



**BSR/ASHRAE/IES Addendum e  
to ANSI/ASHRAE/IES Standard 90.1-2019**

**Public Review Draft**

# **Proposed Addendum e to Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings**

**First Public Review (March 2020)  
(Draft Shows Proposed Changes to Current Standard)**

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## FOREWORD

This addendum is intended to:

1. Create requirements for the insulation of hot gas refrigerant piping used for space heating or service water heating.
2. Clarify that service water piping insulation requirements apply only to piping not supplied by the manufacturer of the service water heating equipment.
3. Update the title of Table 6.8.3-1 to reflect current definitions.

### Hot gas refrigerant piping

Hot gas refrigerant is widely used as a fluid for space heating systems and gaining popularity as a fluid for service water heating systems. But unlike other the other fluids used for heating – water and steam – there are no requirements for piping insulation. This addendum introduces requirements.

SSPC 90.1 reviewed the insulation requirements in Table 6.8.3-1 during the 2010 cycle and updates were published in that version of the standard. The Mechanical Subcommittee believes that the analysis is still applicable and hot gas refrigerant piping insulation should meet the same requirements as other fluids used for heating. Users should be aware of note c to the table, which allows a reduction of up to 1 inch of insulation thickness for piping of diameter 1.5 inches or less that is located within partitions of conditioned spaces. For reference, the definitions for space types are shown below:

**space:** an *enclosed space* within a *building*. The classifications of *spaces* are as follows for the purpose of determining *building envelope* requirements:

**conditioned space:** a *cooled space*, *heated space*, or *indirectly conditioned space* defined as follows:

- a. **cooled space:** an *enclosed space* within a *building* that is cooled by a *cooling system* whose sensible output capacity is 3.4 Btu/h·ft<sup>2</sup> of floor area.
- b. **heated space:** an *enclosed space* within a *building* that is heated by a *heating system* whose output capacity relative to the floor area is greater than or equal to the criteria in Table 3.2.
- c. **indirectly conditioned space:** an *enclosed space* within a *building* that is not a *heated space* or a *cooled space*, which is heated or cooled indirectly by being connected to adjacent *spaces*, provided:
  1. the product of the *U-factors* and surface areas of the *space* adjacent to connected *spaces* exceeds the combined sum of the product of the *U-factors* and surface areas of the *space* adjoining the outdoors, *unconditioned spaces*, and to or from *semiheated spaces* (e.g., corridors) or
  2. that air from heated or *cooled spaces* is intentionally transferred (naturally or mechanically) into the *space* at a rate exceeding 3 ach (e.g., atria).

**semiheated space:** an *enclosed space* within a *building* that is heated by a *heating system* whose output

capacity is greater than or equal to 3.4 Btu/h·ft<sup>2</sup> of floor area but is not a *conditioned space*.

***unconditioned space:*** an *enclosed space* within a *building* that is not a *conditioned space* or a *semiheated space*. Crawlspace, attics, and parking garages with natural or mechanical *ventilation* are not considered *enclosed spaces*.

For hot gas refrigerant used for space heating, users shall use the insulation thickness required for fluids in the temperature range of 141 °F to 200 °F (61°C to 93°C). For service hot water heating, users shall use the insulation thickness required for fluids in the temperature range of 201 °F to 250 °F (94°C to 121°C). The difference is driven by the fact that space heating is only used during cooler weather, while service water heating is year-round. It is understood that some refrigerants, particularly CO<sub>2</sub>, may have higher compressor discharge temperatures than others, but it was decided that the value of simplified compliance and enforcement outweighs the value of requiring users to determine discharge temperatures.

It is important to note that the term “hot gas refrigerant” does not include refrigerant in liquid state after passing through the indoor heat exchanger, and these requirements do not apply to liquid lines in which refrigerant is returning to the compressor.

### **Insulation requirements apply to piping not supplied by the manufacturer**

Section 6, which applies to HVAC equipment, exempts piping inside equipment supplied by an equipment manufacturer from the insulation requirements in 6.8.3, as the performance of the equipment is rated as the equipment is built. The same should apply to service water heating equipment.

Reviewers may note that the language specifies “...piping not supplied by the manufacturer,” which is slightly broader than the HVAC exemption. This language was chosen because it is not uncommon for service hot water heating equipment to include piping outside of a casing and be rated for performance with that configuration. The committee considered language that would require that the piping be part of the rated unit but decided that such a distinction would be difficult for an Authority Having Jurisdiction to verify.

### **Title Updates**

- The phrase “hot water heating” in the title changed to “service water heating” to match the defined term used in this standard.
- The word space is added to define heating.
- The redundant subtitle is deleted.

