Department of Public Service

Energy Division

Adopted Permanent Rules Relating to the Minnesota Energy Code

Rules as Adopted

7670.0100 AUTHORITY; SCOPE; APPLICABILITY.

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

Subp. 2. **Scope.** 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 parts 7670.0260 to 7670.0800. This chapter also applies to driveways, walkways, entrances, parking lots, and grounds. Enforcement of this chapter shall not abridge safety, health, or environmental requirements under other applicable codes or ordinances.

Subp. 4. **Exempt buildings.**

A. This chapter does not cover buildings, structures, or portions of buildings or structures whose peak design rate of energy usage is less than 3.4 Btu per hour per square foot or 1.0 watt per square foot of floor area for all purposes.

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

Subp. 5. **Application to existing buildings.**

A. Additions, alterations, and repairs. Additions, alterations, and repairs to existing buildings or structures may be made without making the entire building or structure comply, provided that the additions, alterations, and repairs comply with all the requirements of this chapter.

B. Historic buildings. Buildings that have been specifically designated as historically significant by the state or local governing body or listed or determined to be eligible



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for listing in the National Register of Historic Places are exempt from this code.

C. Mixed occupancy. If a building houses more than one occupancy, each portion of the building must conform to the requirements for the occupancy housed in that portion. If minor accessory uses do not occupy more than ten percent of the area of any floor of a building, the major use is considered the building occupancy.

D. Change of occupancy. A change in the occupancy or use of an existing building or structure constructed under this chapter which would require an increase in demand for either fossil fuel or electrical energy supply shall not be permitted unless the building or structure is made to comply with the requirements of this chapter.

Subp. 6. **Alternate materials and methods.** The provisions of this chapter are not intended to prevent the use of any material, method of construction, design, or insulating system not specifically prescribed herein, provided that such construction, design, or insulating system has been approved by the building official as meeting the intent of the chapter.

Subp. 7. **Plans and specifications.**

A. General. With each application for a building permit, and when required by the building official, plans and specifications shall be submitted. The building official may require that plans and specifications be prepared by an engineer or architect licensed to practice by the state. Designs submitted under the provisions of part 7670.0460 must be prepared by an engineer or architect licensed to practice in Minnesota.

EXCEPTION: In accordance with Minnesota Statutes, section 326.02, subdivision 5, work performed by an electrical contractor or master plumber as defined in and licensed pursuant to Minnesota Statutes, chapter 326, shall not be required to be prepared by an engineer or architect licensed to practice in the state.

B. Details. Plans and specifications shall show in



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sufficient detail pertinent data and features of the building and the equipment and systems as herein governed, including, but not limited to: design criteria, exterior envelope component materials, U-factors of the envelope systems, R-values of insulating materials, size and type of apparatus and equipment, equipment and systems controls, and other pertinent data to indicate conformance with the requirements of this chapter.

7670.0130 INCORPORATIONS BY REFERENCE.

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

A. Chapters 4 and 6 of the Model Energy Code, 1989 Edition, as published by the Council of American Building Officials (Falls Church, Virginia).

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 and part 430, National Appliance Energy Conservation Act of 1987.

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

D. ENVSTD, Envelope System Performance Compliance Calculation program, a computer program developed by Battelle Pacific Northwest Laboratories.

E. ASTM E779-87, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization.

F. ASTM E283-91, Standard Method of Test for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors.

G. NFRC 100-91: Procedure for Determining Fenestration Product Thermal Properties (Currently Limited to U-values).

H. ASHRAE, 1993 Handbook of Fundamentals, chapters 25, 26, and 27.

I. ASHRAE Standard 55-1992, Thermal Environmental Conditions for Human Occupancy.



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J. ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality.

K. ASHRAE Standard 84-1991, Method of Testing Air-to-Air Heat Exchangers.

L. R-2000 Home Program Technical Requirements for homes enrolled after September 1992, Canadian Home Builders' Association.

M. Section 4 of the HVAC Air Duct Leakage Test Manual, 1985 edition, as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (Vienna, Virginia).

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

C. NFRC standards are available from National Fenestration Rating Council, 1300 Spring Street, Silver Spring, MD 20910.

7670.0260 MATERIALS AND EQUIPMENT.

Subpart 1. **Identification.** Materials and equipment must be identified in order to show compliance with this chapter.

Subp. 2. **Maintenance information.** Required regular maintenance actions must be clearly stated and incorporated on a readily accessible label. The label may be limited to identifying, by title or publication number, the operation and maintenance manual for that particular model and type of product. Maintenance instructions must be furnished for equipment that requires preventive maintenance for efficient operation.



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Subp. 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. All thermal insulation must achieve stated performance at 75 degrees Fahrenheit mean temperature and no less than stated performance at winter design conditions.

EXCEPTION: Thermal insulation designed to reduce summer cooling load only is not required to achieve stated performance at winter design conditions.

7670.0325 DEFINITIONS.

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

Subp. 2. **Accessible or readily accessible.** "Accessible" means admitting close approach because not guarded by locked doors, elevation, or other effective means. "Readily accessible" means capable of being reached quickly for operation, renewal, or inspections, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, or similar aids.

Subp. 3. **Advanced or improved framing.**

A. "Advanced area framing" means framing techniques used to minimize the amount of uninsulated area that is required for proper structural support consistent with requirements of the Uniform Building Code, including section 2517.

B. "Advanced wall framing" means two inch by six inch stud spacing of 24 inches on center, insulated headers, two-stud corners using approved backing for the attachment of facing materials, full insulation wherever possible between partition wall intersections with exterior walls, and, when foam insulated sheathing is used, replacement of cripples with hangers whenever possible. "Standard framing" means wall framing that is not advanced framing.

C. "Advanced ceiling framing" means achieving full insulating value to the outside of exterior walls.



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D. "Improved ceiling framing" means a minimum of 7-1/2 inches between the wall top plate and roof sheathing.

Subp. 4. **Air conditioning comfort.** "Air conditioning comfort" means the process of treating air so as to control simultaneously its temperature, humidity, cleanliness, and distribution to meet requirements of the conditioned space.

Subp. 5. **Automatic.** "Automatic" means self-acting, operating by its own mechanism when actuated by some impersonal influence, for example, a change in current strength, pressure, temperature, or mechanical configuration.

Subp. 6. **Boiler capacity.** "Boiler capacity" means the rate of heat output in Btu per hour measured at the boiler outlet, at the design inlet and outlet conditions, and rated fuel/energy input.

Subp. 7. **Building envelope.** "Building envelope" means the elements of a building which enclose conditioned spaces through which thermal energy may be transferred to or from the exterior.

Subp. 8. **Building project.** "Building project" means a building or group of buildings, including on-site energy conversion or electric-generating facilities, which utilize a single submittal for a construction permit or are within the boundary of a contiguous area under one ownership.

Subp. 9. **Comfort envelope.** "Comfort envelope" means the area on a psychometric chart enclosing all those conditions described in Figure No. 2, ASHRAE Standard 55-1992 Thermal Environment Conditions for Human Occupancy.

Subp. 10. **Conditioned floor area.** "Conditioned floor area" means the horizontal projection of that portion of interior space which is contained within exterior walls and which is conditioned directly or indirectly by an energy-using system.

Subp. 11. **Conditioned space.** "Conditioned space" means space within a building which is provided with heated and/or cooled air or surfaces and, where required, with humidification or dehumidification means so as to be capable of maintaining a space condition falling within the comfort zone defined in ASHRAE Standard 55-1992 Thermal Environment Conditions for Human

Occupancy.

Subp. 12. **Cooled space.** "Cooled space" means space within a building which is provided with a positive cooling supply.

Subp. 13. **Deadband.** "Deadband" means the temperature range in which no heating or cooling is used.

Subp. 14. **Degree day, heating.** "Degree day, heating" means a unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal heating load of a building in winter. For any one day, when the mean temperature is less than 65°F there exist as many degree days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65°F.

Subp. 15. **Dwelling unit.** "Dwelling unit" means a single housekeeping unit comprised of one or more rooms providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation.

Subp. 16. **Efficiency, combustion.** "Efficiency, combustion" means 100 percent minus flue loss.

Subp. 17. **Efficiency, HVAC system.** "Efficiency, HVAC system" means the ratio of useful energy, at the point of use, to the energy input for a designated time period, expressed in percent.

Subp. 18. **Efficiency, thermal.** "Efficiency, thermal" means the results of a thermal efficiency test referenced in Code of Federal Regulations, title 10, part 430 or 435.

Subp. 19. **Energy, kWh and Btu.** "Energy" means the capacity for doing work; taking a number of forms which may be transformed from one into another, such as thermal (heat), mechanical (work), electrical, and chemical; in customary units, measured in kilowatt-hours (kWh) or British thermal units (Btu).

Subp. 20. **Energy efficiency ratio (EER).** "Energy efficiency ratio (EER)" means the ratio of net equipment cooling capacity in Btu per hour to total rate of electric input in watts under designated operating conditions.

Subp. 21. **Gross floor area.** "Gross floor area" means the



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sum of the areas of the several floors of the building, including basements, cellars, mezzanine and intermediate floored tiers, and penthouses of headroom height, measured from the exterior faces of exterior walls or from the center line of walls separating buildings, but excluding:

A. covered walkways, open roofed-over areas, porches and similar spaces; and

B. pipe trenches, exterior terraces or steps, chimneys, roof overhangs, and similar features.

Subp. 22. **Gross wall area.** "Gross wall area" means the normal projection of the building envelope wall area bounding interior space which is conditioned by an energy-using system, including opaque wall, window, and door area.

The gross area of walls consists of all opaque wall areas, including between floor spandrels, peripheral edges of floors, window areas including sash, and door areas, where such surfaces are exposed to outdoor air and enclose a heated or mechanically cooled space including interstitial areas between two such spaces. For basement walls with an average below-grade area less than 50 percent of the total wall area, including openings, the entire wall, including the below-grade portion, is included as part of the gross wall area. Nonopaque areas, such as windows and doors of all basement walls are included in the gross wall area.

Subp. 23. **Heat.** "Heat" means the form of energy that is transferred by virtue of a temperature difference.

Subp. 24. **Heated slab.** "Heated slab" means slab-on-grade construction in which the heating elements or hot air distribution system is in contact with or placed within the slab or the subgrade.

Subp. 25. **Heated space.** "Heated space" means space within a building which is provided with a positive heat supply. Finished living space within a basement with registers or heating devices designed to supply heat to a basement space shall automatically define that space as heated space.

Subp. 26. **HVAC.** "HVAC" means heating, ventilating, and

air conditioning.

Subp. 27. **HVAC system.** "HVAC system" means a system that provides either collectively or individually the processes of comfort heating, ventilating, and/or air conditioning within or associated with a building.

Subp. 28. **Infiltration.** "Infiltration" means the uncontrolled inward air leakage through cracks and interstices in any building element and around windows and doors of a building caused by the pressure effects of wind and/or the effect of differences in the indoor and outdoor air density.

Subp. 29. **Manual.** "Manual" means capable of being operated by personal intervention.

Subp. 30. **Mechanical ventilation system, residential.** "Mechanical ventilation system, residential" means a system that, by mechanical means, is capable of introducing and distributing outdoor air to all habitable rooms and removes indoor air at a rate of not less than 0.35 air changes per hour, or 15 cubic feet per minute per bedroom plus an additional 15 cubic feet per minute, whichever is greater.

Subp. 31. **Multifamily dwelling.** "Multifamily dwelling" means a building containing three or more dwelling units.

Subp. 32. **New energy.** "New energy" means energy, other than recovered energy, used for the purpose of heating or cooling.

Subp. 33. **Once-through system.** "Once-through system" means a HVAC or refrigeration system used for any type of temperature or humidity control application, utilizing groundwater, that circulates through the system and is then discharged without reusing it for a higher priority purpose.

Subp. 34. **Opaque areas.** "Opaque areas" means all exposed areas of a building envelope which enclose conditioned space, except openings for windows, skylights, doors, and building service systems.

Subp. 35. **Passive or natural ventilation.** "Passive or natural ventilation" means the movement of outdoor air into a space through intentionally provided openings, such as windows



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and doors or through nonpowered ventilators.

Subp. 36. **Positive cooling supply.** "Positive cooling supply" means mechanical cooling deliberately supplied to a space, such as through a supply register.

Subp. 37. **Positive heat supply.** "Positive heat supply" means heat deliberately supplied to a space by design, such as a supply register, radiator, or heating element.

Subp. 38. **Recooling.** "Recooling" means the removal of heat by sensible cooling of the supply air, directly or indirectly, that has been previously heated above the temperature to which the air is to be supplied to the conditioned space for proper control of the temperature of that space.

Subp. 39. **Recovered energy.** "Recovered energy" means energy utilized which would otherwise be wasted, for example, not contribute to a desired end use, from an energy utilization system.

Subp. 40. **Reheat.** "Reheat" means the application of sensible heat to supply air that has been previously cooled below the temperature of the conditioned space by either mechanical refrigeration or the introduction of outdoor air to provide cooling.

Subp. 41. **Renewable energy sources.** "Renewable energy sources" means sources of energy, excluding minerals, derived from incoming solar radiation, including natural daylighting and photosynthetic processes; from phenomena resulting therefrom, including wind, waves and tides, lake or pond thermal differences; and energy derived from the internal heat of the earth, including nocturnal thermal exchanges.

Subp. 42. **Reset.** "Reset" means adjustment of the set point of a control instrument to a higher or lower value automatically or manually to conserve energy.

Subp. 43. **Roof assembly.** "Roof assembly" means all components of the roof/ceiling envelope through which heat flows, thus creating a building transmission heat loss or gain, where such assembly is exposed to outdoor air and encloses a

heated or mechanically cooled space.

The gross area of a roof assembly consists of the total interior surface of such assembly, including skylights exposed to the heated or mechanically cooled space.

Subp. 44. **Service water heating.** "Service water heating" means the supply of hot water for domestic or commercial purposes other than comfort heating.

Subp. 45. **Shading coefficient (SC).** "Shading coefficient (SC)" means: SC = Solar Heat Gain of Fenestration/Solar Heat Gain. Conditions must be as specified in ASHRAE, 1993 Handbook of Fundamentals, chapter 27.

Subp. 46. **Thermal conductance.** "Thermal conductance" means time rate of heat flow through a body, frequently per unit area, from one of its bounding surfaces to the other for a unit temperature difference between the two surfaces, under steady conditions (Btu/h $ft^2$ °F)

Subp. 47. **Thermal resistance (R).** "Thermal resistance (R)" means the reciprocal of thermal conductance (h $ft^2$ °F/Btu).

