shall be determined by using one of the following methods:

(a) Results from laboratory or field test measurements, using one of the procedures specified in Section 5.1.5.

(b) For non-metal surfaces attached to metal framing, where data from tests conducted using procedures specified in Section 5.1.5, such as those provided in Tables 5.3-2 and 5.3-3, is available, the total resistance of the series path may be calculated using Equations 5.3-2a and 5.3-2b, and illustrated in Figure 5.3-1:

$$U_t = 1/R_t$$

Equation 5.3-2a

$$R_t = R_t + R_e$$

Equation 5.3-2b

Where:

R_t = the total resistance of the envelope assembly

R_t = the resistance of the series elements (for i=1 to n), excluding the parallel path element(s)

R_e = the equivalent resistance of the element containing the parallel path, the value of R_e is:

R_e = (R-value of insulation) × F_c

Equation 5.3-2c

Where:

F_c = the correction factor from Table 5.3-2 or Table 5.3-3.

(c) For elements other than those covered in item (b) above, the zone method described in Chapter 23 of the *ASHRAE Handbook, 1985 Fundamentals Volume* shall be used. The equations on pages 23.13 and 23.14 shall be used.

(d) For sheet metal construction, internally insulated with an internal metal structure bonded on one or both sides to a metal skin or covering (see Figure 5.3-2), the following steps shall be used to calculate the U-value of the envelope construction.

Table 5.3-2

Parallel Path Correction Factors[1]

Bridged R-Value	0	5	10	15	20	25	30	35	40	45	50	55
Correction Factor	1.0	0.96	0.92	0.88	0.85	0.81	0.79	0.76	0.73	0.71	0.69	0.67

1. Table 5.3-2 values are based upon metal trusses with 4 ft spacing that penetrate the insulation, and 0.66 in. diameter crossmembers every 1 ft.

Table 5.3-3
Wall Sections With Metal Stops
Parallel Path Correction Factors

Size of Members	Gauge of Stud	Spacing of Framing, In.	Cavity Insulation R-Value	Correction Factor
2 X 4	18-16	16 o.c.	R-11	0.50
2 X 4	18-16	24 o.c.	R-11	0.60
2 X 6	18-16	16 o.c.	R-19	0.40
2 X 6	18-16	24 o.c.	R-19	0.45

Designation: C 755 – 85ε1

Standard Practice for Selection of Vapor Retarders for Thermal Insulation[1]

This standard is issued under the fixed designation C 755; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε1 NOTE—The phrase "vapor barrier" was editorially corrected to "vapor retarder" throughout to agree with the title of the practice in March 1987.

1. Scope

1.1 This practice outlines factors to be considered, describes design principles and procedures for vapor retarder selection, and defines water vapor transmission values appropriate for established criteria. It is intended for the guidance of design engineers in preparing vapor retarder application specifications for control of water vapor flow through thermal insulation. It covers commercial and residential building construction and industrial applications in the temperature range from −40 to +80°F (−40 to +27°C) within the structure. Emphasis is placed on the control of moisture penetration by choice of the most suitable components of the system.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 781 Test Methods for Puncture and Stiffness of Paperboard and Corrugated and Solid Fiberboard[2]

D 828 Test Method for Tensile Breaking Strength of Paper and Paperboard[3]

E 84 Test Method for Surface Burning Characteristics of Building Materials[4]

E 96 Test Methods for Water Vapor Transmission of Materials[5]

E 398 Test Method for Water Vapor Transmission Rate of Sheet Materials Using a Rapid Technique for Dynamic Measurement[5]

F 372 Test Method for Water Vapor Transmission of Flexible Barrier Materials Using an Infrared Detection Technique[3]

3. Definitions

3.1 *dew-point temperature (Dp)*—the temperature at which a specific atmosphere is saturated with water vapor. (Cooling below the dew point will cause release of water vapor in the form of condensation. In problem analysis for vapor barrier selection it is the dew-point temperature, not the relative humidity, that is pertinent. Dew-point temperature is directly related to saturation water vapor pressure and may be obtained from tables.)

3.2 *thermal insulation system*—thermal insulation for resistance to heat flow combined with means for attachment to the surface to be insulated, and with facings, vapor retarders, joint sealants, or protective coatings as installed.

3.3 *vapor retarders*—those materials or systems which adequately retard the transmission of water vapor under specified conditions. (For practical purposes it is assumed that the permeance of an adequate retarder will not exceed 1 perm, although at present this value may be adequate only for residential construction. For certain other types of construction the permeance must be very low.)

3.4 *water vapor diffusion*—the process by which water vapor spreads or moves through permeable materials caused by a difference in water vapor pressure.

3.5 *water vapor permeability (permeability)*—the water vapor transmission of a homogeneous material under unit vapor pressure difference between two specific surfaces, per unit thickness. An acceptable unit of permeability is the perm-inch: grain-in./h·ft²·in. Hg (the metric perm-cm = 1 g·cm/24 h·m²·mm Hg).

3.6 *water vapor permeance (permeance)*—the water vapor transmission of a material under unit vapor pressure difference between two specific surfaces. An acceptable unit of permeance is the perm: grain/h·ft² in. Hg (1 metric perm = 1 g/24 h·m² mm Hg).

3.7 *water vapor transmission (WVT)*—the steady-state time rate of water vapor diffusion or flow through unit area of a material, normal to specific parallel surfaces under specific conditions of temperature and humidity at each surface. An acceptable unit of WVT is grain/h·ft² (1 g/24 h·m²).

4. Significance and Use

4.1 Experience has shown that uncontrolled water entry into thermal insulation is the most serious factor causing

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[2] Discontinued; see *1983 Annual Book of ASTM Standards*, Vol 15.09.

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[4] *Annual Book of ASTM Standards*, Vol 04.07.

[5] *Annual Book of ASTM Standards*, Vol 04.06.

TABLE 2 Recommended Maximum Permeance of Vapor Retarder Systems[A]

Insulation Application	Group I Insulation Permeability 0.3 to 4.0 perm-in.	Group 2 Insulation Permeability, Greater than 4.0 perm-in.
Vapor Retarder Permeance, perms[A]		
Wall (residential)	1.0	1.0
Underslab (residential and commercial)	1.0	0.4
Roof deck	1.0	0.4[B]
Pipe and vessels (33 to 80°F (1 to 27°C))	1.0	0.3
Pipe and vessels (−40 to 32°F (−40 to 0°C))	0.05	0.02
Ducts	1.0	0.03[B]
Metal buildings	0.1	0.3[B]
Cold storage	0.1	0.1

[A] Water vapor permeance of the vapor retarder system in perms when tested in accordance with Test Methods E 96.
[B] Subject to climatic and service conditions.

continuous coats, and suitable membrane reinforcement may also be required. The system must be adequately strong to resist cracking caused by substrate movement. Good workmanship in application is essential to attain design vapor diffusion resistance.

7.2.2.2 The permeance of mastics and coatings varies with varying dry thickness and data showing this relationship for specific products are available from manufacturers. Comparison of permeance values for various mastics and coatings should not be based on wet thickness, but rather on dry thickness (after curing and evaporation of all volatile ingredients).

7.2.3 Structural retarders may be formed from rigid or semirigid materials of low permeability, which form a part of the structure. They include some insulation materials, as well as prefabricated composite units comprising insulation and finish, and metal curtain walls. They require careful sealing of joints and seams.

7.3 *Test Method and Values:*

7.3.1 The latest issue of Test Methods E 96 is acceptable for determining water vapor transmission of materials.

7.3.1.1 This test method provides isothermal conditions for testing materials by the cup method. In the "dry cup" or desiccant method, relative humidity inside is approximately 0 %. In the "wet cup" or water method, the relative humidity inside is approximately 100 %. When evaluating WVT data it is preferable to use data obtained by the procedure in which the test conditions approximate the service conditions.

7.3.1.2 This test method does not permit measurement of WVT values under all conditions of temperature and moisture found in service. It does provide values that permit the selection of suitable barrier materials.

7.3.2 Test Method E 398 covers the dynamic evaluation of the rate of transfer of water vapor through a retarder material and conversion to the generally recognized units of water vapor transmission (WVT) as obtained by the standard gravimetric method given in Test Methods E 96.

7.3.2.1 Test Method E 398 is limited to retarder sheet materials composed of either completely hydrophobic materials, or combinations of hydrophopic and hydrophilic materials having at least one surface which is hydrophobic.

7.3.2.2 The minimum test value obtained by Test Method E 398 is limited by the leakage of water vapor past the clamping seals. A reasonable limit value may be approximately 0.015 g/24 h·m^2 for Procedure E values of Test Methods E 96 and can be checked for each instrument with an impervious specimen. Calibration procedures compensate for this leakage at less than terminal times.

7.3.3 Test Method F 372 covers a rapid procedure for determining the rate of water vapor transmission of flexible retarder materials in film or sheet form. The test method is applicable to sheets and films up to 3 mm in thickness, consisting of single or multilayer synthetic or natural polymers and metal foils including coated materials.

7.3.3.1 A dry chamber is separated from a wet chamber of known temperature and humidity by the retarder material to be tested. The time for a given increase in water vapor concentration of the dry chamber is measured by monitoring the differential between two bands in the infrared spectral region, one in which water molecules absorb and the other where they do not. This information is then used to calculate the water vapor movement through a known area of retarder material.

7.4 *Recommended Vapor Retarder Practices*—Two design principles of vapor control have been presented: flow-through and moisture storage. Both systems are used in general practice.

7.4.1 The intent of the flow-through principle is to eliminate all possibility of condensation within the insulation system; therefore, this system is used with insulation materials with higher permeability to prevent accumulation of moisture.

7.4.2 The moisture-storage principle allows some accumulation of moisture within the insulation system. This principle is used with lower permeability insulation systems because the rate of accumulation is small.

7.4.3 The rate and quantity of moisture accumulation in insulation used in a given end-use application is a function of the permeability of the insulation and the operating conditions of the application as well as being a function of the vapor retarder materials. Therefore, the vapor retarder requirements necessary to control moisture and ensure successful operation can deviate from indicated theory. A case in point is the practice of using higher permeance vapor retarder systems with lower permeability insulations, whereas the flow-through theory would indicate the opposite. This is where the moisture-storage theory comes into practice. From a practical standpoint, a lower permeability insulation collects and stores less water in case of moisture entry and therefore a higher permeance vapor retarder is tolerable.

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ATTACHMENT 5

twin city testing corporation
662 CROMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/645-3601

JUL 05 1989

REPORT OF: PHYSICAL PROPERTIES

PROJECT: POLYETHYLENE SHEETING

REPORTED TO: Minnesota Department of Public Service
Attn: Bruce Nelson
900 American Center
150 East Kellogg Boulevard

DATE: June 29, 1989

CC Robert Anderson

LABORATORY NO: 4141 89-572

P.O. NO: 80500/05328

INTRODUCTION:

This report presents the results of thickness and water vapor transmission tests conducted on 24 samples of polyethylene sheeting. Twenty-three samples of polyethylene sheeting were submitted to our laboratory on May 2, 1989. Two additional large rolls of polyethylene sheeting were submitted to our laboratory on June 21, 1989. All samples were submitted by Mr Bruce Nelson of the Minnesota Department of Public service. Our work was completed on June 29, 1989.

The scope of our work was limited to conducting thickness and water vapor transmission tests on the samples of polyethylene sheeting submitted.

RESULTS:

Sample Identification	Thickness in	Permeance, perms				Average Permeability, perm·in
		Specimen 1	Specimen 2	Specimen 3	Average	
1	0.0039	0.18	0.14	0.16	0.16	0.00062
2	0.0032	0.14	0.11	0.13	0.13	0.00041
3A	0.0032	0.21	0.26	0.18	0.22	0.00070
3B	0.0019	0.14	0.18	0.20	0.18	0.00034
4	0.0031	0.16	0.19	0.15	0.17	0.00051
5	0.0031	0.25	0.16	0.17	0.19	0.00059
6	0.0039	0.18	0.24	0.22	0.22	0.00085
7	0.0033	0.21	0.27	0.17	0.22	0.00071
8	0.0052	0.12	0.20	0.18	0.17	0.00087
9	0.0078	0.15	0.12	0.22	0.17	0.00129
10	0.0034	0.13	0.15	0.19	0.16	0.00053
11	0.0038	0.23	0.19	0.25	0.22	0.00083
12	0.0042	0.12	0.16	0.15	0.14	0.00061
13	0.0038	0.38	0.20	0.27	0.28	0.00109
14	0.0032	0.15	0.16	0.23	0.18	0.00058
15	0.0032	0.25	0.33	0.27	0.28	0.00090
16	0.0028	0.12	0.19	0.17	0.16	0.00045
17	0.0039	0.11	0.15	0.15	0.14	0.00054
18	0.0037	0.11	0.12	0.13	0.12	0.00045
19	0.0039	0.10	0.13	0.16	0.13	0.00050
20	0.0034	0.25	0.27	0.32	0.28	0.00096
21	0.0038	0.16	0.18	0.21	0.18	0.00071
22	0.0036	0.12	0.15	0.16	0.14	0.00052
23	0.0040	0.33	0.27	0.33	0.31	0.00125
24	0.0038	0.30	0.25	0.24	0.26	0.00099

AS A MUTUAL PROTECTION TO CLIENTS, THE PUBLIC AND OURSELVES, ALL REPORTS ARE SUBMITTED AS THE CONFIDENTIAL PROPERTY OF CLIENTS, AND AUTHORIZATION FOR PUBLICATION OF STATEMENTS, CONCLUSIONS OR EXTRACTS FROM OR REGARDING OUR REPORTS IS RESERVED PENDING OUR WRITTEN APPROVAL.

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PHONE 612/645-3601

REPORT OF: PHYSICAL PROPERTIES

LABORATORY NO: 4141 89-572

DATE: June 29, 1989

SAMPLE IDENTIFICATION:

Twenty-three small samples of polyethylene sheeting were received. These samples were marked 1 through 22, sample number 3 contained two different types of material these were arbitrarily identified as 3A and 3B. Two large roll of polyethylene sheeting were received and are identified as 23 and 24.

TEST METHOD:

The thickness of each sample was determined using the following formula:

$$T = W/(A \times 0.03613 \times D)$$

Where : T = average thickness, inches
W = net weight, pounds
A = area of the specimen, in^2
D = specific density of polyethylene

The water vapor transmission test was conducted according to ASTM:E96, "Standard Test Methods for Water Vapor Transmission of Materials," procedure E, "Desiccant Method at 100°F." ASTM:D4397, "Standard specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications," was also used as a reference. Three, 3 inch diameter specimens were removed from each sample. Each specimen was placed in a test dish filled with anhydrous calcium chloride. The specimen was sealed to the mouth of the dish with a metal ring and rubber gasket. The test assemblies were weighed and placed in an environmental chamber maintained at 100°F and 90% relative humidity. The specimens were weighed twice a day until a constant rate of weight gain could be determined. A mathematical least squares regression of the weight as a function of time was used to determine the water vapor transmission rate. The permeance of each specimen was calculated from the water vapor transmission rate. The permeability of the sample was determined by multiplying the average permeance by the average thickness of the sample.

REMARKS:

The test samples will be retained for thirty days from the date of this report then discarded unless notified otherwise.

TWIN CITY TESTING CORPORATION

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JKJ/ALK/89-572

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ATTACHMENT 6

APPLIED BUILDING SCIENCE

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March, 1987

Conversely, in a cooling climate, by installing an insulating sheathing on the interior surface of a building envelope behind the interior cladding, or installing an insulating interior cladding such as insulating gypsum board, a similar reduction of moisture deposited within a building cavity by exterior, moist, warm convecting air will occur.

In a heating climate, installing an insulating interior insulating cladding such as insulating gypsum board will reduce and/or elimate surface condensation and mould and mildew growth on the interior surface of the building envelope caused by convective air flow between the exterior and the building envelope cavity.

Controlling the amount of moisture in convecting air is a partially effective strategy in reducing convective moisture movement only in heating climates, as controlling the amount of moisture contained in exterior air in cooling climates is still beyond the abilities of building science. In heating climates, by preventing excessive levels of moisture from occuring in interior air, should this air leak into building envelope cavities as part of a convective flow, it does so at a lower moisture content. Furthermore, interior surface temperatures required to induce surface condensation and mould and mildew growth are much lower if excessive moisture levels in interior air are avoided.

CONTROL OF WIND WASHING

Much larger air flows can result within building envelope cavities as a result of wind pressures than as a result of convective air flow. However the effects are similar to the effects of convective air flows. This wind-induced air flow through or around insulation within building envelope cavities is called "wind washing". Wind washing can occur if a "perfect" air barrier system exists within the building envelope or on the interior of the building envelope as wind washing does not involve thorugh the envelope air flow. Wind washing involves the flow of exterior air into the building envelope with this exterior air subsequently returning to the exterior. Wind washing will not occur if the air barrier system is located on the exterior of the building envelope. However, installing an air barrier on the exterior of the building envelope is typically not practical for reasons which will be subsequently discussed in the section which deals with "forgiving design".

Wind washing is most often responsible for the appearance of mould and mildew when enclosures are in a "heating" mode. As cold exterior air "short-circuits" cavity insulation and contacts the exterior surfaces of interior cladding, it may cause local chilling of this cladding. The chilling of the interior cladding typically leads to a corresponding increase in the relative humidity of the air at the interior cladding/interior air interface. If the rise in surface relative humidity is sufficient, mould and mildew will appear. If the

surface chilling is extreme, surface condensation and/or frost may result.

In cooling climates wind washing may result in the deposition of significant amounts of moisture within envelope cavities as warm, moisture laden air is blown into envelope cavities and is cooled by cold envelope surfaces towards the interior of the building envelope. These interior envelope surfaces may be cold as a result of air conditioning the enclosed space and if they are below the dew point temperature of the exterior air, condensation may result.

The effects of wind washing can be controlled if the wind induced air movement within an envelope cavity is prevented, or if interior surface temperature cooling is prevented or reduced when envelopes are experiencing a "heating mode", or if temperature reduction of warm exterior, moisture laden air which has found it's way into a building envelope when the envelope is in a "cooling" mode is prevented.

It is also possible, to a limited extent, in "heating" mode situations to reduce incidences of mould and mildew and/or surface condensation and frost even if some wind washing occurs by preventing excessive build-up of interior moisture levels within a building enclosure.

For wind induced air movement to occur in a building envelope cavity under constant wind conditions, air must have both an opening or path to enter and an opening or path to leave. If air can only enter a building cavity and not leave, an air pressure increase will result, but air movement will not. For example, if air permeable insulation is contained in an air tight cube, and one face of the cube is then removed. If wind then blows against the cube some air will enter the cube to pressurize it, but no air flow will result. The practice of installing insulation in this manner is known as "dead-ending" insulation and is common in exterior walls where air barrier systems are located to the interior of building envelopes. However, under fluctuating wind conditions, a "pumping" action may result from changing air pressures, and some air flow may result even though only one opening or path for air flow exists. This "pumping" action often does not result in much air flow, and is not typically considered "wind-washing. In certain circumstances, such as in heating climates, this pumping action can in fact facilitate envelope drying. Such "pumping" action is, of course, not benifical in "cooling" climates.

Wind washing commonly occurs where exterior perimeter walls meet insulated ceilings and at exposed corners. Baffels installed between roof trusses or roof rafters are commonly utilized to control wind washing at exterior wall/roof interfaces. Rigid, air impermeable sheathings, both insulating and non insulating and some building papers are used to provide "wind" barriers on exterior walls and/or to facilitate "dead-ending". "Wind" barriers need not be continuous or "perfect" if incorporated with a "dead-ending" stratedgy. If building papers are used they must be supported in such a manner as to prevent "pumping" from occuring and hence a negation of the "rain screen" principal and pressure equalization. Unfortunately it is seldom

practical to support building paper in such a manner as to prevent pumping from occuring under fluctating wind pressures.

Interior surface temperature reduction or cooling of building envelopes, when they are experiencing a heating mode, can be reduced or prevented as a result of wind washing by installing air impermeable insulating sheathing on the interior of envelope framing or an insulating interior cladding such as insulating gypsum board.

By also installing insulating sheathing on the interior of envelope framing or an insulating interior cladding such as insulating gypsum board in cooling climate situations, the prevention of cooling of wind washed exterior moisture laden air will be facilited when building enclosures are air conditioned.

VAPOUR DIFFUSION RETARDER

Vapour diffusion is a function of a vapour pressure difference, the vapour permeability of the material the vapour pressure differential is acting across and the surface area of the material.

The vapour pressure differential or the driving force is based on the number of molecules of water present on one side of a material as compared to the number of molecules of water on the other side of a material. If more molecules of water exist on one side of a material as compared to the other side, then a vapour pressure differential is said to exist. Water vapour moves through materials as a result of a vapour pressure differential by the mechanism of diffusion, with water vapour moving from areas of higher vapour pressure to areas of lower vapour pressure.

If a vapour pressure differential acts across a material, then the permeability of that material to vapour diffusion can be utillized infulence the total amount of water vapour which diffuses across the material. Materials with "higher" resistance to vapour diffusion or materials which are more impermeable to vapour diffusion than other materials may be used to "retard" or reduce the amount of moisture which diffuses through a building envelope as a result of a vapour pressure differential. These types of materials are sometimes refered to as vapour diffusion retarders.

Water vapour diffusion is also dependant on the total amount of surface area involved for diffusion to take place. The greater the area, the greater the amount of vapour diffusion which takes place, all other things being equal. Since vapour diffusion is directly dependant on surface area, if for example, a vapour diffusion retarder is installed over 90 per cent of the surface area of a building envelope, then that vapour diffusion retarder can be said to be 90 per cent effective, all other things being equal. Since vapour diffusion is a slow moisture transport mechanism, as compared to the other moisture transport mechanisms, and does not move great amounts of

moisture in the "absolute" sense, and since it is directly dependant on surface area, it can be said that vapour diffusion retarders, if they are to be used in a building envelope, need not be continuous, the need only cover most of the building envelope from a total surface area of diffusion perspective.

Since vapour diffusion is a function of the vapour pressure differential, vapour permeability of envelope materials and surface area, all three factors can be manipulated to help control vapour diffusion in building envelopes. Typically it is most practical to control the vapour permeabilities of the building compenents comprising the building envelope, although to a more limited extent, the vapour pressure differentials across building envelopes can be also influenced, notably in heating climates where interior air moisture contents are limited by the action of controlled ventilation systems.

In certain situations, below grade, vapour permeable, rigid insulations installed on the exterior of concrete foundation systems may be used to help manipulate vapour pressure differentials and promote concrete drying directly into saturated soils since concrete is influenced more by relative humidities than by vapour pressure. If a sufficient temperature gradient across below grade or ground contact concrete is established with the use of external permeable insulation, the equalibrium relative humidity of the concrete and its corresponding vapour pressure may be higher than the vapour pressure in the ground, and moisture will migrate in that direction.

Where vapour diffusion retarders are used in building envelopes they should be located on the warm side of the building envelopes condensing surface in heating, cooling and combined climates.

In a heating climate, adequate vapour diffusion retarder characteristics are often provided by typical interior paint finishes. Additional vapour impermeability can be provided by installing polyethylene films and aluminum foils behind interior claddings but is often not necessary.

In a cooling climate, where insulating sheathing is installed on the interior surface of envelope framing, if the insulating sheathing is also relatively vapour impermeable, then it can also act as the vapour diffusion retarder. The vapour diffusion retarder would be the exterior surface of the insulating sheathing and if the insulating sheathing were of appropriate thermal resistance, the location of the vapour diffusion retarder would be on the warm side of the envelope dew point. Such wall construction, will also provide appropriate vapour diffusion characteristics in combined climates. In a combined climate, when a heating mode is being experienced, the vapour diffusion retarder is defacto located on the interior surface of the insulating sheathing (the permeabilities of interior cladding surface finishes such as paint are being ignored here for clarity only, paint is often more than sufficient to act as a vapour diffusion retarder in such envelope constructions) and on the warm side of the dew point. In a combined climate, when a cooling mode is being experienced, the

ATTACHMENT 7

HOME BUILDERS' ENERGY UPDATE

Winter 1991

KEEPING WATER VAPOR OUT OF WALLS:

The Vapor Retarder Can't Do It All

Builders put considerable effort into installing the vapor retarder (previously called vapor barrier — see sidebar, page 3). Purpose of the retarder is to protect insulation and framing materials from water vapor damage. Without a retarder, water vapor comes through the sheetrock and condenses, possibly leading to warped siding, damp insulation, and, over a long time, structural damage.

Unfortunately, even a continuous vapor retarder doesn't guarantee protection from water vapor. The unchecked culprit is air movement. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) only recently acknowledges this, in its latest edition of the *Handbook of Fundamentals*: "The quantity of water vapor that can be transported by air leakage through cracks can be several times greater than that which occurs by vapor diffusion alone." ASHRAE points out that although the vapor retarder is important, it cannot do the job alone.

Air leakage as a major contributor to moisture condensation in walls was identified as early as

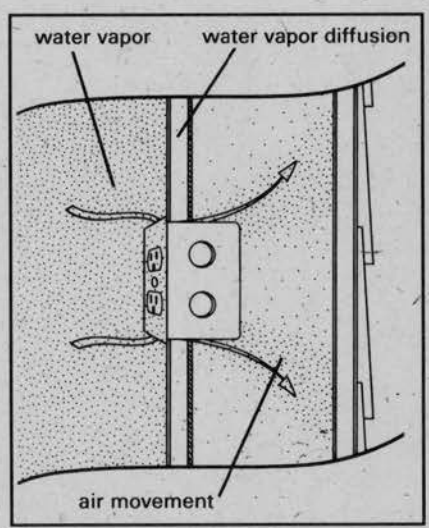


Figure 1. Much more water vapor is carried into walls by air movement through leaks than by water vapor diffusion through the vapor retarder.

1982 in a study by the US Department of Agriculture Forest Products Laboratory in Madison, Wis. [Reference 1]. Researchers found that puncturing the vapor retarder — with an electrical outlet, for example — resulted in considerable condensation on the sheathing in the region of the puncture.

The fact is that both a vapor retarder and an air retarder are needed to keep water vapor out of exterior walls. In practice, one material properly installed (such as polyethylene sealed at all laps and penetrations) can serve as both vapor and air retarder. Or more than one material may be used; for example, a standard installation of polyethylene can form the vapor retarder, and a gasketed sheetrock with all other air penetrations sealed can serve as the air retarder. Such installations, whether consisting of one or more materials, are termed an "air/vapor retarder."

