

## 780 CMR 61.00

### ENERGY EFFICIENCY

(Note: Chapter 61 is unique to Massachusetts)

#### 780 CMR 6101 SCOPE AND GENERAL REQUIREMENTS

**6101.1 Intent.** The provisions of 780 CMR 61.00 shall regulate the design and construction of building envelopes for adequate thermal resistance, low air leakage and water vapor control, and the design and selection of mechanical, electrical and service water-heating systems and equipment which will enable effective use of energy in new one- and two-family building construction. It is intended that these provisions provide flexibility to permit the use of innovative approaches and techniques to achieve effective utilization of energy. 780 CMR 51.00 through 99.00 is not intended to abridge safety, health or environmental requirements under other applicable codes or ordinances.

**6101.2 Compliance.** Envelope design compliance with 780 CMR 51.00 through 99.00 shall be determined in accordance with one of the following alternatives:

1. 780 CMR 6107.2, Building design by prescriptive package;
2. 780 CMR 6107.3, Building design by approved software;
3. 780 CMR 6108, Building design by systems analysis and design of buildings utilizing renewable energy resources; or
4. 780 CMR 6109, Building design by home energy rating.

**6101.3 Scope.** 780 CMR 61.00 sets forth energy-efficiency requirements for the design and construction of new one- and two-family residential occupancy buildings.

**Note 1:** 780 CMR 61.00 may also be used for compliance of envelope and mechanical, electrical and service water-heating systems in new residential buildings three stories or less in height.

**Note 2:** 780 CMR 61.00 may also be used for envelope compliance in new buildings other than residential occupancies three stories or less in height, if the total conditioned floor area does not exceed 10,000 square feet (929 m<sup>2</sup>) (per 780 CMR 1301.2 of the *Sixth Edition, Massachusetts Building Code*). In such cases, HVAC, service water-heating, power distribution and lighting systems must satisfy the requirements of 780 CMR 13.00 of the *Sixth Edition, Massachusetts Building Code*.

**6101.3.1 Exempt Buildings.** Buildings and structures indicated in 780 CMR 6101.3.1.1 through 6101.3.1.4 shall be exempt from the

provisions of 780 CMR 51.00 through 99.00.

**6101.3.1.1 Separated Buildings.** Buildings and structures, or portions thereof, separated by building envelope assemblies from the remainder of the building, that have a peak design rate of energy usage less than 3.4 Btu/h per square foot (10.7 W/m<sup>2</sup>) or 1.0 watt per square foot (10.7 W/m<sup>2</sup>) of floor area for all purposes.

**6101.3.1.2 Unconditioned Spaces.** Buildings or portions thereof which are not conditioned, per the definition in 780 CMR 52.00.

**6101.3.1.3 Greenhouses used Exclusively for Agricultural Purposes.** Greenhouses that are free-standing, or attached to a building and separated by a wall having the same thermal value as an exterior wall, and provided with a separate temperature control system.

**6101.3.1.4 Small Buildings.** Buildings with less than 100 square feet (9.3 m<sup>2</sup>) of gross floor area.

**6101.3.2 Applicability.** The provisions of 780 CMR 61.00 shall apply to all matters affecting or relating to structures and premises, as set forth in 780 CMR 6101. Where, in a specific case, different sections of 780 CMR 51.00 through 99.00 specify different materials, methods of construction or other requirements, the most restrictive shall govern.

**6101.3.2.1 Existing Buildings.** For alterations to existing buildings, *see* 780 CMR 6101.3.2.2 and 780 CMR 93.00.

**6101.3.2.2 Additions to Existing Buildings.** Additions to existing buildings or structures shall comply with one of the applicable criteria below:

1. The new addition, by itself, shall conform to the applicable provisions of 780 CMR 61.00;
2. The new addition plus the existing building/dwelling unit may be considered together for compliance with all applicable provisions of 780 CMR 61.00; or
3. Additions that are open to or separated by an exterior wall from the existing building/dwelling unit shall meet the prescriptive envelope component criteria of 780 CMR Table 6101.3. The total area (based on rough opening dimensions) of glazed fenestration products (windows, skylights and glazed portion of doors) shall not exceed 40% of the gross wall and gross

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ceiling/roof area of the addition combined. If any individual fenestration component exceeds the maximum U-factor listed in 780 CMR Table 6101.3, then the area-weighted average U-factor for all fenestration components must be less than or equal to the listed value. The R-value requirements for opaque thermal envelope components indicate insulation products (cavity and/or insulating sheathing), and shall be equal to or exceed the applicable listed values found in 780 CMR Table 6101.3. If such addition is separated from the main house by a wall or doors and is conditioned, then a readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to the addition space. That portion of a wall that separates the addition from the existing building/dwelling unit, if an existing exterior wall, shall be allowed to remain, and neither that portion of said wall nor any fenestration within said portion of wall common to the addition need comply with the thermal envelope requirements of 780 CMR 61.00.

**Exception: Sunroom Additions/ Consumer Notification:** Sunrooms, as defined in 780 CMR 52.00, shall be exempt from the compliance requirements set forth in 780 CMR 6101.3.2.2 and 6101.2, provided that the actual property owner (not the owner's agent or representative) of the structure onto which the sunroom addition is being made, provides a signed copy of the sunroom "CONSUMER INFORMATION FORM" (found in 780 CMR 120.P) to the Building Department. This signed "CONSUMER INFORMATION FORM" shall be submitted to the building official as a requirement of building permit issuance, and shall remain as part of the construction documents. If such sunroom additions are separated from the main house by a wall and are conditioned spaces, then a readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to the sunroom addition space. That portion of a wall that separates the sunroom addition from the existing building/dwelling unit, if an existing exterior wall, shall be allowed to remain, and neither that portion of said wall on any fenestration within said portion and common to the sunroom addition, need comply with the thermal envelope requirements of 780 CMR 61.00.

**780 CMR TABLE 6101.3  
PRESCRIPTIVE ENVELOPE COMPONENT  
CRITERIA ADDITIONS TO EXISTING  
LOW-RISE RESIDENTIAL BUILDINGS**

MAXIMUM	MINIMUM				
	Ceilings and exposed floors R-Value	Wall R-Value	Floor R-Value	Basement Wall R-Value	Slab Perimeter R-Value and Depth
0.39	R-37 <sup>a</sup>	R-13	R-19	R-10	R-10, 4 feet

For SI: 1 foot = 304.8 mm.

