



**BSR/ASHRAE/IES Addendum bk
to ANSI/ASHRAE/IES Standard 90.1-2022**

Public Review Draft

Proposed Addendum bk to Standard 90.1-2022, Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings

**First Public Review (December 2024)
(Draft Shows Proposed Changes to Current Standard)**

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FOREWORD

This addendum establishes requirements that HVAC systems that serve building areas that are both heated and cooled be “space heating heat pump primary” systems. The addendum reduces energy usage and reduces emissions associated with providing space heating and cooling through proven and effective system design. The addendum includes requirements for all buildings following Section 6.5, “Prescriptive Compliance Path,” or Section 6.3, “Simplified Approach Building Compliance Path for HVAC Systems.” Although analysis indicates cost-effective energy and emissions reductions at different electric heat pump design temperatures, this addendum is based on heating system design load and heat pump sizing at 47 F outdoor air temperature:

- Where the heating system design load is no greater than the cooling system design load, the heat pump heating capacity shall be no less than the heating system design load under heating design conditions.
- Where the heating system design load is greater than the cooling system design load, and the heating system peak load at 47°F (8.3°C) outdoor air temperature is no greater than the cooling system design load, the heat pump heating capacity (at 47°F outdoor air temperature for air-source electric heat pumps and at rating conditions for all other electric heat pumps) shall be no less than the system cooling design load.
- Where the heating system design load is greater than the cooling system design load, and the heating system peak load at 47°F (8.3°C) outdoor air temperature is greater than the cooling system design load, the heat pump heating capacity (at 47°F outdoor air temperature for air-source electric heat pumps and at rating conditions for all other electric heat pumps) shall be no less than the peak heating system load at 47°F (8.3°C) outdoor air temperature

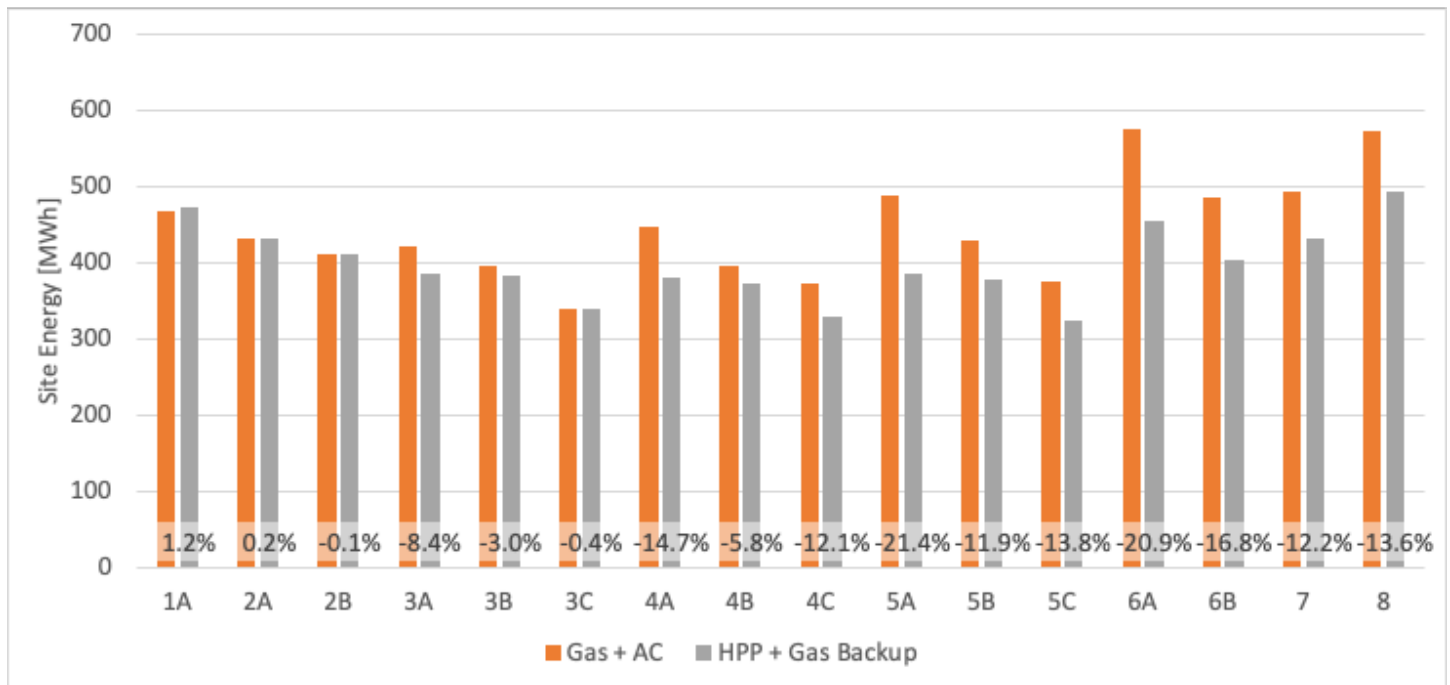
An exception to these requirements is provided for where the HVAC system includes thermal energy storage combined with electric heat pumps (including heat recovery chillers). There are, in fact, numerous other higher performing systems that go beyond the minimum requirements in this addendum, in addition to the many proven technologies and system designs that meet its requirements.