Previous editions of *Builders' Update* discussed the problem of water vapor protection as it applies to specific areas such as bathroom walls. This issue of *Builders' Update* will discuss additional common air leaks into walls and how they can be corrected.

Three problem areas

Air carrying moisture can leak into exterior walls in many places. This edition of *Update* will focus on mechanical (heat ducts), plumbing, and electrical penetrations.

Mechanical penetrations. Recent studies [Reference 2] indicate that furnace ducts leak

much of the air they are supposed to be delivering. One study of 31 homes documented large increases in air infiltration when the furnace blower was turned on (see Figure 2). This air carries large quantities of moisture which can settle in and damage the home insulation. Here are a few recommended solutions.

First, install heat registers in the floor rather than in exterior walls. This way, if there is any duct leakage, air won't leak into the wall. In the case of two-story homes with ducts running through exterior walls, use a tight-fitting high R-value insulation (such as foil-backed polyisocyanurate) to separate the duct from the sheathing. Whenever possible, however, avoid running ducts through exterior walls. In two-story houses where the floor joist space is used as the return plenum, be sure the "blank-off" (used to close off the joist plenum) is tightly caulked.

Second, permanently seal ducts against all air leakage, especially those ducts running outside the air/vapor retarder. The duct tape now on the market does not seem to be doing the job. Mastic works much better. In fact, because of the problem of duct leakage, the Florida building code now requires a duct sealing standard that excludes using any current rubber-based duct tape.

Finally, you can take a radical approach. Some average-size houses built in northern climates feature high performance windows, walls, and ceilings, and have heat losses below 30,000 Btus per hour. The interior surfaces of these walls and windows can maintain close to room temperature without having to be washed with warm air. With this type of house, the warm air grills may not need to be under the windows. Rather, grills could be more conveniently located on interior walls. The extra cost of high performance windows and walls is somewhat offset by cost savings on the heat distribution system. Remember, this approach works only for very energy efficient houses.

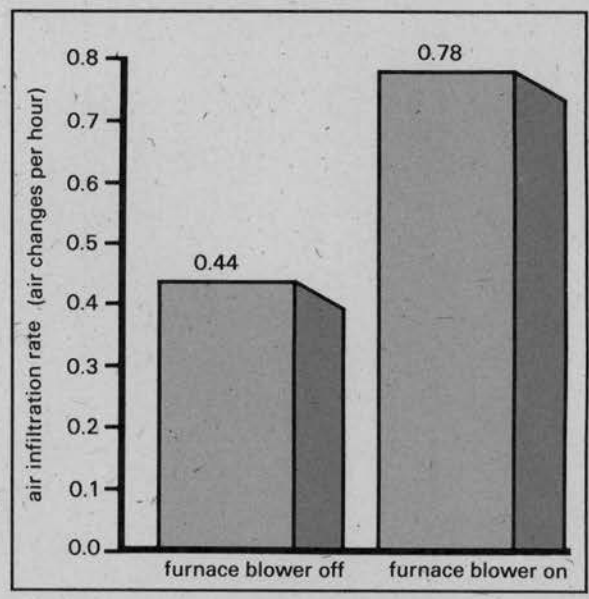


Figure 2. Average measured infiltration of 31 homes is shown with the furnace blower on and off.

Plumbing penetrations. Plumbing pipes and stacks should not be run through exterior walls. Compressed insulation and freezing pipes will be the likely result. If all other options have been considered and plumbing must run through an exterior wall, reduce the negative consequences by providing an air seal where the pipes enter the wall. Sealing the vapor retarder to the pipes will prove very difficult. Instead, the Canadian Home Builders Association Builders' Manual [Reference 3] recommends the following procedure:

Install a wood panel backing board flush with the inside surface of the studs (Figure 3). Holes are placed in the wood panel where the pipes will penetrate. (Make sure the holes are large enough to allow clearance around each pipe, or the pipes may rub against the edge causing squeaks whenever hot water is used.) Caulk (or better yet, foam-seal) the gap between the pipes and edge of the hole, and caulk the vapor retarder to the panel as it is installed.

If there is only one pipe, or the pipes are in a line, a simpler solution might be possible. The panel could be split and installed after the piping is in, notching for pipes. Because of the larger notch holes, foam sealant should be used to seal the pipes in place. Be sure to caulk the split in the panel.

Electrical penetrations. Air leakage is a problem at the electric service entrance, at outlets and switch boxes on exterior walls, and where wires pass through top plates and end studs of partition walls. To caulk or foam-seal wire service entrance is easy. Sealing wire penetrations is more work, but should be done on all houses to assure the integrity of fire stops.

Switch boxes and outlets on exterior walls are more difficult to seal than plumbing or mechanical penetrations. More is needed than just a foam gasket under the cover plate; an air seal should be formed around the outside of the box. Using one of the plastic box products on the market that fit around the switch or outlet box will accomplish this efficiently. (See Figure 4.)

Another option is to install floor outlets along exterior walls and locate switches on adjacent interior walls.

Mark LaLiberte of Shelter Supply (a Minneapolis distributor of building products) sees many builders moving toward air-sealing all exterior wall penetrations because it improves client comfort. "Home owners used to complain of cold drafts coming through penetrations in the exterior wall. Sealing these penetrations is good insurance against a callback," says LaLiberte.

How to tell if you have tightened a house

Is there any way you (and your clients) can know how successful you've been in eliminating air leaks in residential construction? Yes! ASHRAE has published Standard 119-88, "Air Leakage Performance for Detached Single-Family Residential Buildings" [Reference 4]. Using this standard, tightness is classified by combining the results of a blower door test with the building height. Houses of very tight construction should always have a controlled ventilation system to assure indoor air quality. Refer to the Fall, 1985, *Update.*

References

1. *Condensation Potential in High Thermal Performance Walls — Cold Weather Climate,* G. E. Sherwood, USDA Forest Products Laboratory. Order from National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161. Price $14.00 (postage included). Specify order number ADA129452.

2. "Surprising Field Observations on Forced Air Distribution Systems," *Energy Design Update*, January 1990, Cutter Information Corp, 1100 Massachusetts Ave., Arlington, MA 02174. Price $5.00.

3. *Canadian Home Builders Association Builders' Manual,* Canadian Home Builders Association, 331 Cooper Street # 701, Ottawa, Ontario, Canada K2P 0G5. Price $50 (US currency).

4. *ASHRAE Standard 119-88, "Air Leakage Performance for Detached Single-Family Residential Buildings,"* ASHRAE Publication sales department, 1791 Tullie Circle NE, Atlanta, GA 30329. Cost is $18 (payment must accompany order).

'Barrier' or 'Retarder?'

Long known as "vapor barrier," the sheet of polyethylene, kraft paper, foil, or similar material installed behind sheetrock in northern climates is rapidly changing its name. This change recognizes that the material is *not* a solid barrier to water vapor movement, but only retards movement. Recent editions of ASHRAE handbooks and ASTM standards use the new name; we expect the term will soon be in common use in the building industry.

Figure 3. To stop air leaks at plumbing penetrations, a plywood panel is installed and the vapor retarder is sealed to it.

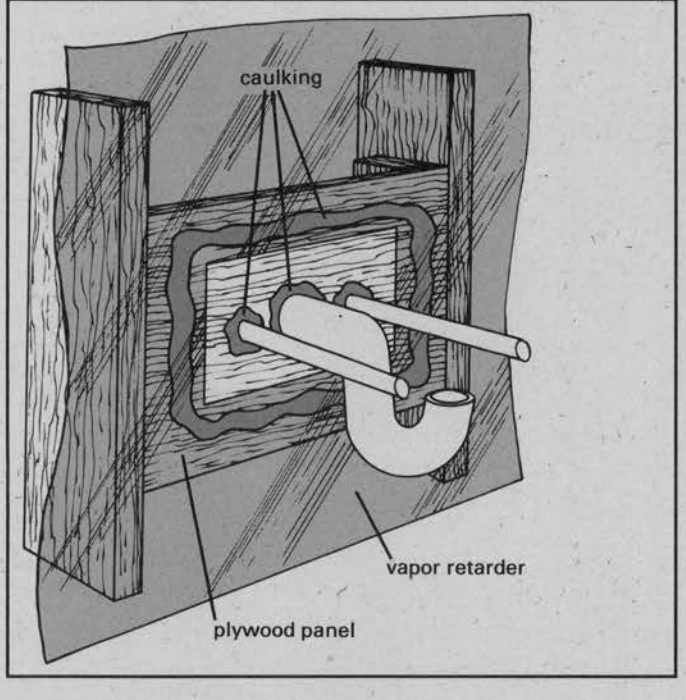
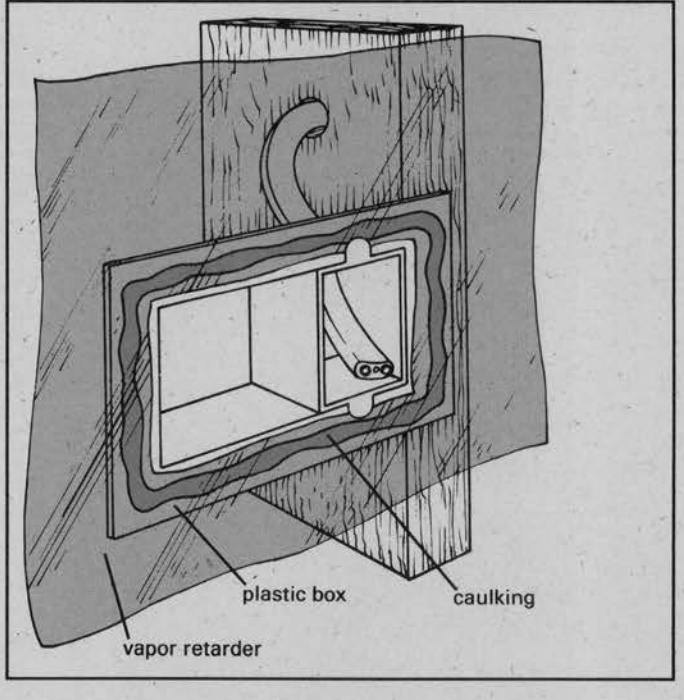


Figure 4. The electrical box is mounted inside a plastic box designed to be a barrier against air leakage into the wall. The wire is caulked where it enters the plastic box.



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HOME BUILDERS' ENERGY UPDATE

Winter 1989

COLD CEILING CORNER MYSTERY EXAMINED

It may show up as patches of frost or accumulations of dirt on the ceiling at the corner of an outside wall. Or, in cases of high moisture levels inside the house, mold may even form.

The most common explanation for this "cold area" is that the ceiling insulation is thinner near the soffit. However, we have solved the thin insulation problem with the use of raised-heel energy trusses (see side-bar – Raised heel trusses). Another reason for the cold spot might be thinner insulation over the double-top plate. In this case, using insulated sheathing will help keep the wall warmer at the top plate. Yet, despite these measures, the problem still occurs. Could there be another reason for the cold ceiling near the soffit?

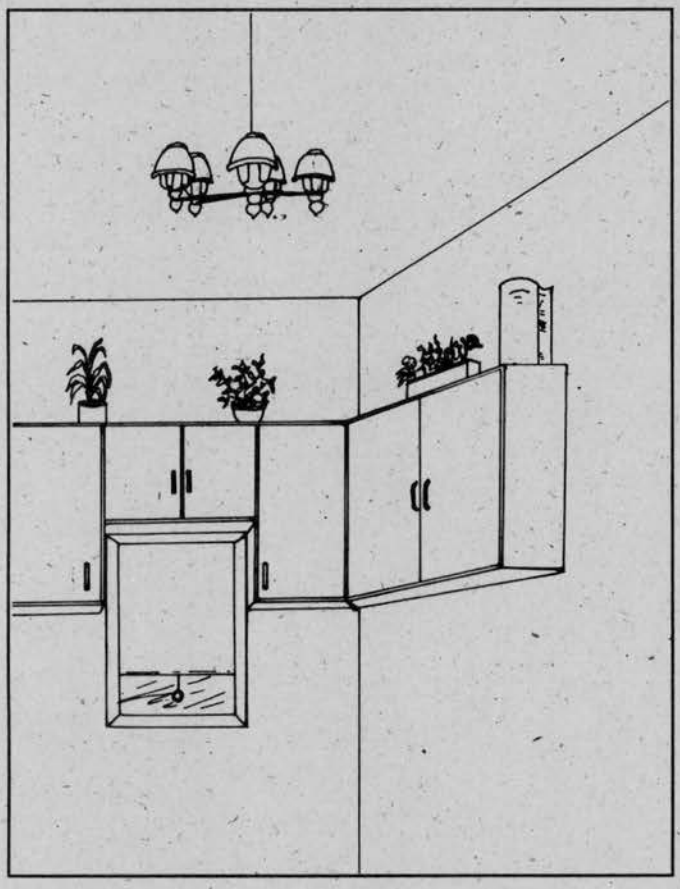
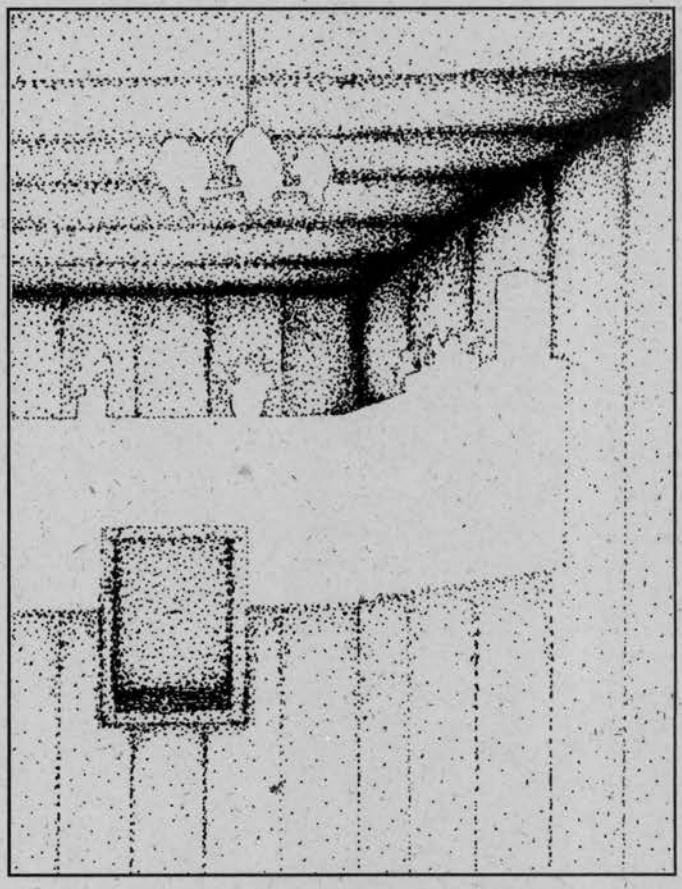


Figure 1
A drawing to represent a "visual" picture of a residential kitchen.



An "infrared scan" of the same scene portrays a "ghostly" image where colder surfaces appear in dark shades.

A new look at the problem

A look at an infrared scan of this area would surprise most builders (see side-bar – What is an infrared scan?). The scan might show that on the windward side of the building the cold area on the ceiling is not limited to the area next to the top plate. Rather, it may show dark streaks representing even colder areas that extend along the ceiling inward from the wall (Figure 1). Yet, on the downwind side of the house, this is not the case. What could be causing this difference?

What happens is that cold air entering the soffit vents on the windward side blows *through* the attic insulation on its way into the attic (see Figure 2). In batt-insulated ceilings, cold air may also travel along small gaps between the batts and the truss bottom chords. As the cold ventilation air blows through the insulation, it creates the effect of less insulation between the ceiling and the cold. The result is that cold areas (shown as dark) are formed which can cause condensation of moisture and formation of frost (See Figure 1).

But wait – I'm paying extra for the energy truss and extra insulation, and now you're telling me that it's not doing much good? Sure, the extra insulation is helping on all but the windward side, or when there is no wind (most nights) as well as in the summer. However, under some conditions, it may seem as if that extra insulation is not even there.

Surprisingly, it is only a small oversight in our construction that allows this to happen. Usually, in blown attics, a piece of batt insulation is folded and placed in this area to block the loose-fill insulation from the soffit. And, in a batt insulated house, the ends of the batts are often exposed to the air flow.

What is an infrared scan?

An infrared scan (or thermograph) is a television-like image of surface temperatures. It is based on the principle that a warm surface emits more infrared energy than a cold surface. On the infrared scanner warm surfaces appear light and cold surfaces appear dark. We suggest that all builders examine one or more of their completed houses with an infrared scanner. Also, don't neglect to show your crew! Contractors with infrared equipment may be listed in the Yellow Pages under Energy Conservation Products & Services, or Energy Management & Conservation Consultants. Contact the Energy Information Center for a listing of Minnesota contractors with such equipment.

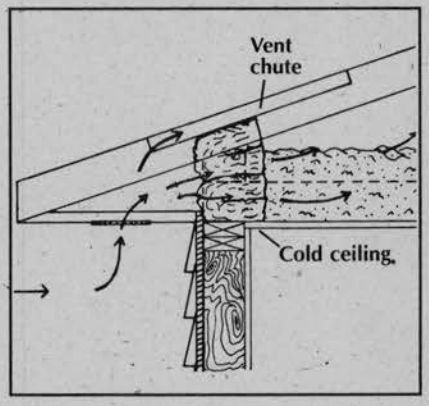


Figure 2
Attic ventilation air commonly passes through ceiling insulation on its way into the attic.

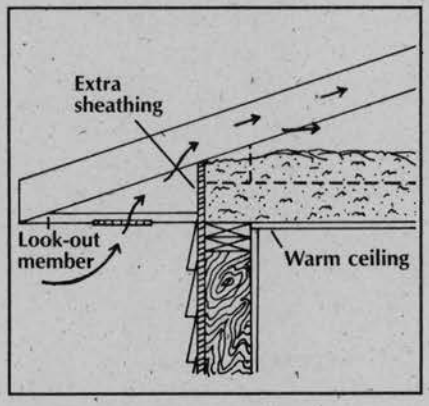


Figure 3
Extending the sheathing up to touch the truss top chord can block air from flowing through the insulation.

The Solution

The solution to the problem is to prevent cold air from blowing through the insulation at this point. This can be done by installing a barrier that covers the edge of the insulation. This covering needs to be nothing more than a piece of sheathing (see Figure 3) which can be installed at the same time that the house is being sheathed. The details, of course, depend on the particular truss design.

Raise heel truss. In this case, the sheathing would run up to touch the top web of the truss. This is easy to do before the look-out member is attached. For blown attics, depending upon the height of the heel, this sheathing might also serve as the insulation block.

Cantilevered truss. Here, the bottom chord extends out to the full length of the soffit. To block air movement with pieces of sheathing, the sheathing would have to be cut and blocked in between each truss and extended to the bottom of the vent chutes. A simpler solution would be to install waxed cardboard vent chutes that can be bent to extend down to the top plate (as shown in Figure 5).

What about remodeling? The attic near the soffit is one of the worst places for the remodeler to work. The National Center for Appropriate Technology recommends scraping back the existing insulation, installing vent chutes and spraying polyurethane in the area between the ceiling and vent chutes. A simpler solution might be to snugly fit in a piece of batt insulation covered with a sheet of polyethylene (Figure 6).

More benefits

Taking care of this problem, whichever method is used, will certainly benefit the homeowner who will avoid future condensation problems, realize energy savings, and feel more comfortable with a warmer ceiling.

For the builder there will be one less potential cause for a callback, and an all-around improved energy performance of that builder's houses. In addition, for blown attics, using a sheathing baffle will make the insulation job simpler because it can replace both the batt insulation plug and vent chutes, that is if the raised heel is tall enough to allow the sheathing to extend to the top of the attic insulation (as shown in Figure 3).

North Dakota builders are offered solution

Harvey Hirning, with the North Dakota State University Extension Service, has helped many builders in his area solve this problem. "Once they recognize that the reason behind cold wall/ceiling corners is cold air blowing through the attic insulation," Hirning says, "they easily take care of it, and they never call back with that problem again."

Raised Heel Trusses – Once a Custom Item, Now Commonplace

The old-fashioned no-heel truss (Figure 4-A) is now used only for garages and less efficient housing. And, while it used to be the standard in all climates, some people now consider it suitable only for southern climates. In contrast, any raised heel, which is common today, used to be a custom item.

Today's standard is the wedged heel (Figure 4-B), and it is used for most medium priced housing. It allows for some increase in thickness of insulation above the plate and also allows for some extension of the sheathing to cover the edge of the insulation for reducing air flow into the insulation.

The raised heel truss (Figure 4-C) is currently the standard in both good quality homes and nearly all of the higher-priced homes and usually costs about 10 percent more than the standard wedged heel trusses. With this truss, sheathing can be extended to stop cold air flow into the insulation in order to take full advantage of its energy saving potential.

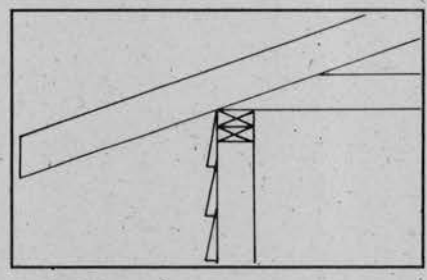


Figure 4-A
Old-fashioned no-heel truss or rafter framed house.

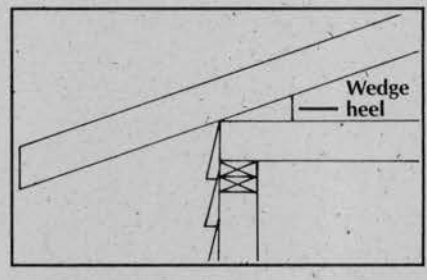


Figure 4-B
Standard wedged heel truss.

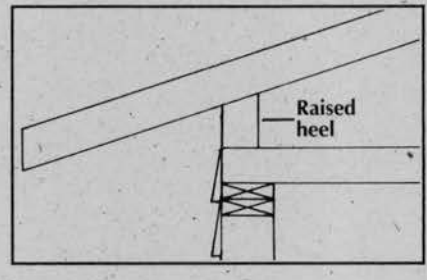


Figure 4-C
Raised heel (or energy) truss.

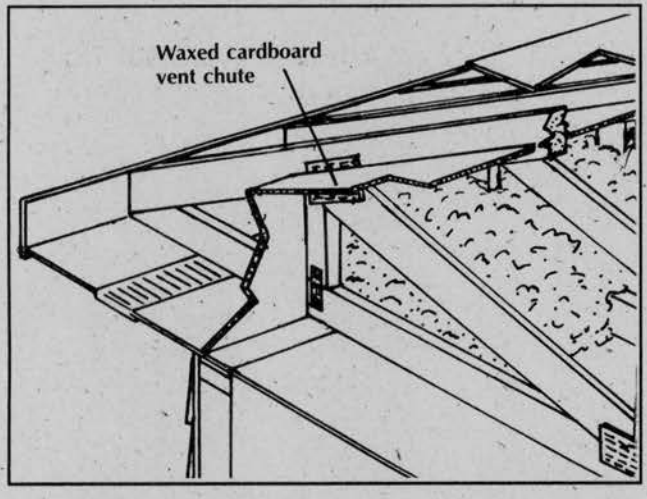


Figure 5
Cantilevered truss.

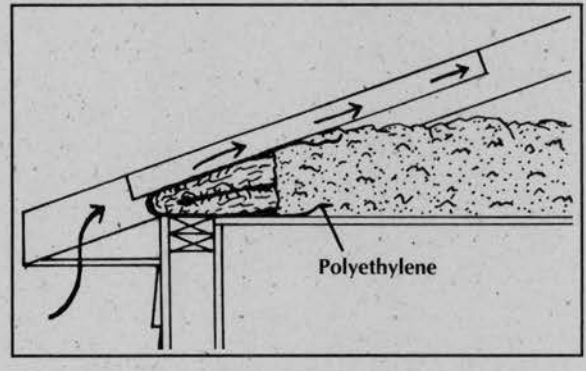


Figure 6
Spray urethane or a snug fitting piece of batt insulation covered with polyethylene can be used to block air passage into the ceiling insulation in a retrofit or cantilevered truss application.

Radiant barrier advisory

Minnesotans are being cautioned about the purchase of radiant barrier home energy products. A radiant barrier is a sheet of aluminum foil installed in the attic which may be useful in reducing ceiling heat gain on summer days by resisting downward heat flow. However, it is the ability of the aluminum foil to save energy in the winter by resisting upward heat flow that has been questioned.

Some radiant barrier sales literature has shown heat flowing down through roofs or up through ceilings, only to be turned back by a radiant barrier. The fact is that roofs and ceilings alone are barriers to radiant heat flow.

Studies conducted by the Florida Solar Energy Center show that reasonably priced radiant barrier products can be worthwhile in hot climates, such as in Florida and Texas, or where the cooling requirements are at least twice as much as the Twin Cities had this past summer. In Minnesota, radiant barriers would not be as worthwhile as in the south because our main concern is heating, not cooling.

Single sheet aluminum foil products are being sold as radiant barriers in southern states for 15 cents or less per square foot. The Minnesota Department of Public Service has learned that some companies have been trying to sell radiant barriers in Minnesota for as much as two dollars per square foot!

continued from page 3

Report Available

The problem of air movement through attic insulation was recognized in research performed on a group of energy efficient homes in Minnesota. In this 1985 project, investigators looked closely at the characteristics of more than 100 energy efficient homes. The report based on this research, titled the "Energy Efficient House Research Project," reveals much about what works best to make a home energy efficient.

A summary of this report is available free from the Energy Information Center. Ask for the "Energy Efficient House Research Summary."

The entire 193-page research report can be ordered from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (Order number DE86015941). The cost is $11.95, postage included.

Previous editions of the **Update** are available free from the Energy Information Center.

Fall 1985	**Household Ventilation**
Winter 1986	**Water Heating**
Spring 1986	**Energy Calculations**
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Spring 1987	**Ice Dam Causes**
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Summer 1988	**Moisture Problems in Bathroom Exterior Walls**

To receive past editions, or to be put on the mailing list to receive future editions of Home Builders Energy Update, call the Energy Information Center at 296-5175, or Minnesota toll free, 800/652-9747.