- a. R-30 ceiling insulation may be used in place of R-37 if the insulation achieves the full R-value over the entire ceiling area (i.e., not compressed over exterior walls, and including any access openings).

**6101.3.2.3 Historic Buildings.** Historic buildings, as defined in 780 CMR 9309 of 780 CMR 51.00 through 99.00, are exempt from the requirements of 780 CMR 61.00.

**6101.3.2.4 Change in Occupancy.** A change in the occupancy or change in use of an existing building or structure shall be permitted, subject to the applicable provisions of 780 CMR 93.00.

## 780 CMR 6102 MATERIALS, SYSTEMS AND EQUIPMENT

**6102.1 General.** Materials, equipment and systems shall be identified in a manner that will allow a determination of their compliance with the applicable provisions of 780 CMR 61.00.

**6102.2 Materials, Equipment and Systems Installation.** All insulation materials, caulking and weatherstripping, fenestration assemblies, mechanical equipment and systems components, and water-heating equipment and system components shall be installed in accordance with the manufacturer's installation instructions.

**6102.3 Maintenance Information.** Required regular maintenance actions shall be clearly stated and incorporated on a readily accessible label on the equipment or made otherwise available for permanent reference. Such label shall include the title or publication number, the operation and maintenance manual for that particular model and type of product. Maintenance instructions shall be furnished for equipment that requires preventive maintenance for efficient operation.

**6102.4 Insulation Installation.** Roof/ceiling, floor, wall cavity and duct distribution system insulation shall be installed in a manner that permits inspection of the manufacturer's R-value identification mark.

**6102.4.1 Protection of Exposed Foundation Insulation.** Insulation applied to the exterior of foundation walls and around the perimeter of slab-on-grade floors shall have a rigid, opaque and weather-resistant protective covering to prevent

the degradation of the insulation’s thermal performance. The protective covering shall cover the exposed area of the exterior insulation and extend a minimum of six inches (153 mm) below grade.

**6102.5 Identification.** Materials, equipment and systems shall be identified in accordance with 780 CMR 6102.5.1, 6102.5.2 and 6102.5.3.

**6102.5.1 Building Envelope Insulation.** A thermal resistance (R) identification mark shall be applied by the manufacturer to each piece of building envelope insulation 12 inches (305 mm) or greater in width.

Alternatively, the insulation installer shall provide a signed and dated certification for the insulation installed in each element of the building envelope, listing the type of insulation installations in roof/ceilings, the manufacturer and the R-value. For blown-in or sprayed insulation, the installer shall also provide the initial installed thickness, the settled thickness, the coverage area and the number of bags installed. Where blown-in or sprayed insulation is installed in walls, floors and cathedral ceilings, the installer shall provide a certification of the installed density and R-value. The installer shall post the certification in a conspicuous place on the job site.

**6102.5.1.1 Roof/Ceiling Insulation.** The thickness of roof/ceiling insulation that is either blown in or sprayed shall be identified by thickness markers that are labeled in inches or millimeters installed at least one for every 300 square feet (28 m<sup>2</sup>) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness and minimum settled thickness with numbers a minimum of one inch (25 mm) in height. Each marker shall face the attic access. The thickness of installed insulation shall meet or exceed the minimum initial installed thickness shown by the marker.

**6102.5.2 Fenestration Product Rating, Certification and Labeling.** U-factors of fenestration products (windows, doors and skylights) shall be determined in accordance with NFRC 100 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Such certified and labeled U-factors shall be accepted for purposes of determining compliance with the building envelope requirements of 780 CMR 61.00

When a manufacturer has not determined product U-factor in accordance with NFRC 100 for a particular product line, compliance with the building envelope requirements of 780 CMR 51.00 through 99.00 shall be determined by assigning such products a default U-factor in accordance with 780 CMR Tables 6102.5.2(1) and 6102.5.2(2). Product features must be verifiable for the product to qualify for the default

value associated with those features. Where the existence of a particular feature cannot be determined with reasonable certainty, the product shall not receive credit for that feature. Where a composite of materials from two different product types is used, the product shall be assigned the higher U-factor.

**6102.5.3 Duct Distribution Systems Insulation.** A thermal resistance (R) identification mark shall be applied by the manufacturer in maximum intervals of no greater than ten feet (3048 mm) to insulated flexible duct products showing the thermal performance R-value for the duct insulation itself (excluding air films, vapor retarders or other duct components).

**780 CMR TABLE 6102.5.2(1)  
U-FACTOR DEFAULT TABLE FOR WINDOWS,  
GLAZED DOORS AND SKYLIGHTS**

FRAME MATERIAL AND PRODUCT TYPE <sup>a</sup>	SINGLE GLAZED	DOUBLE GLAZED
<b>Metal without thermal break</b>		
Operable (including sliding and swinging glass doors)	1.27	0.87
Fixed	1.13	0.69
Garden window	2.6	1.81
Curtain wall	1.22	0.79
Skylight	1.98	1.31
Site-assembled sloped/overhead glazing	1.36	0.82
<b>Metal with thermal break</b>		
Operable (including sliding and swinging glass doors)	1.08	0.65
Fixed	1.07	0.63
Curtain wall	1.61	0.68
Skylight	1.89	1.61
Site-assembled sloped/overhead glazing	1.25	0.7
<b>Reinforced vinyl/metal clad wood</b>		
Operable (including sliding and swinging glass doors)	0.9	0.57
Fixed	0.98	0.56
Skylight	1.75	1.05
<b>Wood/vinyl/fiberglass</b>		
Operable (including sliding and swinging glass doors)	0.89	0.55
Fixed	0.98	0.56
Garden window	2.31	1.61
Skylight	1.47	0.84

a. Glass block assemblies with mortar but without reinforcing or framing shall have a U-factor of 0.60.

**780 CMR TABLE 6102.5.2(2)  
U-FACTOR DEFAULT TABLE FOR NONGLAZED  
DOORS**

DOOR TYPE	WITH FOAM CORE	WITHOUT FOAM CORE
	Steel doors (1.75 inches thick)	0.35
	WITHOUT STORM DOOR	WITH STORM DOOR
Wood doors (1.75 inches thick)		
Panel with 0.438-inch panels	0.54	0.36
Hollow core flush	0.46	0.32
Panel with 1.125-inch panels	0.39	0.28
Solid core flush	0.4	0.26

For SI: 1 inch = 25.4 mm.