An alternative “fuel space heating” compliance option is included, which allows the use of fuel-fired heat pumps. The most common fuel-fired heat pumps use natural gas as a thermal source and an ammonia-water absorption cycle to draw heat from a lower temperature source (generally outdoor air in an air-source system) and supply heat to a higher temperature sink (generally indoor air or hot water in a hydronic heating system). Other fuel-fired heat pumps include a gas engine driving a compressor in a vapor compression cycle. The energy, emissions and economic analyses underlying this addendum are based on electric heat pumps; as adequate gas heat pump cost data is unavailable, the gas heat pump performance requirements aim for similar performance between the electric and gas heat pump options based on the cost of fuels, including SSPC 90.1’s approved social costs of greenhouse gas emissions (SC-GHG). (The energy usage and greenhouse gas emissions of gas HPs are significantly higher than those computed for electric HPs.)

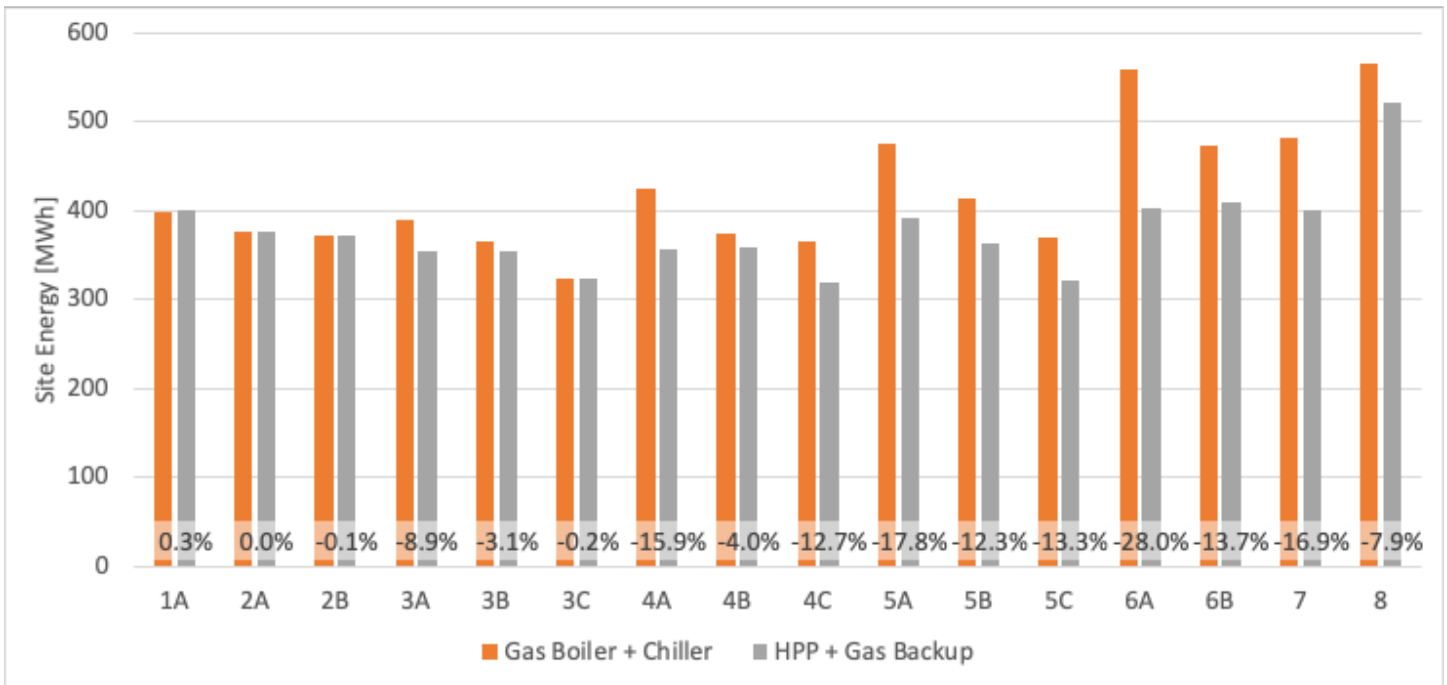
Secondary heat from electric resistance or fuels is allowed where heat pumps (or on-site renewable energy or site-recovered energy) cannot provide the necessary heating to satisfy the load. Further exceptions are included for space heating loads that may be difficult to serve with electric heat pumps.