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Cold Climate Housing NEWS

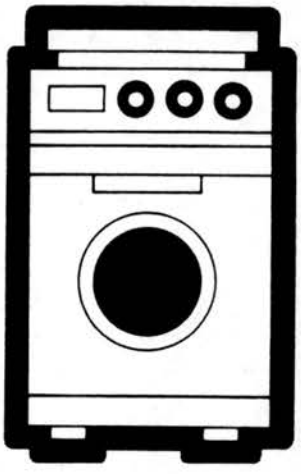
Cold Climate Housing Center, Minnesota Extension Service
Minnesota Cold Climate Building Research Center, University of Minnesota

MnBRC Volume 2, Issue 3

Appliances And Energy Use: 1990's

Wanda Olson, Design, Housing and Apparel

Consumers can benefit by selecting energy-efficient appliances. To help consumers with their selections, appliance efficiency standards have been established. The law establishing the standards, the National Appliance Energy Conservation Act (NAECA), was signed in 1987. The standards for clothes washers (requiring a cold water rinse option), for dishwashers (requiring an "air dry" option), and for gas clothes dryers (electric ignition) took effect in 1988. Electric ignition rather than standing pilot for gas ranges and ovens with a power cord is scheduled to take effect on January 1, 1990. In Minnesota electric ignition has been required since 1979. The standards for refrigeration and water heating appliances are scheduled to take effect, on all models manufactured, on or after January 1, 1990.



Refrigerators and Freezers

There will need to be many new models of refrigerators and freezers introduced, since only 25% of the models available in 1987 meet the new requirements. The standards specify the maximum energy consumption according to volume (cubic feet), type of defrost, features such as through-the-door ice (refrigerator), and style such as upright or chest (freezer). These features are considered to be a benefit to the consumer and additional kilowatt hours (kwhs) are allowed for them. Table 1 gives some indication of how current models listed in the *1989 AHAM Directory of Certified Refrigerators and Freezers* fit with the NAECA requirements.

Water Heaters

The efficiency standards for water heaters are based on storage tank volume. The efficiency is indicated by its energy factor (EF), which is an overall efficiency based on heating 64 gallons of water per day.

Continued on page 2.

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Windows Make A Home

Patrick Huelman, Forest Products

Windows are a very important component of our homes. First, they play an important role in our physical and psychological comfort, health, and well-being in the home by providing a vital connection with the exterior environment. Secondly, they provide architectural interest and character to both the interior and exterior of the home. Thirdly, they are a major contributor to the energy efficiency or inefficiency of the home. This article will address the energy aspects of window location as well as the individual window unit.

Continued on page 4.

Windwashing And Its Effects On Wood Frame Buildings

Timothy D. Larson, Forest Products

Windwashing is defined as the penetration of the building envelope by outside air. The discovery that air leakage (or *exfiltration*) in cold climates leads to more moisture condensation problems than diffusion alone has increased interest in developing a good air barrier within the building envelope. Builders have used polyethylene and/or drywall in combination with caulks and gaskets on the warm side of the envelope to establish the air barrier. This has become particularly effective in reducing air leakage through ceilings into attic spaces. This article focuses on the areas of the building where intrusion or entry of air from the outside occurs and the problems it may create.

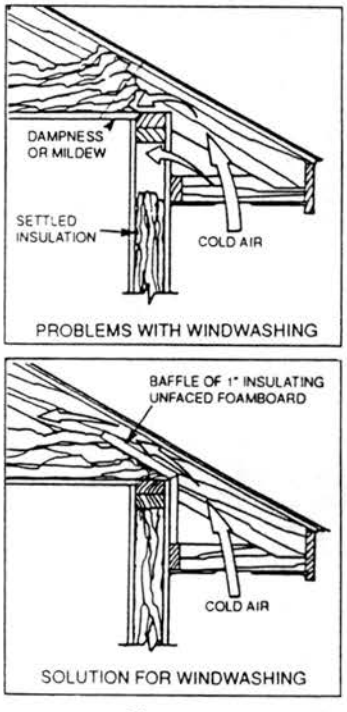

Figure 1.

The Minnesota Energy Division has written an excellent piece on the entry of air into the insulation at the truss heel/exterior wall intersection (see References). Figure 1 shows the problem and the solution with this type of windwashing. Air is shown entering through the soffit and then penetrating the attic insulation. This type of windwashing leads to interior condensation and energy loss. Signs of this condensation include thermal dusting, paint failure, drywall deterioration, water staining, mold, and mildew. Placing a baffle at the truss heel location to direct the ventilation air up over the insulation into the attic space can solve the problem. When continuous soffit venting is used, it is advisable to use baffles between each of the trusses. For more detailed information on this type of windwashing, contact the Minnesota Energy Division at (612) 297-5175; or in Minnesota call toll free 1-800-652-9747. Ask for the 1989 winter edition of the *Home Builders' Energy Update*.

Danish research on cathedral ceilings has demonstrated a number of problems associated with windwashing. The most serious of these problems was the use of batts too small to fill spaces between the insulation and the rafters. This caused a tremendous drop in ceiling insulation performance. Oversized batts and poor installation also degraded the performance of ceiling insulation. Furthermore, it was found that increasing the air speed from 0.65 ft/sec to 1.3 ft/sec dropped the R-value of the ceiling from 18.1 to 14.1 (a 21.9% reduction in R-value). This reduction took place in what was defined as perfectly installed fiberglass batt insulation. This research emphasizes the importance of proper insulation installation in cathedral ceilings and the protection of that insulation from windwashing, particularly at the junction of the ceiling and the exterior wall (by use of a baffle) so that ventilation air does not enter the insulation.

Windwashing also affects exterior walls. This is particularly visible at corners during the winter when mold and mildew appear because of condensation. There are many reasons for the condensation. Thermal bridging is one. This occurs when the number of studs at the corner reduces the potential to insulate and causes a greater heat loss. Natural convection or air movement in the corner is restricted so interior surfaces at this point are colder than other interior surfaces. Also radiant heat exchange is not good at the corner of exterior walls which leads to reduced surface temperatures. Furniture in corners contributes even further to the reduction of air flow and radiant heat exchange that takes place at corners. The geometry at the corner causes more conductive heat loss than at other places in the exterior wall. This is referred to as two-dimensional heat flow.

Research at the University of Toronto indicates that the preceding reasons were generally not enough to account for the condensation that was taking place at the corners of exterior walls. Laboratory research reveals that wind pressure differences at the exterior corners resulted in cold outside air entering, traveling through, and then exiting the wall at exterior corners (see Figure 2). It was shown that the wind

Continued on page 7.

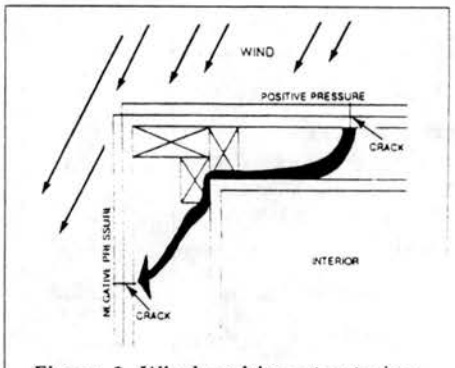

Figure 2. Windwashing at exterior wall corners.

Windwashing And Its Effects On Wood Frame Buildings

Continued from page 3.

factor alone would lower the interior surface temperature enough so that interior relative humidities had to be reduced from 65% to 40% to prevent condensation at the corners under the experimental conditions. In addition to reducing interior surface temperatures, this cold air traveling through the corner of the exterior walls would increase heat loss. This research indicates that one needs to be careful when installing exterior sheathing and/or weather barriers so that windwashing will not take place at exterior wall corners or at other places where wind may penetrate the envelope.

Research in Norway has shown that the lack of a weather barrier (wind barrier) can increase the heat loss through an exterior wall by 50% when it is exposed to a wind velocity of about 13.6 miles per hour. A builder can use the exterior sheathing as a weather barrier if installed correctly.

Attention should be directed towards the design and construction of the building envelope to prevent windwashing. Windwashing can lead to deterioration of interior surfaces as in the cases of exterior wall corners and ceiling/exterior wall intersections. Windwashing can also degrade the R-Value of both ceiling and wall insulation. The remedy to windwashing is to have controlled pathways for attic ventilation and an adequate weather barrier near the exterior surface of the wall.

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Fixing A Home Radon Problem

Continued from page 6.

house been built according to new construction recommendations by EPA, at minimum it would have a sealed sump, gravel under the slab, and a roughed-in PVC pipe from the basement ceiling to the attic floor, capped at both ends. Another option being researched by EPA investigators is to connect the PVC from the sump lid through to the roof, creating a "passive stack" for the radon. If this stack fails, a fan can be inexpensively added.

For more information on radon, the following publications are available: "Application of Radon Reduction Methods," (EPA/625/5-88/024), which can be obtained from the Center for Environmental Research Information, 26 West Martin Luther King Drive, Cincinnati, Ohio, 45268; "Radon Issues in House Buying and Selling," (Folder HE-FO-3532), and "Radon Facts for House Sellers and Buyers," (Fact Sheet HE-FS-3533), both of which can be obtained by writing or calling the Cold Climate Housing Center.

Radon Policy Action

William J. Angell,
Extension Housing Specialist

Mortgage lenders, commercial property owners, and school officials have recently learned that some of the most important radon policy actions flow from the administrative decisions of government agencies.

Savings and loan (S&L's) associations have been advised that radon is a potential risk and liability in a February 16 bulletin from the federal Home Loan Bank System's Office of Regulatory Activities. The risks to S&L's include borrower loan default if corrective action is costly, direct lender liability for the cost of repairs in the case of foreclosure or S&L ownership or management of the property, and liability in the case of personal injury of an occupant. The Bank System advises lenders to limit risk and liability through a number of steps including defining criteria to reject mortgage applications when radon levels are unacceptably high.

Commercial property owners who desire to lease space or to sell buildings to the federal government are learning that the General Services Administration (GSA) has initiated a radon policy. The policy calls for indoor radon testing. If test results are confirmed above the Environmental Protection Agency's (EPA) threshold for action (4 pCi/L), radon levels must be reduced. Furthermore, GSA advises that temporary employee relocation should be considered if radon levels are above 200 pCi/L.

School officials are receiving further details from EPA and state agencies about how to test school rooms for radon. While EPA believes the radon threat to the general population may be several thousand times greater than that related to asbestos, the cost of radon testing and reduction is comparatively cheap. For example, school radon testing is expected to cost less than $1.00 per child.

On the state legislative front, the 1989 Minnesota Senate failed to pass Senate File 342 that would have funded radon research and education as well as qualified Minnesota to receive federal matching grants. The 1990 legislative sessions will be the next opportunity for Minnesota to join 20 other states that have acted on the radon issue.

R - V A L U E C O M P A R I S O N
8" Insulated Concrete Masonry Systems
(Steady-State Values Before Mass
Adjustments Which Varies With Climate)

INSULATED CONCRETE BLOCK SYSTEM	INSERT THICK	SERIES-PARALLEL (ISOTHERMAL PLANES) CALCULATION METHOD(1) LIGHT WEIGHT 80 PCF	LIGHT WEIGHT 100PCF	MEDIUM WEIGHT 120PCF	HEAVY WEIGHT 140PCF	PARALLEL-PATH CALCULATION METHOD (I N A C C U R A T E) LIGHT WEIGHT 80 PCF	LIGHT WEIGHT 100PCF	MEDIUM WEIGHT 120PCF	HEAVY WEIGHT 140PCF	COMPANY PUBLISHED LITERATURE(2) LIGHT WEIGHT 80 PCF	LIGHT WEIGHT 100PCF	MEDIUM WEIGHT 120PCF	HEAVY WEIGHT 140PCF
 EnerBlock™ (Continuous Between Block)	1.25"	6.2	5.3	4.5	3.6	7.8	7.1	6.4	5.9	S A M E A S			
	2.00"	6.9	5.7	4.7	3.8	9.6	8.7	7.8	7.0	S E R I E S - P A R A L L E L			
	2.50"	8.7	7.1	5.9	4.6	11.0	9.8	8.7	7.8	C A L C U L A T I O N			
	4.00"	10.1	8.1	6.4	4.9	13.7	12.0	10.5	9.2	M E T H O D			
 C-SHAPED INSERTS (Cores Only)	1.125" Each Side	4.0	3.5	3.0	2.6	5.8	5.0	4.4	3.9	7.7 (93%)	6.3 (80%)	5.3 (77%)	4.2 (62%)
 PLAIN INSERTS (Cores Only)	2.00"	3.8	3.3	2.8	2.4	5.5	4.8	4.2	3.9	7.7 (103%)	6.3 (91%)	5.3 (89%)	4.2 (75%)
 CUT-DOWN WEB (NOT Continuous Between Block)	1" Plus	4.2	3.6	3.0	2.5	6.8	6.1	5.5	5.0	6.7 (60%)	5.5 (53%)	4.4 (33%)	3.1 (24%)
 CUT-DOWN WEB (Continuous Between Block)	2.375"	7.4	6.0	4.8	3.8	10.7	9.6	8.6	7.8	11.1 (50%)	9.1 (52%)	7.7 (60%)	—

NOTES: (1) Series-Parallel R-values are according to the "STANDARD PROCEDURE FOR CALCULATING THE OVERALL COEFFICIENT OF HEAT TRANSFER OF CONCRETE MASONRY" as developed by the National Concrete Masonry Association (NCMA). This calculation procedure is mandated by the U.S. Department of Energy (DOE) and the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), STANDARD 90.1. Values for insulated bloc other than EnerBlock were calculated using the best dimensional information available. For additional comparison, results from the same NCMA "STANDARD PROCEDURE" should be obtained from other companies marketing insulated concrete masonry.

(2) The figure in parenthesis for published literature is the percentage above the R-Values as calculated according to the ASHRAE Series-Parallel (Isothermal Planes) calculation method.

10/89

R - V A L U E C O M P A R I S O N

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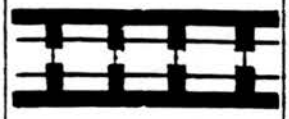
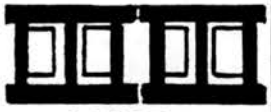
	1.25"	6.2	5.3	4.5	3.6	7.8	7.1	6.4	5.9	S A M E A S			
	2.00"	6.9	5.7	4.7	3.8	9.6	8.7	7.8	7.0	S E R I E S - P A R A L L E L			
EnerBlock™ (Continuous Between Block)	2.50"	8.7	7.1	5.9	4.6	11.0	9.8	8.7	7.8	C A L C U L A T I O N			
	4.00"	10.1	8.1	6.4	4.9	13.7	12.0	10.5	9.2	M E T H O D			
 C-SHAPED INSERTS (Cores Only)	1.125" Each Side	4.0	3.5	3.0	2.6	5.8	5.0	4.4	3.9	7.7 (93%)	6.3 (80%)	5.3 (77%)	4.2 (62%)
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 CUT-DOWN WEB (NOT Continuous Between Block)	1" Plus	4.2	3.6	3.0	2.5	6.8	6.1	5.5	5.0	6.7 (60%)	5.5 (53%)	4.4 (33%)	3.1 (24%)
 CUT-DOWN WEB (Continuous Between Block)	2.375"	7.4	6.0	4.8	3.8	10.7	9.6	8.6	7.8	11.1 (50%)	9.1 (52%)	7.7 (60%)	—

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(2) The figure in parenthesis for published literature is the percentage above the R-Values as calculated according to the ASHRAE Series-Parallel (Isothermal Planes) calculation method.

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Energy Efficient Building Association
Technology Center, University of Southern Maine
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EEBA ALERT

WINDOW R-VALUES SUBSTANTIALLY OVERSTATED !!

For several years EEBA has reported at it's annual conferences that published window **R-Values** were **inflated** and **unrealistic.** The window industry has touted numbers based upon an antiquated ASHRAE formula. The calculated results which were consistently and substantially higher than accurate laboratory testing results have been consciously reported by the industry for many years. As this ALERT is being prepared most window manufacturers product literature and advertising still list these artificially high R-Values.

The basic problem? The window manufacturing industry, almost unanimously, has been using calculations provided by ASHRAE in it's 1985 (and earlier) Handbook of Fundamentals. Unfortunately, that ASHRAE formula did not include many factors widely known about windows.

The **1989 ASHRAE Handbook of Fundamentals** has a drastically different and substantially improved formula for these calculations. The result is significantly greater accuracy **but substantially LOWER R-Values.** The new formula includes the following criteria:

R-Values at center of glass.
Insulation value of frame materials.
Wind velocity of 15 MPH.
Inside (70°F) & Outside (0°F) Temperatures
A standard size unit (3" x 4" for residential)
The "edge effect"

What does all of this mean? To illustrate the point let's consider a very popular "Low E" casement unit gas filled insulating glass. It has been advertised, through the last day of 1989, as having a **4.2 R-Value.** Starting January 1, 1990 that **exact same window** will have only a **3.2 R-Value,** or about **26% less.** Windows smaller than 3' x 4' are even more dramatically downgraded.

Further, the numbers for inside glass surface temperatures, % RH when condensation occurs, shading coefficients and relative heat gain are all **adversely lower** than previously reported.

EEBA believes this is **very significant** information effecting all heat loss calculations. We caution all designers, architects, contractors, builders, weatherization staff, utility auditors and others to **use the new more accurate R-Values** based upon the **1989** ASHRAE Handbook of Fundamentals. **Possibly less glazing area should be seriously considered in some buildings.**

Only two or three major manufacturers have made the corrections in their latest literature; however not all dealers have this information at this time. Most manufacturers have not published the corrected R-Values. It is not clear when or if they will.

Consequently, the status of window product literature in the market place today relative to correct R-Values is shamefully chaotic. The problem is further compounded by the fact that several manufacturers are using inert gases and claiming additionally higher R-Values for units with these gases. Unfortunately, some manufacturers do not explain this in their literature. Thus, frequently the consumer has great difficulty in knowing the true R-Value of the product being purchased.

As a suggestion, when only "old" **R-Values** are known, subtract one (1) R-Value from the old published numbers. This will be close to the newer more accurate values.

Congratulations to our friends at LBL Berkeley who developed the new comprehensive calculations. Special recognition also to the very able researchers at Energy, Mines and Resources, Canada for their "edge effect" work. And thanks to ASHRAE for recognizing this problem and doing something about it.

Now the window industry must be encouraged to provide this new correct data without delay. The newly formed National Fenestration Rating Council (NFRC) should play a major role in this important task.

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ATTACHMENT 12

Window U-Values

Revisions for the 1989 ASHRAE Handbook—Fundamentals

By Michael E. McCabe, P.E., Dsc
Member ASHRAE

Editor's Note: Chapter 27 in the *1989 ASHRAE Handbook—Fundamentals* is the authoritative source of technical information on fenestration products such as windows, patio doors, skylights, shading devices, etc. Its revision every four years is the responsibility of Technical Committee 4.5 (Fenestration). *Table 13* in this chapter lists Overall Coefficients of Heat Transfer (U-Values) for a variety of fenestration, based on standard outdoor design conditions. This data has been used by engineers, architects, manufacturers, code officials, etc., for many purposes; including design calculations for sizing heating and cooling equipment, for estimating building energy consumption, and for comparing thermal performance between competing fenestration products. The *1989 ASHRAE Handbook—Fundamentals* was printed and mailed to ASHRAE members entitled to receive the book in May.

Recently, the thermal resistance of insulated glazing units has undergone significant improvement due to commercialization of products having low-emittance coatings and or low-conductance gas fills. Thus, heat conduction in the non-glazed portion such as the frame and sash has become more important in determining the overall U-Value of the system. The U-Value Subcommittee of T.C. 4.5 has recommended a number of changes to be made to *Table 13* in the 1989 Handbook. This article discusses the technical basis for the changes and illustrates the differences between data in the 1989 Handbook and previous Handbooks.

Overall coefficient of heat transfer

The general equation used to estimate the total rate of heat transfer, Q_o, through a fenestration system from inside to outside is.

$$Q_o = U_o \cdot A_o (t_{i\,air} - t_{o\,air}) \qquad (1)$$

where

U_o = overall heat transfer coefficient (U-Value). Btu/h · ft² · F (W/m² · K).

A_o = combined glazing plus frame area projected to a plane parallel to glass as viewed from outside. ft² (m²).

$t_{i\,air}$ = temperature of warm space air. F (C).

$t_{o\,air}$ = temperature of cold space air. F (C).

The total rate of heat transfer through a fenestration system can be calculated knowing the separate heat transfer contributions of the glazing and frame. With insulating glass, the glazing heat transfer contribution includes a center of glass component and an edge of glass component that is due to the presence of a spacer. The overall U-Value is estimated using area-weighted U-Values for each contribution by:

$$U_o = (U_{cg} \cdot A_{cg} + U_{eg} \cdot A_{eg} + U_f \cdot A_f) / (A_{cg} + A_{eg} + A_f) \qquad (2)$$

where the subscripts *cg*, *eg*, and *f* refer to, respectively, the center-of-glass, edge-of-glass and frame.

Center-of-glass coefficient

Center-of-glass U-Values are calculated based on one-dimensional heat flow theory using convective heat transfer correlations for enclosures (El Sherbiny, 1982) and standard computational methodologies (Rubin, 1982). Values for U_{cg} depend on the surrounding air temperatures and velocities, and the glazing construction features, including the number of glazing lites, the air-space dimensions, the orientation relative to vertical, the emittance of each surface and the composition of the fill gas. Public-domain computer programs, such as WINDOW3 (Lawrence Berkeley Laboratory, 1987), and VISION (University of Waterloo, 1987) provide rapid estimates of U-Value for a wide range of glazing constructions.

Figure 1 shows values of U_{cg} for double and triple-glazed, vertical fenestration at standard winter design conditions calculated using WINDOW3. The plot shows the important effects of low-emittance coatings and argon gas fill. The reduced importance of air-space dimensions greater than about 1/2 in. (13 mm) are evident. Emittance values of 0.84, 0.40, and 0.15 correspond, respectively, to conventional glass (uncoated), pyrolitic coated glass and sputter coated glass. The vertical lines in *Figure 1* show the gas space widths listed in the *1989 ASHRAE Handbook—Fundamentals*.

Edge-of-glass coefficient

Insulating glass units have continuous members around the glass perimeter to separate the glazing lites and provide an edge seal. The spacers are often made of highly conductive materials (aluminum), which locally degrades thermal performance of the glazing unit. Alternate spacer materials include thermally insulating materials such as fiberglass and butyl rubber, and partly insulating glass edges. Edge heat transfer can make a significant difference in the U-Value of the glazing unit, especially those with small glazing dimensions or with high-performance insulating glass. Thus, it is important to use test data or design specific computations to account for this important feature.

Laboratory measurements reported by Peterson (1987) have shown this conductive region to be limited to a band approximately 2-1/2 in. (63 mm) wide around the perimeter of the glazing unit. *Figure 2* shows the heat flow in the edge region of an insulating glass unit to be two-dimensional, as depicted by the computer generated isotherms for a glazing unit with an aluminum spacer. *Figure 3* shows the edge-of-glass U-Value as a function of the center-of-glass U-Value for different spacer materials. Data for aluminum spacers and insulating spacers will appear in the 1989 Handbook. Test data are shown for aluminum spacers. Calculated values are also

shown for the three spacing materials (Carpenter and McGowan, 1989). Data for partly insulating glass edges also apply to stainless steel spacers. Computer simulations indicate the edge-of-glass effect is independent of the framing material and design.

Frame geometry and coefficient

Fenestration products are usually framed in either wood, aluminum or vinyl, and some products utilize a combination of these materials for structural, durability or aesthetic purposes. Aluminum-framed units are sometimes available with "thermal breaks" that reduce the conductive heat transfer through the framing element. Fenestration products also come in many sizes, with frame cross-section and glass-to-frame ratio differing between the larger commercial windows and the smaller residential windows. The U-Value Subcommittee recommended that two product types, Type R (residential), and Type C (commercial) distinguish between the different frame geometries and glass-to-frame ratios. *Figure 4* shows the geometry of these two product types.

Characterization of frame heat transfer coefficients is complicated by the variety of frame configurations for operable windows, the different materials and the different product sizes. Standard methods for measuring frame heat transfer are not generally available. Also, calculations are difficult due to the two- and three-dimensional nature of the heat conduction path and the uncertainties of contact resistance at moving joints. However substantial progress has recently been made in analyzing frame heat conduction. Energy Mines and Resources Canada (1987) developed a computer program specifically for frame heat transfer. Ongoing research is expected to provide additional frame conduction data for a range of fenestration products.

Frame heat transfer coefficients recommended for the 1989 Handbook are as follows:

Material	U_f, Btu/hr · ft² · F (W/m² · K)
Aluminum (without thermal break)	1.9 (10.8)
Aluminum (with thermal break)	1.0 (5.68)
Wood or Vinyl	0.4 (2.27)

These coefficients are based on laboratory testing of specific window products provided by Bulger (1987), which were judged to be representative. Computer simulations by Carpenter and McGowan (1989) confirmed that the laboratory data are reasonable. Significant variation in these frame coefficients is expected between the different commercial products in the market.

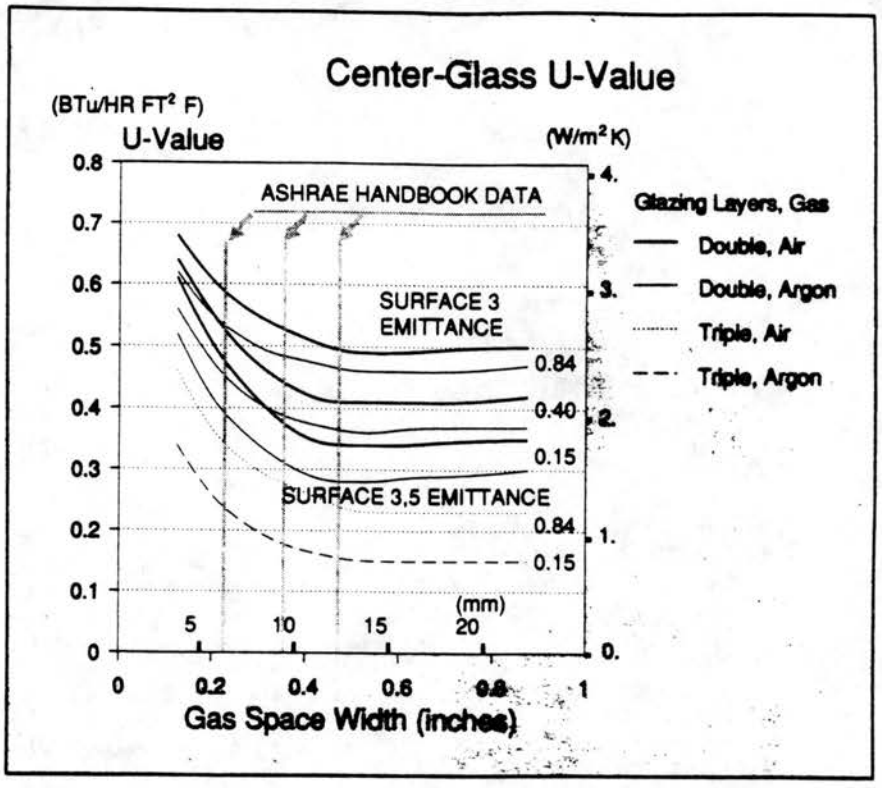

Figure 1. Center-of-glass U-Value for double and triple-glass at ASHRAE winter design conditions.

