

## CHAPTER 11 ENERGY EFFICIENCY

### SECTION N1101 GENERAL

**N1101.1 Scope.** This chapter sets forth energy-efficiency related requirements for the design and construction of buildings regulated by this code.

**Exceptions:**

1. Portions of the building thermal envelope that do not enclose conditioned space.
2. Portions of the building that are designated by ordinance as a historical building when provisions of this code will affect the historical designation of the building.

**N1101.2 Compliance.** Compliance with this chapter shall be demonstrated by meeting either the requirements of the applicable sections and tables of this chapter or the *City of Houston Residential Energy Conservation Code*.

**N1101.2.1 Climate Data.** The City of Houston climate zone is 2A and is designated as a warm-humid climate.

**N1101.2.2 Phased standards.** Provisions requiring increased energy efficiency shall be phased in as provided by Section N1101.4.

**N1101.3 Materials and equipment.** Materials and equipment shall be identified in a manner that will allow a determination of their compliance with the provisions of this chapter. Materials and equipment used to conform to the applicable provisions of this chapter shall be installed in accordance with the manufacturer's installation instructions.

**N1101.3.1 Insulation.** The thermal resistance (*R*-value) shall be indicated on all insulation and the insulation installed such that the *R*-value can be verified during inspection, or a certification of the installed *R*-value shall be provided at the job site by the insulation installer. Where blown-in or sprayed insulation is applied in walls, the installer shall provide a certification of the installed density and *R*-value. Where blown-in or sprayed insulation is applied in the roof-ceiling assembly, the installer shall provide a certification of the initial installed thickness, settled thickness, coverage area, and number of bags of insulating material installed. Markers shall be provided for every 300 square feet (28

m<sup>2</sup>) of attic area, attached to the trusses, rafters, or joists, and indicate in 1-inch-high (25.4 mm) numbers the installed thickness of the insulation. Insulation material used in layers, such as framing cavity insulation and insulation sheathing, shall be summed to compute the component *R*-value. The manufacturer's settled *R*-value shall be used for blown insulation. Computed *R*-values shall not include an *R*-value for other building materials or air films.

**N1101.3.2 Fenestration.** The *U*-factor of fenestration shall be determined in accordance with NFRC 100 by an accredited, independent laboratory, and labeled and certified by the manufacturer. The solar heat gain coefficient (SHGC) of fenestration shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer.

**N1101.3.2.1 Default fenestration performance.** When a manufacturer has not determined a fenestration product's *U*-factor in accordance with NFRC100, compliance shall be determined by assigning such products a default *U*-factor from Tables 102.1.3(1) and 102.1.3(2) in the *City of Houston Residential Energy Conservation Code*. When a manufacturer has not determined a fenestration product's SHGC in accordance with NFRC 200, compliance shall be determined by assigning such products a default SHGC from Table 102.1.3(3) of the *City of Houston Residential Energy Conservation Code*.

**N1101.3.2.2 Air leakage.** The air leakage of prefabricated fenestration shall be determined in accordance with AAMA/WDMA 101/I.S.2 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Alternatively, the manufacturer shall certify that the fenestration is installed in accordance with Section 402.4.1 of the *City of Houston Residential Energy Conservation Code*.

**N1101.3.3 Maintenance.** Where mechanical or plumbing system components require preventive maintenance for efficient operation, regular maintenance requirements shall be clearly stated and affixed to the component, or the source for such information shall be shown on a label attached to the component.

**N1101.3.4 Certificate.** A permanent certificate shall be posted on or in the electrical distribution panel. The certificate shall be completed either by the builder or registered design professional. The certificate shall list the predominant R-values of insulation installed in or on ceiling/roof, walls, foundation (slab, basement wall, crawl space wall and/or floor) and ducts outside conditioned spaces; U-factors for fenestration, and the solar heat gain coefficient (SHGC) of fenestration. Where there is more than one value for each component, the certificate shall list the value covering the largest area. The certificate shall list the type and efficiency of heating, cooling and service water heating equipment.

#### **N1101.4 Phased standards.**

**N1101.4.1 General.** For any permit application filed on or after October 1, 2009, compliance with additional performance objectives for new construction and additions over 500 square feet shall be required to achieve minimum fifteen percent improvement in efficiency above the minimum provisions of this code.