For certain systems where the minimum cooling efficiency for heat pumps is less than the minimum cooling efficiency for air-conditioners, cooling energy may be higher; an exception is also included for climate zones where these effects negatively impact the cost-effectiveness of the space heating heat pump primary requirement.

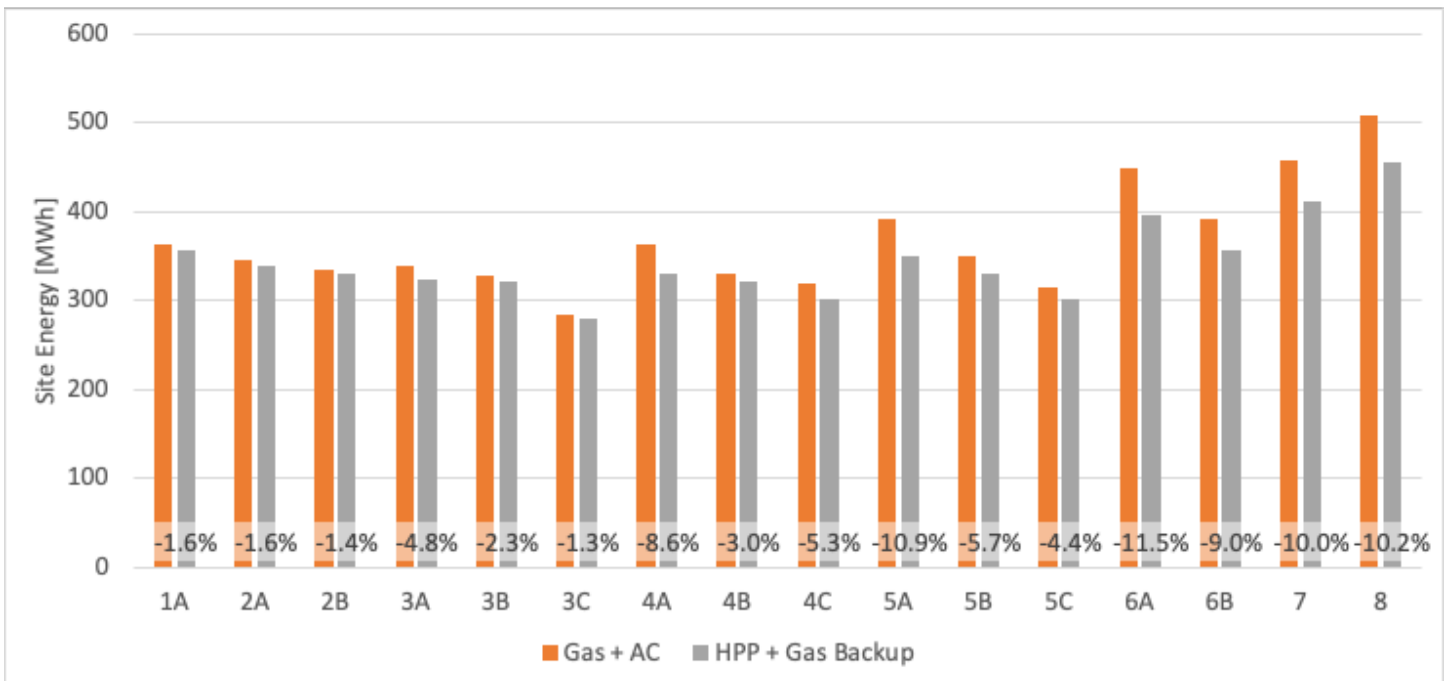
The typical ASHRAE 90.1 scalar analysis is not particularly insightful because of the closeness in costs associated with AC + Gas Furnace and Heat Pump systems. We can largely consider costs to be about the same, though energy and emissions reductions are significant from the heat pump primary systems. (Note: in the figures below, we show site energy savings and not emissions; because emissions factors for electricity and natural gas are very similar, there is generally no discernible difference in site energy percentage savings and emissions percentage savings.)