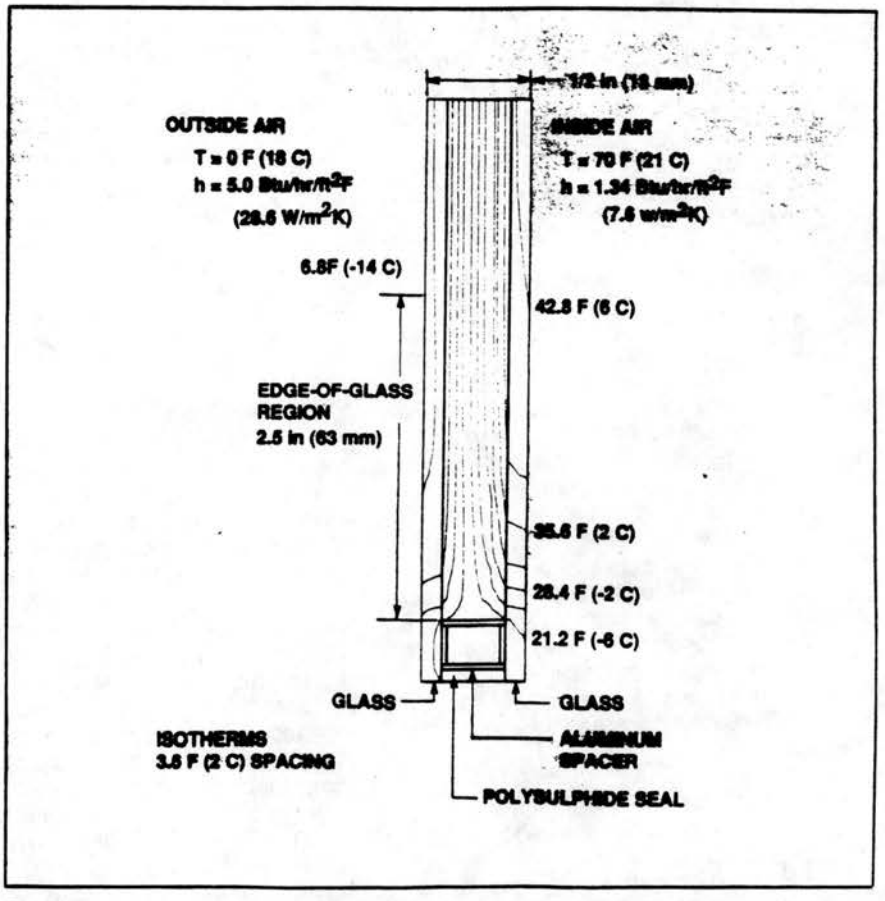

Figure 2. Isotherms in edge-of-glass region for 4-3/4 in. (120 mm) long region of 1/2 in. (13 mm) insulating, uncoated glazing unit.

Revisions in the 1989 Handbook

The 1985 Handbook includes a set of "adjustment factors" that multiply the center-of-glass U-value to account for the thermal conductivity of the different frame materials. The original frame adjustment factors were constants derived from laboratory test data. However, in recent Handbook revisions, a range of adjustment factors was provided instead of a single value for each frame type, apparently to reflect the measured variation in U-Value for commercial products based on laboratory testing. However, the current data have limited value because the frame adjustment factors do not consider different product sizes or glass to frame ratios, and the frame factors are not applicable for the newer framing materials such as extruded vinyl, or composites of aluminum or vinyl-clad wood.

These limitations have been partially addressed in the 1989 Handbook. The format has been revised to provide a consistent set of winter design day data for currently important products. U-Value data in previous Handbooks for summer design conditions, and for combinations of added shades and storm sash are no longer considered important and have been eliminated. The revised format for *Table 13* in the 1989 Handbook should permit comparison between alternative products based on product size, glazing design and framing material. The actual table is too lengthy to present in this article. Therefore, the pertinent changes are summarized in the 1985 Handbook illustrations.

U-Values in the 1989 Handbook consist of calculated data for a variety of glazing systems and framing materials for two product types designated Type R (residential) and Type C (commercial). Part A of the table provides winter design U-Values for vertical glazing. Part B provides approximate factors to convert vertical data to sloped (45 deg) and horizontal orientation. Glazing unit descriptors include: one, two, or three glazing layers; glass, acrylic, or polyester film, and spacing dimensions of 1/4-, 3/8- or 1/2-in. (6, 10 or 13 mm) with emittance values of 0.84, 0.40 or 0.15; and gas fills of air or argon. The spacer material is assumed to be aluminum. Whenever a fenestration system differs from that assumed in the Handbook, such as due to different glazing spacings, emittances, spacer materials, frame conductances, etc., Equation 2 can be used to calculate the appropriate U-Value.

Comparison between uncoated insulating windows

To illustrate the changes appearing in the 1989 ASHRAE Handbook, uncoated insulating glass (e = 0.84) with an air fill is compared with previous Handbook data. *Figure 5a* displays overall U-Values for a double-glazed window with a 1/2-in. (13 mm) airspace having either a thermally-broken aluminum frame, a non-thermally-broken aluminum frame or a wooden or vinyl frame. *Figure 5b* displays similar data, however for triple-glazed windows with two 1/2-in. (13 mm) air spaces. (Note that the center-of-glass U-Value for these glazing units are identical with the 1985 Handbook data, therefore the differences are due to the edge-of-glass factors, frame geometry and thermal conductance.)

Figures 5a and *5b* show a significant increase in the 1989 U-Value data for aluminum-framed windows, especially without thermal breaks. These changes reflect the importance of frame geometry and thermal conductivity in computing overall U-Value. There are no significant changes noted for wooden-framed windows. Aluminum-framed windows show a greater difference between the Product Types R and C as compared to differences attributed to the range of adjustment factors previously used. The graphs depict both double glass and triple glass U-Values.

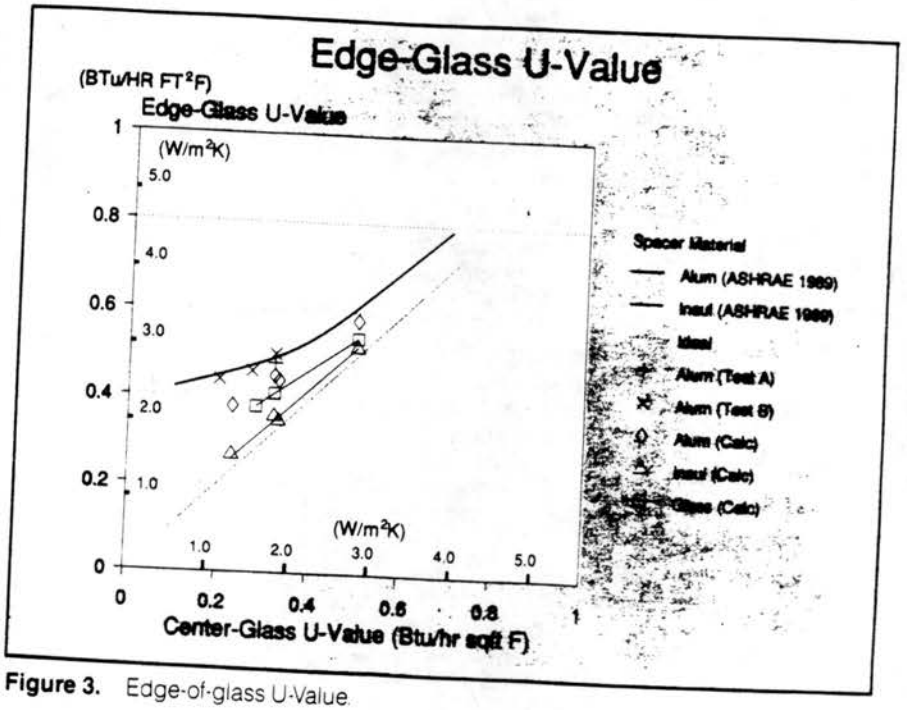

Figure 3. Edge-of-glass U-Value.

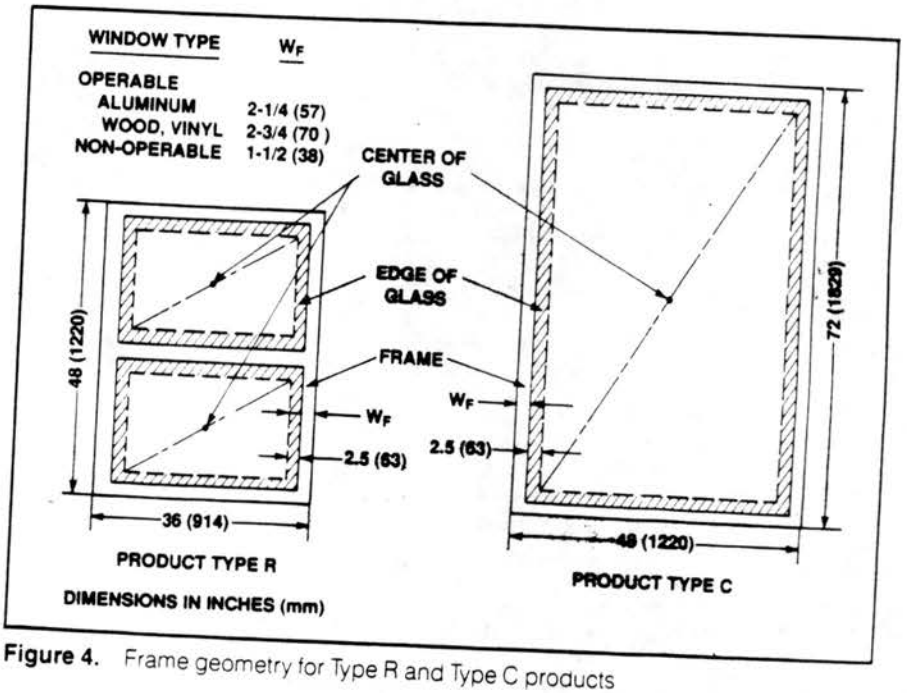

Figure 4. Frame geometry for Type R and Type C products

Conclusions

Significant progress in reducing center-of-glass heat transfer has recently been made with commercially-available glazing units. However, reduction in edge and frame heat transfer still needs to be addressed. It is anticipated that the revised table of U-Values published in the *1989 ASHRAE Handbook—Fundamentals* will provide sufficient technical information to enable rational decisions to be made in specifying generic window products, and also would encourage manufacturers to develop improved products. It is apparent that additional subclassification of the different materials and construction techniques are required for framing members. Both analytical and experimental methods need to be further refined to assist in this important undertaking.

Acknowledgements

Revisions to *Table 13* (Window U-Value Table), in the Fenestration Chapter of the *1989 ASHRAE Handbook—Fundamentals* were conducted by the U-Value Subcommittee of TC 4.5. Major contributions to these efforts were provided by D. Arasteh, Lawrence Berkeley Laboratory, Stephen Carpenter, Enermodal Engineering Ltd., Harry Sullivan, University of Waterloo, and John Hogan, Seattle (Washington) Department of Construction and Land Use.

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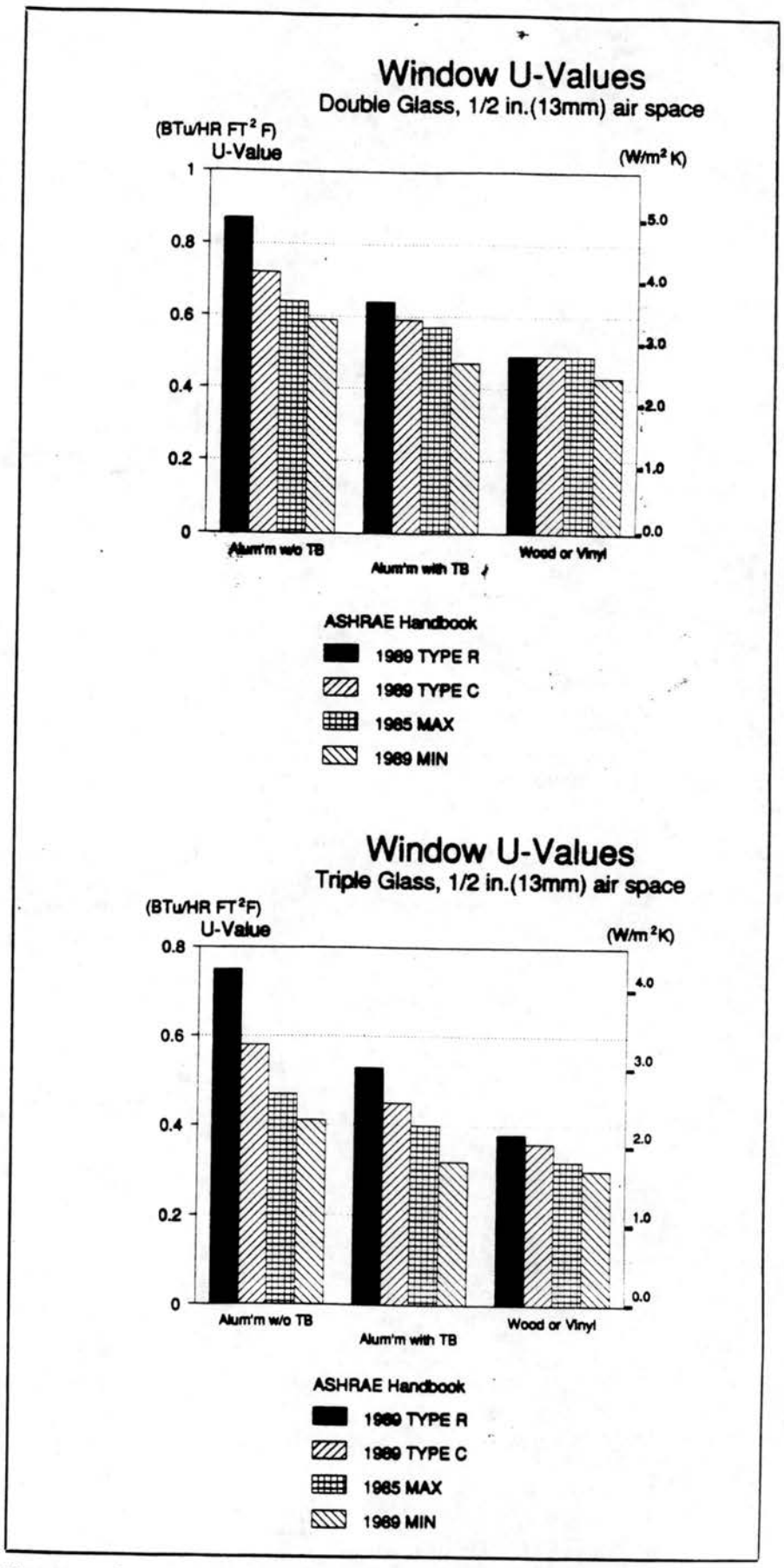


Figures 5A & 5B. Comparison of U-Values between 1985 and 1989 Handbooks. (a) double glazed window, (b) triple-glazed window.

Table 13 Overall Coefficients of Heat Transmission of Various Fenestration Products

Part A: U-Values for Vertical Installation[a], Btu/h·ft²·°F

Glazing Type[b]	Glass Only: Center of Glass	Glass Only: Edge[c] of Glass	Aluminum Frame no thermal break ($U_f = 1.9$): Product[d] Type R	Aluminum Frame no thermal break ($U_f = 1.9$): Product[d] Type C	Aluminum Frame thermal break ($U_f = 1.0$): Product[d] Type R	Aluminum Frame thermal break ($U_f = 1.0$): Product[d] Type C	Wood or Vinyl Frame ($U_f = 0.4$): Product[d] Type R	Wood or Vinyl Frame ($U_f = 0.4$): Product[d] Type C
Single glazing								
glass	(1.11)	(n/a)	1.31	1.23	1.09	1.10	0.90	0.98
1/8 in. acrylic	(1.03)	(n/a)	1.26	1.16	1.02	1.03	0.84	0.92
Double glass								
1/4 in. air space	(0.57)	(0.66)	0.92	0.78	0.70	0.65	0.54	0.55
3/8 in. air space	(0.52)	(0.62)	0.88	0.74	0.66	0.60	0.50	0.51
1/2 in. and greater air space	(0.49)	(0.59)	0.87	0.72	0.64	0.59	0.49	0.49
Double glass, $\varepsilon = 0.40$ on surface 2 or 3								
1/4 in. air space	(0.50)	(0.60)	0.87	0.73	0.65	0.59	0.49	0.50
3/8 in. air space	(0.43)	(0.55)	0.83	0.67	0.60	0.54	0.45	0.45
1/2 in. and greater air space	(0.41)	(0.54)	0.81	0.65	0.58	0.52	0.43	0.42
Double glass, $\varepsilon = 0.15$ on surface 2 or 3								
1/4 in. air space	(0.45)	(0.56)	0.84	0.68	0.61	0.55	0.46	0.46
3/8 in. air space	(0.36)	(0.51)	0.78	0.62	0.56	0.48	0.41	0.39
1/2 in. air space	(0.34)	(0.50)	0.76	0.60	0.54	0.46	0.39	0.37
Double glass								
1/4 in. argon space	(0.52)	(0.62)	0.88	0.74	0.66	0.61	0.50	0.51
3/8 in. argon space	(0.48)	(0.59)	0.86	0.71	0.63	0.57	0.48	0.48
1/2 in. and greater argon space	(0.46)	(0.57)	0.82	0.69	0.62	0.56	0.47	0.47
Double glass, $\varepsilon = 0.40$ on surface 2 or 3								
1/4 in. argon space	(0.43)	(0.55)	0.83	0.67	0.60	0.54	0.45	0.45
3/8 in. argon space	(0.38)	(0.52)	0.79	0.63	0.57	0.49	0.42	0.40
1/2 in. and greater argon space	(0.36)	(0.51)	0.78	0.62	0.56	0.48	0.41	0.39
Double glass, $\varepsilon = 0.15$ on surface 2 or 3								
1/4 in. argon space	(0.36)	(0.51)	0.78	0.62	0.56	0.48	0.41	0.39
3/8 in. argon space	(0.30)	(0.48)	0.74	0.57	0.51	0.43	0.37	0.34
1/2 in. and greater argon space	(0.28)	(0.47)	0.73	0.55	0.50	0.42	0.36	0.33
Double glazing, 1/8 in. acrylic or polycarbonate								
1/4 in. air space	(0.52)	(0.62)	0.89	0.74	0.67	0.61	0.51	0.51
3/8 in. air space	(0.48)	(0.59)	0.86	0.71	0.64	0.57	0.48	0.48
1/2 in. and greater air space	(0.46)	(0.57)	0.85	0.69	0.62	0.56	0.47	0.47
Double glazing, 1/4 in. acrylic or polycarbonate								
1/4 in. air space	(0.48)	(0.59)	0.86	0.71	0.64	0.57	0.48	0.48
3/8 in. air space	(0.44)	(0.56)	0.84	0.68	0.61	0.54	0.46	0.45
1/2 in. and greater air space	(0.42)	(0.54)	0.82	0.66	0.60	0.53	0.45	0.43
Triple glass								
1/4 in. air space	(0.38)	(0.52)	0.79	0.64	0.57	0.50	0.42	0.41
3/8 in. air space	(0.34)	(0.50)	0.76	0.60	0.54	0.46	0.39	0.38
1/2 in. and greater air space	(0.32)	(0.49)	0.75	0.58	0.53	0.45	0.38	0.36
Triple glass, $\varepsilon = 0.40$ on surface 2, 3, 4 or 5								
1/4 in. air spaces	(0.35)	(0.50)	0.77	0.61	0.55	0.48	0.40	0.39
3/8 in. air spaces	(0.30)	(0.48)	0.74	0.57	0.52	0.44	0.37	0.35
1/2 in. and greater air spaces	(0.28)	(0.47)	0.72	0.55	0.50	0.41	0.36	0.33
Triple glass or double glass with polyester film suspended in between, $\varepsilon = 0.15$ on surface 2, 3, 4, or 5								
1/4 in. air spaces	(0.33)	(0.49)	0.76	0.59	0.53	0.45	0.39	0.37
3/8 in. air spaces	(0.27)	(0.46)	0.72	0.54	0.50	0.41	0.35	0.32
1/2 in. and greater air spaces	(0.24)	(0.45)	0.70	0.52	0.48	0.39	0.34	0.30
Triple glass or double glass with polyester film suspended in between, $\varepsilon = 0.15$ on surfaces 2 or 3 and 4 or 5								
1/4 in. air spaces	(0.28)	(0.47)	0.73	0.55	0.53	0.42	0.36	0.33
3/8 in. air spaces	(0.22)	(0.45)	0.69	0.51	0.47	0.37	0.32	0.29
1/2 in. and greater air spaces	(0.19)	(0.44)	0.67	0.48	0.45	0.35	0.31	0.26
Triple glass								
1/4 in. argon spaces	(0.34)	(0.50)	0.77	0.60	0.54	0.46	0.39	0.38
3/8 in. argon spaces	(0.31)	(0.48)	0.74	0.57	0.52	0.44	0.37	0.35
1/2 in. and greater argon spaces	(0.29)	(0.47)	0.73	0.56	0.51	0.42	0.36	0.34
Triple glass, $\varepsilon = 0.40$ on surface 2, 3, 4 or 5								
1/4 in. argon spaces	(0.30)	(0.48)	0.74	0.57	0.52	0.44	0.37	0.35
3/8 in. argon spaces	(0.26)	(0.46)	0.72	0.54	0.49	0.41	0.35	0.32
1/2 in. and greater argon spaces	(0.25)	(0.46)	0.71	0.53	0.48	0.39	0.34	0.31

Table 13 Overall Coefficients of Heat Transmission of Various Fenestration Products (*Concluded*)

Part A: U-Values for Vertical Installation[a], Btu/h·ft²·°F

Glazing Type[b]	Glass Only: Center of Glass	Glass Only: Edge[c] of Glass	Aluminum Frame no thermal break ($U_f = 1.9$): Product[d] Type R	Aluminum Frame no thermal break ($U_f = 1.9$): Product[d] Type C	Aluminum Frame thermal break ($U_f = 1.0$): Product[d] Type R	Aluminum Frame thermal break ($U_f = 1.0$): Product[d] Type C	Wood or Vinyl Frame ($U_f = 0.4$): Product[d] Type R	Wood or Vinyl Frame ($U_f = 0.4$): Product[d] Type C
Triple glass or double glass with polyester film suspended in between, $\varepsilon = 0.15$ on surface 2, 3, 4, or 5								
1/4 in. argon spaces	(0.27)	(0.46)	0.72	0.54	0.50	0.41	0.35	0.32
3/8 in. argon spaces	(0.22)	(0.45)	0.69	0.51	0.47	0.37	0.33	0.29
1/2 in. and greater argon spaces	(0.20)	(0.44)	0.68	0.50	0.46	0.36	0.31	0.28
Triple glass or double glass with polyester film suspended in between, $\varepsilon = 0.15$ on surfaces 2 or 3 and 4 or 5								
1/4 in. argon spaces	(0.22)	(0.45)	0.69	0.51	0.47	0.37	0.32	0.29
3/8 in. argon spaces	(0.17)	(0.43)	0.66	0.47	0.44	0.34	0.30	0.25
1/2 in. and greater argon spaces	(0.15)	(0.43)	0.65	0.46	0.43	0.32	0.29	0.24

Part B: U-Value Conversion Table for Sloped and Horizontal Glazing for Upward Heat Flow

Slope	U-Value, Btu/h·ft²·°F												
90° (vertical)	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30
45°	0.14	0.25	0.36	0.47	0.57	0.68	0.79	0.90	1.00	1.11	1.22	1.33	1.44
0 (horiz.)	0.19	0.29	0.40	0.51	0.61	0.72	0.82	0.93	1.04	1.14	1.25	1.35	1.46

[a]All U-values are based on standard ASHRAE winter conditions of 70°F indoor and 0°F outdoor air temperature with 15 mph outdoor air velocity and zero solar flux. The outside surface coefficient at these conditions is approximately 5.1 Btu/hr·ft²·°F, depending on the glass surface temperature. With the exception of single glazing, small changes in the interior and exterior temperatures do not significantly affect overall U-values.

[b]Glazing layer surfaces are numbered from the outside to the inside. Double and triple refer to the number of glazing lites. All data are based on 1/8 in. glass unless otherwise noted. Thermal conductivities are: 0.53 Btu/h·ft·°F for glass, and 0.11 Btu/h·ft·°F for acrylic and polycarbonate.

[c]Based on aluminum spacers data (see Figure 6). Edge of glass effect assumed to extend over the 2.5 in. band around perimeter of each glazing unit as seen in Figure 7.

[d]Product types described in Figure 7.

edge-of-glass U-values as a function of the center-of-glass U-value. The spacer edge is assumed to be even with the line of sight of the glazing. Data are given for aluminum spacers with sealants and non-metal spacers including fiberglass, wood, and butyl. Values for glass edges and steel spacers fall between the aluminum and the non-metal spacers. This edge effect does not occur with single glazing. For highly insulating glazing, edge heat transfer can significantly increase overall U-value. Thus, test data or design-specific computations should account for this effect.

Estimation of the rate of heat transfer through the framing elements of a fenestration system is complicated by (1) the variety of frame configurations for operable windows, (2) the different combinations of materials used for sash and frames, and (3) the difference in sizes available in residential and commercial applications. Available windows are usually framed in either wood, aluminum, or vinyl; and many manufacturers combine materials for structural or aesthetic purposes. Some aluminum-framed units have *thermal breaks* that reduce the conductive heat transfer through the framing element. Standard methods for calculating frame heat transfer are not generally available, however Energy Mines and Resources Canada (1987) and Johnson (1985) have developed computer programs that analyze frame conduction.