Subp. 48. **Thermal transmittance (U).** "Thermal transmittance (U)" means 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 of air films (Btu/h $ft^2$ °F). The U-factor of an element is calculated by items A to E, as appropriate.

A. Parallel heat flow method. The parallel heat flow U-factor is the area weighted average of the thermal transmittance of the subelements of an element, as computed with the equations below.

Equation for thermal transmittance of an element:

$$U = (A_1/R_1 + A_2/R_2 + A_3/R_3 + \ldots)/A_o$$

Where:

$A_1$, $A_2$, $A_3$, ... = the cross-sectional area of the different subelements

$R_1$, $R_2$, $R_3$, ... = the cross-sectional R-value of the different subelements

$A_o$ = the gross area of the element or overall component



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B. Series-parallel heat flow method. The series-parallel heat flow method is a procedure that accounts for the fact that heat does not always flow straight through a wall.

Equations for series-parallel thermal transmittance:

$U = 1/R_o$

$R_o = R_f + (R_w \times R_c)/[(A_c \times R_w) + (A_w \times R_c)] + R_{film}$

Where:

$R_f$ = thermal resistance of faces

$R_w$ = thermal resistance of the web

$R_c$ = thermal resistance of the core

$A_w$ = fraction of the total area perpendicular to heat flow of the web (conductive)

$A_c$ = fraction of the total area perpendicular to heat flow of the core (insulated)

C. Metal stud framing equivalent R-value method. The metal stud framing equivalent R-value method employ a table giving equivalent R-values of opaque elements containing metal stud framing. The following equations must be used to determine the thermal transmittance of the opaque element.

Equations for the thermal transmittance of the opaque element:

$U = 1/R_t$

$R_t = R_i + R_e$

Where:

$R_t$ = the total resistance of the opaque assembly

$R_i$ = the resistance of the series elements (for i=1 to n), excluding the insulated metal stud framed element

$R_e$ = the equivalent R-value of the element containing the insulated metal stud framing

Equivalent R-values for metal stud framed (16 gauge or thinner) insulated cavities

| Size of studs | Spacing of studs, inches on center | Cavity Insulation R-value | Insulated wall cavity equivalent R-value |
|---|---|---|---|
| 2 x 4 | 16 | R-11 | R-5.5 |
| 2 x 4 | 16 | R-13 | R-6.0 |



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| | | | |
|---|---|---|---|
| 2 x 4 | 16 | R-15 | R-6.4 |
| 2 x 4 | 24 | R-11 | R-6.6 |
| 2 x 4 | 24 | R-13 | R-7.2 |
| 2 x 4 | 24 | R-15 | R-7.8 |
| 2 x 6 | 16 | R-19 | R-7.1 |
| 2 x 6 | 16 | R-21 | R-7.4 |
| 2 x 6 | 24 | R-19 | R-8.6 |
| 2 x 6 | 24 | R-21 | R-9.0 |
| 2 x 8 | 16 | R-25 | R-7.8 |
| 2 x 8 | 24 | R-25 | R-9.6 |

D. Draped insulation effective assembly R-value method. The draped insulation effective assembly R-value method employs a table of effective R-values ($R_e$) of metal wall or roof assemblies with insulation draped over purlins or girts where insulation is compressed between the outside skin and purlin or girt.

Equation for draped insulation effective assembly R-value thermal transmittance calculation:

$$U = 1/(R_i + R_e)$$

Where:

$R_i$ = the R-values of series elements excluding the draped insulation and framing

$R_e$ = the effective assembly R-value

Air film coefficients included in table values.

Assembly effective R-values ($R_e$)

| Batt Insulation R-value | One Fastener Per Linear Foot of Purlin/Girt Purlin/Girt Spacing (Feet) | | | |
|---|---|---|---|---|
| | 5 | 4 | 3 | 2 |
| R-38 | 11.61 | 10.18 | 8.45 | 6.30 |
| R-30 | 11.08 | 9.79 | 8.21 | 6.20 |
| R-26 | 10.80 | 9.59 | 8.08 | 6.14 |
| R-22 | 10.06 | 9.04 | 7.73 | 5.99 |
| R-19 | 9.95 | 8.95 | 7.67 | 5.97 |

| Batt Insulation R-value | Two Fasteners Per Linear Foot of Purlin/Girt Purlin/Girt Spacing in (Feet) | | | |
|---|---|---|---|---|
| | 5 | 4 | 3 | 2 |
| R-38 | 9.96 | 8.64 | 7.07 | 5.19 |
| R-30 | 9.56 | 8.36 | 6.91 | 5.12 |
| R-26 | 9.35 | 8.21 | 6.81 | 5.09 |
| R-22 | 8.80 | 7.80 | 6.56 | 4.98 |
| R-19 | 8.71 | 7.74 | 6.52 | 4.96 |

E. Zone method. The zone method is a procedure in which the thermal transmittance of a surface is computed by dividing the surface into its "highly conductive" and "remaining" areas. The "highly conductive" area is a function



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of the width or diameter of the metal heat path terminal and the distance from the panel surface to the metal. The respective thermal transmittance of the two areas are separately computed, combined, and then divided by the total cross-sectional area.

Equation for zone method thermal transmittance:

$$U = (U_1A_1 + U_2A_2)/A_o$$

Where:

For the highly conductive area

$A_1$ = the highly conductive area

$U_1$ = the thermal transmittance of the highly conductive area

For the remainder of the area

$A_2$ = the remainder of the area

$U_2$ = the thermal transmittance of the remaining area

$A_o$ (cross-sectional area of the element) = $A_1 + A_2$

Equation for areas:

$$A_1 = m + 2d,\ A_2 = A_o - A_1$$

Where:

m = width or diameter of the metal heat path terminal

d = distance from panel surface to metal

Subp. 49. **Thermal transmittance, overall ($U_o$).** "Thermal transmittance, overall ($U_o$)" means the overall thermal transmittance of an exterior building envelope component, such as a wall, floor, or roof/ceiling. The value of $U_o$ is calculated by the parallel path heat flow method using the areas and thermal transmittance values of the various elements, such as windows, doors, and opaque surfaces that comprise the gross area of the building component.

Subp. 50. **Vapor retarder.** "Vapor retarder" means a material to retard air and water vapor passage designed to meet a maximum permeability rating of 1.0 grain per hour per square foot 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. 51. **Ventilation or ventilation air.** "Ventilation"

means the process of supplying or removing air by natural or mechanical means to or from any space. Such air may or may not have been conditioned. "Ventilation air" means that portion of supply air which comes from outside (outdoors) plus any recirculated air that has been treated to maintain the desired quality of air within a designated space.

Subp. 52. **Wind wash.** "Wind wash" means the passage of unconditioned air through thermal insulation of the building envelope.

Subp. 53. **Window area.** "Window area" means the rough opening less installation clearances.

7670.0400 DESIGN CONDITIONS.

Subpart 1. **General.** The criteria of this chapter establish the design conditions upon which the minimum thermal design of the HVAC system must be based.

Subp. 2. **Heating and cooling.** A building designed to be both heated and cooled must meet the more stringent of the heating or cooling requirements as provided in this chapter when requirements of the exterior envelope differ.

Subp. 3. **Exterior design temperature.** The exterior design temperature must be selected from the "Design Conditions" columns in this subpart.

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

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 | |



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| | | | | | |
|---|---|---|---|---|---|
| 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

Adjustments may be made as determined by the building official to reflect local climates which differ from the tabulated temperatures or local weather experience.

Subp. 4. **Interior design conditions.**

A. Indoor design temperature. Indoor design temperature must be 72°F for heating and 78°F for cooling.

EXCEPTION: Other design temperatures may be used for equipment selection if it results in a lower energy usage.

B. Humidification. If humidification is provided during heating, it must be designed for a maximum relative humidity of 30 percent. When comfort air conditioning is provided, the actual design relative humidity within the comfort envelope must be selected for minimum total HVAC system energy use.

7670.0450 VENTILATION.

Ventilation systems must be designed to conform with ASHRAE Standard 62-1989.

EXCEPTION: Infiltration does not satisfy the requirement for ventilation in residential construction. Enclosed parking garages and auto repair rooms must be ventilated with outdoor air as required by chapter 1305.

7670.0460 BUILDING DESIGN BY SYSTEMS ANALYSIS.

Building design by systems analysis must comply with the Model Energy Code, chapter 4. The Model Energy Code, chapter 4, is amended by replacing references to chapter 5 or 6 with "Minnesota Rules, parts 7670.0260 to 7670.0800."

7670.0470 ENVELOPE THERMAL TRANSMITTANCE FOR ALL BUILDINGS.

Subpart 1. **General.** Buildings that are heated or mechanically cooled must be constructed so as to provide the required thermal performance of the various components.

A building that is designed to be both heated and cooled must meet the more stringent of the heating or cooling requirements as provided in this chapter when requirements of the exterior envelope differ.

Subp. 2. **Total heat gain or loss for entire building.** The value of $U_o$ for any assembly such as roof/ceiling, wall, or floor may be increased and the value of $U_o$ for other components decreased, provided that the total heat gain or loss for the entire building envelope does not exceed the total resulting from conformance to the values of $U_o$ specified in parts 7670.0470, 7670.0480, 7670.0490, and 7670.0495.

Subp. 3. **Thermal mass of building components.** The proposed design may take into account the thermal mass of the building components in considering energy conservation. This applies only for walls in locations less than 8,000 heating degree days (base temperature of 65°F) with heat capacity equal to or exceeding 6.7 Btu/ft$^2$ °F. The required wall thermal transmittance may be adjusted in accordance with the table below:

| Required Value of $U_w$ without Consideration of Thermal Mass | Required Value of $U_w$ with Consideration of Mass (position of insulation) | | |
|---|---|---|---|
| | Exterior of wall mass | Interior of wall mass | Integral with wall mass |
| 0.20 | 0.22 | 0.21 | 0.22 |
| 0.18 | 0.20 | 0.19 | 0.20 |
| 0.16 | 0.18 | 0.17 | 0.18 |
| 0.14 | 0.15 | 0.14 | 0.16 |
| 0.12 | 0.13 | 0.13 | 0.13 |
| 0.10 | 0.11 | 0.10 | 0.11 |
| 0.08 | 0.09 | 0.08 | 0.09 |
| 0.06 | 0.07 | 0.06 | 0.07 |
| 0.04 | 0.05 | 0.04 | 0.05 |

Subp. 4. **Thermal transmittance of opaque components.**

A. When return air ceiling plenums are employed, the roof/ceiling assembly must:

(1) for thermal transmittance purposes, not include the ceiling proper nor the plenum space as part of the assembly; and

(2) for gross area purposes, be based upon the interior face of the upper plenum surface.



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B. Thermal transmittance of opaque wall, roof/ceiling, and floor components, except as permitted in item C, 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) Wall or roof assemblies with insulation draped over purlins or girts (insulation compressed between the outside skin and purlin or girt): Draped insulation effective assembly R-value method.

(4) Metal stud walls: Metal stud framing equivalent R-value method.

(5) For elements not identified in subitem (1), (2), (3), or (4): Zone method.

C. Overall thermal transmittance of walls and floors may be determined from chapter 6 of the Model Energy Code.

Subp. 5. **Thermal transmittance of window area and skylight elements.** Thermal transmittance of window area and skylight elements must be determined in accordance with one of the following methods:

A. Representative U-factors for Fenestration Systems, ASHRAE, 1993 Handbook of Fundamentals, chapter 27, table 5; or

B. NFRC 100-91: Procedure for determining Fenestration Product Thermal Properties (Currently Limited to U-Values).

Subp. 6. **Effectiveness of required thermal insulation.** Building assemblies are required to maintain the thermal performance of required insulation and the integrity of building materials against cold weather water vapor condensation and intrusion of unconditioned air.

A. Requirements for buildings. This item classifies two categories of buildings, identifying which elements of this subpart are required and when a mechanical ventilation system must be installed.

(1) Category 1: All buildings, except those

classified as category 2, must meet all requirements in the table in subitem (3). Category 1 residential buildings must have a residential mechanical ventilation system.

(2) Category 2: Buildings where infiltration and passive ventilation are relied on to provide necessary year-round ventilation must only meet the requirements identified in subitem (3), units (a) to (g). Category 2 buildings may also be equipped with a mechanical ventilation system. If a measure identified in subitem (3), unit (h), (i), (j), (k), or (l), is also installed in a residential building, then a residential mechanical ventilation system must be installed.

| (3) Table of requirements | Reference |
|---|---|
| (a) Vapor retarder | Item B |
| (b) Continuous air barrier at all plumbing and heating penetrations | Item C (1) |
| (c) Fire stops must be installed to block air movement | Item C (2) |
| (d) Penetrations in the building envelope for electrical and telecommunications equipment (except for electrical boxes and fan housings) must be sealed to prevent air leakage | Item C (3)(a) |
| (e) Wind wash barrier required at the exterior edge of attic insulation | Item D (1) |
| (f) Wind wash barrier required at cantilevered floors and bay windows | Item D (2) |
| (g) Window and door frames and utility penetrations must be sealed | Subpart 7, item B (1) |
| (h) Electrical boxes and fan housings must be sealed to prevent air leakage | Item C (3)(b) |
| (i) Rim joists must be sealed to prevent air leakage | Item C (4) |
| (j) The top of interior partition walls must be sealed to prevent air leakage | Item C (5) |



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(k) All exterior joints that may be sources of air intrusion must be sealed Item D (3)

(l) Between wall assemblies, rim joists and foundations must be sealed to prevent air leakage Subpart 7, item B (2)

B. 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 to prevent diffusion of moisture into thermal insulation.

(1) If the vapor retarder is also intended to serve as the air leakage barrier, then the vapor retarder must be continuously sealed.

(2) EXCEPTION: A vapor retarder need not be installed on rim joist insulation not susceptible to condensation from moisture diffusion.

C. Air leakage barrier. A barrier against air leakage must be installed to prevent the leakage of moisture-laden air from the conditioned space into the building envelope.

(1) Plumbing and heating penetrations. An air barrier must be continuous at all plumbing and heating penetrations of interior surface of the building 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 envelope behind the tub or shower.

(2) Fire stops or fire block. When mineral fiber or glass fiber materials are used as fire stop or fire block construction at ceilings and wall cavities separating conditioned and unconditioned spaces, an additional air leakage barrier must be installed to block air movement.