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**780 CMR 6103 ALTERNATE MATERIALS —  
METHOD OF CONSTRUCTION, DESIGN  
OR INSULATING SYSTEMS**

**6103.1 General.** The provisions of 780 CMR 51.00 through 99.00 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, if necessary, by the BBRs as meeting the intent of the code.

Compliance with specific provisions of 780 CMR 51.00 through 99.00 shall be determined through the use of computer software, worksheets, compliance manuals and other similar materials when they have been approved by the BBRs as meeting the intent of 780 CMR 51.00 through 99.00.

**780 CMR 6104 CONSTRUCTION  
DOCUMENTS**

**6104.1 General.** Construction documents and other supporting data shall be submitted in one or more sets with each application for a permit. The construction documents and designs submitted under the provisions of 780 CMR 6108 shall be prepared by a registered design professional. Where special conditions exist, the building official is authorized to require additional construction documents to be prepared by a registered design professional.

**6104.2 Information on Construction Documents.** Construction documents shall be drawn to scale upon suitable material. Electronic media documents are permitted to be submitted when approved by the building official. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in 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 fenestration products, 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 780 CMR 51.00 through 99.00

If using 780 CMR 6107.3 (Building design by approved software), a window schedule including the areas (based on rough opening), and the number of windows, skylights and other glazed fenestration, shall also be submitted.

When HVAC equipment sizing information is not available at the time of initial building permit application, such information shall be submitted prior to the installation of said equipment, and supporting calculations shall demonstrate compliance with 780 CMR 6106.4.3.1.1. Installed equipment must meet or exceed the efficiency rating listed in the submitted construction documents.

**780 CMR 6105 DESIGN CRITERIA**

**6105.1 General.** The criteria of 780 CMR 61.00 establish the design conditions for use with all sections of 780 CMR 61.00.

**6105.2 Exterior Design Conditions.** Exterior design parameters to be used for calculations required under 780 CMR 51.00 through 99.00 shall be taken from 780 CMR Table 6105.1, based on the climate zones defined in 780 CMR Table 6105.2.

**780 CMR TABLE 6105.1**

**CLIMATE ZONE THERMAL DESIGN CRITERIA**

CLIMATE ZONE #	12a	13a	14a
Winter, Design Dry-bulb (°F)	9	7	-1
Summer, Design Dry-bulb (°F)	86	87	86
Summer, Design Wet-bulb (°F)	74	74	73
Heating Degree Days Base 65	5,884	5,641	6,894
Heating Degree Days Base 50	2,553	2,399	3,448
Cooling Degree Days Base 65	606	678	507
Cooling Degree Days Base 50	2,743	2,897	2,525
Cooling Degree Hours Base 80	939	1299	409

**780 CMR TABLE 6105.2**

**CLIMATE ZONE BY COUNTY**

COUNTY	CLIMATE ZONE #
Barnstable	12a
Berkshire	14a
Bristol	12a
Dukes	12a
Essex	13a
Franklin	14a
Hampden	14a
Hampshire	14a
Middlesex	13a
Nantucket	12a
Norfolk	13a
Plymouth	12a
Suffolk	13a
Worcester	14a

**6105.3 Indoor Design Conditions.** Indoor design temperature and relative humidity shall be determined in accordance with ASHRAE Standard 55, and shall be selected for minimum total HVAC system energy use in accordance with accepted practice.

**6105.4 Ventilation.** Living space fresh air ventilation shall conform to the requirements of 780 CMR 5303.

**Exception:** If outdoor air quantities other than those specified in the *International Mechanical Code* are used or required because of special occupancy requirements, source control of air contamination, health and safety, or other standards, the required outdoor air quantities shall be used as the basis for calculating the heating and cooling design loads.

**780 CMR 6106 GENERAL REQUIREMENTS****6106.1 Scope.**

**6106.1.1 General.** All buildings or portions thereof that are conditioned and meet the provisions of 780 CMR 61.00 using the compliance paths of 780 CMR 6107.2 or 6107.3 shall also meet the requirements of 780 CMR 6106. Buildings that meet the provisions using the compliance paths of 780 CMR 6108 or 6109 are exempt from the requirements of 780 CMR 6106.

**Exception:** All buildings must comply with the requirements of 780 CMR 6106.2.1

**6106.2 Building Envelope Requirements.**

**6106.2.1 Vapor Retarder.** The design shall not create conditions of accelerated deterioration from moisture condensation. In all frame walls, floors, ceilings and roofs, an approved vapor retarder having a maximum rating of 1.0 perm, when tested in accordance with Standard ASTM E 96, as listed in 780 CMR Appendix A, shall be installed on the warm-in-winter side of the thermal insulation.

**Exceptions:**

1. Where it can be demonstrated to the satisfaction of the building official that the absence of a vapor retarder will not damage the materials or adversely affect the performance of the insulation due to moisture or its freezing.
2. As allowed in 780 CMR 5806.1.

**6106.2.2 Basements.** When the basement is a conditioned space, the basement walls shall be insulated. When the basement is not a conditioned space, either the basement walls or the ceilings separating the basement from conditioned space shall be insulated. When insulating basement walls, the required R-value shall be applied from the top of the basement wall to a depth of ten feet (3048 mm) below grade or to the top of the basement floor, whichever is less.

**6106.2.3 Slab-on-grade Floors.** For slabs in heated or cooled areas, when the top edge of the slab is above finished grade, or 12 inches (305 mm) or less below finished grade, the required R-value (as determined by 780 CMR 6107.2, 6107.3, 6108 or 6109) shall be applied to the outside of the foundation or the inside of the foundation wall. The insulation shall extend downward from the top of the slab, or downward to the bottom of the slab and then horizontally in either direction, until reaching the required distance as determined by 780 CMR 6107.2, 6107.3, 6108 or 6109.

When installed between the exterior wall and the edge of the interior slab, the top edge of the insulation shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the exterior

wall. Insulation extending horizontally away from the building shall be protected by pavement or by a minimum of ten inches (254 mm) of soil.

