BSR/ASHRAE/IES Addendum o
to ANSI/ASHRAE/IES Standard 90.1-2025

Public Review Draft

Proposed Addendum o to Standard 90.1-2025, Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings

Advisory Public Review (August 2026)
(Draft Shows Proposed Changes to Current Standard)

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FOREWORD

Standard 90.1 includes several provisions related to multiple pieces of heating equipment serving the same load. In general, these provisions assume utilization of this equipment to align with installed capacities, requiring average efficiencies to be calculated as capacity-weighted average efficiencies. However, this does not accurately reflect how equipment is sequenced, particularly for two recent developments:

- *The increased prevalence of hybrid heating systems that include both electric heat pumps and fuel-fired equipment (e.g. furnaces or boilers).*
- *The inclusion of gas heat pumps in 90.1-2025 for compliance of large gas-fired space heating and water heating systems, as well as for consideration in the energy credits section for all buildings.*

Both of these approaches, as well as efficiency-focused sequencing of traditional boiler plants, have the potential for significant energy savings and to reduce upfront costs to comply with 90.1. However, there are no mandatory or prescriptive requirements in 90.1 to ensure the energy cost savings potential of these systems are realized, and there are structural issues in all compliance paths that disincentivize these higher efficiency systems by requiring higher upfront costs to comply with the Standard:

- *Requirements for large gas-fired space heating (Section 6.5.4.8) and water heating (Section 7.5.3) require compliance to be shown using a capacity-weighted average efficiency. This does not reflect energy efficient operation of primary and secondary equipment of different efficiencies. This has some impact on boiler-only plants, but is highly inaccurate for a properly sequenced plant that includes both gas heat pumps and boilers, since gas heat pumps can achieve much higher efficiency (coefficient of performance) than boilers.*
    - *Example: Preliminary analysis indicates that, compared to a compliant plant with 40% gas HP capacity, a plant with half that gas HP capacity could achieve 17% energy savings, but does not comply.*
- *The Total System Performance Ratio (TSPR) path <u>does not</u> allow equipment sequencing to be considered and requires use of a capacity-weighted average, cutting off a compliance path that should be very beneficial to hybrid systems that include both HPs (gas or electric) and fuel-fired furnaces/boilers. The capacity-weighting average approach further skews the compliance calculations, disincentivizing higher efficiency systems by requiring higher upfront costs to comply. Systems that are lower energy cost and lower upfront cost have more difficulty complying with 90.1*
    - *Example: For the Small Office Prototype in Climate Zone 4A, comparing a gas-furnace-only heating system to system with electric HPs with gas furnace backup. Here, the lowest energy cost system does not currently comply and would require increased upfront costs to comply with no energy savings.*

Heating Costs	***Gas-Only Baseline Current 90.1 TSPR***	*Hybrid Heating Current 90.1 TSPR*	*Hybrid Heating TSPR w/ Sequencing*
Electricity	*$0*	*$116.00*	*$121.63*
Gas	*$307.33*	*$197.13*	*$175.62*
Total	*$307.33*	*$313.13*	*$297.25*

- *The credits for space heating efficiency improvement (Section 11.5.2.2.2) and water heating efficiency improvement (11.5.2.3.1) also require use of capacity-weighted average efficiencies rather than considering energy efficiency equipment sequencing. This prevents one from getting credit for investing more in improved primary heating equipment, requiring additional investment in secondary equipment when it is not necessary to achieve the energy savings associated with these credits.*
- *Neither whole building performance path (ECB in Section 12 or Appendix G) says anything about equipment sequencing.*
- *Prescriptive requirements for sequencing of heating equipment are justified for two broad reasons:*
    - *To realize the energy savings potential of systems with different equipment efficiencies and ensure that building owners receive a building configured to minimize energy costs from their design and construction teams. This requires no additional upfront cost.*
    - *To ensure that buildings in the performance paths (TSPR, ECB, Appendix G) model equipment sequencing consistently to both set reasonable baselines and to allow users to show compliance of high efficiency systems that do not currently comply without additional upfront cost.*

Cost statement: This addendum does not increase upfront costs. It is intended to reduce upfront costs for compliance and to enable reduction of energy costs.