(3) Penetrations for electrical equipment. Penetrations in the building envelope for electrical and telecommunication equipment must be sealed in accordance with this item to prevent air leakage.

(a) For category 2 buildings, the service



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entrance, wires, conduit, cables, panels, recessed light fixtures, and fans at point of penetrating the air barrier must be sealed.

(b) Category 1 buildings must be sealed as required in unit (a), and in addition, electrical boxes and fan housings must be sealed.

(4) Rim joists. Rim joists, band joists, and where floor joists or trusses meet the building envelope must be sealed to prevent air leakage.

EXCEPTION: Not required for category 2 buildings.

(5) Interior partition walls. The top of interior partition walls that join insulated ceilings must be sealed to prevent air leakage.

EXCEPTION: Not required for category 2 buildings.

D. Air intrusion barrier. An air-impermeable barrier must be provided where thermal insulation is susceptible to intrusion of outdoor air.

(1) Attic edge. A baffle must be installed at the exterior edge of attic insulation to mitigate wind wash. Baffles must be rigid material resistant to wind driven moisture.

(2) Overhangs. A barrier must be installed at cantilevered floors and bay windows, including corners with adjoining walls above and below, to mitigate wind wash.

(3) Exterior joints. Exterior joints in the building envelope that may be sources of air intrusion must be caulked, foamed, gasketed, joined over solid blocking, or otherwise sealed.

EXCEPTION: Not required for category 2 buildings.

Subp. 7. **Air leakage.**

A. Doors and windows. Exterior doors and windows must have air infiltration rates not exceeding those shown in this subpart. The allowable air infiltration rates are tested at a pressure differential of 1.567 pounds per square foot, which is equivalent to the impact pressure of a 25-mile per hour wind.

Allowable Air Infiltration Rate

| Elements | Value | Dimensional Unit |
|---|---|---|
| Windows | 0.34 | cfm per foot of operable sash crack |
| Residential doors | 0.5 | cfm per square foot of door area |
| Nonresidential doors | 1.25 | cfm per square foot of door area |

For doors, compliance with the criteria for air leakage must be determined by ASTM E283-91.

B. Joints. Joints in the building conditioned envelope that are sources of air leakage must be sealed in accordance with this item. Required items must be sealed with compatible, durable caulking, foam, gasketing, or other materials.

(1) Category 2 buildings must be sealed around window and door frames, between wall cavities and window or door frames, and at utility penetrations.

(2) Category 1 buildings must be sealed as required in subitem (1), and in addition, between wall assemblies and their rim joists, sill plates, foundations; between wall and roof/ceilings; and between separate wall panels.

C. Performance alternative. As an alternative to the prescriptive requirements of item B, detached single-family residential buildings must meet the requirements of this item.

(1) The air leakage rate must be 0.24 cubic feet per minute per square foot of conditioned space or less at 50 pascals when tested in accordance with ASTM 779-87; and

(2) A residential mechanical ventilation system must be installed, and the ventilation rate must be verified by measurement.

Subp. 8. **Slab on grade floors.** Slab on grade floors must be insulated around the perimeter of the floor. The thermal insulation must be continuous and must be not less than R-10. The insulation must extend from the top of the slab downward to either the design frost line or to the bottom of the slab then horizontally beneath the slab for a total distance equal to the design frost line.

Subp. 9. **Foundation walls.**



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A. Foundation walls enclosing conditioned spaces must be insulated.

B. The thermal resistance of the insulation on the opaque foundation wall must be not less than required in this item from the top of the wall down to the top of the footing.

(1) For residential buildings three stories and less, insulation must be R-10 minimum.

(2) For all buildings other than residential buildings three stories and less insulation must be R-13 minimum.

C. 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.

D. If 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.

E. If foundation wall insulation is on the interior, a moisture barrier must be located between the insulation and the foundation wall from the floor to grade.

Subp. 10. **Floors over unheated spaces.** Floors over unheated spaces must have a maximum overall thermal transmittance of 0.04.

Subp. 11. **Performance and identification of loose fill insulation.**

A. Loose fill insulation installed to meet the requirements of this chapter must provide the required performance at 75°F mean temperature and no less than the required performance at winter design conditions.

B. The insulation installer shall place identification in accordance with this subpart in accessible attics of all buildings with loose fill insulation. Such identification shall be used by the code official to verify the claimed insulation.

C. A means must be provided to verify the claimed

insulation level by either:

(1) installing insulation thickness markers labeled with a minimum of one-inch increments at approximately ten-foot spacing throughout the attic space at points visible from the attic access point; or

(2) affixing a label or other unique portion of each bag containing the insulation blown into the attic to the attic card.

D. A completed insulation receipt attic card must be attached to the framing near the access opening in a clearly visible place. The attic card must identify the type of insulation installed, the manufacturer, the installer, the R-value, the design settled thickness, the square footage of attic coverage area, and the number of bags installed, and must be signed and dated by the installer.

7670.0475 CRITERIA FOR WALLS, ROOFS, AND FLOORS OVER UNHEATED SPACES OF ONE- AND TWO-FAMILY RESIDENTIAL BUILDINGS.

Subpart 1. **Scope.** One- and two-family residential buildings that are heated or mechanically cooled must comply with the requirements of subpart 2 or 3.

Subp. 2. **Prescriptive criteria.**

A. Minimum thermal resistance of the insulation in ceilings to achieve a $U_o$ factor of 0.026 is as follows: In ceilings with attics insulation must be R-38 with improved or advanced framing, or R-44 without improved or advanced framing. In ceilings without attics insulation must be R-38 between framing plus R-5 sheathing.

B. Minimum thermal resistance of the insulation in rim joists: R-19.

C. Maximum thermal transmittance of entrance doors: U=0.30 Btu/h $ft^2$ °F (equivalent to 1-3/4 inch solid core wood door with storm).

EXCEPTION: Swinging and sliding glass patio doors must have a U-factor not greater than the window U-factor for the building.

D. Floors over unheated spaces: $U_O \leq$ 0.04 Btu/h ft$^2$ ° F (equivalent to R-24 insulation between floor joists).

E. Foundation windows must be insulated glass, one-half inch between panes and wood or vinyl frame, or equivalent.

F. The building must not exceed the maximum window and door area as a percentage of overall exposed wall area listed below for the combination of framing technique, R-value of insulation within the insulated cavity, sheathing R-value, and window U-factor. Other components must meet the requirements of this subpart.

MAXIMUM WINDOW AND DOOR AREA

AS A PERCENT OF OVERALL EXPOSED WALL

| | Cavity | | Window U-Factor | | | |
|---|---|---|---|---|---|---|
| Framing | Insulation | Sheathing | 0.49 | 0.36 | 0.31 | 0.27 |
| STANDARD | R-13 | ≥R-7 | 13.4% | 17.8% | 21.3% | 24.3% |
| STANDARD | R-15 | ≥R-5 | 12.9% | 17.1% | 20.1% | 23.4% |
| STANDARD | R-18 | <R-5 | 11.1% | 16.0% | 18.8% | 22.0% |
| STANDARD | R-18 | ≥R-5 | 13.5% | 18.6% | 21.8% | 25.3% |
| ADVANCED | R-18 | <R-5 | 11.1% | 17.1% | 20.1% | 23.4% |
| ADVANCED | R-18 | ≥R-5 | 13.5% | 19.2% | 22.5% | 26.1% |
| STANDARD | R-21 | <R-5 | 11.8% | 17.0% | 19.9% | 23.1% |
| STANDARD | R-21 | ≥R-5 | 14.0% | 19.3% | 22.5% | 26.1% |
| ADVANCED | R-21 | <R-5 | 11.8% | 18.1% | 21.2% | 24.6% |
| ADVANCED | R-21 | ≥R-5 | 14.0% | 19.9% | 23.2% | 26.9% |

Subp. 3. **Performance criteria.** The combined thermal transmittance ($U_O$) factors for walls, roof/ceilings, and floors over unheated spaces must be less than or equal to:

A. 0.110 Btu/h ft$^2$ °F for walls;

B. 0.026 Btu/h ft$^2$ °F for roof/ceilings; and

C. 0.04 Btu/h ft$^2$ °F for floors.

7670.0490 WALL AND ROOF CRITERIA FOR MULTIFAMILY RESIDENTIAL BUILDINGS, THREE STORIES OR LESS.

Subpart 1. **Scope.** Residential buildings that are not one- or two-family and are three stories or less in height must comply with the requirements of subpart 2 and either subpart 3 or 4, as applicable.

Subp. 2. **Roof assembly.** The gross area of the roof/ceiling assembly must have a combined thermal transmittance ($U_O$) factor not exceeding 0.026 Btu/°F ft$^2$.



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EXCEPTION: Alterations and repairs to an existing built-up or membrane roof must have a thermal transmittance value not exceeding 0.033 Btu/°F $ft^2$.

Subp. 3. **Zone I walls.** For buildings in Zone I (northern Minnesota) as defined in part 1305.5400, the gross area of the exterior walls must have a combined thermal transmittance ($U_O$) factor not exceeding 0.145 Btu/°F $ft^2$.

Subp. 4. **Zone II walls.** For buildings in Zone II (southern Minnesota) as defined in part 1305.5400, the gross area of the exterior walls must have a combined thermal transmittance ($U_O$) factor not exceeding 0.148 Btu/°F $ft^2$.

7670.0495 ROOF AND WALL CRITERIA FOR ALL OTHER BUILDINGS.

Subpart 1. **Scope.** Buildings not regulated by part 7670.0480 or 7670.0490 must comply with the requirements of subpart 2 or 3.

Subp. 2. **Prescriptive criteria.**

A. Zone I. Buildings located in Zone I (northern Minnesota) as defined in part 1305.5400 must comply with this part. The combined thermal transmittance factor ($U_O$) for the roof/ceiling must not exceed 0.040 Btu/h $ft^2$ °F. The maximum window area as a percentage of exposed wall must not exceed the values given in the table below using the thermal transmittance of the opaque wall, thermal transmittance of the window, and shading coefficient (SC) of the window. Interpolations to intermediate values are permitted.

| | Maximum Window Area | | | |
|---|---|---|---|---|
| Window U = | 0.3 | 0.4 | 0.5 | 0.6 |
| Opaque Wall U = 0.06 | | | | |
| SC 0.8 | 32% | 27% | 23% | 20% |
| SC 0.6 | 38% | 30% | 25% | 21% |
| SC 0.4 | 44% | 33% | 26% | 22% |
| Opaque Wall U = 0.07 | | | | |
| SC 0.8 | 30% | 26% | 22% | 18% |
| SC 0.6 | 36% | 29% | 23% | 19% |
| SC 0.4 | 42% | 31% | 24% | 20% |
| Opaque Wall U = 0.08 | | | | |
| SC 0.8 | 29% | 24% | 20% | 17% |
| SC 0.6 | 34% | 27% | 21% | 17% |



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| | | | | |
|---|---|---|---|---|
| SC 0.4 | 40% | 29% | 22% | 18% |

Opaque Wall U = 0.09

| | | | | |
|---|---|---|---|---|
| SC 0.8 | 27% | 22% | 18% | 15% |
| SC 0.6 | 32% | 24% | 19% | 16% |
| SC 0.4 | 37% | 26% | 20% | 16% |

B. Zone II. Buildings located in Zone II (southern Minnesota), as defined in part 1305.5400, must comply with this part. The combined thermal transmittance factor ($U_o$) for the roof/ceiling must not exceed 0.045 Btu/h $ft^2$ °F. The maximum window area as a percentage of exposed wall must not exceed the values given in the table below using the thermal transmittance of the opaque wall, thermal transmittance of the windows, and shading coefficient (SC) of the windows. Interpolations to intermediate values are permitted.

Maximum Window Area

| Window U = | 0.3 | 0.4 | 0.5 | 0.6 |
|---|---|---|---|---|

Opaque Wall U = .06

| | | | | |
|---|---|---|---|---|
| SC 0.8 | 23% | 22% | 20% | 18% |
| SC 0.6 | 30% | 27% | 24% | 21% |
| SC 0.4 | 40% | 33% | 29% | 25% |

Opaque Wall U = .07

| | | | | |
|---|---|---|---|---|
| SC 0.8 | 23% | 21% | 19% | 18% |
| SC 0.6 | 29% | 25% | 23% | 20% |
| SC 0.4 | 38% | 32% | 27% | 23% |

Opaque Wall U = .08

| | | | | |
|---|---|---|---|---|
| SC 0.8 | 22% | 20% | 18% | 16% |
| SC 0.6 | 28% | 24% | 21% | 19% |
| SC 0.4 | 37% | 31% | 26% | 22% |

Opaque Wall U = .09

| | | | | |
|---|---|---|---|---|
| SC 0.8 | 21% | 19% | 17% | 16% |
| SC 0.6 | 27% | 23% | 20% | 18% |
| SC 0.4 | 35% | 29% | 24% | 21% |

Subp. 3. **Performance criteria.** The envelope criteria for buildings located anywhere in Minnesota may be determined by the Envelope System Performance Compliance Calculation program.

## BUILDING MECHANICAL SYSTEMS

### 7670.0610 BUILDING MECHANICAL SYSTEMS.

Subpart 1. **General.**

A. Scope. Building mechanical systems must be designed and constructed in accordance with this part.



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Standards and definitions for building mechanical systems (including, but not limited to, service systems, sequence, system, thermostat, terminal element, and zone) are located in Code of Federal Regulations, title 10, parts 430 and 435, Energy Conservation Standards for Consumer Products, and Energy Conservation Voluntary Performance Standards for new buildings.

B. Exception. Special applications, including, but not limited to, hospitals, laboratories, thermally sensitive equipment rooms, computer rooms, and facilities with open refrigerated display cases may be exempted from certain requirements of this part when approved by the building official.

Subp. 2. **Heated commercial parking garages.** 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.

Subp. 3. **Calculation procedures.**

A. Design loads. Heating and cooling system design loads for the purpose of sizing systems and equipment must be determined in accordance with the procedures described in ASHRAE, 1993 Handbook of Fundamentals, chapters 25 and 26.

B. 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.

C. 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 item B.

Subp. 4. **System and equipment sizing.**

A. Standard. 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 subpart 3.

B. Exceptions.

(1) 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.

(2) 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.

(3) 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.

(4) 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.

(5) 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 part. Capacity for the other function must be, within available equipment options, the smallest size necessary to meet the load.