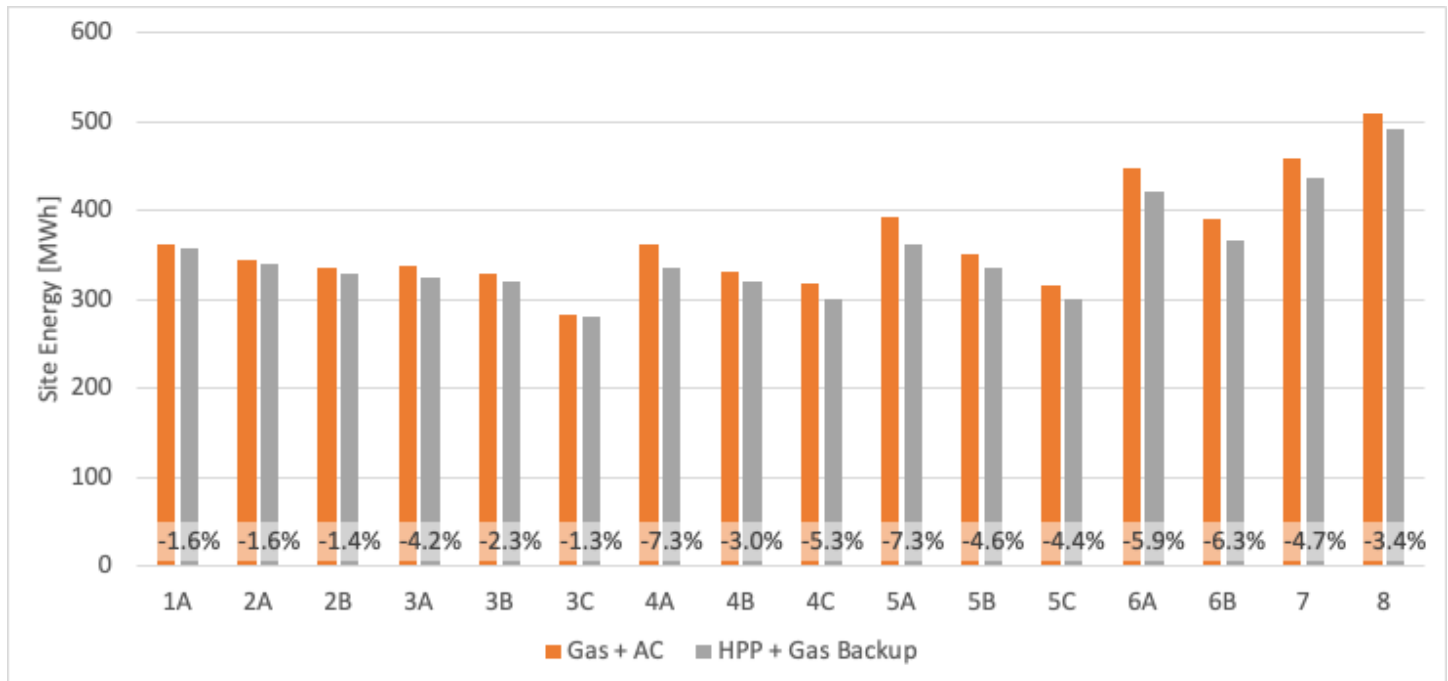
Similar to air-source systems, heat pump primary hydronic systems that comply with this addendum can also be lower cost than Gas Boiler + Chiller systems. So, again, the typical ASHRAE 90.1 scalar analysis is not particularly insightful. We can largely consider costs to be about the same (with computed upfront costs for heat pump primary systems actually lower than natural gas-heated alternatives in all Climate Zones), though energy and emissions reductions are significant from the heat pump primary systems:



There is more nuance to the analysis for residential split systems because the total installed cost for Central AC + Gas Furnace (\$710/kW) is higher than for a HP-only system (\$645/kW), but the total installed cost of a HP + Gas Furnace heat pump primary system is highly sensitive to the heating capacity of both the HP and the gas furnace. As an upper bound, if both the HP and gas furnace are sized to meet the full heating load, the total installed cost would be \$760/kW, but this is mitigated by the sizing of the heat pump to partial load. For the requirements of the electric heat pump path of this addendum, where a natural gas furnace provides secondary space heating where an electric heat pump cannot provide the necessary heating energy to satisfy the thermostat setting, the energy and emissions reductions are significant:



As traditional residential system configurations may not allow simultaneous heat pump and combustion-based heating, an additional analysis is presented for the midrise apartment building where there is a fully redundant natural gas system in addition to the heat pump, with the following computed energy and emissions impacts:



Taken together, this addendum represents a low-cost approach to very significant energy and emissions reductions, with the flexibility for individual designers and building projects to achieve the intent of the addendum.