Representative U-Values for Fenestration Products

Table 13 can be used to select a particular fenestration product to obtain a desired U-value. Part A of this table presents computed overall U-values for a wide range of glazing units and framing materials installed vertically and based on component U-values shown in parentheses. Part B presents approximate U-values for non-vertical installation. The overall U-values in part A are appropriate for calculating compliance with the requirements of ASHRAE Standard 90. However, the values apply only to the specific design conditions described in the footnotes and are typically used to determine peak load conditions for sizing heating equipment. While these U-values have been determined for winter conditions, they can be used to estimate heat gain during peak cooling conditions since conductive gain which is one of several factors, is usually a small portion of the total heat gain for windows in direct sunlight. Glazing designs and framing materials may be compared to choose a fenestration system that needs a specific winter design U-value.

The overall U-values in Table 13 are based on the rough opening area for representative generic glazing products. Test data, when available, may provide more accurate results for specific products. However, a wide range of measured U-values for similar products has been reported (Hogan 1988). Standard test methods for fenestration systems are still under development and different test methods sometimes give different U-values (McCabe *et al.* 1986).

The multiple glazing categories are appropriate for sealed glass units, acrylic domes, and the addition of storm sash to other glazing units. No distinction is made between flat and domed units such as skylights. For acrylic domes, use average airspace width to determine U-value. Unless otherwise noted, all multiple glazed units are filled with dry air. Argon units are assumed filled with 100% Argon. U-values for CO_2 filled units are similar to Argon fills. For spaces up to 0.5 in., Argon/SF_6 mixtures up to 70% SF_6 are generally the same as Argon fills. (A unit with 0.25 in. Krypton fill gas has about the same U-value as a unit with 0.5 in. Argon fill gas.)

Table 13, Part A lists data for three values of hemispherical emittance. Uncoated glass has an emittance of 0.84. Emittance of various low-emittance glasses vary considerably between manufacturers and processes. When the emittance is known to be between the listed values, interpolation is recommended. When manufacturers data are not available for low-emittance

HOME BUILDERS' ENERGY UPDATE

Summer 1988

Moisture Problems in Bathroom Exterior Walls

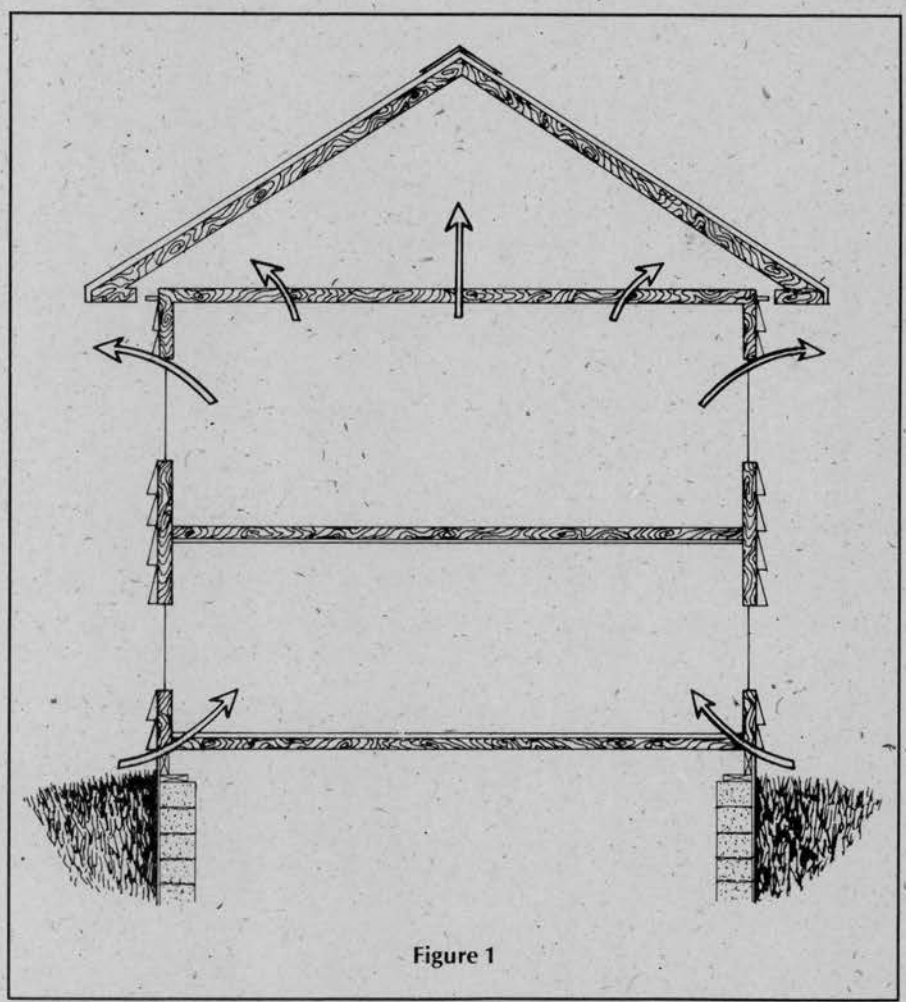


Figure 1

During the winter warm air inside a house will cause the house to act like a big chimney, drawing air in at the lower parts of the house and exhausting the warm and moistened air wherever there is an opening in the wall or ceiling. This is called the "stack effect."

It's a familiar problem for many builders: a call back because the siding outside the bathroom wall is buckling, peeling—sometimes even sprouting icycles—or the interior gypsum board is damp, resulting in paint, wallpaper, and tiles peeling off. This may be especially frustrating for a homeowner who has been regularly using the bathroom fan for several minutes after each shower in an effort to minimize moisture problems.

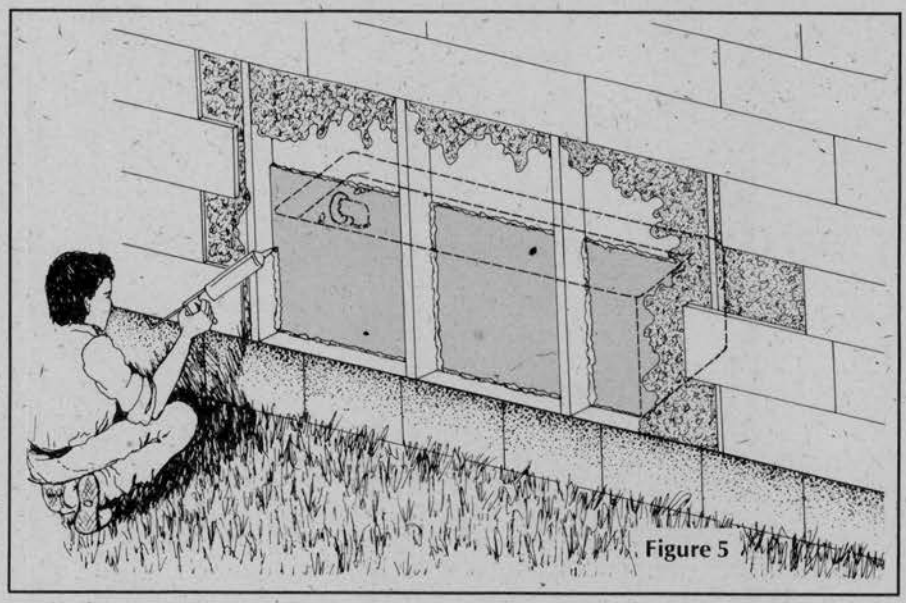
Of course, sometimes these problems are caused by liquid water from a leaky pipe inside the wall or from a roof with a severe ice dam. When the problem is not liquid water, however, different explanations have been offered and many different solutions tried. Perhaps, as with ice dams (see **Update** Spring 1987), the problem needs to be examined in a slightly different way.

Is a double vapor barrier the culprit?

Until recently, the vapor barrier behind the gypsum board has been routinely blamed for both interior and exterior wall moisture problems. The theory was that water was being "trapped" between the wall board and the vapor barrier, resulting in condensation. It was a reasonable explanation, especially in this high humidity area. However, the theory was flawed; it didn't ex-

rial to above the tub support will reduce the chance of an air leak at this seam.) Slide the air blocking material in to fit tightly on the tub side of the wall to block the air passage.

Finally, if the siding in this area is removed, slide the air stopping insulation board or plywood into the tub side of the wall extending from above the tub support to the floor plate. Because you have more access to the wall in this case, you might as well caulk it into place to completely stop air flow (Figure 5). Replace the insulation or put in new insulation if the material removed has deteriorated.



If the siding must be replaced in a retrofit application, the material used to block air flow should be caulked into place to assure stoppage of air movement.

Reports available

A 12-page Canadian report of investigations of moisture problems in walls, including exterior bathroom walls, is available free from the Energy Information Center. Ask for "Field Visits to Moisture Troubled Housing in a Maritime Climate."

Previous editions of the **Update** are available free from the Energy Information Center.

Summer 1985	**Foundation Wall Insulation**
Fall 1985	**Household Ventilation**
Winter 1986	**Water Heating**
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Winter 1988	**Indoor Moisture a Problem for Homeowner, Home Builder Alike**

Other publications related to the topic of this edition are also available from the Energy Information Center:

Wall Insulation
Attic Bypasses

Call the Energy Information Center at 296-5175, or Minnesota toll free, 800-652-9747.

The Minneapolis Energy Office has published several reports which may be of interest to some readers. Two titles are: "Measured vs. Predicted Savings from Single Retrofits: A Sample Study (cost $2.20), and Measured Energy Savings from Vent Dampers in Low Rise Apartment Buildings (cost $3.80). Order from their office at 334 City Hall, Minneapolis, MN 55415. A complete list of available titles may be requested by calling 612-348-6829.

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HOME BUILDERS' ENERGY UPDATE

Winter 1990

EXTERIOR FOUNDATION WALL INSULATION

Over the past six years, foundation wall insulation has become standard building practice in Minnesota. Placing the foundation wall insulation on the exterior has several advantages which are discussed on page 2. This edition of Update discusses the results of a study of exterior foundation wall insulation conducted in Minnesota by the Department of Public Service. Based on the results, we have certain recommendations for builders installing exterior foundation wall insulation.

The project

The Minnesota research project, conducted in the spring of 1988, looked at the exterior foundation insulations of 59 Twin Cities houses ranging from two to seven years old. We examined all five materials commonly used in this application (see page 3). Rather than focusing on the energy savings potential, this study investigated how the insulation materials and their protective coatings survived both above and below ground. Several general recommendations are drawn from the study that relate to all five insulation types; however, limitations of the study make it hard to determine the relative performance of the products in below ground application.

Recommendations

1. Insulate the exposed foundation wall

In several cases, we found that the exterior foundation wall was insulated below grade only, leaving the wall above grade exposed. From a comfort and energy standpoint, this doesn't make any sense. The uninsulated exposed wall loses much more heat than an uninsulated below grade wall. In fact, the exposed wall may actually be "pumping" heat right out of the basement due to air circulation inside the block wall (see Figure 4). Furthermore, the State Energy Code specifically requires foundation wall insulation to extend "from the top of the foundation wall" to either the frost line or to the footing. Therefore, when you apply insulation to the exterior *be sure* to extend it to the top of the foundation wall.

2. Adequately protect the exposed foundation insulation

Some types of the above grade protective coatings used in the study were found to be in excellent condition. Unfortunately, at 62 percent of the sites where insulation covered most of the above grade wall, the protective coating was either missing or already damaged. This left the insulation exposed to deterioration from sunlight



Figure 1. A house with an uninsulated foundation is hard to keep warm.

A simple installation tip

Here's an idea to simplify the installation of exterior foundation wall insulation. With 2x6 walls, the bottom plate can be cantilevered 1" - 2" over the rim joist. The space below will easily accommodate the 1 to 2 inches of exterior foundation insulation (see Figure 6). An additional advantage of this design is that the rim joist is easily insulated, which reduces infiltration.

Report available

This edition of the Update was based on a research project conducted in 1988 by the Minnesota Department of Public Service. For a free copy of the complete report, call the Energy Information Center at 296-5175; or, call toll-free 800-652-9747.

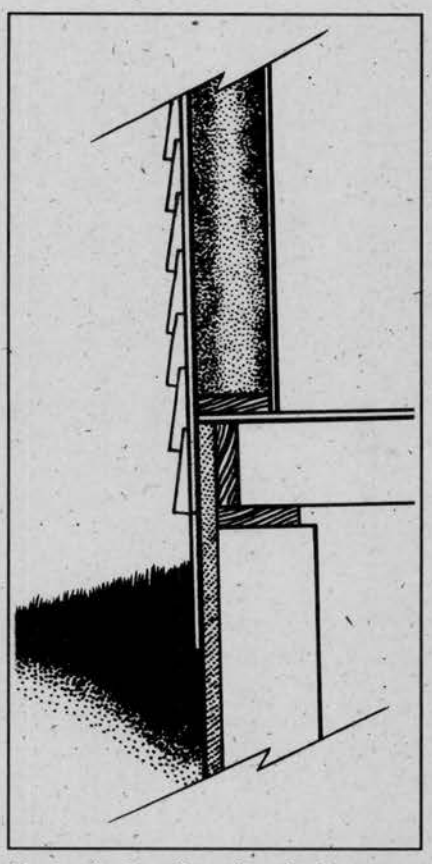

Figure 6. Cantilevering the bottom plate leaves room for exterior foundation wall insulation to cover the rim joist.

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ATTACHMENT 15

REPORT ON THE SUITABILITY OF INCORPORATING ASHRAE 119-1988 "AIR LEAKAGE PERFORMANCE FOR DETACHED SINGLE FAMILY" "RESIDENTIAL BUILDINGS" INTO THE MINNESOTA ENERGY CODE

April, 1990

Prepared for:
Minnesota Department of Public Service
Energy Division

Prepared by:
Advanced Certified Thermography
Lakeland, Minnesota

ADVANCED CERTIFIED THERMOGRAPHY

672 QUIXOTE AVE., LAKELAND, MINN. 55043

STEPHEN R. KLOSSNER (612) 436-5120

Advanced Certified Thermography is a six year old company that specializes in a wide variety of diagnostic work, and consulting, on new homes.

Overview of ASHRAE 119-1988

This is an American National Standard adopted in 1988. The stated purpose of the standard is to establish performance requirements for single family detached residences. In doing this, it provides a method to classify our housing stock.

This standard would prescribe upper limits of leakage area and provide a quantitative number for infiltration measurement. This standard also carefully separates the need for combustion air and ventilation air for indoor air quality.

This standard also references, in Appendix A, ASHRAE 62-1989, and allows the infiltration to be quantified and supplemented with additional ventilation, if required.

This standard uses the height of the home, the measured leakage area at 4 Pascals of pressure difference, and the square feet of living area to classify normalized leakage.

The standard then classifies the normalized leakage area from A to E for for the southern two thirds of Minnesota, and A to D for the northern one third.

Recommendations

I would recommend the following:

1. Adopt ASHRAE 119-1988 into the Minnesota Energy Code, as an alternative to prescriptive measures
2. Amend ASHRAE 119-1988 to include classifications A-D only
3. Support this document with brochures or other informational material from the State level

Discussion

As ASHRAE 119-1988 will be adopted as an alternative to prescriptive measures, it will not be required unless the

builder or buyer request it. This should negate any disadvantage of adopting this into code, while still allowing the builders who choose it, or who are already building homes to this level of tightness, benefit from the advantages.

As the the E classification exceeds .35 air changes per hour, and is little improvement over existing building practices, it is my opinion that the E classification should be dropped as a classification. In addition, if homes truly were built to the intent of the Minnesota Energy Code, they would already meet the A-D classification of ASHRAE standard 119-1988.

The disadvantages of adopting ASHRAE 119-1988 will be discussed first.

1. Added costs to comply

This was the primary disadvantage stated by builders interviewed. Any additional costs incurred to the home builder would be passed on to the home buyer. Testing and the additional sealing may add $100-$1,000 additional cost to the price of a home. As many builders are already building to this standard, the only additional cost would be for testing. Even with the extra sealing and testing costs, energy savings could easily offset any additional mortgage costs on the home.

I am also aware of many builders and insulators who are already offering this "standard of tightness" on their homes. To date, there is some difficulty for the builders and buyers in defining exactly what benefits are derived from this. In my view, the State could go a long way toward increasing awareness of the benefits of current building technology and proper ventilation by adopting this into code.

The advantages of adopting ASHRAE 119-1988 would include:

1. Better definition of Energy Efficient Home.

Almost all homes built with six inches of wall insulation are marketed as Energy Efficient homes. With uncontrolled infiltration, the cost to heat two identically insulated homes can vary by a factor of two or more. As tightness is something that cannot be seen after the finish work, the home buyer has little to go on until he experiences a winter in the home. The home builder, likewise, has no effective means of differentiating between bids to insulate his homes. A common comment I hear from builders is "they are all putting six mil poly and six inches of fiberglass in my walls, and 12 inches of fiberglass in my attic, what's the difference in the bids?"

2. A method of quality control for builders.

A builder can request insulation/sealing bids from a variety of subcontractors. If he specifies that his homes are to meet "Classification A" of ASHRAE standard 119-1988, he can compare bids as apples to apples. He will also be able to check the work upon completion to confirm compliance.

3. Thermal Recognition

There are currently many builders who are requiring the Canadian standard of "3 Air Changes Per Hour at 50 Pascals" for insulation/sealing work on their homes. This is often difficult to understand to an average builder or buyer. Also, Air Changes Per Hour at 50 Pascals does not correlate well to building size, and is difficult to understand for the average home buyer. To date there is no simple, and understandable, method to help in quantifying what he is doing. If a builder can say his home meets State Building Code and rates an A for thermal integrity, that is something the buyer can understand. It will also allow the builder to offer this as an easily understandable option to home buyers, and allow the buyer to evaluate his level of tightness. This standard could be referenced in the Energy Agencies current "HouseWarming Guide on New Homes".

4. Relation to Ventilation Standards

This is probably one of the better applications of this standard. For years, the need for ventilation has been poorly understood in the home building and buying markets. The need for ventilation has been recognized, but there has been little guidance as to when ventilation is required. We are currently building the vast majority of our homes with no ventilation. That is, we are assuming that the homes are loose enough to provide adequate indoor air quality by virtue of infiltration. As infiltration is partially controlled by outside weather conditions, this is not a consistent form of ventilation. This standard does reference ASHRAE Standard 62-1989, and can be used to help estimate infiltration's role in ventilation. This will allow the builders and designers to reference the building's tightness when making ventilation recommendations.

In closing, I believe that this standard would be a benefit to the builders, buyers, both present and future, our natural resources and our environment. Any additional costs for compliance can be easily offset by decreased conditioning costs, both present and future, and increased structural integrity. In addition, any added costs will be spent for Minnesota labor and material, and the decreased conditioning costs will be mainly from imported sources.

HOME BUILDERS' ENERGY UPDATE
Summer 1990

PREVENTING AIR LEAKS AT FIRE STOPS

Fire stops are a vital part of all combustible construction. A fire stop cuts off concealed draft openings through which a fire could pass. The state building code requires that fire stops be installed in conformance with the Uniform Building Code, section 2516 (f).

Fire stops can be made either of wood or other solid blocking material meeting certain specifications, or they can be made of mineral fiber insulation. Unfortunately, fire stops made of mineral fiber or fiberglass do not completely seal the opening. Energy audits conducted in hundreds of Minnesota single and multi-family buildings over the past 15 years have provided countless examples of fiberglass and mineral fiber fire stops that are laden with dirt (Figure 1). The dirt is deposited when air passes through the fiberglass fire stop, just as dirt is collected by a furnace filter. The soiled fiberglass is a sure sign that air is leaving or entering the building through the fire stop.

Air loss through fire stops causes problems. Many of the residences audited (some of them new homes) report frost in attics and other problems caused by air flow from the living space into the attic. Unless solid blocking materials are used, fire stops don't block air flow. This edition of the *Update* focuses on why fire stops should also be air stops, and describes measures for making them air stops.

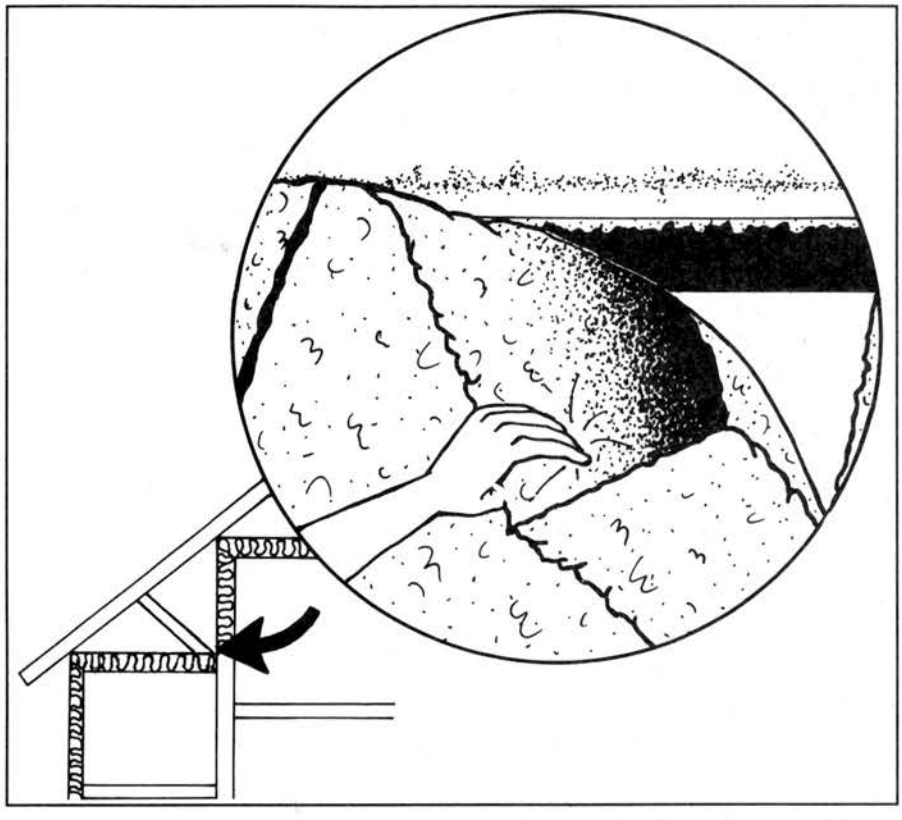

Figure 1 — Dirt is filtered out of air passing through the fire stop at a mid-wall/ceiling intersection in a split-level home.

Problems caused by non-air sealed fire stops

Ice dams. Warm air entering the attic through unsealed fire stops is a major contributor to ice dams. (The Spring 1987 edition of *Update* covers this topic in some detail.) The warm air not only melts snow next to the roof, but the moisture it carries condenses in the attic insulation and reduces the insulation's effectiveness as a barrier against roof snow melt.

Roof sheathing damage. Much

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§ 430.32 Energy conservation standards and effective dates.

The energy conservation standards for the covered product classes are:

(a) *Refrigerators/refrigerator-freezers/freezers.*

Product class	Energy standards equations, Jan. 1, 1990
1. Refrigerators and refrigerator-freezers with manual defrost	16.3 AV+316
2. Refrigerator-freezers—partial automatic defrost	21.8 AV+429
3. Refrigerator-freezers-automatic defrost with top-mounted freezer without ice	23.5 AV+471
4. Refrigerator-freezers—automatic defrost with side-mounted freezer without ice	27.7 AV+488
5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer without ice	27.7 AV+488
6. Refrigerator-freezers-automatic defrost with top-mounted freezer with through the door ice service	26.4 AV+535
7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through the door ice	30.9 AV+547
8. Upright freezers with manual defrost	10.9 AV+422
9. Upright freezers with automatic defrost	16.0 AV+623
10. Chest freezers and all other freezers	14.8 AV+223

AV = Total adjusted volume, expressed in ft.^{3}

(b) *Room air conditioners.*

Product class	Energy efficiency ratio Jan. 1, 1990
1. Without reverse cycle and with louvered sides less than 6,000 Btu	8.0
2. Without reverse cycle and with louvered sides 6,000 to 7,999 Btu	8.5
3. Without reverse cycle and with louvered sides 8,000 to 13,999 Btu	9.0
4. Without reverse cycle and with louvered sides 14,000 to 19,999 Btu	8.8
5. Without reverse cycle and with louvered sides 20,000 and more Btu	8.2
6. Without reverse cycle and without louvered sides Less than 6,000 Btu	8.0
7. Without reverse cycle and without louvered sides 6,000 to 7,999 Btu	8.5
8. Without reverse cycle and without louvered sides 8,000 to 13,999 Btu	8.5
9. Without reverse cycle and without louvered sides 14,000 to 19,999 Btu	8.5
10. Without reverse cycle and without louvered sides 20,000 and more Btu	8.2
11. With reverse cycle, and with louvered sides	8.5
12. With reverse cycle, without louvered sides	8.0

(c) *Central air conditioners and central air conditioning heat pumps.*

Product class	Seasonal energy efficiency ratio	Heating seasonal performance factor	Effectve date
1. Split systems	10.0	6.8	01/01/92
2. Single package systems	9.7	6.6	01/01/93

(d) *Water heaters*

Product class	Energy factor, Jan. 1, 1990
1. Gas Water Heater	0.62—(.0019 x Rated Storage Volume in gallons).
2. Oil Water Heater	0.59—(.0019 x Rated Storage Volume in gallons).
3. Electric Water Heater	0.95—(.00132 x Rated Storage Volume in gallons).

(e) *Furnaces*

Product class	Annual fuel utilization efficiency	Effective date
1. Furnaces (excluding classes noted below) (percent)	78	01/01/92
2. Mobile Home Furnaces (percent)	75	01/01/90
3. "Small" furnaces (input rate less than 45,000 Btu/hour	[1]	01/01/92
4. Boilers (excluding gas steam) (percent)	80	01/01/92
5. Gas steam boilers (percent)	75	01/01/92

[1] Reserved.

(f) *Dishwashers.* Dishwashers must be equipped with an option to dry without heat. The standard was effective on January 1, 1988.

(g) *Clothes washers.* Clothes washers must have an unheated water rinse option. The standard was effective on January 1, 1988.

(h) *Clothes dryers.* Constant burning pilot lights in gas clothes dryers are prohibited. The standard was effective on January 1, 1988.