Subp. 5. **Simultaneous heating and cooling.**

A. General. Use of simultaneous heating and cooling by reheating or recooling supply air or by concurrent operation of independent heating and cooling systems serving a common zone must be restricted according to items B to D.

B. Recovered energy. Recovered energy in excess of the new energy expended in the recovery process may be used for control of temperature and humidity.

C. New energy for humidity control. New energy may be used to prevent relative humidity from rising above 60



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percent for comfort control or to prevent condensation on terminal units or outlets, or functioning of special equipment.

D. New energy for temperature control. New energy may be used for temperature control if minimized in accordance with subitems (1) to (5).

(1) Reheat systems. Systems employing reheat and serving multiple zones, other than those employing variable air volume for temperature control, must be provided with control that will automatically reset the system cold-air supply to the highest temperature level that will satisfy the zone requiring the coolest air. Single-zone reheat systems must be controlled to sequence reheat and cooling.

(2) Dual duct and multizone systems. These systems, other than those employing variable air volume for temperature control, must be provided with control that will automatically reset:

(a) the cold-deck air supply to the highest temperature that will satisfy the zone requiring the coolest air; and

(b) the hot-deck air supply to the lowest temperature that will satisfy the zone requiring the warmest air.

(3) Recooling systems. Systems in which heated air is recooled, directly or indirectly, to maintain space temperature must be provided with control that will automatically reset the temperature to which the supply air is heated to the lowest level that will satisfy the zone requiring the warmest air.

(4) Multiple zones. For systems with multiple zones, one or more zones may be chosen to represent a number of zones with similar heating/cooling characteristics. A multiple zone system that employs reheating or recooling for control of not more than 5,000 cfm, or 20 percent of the total supply air of the system, whichever is less, must be exempt from the supply-air-temperature reset requirement of subitems (1) to (3).

(5) Concurrent operation. Concurrent operation of independent heating and cooling systems serving common spaces

and requiring the use of new energy for heating or cooling must be minimized by:

(a) providing sequential temperature control of both heating and cooling capacity in each zone; or

(b) limiting the heat energy input through automatic reset control of the heating medium temperature, or energy input rate, to only that necessary to offset heat loss due to transmission and infiltration and, where applicable, to heat the ventilation air supply to the space.

Subp. 6. **Heat-operated water chiller packages.** Double-effect, heat-operated water chilling packages must be used in lieu of single-effect equipment.

EXCEPTION: Single-effect equipment may be used when the energy input is from low temperature waste-heat or renewable energy sources.

Subp. 7. **Heat pumps.**

A. Heat pumps must be provided with a control to prevent supplementary heater operation when the operating load can be met by the heat pump alone.

B. Supplementary heater operation is permitted during transient periods, such as start-ups, following room thermostat set-point advance, and during defrost. A two-stage thermostat, which controls the supplementary heat on its second stage, must be accepted as meeting this requirement. The cut-on temperature for the compression heating must be higher than the cut-on temperature for the supplementary heat, and the cut-off temperature for the compression heating must be higher than the cut-off temperature for the supplementary heat.

Subp. 8. **Mechanical ventilation.**

A. Requirement. Both supply and exhaust ducts of mechanical ventilation systems must be equipped with a means for shutoff or volume reduction and shutoff when ventilation is not required. Automatic or gravity dampers that close when the system is not operating must be provided for outdoor air intakes and exhausts. Automatic or manual dampers installed for the purpose of shutting off ventilation systems must be designed

with tight shutoff characteristics to minimize air leakage.

B. EXCEPTIONS:

(1) Manual dampers for outdoor air intakes may be used in the following cases:

(a) for single-family and multifamily residential buildings; and

(b) if the fan system capacity is less than 2,500 cfm.

(2) Dampers are not required when the ventilation system is designed for continuous operation.

Subp. 9. **Transport energy.** The power required by motors of constant air volume fan systems must not exceed 0.8 W/cfm of supply air at design conditions.

The power required by motors of variable air volume fan systems must not exceed 1.25 W/cfm of supply air at design conditions.

Subp. 10. **Piping system design criteria.** Piping systems must be designed at a friction pressure loss rate of no more than 4.0 feet of water per 100 equivalent feet of pipe where a "C-factor" of 125 is used.

Subp. 11. **Variable flow pumping.** Pumping systems serving control valves designed to modulate or step open and closed as a function of load must be designed for variable fluid flow. The system must be capable of reducing system flow to 50 percent of design flow or less.

EXCEPTIONS: Pumping loops where a minimum flow greater than 50 percent of the design flow is required for the proper operation of equipment served by the system, such as chiller loops and systems that serve no more than one control valve.

Subp. 12. **Balancing.** Means must be provided to balance air and water systems in accordance with this part.

A. Air system balancing. Air systems must be balanced. Fan speed must be adjusted to meet design air system flow.

EXCEPTION: Speed adjustment is not required for air system balancing with fan motors of 1 hp or less.



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B. Hydronic system balancing. Hydronic systems must be balanced. Pump impellers must be trimmed or pump speed must be adjusted to meet design system flow.

EXCEPTION: Impeller trimming or speed adjustment is not required for hydronic system balancing with pump motors of 5 hp or less.

C. Systems balancing reports. Systems balancing reports must be submitted to the building official upon request.

Subp. 13. **Economizer cycle.**

A. Requirement. Each fan system must be designed to use up to and including 100 percent of the fan system capacity for cooling with outdoor air automatically whenever its use will result in lower usage of new energy. Activation of the economizer cycle must be controlled by sensing outdoor air enthalpy or outdoor air dry-bulb temperature alone or alternate means approved by the building official.

B. EXCEPTIONS: Cooling with outdoor air is not required if:

(1) the fan capacity is less than 5,000 cfm or total cooling capacity is less than 134,000 Btu per hour;

(2) the quality of the outdoor air is so poor as to required extensive treatment of the air and approval by the building official;

(3) the need for humidification or dehumidification requires the use of more energy than is conserved by the outdoor air cooling on an annual basis;

(4) the use of outdoor air cooling may affect the operation of other systems so as to increase the overall energy consumption of the building;

(5) energy recovered from an internal/external zone heat recovery system exceeds the energy conserved by outdoor air cooling on an annual basis;

(6) all space cooling is accomplished by a circulating liquid which transfers space heat directly or indirectly to a heat rejection device such as a cooling tower without the use of a refrigeration system;

(7) the use of 100 percent outside air will cause coil frosting, controls may be added to reduce the quantity of outside air; however, the intent of this exception is to use 100 percent air in lieu of mechanical cooling when less energy usage will result and this exception applies only to direct expansion systems when the compressors are running;

(8) the fan system will regularly be operated for less than 30 hours per week;

(9) the total design sensible cooling load is less than 6.8 Btu/h/ft$^2$ of floor area; or

(10) the building is a single-family or multifamily residential building.

Subp. 14. **Controls.**

A. Temperature control. Each system must be provided with at least one adjustable thermostat for the regulation of temperature. Each thermostat must be capable of being set by adjustment or selection of sensors as follows:

(1) when used to control heating only, it must be capable of being set from 55 to 75 degrees Fahrenheit;

(2) when used to control cooling only, it must be capable of being set from 70 to 85 degrees Fahrenheit;

(3) when used to control both heating and cooling, it must be capable of being set from 55 to 85 degrees Fahrenheit and must be capable of operating the system heating and cooling in sequence. The thermostat or control system must have an adjustable deadband of up to ten degrees Fahrenheit or more except as allowed by subpart 5, item D, subitem (5), unit (b).

B. Humidity control.

(1) A humidistat must be provided if a system is equipped with a means for adding moisture to maintain specific selected relative humidities in spaces or zones.

(2) A humidistat must be provided to control ventilating systems serving pool and spa areas.

(3) Humidistats must be capable of being set to prevent new energy from being used to produce space-relative

humidity above 30 percent. When a humidistat is used in a system for controlling moisture removal to maintain specific selected relative humidities in spaces or zones, it must be capable of being set to prevent new energy from being used to produce a space-relative humidity less than 60 percent.

EXCEPTION: Special occupancies requiring different relative humidities may be permitted by the building official.

C. Zoning for temperature control.

(1) One- and two-family dwellings. At least one thermostat for regulation of space temperature must be provided for each separate system. In addition, a readily accessible manual or automatic means must be provided to partially restrict or shut off the heating or cooling input to each zone or floor.

(2) Multifamily dwellings. For multifamily dwellings, each individual dwelling unit must have at least one thermostat for regulation of space temperature. A readily accessible manual or automatic means must be provided to partially restrict or shut off the heating or cooling input to each room. Spaces other than living units must meet the requirements of subitem (3).

(3) Other types of buildings or occupancies. At least one thermostat for regulation of space temperature must be provided for:

(a) each separate system; or

(b) each separate zone as defined in part 7670.0325. As a minimum, each floor of a building must be considered as a separate zone. In a multistory building where the perimeter system offsets only the transmission losses of the exterior wall, an entire side of uniform exposure may be zoned separately. A readily accessible manual or automatic means must be provided to partially restrict or shut off the heating or cooling input to each floor.

(4) Control setback and shutoff.

(a) Residential occupancy groups. One- and two-family and multifamily dwellings: the thermostat required in subitems (1) and (2) or an alternate means, including, but

not limited to, a switch or a clock, must provide a readily accessible manual or automatic means for reducing the energy required for heating and cooling during periods of nonuse or reduced need including, but not limited to, unoccupied periods and sleeping hours. Lowering thermostat set points to reduce energy consumption of heating systems must not cause energy to be expended to reach the reduced setting.

(b) Other buildings and occupancies. Each system must be equipped with automatic controls capable of shutting off or reducing the energy used during periods of nonuse or alternate uses of the building spaces or zone served by the system.

EXCEPTIONS:

i. systems serving areas expected to operate continuously;

ii. where it can be shown that setback or shutdown will not result in a decrease in overall building energy costs; and

iii. equipment with full load demands of 2 kW (6826 Btu/h) or less may be controlled by readily accessible manual off-hour controls.

D. Variable air volume (VAV) fan controls. VAV fans with motors 75 hp and larger must provide controls for the fan motor to demand no more than 50 percent of design wattage at 50 percent of design air volume, based on manufacturer's test data.

E. Isolation of zones. Systems that serve zones which can be expected to operate nonsimultaneously for more than 750 hours per year shall include isolation devices and controls to shut off or set back the supply of heating and cooling to each zone independently. Zones may be grouped into a single isolation area provided that the total conditioned floor area does not exceed 25,000 $ft^2$ per group nor include more than one floor.

EXCEPTION: Isolation is not required for zones expected to operate continuously or expected to be inoperative only when all other zones are inoperative.



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F. HVAC control system testing. HVAC control systems must be tested to assure that control elements are calibrated, adjusted, and in proper working condition.

Subp. 15. **Duct insulation.** Ducts must be insulated in accordance with this subpart.

Minimum Required Duct Insulation

(see table notes for letter interpretations)

| Duct Location | Cooling only or heating and cooling | Heating only |
|---|---|---|
| Exterior of building, attics, garages, and ventilated crawl spaces | C, V, and W | C and W |
| Inside of building and in unconditioned spaces[1] TD less than ~~25°F~~ or equal to 15°F | None required | None required |
| TD greater than ~~25°F~~ 15°F and less than or equal to 40°F | A and V | A |
| TD greater than 40°F | B and V | B |
| Within conditioned space or in basements with insulated walls | None required | None required |
| Intake and exhaust ducts[2] | A and V | A |
| Within cement slab or within ground | B | B |

NOTES:

[1]Duct insulation is not required at the following locations:

(a) ceilings which form plenums; and

(b) for that portion of the duct which is located within a wall or a floor-ceiling space with conditioned space on both sides.

[2]Exhaust ducts within a heated space must be insulated for a distance of three feet from the duct outlet.

A = A material with installed minimum thermal resistance of R-3.3. Examples:

1.5-inch, 0.60 lb/cu ft mineral fiber, slag, or fiberglass blankets;

one-inch, 1.5 to 3.0 lb/cu ft mineral fiber blanket duct liner;

one-inch, 3.0 to 10.0 lb/cu ft mineral fiber board.

B = A material with installed minimum thermal resistance of R-5.0. Insulation encased in cement or within ground must be



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approved for that application and be installed on the bottom and sides of plenums. Examples:

2.5-inch, 0.60 lb/cu ft mineral fiber, slag, or fiberglass blankets;

1.5-inch, 1.5 to 3.0 lb/cu ft mineral fiber blanket duct liner;

1.5-inch, 3.0 to 10.0 lb/cu ft mineral fiber board;

one-inch, 1.35 lb/cu ft extruded polystyrene board.

C = A material with installed minimum thermal resistance of R-8.0. Examples:

four-inch, 0.60 lb/cu ft mineral fiber, slag, or fiberglass blankets;

two-inch, 1.5 to 3.0 lb/cu ft mineral fiber blanket duct liner;

two-inch, three to ten lb/cu ft mineral fiber board.

The example of materials listed under each type is not meant to limit other available thickness or density combinations with the equivalent installed resistance based on the insulation only.

V = Vapor retarder with all joints sealed.

W = Approved weatherproof barrier.

TD = the design temperature differential between the air in the duct and the ambient temperature outside of the duct.

Subp. 16. **Duct construction.** Ductwork must be constructed and erected in accordance with chapter 1346, Uniform Mechanical Code, adopted by the Department of Administration.

Ducts must be sealed in accordance with this subpart. Pressure sensitive tape must not be used as the primary sealant for ducts designed to operate at static pressure of 1 in. water gauge or greater. In accordance with the Uniform Mechanical Code, section 706(e), adopted by chapter 1346, return air ducts conducting air into a furnace through the same space as the furnace must be continuously airtight.

Minimum Required Sealing

| Location | Design Static Pressure | Sealing Required |
|---|---|---|
| All locations | Greater than three inches water gauge | Joints, seams, and all duct wall penetrations must be sealed. Ductwork must be ~~no~~ equal to or less than leakage Class 6 as defined in section 4 |



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| | | |
|---|---|---|
| | | of the HVAC Duct Leakage Test Manual.* |
| Outside conditioned space | 3.0 inches water gauge and less | All transverse joints and longitudinal seams must be sealed. |
| All locations <u>except ducts within return, relief, and exhaust plenums</u> | 3.0 to <u>greater than</u> 0.25 inches water gauge ~~inclusive~~ | All transverse joints must be sealed. |
| <u>Ducts within return, relief, and exhaust plenums</u> | <u>3.0 to 0.25 inches water gauge inclusive</u> | <u>All transverse joints must be sealed.</u> |

*Leakage testing may be limited to representative sections of the duct system, but in no case shall such tested sections include less than 25 percent of the total installed duct area for the design pressure class.