An additional R-2 of insulation shall be added to the required values (as determined by 780 CMR 6107.2 or 6107.3) where uninsulated hot water pipes, air distribution ducts or electric heating cables are installed within or under the slab.

**6106.2.4 Crawl Space Walls.** Where the floor above a crawl space is uninsulated, insulation shall be installed on crawl space walls, and the crawl space shall not be vented to outside air. The required R-value (as determined by 780 CMR 6107.2, 6107.3, 6108 or 6109) shall be applied inside of the crawl space wall, downward from the sill plate to the exterior finished grade level and then vertically and/or horizontally for at least an additional 24 inches (610 mm). Where a crawl space is vented to outside air, the floor above the crawl space shall be insulated to a minimum of R-19, and a protective barrier shall be installed to prevent wind from moving into the insulation. The exposed earth in all crawl space foundations shall be covered with a continuous vapor retarder having a maximum permeance rating of 1.0 perm [(57 mg)/(s • m<sup>2</sup> • Pa)] when tested in accordance with ASTM E 96, and the vapor retarder shall be sealed to prevent moisture migration.

**6106.2.5 Access Openings.** Access doors, hatches, scuttles, pull down staircases and similar constructions that are part of the building envelope shall be insulated to a level equivalent to the insulation of the surrounding floor, wall and ceiling.

**Exception:** If the access opening has less insulation than the surrounding area, for calculation purposes the R-value of the surrounding floor, wall and ceiling shall be increased accordingly.

**6106.2.6 Masonry Veneer.** When insulation is placed on the exterior of a foundation supporting a masonry veneer exterior, the horizontal foundation surface supporting the veneer is not required to be insulated to satisfy the foundation insulation requirement.

**6106.2.7 Return-air Ceiling Plenums.** When return-air ceiling plenums are employed, the roof/ceiling assembly shall:

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.

**6106.3 Air Leakage.**

**6106.3.1 General.** The requirements of 780 CMR 6106.3 shall apply to those locations separating outdoor ambient conditions or exempted portions of the building (e.g., attics,

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unconditioned basements) from interior conditioned spaces, and where infiltration of outdoor air can affect the performance of materials (e.g., attic insulation). The requirements are not applicable to the separation of interior conditioned spaces from each other.

**6106.3.2 Window and Door Assemblies.**

Exterior doors and windows shall be designed to limit air leakage into and from the building envelope. Manufactured doors and windows shall comply with the maximum allowable infiltration rates in 780 CMR Table 6106.3.2

**Exception:** Site-constructed windows and doors sealed in accordance with 780 CMR 6106.3.3.

**780 CMR TABLE 6106.3.2**

**ALLOWABLE AIR INFILTRATION RATES<sup>a</sup>**

WINDOWS (cfm per square foot of window area)	DOORS (cfm per square foot of door area)	
	Sliders	Swinging
0.3 <sup>b,c</sup>	0.3	0.5 <sup>d</sup>

- a. When tested in accordance with ASTM E 283, as listed in 780 CMR 100.00.
- b. See standard AAMA/WDMA 101/I.S.2, as listed in 780 CMR 100.00.
- c. See standard ASTM D 4099, as listed in 780 CMR 100.00.
- d. See standards AAMA 101V and ASTM D 4099, each as listed in 780 CMR 100.00.

**6106.3.3 Building Envelope.** The building envelope shall be designed and constructed to reduce air leakage into or out of conditioned spaces. Sealant materials shall be compatible with the construction materials, location and anticipated conditions. Sealant materials spanning joints between dissimilar construction materials shall be joined in a flexible manner to create a continuous barrier to control accidental infiltration through assemblies, allowing for the relative movement of materials due to thermal and moisture variations and creep.

Joints, seams or penetrations in the building envelope that are sources of air leakage shall be sealed with durable caulking materials, closed with gasketing systems, taped or covered with moisture vapor-permeable house-wrap per manufacturer's directions. Air leakage locations to be treated shall include:

- 1. Between wall assemblies or their sill-plates and foundations;
- 2. Openings, cracks and joints between framing members and window or door frames;
- 3. Between walls and roof/ceilings or

attic/ceiling seals and between separate wall panels;

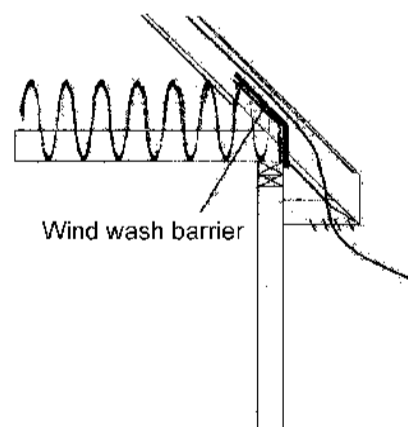
- 4. Between walls and floor assemblies;
- 5. Penetrations of utility services through walls, floors and roof assemblies;
- 6. Penetration through the wall cavity of top and/or bottom plates; and
- 7. All other such openings in the building envelope. This includes sealing behind tubs and showers on exterior walls, at the attic and crawl space access panels, at recessed lights and around all plumbing, electrical and HVAC penetrations.

**6106.3.3.1 Exterior Wind Wash Barrier.** In ventilated attics or roofs, a rigid wind wash barrier must be tightly installed at the exterior edge of the exterior wall top plate (i.e., the eave area), extending vertically to the height of the uncompressed insulation of to within 3.5 inches (89 mm) of the underside of the roof deck, to maintain the required ventilation space. See 780 CMR Figure 6106.3.3.1.

**6106.3.4 Recessed Lighting Fixtures.** When installed in the building envelope, recessed lighting fixtures shall meet one of the following requirements:

- 1. Type IC rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity and sealed or gasketed to prevent air leakage into the unconditioned space.
- 2. Type IC rated, with no more than 2.0 cfm (0.944 L/s) air movement from the conditioned space to the ceiling cavity, when tested in accordance with ASTM E 283 at 1.57 lbs/ft.<sup>2</sup> (75 Pa) pressure difference. Such fixtures shall be labeled to document compliance.