[Note to Reviewers: This addendum makes proposed changes to the current standard. These changes are indicated in the text by <u>underlining</u> (for additions) and ~~strikethrough~~ (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 o to 90.1-2025

Add the following definition to Section 3:

<u>lead equipment capacity</u><u>: a portion of the total installed heating or cooling capacity of a sequenced *system* with multiple pieces of *equipment*, measured from the beginning of the *control* sequence. *Lead equipment capacity* encompasses the full rated capacity of each piece of *equipment* called upon in sequence to meet or exceed a specified load.</u>

Modify Section 6.5.4.8.1 as follows:

6.5.4.8.1 Boiler and Gas-Fired Hydronic Heat-Pump Efficiency. *Systems* with a single gas hot-water *boiler* or gas-fired hydronic heat pump shall have a minimum thermal *efficiency* (*Et*) of 90% when rated in accordance with the following:

a. *Boilers* shall be rated in accordance with the test procedures in Sections 6.8.1-6.
b. Gas-fired hydronic heat pumps shall be rated in accordance with Section 6.4.7, and the rated COP, expressed as a percent, shall be the *Et* of that *equipment*.

Systems with multiple *boilers*, gas-fired hydronic heat pumps, or combinations thereof, are allowed to meet this requirement if the *space* heating input provided by *equipment* with thermal *efficiency* (*Et*) above and below 90% provides <u>an overall *system thermal efficiency* of 90% or greater as determined using one or more of the following:</u>

a. an input capacity-weighted average thermal *efficiency* of all *equipment* ~~at least 90%.~~,
b. an input capacity-weighted average thermal *efficiency* of *lead equipment capacity* that meets or is greater than the heating *system* design load and is based on *equipment* sequencing in accordance with Section 6.5.13, or
c. an input *energy*-weighted average thermal *efficiency* of all *equipment* as demonstrated to comply with Section 6.5.13.

For *boilers* rated only for combustion *efficiency*, the calculation for the input capacity-weighted average thermal *efficiency* shall use the combustion *efficiency* value.

6.5.13 Heating Equipment Sequencing. *HVAC systems* that include multiple pieces of heating *equipment* with different *efficiencies* or that use different *energy* sources and that provide heating into a common *distribution system* shall include *automatic* controls configured in accordance with one or more of the following, based on *energy* performance determined in accordance with the test procedures required by Sections 6.4.1 and 6.4.7:

a. All *equipment* is of the same *equipment* type and is sequenced in order from highest to lowest rated *efficiency*;

b. All *equipment* uses the same *energy* source and is sequenced in order from highest to lowest *efficiency*, including part-load and temperature-dependent performance;

c. All *equipment* is of one air-source *equipment* type and one other *equipment* type and a single changeover *outdoor air* temperature is programmed that minimizes annual *energy* costs based on *purchased energy rates* for the project;

d. The *equipment* is sequenced to minimize annual *energy* costs based on all *equipment*'s *energy efficiency*, including part-load and temperature-dependent performance, and *purchased energy rates* for the project; or

e. The *equipment* sequencing reduces overall *system* annual *energy* costs relative to (a) through (d) as can be demonstrated to and *approved* by the *AHJ*.

For the purpose of complying with this section, thermal energy storage and *terminal* units are permitted to be considered as not supplying heat to a *distribution system*.

Exceptions to Section 6.5.13:
1. Configuration for *automatic* or *manual* exercising of *equipment* and maintenance.
2. Configuration for time delays to prevent switching to or from *equipment* in excess of *manufacturer*'s recommendations or as *approved* by the *AHJ*.
3. Configuration for hydronic *system* temperature maintenance.
4. *Systems* with one or more pieces of *equipment* capable of simultaneously providing heating and cooling to separate *distribution systems*.

Modify Section 6.7.3.1 as follows:

6.7.3.1 Record Documents. *Construction documents* shall require that, within 90 days after the date of *system* acceptance, *record documents* be provided to the *building* owner or the designated representative of the *building* owner. *Record documents* shall include, as a minimum, the location and performance data on each piece of equipment; general configuration of the duct and pipe *distribution system*, including sizes; ~~and~~ the *terminal* air or water design flow rates; and all *control* sequences required to demonstrate compliance.