Subp. 17. **Pipe insulation.**

A. Piping installed to service buildings and within buildings must be thermally insulated in accordance with this subpart. For service water-heating systems, see part 7670.0710.

EXCEPTIONS: Piping insulation is not required if:

(1) piping is installed within HVAC equipment;

(2) piping is at fluid temperatures between 55 and 120°F when not required for energy conservation purposes;

(3) the heat loss or heat gain of the piping without insulation does not increase the energy requirement of the building; and

(4) piping is installed in basements, cellars, or unventilated crawl spaces having insulated walls in one- and two-family dwellings.

B. Other insulation thicknesses. Insulation thicknesses in the minimum HVAC System Pipe Insulation table are based on insulation having thermal resistivity in the range of 4.0 to 4.6 h $ft^2$ °F/Btu per inch of thickness on a flat surface at a mean temperature of 75°F.

Minimum insulation thickness must be increased for materials having values less than 4.0, or may be reduced for materials having values greater than 4.6 as follows:

For materials with thermal resistivity greater than 4.6,



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the minimum insulation thickness may be reduced as follows: New Minimum Thickness = [4.6 x Thickness from Table] ÷ Actual thermal resistance.

For materials with thermal resistivity less than 4.0, the minimum insulation thickness must be increased as follows: New Minimum Thickness = [4.0 x Thickness from Table] ÷ Actual thermal resistance.

C. Table of minimum HVAC system pipe insulation.

INSULATION THICKNESS FOR PIPE SIZES[1](INCHES)

| PIPING SYSTEM TYPES | FLUID TEMPERATURE RANGE °F | Run-outs[2] | 1" and Less | 1-1/4" to 2" | 2-1/2" to 4" | 5" to 6" | 8" and larger |
|---|---|---|---|---|---|---|---|
| HEATING SYSTEMS (STEAM CONDENSATE AND HOT WATER) | | | | | | | |
| | Above 350 | 1.5 | 2.5 | 2.5 | 3.0 | 3.5 | 3.5 |
| | 251-350 | 1.5 | 2.0 | 2.5 | 2.5 | 3.5 | 3.5 |
| | 201-250 | 1.0 | 1.5 | 1.5 | 2.0 | 2.0 | 3.5 |
| | 141-200 | 0.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| | 105-140 | 0.5 | 1.0 | 1.0 | 1.0 | 1.5 | 1.5 |
| COOLING SYSTEMS | | | | | | | |
| Chilled water | 40-55 | 1/2 | 1/2 | 3/4 | 1 | 1 | 1 |
| Refrig-erant or Brine | Below 40 | 1 | 1 | 1-1/2 | 1-1/2 | 1-1/2 | 1-1/2 |

[1]For piping exposed to outdoor air, increase thickness by one-half inch.

[2]Runouts two inches and less not exceeding 12 feet in length to individual terminal units.

C. Fluids 32°F and below. For applications with fluid temperatures of 32°F and below, the designer shall consider additional insulation with vapor retarder to prevent condensation.

Subp. 18. **Operation and maintenance manual.** An operation and maintenance manual must be provided. The manual must include basic data relating to the operation and maintenance of HVAC systems and equipment. Required routine maintenance actions must be clearly identified. Where applicable, HVAC controls information such as diagrams, schematics, control sequence descriptions, and maintenance and calibration information must be included.



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7670.0660 EQUIPMENT EFFICIENCY.

Subpart 1. **HVAC equipment performance requirements.** HVAC equipment must meet minimum efficiency requirements specified in this part.

Standards and definitions for HVAC equipment (including, but not limited to, coefficient of performance; package terminal air conditioner; package terminal heat pump; room air conditioner; unitary cooling and heating equipment; unitary heat pump; water-chilling package of absorption; water-chilling package, centrifugal or rotary; and water-chilling package, reciprocating) are located in Code of Federal Regulations, title 10, parts 430 and 435, Energy Conservation Standards for Consumer Products, and Energy Conservation Voluntary Performance Standards for new buildings.

Subp. 2. **Electrically operated, air-cooled equipment.** Unitary air conditioners and heat pumps air-cooled, electrically operated must meet the requirements of this subpart.

| EQUIPMENT CATEGORY | EQUIPMENT SIZES & MODE | RATING CONDITION | EFFICIENCY |
|---|---|---|---|
| One Phase Single Package | <65,000 Btu/h Cooling Capacity Cooling Mode | Seasonal Rating | 9.7 SEER |
| Split System | | | 10.0 SEER |
| Three Phase Split System & Single Package | <65,000 Btu/h Cooling Capacity Cooling Mode | Standard Rating (95°F db) | 9.5 EER |
| | | Integrated Part Load Value (80°F db) | 8.5 IPLV* |
| All Phase Split System & Single Package | ≥65,000<135,000 Btu/h Cooling Mode | Standard Rating (95°F db) | 8.9 EER |
| | | Integrated Part Load Value (80°F db) | 8.3 IPLV* |
| One Phase Split System | <65,000 Btu/h Cooling Capacity Heating Mode | Seasonal Rating | 6.8 HSPF** |
| Single Package | | | 6.6 HSPF** |
| Three Phase Split System & Single Package | <65,000 Btu/h Cooling Capacity Heating Mode | High Temperature Rating (47°F db/ 43°F wb) | 3.0 COP |
| | | Low Temperature Rating (17°F db/ 15°F wb) | 2.0 COP |
| All Phases | ≥65,000<135,000 | High Temperature | |



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| | | | |
|---|---|---|---|
| Split System & Single Package | Btu/h Cooling Capacity Heating Mode | Rating (47°F db/ 43°F wb) | 3.0 COP |
| | | Low Temperature Rating (17°F db/ 15°F wb) | 2.0 COP |

*IPLV - Integrated Part Load Value.

**HSPF - Heating Seasonal Performance Factor.

Subp. 3. **Electrically operated, evaporatively cooled equipment.** Unitary air conditioners and heat pumps evaporatively cooled, electrically operated must meet the requirements of this subpart.

| EQUIPMENT CATEGORY | EQUIPMENT SIZES & MODE | RATING CONDITION | EFFICIENCY |
|---|---|---|---|
| All Equipment | <65,000 Btu/h Cooling Capacity | Indoor Temperature (80°F db/67°F wb) Outdoor Temperature (95°F db/75°F wb) | 9.3 EER |
| | | Integrated Part Load Value (80°F db/67°F wb) | 8.5 IPLV |
| | ≥65,000<135,000 Btu/h Cooling Capacity | Indoor Temperature (80°F db/67°F wb) Outdoor Temperature (95°F db/75°F wb) | 10.5 EER |
| | | Integrated Part Load Value (80°F db/67°F wb) | 9.7 IPLV |

Subp. 4. **Water-cooled equipment.** Water-cooled air conditioners and heat pumps must meet the requirements of this subpart. Minnesota Statutes, section 103G.001, subdivision 13a, prohibits once-through systems.

| EQUIPMENT CATEGORY | EQUIPMENT SIZES | RATING CONDITION | EFFICIENCY |
|---|---|---|---|
| Water-Source Heat Pumps | <65,000 Btu/h Cooling Capacity | Standard Rating Indoor Air (80°F db/67°F wb) and Entering Water (85°F) | 9.3 EER |
| | | Low Temperature Rating Indoor Air (80°F db/67°F wb) and Entering Water (75°F) | 10.2 EER |
| | ≥65,000<135,000 Btu/h Cooling Capacity | Standard Rating Indoor Air (80°F db/67°F wb) and Entering Water (85°F) | 10.5 EER |
| Groundwater-Cooled Heat | <135,000 Btu/h Cooling Capacity | Standard Rating Entering Water | 11.0 EER |



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| | | | |
|---|---|---|---|
| Pumps | | (70°F) | |
| | | Low Temperature Rating Entering Water (50°F) | 11.5 EER |
| Water-Cooled Unitary Air Conditioners | <65,000 Btu/h Cooling Capacity | Standard Rating Indoor Air (80°F db/67°F wb) and Entering Water (85°F) | 9.3 EER |
| | | Integrated Part Load Value Entering Water (75°F) | 8.3 IPLV |
| | ≥65,000<135,000 Btu/h Cooling Capacity | Standard Rating Indoor Air (80°F db/67°F wb) and Entering Water (85°F) | 10.5 EER |

Subp. 5. **Packaged terminal equipment.** Packaged terminal air conditioners and heat pumps air-cooled, electrically operated must meet the requirements of this subpart.

| EQUIPMENT CATEGORY | EQUIPMENT SIZES & MODE | RATING CONDITION | EFFICIENCY |
|---|---|---|---|
| PTAC & PTAC H.P.'s | All Capacities Cooling Mode | Standard Rating (95°F db) | 10.0 - (.16 x Cap. 1,000) EER |
| | | Low Temperature Rating (82°F db) | 12.2 - (.20 x Cap. 1,000) EER |
| PTAC H.P.'s | All Capacities Heating Mode | Standard Rating (47°F db/43°F wb) | 2.9 - (.026 x Cap. 1,000) COP |

Where: "Cap." is the rated cooling capacity in Btu/h.

Subp. 6. **Room equipment.** Room air conditioners and room air conditioner heat pumps must meet the requirements of this subpart.

| EQUIPMENT CATEGORY | EQUIPMENT SIZES & MODE | EFFICIENCY |
|---|---|---|
| Without Reverse Cycle and with Louvered Sides | <6,000 Btu/h | 8.0 EER |
| | ≥6,000<8,000 Btu/h | 8.5 EER |
| | ≥8,000<14,000 Btu/h | 9.0 EER |
| | ≥14,000<20,000 | 8.8 EER |
| | ≥20,000 Btu/h | 8.2 EER |
| Without Reverse Cycle and without Louvered Sides | <6,000 Btu/h | 8.0 EER |
| | ≥6,000<20,000 Btu/h | 8.5 EER |
| | ≥20,000 Btu/h | 8.2 EER |



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| | |
|---|---|
| With Reverse Cycle and With Louvered Sides - All Capacities | 8.5 EER |
| With Reverse Cycle and Without Louvered Sides - All Capacities | 8.0 EER |

Subp. 7. **Water-source equipment.** Water-source and groundwater source heat pumps electrically operated must meet the requirements of this subpart. Minnesota Statutes, section 103G.001, subdivision 13a, prohibits once-through systems.

| EQUIPMENT CATEGORY | EQUIPMENT SIZES | RATING CONDITION | EFFICIENCY |
|---|---|---|---|
| Water-Source Heat Pumps | <135,000 Btu/h | Standard Rating Entering Water (70°F) | 3.8 COP |
| Groundwater-Source Heat Pumps | <135,000 Btu/h | High Temperature Rating Entering Water (70°F) | 3.4 COP |
| | | Low Temperature Rating Entering Water (50°F) | 3.0 COP |

Subp. 8. **Large unitary equipment.** Large unitary air conditioners and heat pumps electrically operated must meet the requirements of this subpart.

| EQUIPMENT CATEGORY | EQUIPMENT SIZES | RATING CONDITION | EFFICIENCY |
|---|---|---|---|
| Air Conditioners Air-Cooled | >135,000 Btu/h | | 8.5 EER |
| | <760,000 Btu/h | | 7.5 IPLV |
| | >760,000 Btu/h | | 8.2 EER |
| | | | 7.5 IPLV |
| Air Conditioners Water/Evap.-Cooled | >135,000 Btu/h | | 9.6 EER |
| | | | 9.0 IPLV |
| Heat Pumps Air-Cooled Cooling | >135,000 Btu/h | | 8.5 EER |
| | <760,000 Btu/h | | 7.5 IPLV |
| | ≥760,000 Btu/h | | 8.7 EER |
| | | | 7.5 IPLV |
| Heat Pumps Air-Cooled Heating | ≥135,000 Btu/h | Entering Air (47°F) | 2.9 COP |
| | | Entering Air (17°F) | 2.0 COP |
| Condensing Units Air-Cooled | ≥135,000 Btu/h | | 9.9 EER |
| | | | 11.0 IPLV |
| Condensing Units Water/Evap.-Cooled | ≥135,000 Btu/h | | 12.9 EER |
| | | | 12.9 IPLV |

Subp. 9. **Gas-fired and oil-fired equipment.** Gas-fired and oil-fired boilers, furnaces, and unit heaters and combination furnace/air conditioner units must meet the requirements of this subpart.



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| EQUIPMENT CATEGORY | EQUIPMENT SIZES | RATING CONDITION | EFFICIENCY |
|---|---|---|---|
| Gas-Fired Boilers | <300,000 Btu/h | Seasonal Rating | 80% AFUE |
| | ≥300,000 | Both Maximum and Minimum Rated Capacity | 80% Ec* |
| Gas-Fired Furnaces | <225,000 Btu/h | Seasonal Rating | 78% AFUE |
| | ≥225,000 Btu/h | Maximum Rated Capacity | 80% Et** |
| | | Minimum Rated Capacity | 78% Et |
| Gas-Fired Duct Furnaces | All Sizes | Minimum Rated Capacity | 78% Et |
| | | Minimum Rated Capacity | 75% Et |
| Gas-Fired Unit Heaters | All Sizes | Maximum Rated Capacity | 78% Et |
| | | Minimum Rated Capacity | 74% Et |
| Oil-Fired Furnaces | <225,000 Btu/h | Seasonal Rating | 78% AFUE |
| | >225,000 Btu/h | Both Maximum and Minimum Rated Capacity | 81% Et** |
| Oil-Fired Boilers | <300,000 Btu/h | Seasonal Rating | 80% AFUE |
| | >300,000 Btu/h | Both Maximum and Minimum Rated Capacity | 83% Ec* |
| Oil-Fired Boilers (Residual) | >300,000 Btu/h | Both Maximum and Minimum Rated Capacity | 83% Ec |
| Oil-Fired Unit Heaters | All Sizes | Both Maximum and Minimum Rated Capacity | 81% Et |

*Ec = Combustion Efficiency

**Et = Thermal Efficiency

Subp. 10. **Mobile home equipment.** Mobile home furnaces, steam boilers, and direct heating equipment must meet the requirements of this subpart.

| EQUIPMENT CATEGORY | EQUIPMENT SIZES | EFFICIENCY AFUE |
|---|---|---|
| Mobile Home Furnaces | | 75 |
| Gas Steam Boilers | | 75 |
| Gas Fueled Direct Heating Equipment | | |
| Vented Wall Furnaces | <42,000 Btu/h | 73 |
| Fan Type | ≥42,000 Btu/h | 74 |
| Vented Wall | <10,000 Btu/h | 59 |



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| | | |
|---|---|---|
| Furnaces | ≥10,000<12,000 Btu/h | 60 |
| Gravity Type | ≥12,000<15,000 Btu/h | 61 |
| | ≥15,000<19,000 Btu/h | 62 |
| | ≥19,000<27,000 Btu/h | 63 |
| | ≥27,000<46,000 Btu/h | 64 |
| | ≥46,000 Btu/h | 65 |
| Vented Floor | <37,000 Btu/h | 56 |
| Furnaces | ≥37,000 Btu/h | 57 |
| Vented | <18,000 Btu/h | 57 |
| Room | ≥18,000<20,000 | 58 |
| Heaters | ≥20,000<27,000 Btu/h | 63 |
| | ≥27,000<46,000 Btu/h | 64 |
| | ≥46,000 Btu/h | 65 |

Subp. 11. **Water chilling packages.** Water chilling packages - water- and air-cooled, electrically operated must meet requirements of this subpart.

| | CFC | NON-CFC |
|---|---|---|
| WATER-COOLED | | |
| Centrifugal | 0.63 KW/Ton | 0.73 KW/Ton |
| Helical-rotary (screw) | 0.75 KW/Ton | 0.80 KW/Ton |
| Reciprocating or scroll | 0.93 KW/Ton | |
| AIR-COOLED (any type) | | |
| ≥150 Ton | 1.41 KW/Ton | |
| <150 Ton | 1.30 KW/Ton | |

7670.0710 SERVICE WATER HEATING.

Subpart 1. **Ice-making water supply.** Water supplies to ice-making machines and residential refrigerators shall be taken from a cold-water line of the water distribution system.