(i) *Direct heating equipment.*

Product class	Annual fuel utilization efficiency, Jan. 1, 1990 (percent)
1. Gas wall fan type up to 42,000 Btu/hour	73
2. Gas wall fan type over 42,000 Btu/hour	74
3. Gas wall gravity type up to 10,000 Btu/hour	59
4. Gas wall gravity type over 10,000 Btu/hour up to 12,000 Btu/hour	60
5. Gas wall gravity type over 12,000 Btu/hour up to 15,000 Btu/hour	61
6. Gas wall gravity type over 15,000 Btu/hour up to 19,000 Btu/hour	62
7. Gas wall gravity type over 19,000 Btu/hour up to 27,000 Btu/hour	63
8. Gas wall gravity type over 27,000 Btu/hour up to 46,000 Btu/hour	64
9. Gas wall gravity type over 46,000 Btu/hour	65
10. Gas floor up to 37,000 Btu/hour	56
11. Gas floor over 37,000 Btu/hour	57
12. Gas room up to 18,000 Btu/hour	57
13. Gas room over 18,000 Btu/hour up to 20,000 Btu/hour	58
14. Gas room over 20,000 Btu/hour up to 27,000 Btu/hour	63

Product class	Annual fuel utilization efficiency, Jan. 1, 1990 (percent)
15. Gas room over 27,000 Btu/hour up to 46,000 Btu/hour	64
16. Gas room over 46,000 Btu/hour	65

(j) *Kitchen ranges and ovens.* Gas kitchen ranges and ovens with an electrical supply cord shall not be equipped with a constant burning pilot. The standard is effective on January 1, 1990.

(k) *Pool heaters.* The thermal efficiency of pool heaters must be no less than 78%. The standard is effective on January 1, 1990.

(l) *Television sets.* [Reserved]

(m) *Fluorescent lamp ballasts.* (1) Except as provided in paragraph (m)(2) of this section, each fluorescent lamp ballast—

(i)(A) Manufactured on or after January 1, 1990;

(B) Sold by the manufacturer on or after April 1, 1990; or

(C) Incorporated into a luminarie by a luminarie manufacturer on or after April 1, 1991; and

(ii) Designed—

(A) To operate at nominal input voltages of 120 or 277 volts;

(B) To operate with an input current frequency of 60 Hertz; and

(C) For use in connection with F40T12, F96T12, or F96T12HO lamps; shall have a power factor of 0.90 or greater and shall have a ballast efficacy factor not less than the following:

Application for operation of	Ballast input voltage	Total nominal lamp watts	Ballast efficacy factor
One F40T12 lamp	120	40	1.805
	277	40	1.805
Two F40T12 lamps	120	80	1.060
	277	80	1.050
Two F9T12 lamps	120	150	0.570
	277	150	0.570
Two F96T12HO lamps	120	220	0.390
	277	220	0.390

(2) The standards described in paragraph (m)(1) of this section do not apply to (i) a ballast which is designed for dimming or for use in ambient temperatures of 0°F or less, or (ii) a ballast which has a power factor of less than 0.90 and is designed for use only in residential building applications.

EFFECTIVE DATE NOTE:: At 54 FR 47943, Nov. 17, 1989, §430.32 was amended by revising paragraph (a), effective January 1, 1993, and amending the Table headings and Item 3 in paragraph (e), effective January 1, 1992. The text which will become effective January 1, 1993, and January 1, 1992, follows below:

§ 430.32 Energy conservation standards and effective dates.

* * * * *

(a) *Refrigerators/refrigerator-freezers/freezers.* These standards do not apply to refrigerator and refrigerator-freezers with total refrigerated volume exceeding 39 cubic feet or freezers with total refrigerated volume exceeding 30 cubic feet.

Product class	Energy standards equations (Kwh/yr) Effective dates	
	January 1, 1990	January 1, 1993
1. Refrigerators and Refrigerator-Freezers with manual defrost	(16.3AV + 316)	(19.9AV + 98)
2. Refrigerator-Freezer—partial automatic defrost	(21.8AV + 429)	(10.4AV + 398)
3. Refrigerator-Freezers—automatic defrost with: Top-mounted freezer without through-the-door ice service [1]	(23.5AV + 471)	(16.0AV + 355)
4. Refrigerator-Freezers—automatic defrost with: Side-mounted freezer without through-the-door ice service	(27.7AV + 488)	(11.8AV + 501)
5. Refrigerator-Freezers—automatic defrost with: Bottom-mounted freezer without through-the-door ice service	(27.7AV + 488)	(14.2AV + 364)
6. Refrigerator-Freezers—automatic defrost with: Top-mounted freezer with through-the-door ice service	(26.4AV + 535)	(17.6AV + 391)
7. Refrigerator-Freezers—automatic defrost with: Side-mounted freezer with through-the-door ice service	(30.9AV + 547)	(16.3AV + 527)
8. Upright Freezers with: Manual defrost	(10.9AV + 422)	(10.3AV + 264)
9. Upright Freezers with: Automatic defrost	(16.0AV + 623)	(14.9AV + 391)
10. Chest Freezers and all other Freezers	(14.8AV + 223)	(12.0AV + 124)

[1] Including all refrigerators with automatic defrost
AV = Total adjusted volume, expressed in Ft^3, as determined in Appendices A1 and B1 of Subpart B of this Part

* * * * *

(e) *Furnaces.*

Product class	AFUE [1] (percent)	Effective date
* * * * *		
3. Small furnaces (other than furnaces designed solely for installation in mobile homes) having an input rate of less than 45,000 Btu/hr		
(A) Weatherized (outdoor).	78	January 1, 1992.
(B) Non-weatherized (indoor).	78	January 1, 1992.

[1] Annual Fuel Utilization Efficiency, as determined in § 430.22(n)(2) of this part.

* * * * *

§ 430.33 Preemption of state regulations.

Any state regulation providing for any energy conservation standard, or other requirement with respect to the energy efficiency or energy use, of a covered product that is not identical to a Federal standard in effect under this subpart is preempted by that standard, except as provided for in section 327 (b) and (c) of the Act.

Table 3.4-1
Prescriptive Unit Lighting Power Allowance (ULPA), w/ft^2

BUILDING TYPE/AREA FUNCTION	Gross Lighted Area Ranges						Effective Date
	0 to 2,000 ft^2	2,001 to 10,000 ft^2	10,001 to 25,000 ft^2	25,001 to 50,000 ft^2	50,001 to 250,000 ft^2	> 250,000 ft^2	
Food Service							
Fast Food/Cafeteria	1.50	1.38	1.36	1.32	1.31	1.30	1988
	0.92	0.85	0.82	0.81	0.81	0.80	1993
Leisure Dining/Bar	2.20	1.91	1.71	1.56	1.46	1.40	1988
	1.60	1.56	1.52	1.48	1.44	1.40	1993
Offices	1.90	1.81	1.72	1.65	1.57	1.50	1988
	1.40	1.36	1.27	1.22	1.16	1.11	1993
Retail[1]							
Retail General	3.30	3.08	2.83	2.50	2.28	2.10	1988
	2.70	2.52	2.32	2.05	1.87	1.72	1993
Mall Concourse							
Multi-Store Service	1.60	1.58	1.52	1.46	1.43	1.40	1988
	0.60	0.68	0.65	0.63	0.61	0.60	1993
Service Establishment	2.70	2.37	2.08	1.92	1.80	1.70	1988
	2.01	2.03	1.78	1.65	1.54	1.46	1993
Garages	0.30	0.28	0.26	0.22	0.21	0.20	1988
	0.25	0.24	0.23	0.22	0.21	0.20	1993
Schools							
Pre-elementary	1.80	1.80	1.72	1.65	1.57	1.50	1988
	1.33	1.33	1.27	1.22	1.16	1.11	1993
Jr. High/High School	1.90	1.90	1.88	1.83	1.76	1.70	1988
	1.40	1.40	1.39	1.35	1.30	1.26	1993
Technical/Vocational	2.40	2.33	2.17	2.01	1.84	1.70	1988
	1.77	1.72	1.60	1.49	1.36	1.26	1993
Warehouse/Storage	0.80	0.66	0.56	0.48	0.43	0.40	1988
	0.60	0.50	0.42	0.36	0.32	0.30	1993

Notes:
1. Includes general, merchandising and display lighting.

TABLE 3.5-1
BASE LPD (P_b) FOR AREA/ACTIVITY

AREA/ACTIVITY COMMON ACTIVITY AREAS	1989 LPD	1989 NOTE	1993 LPD	1993 NOTE
Auditorium	1.6	(d)	1.4	(d)
Corridor	0.8	(a)	0.8	(a)
Classroom/Lecture Hall	2.0		1.8	
Elec/Mech Equipment Room				
General	0.7	(a)	0.7	(a)
Control Rooms	1.5	(a)	1.5	(a)
Food Service				
Fast Food/Cafeteria	1.3		0.8	
Leisure Dining	2.5	(c)	1.4	(c)
Bar/Lounge	2.5	(c)	1.3	(c)
Kitchen	1.4		1.4	
Recreation/Lounge	0.7		0.5	
Stairs				
Active Traffic	0.6		0.6	
Emergency Exit	0.4		0.4	
Toilet & Washroom	0.8		0.5	
Garage				
Auto/Pedestrian Circulation	0.3		0.25	
Parking Area	0.2		0.2	
Laboratory	2.3		2.2	
Library				
Audio Visual	1.1		1.1	
Stack Area	1.5		1.5	
Card File & Cataloging	1.6		0.8	
Reading Area	1.9		1.0	
Lobby (General)				
Reception & Waiting	1.0		0.55	
Elevator Lobbies	0.8		0.4	
Atrium (Multi-Story)				
First 3 Floors	0.7		0.6	
Each Additional Floor	0.2		0.15	
Locker Room & Shower	0.8		0.6	
Offices				
Enclosed offices of less than 900 ft^2 and all open plan offices w/out partitions or w/partitions lower than 4.5 ft below ceiling.		(h)		(h)
Reading, Typing and Filing	1.8	(g)	1.3	(g)
Drafting	2.6	(g)	2.2	(g)
Accounting	2.1	(g)	1.8	(g)
Open plan offices, 900 ft^2 or larger, w/medium height partitions 3.5 to 4.5 ft below ceiling.		(h)		(h)
Reading, Typing and Filing	1.9	(a)	1.5	(a)
Drafting	2.9	(a)	2.6	(a)
Accounting	2.4	(a)	2.1	(a)
Open plan offices, 900 ft^2 or larger, w/partitions higher than 3.5 ft below ceiling.		(h)		(h)
Reading, Typing and Filing	2.2	(a)	1.7	(a)
Drafting	3.4	(a)	3.0	(a)
Accounting	2.7	(a)	2.4	(a)
Common Activity Areas				
Conference/Meeting Room	1.8	(d)	1.3	(d)
Computer/Office Equipment	2.1		2.1	
Filing, Inactive	1.0		1.0	
Mail Room	1.8		1.8	
Shop (Non-Industrial)				
Machinery	2.5		2.5	
Electrical/Electronic	2.5		2.5	
Painting	1.6		1.6	
Carpentry	2.3		2.3	
Welding	1.2		1.2	
Storage & Warehouse				
Inactive Storage	0.3		0.2	
Active Storage, Bulky	0.5		0.3	
Active Storage, Fine	1.0		0.9	
Material Handling	1.0		1.0	
Unlisted Space	0.2		0.2	

TABLE 3.5-1 (Continued)
BASE LPD (P_b) FOR AREA/ACTIVITY

AREA/ACTIVITY SPECIFIC BUILDINGS	1989 LPD	1989 NOTE	1995 LPD	1995 NOTE
Airport, Bus and Rail Station				
Baggage Area	0.8		0.75	
Concourse/Main Thruway	0.9		0.45	
Ticket Counter	2.5		1.3	
Waiting & Lounge Area	1.2		0.6	
Bank				
Customer Area	1.0		0.8	
Banking Activity Area	2.8		2.2	
Barber & Beauty Parlor	2.0		1.6	
Church, Synagogue, Chapel				
Worship/Congregational	2.3		1.3	
Preaching & Bema/Choir	2.7		1.8	
Dormitory				
Bedroom	1.0		0.6	
Bedroom with Study	1.3		1.3	
Study Hall	1.8		0.9	
Fire & Police Department				
Fire Engine Room	0.7		0.7	
Jail Cell	0.8		0.4	
Hospital/Nursing Home				
Corridor	1.3	(a)	0.9	(a)
Dental Suite/Exam/Treat	1.6		1.4	
Emergency	2.3		2.0	
Laboratory	1.9		1.7	
Lounge/Waiting Room	0.9		0.6	
Medical Supplies	2.4		2.4	
Nursery	2.0		1.6	
Nurse Station	2.1		1.8	
Occu./Physical Therapy	1.6		1.4	
Patient Room	1.4		0.9	
Pharmacy	1.7		1.5	
Radiology	2.1		1.8	
Surgical & O.R. Suites				
General Area	2.1		1.8	
Operating Room	7.0		6.0	
Recovery	3.0		2.0	

AREA/ACTIVITY SPECIFIC BUILDINGS	1989 LPD	1989 NOTE	1995 LPD	1995 NOTE
Hotel/Conference Center				
Banquet Room/Multipurpose	2.4	(d)	1.4	(d)
Bedroom/Powder Room	1.2		0.6	
Guest Room	1.4		0.7	
Public Area	1.1		0.8	
Exhibition Hall	2.6		1.3	
Conference/Meeting	1.8	(d)	1.5	(d)
Lobby	1.9		1.3	
Reception Desk	2.4		2.4	
Laundry				
Washing	0.9		0.6	
Ironing & Sorting	1.3		1.3	
Museum & Gallery				
General Exhibition	1.9		1.2	
Inspection/Restoration	3.9		3.0	
Storage (Artifacts)				
Inactive	0.6		0.25	
Active	0.7		0.5	
Post Office				
Lobby	1.1		0.8	
Sorting & Mailing	2.1		2.1	
Service Station/Auto Repair	1.0		0.8	
Theater				
Performance Area	1.5		1.1	
Motion Picture	1.0		0.75	
Lobby	1.5		1.0	
Retail Establishments				
(Merchandising & Circulation Area)				
Applicable to all lighting, including accent and display lighting, installed in merchandising and circulation areas				
Type A	5.6	(e)	4.0	(e)
Type B	3.2	(e)	2.9	(e)
Type C	3.3	(e)	2.7	(e)
Type D	3.0	(e)	2.5	(e)
Type E	2.8	(e)	2.4	(e)
Type F	2.7	(e)	2.6	(e)
Mall Concourse	1.4		0.6	
Retail Support Area				
Tailoring	2.1		2.1	
Dressing/Fitting Rooms	1.4		1.1	

TABLE 3.5-1 (Continued)
BASE LPD (P_b) FOR AREA/ACTIVITY

AREA/ACTIVITY INDOOR ATHLETIC AREAS	1989 LPD	1989 NOTE	1995 LPD	1995 NOTE
		(b)		(b)
Boating Area, All Sports	0.4		0.4	
Badminton				
Club	0.5		0.5	
Tournament	0.8		0.8	
Basketball/Volleyball				
Intramural	0.8		0.8	
College	1.3		1.3	
Professional	1.9		1.9	
Bowling				
Approach Area	0.5		0.5	
Lanes	1.1		1.1	
Boxing or Wrestling (platform)				
Amateur	2.4		2.4	
Professional	4.8		4.8	
Gymnasium				
General Exercising & Recreation Only	1.0		1.0	
Handball/Racquetball/Squash				
Club	1.5		1.5	
Tournament	2.6		2.6	
Hockey, Ice				
Amateur	1.3		1.3	
College or Professional	2.6		2.6	
Skating Rink				
Recreational	0.6		0.6	
Exhibition/Professional	2.6		2.6	
Swimming				
Recreational	0.9		0.9	
Exhibition	1.5		1.5	
Underwater	1.8		1.8	
Tennis				
Recreational (Class III)	1.3		1.3	
Club/College (Class II)	1.9		1.9	
Professional (Class I)	2.6		2.6	
Tennis, Table				
Club	1.0		1.0	
Tournament	1.6		1.6	

NOTES:
(a) Area Factor of 1.0 shall be used for these spaces.
(b) Area Factor of 1.0 shall be used for all indoor athletic spaces.
(c) Base LPD includes lighting power required for clean-up purposes.
(d) A 1.5 adjustment factor is applicable for multi-functional spaces
(e) See Section 11.0 - Definitions for Classification of Retail Facilities
(f) These Standards do not prescribe LPD for dwelling units.
(g) Area factor shall not exceed 1.95.
(h) Minimum of 90% of all work stations shall be enclosed with partitions of the height prescribed.

ATTACHMENT 19

Date: 07/19/90 RENA Analysis

SYLVANIA INFORMATION ANALYSIS

FIRST BANK TOWER/IBM

JOEL JOHNSON

SYLVIA Relight Energy Analysis (RENA) Analysis

Description	Present	Proposal 1	Proposal 2
Ballast	F40WW ENERGY SAVING	FO32/31K ELECTRONIC	
Number of Lamps	39,918	39,918	
Annual Savings-Lighting			
Total Present System Lighting Load (KW)		1,808.29	
Total New System Lighting Load (KW)		1,117.70	
		==========	==========
Load Reduction Due To Lighting (KW)		690.59	
Load Reduction For 3,000 Hrs/Yr		2,071,770	
Savings at $ .050 per KWH		$103,588.50	
Demand Charge Savings at $6.00 /KW		$49,722.48	
Annual Savings-Air Conditioning			
Reduced A/C Load per Year (Therms)			
Reduced A/C Capacity Required (Tons)		196.42	
Savings on Reduced A/C Load		x 2500	
Annual Expense Heating			
Heat Load Reduction (BTU/Hr)		2,356,984	
Total Heat Load Reduction per Yr (Therms)		70,709.52	
Add'l Fuel Req./Yr of			
Annual Cost for Add'l Fuel			
Annual Savings Summary			
Total Lighting Energy Savings		$153,310.98	
Plus Annual Savings in A/C Costs			
Less Annual Add'l Fuel Cost			
		==========	==========
Total Annual Energy Savings		$153,310.98	
Return On Investment			
Total Energy Savings Over Life		$1,022,073.20	
Less Total Investment for New Lamps/Sys			
		==========	==========
Net Return on Investment		$1,022,073.20	
Annual Net Return		$153,310.98	
Return On Investment (%)			
Pay Back Period of Proposal (Months)			

The calculations are believed appropriate for most lighting installations.

Form: SYLZR31 GTE Sylvania - Danvers, MA

S Y L V A N I A I N F O R M A T I O N A N A L Y S I S

FIRST BANK TOWER/IBM

JOEL JOHNSON

SYLVIA Relight Energy Analysis (RENA) Analysis
Input Recap

Common System Data	
Burning Hours per Year:	3,000
Average Energy Cost/KWH:	$.050
Average Monthly Demand:	$6.00
Heating Fuel Code:	
Fuel Description	
Unit Description	
Fuel Content (BTU)	
Net Cost of Fuel:	
Pct of Heating per Year:	
Pct of Air Cond per Year:	

Lamp Data	Present	Proposal 1	Proposal 2
Lamp Type Code:	24435	21825	
Description	F40WW	FO32/31K	
Wattage	45.3	28.0	
Rated Lamp Life	20,000	20,000	
Thrift/Mate:			
Description			
Luminaire Data			
No. Lamps per Luminaire:	3	3	
No. Luminaires:	13,306	13,306	
Net Cost per Luminaire:		1,330.00	

IS ASHRAE/IES STANDARD 90.1P BEING FOLLOWED?

Pre-code construction is studied for efficiency

Steven M. Nadel and Fred Davis

The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) and the IESNA have been working together for several years to develop *ASHRAE/IES Standard 90.1P Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings*. The proposed standard that emerged from this work promises to reduce lighting energy use by an average of 14–30 percent compared to the old ASHRAE 90A-1980 standard.* Because of these projected savings, Massachusetts formally incorporated 90.1P into the state building code, effective October 1, 1988.

A persistent concern about the proposed standards has been how the current lighting design practice compares with the proposed standards? On the one hand, if current practice is far from meeting the standards, the standards may be too stringent. Conversely, if construction already conforms to the standards, no net energy savings will result.

The New England Power Company (NEP) is a wholesale power generation company that sells power to retail subsidiaries in Massachusetts, Rhode Island, and New Hampshire. NEP recently began offering an energy conservation program designed to help developers and design professionals meet and exceed the newly revised Massachusetts building code. In order to determine whether meeting or exceeding the new building code was feasible, NEP commissioned a study to determine how current lighting design practices in new commercial buildings measured up to the new building code. The results of this study are the subject of this paper.

**The savings estimates were made by Batelle Pacific Northwest Laboratories based on computer modelling of several prototypical buildings across a range of systems and climates.*

Methodology

The study was jointly conducted by NEP and the Fred Davis Corporation (FDC), an independent firm that consults on and sells energy-efficient lighting products. For the project, NEP selected a representative sample of 18 office and retail buildings in its service territory that were completed and occupied between August 1987 and November 1988. Projects selected provide an even mix of owner-occupied and speculative buildings. Buildings of less than 15,000 ft², between 15,000 and 50,000 ft², and over 50,000 ft² were includ-

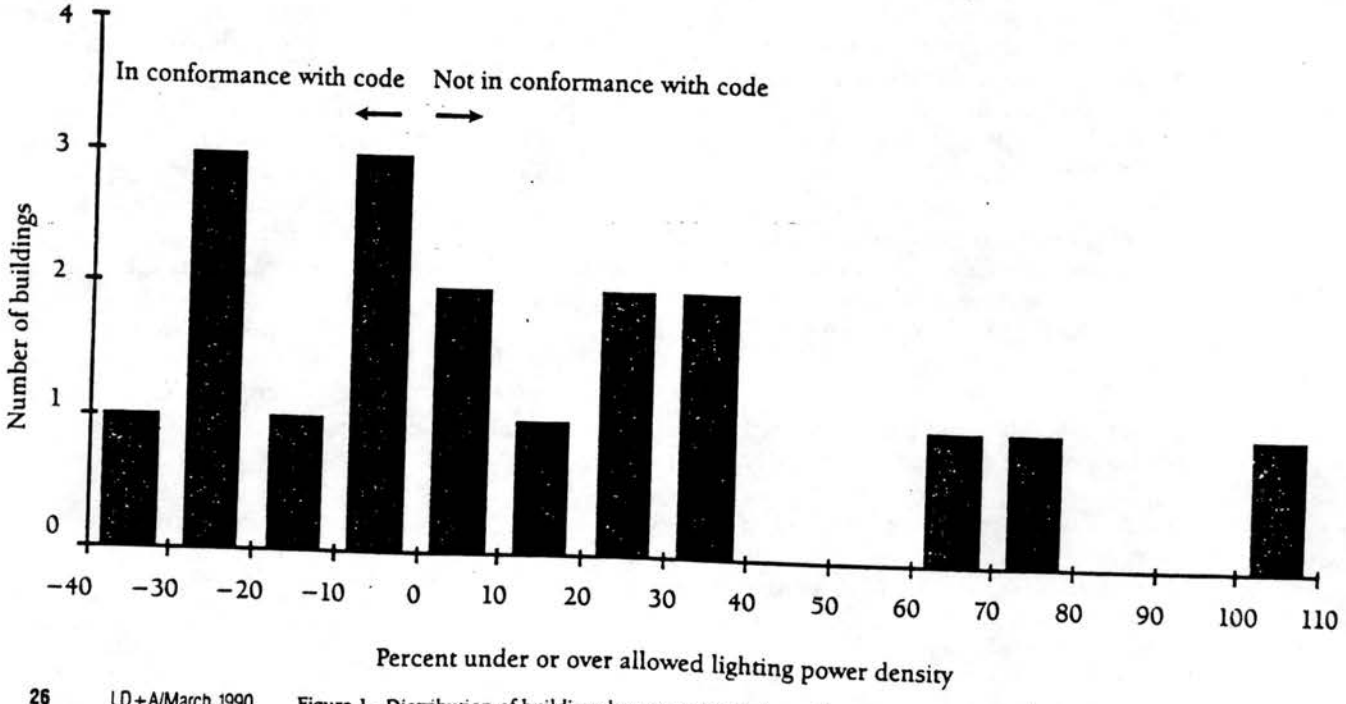

Figure 1—Distribution of buildings by percent under/over allowed lighting power density



The main concourse in building 18 account for 31 percent of the adjusted lighting power. Though well-daylit and automatically controlled, most lighting is incandescent, and therefore ineligible for the power adjustment factor.



Building 4 was a small spec-built office building used by a counselling center.



In this room in building 4, there are 325 W of incandescent and 190 W of fluorescent load. While this facility had the highest proportion of task lighting, it still was in conformance with the code.

ed. FDC visited each site and collected information on building use, floor area, installed lighting type and load, and illuminance in a limited sample of spaces.

Based on these data, NEP and FDC calculated the actual lighting power desnsity for each building and the maximum lighting power density allowed by the new building code. None of the buildings surveyed had any legal reason to be in compliance with the new code, because all of the buildings surveyed predated its effective date. All calculations were based on the prescriptive criteria specified in the Massachusetts building code which is based on the second public review draft of 90.1P. The prescriptive criteria were used rather than the system performance criteria, because less data collection was required to use the prescriptive criteria. While we would have also liked to use the system performance criteria, it was not possible to collect all the necessary data within the time and budget constraints of the project.

Buildings surveyed

The 18 buildings surveyed included 14 in Massachusetts and four in Rhode Island. Eleven of the buildings were offices; seven were retail facilities. Eight of the buildings were owner-occupied; the remaining ten were speculative (renter-occupied). Buildings ranged in size from 4157 ft^2 to 257,790 ft^2 with an average size of 43,770 ft^2. Based on the size definitions discussed above, eight of the buildings were small, six medium, and four large.

Results

Eleven buildings used F40 fluorescent fixtures as their dominant lighting system. One building used F96 fluorescents and one used F32T8 fluorescents as their major lighting system. The remaining five buildings had more than one type of lighting installed. Of the fluorescent lighting systems installed, approximately 40 percent used energy-saving lamps (e.g., 34-W 4-ft lamps) and two-thirds used energy-saving ballasts (one set of which was electronic). Only one building had any type of automatic lighting controls that qualify for power adjustment factor credits.* This building had time controls installed in a limited portion of the building.

Approximately half of the office buildings and all of the retail buildings did not make use of task lights. The other office buildings, for the most part, used task lights in a limited manner. In these office buildings task lights accounted for 1–6 percent of the connected lighting load. One office building had task lights on nearly every desk. In this building task lights accounted for 15 percent of the total connected lighting load.