Modify Section 7.5.3 as follows:

7.5.3 Large Gas-Fired Service Water-Heating Systems. New *buildings* with *service water-heating systems* with a total installed input capacity of 1,000,000 Btu/h or greater, provided by *high-capacity gas-fired service water-heating equipment*, not installed in individual *dwelling units*, shall meet the following requirements:

a. Where a single unit of *high-capacity gas-fired service water-heating equipment* is installed, it shall have a minimum thermal *efficiency* (*Et*) of 92%~~.~~

b. Multiple units of *high-capacity gas-fired service water-heating equipment* connected to the same *service water-heating system* shall have achieve an overall *system thermal efficiency* of 90% or greater as determined using one or more of the following:

1. an ~~total~~ input capacity-weighted average thermal *efficiency (Et)* of all *equipment* not less than 90%,
2. an input capacity-weighted average thermal *efficiency* of *lead equipment* that meets or is greater than the *service water heating system* design load and is based on equipment sequencing in accordance with Section 7.5.4, or
3. a total input energy-weighted average thermal *efficiency (Et)* of all *equipment* as demonstrated to comply with Section 7.5.4.

c. A~~a~~ minimum of 30% of the input of the *high-capacity gas-fired service water-heating equipment* in the *service water heating-system* shall have a thermal *efficiency (Et)* of not less than 92%.

~~e~~d. Where gas-fired heat-pump *water heaters* are used, they shall be rated in accordance with Section 7.4.7 and, for the purpose of this section, Et shall be the rated COP expressed in percent.

Add new section as follows:

7.5.4 Service Water Heating Sequencing. *Systems* that include multiple pieces of *equipment* with different *efficiencies* or that use different *energy* sources and that provide heat into a common *service water heating distribution system* shall include *automatic* controls configured in accordance with one or more of the following, based on *energy* performance determined in accordance with the test procedures required by Sections 7.4.2 and 7.4.7:

a. All *equipment* is of the same *equipment* type and is sequenced in order from highest to lowest rated *efficiency*;

b. All *equipment* uses the same *energy* source and is sequenced in order from highest to lowest *efficiency*, including part-load and temperature-dependent performance;

c. All *equipment* is of one air-source *equipment* type and one other *equipment* type and a single changeover *outdoor air* temperature is programmed that minimizes annual *energy* costs based on *purchased energy rates* for the project;

d. The *equipment* is sequenced to minimize annual *energy* costs based on all *equipment*'s *energy efficiency*, including part-load and temperature-dependent performance, and *purchased energy rates* for the project; or

e. The *equipment* sequencing reduces overall *system* annual *energy* costs relative to (a) through (d) as can be demonstrated to and *approved* by the *AHJ*.

For the purpose of complying with this section, thermal energy storage is permitted to be considered as not supplying heat to a *distribution system*.

Exceptions to Section 7.5.4:

1. Configuration for *automatic* or *manual* exercising of *equipment* and maintenance.
2. Configuration for time delays to prevent switching to or from *equipment* in excess of *manufacturer*'s recommendations or *approved* by the *AHJ*.
3. Configuration for hydronic *system* temperature maintenance.
4. *Systems* with one or more pieces of *equipment* capable of simultaneously providing heating and cooling to separate *distribution systems*.

Modify Section 7.7.3.1 as follows:

7.7.3.1 Record Documents. *Construction documents* shall require that, within 90 days after the date of ~~*building* envelope~~ *system* acceptance, *record documents* be provided to the *building* owner or the designated representative of the *building* owner. *Record documents* shall include, as a minimum, the location and performance data on each piece of equipment; general configuration of the pipe *distribution system*, including sizes; water design flow rates; and all *control* sequences required to demonstrate compliance.