Subp. 2. **Efficiency requirements.** Service water heating equipment must meet the minimum efficiency requirements in this subpart. Standards for service water heating equipment are located in Code of Federal Regulations, title 10, parts 430 and 435, Energy Conservation Standards for Consumer Products, and Energy Conservation Voluntary Performance Standards for new buildings.

Efficiency Requirements for Water Heaters Regulated by NAECA

| Fuel Type (Size) | Energy Factor |
|---|---|
| Gas (<75,000 Btuh) | 0.62 - (0.0019 x Vv) |
| Oil (<75,000 Btuh) | 0.59 - (0.0019 x Vv) |
| Electric (<12 kw) | 0.93 - (0.00132 x Vv) |

Where: Vv is the rated storage volume in gallons.

Efficiency Requirements for Water Heaters Not Regulated by NAECA

| Fuel Type | Input Rating or Volume | Input to Volume Ratio (Btuh/gal) | Efficiency | Standby Loss (%/hour) |
|---|---|---|---|---|



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| | | | | |
|---|---|---|---|---|
| Electric | >12 KW | | | 0.30 + 27 ÷ Vt |
| Gas/Oil | ≤155,000 Btuh | <4,000 | 80 percent | 1.3 + 114 ÷ Vt |
| Gas/Oil | >155,000 Btuh | <4,000 | 80 percent | 1.3 + 95 ÷ Vt |
| Gas/Oil | ≥10 gal | ≥4,000 | 80 percent | 2.3 + 67 ÷ Vt |
| Gas/Oil | <10 gal | ≥4,000 | 80 percent | |
| Unfired storage | All | | | <6.5 |
| Instantaneous | | | | |
| Gas | All | | 80 percent Et | |
| Oil | All | | 83 percent Ec | |
| Pool Heater | All | | 78 percent Et | |

Where:

Vt = the measured storage volume in gallons.

Et = thermal efficiency.

Ec = combustion efficiency.

Subp. 3. **Automatic controls.** Service water-heating systems must be equipped with automatic temperature controls capable of adjustment from the lowest to the highest acceptable temperature settings for the intended use. Temperature setting range must be in accordance with this subpart.

Representative Hot Water Utilization Temperatures

| Use | Temperature °F | (°C) |
|---|---|---|
| Lavatory | | |
| Hand washing | 105 | (40.6) |
| Shaving | 115 | (46.1) |
| Showers and tubs | 110 | (43.3) |
| Therapeutic baths | 95 | (35.0) |
| Commercial and institutional dishwashing | | |
| Wash | 140 | (60.0) |
| Sanitizing rinse | 180 | (82.2) |
| Commercial and institutional laundry | 180 | (82.2) |
| Residential dishwashing and laundry | 140 | (60.0) |
| Surgical scrubbing | 110 | (43.3) |

Subp. 4. **Shutdown.** A separate switch must be provided to permit turning off the energy supplied to electric service water-heating systems. A separate valve must be provided to permit turning off the energy supplied to the main burners of all other types of service water-heating systems.

Subp. 5. **Swimming pools and spas.**

A. Control. All pool and spa heaters must be equipped with a readily accessible ON/OFF switch to allow shutting off the operation of the heater without adjusting the thermostat setting and to allow restarting without relighting the pilot light.

B. HVAC systems serving all indoor pool and spa areas



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must conform to part 7670.0610, subpart 14, item B. Additionally, heated indoor swimming pools and spas must provide for energy conservation by one of the following methods:

(1) the pool or spa must be equipped with a cover;

(2) the ventilating system serving the pool and spa area must provide a heat recovery of 70 percent as calculated by ASHRAE Standard 84-1991 at winter design conditions; or

(3) renewable energy sources must be capable of providing at least 50 percent of the heating energy required over an operating season.

C. Heated outdoor swimming pools and spas must either be provided with a cover, or the heating system must use renewable energy sources to provide at least 70 percent of the heating energy required over an operating season.

Subp. 6. **Pump operation.** Circulating hot-water systems must be equipped with automatic time switches or other controls so that the circulation pumps can be conveniently turned off when the use of hot water is not required.

Subp. 7. **Pipe insulation.**

A. Service Water Heating Minimum Pipe Insulation. Domestic and service water heating systems with design temperature of 105°F and greater must comply with this subpart.

EXCEPTION: Piping insulation is not required when the heat loss of the pipeline, without insulation, does not increase the annual energy requirements of the building.

Minimum insulation thickness for normal iron pipe sizes

| Application | Insulation thickness |
|---|---|
| Noncirculating and runouts up to 2 inches | 1/2 inch |
| Circulating up to 2 inches | one inch |
| Circulating and runouts over 2 inches | 1-1/2 inches |

Assumed insulation conductivity(k)=0.27

B. Recirculating systems. For recirculating systems, the minimum pipe insulation must be in accordance with item A.

C. Nonrecirculating systems. Either the first eight

feet of both inlet and outlet pipe from the storage tank must be insulated in accordance with item A, or heat traps must be installed on both inlet and outlet pipes with pipe insulation between the storage tank and heat traps installed in accordance with item A.

ELECTRICAL POWER AND LIGHTING

7670.0800 ELECTRICAL POWER AND LIGHTING.

Subpart 1. **Electrical energy determination.**

A. Multifamily electrical metering. In new multifamily dwellings, the electrical energy consumed by each individual dwelling unit must 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.

B. Electrical distribution monitoring. In electrical panels of buildings other than residential buildings three stories or less in height, all feeder wiring and the panel feeder must be capable of accepting a clamp-on ampmeter.

Subp. 2. **Lighting power budget.**

A. General.

(1) Purpose. This subpart contains a set of minimum requirements for all lighting, exterior lighting power requirements, and two alternative compliance procedures for building interior lighting and lighting control systems. The procedures in this subpart are solely for use in establishing lighting power budgets and are not intended for use as lighting design procedures.

(2) Scope. The following are covered by this subpart:

(a) interior spaces of buildings;

(b) building exteriors and exterior areas,

such as entrances, exits, and loading docks; and

(c) roads, grounds, parking, and other exterior areas where lighting is energized through the building electrical service.

(3) Exemptions. Except for fluorescent lamp ballasts, which must meet the requirements of item B, subitem (2), the following are exempt from the lighting power budget standards:

(a) manufacturing, processing facilities, and commercial greenhouses;

(b) lighting power for theatrical production studios and stages, television broadcasting, audio-visual presentation, and entertainment facilities in spaces such as stages, hotel ballrooms, nightclubs, discos, and casinos, and where lighting is an essential technical element for the function performed;

(c) specialized luminaires for medical and dental purposes;

(d) outdoor athletic facilities;

(e) lighting power for display lighting required for art exhibits or displays in galleries, museums, and monuments;

(f) exterior lighting for public monuments;

(g) special lighting needs for research;

(h) lighting power for lighting used solely for indoor plant growth during the hours of 10:00 p.m. to 6:00 a.m.;

(i) emergency lighting that is automatically off during normal operation;

(j) high risk security areas or any area identified by local ordinances or regulations or by security or safety personnel as requiring additional lighting;

(k) lighting power densities for spaces with enhanced lighting specifically designed for primary use by the visually impaired, hard of hearing, or for senior citizens;

(l) lighting for one- and two-family

detached dwellings and the dwelling portion of multifamily buildings;

(m) lighting for signs;

(n) storefront exterior-enclosed display windows in retail facilities; and

(o) lighting power for internally illuminated exit signs.

(4) Outdoor display lighting. Outdoor display lighting is regulated by chapter 7625.

(5) Credit for daylighting. Daylighting credit, for reduced use of electric lighting energy resulting from the use of automatic lighting control devices in conjunction with fenestration, for example, windows and skylights, may be taken in this subpart. However, if such daylighting credit is to be applied to other building subsystems, such as use of additional fenestration area, part 7670.0450 must be used.

(6) Compliance. A building must be considered in compliance with this subpart if the following conditions are met:

(a) the minimum requirements of item B are met;

(b) the exterior lighting power to be installed is not greater than the exterior lighting power allowance required in item C; and

(c) the interior connected lighting power to be installed is not greater than the interior lighting power allowance, based on either the prescriptive criteria in item D or the systems performance criteria in item E.

i. The connected lighting power includes permanently installed lighting plus supplemental or task-related lighting provided by movable or plug-in luminaires.

ii. The connected lighting power for luminaires with incandescent medium base sockets is the higher of the following two wattages: the total lamp wattage proposed for the luminaire; or 50 percent of the listed lighting power capacity of the luminaire in watts.

iii. The connected lighting power for

track lights is the higher of the following three wattages: the total lamp wattage proposed for the track; 50 percent of the total listed power capacity of the elements proposed for the track; or 45 watts per foot of track.

(7) Tradeoffs. Tradeoffs between interior lighting power allowance and exterior lighting power allowance are not allowed. Tradeoffs of the interior lighting power budgets among interior spaces are allowed as long as the total adjusted lighting power within the building does not exceed the interior lighting power allowance and lighting power control credits are used only for connected lighting power in those spaces for which credit is claimed. Tradeoffs of exterior lighting power budgets among exterior areas are allowed as long as the total connected lighting power of exterior lighting does not exceed the exterior lighting power allowance and the allowance for the building exterior surfaces is not exceeded.

(8) Multibuilding facilities. The total lighting power allowances for each building in a multibuilding facility must be calculated separately.

(9) Acronyms. The following are acronyms found in this subpart.

(a) AF = area factor;

(b) ALP = adjusted lighting power, watts;

(c) CLP = connected lighting power, watts;

(d) CLPC = connected lighting power for the luminaires controlled by the automatic control device, watts;

(e) ELPA = exterior lighting power allowance, watts;

(f) GLA = gross lighted area, square feet;

(g) GLAF = gross lighted area for each qualifying secondary function, square feet;

(h) ILPA = interior lighting power allowance, watts per square feet;

(i) LPB = lighting power budgets, watts;

(j) LPCC = lighting power control credits, watts;

(k) LSA = listed space area, square feet;

(l) PAF = power adjustment factor;

(m) ULPA = unit lighting power allowance, watts per square feet; and

(n) UPD = unit power density, watts per square feet.

B. Minimum requirements.

(1) Lighting controls.

(a) General. All lighting must be provided with manual, automatic, or programmable controls.

EXCEPTION: Controls for emergency or exit lighting.

(b) Minimum number of lighting controls. Each space enclosed by walls or ceiling-height partitions must be provided with controls that, together or alone, are capable of controlling all lights within that space, excluding those requiring continuous operation for security purposes.

(c) The minimum number of controls must not be less than one lighting control for each space and one lighting control for each task or group of task locations within an area of 450 square feet or less.

i. Equivalent number of controls. A reduction in the minimum number of controls is permitted by using an equivalent number of controls indicated in the table below. The minimum number of controls must not be less than one for each 20 ampere circuit. Control of the same load from more than one location must not be credited as additional control points.

Equivalent Number of Controls

| TYPE OF CONTROL | EQUIVALENT NUMBER OF CONTROLS |
|---|---|
| Manually operated ON/OFF switch | 1 |
| Occupancy sensor | 2 |
| Programmable timer readily accessible from the space being controlled | 2 |
| Three level, including off, step control or preset dimming | 2 |
| Four level, including off, step control or preset dimming | 3 |



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Automatic or continuous dimming 3

ii. EXCEPTION: Lighting for spaces that must be used as a whole, such as public lobbies of office buildings, hotels, and hospitals; retail and department stores; and warehouses, storerooms, and service corridors under centralized supervision is permitted to be controlled by a lesser number of controls, but not less than one control for each 20 ampere circuit of connected lighting power.

(d) Hotel and motel guest rooms must have one or more master controls at the main entry door that turn off all permanently wired lighting fixtures and lighting and television receptacles. For multiple room suites, controls at the entry of each room, in lieu of a master switch, will meet these requirements.

(e) All lighting controls must be readily accessible to personnel occupying or using the space. Exceptions are automatic controls, programmable controls, lighting for safety hazards and security, controls requiring trained operators, and those controls for spaces that must be used as a whole.

(f) Controls provided for task areas, if readily accessible, may be mounted as part of the task lighting luminaire.

(g) Exterior lighting must be automatically controlled by timer, photocell, or combination of timer and photocell. Timers must be of the automatic type capable of adjustment for seven days and for seasonal daylight schedule variations. All time-controllers must be equipped with back-up mechanisms to keep time during a four-hour power outage.

(h) When the building is served by an energy management system, programmable controls, shared tenant services that affect interior environments, or "intelligent building" systems, provisions must be made to incorporate lighting controls into the system if a separate automatically controlled lighting system is not provided.