[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 bk to 90.1-2022

Add following section:

6.1.4.6 Substantial Alterations to Existing Building HVAC Systems. *Alterations of HVAC equipment that account for not less than 50% of the capacity serving either the heating or cooling loads of a building or alteration area shall comply with Section 6.5.12.*

Add the following to Section 6.3.2:

u. The system complies with Section 6.5.12.

6.5.12 Heat pump primary HVAC systems. *HVAC systems serving spaces that are both heated and cooled shall comply with Sections 6.5.12.1 through 6.5.12.3.*

Exceptions to 6.5.12:

1. Where unitary air conditioners with a rated cooling capacity of not less than 65,000 Btu/h (19 kW) are used in Climate Zones 0A, 0B, 1A, 1B, 2A, 2B and 3C.
2. Chilled water and hot water systems in Climate Zones 0A, 0B, 1A, 1B, 2A, 2B and 3C.

6.5.12.1 Primary space heating. *HVAC systems shall comply with Section 6.5.12.1.1 and Section 6.5.12.1.2.*

6.5.12.1.1 Electric space heating. *HVAC systems using electricity as a heat source shall include electric heat pumps with heating capacity sized in accordance with Table 6.5.12.1.1 based on load calculations in accordance with Section 6.4.2.1.*

Exceptions to 6.5.12.1.1:

1. HVAC systems with both thermal energy storage and no heat source other than electric heat pumps, on-site renewable energy, site-recovered energy, or electric resistance or fuel heating allowed by Sections 6.5.12.2.2 through 6.5.12.2.10.
2. HVAC zones in multiple-zone HVAC systems where the airflow rate in heating does not exceed the larger of the following:
 - i. The minimum primary airflow rate required to meet the Simplified Procedure ventilation requirements of ASHRAE Standard 62.1 for the zone, permitted to be the average airflow rate as allowed by ASHRAE Standard 62.1.
 - ii. Any higher rate that can be demonstrated, to the satisfaction of the authority having jurisdiction, to reduce overall system annual energy use by offsetting reheat/recool energy losses through a reduction in outdoor air intake.
 - iii. The airflow rate required to comply with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates.
3. Alterations of cooling systems that do not include fuel-fired heating systems or increased capacity of power distribution systems and where the electric heat pump space heating capacity serving the alteration area is no less than the lesser of the design heat load and design cooling load of the alteration area.

Table 6.5.12.1.1 Electric Heat Pump Minimum Heating Capacity for Primary Space Heating

<u>HVAC System Heating and Cooling Load Conditions</u>	<u>Electric Heat Pump Minimum Heating Capacity</u>
<u>Where the heating system design load is no greater than the cooling system design load:</u>	<u>The heat pump heating capacity under heating design conditions shall be no less than the heating system design load.</u>
<u>Where the heating system design load is greater than the cooling system design load, and the heating system load at 47°F (8.3°C) outdoor air temperature is no greater than the cooling system design load:</u>	<u>The heat pump heating capacity determined in accordance with Section 6.5.12.1.1.1 shall be no less than the system cooling design load.</u>

<p><u>Where the heating <i>system</i> design load is greater than the cooling <i>system</i> design load, and the heating <i>system</i> load at 47°F (8.3°C) outdoor air temperature is greater than the cooling <i>system</i> design load:</u></p>	<p><u>The heat pump heating capacity determined in accordance with Section 6.5.12.1.1.1 shall be no less than the peak heating <i>system</i> load at 47°F (8.3°C) outdoor air temperature.</u></p>
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6.5.12.1.1 Heat pump capacity determination. For air-source heat pumps, compliance shall be demonstrated using the heating capacity at 47°F (8.3°C) outdoor air temperature when tested in accordance with the applicable test procedures in Table 6.8.1-2, Table 6.8.1-4, Table 6.8.1-9, Table 6.8.1-13 or Table 6.8.1-14. For all other heat pumps, compliance shall be demonstrated using the heating capacity under the applicable rating conditions and test procedures in Table 6.8.1-9, Table 6.8.1-13, Table 6.8.1-14, Table 6.8.1-15 or Table 6.8.1-16.