Conformance

Eight of the buildings surveyed conformed with the prescriptive criteria of the Massachusetts building code; 10

**Under 90.1P, buildings with qualifying automatic lighting controls are allowed increased lighting power densities through the application of a power adjustment factor.*

Appendix A: Summary Data on Buildings Included in Sample

Building Number	State	Floor Area (ft^2)	Owner-Occupied or Speculative	Office or Retail	Predominant Lighting	Actual LPD (W/ft^2)	Percent LPD in Task Lighting	Automatic Controls
1	MA	4157	spec	office (limited retail)	4L F40ES/ES ballasts	1.73	0.0	No
2	MA	7280	own	office	2&4L F40ES/ES ballasts	1.18	0.0	No
3	MA	9960	spec	office & workshop	2L F96/ES ballasts, 400-W metal halide	1.30	3.7	No
4	MA	11,316	spec	office	4L F40/std ballasts	1.77	15.0	No
5	RI	14,856	own	office	4L F40/std ballasts, 75-W floods in high hats	2.40	2.4	No
6	MA	18,544	own	office & warehouse	4L F40ES, 2L F96ES/ all ES ballasts	1.00	0.0	No
7	RI	22,934	spec	office	2&4L F40/ES ballasts	1.75	1.2	No
8	MA	29,875	own	office, garage, warehouse, & workshop	2L F96HO, 1L F96, 4L F40/ all ES ballasts	0.79	0.0	No
9	MA	71,272	spec	office	3L F40ES/ES ballasts	2.49	0.3	No
10	MA	82,500	own	office	4L F32T8/electronic ballasts,	1.07	4.1	No
11	MA	156,981	spec	office (limited retail)	3&4L F40/std ballasts, 100-W incand	2.19	6.3	No
12	MA	6000	own	retail	2L F96/std ballasts	1.86	0.0	No
13	RI	9774	spec	retail	4L F40/ES ballasts	3.06	0.0	No
14	MA	10,540	spec	retail	4L F40/std ballasts	2.46	0.3	No
15	MA	15,522	spec	retail	4L F40/ES ballasts	1.15	0	No
16	MA	25,185	own	retail	2&3L F40ES, 1&2L F96ES/ all ES ballasts	2.38	0.0	No
17	RI	33,365	own	retail	1L 400-W metal halide, 2L F40ES/std ballasts	3.26	2.3	No
18	MA	257,790	spec	retail	500-W PAR, 2&4L F40/ES ballasts, 90-W PAR38(halogen), 11-W S14	3.41	0.0	Programmable timers in concourse

LPD = lighting power density; ES = energy saving; L = lamp

Code Allowed LPD (W/ft^2)	Actual/ Allowed LPD	Average fc in Spaces Measured	Steps to Bring into Compliance with Code
.88	0.92		
1.51	0.78	47	
1.36	0.95	118 (offices)	
1.79	0.99		
1.80	1.33	141	ES lamps and ballasts in F40 fixtures, replace each flood with 2 PL7s
1.19	0.84		
1.66	1.06		Change half of F40 to F40ES, use ES lamps where not currently used
0.70	1.12		
1.50	1.66		Use electronic ballasts throughout, convert most incand to PLs Alternatively, add automatic controls
1.50	0.71	88	
1.60	1.37	100 (office) 95 (retail)	Use electronic ballasts where appropriate, ES ballasts elsewhere; use F40ES lamps; convert most incand to PLs. Alternatively add automatic controls
2.95	0.63	110	
2.35	1.30	62	Install electronic ballasts in F40 fixtures
2.37	1.04	71	Replace a third of F40 lamps or ballasts with ES equivalents
1.45	0.79		
1.95	1.22		Electronic ballasts in all 4 & 8-ft fluorescent fixtures
1.84	1.78	106	Electronic ballasts in F40 fixtures, switch to 175-W metal halide (this will reduce light levels)
1.65	2.06	highly variable	Requires significant modifications to lighting design

did not. The most efficient building surveyed used 37 percent fewer watts than allowed by the prescriptive criteria. The code allowed this small retail space relatively high lighting power density. The least-efficient building surveyed used 106 percent more watts than the prescriptive criteria allowed. This building was a large mall that made extensive use of incandescent lights for area lighting and for decorative purposes. The median building surveyed used 5 percent more watts than allowed by the prescriptive criteria. The percentage by which each building was over or under its allowed lighting power density is summarized in Figure 1.

Of the buildings in Massachusetts, 57 percent were in conformance with the prescriptive criteria of the Massachusetts building code. None of the buildings in Rhode Island were. This discrepancy may be caused by the effects of stronger building code standards in Massachusetts: For years the Massachusetts building code has had lower lighting power limits than the Rhode Island code. The impact of the Massachusetts Ballast Efficiency Law also contributed to the difference. Since January 1988 Massachusetts has required energy-efficient ballasts, but a similar Rhode Island law did not take effect until July 1989.

Office buildings, small buildings, and owner-occupied buildings were found to conform with the prescriptive criteria more often than retail buildings, large buildings, and speculative buildings. Fifty-five percent of the office buildings conformed with the prescriptive criteria; only 29 percent of the retail buildings did. Sixty-two percent of the small buildings conformed, compared to 30 percent of the medium and large buildings. Fifty percent of the owner-occupied buildings conformed, compared to 40 percent of the speculative buildings. All of these differences are statistically significant at a .05 level.*

Light levels

During half of the site visits illuminances were measured at desktop or display level in a representative sample of spaces. Measurements were made using a Minolta Illuminance Meter model T-1. The measurements were made for illustrative purposes, not to produce a definitive and reproducible light level estimate for each building. Among the five offices measured the average of individual illuminance measurements in each building ranged between 47 and 141 fc. The median illuminance level of general areas was 100fc, a level in excess of IESNA recommendations for most office tasks. Many of the offices surveyed were overlit. Of the five retail buildings measured average illuminances in each building ranged from 62–110 fc.

Bringing buildings into conformance

As part of this study, steps were investigated to bring the buildings surveyed into conformance with the Massachusetts building code. This was done in order to see how easy or difficult it would be to make these representative buildings conform. As was previously noted, all of these buildings predate the new building code and are not required to comply with

*Statistical significance was determined using a T-test.

the new code.

Perhaps the simplest method for bringing the nonconforming buildings into conformance with the new code is to use the system performance criteria instead of the prescriptive criteria. For example, the actual lighting power density in building 16, a medium-sized clothing store, was 22 percent greater than the lighting power density allowed by the prescriptive criteria. But it was 4 percent less than the lighting power density allowed by the system performance criteria. Sufficient data were not available to determine whether other buildings would conform using the system performance criteria.

In cases in which a building does not conform with the system performance criteria, or in which use of the system performance criteria is too cumbersome, changes to the lighting system are needed to bring the building into conformance. Of the 10 buildings in the survey that do not currently meet the prescriptive requirements of the new Massachusetts building code, three can be brought into conformance through the use of energy-efficient magnetic ballasts or energy-saving fluorescent lamps. An additional six buildings can be brought into conformance through the use of electronic ballasts or compact fluorescent lamps. Alternatively, automatic lighting controls can be used in place of electronic ballasts. One building required a redesign of the lighting system to bring the building into conformance.

Conclusions

Based on the findings of the survey, the authors conclude that standards such as 90.1P are not unduly strict and will save significant amounts of energy. Furthermore, those buildings in our study that exceeded the requirements of 90.1P indicate that additional energy savings is possible in many cases. As standards such as 90.1P are incorporated into building codes, designers will find that incorporating simple energy saving measures into their designs will be enough to ensure compliance in most cases. Adoption of 90.1P will be a significant step toward improving lighting energy efficiency without causing undue hardship on the practice of lighting design.



The author: Steven Nadel is a senior associate with the American Council for an Energy-Efficient Economy. At the time of the survey he was employed by an affiliate of the New England Power Company.



The author: Fred Davis is president of the Fred Davis Corporation, energy and lighting specialists.

DIGITAL MEMORY CONTROL ARCHITECTURAL LIGHTING

Controls all incandescent, fluorescent & low voltage dimmers

Digital/Multiplex
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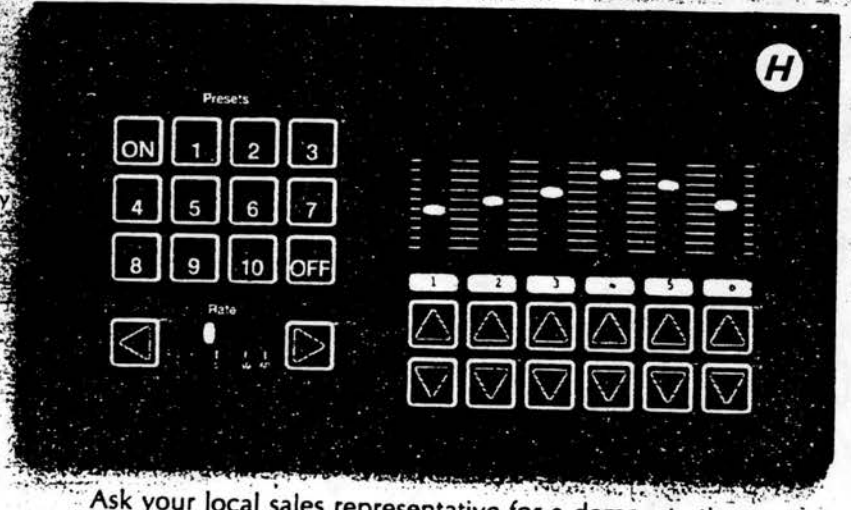
Battery backed memory
No moving parts
Standard back box
Membrane switches
Lighted displays
Time of day clock



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STATE OF MINNESOTA
DEPARTMENT OF PUBLIC SERVICE

In the Matter of the Proposed Amendments to Rules of the Minnesota Department of Public Service amending the State Building Code regarding Heat Loss, Illumination, and Climate Control (Minn. Rules ch. 7670).

STATEMENT OF NEED AND REASONABLENESS

January, 1991

I. INTRODUCTION

The Commissioner of the Minnesota Department of Public Service (department) proposes to adopt amendments to Minn. Rules Chapter 7670, rules known as the Minnesota Energy Code.

The principal rule changes proposed include adoption of the new edition (1989) of the Model Energy Code, provisions to maintain the effectiveness of thermal insulation in residential buildings, and new lighting standards. Reorganization and grammatical changes also are proposed to improve clarity and to conform with current style requirements.

The department began the present rule notification process on June 19, 1989, by publishing a note in the State Register (13 S.R. 2991) soliciting opinions and information from the public on the rules regarding the Minnesota Energy Code.

These rules were previously published in 15 S.R. 828 (October 1, 1990) and mailed on September 25, 1990. However, significant amendments are being proposed, so the rule is being re-noticed with a new comment period. The previously noticed rules were rejected by the Attorney General's Office on December 26, 1990 because the department did not

provide a 30-day comment period as required (see Attachment 1). It is the department's understanding that all of these changes to the rules in its Findings of Fact submitted to the Attorney General's Office on December 12, 1990 were found to be non-substantive and supported by the record. The rules now being proposed incorporated all of the non-substantive changes in its December 12 Findings of Fact. In addition, the rules now being proposed add three changes that the department feels might be considered substantive. These changes relate to the scope (at 7670.0100, subp. 2), thermal transmittance calculation (at 7670.0325, subp. 1 and 7670.0470, subp. 1), and an added reference to the National Appliance Energy Conservation Act of 1987 (at 7670.0660, subp. 3 and 7670.0710, subp. 4).

II. STATEMENT OF DEPARTMENT'S STATUTORY AUTHORITY

The Commissioner's authority to adopt the rule amendments is set forth in Minnesota Statute § 216C.19, subd. 8 which provides:

> In recognition of the compelling need for energy conservation in order to safeguard the public health, safety, and welfare, it is necessary to provide building design and construction standards consistent with the most efficient use of energy. Therefore, the commissioner shall, pursuant to chapter 14, adopt rules governing building design and construction standards regarding heat loss control, illumination and climate control. To the maximum extent practicable, the rules providing for the energy portions of the building code shall be based on and conform to model codes generally accepted throughout the United States. The rules shall apply to all new buildings and remodeling affecting heat loss control, illumination and climate control. The rules shall be economically feasible in that the resultant savings in energy procurement shall exceed the cost of the energy conserving requirements amortized over the life of the building. The rules adopted pursuant to this subdivision, shall be part of the state building code. Notwithstanding the provisions of this subdivision, all applications for approval of building specifications and plans may be submitted to the state building inspector as provided in section 16B.66.

III. STATEMENT OF NEED

Minnesota rules governing the Minnesota Energy Code were last modified in January, 1984.

Since then, major changes have occurred in the understanding of both residential and commercial building energy performance and the factors affecting it. These changes are reflected in new national standards regarding building design and construction. To bring Minnesota into agreement with current understanding of building energy conservation and with updated national standards, changes in the current energy code are needed.

First, the department proposes to adopt the latest (1989) edition of the Model Energy Code to replace the 1983 edition currently in place.

Second, the U. S. Department of Energy (DOE) sponsored several major studies of energy performance in new buildings. The DOE studies revealed major opportunities for energy conservation, particularly in lighting standards. Based on the results of these studies, DOE adopted in July, 1989, new energy conservation standards for new commercial and high-rise multi-family residential buildings (10 CFR Part 435). These standards also have been published by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) as ASHRAE Standard 90.1-1989. The department proposes that these new standards, as they apply to determination of thermal transmittance, design conditions, equipment sizing, and lighting, be made a part of the Minnesota Energy Code.

Third, the department also proposes additional changes to requirements for low-rise residential buildings. It proposes changes to requirements covering effectiveness of required thermal insulation and air leakage.

IV. STATEMENT OF REASONABLENESS

The department is required by Minnesota Statutes Ch. 14 to make an affirmative presentation of facts establishing the reasonableness of the proposed rules. In general terms, this means that the department must set forth the reasons for its proposal, and the reasons must not be arbitrary or capricious. However, to the extent that need and reasonableness are separate, need has come to mean that a problem exists which requires administrative attention, and reasonableness means that the solution proposed by the department is appropriate. The need and reasonableness for the proposed rule amendments are discussed below.

Part 7670.0100 Authority; Scope; Applicability.

The part is divided into three subparts for clarity. The department proposes adding the word "applicability" to the title to recognize the addition of subpart 3 relating to that matter.

Subpart 2, scope, is added to make clear that chapter 7670 is a part of the State Building Code and cites the Minnesota statutes that make it part of the State Building Code. In addition, the State Building Code is defined by the Minnesota statutes that authorize it.

The department proposes to delete language "In cases of conflict with other parts of the State Building Code, this chapter governs in all cases not affecting safety and health requirements." This language is superfluous because the State Building Code (incorporated 1988 edition of the Uniform Building Code, section 103) already states:

Where, in any specific case, different sections of this code specify different materials,

methods of construction or other requirements, the most restrictive shall govern. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable.

The paragraph relating to a standard for maxi-audits is deleted to minimize duplication of statutory language in accordance with Minnesota Statute § 14.07, subdivision 3(1).

Subpart 3, applicability, is added to make clear that buildings covered by this chapter must comply with the Model Energy Code as amended. An exception to the applicability of the energy code for relocated residential buildings mandated by Minn. Stat. § 16B.61, subdivision 3 (1) (1989 Supp.) is added here to inform users of this chapter of this relevant provision.

Part 7670.0125 Legislative Mandates Concerning Minnesota Energy Code

The department proposes adding a part that lists a legislative mandate concerning the Minnesota Energy Code. This mandate currently is covered in two different parts of the Energy Code -- 7670.0310, subpart 1 and 7670.0600, subpart 1. Including it in a single, separate part would improve organizational clarity. The old parts are included in the repealer at the end of the proposed rule amendments.

Part 7670.0130 Incorporations by Reference

A complete explanation or citation is required for each of the standards and references referred to in the Minnesota Energy Code. Subpart 1, items B through I incorporates into Chapter 7670 the citations referred to in the proposed amendments to Chapter 7670. Item A of subpart 1 changes the date of the Model Energy Code reference to the most recent edition, 1989. It also deletes the clause incorporating the Model Code by reference and

making it a part of the State Building Code because this is already stated in 7670.0100, subpart 2. For clarity, the phrase "subject to the amendments in this chapter" is replaced with the specific parts of Chapter 7670 that amend the Model Energy Code.

Subpart 2 states where these standards and documents incorporated by reference are conveniently available to the public. This statement of availability is required by Minnesota Statute § 14.07, Subdivision 4. Items A through D list additional sources for these standards and documents for the convenience of users of this chapter.

Part 7670.0260. MATERIALS AND EQUIPMENT.

The rule cited here is established in Minnesota Rules Chapter 7640 as adopted by the department. The department proposes to restate this requirement here (with a cross reference to 7640) because of its relevance and importance to the Energy Code.

Part 7670.0325 Amendments to Section 201: Definitions

Subparts 1, 2, 3, and 4 are added to provide definitions of thermal transmittance, vapor retarder, wind wash, and window area.

Subpart 1 - Thermal transmittance. The department proposes to add definitions of thermal transmittance for opaque wall components (U_w), roof/ceiling components (U_r). A definition of these terms is needed to ensure that they will be used correctly so that buildings will achieve the expected energy performance. Because these terms are not defined in the Model Energy Code, they need to be defined here.

These four methods are referred to in the proposed rules part 7670.0470.

In item 1 the department proposes to define the "parallel path heat flow" method according to the Model Energy Code chapter 5, equations 1 and 2. The definition includes the phrase "substituting the framing and insulated cavity components of the opaque wall or roof/ceiling for the elements designated by subscripts in these equations" because the equations in the Model Energy Code contain other subscripts. The phrase is needed to point out to users that subscripts of equations 1 and 2 must be modified when the equations are used in this context.

The department proposes in item 2 that the definition of the "series-parallel" method be follow page 20.8 of Standard RS-1 (i.e., the ASHRAE Handbook, see Attachment 2).

The department proposes in item 3 that the "parallel path correction factor method" be as defined in Standard RS-24 (i.e., 10 CFR part 435.105, see Attachment 3).

The department proposes in item 4 that the definition of "sheet metal construction method" be as defined in Standard RS-25 (i.e., 10 CFR Part 435.105, see Attachment 3).

The department proposes in item 5 that the definition "zone method" be calculated as shown in Standard RS-1, pages 22.10 and 22.11 (i.e., the ASHRAE Handbook, see Attachment 2).

The five definitions listed in the proposed rule amendment (identified as 1 through 5) are reasonable because they coincide with definitions of the ASHRAE Handbook and 10 CFR

Part 435.105.

Subpart 2 - vapor retarder. The definition of vapor retarder, previously in part 7670.0340, is included here with the other proposed definitions; 7670.0340 is included in the repealer at the end of the proposed rule amendments. Two substantial changes are made in the proposed definition of vapor retarder. The first change adopts the term "vapor retarder" in place of the term "vapor barrier." This change is consistent with the ASHRAE Handbook of Fundamentals which uses this new term in its 1989 edition, a change from the 1985 edition (see page 21.4 of the ASHRAE Handbook, Attachment 2). The change is also consistent with ASTM C 755-84, "Standard Practice for Selection of Vapor Retarders for Thermal Insulations." (Attachment 4) The new term more accurately describes the function of the material described; the material does not completely prevent water vapor movement, but retards it. Although the term vapor barrier is still widely used by the building industry, the terminology is changing to vapor retarder.

The second change alters the maximum perm rating from 0.1 to 1.0. The 0.1 perm rating is too stringent. Four mil polyethylene (found to work satisfactorily in this application) is, in fact, greater than 0.1 perm, as indicated by laboratory tests (Attachment 5). Measurements of permeability and thickness were made on 23 specimens of polyethylene, taken in 1989 from recently constructed Minneapolis-St. Paul area houses, and on two large rolls of polyethylene sheeting from Minnesota retail outlets. Although many of the thicknesses were less than 4 mils, even those over 4 mils (underlined on table) had average permeability measures of 0.17 to 0.31 perms. This change in the maximum perm rate is needed for builders to continue to use 4-mil polyethylene without violating these rules.

The change will not significantly affect the amount of water vapor diffusing into the insulated cavity, since only a very small amount of water vapor moves into the wall by diffusion through the vapor retarder. This fact is confirmed by the ASHRAE Handbook (Attachment 2), page 21.4, which states in regard to cold weather water condensation in walls, "... rarely is vapor diffusion a major factor." Canadian educators concur by stating "...(vapor) diffusion is a slow moisture transport mechanism, as compared to the other moisture transport mechanisms, and does not move great amounts of moisture..." (see page 23, Attachment 6). The point is further discussed tin the Home Builders' Energy Update Winter, 1991 edition (Attachment 7).

The 1.0 perm rating also conforms to the national standard ASTM C 755-84, Table 1 (Attachment 4) for residential buildings. In addition, this change is consistent with the Council of American Building Officials 1990 amendments to the 1989 Model Energy Code requiring a vapor retarder of 1.0 perm or less.

In a previous rulemaking for this chapter, a perm rating of 0.1 was specified to help ensure thickness or durability of polyethylene. This thickness is ensured, however, by the rule requiring the polyethylene to be not less than 4 mils (i.e., four thousandths of an inch) thick. It is anticipated that the change in perm rating will not, in fact, alter current construction practices.

Subpart 3 -- Wind wash. Wind wash is a new term referred to in proposed amendment to 7670.0480, subdivision. 3. Home Builders' Energy Update (Attachment 8) illustrates the use

of this term. The term is also used in Cold Climate Housing News, Volume 2 issue 3. (Attachment 9). A definition is needed because the term is just now coming into use and is not widely understood.

Subpart 4 -- Window area. The department proposes to add a new term, "window area," to the Model Energy Code. It defines the term as including the glazing and sash or the area used to determine window thermal transmittance.

The Model Energy Code uses the term "glazing area" to refer to windows. This term is not defined in the Model Energy Code, and since "glazing" is often understood to mean only the glass area, the term is misleading. The term "window area" more accurately conveys the meaning of the term as it is used in determining the thermal performance of windows.

Part 7670.0400 Amendment to Section 302: Design Conditions

The proposed changes make the Model Energy Code consistent with 10 CFR Part 435 and ASHRAE/IES Standard 90.1-1989, which are nationally accepted standards. Although the cooling design condition may appear more restrictive (Minneapolis-St. Paul summer design condition of 89°F instead of 92°F in the existing rule.), when combined with the proposed amendment to Part 7670.0610 (calculation procedures and equipment sizing), it is not.

Instead of the reference to Standard RS-1, the department proposes to add Table 302.1 to this part. This addition is needed for the convenience of users of this chapter. All the values in this table are taken from appropriate columns of the RS-1 document previously referenced (see Attachment 2, page 24.9).

Part 7670.0450 Amendment to Section 303: Ventilation

This amendment, in association an amendment to Standard RS-3 in part 7670.1000, is proposed to incorporate the latest ASHRAE standard for ventilation. Because the 1989 edition of the Model Energy Code was published before ASHRAE came out with the new standard, an older version of the standard is referenced in the Model Energy Code. The language in section 303 is modified to be consistent with the new ventilation standard.

This amendment is needed to make the ventilation standards consistent with nationally recognized standards. It is reasonable because ASHRAE Standard 62-1989 is a national consensus standard adopted by ASHRAE.

Chapter 7670.0470 Amendment to Section 502: Envelope Thermal Transmittance

In subpart 1, the department proposes to add a paragraph to the Model Energy Code that, depending on the material of the framing and surface components, one of several methods be used to calculate thermal transmittance. Which methods to use for which materials are illustrated in Chapter 22 of the ASHRAE Handbook of Fundamentals, 1989 Edition. The reasons why different methods must be used for different materials also are set out in the ASHRAE Handbook, chapter 22 (Attachment 2). These are defined in part 7670.0325, subp. 1.

In item 1 the department proposes to require that the parallel path heat flow method be used for wood frame construction. According to the ASHRAE Handbook (Attachment 2, page 22.3), this method is valid for this application. This is the simplest of the four methods

and has always been used for the designated applications.

The department proposes in item 2 that the series-parallel method be required for masonry blocks with insulation inserts or filled cores and other envelope assemblies containing nonmetal framing. The need to use this method for masonry blocks with insulation fillings is established in the ASHRAE Handbook (Attachment 2, page 22.4). The Handbook points out that calculations by this method agree with measured values. The need for using this method is further supported by the National Concrete Masonry Association (NCMA) Standard Series Parallel Procedure for calculating the overall coefficient of heat transfer. In response to the department's solicitation for outside facts and opinions, the Minnesota Masonry Institute (MMI) provided a table (Attachment 10) that gives further evidence of the need for application of a uniform standard. The MMI table compares masonry block R-values (based on U-values calculated by the series parallel method) with R-values listed by manufacturers and obtained by other methods. In some cases manufacturers' R-values are as much as 224 percent higher than the calculations based on the recommended series-parallel method.

Continuing the discussion of item 2, the need for requiring the "series-parallel" method for other envelope assemblies containing nonmetal framing is indicated by example 3 in the ASHRAE Handbook (Attachment 2, page 22.5) which shows that the closest correlation with measured values is obtained with the series-parallel method. The ASHRAE Standard 90.1 and 10 CFR Part 435 (Attachment 3) also require use of the series-parallel method for envelope assemblies containing nonmetal framing.

The department proposes in item 3 that for assemblies with metal framing and a metal skin or covering on one or both sides, the U-value be computed using the "sheet metal construction" method. This requirement accords with ASHRAE Standard 90.1 and 10 CFR Part 435 (Attachment 3).

The department proposes in item 4 that two alternate methods be employed to calculate the U-value for assemblies with metal framing. For elements identified in Standard RS-24, use of the parallel path correction factor method is proposed. The elements identified in the cited standard as a table of common wall and roof components (see Attachment 3). For elements with metal framing not identified in standard RS-24, use of the "zone method" is proposed. The zone method calculation is illustrated in the ASHRAE Handbook (Attachment 2, pages 22.10 and 22.11). This division of calculation methods for assemblies with metal framing is identical to the requirements of 10 CFR Part 435.105 section 5.3.3.2.1 (b) and (c) (see Attachment 3).

The methods for opaque U-value determination required in the proposed rule amendment (identified as 1 through 4) are reasonable because they coincide with the recommendations of the ASHRAE Handbook and NCMA and requirements of 10 CFR Part 435 and ASHRAE Standard 90.1 These requirements should not be a burden for small businesses such as home builders who can use the simple parallel heat flow method for wood-framed construction (which they have used all along) for all assemblies except insulation-filled blocks. In the case of insulation-filled blocks, the supplier of the insulation system will likely provide the analysis.

In subpart 2, the proposed rule adds paragraph 502.1.5 to the Model Energy Code requiring use of one of four alternative methods for window U-value (U_g). The proposal is needed to assure accurate window U-value calculations. (See Attachment 11) The department proposes that any one of four methods, listed in subitems 1 - 4, be acceptable for calculating U_g. Most manufacturers already use one of these alternatives, and stipulating that any one of the four is acceptable lessens the burden of these rules. Support for the acceptability of these four methods is given below.