**780 CMR FIGURE 6106.3.3.1  
WIND WASH BARRIER**



**6106.4 Building Mechanical Systems.**

**6106.4.1 General.** 780 CMR 6106.4 covers mechanical systems and equipment used to provide heating, ventilating and air-conditioning functions. 780 CMR 6106.4 assumes that residential buildings and dwelling units therein will be designed with individual HVAC systems. Where equipment not shown in 780 CMR Table 6106.4 is specified, it shall meet the applicable provisions of 780 CMR 13.00 of the *Sixth Edition, Massachusetts Building Code*.

**6106.4.2 Mechanical Equipment Efficiency.** Equipment shown in 780 CMR Table 6106.4 shall meet the specified minimum performance. Data furnished by the equipment supplier, or certified under a nationally recognized certification procedure, shall be used to satisfy these requirements. All such equipment shall be installed in accordance with the manufacturer's instructions.

**6106.4.3 HVAC Systems.** HVAC systems shall meet the criteria set forth in 780 CMR 6106.4.3.1 through 6106.4.3.3.

**6106.4.3.1 Load Calculations.** Heating and cooling system design loads for the purpose of sizing systems and equipment shall be determined in accordance with the procedures described in the *ASHRAE Handbook of Fundamentals* or the *Air Conditioning*

Contractors Association's Manual "J," or other procedure approved by the BBRS, using the design parameters specified in 780 CMR 6105.

**6106.4.3.1.1 System Heating and Cooling Capacity.** The rated output capacity of the heating/cooling system at design conditions shall not be greater than 125% of the design load calculated in accordance with 780 CMR 6106.4. Capacity shall be, within available equipment options, the smallest size necessary to meet the load.

**Exceptions:**

1. If the rated output capacity of available equipment options exceeds 125% of the design load, then equipment with the smallest output capacity above 125% of the load shall be utilized.
2. In multiple-family buildings, where the HVAC system for the building uses interconnected equipment designed to sequence with the load and it can be shown that such design will use less energy on an annual basis than one large unit.
3. In multiple-family buildings, equipment designed for standby purposes is not included in the capacity limitation requirement.

**780 CMR TABLE 6106.4  
MINIMUM EQUIPMENT PERFORMANCE**

EQUIPMENT CATEGORY	SUBCATEGORY <sup>e</sup>	REFERENCED STANDARD	MINIMUM PERFORMANCE <sup>f</sup>
Air-cooled heat pumps heating mode < 65,000 Btu/h cooling capacity, single phase	Split systems and single package	ARI 210/240	7.7 HSPF <sup>a,b</sup>
	Through-the-wall split systems		7.1 HSPF <sup>a,b</sup>
	Through-the-wall single package		7.0 HSPF <sup>a,b</sup>
Gas-fired or oil-fired furnace < 225,000 Btu/h	—	DOE 10 CFR Part 430, Subpart B, Appendix	AFUE 78% <sup>b</sup> , Et 80% <sup>c</sup>
Gas-fired or oil-fired steam and hot-water boilers < 300,000 Btu/h	—	DOE 10 CFR Part 430, Subpart B, Appendix	AFUE 80% <sup>b,d</sup>
Air-cooled air conditioners and heat pumps cooling mode < 65,000 Btu/h cooling capacity, single phase	Split systems	ARI 210/240	13.0 SEER <sup>b</sup>
	Through-the-wall split systems <sup>g</sup>		10.9 SEER <sup>b</sup>
	Through-the-wall single package <sup>g</sup>		10.6 SEER <sup>b</sup>

For SI: 1 Btu/h = 0.2931 W.

- a. For multicapacity equipment, the minimum performance shall apply to each capacity step provided. Multicapacity refers to manufacturer-published ratings for more than one capacity mode allowed by the product's controls.
- b. This is used to be consistent with the National Appliance Energy Conservation Act (NAECA) of 1987 (Public Law 100-12), as amended.
- c. These requirements apply to combination units not covered by NAECA (three-phase power or cooling capacity 65,000 Btu/h).
- d. Except for gas-fired steam boilers for which the minimum AFUE shall be 75%.
- e. Seasonal rating.
- f. Heat pumps manufactured before January 23, 2006 may have an HSPF of 6.8 for split systems and 6.7 for single-package units, and air-conditioners manufactured before January 23, 2006 may have a SEER of 10 for split systems and 9.7 for single-package units. Trade-offs between equipment and other building components are not allowed for equipment that does not exceed the minimums in this table.
- g. These requirements apply to through-the-wall products with cooling capacities less than or equal to 30,000 Btu/h manufactured prior to January 23, 2010.

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**6106.4.3.1.2 Infiltration.** Infiltration for heating and cooling design loads for one-family through four-family dwellings shall be calculated using the methods identified in 780 CMR 6106.4.3.1. For all other buildings covered by 780 CMR 61.00, infiltration shall be calculated using the procedures in 780 CMR 25.00 of the *ASHRAE Handbook of Fundamentals*.

**6106.4.3.2 Temperature and Humidity Controls.** Temperature and humidity controls shall be provided in accordance with 780 CMR 6106.4.3.2.1 through 6106.4.3.2.4.

**6106.4.3.2.1 System Controls.** Each dwelling unit shall be considered a zone, and shall be provided with thermostatic controls responding to temperature within the zone. Each zone shall include at least one temperature control device.

In addition, a readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to each zone or floor. For spaces other than living units, at least one thermostat for regulation of space temperature shall be provided for:

1. Each separate system.
2. Each separate zone as defined in 780 CMR 52.00. As a minimum, each floor of a building shall be considered as a separate zone. A readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to each floor.

**6106.4.3.2.2 Thermostatic Control Capabilities.** Where used to control comfort heating, thermostatic controls shall be capable of being set locally or remotely by adjustment or selection of sensors down to 55°F (13°C) or lower.

Where used to control comfort cooling, thermostatic controls shall be capable of being set locally or remotely by adjustment or selection of sensors up to 85°F (29°C) or higher.

Where used to control both comfort heating and cooling, thermostatic controls shall be capable of providing a temperature range or deadband of at least 5°F (3°C) within which the supply of heating and cooling energy is shut off or reduced to a minimum.

**Exceptions:**

1. Special occupancy or special usage conditions approved by the building official.
2. Thermostats that require manual changeover between heating and cooling modes.

**6106.4.3.2.3 Heat Pump Auxiliary Heat.** Heat pumps having supplementary electric resistance heaters shall have controls that prevent heater operation when the heating load is capable of being met by the heat pump. Supplemental heater operation is not allowed except for a maximum of 15 minutes during outdoor coil defrost cycles.