**N1101.4.2 Energy use.** New residences and apartments and new additions that exceed 500 square feet to existing residences or apartments must use 15 percent less energy as shown by one of the methods indicated in Sections N1101.4.2.1 through N1101.4.2.3.

**N1101.4.2.1 Energy Star.** The United States Environmental Protection Agency's ENERGY STAR Program certification of energy code equivalency; or

**N1101.4.2.2 Software and Testing.** Energy code compliance modeling through Texas A&M Energy Systems Laboratory approved software, along with testing of the building thermal envelope for infiltration and the duct system for leakage; or

**N1101.4.2.3 Option Packages.** Prescriptive option packages approved by Texas A&M Energy Systems Laboratory and listed in Table N1101.4.2.

**N1101.4.3 Testing.** When required by Section N1101.4.2.2 testing shall be performed

according to Sections N1101.4.3.1 and N1101.4.3.2. Batch testing shall be permitted as approved by the Building Official.

#### **N1101.4.3.1 Testing of the Building Thermal Envelope for Infiltration.**

Leakage of the building thermal envelope shall not exceed .50 Air Changes per Hour (ACHn) as measured by the blower door test. The testing procedure shall be based on ASTM E779, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization, or ANSI/ASHRAE 136, A Method of Determining Air Change Rates in Detached Dwellings.

Testing shall be performed by an independent third-party technician approved by the building official. Documentation verifying thermal envelope air leakage equal to or less than .50 ACHn shall be submitted with the final mechanical code compliance package on the jobsite and include the following information:

- a. Address of residence
- b. Name and company of technician performing testing
- c. Date of final test
- d. Test results as percentage ACHn

**Exception:** Existing construction where the volume of the conditioned space is unchanged.

#### **N1101.4.3.2 Testing of Duct Systems for Leakage.**

Leakage of supply ducts and return plenum/ducts shall not exceed 10% of total design airflow. The testing procedure shall be based on ASTM E1554, Standard Test Methods for Determining External Air Leakage of Air Distribution Systems by Fan Pressurization, ASHRAE 111 Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems, ASHRAE 152-2004, Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems, or a generally accepted equivalent method.

**TABLE N1101.4.2  
COMBINED ENERGY SAVINGS FOR ONE AND TWO FAMILY STRUCTURES WITH  
NATURAL GAS HEATING**

Groups	Measures	Notes	Combined Energy Savings
Group 1	Solar Domestic Hot Water System 80 gal	1	18.5 %
Group 2	Photovoltaic Array for 6kW	2	32.4 %
Group 3	Photovoltaic Array for Partial Demand at 4kW	3	21.6 %
Group 4	Mechanical Systems within Conditioned Spaces	5	18.3 %
	50% Energy Star CFL Indoor Lamps	6	
Group 5	Photovoltaic Array for Partial Demand at 2kW	4	19.3 %
	Decreased Duct Leakage (from 30% to 10%)	8	
Group 6	50% Energy Star CFL Indoor Lamps	6	16.4 %
	Tankless water heater (from .54 to .748 Energy Factor)	9	
	Decreased Infiltration (from .462 to .35 ACHn)	10	
Group 7	50% Energy Star CFL Indoor Lamps	6	17.5 %
	Decreased Duct Leakage (from 30% to 10%)	8	
	Improved SEER (from 13 to 15)	10	
Group 8	Decreased Duct Leakage (from 30% to 10%)	8	18.6 %
	Improved SEER (from 13 to 15)	11	
	Decreased SHGC (from .4 to .3) & U-Value (from .47 to .35)	12	
	Decreased Infiltration (from .462 to .35 ACHn)	10	
Group 9	Decreased Duct Leakage (from 30% to 10%)	8	16.8 %
	Decreased Duct Static Pressure (from 1.0 inch to .5 inch)	13	
	Decreased SHGC (from .4 to .3) & U-Value (from .47 to .35)	12	
	Window Shading and Redistribution (E/W = 16.27%, S= 48.82%, N=27.12%)	14	
Group 10	Improved Furnace Efficiency (from .78 to .93 AFUE)	15	17.3 %
	Decreased Infiltration (from .462 to .35 ACHn)	10	
	Decreased Duct Leakage (from 30% to 10%)	8	
	Improved SEER (from 13 to 15)	11	