*[Note to Reviewers: This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~striketrough~~ (for deletions) except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the current standard are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed changes.]*

### **Addendum e to 90.1-2019**

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**Change Table 6.8.3-1 and Section 7.4.3 as shown [I-P]:**

### 6.8.3 Piping Insulation Tables

**Table 6.8.3-1 Minimum Piping Insulation Thickness for Space Heating and Hot Service Water Heating Systems<sup>a,b,c,d,e,f,g</sup>**  
 (~~Steam, Steam Condensate, Hot Water Heating and Domestic Water Systems~~)

Fluid Operating Temperature Range (°F) and Usage	Insulation Conductivity		≥Nominal Pipe or Tube Size, in.				
	Conductivity, Btu·in/h·ft <sup>2</sup> ·°F	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350	0.32 to 0.34	250	4.5	5.0	5.0	5.0	5.0
251 to 350	0.29 to 0.32	200	3.0	4.0	4.5	4.5	4.5
201 to 250	0.27 to 0.30	150	2.5	2.5	2.5	3.0	3.0
141 to 200	0.25 to 0.29	125	1.5	1.5	2.0	2.0	2.0
105 to 140	0.22 to 0.28	100	1.0	1.0	1.5	1.5	1.5

- For insulation outside the stated conductivity range, the minimum thickness ( $T$ ) shall be determined as follows:  $T = r\{(1+t/r)^{K/k} - 1\}$ , where  $T$  = minimum insulation thickness (in.),  $r$  = actual outside radius of pipe (in.),  $t$  = insulation thickness listed in this table for applicable fluid temperature and pipe size,  $K$  = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature [Btu·in/h·ft<sup>2</sup>·°F], and  $k$  = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- These thicknesses are based on *energy efficiency* considerations only. Additional insulation is sometimes required relative to safety issues/surface temperature.
- For *piping* smaller than 1.5 in. and located in partitions within *conditioned spaces*, reduction of these thicknesses by 1 in. shall be permitted (before thickness adjustment required in footnote [a]) but not to thicknesses below 1 in.
- For direct-buried heating and service hot-water heating system piping, reduction of these thicknesses by 1.5 in. shall be permitted (before thickness adjustment required in footnote [a]) but not to thicknesses below 1 in.
- The table is based on steel pipe. Nonmetallic pipes schedule 80 thickness or less shall use the table values. For other nonmetallic pipes having *thermal resistance* greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown in the table.
- For systems providing hot gas refrigerant intended for space heating, the fluid operating temperature range used to determine insulation thickness shall be 141°F to 200°F.
- For systems providing hot gas refrigerant intended for service water heating, the fluid operating temperature range used to determine insulation thickness shall be 201°F to 250°F.

### 7.4.3 Service Hot-Water Heating Piping and Refrigerant Hot Gas Piping Insulation

The following *piping* shall be insulated to levels shown in Section 6, Table 6.8.3-1:

...

- Refrigerant hot gas *piping* for heat pump *service water heating systems*.

#### Exceptions to 7.4.3

- Piping* inside the *equipment* cabinet supplied by the *manufacturer*.
- Service water heating piping* supplied as part of the *equipment* by the *manufacturer*.

**Change Table 6.8.3-1 and Section 7.4.3 as shown [SI]:**

**6.8.3 Piping Insulation Tables**

**Table 6.8.3-1 Minimum Piping Insulation Thickness for Space Heating and Hot Service Water Heating Systems<sup>a,b,c,d,e,f,g</sup>  
 (Steam, Steam Condensate, Hot-Water Heating and Domestic Water Systems)**

Fluid Operating Temperature Range (°C) and Usage	Insulation Conductivity		≥Nominal Pipe or Tube Size, mm				
	Conductivity, W/(m·°C)	Mean Rating Temperature, °C	<25	25 to <40	40 to <100	100 to <200	≥200
			Insulation Thickness, mm				
>177	0.046 to 0.049	121	115	125	125	125	125
122 to 177	0.042 to 0.046	93	80	100	115	115	115
94 to 121	0.039 to 0.043	66	65	65	80	80	80
61 to 93	0.036 to 0.042	52	40	40	50	50	50
41 to 60	0.032 to 0.040	38	25	25	40	40	40

- a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:  $T = r\{(1 + t/r)K/k - 1\}$ , where T = minimum insulation thickness (mm), r = actual outside radius of pipe (mm), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature [W/(m·°C)]; and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- b. These thicknesses are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.
- c. For piping smaller than 40 mm and located in partitions within conditioned spaces, reduction of these thicknesses by 25 mm shall be permitted (before thickness adjustment required in footnote [a]) but not to thicknesses below 25 mm.
- d. For direct-buried heating and hot-water system piping, reduction of these thicknesses by 40 mm shall be permitted (before thickness adjustment required in footnote[a]) but not to thicknesses below 25 mm.
- e. The table is based on steel pipe. Nonmetallic pipes schedule 80 thickness or less shall use the table values. For other nonmetallic pipes having thermal resistance greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown in the table.
- f. For systems providing hot gas refrigerant intended for space heating, the fluid operating temperature range used to determine insulation thickness shall be 61°C to 93°C.
- g. For systems providing hot gas refrigerant intended for service water heating, the fluid operating temperature range used to determine insulation thickness shall be 94°C to 121°C.

**7.4.3 Service Hot-Water Heating Piping and Refrigerant Hot Gas Piping Insulation**

The following *piping* shall be insulated to levels shown in Section 6, Table 6.8.3-1:

...

- f. Refrigerant hot gas piping for heat pump service water heating systems.

**Exceptions to 7.4.3**

1. Piping inside the equipment cabinet supplied by the manufacturer.
2. Service water heating piping supplied as part of the equipment by the manufacturer.