(2) Fluorescent lamp ballasts.

(a) Fluorescent lamp ballasts must comply with Code of Federal Regulations, title 10, part 435.103, section 3.3.2, Fluorescent Lamp Ballast Standards.

EXCEPTION: Ballasts specifically designed for use with dimming controls.

(b) One-lamp or three-lamp fluorescent luminaires must be tandem wired to eliminate unnecessary use of single lamp ballasts if they are used for general lighting; recess mounted within ten feet center-to-center of each other; or pendant or surface mounted within one foot of each other, and within the same room. Tandem wiring consists of pairs of luminaires powered by a single two-lamp ballast.

EXCEPTION: Three-lamp ballasts may be used.

(c) Fluorescent lamp ballasts must have a power factor equal to or greater than 80 percent.

EXCEPTION: Ballasts for circline lamps <u>and compact fluorescent lamps</u>.

C. Exterior lighting power allowance.

(1) Scope. Building exteriors, exterior areas, roads, grounds, and parking must have a lighting power density not to exceed the exterior lighting power allowance of this item.

(2) Procedure. The exterior lighting power allowance is the sum of the allowances for each of the area descriptions below, as calculated in accordance with this item, using unit power densities from the table in this item.

$ELPA = \Sigma DO_i \times UPD_{Di} + \Sigma A_i \times UPD_{Ai}$

Where:

DO = Door opening, linear feet.

i = Numerical subscript (1,2,.....n) for each occurrence of doors or exterior areas of the building.

$UPD_D$ = UPD for the door.

A = Exterior area for each separate UPD, square feet.

$UPD_A$ = UPD for the area.

(3) Exterior lighting unit power density table.

Exterior Lighting Unit Power Density



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| AREA DESCRIPTION | UNIT POWER DENSITY |
|---|---|
| Exit (with or without canopy) | 25 W/Lin.ft. of door opening |
| Entrance (without canopy) | 30 W/Lin.ft. of door opening |
| Entrance (with canopy) | |
| High Traffic (retail, hotel, airport, theater, etc. | 10 $W/ft^2$ of canopied area |
| Light Traffic (hospital, office, school, etc.) | 4 $W/ft^2$ of canopied area |
| Loading area | 0.40 $W/ft^2$ |
| Loading door | 20 W/Lin.ft. of door opening |
| Building Exterior Surfaces/Facades | 0.25 $W/ft^2$ of surface area to be illuminated |
| Storage and nonmanufacturing work areas | 0.20 $W/ft^2$ |
| Other activity areas for casual use such as picnic grounds, gardens, parks, and other landscaped areas | 0.10 $W/ft^2$ |
| Private driveways/walkways | 0.10 $W/ft^2$ |
| Public driveways/walkways | 0.15 $W/ft^2$ |
| Private Parking lots | 0.12 $W/ft^2$ |
| Public Parking lots | 0.10 $W/ft^2$ |

D. Lighting; prescriptive procedure.

(1) Scope. This item provides a procedure for determining the interior lighting power allowance for specific types of buildings. It is intended for use with buildings having simple lighting requirements and where the minimum amount of calculation and effort to achieve compliance is of primary concern. For other building types, to receive credit for switching, daylighting, or other tradeoffs, or to receive credit for lighting optimization, use item E or part 7670.0450.

(2) Interior lighting power allowance table.

Prescriptive Unit Lighting Power Allowance, $W/ft^2$

| | GROSS LIGHTED AREA | | | | | |
|---|---|---|---|---|---|---|
| BUILDING TYPE/AREA FUNCTION | 0-2,000 $ft^2$ | 2,001-10,000 $ft^2$ | 10,001-25,000 $ft^2$ | 25,001-50,000 $ft^2$ | 50,001-250,000 $ft^2$ | >250,000 $ft^2$ |

| | | | | | | |
|---|---|---|---|---|---|---|
| Food Service | | | | | | |
| Fast Food/ Cafeteria | 0.92 | 0.85 | 0.82 | 0.81 | 0.81 | 0.80 |
| Leisure Dining/ Bar | 1.60 | 1.56 | 1.52 | 1.48 | 1.44 | 1.40 |
| Offices | 1.40 | 1.34 | 1.27 | 1.22 | 1.16 | 1.11 |
| Retail | | | | | | |
| Retail General | 2.70 | 2.52 | 2.32 | 2.05 | 1.87 | 1.72 |
| Mall Concourse Multi-store Service | 0.69 | 0.68 | 0.65 | 0.63 | 0.61 | 0.60 |
| Service Establishment | 2.81 | 2.03 | 1.78 | 1.65 | 1.54 | 1.46 |
| Garages | 0.25 | 0.24 | 0.23 | 0.22 | 0.21 | 0.20 |
| Schools | 1.77 | 1.72 | 1.60 | 1.49 | 1.36 | 1.26 |
| Warehouse/ Storage | 0.60 | 0.50 | 0.42 | 0.36 | 0.32 | 0.30 |

(3) The interior lighting power allowance may be used if the predominant function of the proposed building is one of the building types listed in this item. If not, item E or part 7670.0460 must be used. If the building has secondary functions that are ten percent or more of the gross lighted area of the building that are listed in subitem (2), then the interior lighting power allowance may be calculated using the predominant building function in subitem (4), or subitem (5) may be used.

(4) Procedure for single function buildings.

(a) Scope. This procedure may be used if the proposed building has only one function, has no secondary functions with ten percent or more of the gross lighted area, or the primary function of the building is used to determine the interior lighting power allowance.

(b) Procedure. The unit lighting power allowance is the value for the appropriate building type and the gross lighted area of the building in subitem (2). The interior



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lighting power allowance is determined by multiplying the unit lighting power allowance by the gross lighted area as follows:

$ILPA = ULPA \times GLA$

(5) Procedure for multifunction buildings.

(a) Scope. This procedure may be used if a building has more than one function listed in the prescriptive unit power density table with more than ten percent of the gross lighted area.

(b) Procedure. The gross lighted area for the area of the predominate function in the building, and the gross lighted area for each qualifying secondary function in the building must be determined. The unit lighting power allowance for the predominate functional area and each secondary functional area are indicated in the table in subitem (2). The lighting power allowance for each functional area is determined by multiplying the unit lighting power allowance of each functional area by its gross lighted area. The sum of the lighting power allowance for each functional area is the building interior lighting power allowance. This may be performed using the equation:

$ILPA = ULPA_p \times GLA_p + \Sigma(ULPA_i \times GLA_i)$

Where:

$ULPA_p$ = ULP allowance of the predominant function based on the gross lighted area of the predominant function

$GLA_p$ = GLA of the predominant function of the proposed building

$ULPA_i$ = ULPA of qualifying secondary functions based on the gross lighted area of the specific function

$GLA_i$ = GLA of each qualifying secondary function

$i$ = Numerical subscript (1,2,....n) for each secondary function with ten percent or more of the gross lighted area of the building

(6) Interior lighting power allowance in partially defined speculative buildings.

(a) Scope. The interior lighting power allowance for defined functional areas of partially defined



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speculative buildings must be determined by this subitem.

(b) Single function buildings. For single function buildings, the interior lighting power allowance must be based on the gross lighted area of the entire building.

(c) Multifunction buildings. For multifunction buildings with secondary functions with more than ten percent of the gross lighted area, the interior lighting power allowance must be based on the gross area of each secondary function.

E. Lighting; system performance procedure.

(1) Scope. This procedure for determining the maximum lighting power allowance for building interiors allows credit for the use of daylighting and other lighting controls. It also serves as a basis for estimating the lighting heat gain and lighting energy if part 7670.0460 is used.

(2) Procedure. The total adjusted lighting power in a building must not exceed the sum of the interior lighting power allowances. The adjusted lighting power is equal to the connected lighting power minus the lighting power controls credit.

(3) Compliance for lighting in partially defined speculative buildings. The total adjusted lighting power in defined areas of partially defined speculative buildings must not exceed the interior lighting power allowance for the defined areas of the building.

(4) Lighting power budget.

(a) The lighting power budget of each interior space must be determined in accordance with the following equation:

$LPB = A_{wp} \times UPD_b \times AF$

Where:

$A_{wp}$ = Area of the room at the horizontal lighted working plane

$UPD_b$ = Base UPD

(b) The base unit power density must be selected from the table in this item. For applications to areas

or activities other than those given, select values for similar areas or activities.

(c) The area factor must be determined by the equation or table in this unit based on the floor area and ceiling height of the room. Rooms with identical ceiling height and activities, and with similar size may be treated as a group. The area factor of such a group of rooms must be determined from the average area of the rooms.

The equation for area factor (AF) is as follows:

$$AF = [0.2 + 0.8\ EXP\{[10.21 \times (CH - 2.5) - 1] \times 0.1054\}]/\sqrt{A_r}$$

Where:

CH = Ceiling height, feet

$A_r$ = Floor area of room, square feet calculated from the inside dimensions of the room

If AF<1.0 then AF = 1.0

If AF>1.8 then AF = 1.8



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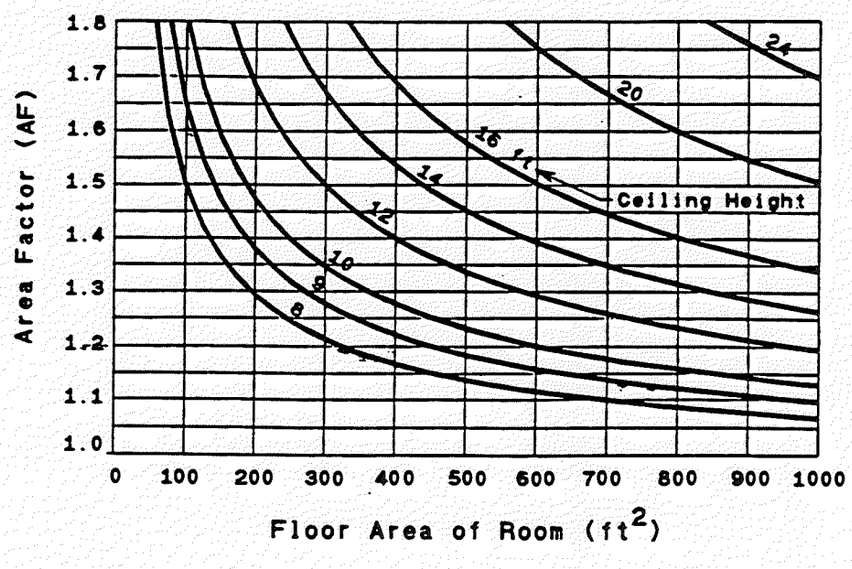
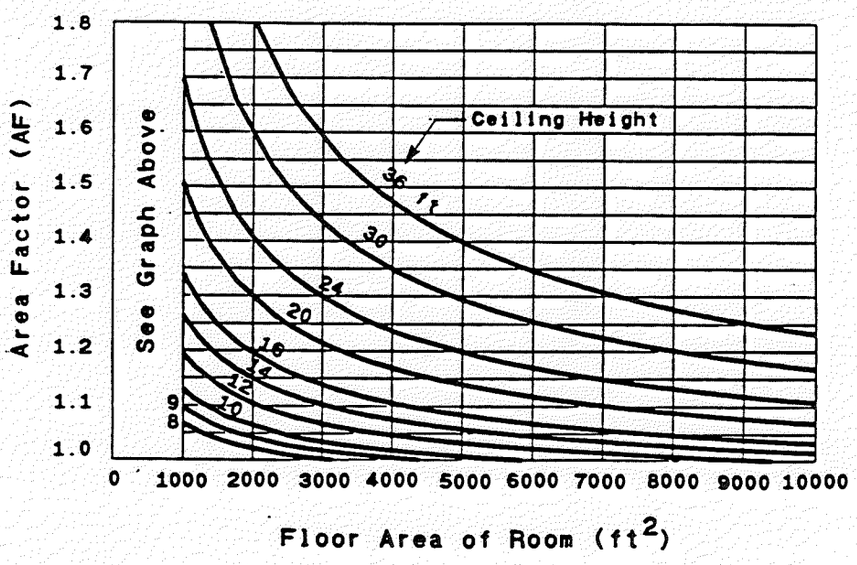
1 Area Factor



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(d) Performance procedure unit power density table.

Performance Procedure Unit Power Density

| AREA/ACTIVITY | UPD | NOTE |
|---|---|---|
| COMMON ACTIVITY AREAS | | |
| Auditorium | 1.4 | (c) |
| Corridor | 0.8 | (a) |
| Classroom/Lecture Hall | 1.7 | |
| Elec/Mech Equipment Room | | |
| General | 0.7 | (a) |
| Control Rooms | 1.5 | (a) |
| Food Service | | |
| Fast Food/Cafeteria | 0.8 | |
| Leisure Dining | 1.4 | (b) |
| Bar/Lounge | 1.3 | (b) |
| Kitchen | 1.4 | |
| Recreation/Lounge | 0.5 | |
| Stairs | | |
| Active Traffic | 0.6 | |
| Emergency Exit | 0.4 | |
| Toilet & Washroom | 0.5 | |
| Garage | | |
| Auto/Pedestrian Circulation | 0.25 | |
| Parking Area | 0.2 | |
| Laboratory | 2.2 | |
| Library | | |
| Audio Visual | 1.1 | |
| Stack Area | 1.5 | |
| Card File & Cataloging | 0.8 | |
| Reading Area | 1.0 | |
| Lobby (General) | | |
| Reception & Waiting | 0.55 | |
| Elevator Lobbies | 0.4 | |
| Atrium (multistory) | | |
| First 3 Floors | 0.4 | |
| Each Additional Floor | 0.15 | |
| Locker Room & Shower | 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. | | (f) |
| Reading, Typing, and Filing | 1.3 | (e) |
| Drafting | 2.2 | (e) |
| Accounting | 1.8 | (e) |
| Open plan offices, 900 $ft^2$ or larger, w/medium height partitions 3.5 to 4.5 ft below ceiling. | | (f) |
| Reading, Typing, and Filing | 1.5 | (a) |
| Drafting | 2.6 | (a) |
| Accounting | 2.1 | (a) |
| Open plan offices, 900 $ft^2$ or larger, | | (f) |