Item 1 states that one acceptable method be the method prescribed in the ASHRAE 1989 Handbook, Chapter 27, pages 27.16-27.18 (Attachment 2) as discussed in the ASHRAE Journal - June, 1989 article (Attachment 12). Window U-values in the 1989 Handbook consist of calculated data for a variety of glazing systems and framing materials based on computer simulations verified by laboratory measurements.

The department proposes in item 2 that a second acceptable method be the American Architectural Manufacturers Association (AAMA) Standard 1503.1. This method is widely used. The AAMA is a respected organization that publishes a Certified Products Directory that lists window U-values based on this method of calculation.

The department proposes in item 3 that a third acceptable method be the use of either American Society for Testing and Materials (ASTM) Standard C 236 or C 976 using specified design conditions. This is identical to one of the options of the Seattle Department of Construction and Land Use for demonstrating compliance with its energy code. This method is also used by several window manufacturers to determine thermal

performance.

A fourth acceptable method is proposed in item 4: use of computer program WINDOW, developed by the Windows and Daylighting Group at Lawrence Berkeley Laboratory. WINDOW was developed in response to a lack of a widely accepted, accurate, and easy-to-use procedure to analyze window thermal performance.

Subpart 3 is moved from 7670.0940 with two slight modifications. (Part 7670.0940 is included in the repealer at the end of these proposed rule amendments.) The purpose of these modifications is to make this alternative approach equivalent to the revised requirements of the 1989 Model Energy Code and to simplify the language.

Footnote 1 is changed from the present rule by adding the word "floors" in recognition of the fact that the footnote also applies to floor assemblies.

In footnote 2, the department proposes to change the specification for windows from "double-glazed" to U-0.49. As discussed in Part 7670.0470, subpart 2, window performance measurements have improved. Change is needed because "double-glazed" is an inadequate description of how a window will perform. A double-glazed window with aluminum or metal frames and without thermal breaks performs poorly. The value of U-0.49 is reasonable because most manufacturers of residential windows offer a window meeting this standard in their moderately-priced product line. Furthermore, the value can be achieved without using more expensive "low-e" glass, argon-gas filling, or other special window construction methods. Finally, meeting this requirement is optional; the builder can still use

the component performance approach which allows more glass area if higher performance windows are used.

Part 7670.0480 Amendment to Section 502: Effectiveness of Required Thermal Insulation

The department proposed to add paragraph 502.2.1.8 to the Model Energy Code relating to cold weather vapor condensation. For organizational clarity, this item is moved from Part 7670.0520 and that part is included in the repealer at the end of these proposed rule amendments. Modifications proposed for this paragraph are deletion of the words "uninterrupted" and "rips in vapor barrier must be patched," and addition of the words "joints in the vapor retarder must be sealed between solid blocking." Meeting the requirement in the added words would more effectively accomplish the objectives sought by the deleted words. Canadian educators add support to the reasonableness of these slightly reduced requirements with the statement "... if, for example, a (vapor) diffusion retarder is installed over 90 percent of the surface area of a building envelope, then that (vapor) diffusion retarder can be said to be 90 percent effective, all other things being equal" (see page 23, Attachment 6).

A new section 502.2.1.8.2 relating to air leakage barrier is proposed to be added to the Model Energy Code. This item is added to give attention to air movement as a factor in transporting moisture into insulated cavities. The importance of air movement is reflected by the ASHRAE Handbook of Fundamentals, 1989 edition, on pages 21.4 and 21.5. (Attachment 2). The Handbook points out that movement of air carrying water vapor is far more influential than vapor diffusion in transporting water vapor within the building

envelope. The Handbook also notes that although a good quality vapor retarder eliminates condensation by vapor diffusion, it is of little use if it can be bypassed by air. Additional explanation of the importance of preventing air movement into insulated cavities and description of simple techniques for preventing this movement are given in the Home Builders' Energy Update, Winter, 1991 (Attachment 7) and Summer, 1988 (Attachment 13).

The department proposes to add a new paragraph 502.2.1.9 to the Model Energy Code requiring that a barrier be provided to mitigate wind wash. The requirement is needed because recent investigations using infrared scans reveal that wind can penetrate insulation, resulting in heat loss and possible moisture damage (see pages 21-23, Attachment 6). This requirement is reasonable because but the methods to comply are easy and inexpensive to apply. An additional explanation of the importance of preventing wind wash and descriptions of simple techniques for preventing it are given in the Home Builders' Energy Update, Winter, 1989 edition (Attachment 8).

Part 7670.0510 Foundation Walls

A third paragraph is added to this part by the proposed rule, requiring that exterior foundation wall insulation be protected from deterioration due to sunlight and physical abuse.

A study of exterior foundation wall insulation conducted in Minnesota by the department found insulation damage caused by failure to apply an adequate protective coating. (See Attachment 14.) Similar findings of inadequate protection also were reported in a study by

the Wisconsin Energy Conservation Corporation*. The Minnesota study concluded that not only is the damage unsightly, but insulation exposed to the elements will soon lose at least some of its effectiveness. An additional requirement for adequate protection is needed to ensure that the exterior insulation functions as intended.

The proposed addition is not new; it is already required by Minnesota Rules part 7640.0140, subpart 3, (Minnesota Residential Thermal Insulation Standards). Adding it to this rule reinforces its importance and increases awareness of the need to comply with it. Furthermore, builders have the choice of installing either exterior or interior foundation insulation; if they choose exterior insulation, it is reasonable to require that they take steps to ensure that the insulation performs as intended.

* Schlegel, J.A., O'Leary, L.A., Post, L.K., Foundation Insulation Field Survey - Final Report, Wisconsin Energy Conservation Corporation, 1045 East Division St., #117, Madison, WI 53703. December, 1986, unpublished.

Part 7670.0550 Air Leakage

Deletion of the existing language of this part reasonable because it is essentially identical to the Model Energy Code. The deleted last sentence has been moved to part 7670.0480. This removal of redundance is needed for clarity.

An exception is added to section 502.4.3 of the Model Energy Code giving and alternative to meeting the requirements of this paragraph is provided for detached single-family residential buildings. If this alternative is selected, the building ventilation system must provide for a minimum of 0.35 air changes per hour, or 15 cfm per person, whichever is greater. This rate must be verified by measurement. This change is needed for the following reason: A wide variety of construction methods can be used to achieve the same

level of air tightness as the methods specified in subpart 1. The department feels that builders would like greater flexibility in selecting methods of achieving air tightness. Providing the option of meeting the ASHRAE Standard 119-1988 gives builders this greater flexibility. It also provides home buyers and builders with an objective measure of air tightness and an accurate basis on which to calculate the home's ventilation needs. The proposed amendment also includes a minimum, verified air change rate, thereby assuring a minimum level of ventilation is installed. This latter is important, since very tight construction may result in indoor air quality problems if adequate ventilation is not provided. Studies in the United States and Canada show that actual performance rates of ventilation systems are often much lower than the systems' rated capacity; therefore, verification of ventilation rates by measurement is needed.

The proposed change is reasonable because it simply adds an option that allows builders to replace design specifications with a performance standard. This change complies with Minnesota Statute § 14.115, subd. 2 (d), that requires the department to consider establishing performance standards to replace design or operational standards. Also, the proposed performance standard is nationally recognized, and including it as an option complies with Minnesota Statute § 216C.19, subd. 8, requiring energy code rules, "to the maximum extent practicable," to conform to model codes generally accepted throughout the United States. In practice, the standard is already in effect in Minnesota, since homes meeting the specifications set out in subpart 1 above would meet Standard 119-1988 classifications A-D, according to a consultant's report to the department (see Attachment 15). The standard also conforms to ASHRAE Standard 62.

The department proposes to add section 502.4.4 to require blockage of air movement through fire stops. Fire stops made of mineral fiber or fiber glass are sources of air leakage that can cause many problems, including energy loss, ice buildup on roofs, and possible contribution to back drafting of combustion appliances (see Attachment 16). A separate provision is needed to call attention to the need to air seal these fires stops.

Weatherization agencies routinely seal "attic bypasses" on existing low-income residences. Attic bypasses (open paths through which warm air flows out of the heated house and into the attic) are acknowledged as a major source of heat loss. Most, if not all attic bypasses are, in fact, simply fire stops that are not air sealed. The methods for sealing these leaks are relatively simple (see Attachment 16), and the choice of methods is left to the builder. Since these fire stops are routinely air sealed during weatherization of older houses, it is reasonable -- and certainly efficient -- to require them to be air-sealed during new home construction.

In case of possible conflict between these two requirements, the State Building Code should take precedence. The exception is needed to resolve any possible conflict with the State Building Code.

Part 7670.0610 Building Mechanical Systems

The department proposes to change the calculation procedures for sizing heating and cooling systems and equipment. The limitation of equipment sizing to 115 percent for heating and 100 percent for cooling is too restrictive and does not allow engineering judgement to be used in this calculation. The procedures described in subparts 1 and 2 will

accomplish the goal of not wasting energy and also will allow engineering judgement concerning safety factors, pick-up loads, and other sizing considerations. These procedures are identical with those in 10 CFR Part 435 and ASHRAE Standard 90.1 and are therefore consistent with other proposed changes which bring the Minnesota Energy Code into agreement with national standards.

Part 7670.0660 Amendment to Section 503: Equipment Efficiency

Subpart 1 is moved from 7670.0540, which is repealed. The subpart proposes to replace the entire table, previously included in 7670.0540, with a single sentence. Including the Table is not necessary since it is in the 1989 Model Energy Code, which is incorporated by reference.

In proposed subpart 2, the numbers from Table No. 503.4.8. are largely deleted since they are part of the 1989 Model Energy Code, which is incorporated by reference. The numbers not deleted are retained because they do not appear in the 1989 Model Energy Code. Neither of proposed amendments to these two subparts would substantively change the rule.

Subpart 3 is added to reference the heating and cooling efficiency requirements of the National Appliance Efficiency Act of 1987 (Attachment 17). The efficiency requirements of this act supersede any state requirements (see 10 CFR part 430.33, Attachment 17). This provision is needed for the convenience of users of this chapter because of its relevance and importance to the Energy Code.

Part 7670.0670 Amendment to Section 503.10: Duct Construction

Minor changes are proposed to improve clarity; they would make no substantive change in the rule.

Part 7670.0710 Amendments to Section 504: Service Water Heating

The proposed changes merge parts 7670.0710, .0720, and .0730, all relating to water heating, into a single part for greater clarity. Parts 7670.0720 and .0730 are included in the repealer.

Subpart 4 is added to reference the service water heating equipment efficiency requirements of the National Appliance Efficiency Act of 1987 (Attachment 17). The efficiency requirements of this act supersede any state requirements (see 10 CFR part 430.33, Attachment 17). This provision is needed for the convenience of users of this chapter because of its relevance and importance to the Minnesota Energy Code.

Part 7670.0800 Amendments to Section 505: Electric Power and Lighting

Subpart 1. The department proposes to delete the first paragraph of the rule since it is identical to the language in the 1989 edition of the Model Energy Code and is therefore not needed. The amended exception, proscribed by Minnesota Statute § 216C.27 subd. 8, differs from the language in the Model Energy Code and therefore is needed.

Subpart 2. The department proposes to amend the lighting requirements of the Model Energy Code to bring them into agreement with U.S. Department of Energy performance standards, 10 CFR, Part 435.103 and ASHRAE/IES Standard 90.1-1989. The proposed rule excludes 10 CFR part 435.103 section 3.2, titled "Principals of design" because this section contains no enforceable provisions. The proposed rule also cites two corrections to be made

to 10 CFR part 453.103. The proposed amendment excluding section 3.2 and making corrections is needed for the convenience of users of this chapter.

The proposed lighting requirements are a change from the Model Energy Code requirements in at least two respects. First, lighting criteria are dramatically simplified. Lighting requirements in the Model Energy Code are difficult to understand without extensive knowledge of the field. They also are highly subjective -- for example, "where good color rendition is important" and "where visual comfort is important" are among the criteria for determining lighting requirements. These are virtually unenforceable. In contrast, proposed criteria specify maximum watts per square foot. (Attachment 18) They are simple and enforceable. The second significant change, and one that well may raise comment, is the rather strict limitations of allowed lighting power. The new requirements will mandate the use of more efficient (and probably more costly) fixtures and control technologies that may be unfamiliar to today's lighting engineers. The department believes, however, that technology and techniques are available to achieve the stricter standards readily and cost effectively. One example is a lighting analysis of the First Bank/IBM Tower under construction in downtown Minneapolis. Attachment 19 indicates that if more efficient lighting design were implemented in this building, capacity demand could be reduced by 690 kilowatts for lighting and 41 kilowatts for air conditioning.

Other states have adopted lighting specifications from either the U.S. Department of Energy Performance Standard 10 CFR Part 435 or ASHRAE/IES 90.1. New York state's commercial building code's Lamp and Fixture Efficiency section is very similar to 10CFR Part 435. According to the New York State Energy Division, the standard was not overly

stringent and its format aided enforcement. Massachusetts adopted an early draft of ASHRAE/IES Standard 90.1, effective October 1, 1988. The Massachusetts Safety Division reports that the standard has been both manageable and achievable. Since July 1978, California has had mandatory lighting requirements for all nonresidential buildings. The requirements are, in fact, more stringent than the changes proposed here.

Further evidence that the proposed lighting requirements are reasonable is reported in *Lighting Design and Application* magazine. (Attachment 20) A study conducted by the New England Power Company and an independent consulting firm found that "standards such as (ASHRAE/IES) 90.1 are not unduly strict and will save significant amounts of energy." The authors of the report also note that "those buildings in our study that exceeded the requirements of 90.1 indicate that additional energy savings is possible in many cases. As standards such as 90.1 are incorporated into building codes, designers will find that incorporating simple energy saving measures into their designs will be enough to ensure compliance in most cases. Adoption of 90.1 will be a significant step toward improving lighting energy efficiency without causing undue hardship on the practice of lighting design."

The exemption for one- and two-family detached buildings and the dwelling portions of multifamily buildings from these requirements is identical to an exemption for lighting requirements in the Model Energy Code.

Part 7670.0850 Design by Acceptable Practice

A sentence is proposed to replace parts 7670.0900 through 7670.0970 which are included in the repealer. This sentence is needed because buildings designed in accordance with this

method should conform to the same amendments made to the Model Energy Code, Chapter 5, "Building Design by Component Performance Approach."

A table is added indicating which sections of the Model Energy Code chapter 6 are modified by which part of Minnesota Rules ch. 7670. The table is needed for the convenience of users of chapter 7670. The inclusion of this table is reasonable because it indicates all of the sections of the Model Energy Code chapter 6 that are modified by Minnesota Rules ch. 7670.

Part 7670.1000 Amendments to Section 701: STANDARDS

Amendments of standards and references are included in this part instead of in five parts; 7670.1010, 7670.1020, 7670.1030, 7670.1100, and 7670.1110 are included in the repealer. Two new items are included in the list of standards and references -- the updated versions of ASHRAE Handbook 1989 edition and ASHRAE Standard 62-89.

The department proposes to replace two reference standards (RS-17 and RS-18) with the single document, "SMACNA HVAC Duct Construction Standards: Metal and Flexible, First Edition, 1985." The two SMACNA reference standards being replaced (1975 and 1976 documents) have been superseded by the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) with the single document cited above.

To conform to the style of the Model Energy Code, throughout chapter 7670, whenever a reference is made to a standard, the "RS" number be cited. These changes are needed for the convenience of the users of this chapter.

V. SMALL BUSINESS CONSIDERATIONS IN RULEMAKING

Minnesota Statue § 14.115, subdivision 2 (1988) requires the department, when proposing rules which may affect small business, to consider the following methods for reducing the impact on small businesses:

> (a) the establishment of less stringent compliance or reporting requirements for small business;
>
> (b) the establishment of less stringent schedules or deadlines for compliance or reporting requirements for small business;
>
> (c) the consolidation or simplification of compliance or reporting requirements for small business;
>
> (d) the establishment of performance standards for small businesses to replace design or operational standards required in the rule;
>
> (e) the exemption of small businesses from any or all requirements of the rule.

The adoption of these rule amendments will affect small businesses in Minnesota. The department has evaluated the effect of the proposed rules on small businesses and has considered each of the methods listed above for reducing the impact of the rules on small businesses.

In regard to item (a) above, the proposed amendments to part 7670.0470, subpart 2 (items 1 and 4) relating to determination of window thermal performance are less stringent because they require no costly physical testing to demonstrate compliance. Chapter 7670 contains no reporting requirements.

Since Chapter 7670 contains no scheduling, deadline or reporting requirements, Minn. Stat.

§ 14.115, subd. 2(b) and (c) are not applicable.

The proposed rules include several significant performance standards in conformance with Minn. Stat. § 14.115, subd. 2(d). Part 7670.0470, subpart 2, includes four performance options for determining the thermal performance of windows. The Model Energy Code chapter 4 (Building Design Systems Analysis) is entirely performance based. The Model Energy Code chapter 5 (Building Design by Component Performance Approach) is also performance based. Finally, the lighting criteria proposed in Part 7670.0800, subpart 2 are performance based.

In regard to item (e) above, Minn. Stat. § 16B.62 establishes the scope of application of the State Building Code. To exempt small businesses would be contrary to the latter statute. It would be inappropriate for the department to usurp statutory requirements by changing the applicability to exempt small business. In the proposed rule part 7670.0100, subpart 3, the applicability of the chapter is modified to exempt relocated residential buildings in conformance with Minn. Stat. § 16B.61, subd. 3(i).

VI. ATTACHMENTS

The following attachments are incorporated by reference into this Statement of Need and Reasonableness.

1. December 26, 1990 memo form the Attorney General's Office disapproving the previously noticed rule.

2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Handbook of Fundamentals, 1989 edition, pages 20.8, 21.4, 21.5, 22.3, 22.4, 22.5, 22.10, 22.11, 24.9, 27.16, 27.17, and 27.18.

3. 10 CFR Part 435.105, section 5.3.3, Thermal Transmittance of an Envelope Assembly.

4. "Standard Practice for Selection of Vapor Retarders for Thermal Insulation," American Society for Testing and Materials (ASTM) C 755-85, Table 1.

5. Twin City Testing report on polyethylene vapor retarder thickness, June 29, 1989.

6. Applied Building Science, J.W. Lstiburek, March, 1987.

7. "Keeping Water Vapor out of Walls: The Vapor Retarder Can't do it all," Home Builders' Energy Update, Winter, 1991.

8. "Cold Ceiling Corner Mystery Examined," Home Builders' Energy Update, Winter 1989.

9. "Windwashing and Its Effects on Wood Frame Buildings," Cold Climate Housing News, Volume 2, Issue 3.

10. Minnesota Masonry Institute table, "R-value Comparison -- 8-inch Insulated Concrete Masonry Systems."

11. "Window R-Values Substantially Overstated," Energy Efficient Building Association (EEBA) Alert, 1990.

12. "Window U-Values: Revisions for the 1989 ASHRAE Handbook -- Fundamentals," ASHRAE Journal, June, 1989,

13. "Moisture Problems in Bathroom Exterior Walls," Home Builders' Energy Update, Summer, 1988.

14. "Exterior Foundation Wall Insulation," Home Builders' Energy Update, Winter, 1990.

15. "Report on the Suitability of Incorporating ASHRAE 119-1988 -- Air Leakage Performance for Detached Single Family Residential Buildings -- into the Minnesota Energy Code," April, 1990.

16. "Preventing Air Leaks at Fire Stops," Home Builders' Energy Update, Summer 1990.

17. 10 CFR Part 430.32, Energy conservation standards and effective dates, and part 430.33, Preemption of state regulations.

18. 10 CFR Part 435, Table 3.4-1 "Prescriptive unit lighting power allowance," and Table 3.5-1 "Base unit power density for area/activity."

19. Sylvania Information Analysis for the First Bank/IBM Tower, downtown Minneapolis.

20. "Is ASHRAE/IES Standard 90.1P Being Followed?," *Lighting Design and Application*, Match, 1990.

VII. CONCLUSION

Based on the foregoing, the proposed amendments to Minnesota Rules Chapter 7670 are both needed and reasonable.

Kris Sanda, Commissioner — Dated 2-1-91

DEPARTMENT OF PUBLIC SERVICE
ENERGY DIVISION

NOTICE OF WITHDRAWAL OF PROPOSED RULE

The proposed permanent rules amending the Minnesota State Building Code regarding heat Loss, illumination and climate control, Minn. Rules chapter 7670, as proposed in 15 S.R. 828 (October 1, 1990) are withdrawn on February 4, 1991. This rule is being renoticed in a modified form elsewhere in this edition of the State Register.

Kris Sanda, Commissioner

2/4/91
Date

Withdrawn Rules

Department of Public Service

Energy Division

Notice of Withdrawal of Proposed Permanent Rules Relating to Minnesota Energy Code

The proposed permanent rules amending the Minnesota State Building Code regarding heat loss, illumination and climate control, *Minnesota Rules* chapter 7670, as proposed in 15 S.R. 828 (October 1, 1990) are withdrawn on February 4, 1991. This rule is being renoticed in a modified form elsewhere in this edition of the *State Register*.

Dated: 4 February 1991

Kris Sanda, Commissioner

Commissioners' Orders

Department of Natural Resources

Commissioner's Order No. 2405: Reserving, Designating and Managing Certain Waters for Their Primary Wildlife Use and Benefit; Superseding Commissioner's Order No. 2359

PURSUANT TO AUTHORITY vested in me by *Minnesota Statutes* § 97A.101 and other applicable law, I, Rodney W. Sando, Commissioner of Natural Resources, upon proper published notices and public hearings held, hereby prescribe that the following lakes be reserved, designated and managed for their primary wildlife use and benefit, particularly for waterfowl and aquatic furbearers.

Section 1. DESIGNATED LAKES.

Lake	County	Location
Perch	Blue Earth	T. 106 N., R. 25, 26 W.
Cottonwood	Blue Earth	T. 106 N., R. 25 W.
Eagle	Blue Earth	T. 108, 109 N., R. 25, 26 W.
Buffalo	Waseca	T. 107 N., R. 24 W.
Rice	Faribault	T. 104 N., R. 27 W.
Bear	Freeborn	T. 101 N., R. 22 W.
Swan	Nicollet	T. 109, 110 N., R. 28, 29 W.
Lower Twin	Freeborn	T. 101 N., R. 22 W.
Heron	Jackson	T. 103, 104 N., R. 36, 37 W.
Pierce	Martin	T. 102 N., R. 31 W.
Geneva	Freeborn	T. 104 N., R. 20, 21 W.
Upper Twin	Freeborn	T. 101, 102 N., R. 22 W.
Pelican	Wright	T. 120, 121 N., R. 24, 25 W.
Patterson	Carver	T. 116 N., R. 25 W.
Goose	Waseca	T. 107 N., R. 22 W.
Rice	Blue Earth	T. 107 N., R. 25 W.
Sanborn	LeSueur	T. 112 N., R. 23 W.
Big Rice	Cass	T. 140, 141 N., R. 26 W.
Sand	Sibley	T. 112 N., R. 29, 30 W.
Ash	Grant	T. 130 N., R. 43, 44 W.

STATE OF MINNESOTA

DEPARTMENT OF PUBLIC SERVICE

In the matter of the Proposed Amendments to Rules of the Minnesota Department of Public Service Amending the State Building Code regarding Heat Loss, Illumination, and Climate Control (Minn. Rules ch. 7670)	**FINDINGS OF FACT, CONCLUSIONS AND ORDER ADOPTING RULE WITHOUT PUBLIC HEARING**

The above entitled matter came before Krista L. Sanda, Commissioner of the Department of Public Service, on March 25, 1991. In accordance with statutory requirements regarding adoption of noncontroversial rules, after considering the Statement of Need and Reasonableness, after considering all of the evidence in the rulemaking record, the Commissioner hereby adopts the following Findings of Fact, Conclusions and Order:

FINDINGS OF FACT

(1) 1. Notice of the Department of Public Service's intent to adopt the above-entitled rule amendments without a public hearing was published in the State Register on 19 February, 1991 (15 S.R. 1831), and was sent by United States mail to all persons on the list maintained by the Department pursuant to Minn. Stat. §§ 14.14, subd. 1a and § 14.22 (1988) on 14 February, 1991. In accordance with Minn. Stat. § 14.115 (1988), additional discretionary notice was mailed to home builders, home energy contractors, building officials and housing researchers in order to provide an opportunity for small businesses to participate in the rulemaking process.

(2) 2. The Statement of Need and Reasonableness was prepared prior to mailing and publication of the notice and was made available to the public.

(4) 3. All persons were given the opportunity to submit comment on the rule amendments for 30 days after notice of proposed rulemaking. The 30 day comment period expired on March 21, 1991.

4. During the comment period, agency received zero (0) requests for a public hearing. Therefore, the agency did not receive requests for a public hearing from 25 or more persons which were not withdrawn.

5. Zero (0) requests for notice of submission to the Attorney General were received by the Department.

6. The Department received no written comments following publication of the proposed rules.

7. The Department adopts the Statement of Need and Reasonableness, in its entirety, as the factual basis for the proposed rules. The Department hearby incorporates the Statement of Need and Reasonableness into these findings.

8. The above-captioned rule amendments are needed and reasonable.

CONCLUSIONS

1. The Minnesota Department of Public Service duly acquired and has jurisdiction over this proceeding.

2. The Department published and served due, timely, and adequate notice of the intent to adopt the rules without a public hearing.

3. All relevant legal and procedural requirements of statute and rule have been complied with.

ORDER

NOW, THEREFORE, IT IS ORDERED that the attached amendments to rules amending the State building code regarding heat loss, illumination and climate control are adopted this 25 day of March, 1991, pursuant to authority vested in me by Minn. Stat. § 216C.19, subd. 8.

Krista L. Sanda

Krista L. Sanda, Commissioner
Department of Public Service

STATE OF MINNESOTA
DEPARTMENT OF PUBLIC SERVICE

In the matter of the Proposed Amendments to Rules of the Minnesota Department of Public Service Amending the State Building Code regarding Heat Loss, Illumination, and Climate Control (Minn. Rules ch. 7670)

DECLARATION OF COUNSEL

I, Eric F. Swanson, Special Assistant Attorney General, do hereby declare that I have examined the above-captioned rule, and the supporting rulemaking record, and that, based on my examination, the Administrative Procedure Act and Minnesota Rules, chapter 2010 have been followed. Any exceptions are listed below. For Attorney General billing purposes, the four digit docket client code is 0730.

ERIC F. SWANSON
Special Assistant
Attorney General

Dated: 3/26/91