Modify Section 11.5.2.2.2 as follows:

11.5.2.2.2 H02: HVAC Heating Performance Improvement. To achieve this credit, *space* heating *equipment* shall exceed the minimum heating *efficiency* requirements by 5% or more than listed in the tables in Section 6.8.1. The measure *energy* credit for heating *efficiency* improvement (EC_{H02_adj}) shall be determined as follows:

$$EC_{H02\_adj} = EC_{H02\_base} \times \frac{EI_{heat}}{0.05}$$

Where

EC_{H02_adj} = *energy* credits achieved for heating *efficiency* improvement

EC_{H02_base} = H02 base *energy* credit from Section 11.5.3

EI_{heat} = the percentage improvement (as a fraction) above minimum heating *efficiency* requirements or 30% (0.30). Where heating *equipment* with different ~~minimum~~ efficiencies or different minimum heating *efficiency* requirements are included in the *building*, the percentage improvement of one of the following shall be used:

a. ~~heating~~ input capacity-weighted- average *efficiency* of all heating *equipment*,~~improvement~~,

b. an input capacity-weighted average thermal *efficiency* of *lead equipment* that meets or is greater than the heating *system* design load and is based on equipment sequencing in accordance with with Section 6.5.13, or

c. input *energy*-weighted average *efficiency* of all heating *equipment*, as demonstrated to comply with Section 6.5.13~~shall be used~~.

Where *electric resistance* primary heating or *reheat* is included in the *building*, it shall be included in the weighted-average improvement with an EI_{heat} of 0. ~~Supplemental gas and electric heat for h~~Heat- pump *systems~~*~~ internal *electric resistance* supplemental heaters controlled in accordance with Section 6.4.3.5 shall be excluded from the weighted EI_{heat}.

For metrics that increase as *efficiency* increases, EI_{heat} shall be calculated as follows:

$$EI_{heat} = \frac{HM_{des}}{HM_{min}} - 1$$

HM_{des} = design heating *efficiency* metric, part-load or annualized where available. For electric heat pumps rated at multiple ambient temperatures, use the *efficiency* at 47°F. Gas-fired hydronic heat pumps shall be rated in accordance with Section 6.4.7.

HM_{min} = minimum required heating *efficiency* metric, part-load or annualized in Section 6.8.1 for *equipment* other than gas-fired heat pumps. HM_{min} for gas-fired heat pumps shall be the same as for a *boiler* or furnace of the same input rating. For electric heat pumps rated at multiple ambient temperatures, use the *efficiency* at 47°F. Where gas-fired *boiler systems* or gas-fired hydronic heat-pump systems are required to meet provisions of Section 6.5.4.8, the minimum *system efficiency* HM_{min} shall be the minimum E_t required in Section 6.5.4.8.

Informative Note: An example of an annualized or part-load heating efficiency is AFUE rather than Et or Ec. Where only one efficiency rating is provided for *equipment* in Section 6.8.1, use that metric.

Modify Section 11.5.2.3.1 as follows:

11.5.2.3.1 Improved Service Water Heating Effectiveness. *Service water heating* effectiveness *energy* credits are permitted to be achieved in *building* use types where credits are available in Section 11.5.3 for one of the following:

…

c. **W03: Efficient Gas Water Heater.** For the purposes of this credit, the combined average *equipment* rating shall be determined using one the following determined in accordance with Sections 7.4.2 and 7.4.7:

1. input capacity-weighted average thermal *efficiency* of all *service water heating equipment*,
2. input capacity-weighted average thermal *efficiency* of *lead equipment* that meets or exceeds the *service water heating system* design load and is based on *equipment* sequencing in accordance with Section 7.5.4, or
3. input *energy*-weighted average rating of all *service water heating equipment*, as demonstrated to comply with Section 7.4.3.

To achieve this credit, the combined ~~input capacity weighted~~ average *equipment* rating of all gas water heating *equipment* in the *building* shall be not less than 95% E_t or 0.93 UEF. ~~Gas-fired heat-pump water heaters shall be rated in accordance with Section 7.4.7.~~ For the purpose of this section, the E_t of gas-fired heat-pump *water heaters* with an input capacity of more than 20,000 Btu/h shall be the rated COP expressed in percent.

Buildings required to comply with Section 7.5.3 shall receive 29.6% of the Section 11.5.3 W03 credit. *Buildings* where the installed *service water heating* capacity is less than 200,000 Btu/h and weighted UEF is not less than 0.82 shall achieve 25% of the base table W03 credit.