**6106.4.3.2.4 Humidistat.** Humidistats used for comfort purposes shall be capable of being set to prevent the use of fossil fuel or electricity to reduce relative humidity below 60% or increase relative humidity above 30%.

**6106.4.4 Distribution System, Construction and Insulation.** Distribution systems shall be constructed and insulated in accordance with 780 CMR 6106.4.4.1 through 6106.4.4.6.

**6106.4.4.1 Piping Insulation.** All HVAC system piping shall be thermally insulated in accordance with 780 CMR Table 6106.4.4.1.

**Exceptions:**

1. Factory-installed piping within HVAC equipment tested and rated in accordance with 780 CMR 6106.4.2.
2. Piping that conveys fluids which have a design operating temperature range between 55°F and 105°F (13°C and 41°C).
3. Piping that conveys fluids which have not been heated or cooled through the use of fossil fuels or electricity.

**6106.4.4.2 Other Insulation Thicknesses.** Insulation thicknesses in 780 CMR Table 6106.4.4.1 are based on insulation having thermal resistivity in the range of 4.0 to 4.6 h • ft.<sup>2</sup> • °F/Btu/inch (0.704 to 0.810 m<sup>2</sup>K/W per 25mm) of thickness on a flat surface at a mean temperature of 75°F(24°C).

Minimum insulation thickness shall be increased for materials having values less than 4.0, or shall be permitted to be reduced for materials having thermal resistivity values greater than 4.6 in accordance with 780 CMR Equation 6106.4.4.2(1).

**780CMR EQUATION 6106.4.4.2(1)**

$$4.6 \times \frac{\text{Table 6106.4.4.1 Thickness}}{\text{Actual Resistivity}} = \text{New Minimum Thickness}$$

For materials with thermal resistivity values less than 4.0, the minimum insulation thickness shall be permitted to be increased in accordance with 780 CMR Equation 6106.4.4.2(2).

**780 CMR EQUATION 6106.4.4.2(2)**

$$4.0 \times \frac{\text{Table 6106.4.4.1 Thickness}}{\text{Actual Resistivity}} = \text{New Minimum Thickness}$$



**780 CMR TABLE 6106.4.4.1  
MINIMUM PIPING INSULATION (thickness in inches)**

PIPING SYSTEM TYPES	FLUID TEMPERATURE RANGE, °F	PIPE SIZES <sup>a</sup>					
		Runouts up to 2" <sup>b</sup>	1" and less	1.25" to 2"	2.5" to 4"	5" to 6"	8" and larger
Heating Systems (Steam and Hot Water)							
Low pressure/temperature	201 - 250	1	1 1/2	1 1/2	2	2	2
Low temperature	120 - 200	1/2	1	1	1 1/2	1 1/2	1 1/2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, °C= [(°F)-32]/1.8.

- a. For piping exposed to outdoor air, increase insulation thickness by 0.5 inch.
- b. Runouts not exceeding 12 feet in length to individual terminal units.

**6106.4.4.3 Duct and Plenum Insulation.** All supply and return-air ducts and plenums installed as part of an HVAC air-distribution system shall be thermally insulated in accordance with 780 CMR Table 6106.4.4.3.

**Exceptions:**

1. Factory-installed plenums, casings or ductwork furnished as a part of the HVAC equipment tested and rated in accordance with 780 CMR 6106.4.2.
2. Ducts within the conditioned space that they serve.
3. R-6 duct insulation (minimum) shall be allowed throughout the entire duct distribution system when the equipment being installed meets or exceeds SEER-14 for central air conditioning equipment and AFUE furnace efficiencies of 83%, (oil), or 90%, (gas). Where two appliances are used within the same distribution system, at least one appliance must meet these requirements.

**6106.4.4.4 Duct Construction.** Ductwork shall be constructed and erected in accordance with the International Mechanical Code.

**6106.4.4.4.1 Duct Systems.** All accessible longitudinal and transverse joints, seams and connections of low-pressure supply and return ducts shall be securely fastened and sealed with welds, gaskets, mastics (adhesives) or mastic-plus embedded-fabric systems.

**Exception:** Continuously welded and locking-type longitudinal joints and seams.

**780 CMR TABLE 6106.4.4.3  
MINIMUM DUCT INSULATION<sup>a</sup>**

INSULATION R-VALUE (h • ft <sup>2</sup> • °F)/Btu <sup>d</sup>			
Ducts in unconditioned attics, or outside of building	Ducts in unconditioned basements, crawl spaces, garages, and other unconditioned spaces <sup>c</sup>		
Supply	Return	Supply	Return <sup>b</sup>
8	4	8	2

For SI: °C= [(°F)-32]/1.8, 1 (h • ft<sup>2</sup> • °F)/Btu = 0.176(m<sup>2</sup> • K)/W; 1 foot = 304.5 mm.

- a. Insulation R-values shown are for the insulation as installed and do not include film resistance. The

required minimum R-values do not consider water vapor transmission and condensation. Where control of condensation is required, additional insulation, vapor retarders or both shall be provided to limit vapor transmission and condensation. For ducts that are designed to convey both heated and cooled air, duct insulation shall be as required by the most restrictive condition. Where exterior walls are used as plenums, wall insulation shall be as required for envelope insulation but shall not be less than R-8.

- b. Insulation on return ducts in basements is not required.
- c. Unconditioned spaces include framed cavities in those floor, wall and ceiling assemblies which (1) separate conditioned space from unconditioned space or outside air, and (2) are uninsulated on the side facing away from the condition space.
- d. Insulation resistance measured on a horizontal plane in accordance with ASTM C 518, at a mean temperature of 75°F.

**6106.4.4.4.2 Sealing Required.** Tapes and mastics used with rigid fibrous glass ducts shall be listed and labeled in accordance with UL 181A. Tapes and mastics used with flexible air ducts shall be listed and labeled in accordance with UL 181B. "Duct tape" is not permitted as a sealant on any ducts.

**6106.4.4.5 Mechanical Ventilation.** Each mechanical ventilation system (supply or exhaust, or both) shall be equipped with a readily accessible switch or other 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 shall be provided for outdoor air intakes and exhausts.