**Notes:**

1. Solar Domestic Hot Water System: *Storage tank type 80 gallon DHW heater with 64 square feet collector area*
2. Photovoltaic Array for 6kW: *Equivalent to 30 panels at 205 watts each at minimum 16% efficiency*
3. Photovoltaic Array for Partial Demand at 4kW: *Equivalent to 20 panels at 205 watts each at minimum 16% efficiency*
4. Photovoltaic Array for Partial Demand at 2kW: *Equivalent to 10 panels at 205 watts each at minimum 16% efficiency*
5. Mechanical Systems within Conditioned Spaces: *Equipment and ducts in ventilated attic moved to location within the thermal envelope of conditioned space including unventilated attic space*
6. 50% Energy Star CFL Indoor Lamps: *Permanent Compact Florescent fixtures excluding closets*
7. Reserved
8. Decreased Duct Leakage (from 30% to 10%): *Ducts tested with less than 10 % leakage as a percentage of air handler rated airflow at 360 CFM / ton*
9. Tankless water heater (from .54 to .748 Energy Factor for Electric/Gas house) *Manufacturer's rating*
10. Decreased Infiltration (from .462 to .35 ACHn): *Base case formula for ACHn is Normalized Leakage 0.57 x Weather Factor 0.8*
11. Improved SEER (from 13 to 15): *Manufacturer's rating*
12. Decreased SHGC (from .4 to .3) & U-factor (from .47 to .35): *NFRC 100 and 200*
13. Decreased Duct Static Pressure (from 1.0 inch to .5 inch): *Measured per NCI std and certified by third party not to exceed 0.5" wc*
14. Window Shading and Redistribution (E/W = 16.27%, S= 48.82%, N=27.12%); *Window orientation with overhang on all sides*
15. Improved Furnace Efficiency (from .78 to .93 AFUE): *Manufacturer's rating*

Testing shall be performed by an independent third-party technician approved by the building official. Documentation verifying duct leakage of less than 10% shall be submitted with the final mechanical code compliance package on the jobsite. Documentation shall include the following:

1. Address of residence
2. Date of final test
3. Name and company of technician performing duct testing
4. Type of test performed (duct pressurization method or blower door subtraction method)
5. Test results in percentage of airflow CFM

**Exception:** Existing construction with no modification of or addition to the existing ductwork.

## SECTION N1102 BUILDING ENVELOPE

**N1102.1 Thermal performance criteria.** The building thermal envelope shall meet the requirements of either Table N1102.1(1) when the total percentage of glazing is less than or equal to 18% of the conditioned floor area or Table N1102.1(2) for window to wall area ratios.

When compliance using Table N1102.1(1) is demonstrated with a ceiling R-value of R-30 or less, no more than 33% of the total projected ceiling area may be of cathedral type construction (ceiling joist/roof rafter assembly) and the required insulation R-value may be reduced to a minimum of R22 insulation when the remaining ceiling area insulation is increased to R-38.

**TABLE N1102.1(1)  
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT (BASED ON WINDOW TO SQUARE FOOTAGE RATIO)<sup>a</sup>**

FENESTRATION U-FACTOR	SKYLIGHT <sup>b</sup> U-FACTOR	GLAZED FENESTRATION SHGC	CEILING R-VALUE	MASS WALL R-VALUE	WOOD FRAME WALL R-VALUE	FLOOR R-VALUE	SLAB <sup>d</sup> R-VALUE & DEPTH	CRAWL SPACE WALL R-VALUE
0.75	0.75	0.40	30	4	13	13	0	0

a.R-values are minimums. U –factors and SHGC are maximums. R-19 shall be permitted to be compressed into a 2 x 6 cavity.

b.The fenestration U-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

c.The first R-value applies to continuous insulation, the second to framing cavity insulation; either insulation meets the requirement.

d.R-5 shall be added to the required slab edge r-values for heated slabs.