6.5.12.1.2 Fuel space heating. HVAC systems using *fuels* as a heat source shall include *fuel*-fired heat pumps sized to meet the heating *system* design load in accordance with Section 6.4.2.1 and with a minimum *coefficient of performance* no less than the applicable values in Table 6.5.12.1.2 at 17°F (-8.3°C) outdoor air temperature when tested in accordance with CSA/ANSI Z21.40.4.

Table 6.5.12.1.2.1 Minimum Fuel-Fired Heat Pump Efficiency

<u>Equipment Sizing Category (Input)</u>	<u>Minimum COP at 17°F (-8.3°C) Outdoor Air Temperature</u>
<u><65,000 Btu/h (19 kW)</u>	<u>1.10</u>
<u>≥65,000 Btu/h (19 kW)</u>	<u>1.20</u>

6.5.12.2 Other space heating allowances. HVAC systems shall be configured to use only *systems* and *equipment* meeting the requirements of Section 6.5.12.1, *on-site renewable energy* or *site-recovered energy* except as allowed by Sections 6.5.12.2.1 through 6.5.12.2.10.

6.5.12.2.1 Secondary heat. Where *systems* and *equipment* meeting the requirements of Section 6.5.12.1, *on-site renewable energy* and *site-recovered energy* cannot provide the necessary heating energy to satisfy the thermostat setting.

6.5.12.2.2 Low space heating capacity. *Systems* serving *buildings* or portions of *buildings* without *mechanical cooling* and having a total installed heating capacity not greater than 4.0 BTU/h per square foot (12.7 W per square meter) of *conditioned space*.

6.5.12.2.3 Small auxiliary heating systems. *Systems* that comprise less than 5 percent of the *building's* total installed heating capacity or that serve less than 5 percent of the *building's* *conditioned floor area*.

6.5.12.2.4 Small buildings. *Systems serving only semiheated spaces of not more than 2500 square feet (23.2 m²) and without mechanical cooling shall be permitted to use electric resistance or fuels for space heating.*

6.5.12.2.5 Freeze protection for low indoor design conditions. *Space heating systems sized and configured for freeze protection in spaces with indoor design conditions of not greater than 40°F (4.5°C), including temporary systems in unfinished spaces.*

6.5.12.2.6 Freeze protection systems. *Freeze protection systems complying with Section 6.4.3.7.*

6.5.12.2.7 Pre-heating outdoor air in energy recovery ventilation systems. *Systems and equipment that preheat outdoor air for defrost or to temper air entering an energy recovery device, and that comply with one of the following:*

1. Where the system recovers latent energy, where the space is mechanically humidified or has a process application that will maintain the space above 30% relative humidity when the outdoor temperature is not greater than 25°F (-4.0°C), and where the outdoor air is preheated to no greater than 25°F (-4.0°C).
2. Sensible-only heat recovery exchangers where the outdoor air is preheated to no greater than 25°F (-4.0°C).
3. Where outdoor air is preheated to no greater than 5°F (-15°C).

6.5.12.2.8 Pre-heating outdoor air in hydronic systems. *Hydronic systems without energy recovery ventilation, that do not use freeze protection fluids and where outdoor air is preheated to no greater than 40°F (4.5°C).*

6.5.12.2.9 Kitchen make-up air. *Where the added heating load of commercial kitchen exhaust system make-up air exceeds the heating capacity of the HVAC system, provided that systems and equipment that do not comply with the requirements of Section 6.5.12.1 are used only to maintain a temperature differential of no more than 10°F (-12°C) between make-up air and the air in the conditioned space.*

6.5.12.2.10 Authorized specific conditions. *Systems serving portions of buildings that cannot be served by systems and equipment meeting the requirements of Section 6.5.12.1, as determined and approved by the authority having jurisdiction.*

6.5.12.3 Other HVAC equipment. *All cooling, refrigeration, and ventilation equipment shall use no energy source other than electricity, on-site renewable energy, or site-recovered energy.*

Add the following to Section 13:

<u>Reference</u>	<u>Section</u>
American National Standards Institute (ANSI)	

CSA/ANSI Z21.40.4-23/CSA 2.94-2023	Performance testing and rating of gas-fired air conditioning and heat pump appliances	6.5.12.2.2