**6106.4.4.6 Balancing.** The HVAC system design shall provide means for balancing air and water systems. Balancing mechanisms shall include, but not be limited to, dampers, temperature and pressure test connections, and balancing valves.

**6106.5 Service Water Heating.**

**6106.5.1 Scope.** The purpose of 780 CMR 6106.5 is to provide criteria for design, equipment selection and system construction that will produce energy savings when applied to heated water for other than space conditioning, including

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generation, distribution, controls, storage, heat loss and vapor transmission.

**6106.5.2 Water Supplies.** Water supplies to ice-making machines, refrigerators and toilets shall be taken from a cold-water line of the water distribution system.**6106.5.3 Water Heaters, Storage Tanks and Boilers.** Water heaters, storage tanks and boilers shall meet the performance criteria set forth in 780 CMR 6106.5.3.1 and 6106.5.3.2.

**6106.5.3.1 Performance Efficiency.** Water heaters and hot water storage tanks shall meet the minimum performance of water-heating equipment specified in 780 CMR Table 6106.5.3.1. Where multiple criteria are listed, all criteria shall be met.

**Exception:** Storage water heaters and hot water storage tanks having more than 140 gallons (530 L) of storage capacity need not meet the standby loss (SL) or heat loss (HL) requirements of 780 CMR Table 6106.5.2 if the tank surface area is thermally insulated to R-12.5 and if a standing pilot light is not used.

**6106.5.3.2 Combination Service Water-heating/Space-heating boilers.** Service water-heating equipment shall not be dependent on year-round operation of space-heating boilers; that is, boilers that have as another function winter space heating.

**Exceptions:**

1. Systems with service/space-heating boilers having a standby loss (Btu/h) (W) less than:

**780 CMR EQUATION 6106.5.3.2**

$$(13.3 \text{ } pmd + 400)/n$$

determined by the fixture count method where:

$pmd$  = Probable maximum demand in gallons/hour as determined in accordance with Chapter 37 of the ASHRAE HVAC Systems and Applications Handbook.

$n$  = Fraction of year when outdoor daily mean temperature exceeds 64.9°F (18°C).

The standby loss is to be determined for a test period of 24-hour duration while maintaining a boiler water temperature of 90°F (32°C) above an ambient of 60 to 90°F (16 to 32°C) and a five foot (1524 mm) stack on appliance.

2. For systems where the use of a single heating unit will lead to energy savings, such unit shall be utilized.

**6106.5.4 Swimming Pools.** Swimming pools shall be provided with energy-conserving measures in accordance with 780 CMR 6106.5.4.1 through 6106.5.4.3.

**6106.5.4.1 On-off Switch.** All pool heaters shall be equipped with an ON-OFF switch mounted for easy access to allow shutting off the operation of the heater without adjusting the thermostat setting and to allow restarting without relighting the pilot light.

**6106.5.4.2 Pool Covers.** Heated swimming pools shall be equipped with a pool cover.

**6106.5.4.3 Time Clocks.** Time clocks shall be installed so that the pump can be set to run in the off-peak electric demand period and can be set for the minimum time necessary to maintain the water in a clear and sanitary condition in keeping with applicable health standards.

**6106.5.5 Pump Operation.** Circulating hot water systems shall be arranged so that the circulation pump(s) can be conveniently turned off, automatically or manually, when the hot water system is not in operation.

**780 CMR TABLE 6106.5.3.1  
MINIMUM PERFORMANCE OF WATER HEATING EQUIPMENT**

CATEGORY	TYPE	FUEL	INPUT RATING	$V_T^a$ (gallons)	INPUT TO $V_T$ RATIO (Btuh/gal)	TEST METHOD	ENERGY FACTOR <sup>b</sup>	THERMAL EFFICIENCY $E_t$ (percent)	STANDBY LOSS (percent/hour) <sup>a</sup>
NAECA- covered water-heating equipment <sup>c</sup>	All	Electric	= 12kW	All <sup>e</sup>	—	Note f	= 0.93-0.00132 $V^*$	—	—
	Storage	Gas	= 75,000 Btu/h	All <sup>e</sup>	—	Note f	= 0.62-0.0019 $V^*$	—	—
	Instantaneous	Gas	= 200,000Btu/he	All	—	Note f	= 0.62-0.0019 $V^*$	—	—
	Storage	Oil	= 105,000 Btu/h	All	—	Note f	= 0.59-0.0019 $V^*$	—	—
	Instantaneous	Oil	= 210,000 Btu/h	All	—	Note f	= 0.59-0.0019 $V^*$	—	—
	Pool heater	Gas/oil	All	All	—	Note g	—	= 78%	—
Other water-heating equipment <sup>d</sup>	Storage	Electric	All	All	—	Note h	—	—	= 0.30 + 27/ $V_T^*$
	Storage/ instantaneous	Gas/oil	= 155,000 Btu/h	All	< 4,000	Note h	—	= 78%	= 1.3 + 614/ $V_T^*$
			> 155,000 Btu/ < 10 = 10	All	< 4,000	Note h	—	= 78%	= 1.3 + 95/ $V_T^*$
				All	= 4,000 = 4,000	Note h	—	=80% =77%	= 2.3 + 67/ $V_T^*$
Unfired storage tanks	—	—	—	All	—	—	—	= 6.5 Btuh/ft <sup>2</sup> <sup>i*</sup>	

For SI: 1 Btu/ft<sup>2</sup> = 3.155 W/m<sup>2</sup>, 1 Btu/h = 0.2931 W, 1 gallon = 3.785 L, °C = [(°F)-32]/1.8.