**TABLE N1102.1(2)  
INSULATION AND FENESTRATION REQUIRMENTS BY COMPONENT(BASED ON WINDOW TO WALL RATIO)<sup>a</sup>**

Maximum Window to Wall Area Ratio	Fenestration U-Factor	Skylight U-Factor <sup>b</sup>	Glazed Fenestration SHGC	Ceiling R-Value <sup>c</sup>	Wood Frame Wall R-Value	Floor R-Value	Slab R-Value & Depth <sup>d</sup>	Crawl Space Wall R-Value
15	0.65	0.65	0.40	30	13	11	0	6
20	0.55	0.55	0.40	30	13	11	0	6
25	0.51	0.51	0.35	30	13	19	0	10
30	0.46	0.46	0.35	38	16	19	0	10

For SI: 1 foot = 304.8 mm.

a. R-values are minimums. U-factors and SHGC are maximums. R-19 shall be permitted to be compressed into a 2 x 6 cavity.

b. The fenestration U-factor column excludes skylights. The SHGC column applies glazed fenestration.

c. If a roof radiant barrier with an emittance of 0.05 or less as tested in accordance with ASTM C-1371 or ASTM E-408 is used, then the roof/ceiling minimum insulation value shall be R-19.

d. R-5 shall be added to the required slab edge R-values for heated slabs.

**N1102.1.1 Exterior walls.** The minimum required *R*-value in Table N1102.1(1) or N1102.1(2) shall be met by the sum of the *R*-values of the insulation materials installed in framing cavities and/or insulating sheathing applied, and not by framing, drywall, structural sheathing, or exterior siding materials. Insulation separated from the conditioned space by a vented space shall not be counted towards the required *R*-value.

**N1102.1.1.1 Specific insulation requirements. (Prescriptive)**

**N1102.1.1.1.1 Ceilings with attic spaces.** When Section N1102.1 would require R-38 in the ceiling, R-30 shall be deemed to satisfy the requirement for R-38 wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Similarly R-38 shall be deemed to satisfy the requirement for R-49 wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves.

**N1102.1.1.1.2 Ceilings without attic spaces.** Where Section N1102.1 would require insulation levels above R-30 and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation for such roof/ceiling assemblies shall be R-30. This reduction of insulation from the requirements of Section N1102.1.1 shall be limited to 500 square feet (46 m<sup>2</sup>) of ceiling area.

**N1102.1.1.1.3 Mass walls.** Mass walls for the purposes of this chapter shall be considered walls of concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth (adobe, compressed earth block, rammed earth) and solid timber/logs. The provisions of Section N1102.1.1 for mass walls shall be applicable when at least 50 percent of the required insulation *R*-value is on the exterior of, or integral to, the wall. Walls that do not meet this criterion for insulation placement shall meet the wood frame wall insulation requirements of Section N1102.1.1.

**Exception:** For walls that do not meet the criterion for insulation placement, the

minimum added insulation *R*-value shall be permitted to be an *R*-value of 6.

**N1102.1.1.1.4 Steel-frame ceilings, walls and floors.** Steel frame ceilings, walls and floors shall meet the insulation requirements of Table N1102.1.1.1.4. The calculation of the *U*-factor for a steel-frame envelope assembly shall use a series-parallel path calculation method.

**TABLE N1102.1.1.1.4  
STEEL-FRAME CEILING, WALL AND  
FLOOR INSULATION  
(R-VALUE)**

WOOD FRAME R-VALUE REQUIREMENT	COLD-FORMED STEEL EQUIVALENT R-VALUE <sup>a</sup>
<b>Steel Truss Ceilings<sup>b</sup></b>	
R-30	R - 38 or R - 30 + 3 or R - 26 + 5
R-38	R - 49 or R - 38 + 3
R-49	R-38+5
<b>Steel Joist Ceilings<sup>b</sup></b>	
R-30	R - 38 in 2×4 or 2×6 or 2×8 R - 49 in any framing
R-38	R - 49 in 2×4 or 2×6 or 2×8 or 2×10
<b>Steel Framed Wall</b>	
R-13	R - 13 + 5 or R - 15 + 4 or R - 21 + 3
R-19	R - 13 + 9 or R - 19 + 8 or R - 25 + 7
R-21	R - 13 + 10 or R - 19 + 9 or R - 25 + 8
<b>Steel Joist Floor</b>	
R-13	R - 19 in 2×6 R - 19 + 6 in 2×8 or 2×10
R-19	R - 19 + 6 in 2×6 R - 19 + 12 in 2×8 or 2×10

- a. Cavity insulation *R*-value is listed first, followed by continuous insulation *R*-value.
- b. Insulation exceeding the height of the framing shall cover the framing.