For gas-fired water heating *equipment* that exceeds 95% E_t or 0.93 UEF, credits shall be adjusted according to the following equation:

$$EC_{W03\_adj} = EC_{W03\_base} \times E_{t,des}/E_{t,min}$$

where

EC_{W03_adj}	adjusted *energy* credits
EC_{W03_base}	base *energy* credits from Tables 11.5.3-1 through 11.5.3-9
$E_{t,des}$	average *equipment* thermal~~rated~~ efficiency of proposed water heating equipment
$E_{t,min}$	95% E_t or 0.93 UEF as applicable to the gas-fired service water heating equipment

Modify Section 12.5.2 as follows:

12.5.2 HVAC Systems. The *HVAC system* type and related performance parameters for the *budget building design* shall be determined from Figure 12.5.2, the *system* descriptions in Table 12.5.2-1 and accompanying notes, and the following rules:

…

j. Determining the HVAC System: Each *HVAC system* in a *proposed design* is mapped on a one-to-one correspondence with one of eleven *HVAC systems* in the *budget building design*. To determine the budget *building system*, do the following:

1. Enter Figure 12.5.2 at "Water/Ground" if the *proposed design system* condenser is water or evaporatively cooled; enter Figure 12.5.2 at "Air/None" if the condenser is air cooled. Closed-circuit dry coolers shall be considered air cooled. *Systems* utilizing district cooling shall be treated as if the con-denser water type were "Water." If no *mechanical cooling* is specified or the *mechanical cooling system* in the *proposed design* does not require heat rejection, the *system* shall be treated as if the condenser water type were "Air." For *proposed designs* with ground-source or groundwater-source heat pumps, the budget *system* shall be water-source heat pump (*System* 6).
2. Select the path that corresponds to the *proposed design* heat source: *electric resistance*, heat pump (including air source and water source), or *fuel*-fired. *Systems* utilizing district heating (steam or hot water) shall be treated as if the heating *system* type were "Fossil Fuel." *Systems* with no heating capability shall be treated as if the heating *system* type were "Fossil Fuel." For *systems* with mixed *fuel* heating sources, the *system* or *systems* ~~that use the secondary heating source type (the one with the smallest total installed output capacity for the *spaces* served by the *system*)~~ shall be modeled in accordance with Section 6.5.13~~identically in the *budget building design*~~, and the primary heating

source type shall be used in Figure 12.5.2 to determine budget system type.

3. Select the *budget building design system* category. The *system* under "Single-Zone Residential System" shall be selected if the *HVAC system* in the *proposed design* is a *single-zone system* and serves a *residential space*. The *system* under "Single-Zone Nonresidential System" shall be selected if the *HVAC system* in the *proposed design* is a *single-zone system* and serves other than *residential spaces*. The *system* under "All Other" shall be selected for all other cases.

k. Sequencing of *HVAC systems* that include multiple pieces of *equipment* that provide heating or cooling into a common *distribution system* shall be modeled in accordance with Section 6.5.13.

~~k~~l. Kitchen Exhaust: For kitchens with a total exhaust hood airflow rate greater than 5000 cfm, use a *demand ventilation system* on 75% of the exhaust air. The *system* shall reduce exhaust and *replacement air system* airflow rates by 50% for one half of the kitchen occupied hours in the *budget building design*. If the *proposed design* uses *demand ventilation*, the same airflow rate schedule shall be used. The maxi-mum exhaust flow rate allowed for the hood or hood section shall meet the requirements of Section 6.5.7.2.2 for the numbers and types of hoods and appliances provided in the proposed design.

Modify Table 12.5.1 as follows:

10. HVAC Systems	
The *HVAC system* type and all related performance parameters, such as *equipment* capacities and efficiencies, in the *proposed design* shall be determined as follows: … b. Where an *HVAC system* has been designed, the HVAC model shall be consistent with design documents. Mechanical *equipment* efficiencies shall be adjusted from actual *design conditions* to the standard rating conditions specified in Section 6.4.1 if required by the simulation model. Where *efficiency* ratings include supply fan *energy*, the *efficiency* rating shall be adjusted to remove the supply fan *energy* from the *efficiency* rating in the *budget building design*. The equations in Section 12.5.2 shall not be used in the *proposed design*. The *proposed design HVAC system* shall be modeled using *manufacturers*' full- and part-load data for the *HVAC system* without fan power. …	The *HVAC system* type and related performance parameters for the *budget building design* shall be determined from Figure 12.5.2, the *system* descriptions in Table 12.5.2-1 and accompanying notes, and in accord with rules specified in Section 12.5.2(a) through 12.5.2(~~k~~l).