- a.  $V_T$  is the storage volume in gallons as measured during the standby loss test. For the purpose of estimating the standby loss requirement using the rated volume shown on the rating plate,  $V_T$  should be no less than 0.95V for gas and oil water heaters and no less than 0.90V for electric water heaters.
- b. V is rated storage volume in gallons as specified by the manufacturer.
- c. Consistent with National Appliance Energy Conservation Act (NAECA) of 1987.
- d. All except those water heaters covered by NAECA.
- e. DOE CFR 10; Part 430, Subpart B, Appendix E applies to electric and gas storage water heaters with rated volumes 20 gallons and gas instantaneous water heaters with input ratings of 50,000 to 200,000 Btu/h.
- f. DOE CFR 10; Part 430, Subpart B, Appendix E.
- g. ANSI Z21.56.
- h. ANSI Z21.10.3. When testing an electric storage water heater for standby loss using the test procedure of Section 2.9 of ANSI Z21.10.3, the electrical supply voltage shall be maintained within ±1% of the center of the voltage range specified on the water heater nameplate. Also, when needed for calculations, the thermal efficiency ( $E_t$ ) shall be 98%. When testing an oil water heater using the test procedures of Sections 2.8 and 2.9 of ANSI Z21.10.3, the following modifications will be made: A vertical length of the flue pipe shall be connected to the flue gas outlet of sufficient height to establish the minimum draft specified in the manufacturer’s installation instructions. All measurements of oil consumption will be taken by instruments with an accuracy of ± 1% or better. The burner shall be adjusted to achieve an hourly Btu input rate within ± 2% of the manufacturer’s specified input rate with the CO<sub>2</sub> reading as specified by the manufacturer with smoke no greater than 1 and the fuel pump pressure within ± 1% of the manufacturer’s specification.
- i. Heat loss of tank surface area (Btu/h • ft<sup>2</sup>) based on 80°F water-air temperature difference.

\* Minimum efficiencies marked with an asterisk are established by preemptive federal law and are printed for the convenience of the user.

**6106.5.6 Pipe Insulation.** For recirculating systems, piping heat loss shall be limited to a maximum of 17.5 Btu/h per linear foot (16.8 W/m) of pipe in accordance with 780 CMR Table 6106.5.6, which is based on a design external temperature no lower than 65°F (18°C). Other design temperatures must be calculated.

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

**780 CMR TABLE 6106.5.6  
MINIMUM PIPE INSULATION (thickness in inches)**

SERVICE WATER HEATING TEMPERATURES (°F)	PIPE SIZES <sup>a</sup>			
	Noncirculating runouts	Circulating mains and runouts		
		Up to 1"	Up to 1.25"	1.5 to 2"
170-180	0.5	1	1.5	2
140-169	0.5	0.5	1	1.5
100-139	0.5	0.5	0.5	1

For SI: 1 inch = 25.4 mm, °C = [(°F)-32]/1.8,

1 Btu/h/inch • ft<sup>2</sup> • °F = 0.144 W/(m • K).

- a. Nominal iron pipe size and insulation thickness. Conductivity, k = 0.27

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**6106.5.7 Conservation of Hot Water.** Hot water shall be conserved in accordance with 780 CMR 6106.5.7.1.

**6106.5.7.1 Showers.** Shower heads shall have a maximum flow rate of 2.5 gallons per minute (gpm) (0.158 L/s) at a pressure of 80 pounds per square inch (psi) (551 kPa) when tested in accordance with ASME A612.18.1.

**6106.5.8 Heat Traps.** Reserved.

**6106.5.9 Automatic Controls.** Service water-heating systems shall 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 shall be in accordance with Table 2 in Chapter 37 of *ASHRAE HVAC Systems and Applications Handbook*, as listed in 780 CMR 100.00.

**6106.5.10 Shutdown.** A separate switch or valve shall be provided to permit turning off the energy supplied to service water-heating systems.

**6106.6 Electrical Power and Lighting.**

**6106.6.1 Electrical Energy Consumption.** In multi-family dwellings, provisions shall be made to determine the electrical energy consumed by each tenant by separately metering individual dwelling units.

**Exception:** Motels, hotels, college dormitories and other transient facilities.

**780 CMR 6107 ENVELOPE DESIGN COMPLIANCE**

**6107.1 General.** Buildings constructed to 780 CMR 6107 shall also meet the applicable requirements of 780 CMR 6106.

**6107.2 Building Design by Prescriptive Package.**

**6107.2.1 Applicability.** This prescriptive package approach is intended for one- and two-family detached buildings of wood frame or mass wall construction (concrete, masonry, log). Metal frame buildings are excluded. This approach may be used for all climate zones,

regardless of glazing percentage.

**6107.2.2 Envelope Requirements.** Component values shall be taken from 780 CMR Table 6107.1.

**6107.3 Building Design by Approved Software.**

**6107.3.1 Applicability.** This software approach may be utilized for all low-rise residential buildings covered by 780 CMR 51.00 through 99.00.

**6107.3.2 Envelope Requirements.** To determine compliance with the various wall, roof and floor assemblies, and heating and/or cooling system efficiencies, a REScheck Version 4.1.2 (October 2007) or later variant Software analysis must be completed, and the “Your UA” value must be less than or equal to the “Max. UA” value calculated by the software.

**6107.3.3 Submittal.** The “Compliance Report” and “Inspection Checklist” of the REScheck Program shall be submitted to the local building department before a permit is issued. A window schedule including the areas (based on rough opening), and the number of windows, skylights and other glazed fenestration, shall also be submitted.

**780 CMR 6108 BUILDING DESIGN BY SYSTEMS ANALYSIS AND DESIGN OF BUILDINGS UTILIZING RENEWABLE ENERGY SOURCES**

**6108.1 General.** 780 CMR 6108 establishes design criteria in terms of total energy use by a residential building, including all of its systems.

**6108.2 Energy Analysis.** Conform to the requirements of the applicable Sections of 780 CMR Chapter 13 of the *Sixth Edition, Massachusetts State Building Code* and with recognition of the amended efficiency requirements of NAECA, if applicable.

**780 CMR 6109 BUILDING DESIGN BY HOME ENERGY RATING**

Reserved

**780 CMR TABLE 6107.1  
PRESCRIPTIVE ENVELOPE COMPONENT CRITERIA FOR NEW ONE- AND TWO-FAMILY BUILDINGS<sup>a</sup>**

MAXIMUM	MINIMUM							
Fenestration <i>U</i> -factor	Ceiling or Exposed Floors <i>R</i> -Value	Wall <i>R</i> -Value	Floor <i>R</i> -Value	Basement Wall <i>R</i> -Value	Slab Perimeter <i>R</i> -Value and Depth	AFUE	HSPF	SEER
0.35	R-38	R-19	R-19	R-10	R-10, 4 ft	National Appliance Energy Conservation Act (NAECA) of 1987 as amended, minimums or greater as applicable		

For SI: 1 foot = 304.8 mm.

a. R-values are for insulation materials only, not for overall component.