**N1102.1.2 Reserved.**

**N1102.1.3 Opaque doors.** Opaque doors separating conditioned and unconditioned space shall have a maximum *U*-factor of 0.75. One opaque door shall be permitted to be exempt from this *U*-factor requirement.

**N1102.1.4 Floors.** The required *R*-value in Table N1102.1 shall apply to all floors, except any individual floor assembly with over 25 percent of its conditioned floor area exposed directly to outside air shall meet the *R*-value

requirement in Section N1102.1 for “Ceilings.” Floor insulation shall be installed to maintain permanent contact with the underside of the subfloor decking.

**N1102.1.5 Basement walls.** When the basement is a conditioned space, the basement walls shall be insulated in accordance with Section N1102.1. When the basement is not a conditioned space, either the basement walls or the ceilings separating the basement from conditioned space shall be insulated in accordance with Section N1102.1. When insulating basement walls, the required *R*-value shall be applied from the top of the basement wall to a depth of 10 feet (3048 mm) below grade or to the top of the basement floor, whichever is less.

➔ **N1102.1.6 Reserved.**

**N1102.1.7 Crawl space walls.** Where the floor above the crawl space is uninsulated, insulation shall be installed on crawl space walls when the crawl space is not vented to outside air. The required *R*-value in Table N1102.1 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). 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. All joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend at least 6 inches (153 mm) up the stem wall and shall be attached to the stem wall.

**N1102.1.8 Masonry veneer.** For exterior foundation insulation, that horizontal portion of the foundation that supports a masonry veneer shall not be required to be insulated.

**N1102.1.9 Protection.** Exposed insulating materials applied to the exterior of foundation walls shall be protected. The protection shall extend at least 6 inches (152 mm) below finished grade level.

**N1102.1.10 Air leakage.** The building thermal envelope shall be durably sealed to limit infiltration. The sealing methods between dissimilar materials shall allow for differential expansion and contraction. The following shall

be gasketed, weatherstripped or otherwise sealed with an air barrier material, suitable film or solid material:

1. All joints, seams and penetrations.
2. Site-built windows, doors and skylights.
3. Openings between window and door assemblies and their respective jambs and framing.
4. Utility penetrations.
5. Dropped ceilings or chases adjacent to the thermal envelope.
6. Knee walls.
7. Walls and ceilings separating a garage from conditioned spaces.
8. Behind tubs and showers on exterior walls.
9. Common walls between dwelling units.
10. Other sources of infiltration

**N1102.2 Maximum solar heat gain coefficient for fenestration products.** The area-weighted-average solar heat gain coefficient (SHGC) for glazed fenestration installed shall not exceed 0.40.

**N1102.3 Fenestration exemption.** Up to 15 square feet (1.4 m<sup>2</sup>) of glazed fenestration per dwelling unit shall be exempt from U-factor and the SHGC requirements.

**N1102.4 Replacement fenestration.** Where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the new fenestration shall meet the applicable U-factor and SHGC requirements in Section N1102.1.

## SECTION N1103 MECHANICAL SYSTEMS

**N1103.1 Heating and air conditioning appliance and equipment performance.** Performance of equipment listed in Table N1103.1 is covered by preemptive Federal law. Appliances and equipment not listed in Table N1103.1 shall meet the minimum efficiency requirements of the *City of Houston Commercial Energy Conservation Code*.

**N1103.2 Controls.** At least one thermostat shall be provided for each separate heating, cooling, or combination heating and cooling system. Heat

pumps shall have controls that prevent supplementary electric resistance heater operation when the heating load can be met by the heat pump alone. Supplementary heater operation shall be permitted during outdoor coil defrost cycles not exceeding 15 minutes.

**N1103.3 Duct insulation.** All portions of the air distribution system shall be installed in accordance with Section M1601 and be insulated to an installed R-5 when system components are located within the building but outside of conditioned space, and R-8 when located outside of the building. When located within a building envelope assembly, at least R-8 shall be applied

between the duct and that portion of the assembly furthest from conditioned space.