Modify footnotes to Table 12.5.2-1 as follows:

…

g. Electric Heat Pump: Electric air source heat pumps shall be modeled with electric auxiliary heat in accordance with Section 6.4.3.5. The *system* shall be controlled with a multistage *space thermostat* and an *outdoor air thermostat* wired to energize auxiliary heat only on the last *thermostat* stage and when *outdoor air* temperature is less than 40°F. The air source heat pump shall be modeled to continue to operate while auxiliary heat is energized.

Modify Normative Appendix G as follows:

Add new Section G3.2.2.10 as follows:

G3.2.2.10 Heating Equipment Sequencing. *HVAC systems* that include multiple pieces of *equipment* that provide heating into a common *distribution system* shall be modeled in accordance with Section 6.5.13.

Modify Normative Appendix L as follows:

L2.1.4 Partial Prescriptive Requirements. *HVAC systems* using the HVAC Performance Rating Method shall meet relevant prescriptive requirements in Section 6.5 as follows:

…

m. *HVAC* systems with multiple pieces of *equipment* providing heating into a common *distribution system* shall meet the requirements of Section 6.5.13.

…

L2.2.3 HVAC System Components. The *HVAC system* parameters shall be provided for the *proposed design* at *design conditions* unless otherwise stated with clarifications and simplifications as described in Table

L2.2.3 and as follows:

a. All *HVAC zones* within a block shall be served by the same *HVAC system* type as listed in Table L.1.1.1.
b. Where multiple *system* components serve a block, *equipment* sequencing or average values weighted by the appropriate metric as described in Section L2.2.3.1 shall be used.
c. The Table L2.2.3 parameter requirements are based on input of full-load *equipment efficiencies* with adjustment using *expanded performance data* integrated in the *simulation program*. Where other approaches to part-load adjustment are used, it is permitted for specific input parameters to vary.

Informative Note: Table L2.2.3 includes both user-defined parameters and parameters that are fixed in the *simulation program* and may not be changed by the user. They are maintained in one table here so related items can be viewed together in context.

L2.2.3.1 Proposed Building HVAC System Aggregation. Projects using the Mechanical System Performance Rating Method shall comply with all the following requirements.

a. Where multiple fan *systems* serve a single block, fan power shall be based on weighted average using the design supply air (cfm).
b. Where multiple cooling *systems* serve a single block, *COP* shall be based on a weighted average using cooling capacity. DX coils shall be entered as multistage if more than 50% of coil capacity serving the block is multistage with staged controls.
c. Where multiple heating *systems* or pieces of heating *equipment* serve a single block, heating *equipment* shall be sequenced in accordance with Section 6.5.13 using energy costs from Table L5-1~~thermal *efficiency* or heating *COP* shall be based on a weighted average using heating capacity~~.
d. Where multiple ~~*boilers* or~~ chillers serve a ~~heating water or~~ chilled-water loop, *efficiency* shall be based on a weighted average for using heating or cooling capacity.
e. When multiple cooling towers serving a condenser water loop are combined, the cooling tower *efficiency*, cooling tower design approach, and design range are based on a weighted average of the design water flow rate through each cooling tower.
f. Where multiple *pumps* serve a heating-water, chilled-water, or condenser water loop, *pump* power shall be based on a weighted average for using design water flow rate.
g. When multiple *system* types with and without economizers are combined, the economizer maximum *outdoor air* fraction of the combined *system* shall be based on weighted average of 100% supply air for *systems* with economizers and design *outdoor air* for *systems* without economizers.
h. Multiple *systems* with and without ERVs cannot be combined.
i. *Systems* with and without supply air temperature *reset* cannot be combined.
j. *Systems* with different fan control (constant volume, multispeed, or *VAV*) for supply fans cannot be combined.