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| | | |
|---|---|---|
| w/partitions higher than 3.5 ft below ceiling. | | |
| Reading, Typing, and Filing | 1.7 | (a) |
| Drafting | 3.0 | (a) |
| Accounting | 2.4 | (a) |
| **Common Activity Areas** | | |
| Conferences/Meeting Room | 1.3 | (c) |
| Computer/Office Equipment | 2.1 | |
| Filing, Inactive | 1.0 | |
| Mail Room | 1.8 | |
| **Shop (Nonindustrial)** | | |
| Machinery | 2.5 | |
| Electrical/Electronic | 2.5 | |
| Painting | 1.6 | |
| Carpentry | 2.3 | |
| Welding | 1.2 | |
| **Storage & Warehouse** | | |
| Inactive Storage | 0.2 | |
| Active Storage, Bulky | 0.3 | |
| Active Storage, Fine | 0.9 | |
| Material Handling | 1.0 | |
| **Unlisted Space** | 0.2 | |
| **Airport, Bus, and Rail Station** | | |
| Baggage Area | 0.75 | |
| Concourse/Main Thruway | 0.45 | |
| Ticket Counter | 1.3 | |
| Waiting & Lounge Area | 0.6 | |
| **Bank** | | |
| Customer Area | 0.8 | |
| Banking Activity Area | 2.2 | |
| **Barber & Beauty Parlor** | 1.6 | |
| **Church, Synagogue, Chapel** | | |
| Worship/Congregational | 1.3 | |
| Preaching & Sermon/Choir | 1.8 | |
| **Dormitory** | | |
| Bedroom | 0.6 | |
| Bedroom with Study | 1.3 | |
| Study Hall | 0.9 | |
| **Fire & Police Department** | | |
| Fire Engine Room | 0.7 | |
| Jail Cell | 0.4 | |
| **Hospital/Nursing Home** | | |
| Corridor | 0.9 | (a) |
| Dental Suite/Exam/Treatment | 1.4 | |
| Emergency | 2.0 | |
| Laboratory | 1.7 | |
| Lounge/Waiting Room | 0.6 | |
| Medical Supplies | 2.4 | |
| Nursery | 1.6 | |
| Nurse Station | 1.8 | |
| Occu./Physical Therapy | 1.4 | |
| Patient Room | 0.9 | |
| Pharmacy | 1.5 | |
| Radiology | 1.8 | |
| Surgical & O.B. Suites | | |
| General Area | 1.8 | |
| Operating Room | 6.0 | |
| Recovery | 2.0 | |
| **Hotel/Conference Center** | | |



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| | | |
|---|---|---|
| Banquet Room/Multipurpose | 1.4 | (c) |
| Bathroom/Powder Room | 0.6 | |
| Guest Room | 0.7 | |
| Public Area | 0.8 | |
| Exhibition Hall | 1.3 | |
| Conference/Meeting | 1.5 | (c) |
| Lobby | 1.3 | |
| Reception Desk | 2.4 | |
| **Laundry** | | |
| Washing | 0.6 | |
| Ironing & Sorting | 1.3 | |
| **Museum & Gallery** | | |
| General Exhibition | 1.2 | |
| Inspection/Restoration | 3.0 | |
| Storage (Artifacts) | | |
| Inactive | 0.25 | |
| Active | 0.5 | |
| **Post Office** | | |
| Lobby | 0.8 | |
| Sorting & Mailing | 2.1 | |
| **Service Station/Auto Repair** | 0.8 | |
| **Theater** | | |
| Performance Arts | 1.1 | |
| Motion Picture | 0.75 | |
| Lobby | 1.0 | |
| **Retail Establishments** (Merchandising & Circulation Area) Applicable to all lighting, including accent and display lighting, installed in merchandising and circulation areas | | |
| Type A | 6.0 | (d) |
| Type B | 2.9 | (d) |
| Type C | 2.7 | (d) |
| Type D | 2.5 | (d) |
| Type E | 2.4 | (d) |
| Type F | 2.6 | (d) |
| Mall Concourse | 0.6 | |
| Retail Support Area | | |
| Tailoring | 2.1 | |
| Dressing/Fitting Room | 1.1 | |
| **Seating Area, All Sports** | 0.4 | (a) |
| **Badminton** | | |
| Club | 0.5 | (a) |
| Tournament | 0.8 | (a) |
| **Basketball/Volleyball** | | |
| Intramural | 0.8 | (a) |
| College/Professional | 1.9 | (a) |
| **Bowling** | | |
| Approach Area | 0.5 | (a) |
| Lanes | 1.1 | (a) |
| **Boxing or Wrestling (platform)** | | |
| Amateur | 2.4 | (a) |
| Professional | 4.8 | (a) |
| **Gymnasium** | | |
| General Exercising & Recreation Only | 1.0 | (a) |
| **Handball/Racquetball/Squash** | | |
| Club | 1.3 | (a) |



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| | | |
|---|---|---|
| Tournament | 2.6 | (a) |
| | | |
| Hockey, Ice | | |
| Amateur | 1.3 | (a) |
| College or Professional | 2.6 | (a) |
| | | |
| Skating Rink | | |
| Recreational | 0.6 | (a) |
| Exhibition/Professional | 2.6 | (a) |
| | | |
| Swimming | | |
| Recreational | 0.9 | (a) |
| Exhibition | 1.5 | (a) |
| Underwater | 1.0 | (a) |
| | | |
| Tennis | | |
| Recreational (Class III) | 1.3 | (a) |
| Club/College (Class II) | 1.9 | (a) |
| Professional (Class I) | 2.6 | (a) |
| | | |
| Tennis, Table | | |
| Club | 1.0 | (a) |
| Tournament | 1.6 | (a) |

NOTES:

(a) Use an area factor of 1.0 these spaces.

(b) Base UPD includes lighting power required for cleanup purpose.

(c) A 1.5 adjustment factor is applicable for multifunctional spaces.

(d) "Retail establishments" means, for the purpose of determining lighting power limit, buildings, the primary functions of which are designed to be:

Type A: Jewelry merchandising, where the minute display and examination of merchandise is critical.

Type B: Fine merchandising includes fine apparel and accessories, china, crystal and silver, and art galleries, where the detailed display and examination of merchandise is important.

Type C: Mass merchandising, where focused display and detailed examination of merchandise is important.

Type D: General merchandising includes general apparel, variety, stationery, books, sporting goods, hobby, cameras, gift, and luggage, where general display and examination of merchandise are adequate.

Type E: Food and miscellaneous includes bakeries, hardware and housewares, grocery, appliances and furniture, where appetizing appearance is important.

Type F: Service establishments, where functional performance is important.

(e) Area factor must not exceed 1.55.

(f) Minimum of 90 percent of all work stations must be enclosed with partitions of the height prescribed.

(5) Special spaces and activities.

(a) Multifunction rooms. For rooms serving multifunctions, such as hotel banquet or meeting rooms and office conference or presentation rooms, an adjustment factor of 1.5 times the base UPD may be used if a supplementary lighting system is actually installed to serve the secondary function of the room and the design meets the following conditions:

i. the installed power for the supplementary system must not be greater than 33 percent of the adjusted lighting power budget calculated for that room; and

ii. independent controls must be installed for the supplementary lighting system.

(b) Simultaneous activities. In rooms containing multiple simultaneous activities, such as a large general office having separate accounting and drafting areas within the same room, the LPB for the rooms must be the weighted average of the activities in proportion to the areas being served.

(c) Indoor sports. The floor area of indoor sports activities areas must be considered as the area within the playing boundaries of the sport, plus the floor area ten feet beyond the playing boundaries, not to exceed the total floor area of the indoor room less the spectator seating area.

(6) Calculation of interior lighting power allowance. The interior lighting power allowance must include a 0.20 watts per square foot allowance for unlisted spaces. The system performance interior lighting power allowance must be calculated in accordance with the equation below:

$ILPA = LPB_1 + LPB_2 + \ldots + LPB_n + 0.2\ W/ft^2 \times$ (Unlisted space)

Where:



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Unlisted space = GLA - LSA

(7) Adjusted lighting power. The adjusted lighting power in a building must not exceed the sum of the interior lighting power allowances. The adjusted lighting power is the connected lighting power minus the lighting power controls credit.

(8) Lighting power controls credit and adjustment factor. Credit for luminaires automatically controlled by occupancy sensors, daylight sensors, programmable timing controls, or lumen maintenance controls must be determined in accordance with the equation:

LPCC = CLPC x PAF

Power Adjustment Factor

| Automatic Control Device(s) | Power Adjustment Factor |
|---|---|
| Daylight Sensing Controls (DS), continuous dimming | 0.30 |
| DS, multiple step dimming | 0.20 |
| DS, ON/OFF | 0.10 |
| DS, continuous dimming and programmable timing | 0.35 |
| DS, multiple step dimming and programmable timing | 0.25 |
| DS, ON/OFF and programmable timing | 0.15 |
| DS, continuous dimming, programmable timing, and lumen maintenance | 0.40 |
| DS, multiple step dimming, programmable timing, and lumen maintenance | 0.30 |
| DS, ON/OFF, programmable timing, and lumen maintenance | 0.20 |
| Lumen maintenance | 0.10 |
| Lumen maintenance and programmable timing control | 0.15 |
| Programmable timing control | 0.15 |
| Occupancy sensor | 0.30 |
| Occupancy sensor DS, continuous dimming | 0.40 |
| Occupancy sensor DS, multiple step dimming | 0.35 |
| Occupancy sensor DS, ON/OFF | 0.35 |
| Occupancy sensor, DS, continuous dimming, and lumen maintenance | 0.45 |
| Occupancy sensor, DS, multiple step dimming, and lumen maintenance | 0.40 |
| Occupancy sensor, DS, ON/OFF, and lumen maintenance | 0.35 |
| Occupancy sensor and lumen maintenance | 0.35 |
| Occupancy sensor and programmable timing control | 0.35 |

(a) The lighting power control credits are limited to the specific luminaires controlled by the automatic control device.

(b) Only one adjustment factor may be used for each building space or luminaire, and 50 percent or more of the controlled luminaire must be within the applicable space to qualify for the power adjustment factor.

(c) Controls must be installed in series

with the lights and in series with all manual switching devices in order to qualify for an adjustment factor.

(d) Daylight sensing controls must be capable of reducing electrical power consumption for lighting, continuously or in steps, to 50 percent or less of maximum power consumption.

(e) Daylight sensing controls must control all luminaires to which the power adjustment factor is applied and that direct a minimum of 50 percent of their light output into the daylight zone.

(f) Programmable timing controls used for credit in conjunction with this item must be:

i. programmable for different schedules for occupied and unoccupied days;

ii. accessible for temporary override by occupants of individual zones, spaces, or tasks, with automatic return to the original schedules; and

iii. capable of keeping time during power outages for a minimum of four hours.

(9) LTGSTD, Lighting Prescriptive and System Performance Compliance Calculation program is an acceptable method for demonstrating compliance of the lighting system design with this subpart.

[For text of subp 3, see M.R.]

Subp. 4. **Electric motor efficiencies.** All permanently wired, single-speed, Design A and B, polyphase induction motors of 1 hp or more and expected to operate more than 500 hours per year must have National Electrical Manufacturers Association nominal efficiencies not less than those listed in the table below.

Electrical Motor Efficiencies

| | OPEN | | | | ENCLOSED | | | |
|---|---|---|---|---|---|---|---|---|
| HORSE POWER | 3600 RPM | 1800 RPM | 1200 RPM | 900 RPM | 3600 RPM | 1800 RPM | 1200 RPM | 900 RPM |
| 1.0 | | 82.5 | 77.0 | 72.0 | | 80.5 | 75.5 | 72.0 |
| 1.5 | 80.0 | 82.5 | 82.5 | 75.5 | 78.5 | 81.5 | 82.5 | 75.5 |
| 2.0 | 82.5 | 82.5 | 84.0 | 85.5 | 81.5 | 82.5 | 82.5 | 82.5 |
| 3.0 | 82.5 | 86.5 | 85.5 | 86.5 | 82.5 | 84.0 | 84.0 | 81.5 |
| 5.0 | 85.5 | 86.5 | 86.5 | 87.5 | 85.5 | 85.5 | 85.5 | 84.0 |



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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7.5 | 85.5 | 88.5 | 88.5 | 88.5 | 85.5 | 87.5 | 87.5 | 85.5 |
| 10.0 | 87.5 | 88.5 | 90.2 | 89.5 | 87.5 | 87.5 | 87.5 | 87.5 |
| 15.0 | 89.5 | 90.2 | 89.5 | 89.5 | 87.5 | 88.5 | 89.5 | 88.5 |
| 20.0 | 90.2 | 91.0 | 90.2 | 90.2 | 88.5 | 90.2 | 89.5 | 89.5 |
| 25.0 | 91.0 | 91.7 | 91.0 | 90.2 | 89.5 | 91.0 | 90.2 | 89.5 |
| 30.0 | 91.0 | 91.7 | 91.7 | 91.0 | 89.5 | 91.0 | 91.0 | 90.2 |
| 40.0 | 91.7 | 92.4 | 91.7 | 90.2 | 90.2 | 91.7 | 91.7 | 90.2 |
| 50.0 | 91.7 | 92.4 | 91.7 | 91.7 | 90.2 | 92.4 | 91.7 | 91.0 |
| 60.0 | 93.0 | 93.0 | 92.4 | 92.4 | 91.7 | 93.0 | 91.7 | 91.7 |
| 75.0 | 93.0 | 93.6 | 93.0 | 93.6 | 92.4 | 93.0 | 93.0 | 93.0 |
| 100.0 | 93.0 | 93.6 | 93.6 | 93.6 | 93.0 | 93.6 | 93.0 | 93.0 |
| 125.0 | 93.0 | 93.6 | 93.6 | 93.6 | 93.0 | 93.6 | 93.0 | 93.6 |
| 150.0 | 93.6 | 94.1 | 93.6 | 93.6 | 93.0 | 94.1 | 94.1 | 96.6 |
| 200.0 | 93.6 | 94.1 | 94.1 | 93.6 | 94.1 | 94.5 | 94.1 | 94.1 |

7670.1115 EFFECTIVE DATES.

The effective date of amendments to this chapter is 45 days after publication of the adopted rule in the State Register.

EXCEPTION: Effective January 1, 1998, residential buildings (one- and two-family and other residential buildings three stories or less in height) must meet the requirements of the R-2000 Home Program Technical Requirements, Canadian Home Builders' Association, September 1992.

REPEALER. Minnesota Rules, parts 7605.0100; 7605.0110; 7605.0120; 7605.0130; 7605.0140; 7605.0150; 7605.0160; 7670.0125; 7670.0480; 7670.0500; 7670.0510; 7670.0530; 7670.0550; 7670.0850; and 7670.1000, are repealed.



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