**Exceptions:** Exhaust air ducts and portions of the air distribution system within appliances or equipment.

**N1103.4 Duct sealing.** All ducts shall be sealed in accordance with Section M1601.3.1.

**N1103.5 Piping insulation.** All mechanical system piping shall be insulated in accordance with Table N1103.5.

**Exceptions:** Piping installed within appliances and equipment or piping serving fluids between 55°F (13°C) and 120°F (49°C).

**TABLE N1103.1  
MINIMUM EQUIPMENT PERFORMANCE**

EQUIPMENT CATEGORY	SUB-CATEGORY <sup>e</sup>	REFERENCED STANDARD	MINIMUM PERFORMANCE
Air-cooled heat pumps heating mode < 65,000 Btu/h cooling capacity	Split systems	ARI210-240	6.8 HSPI <sup>a,b</sup>
	Single Package		6.8 HSPI <sup>a,b</sup>
Gas-fired or oil-fired furnace < 25,000 Btu/h	-	DOE 10 CFR Part 430, Subpart B, Appendix N	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 N	AFUE 78% <sup>b,d</sup>
Air-cooled air conditioners and heat pumps cooling mode < 65,000 Btu/h cooling capacity	Split systems	ARI 210-240	10.0 SEER <sup>b</sup>
	Single package		9.7 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).
- 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 percent.
- e. Seasonal rating.

**TABLE N1103.5  
MINIMUM PIPE INSULATION (thickness in inches)**

PIPING SYSTEM TYPES	FLUID TEMPERATURE RANGE, °F	Pipe Sizes <sup>a, b</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
<b>HEATING SYSTEMS</b>							
Steam and hot water:							
High pressure/temperature	306-450	1 ½	2 ½	2 ½	3	3 ½	3 ½
Medium pressure/temperature	251-305	1 ½	2	2 ½	2 ½	3	3
Low pressure/temperature	201-250	1	1 ½	1 ½	2	2	2
Low temperature	106-200	½	1	1	1 ½	1 ½	1 ½
Steam condensate (for feed water)	Any	1	1	1 ½	2	2	2
<b>COOLING SYSTEMS</b>							
Chilled water, refrigerant and brine:	40-55	¾	¾	¾	1	1	1
	Below 40	1	1	1 ½	1 ½	1 ½	1 1/2

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

- a. Inside pipe diameter.
- b. Runouts not exceeding 12 feet in length to individual terminal units.

**SECTION N1104**

**SERVICE WATER HEATING**

**N1104.1 Water heating appliance and equipment performance.** Performance of equipment listed in Table N1104.1 is covered by preemptive Federal law. Appliances and equipment not listed in Table N1104.1 shall meet the minimum efficiency requirements of the *City of Houston Commercial Energy Conservation Code*.

**N1104.2 Circulating hot water systems.** All circulating service hot water piping shall be insulated in accordance with Table N1104.2. Circulating hot water systems shall include an automatic or readily accessible manual switch that can turn off the hot water circulating pump when the system is not in use.

**TABLE N1104.1  
REQUIRED PERFORMANCE OF DOMESTIC HOT WATER HEATING EQUIPMENT  
SUBJECT TO MINIMUM FEDERAL STANDARDS**

CATEGORY	MAXIMUM INPUT RATING	MINIMUM EFFICIENCY
Electric; storage or instantaneous	12kW	0.93-0.00132 x V <sup>a</sup>
Gas; storage	75,000 Btu/h	0.62-0.0019 x V <sup>a</sup>
Gas; instantaneous	200,000 Btu/h	0.62-0.0019 x V <sup>a</sup>
Oil; Storage	105,000 Btu/h	0.59-0.0019 x V <sup>a</sup>
Oil; instantaneous	210,000 Btu/h	0.59-0.0019 x V <sup>a</sup>

For SI: 1 Btu/h = 0.2931 W, 1 gallon=3.785 L.

a. V is the rated storage volume in gallons as specified by the manufacturer.

**TABLE N1104.2  
HOT WATER PIPING INSULATION**

SERVICE WATER-HEATING TEMPERATURES (°F)	PIPE SIZES <sup>a</sup>			
	Non-circulating 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