What's New in Standard 90.1-2022—Mechanical Updates, Part I: *HVAC&R and Service Water Heating*

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This month, we continue our series focusing on changes to ANSI/ASHRAE/IES Standard 90.1-2022, *Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings*, with this article describing updates to the HVAC&R (Section 6) and Service Water Heating (Section 7) portions of the standard. We begin with the evaluation of mechanical equipment efficiency, followed by a breakdown of the changes to the mandatory and prescriptive requirements of Section 6 and Section 7, respectively.

Updates to Mechanical Efficiency Tables

Since the last publication of Standard 90.1, there have been numerous changes to how HVAC&R equipment and systems are evaluated. Updates have occurred for both federally covered products, and those which fall under the purview of the U.S. Department of Energy (DOE), ASHRAE and AHRI. Overall, the metrics used for comparing equipment and setting minimum efficiency levels have been evolving to be more representative of performance as used in buildings. This has led to a departure from full load metrics like the energy efficiency ratio (EER) in favor of metrics like the integrated energy efficiency ratio (IEER) and the integrated seasonal moisture removal efficiency (ISMRE). Changes to rating requirements are also reflected in metric changes; for example, seasonal energy efficiency rating, version 2 (SEER2) and heating seasonal performance factor, version 2 (HSPF2) are evaluated with a more accurate profile of load conditions compared to SEER and HSPF. As a result, a variety of revisions were

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necessary in the 90.1 Mechanical Efficiency Tables that appear in Section 6.8.1.

Single-phase HVAC products with a capacity less than 65,000 Btu/h (5.4 tons, or 19 kW) are controlled by the National Energy Conservation Policy Act, which preempts local building code efficiency requirements. These are included in 90.1 Informative Appendix F for reference. Commercial products as defined in the Energy Policy Act are also preemptive. The requirements for such products may be established by ASHRAE Standard 90.1 and then approved by the DOE or established directly by the DOE. Products subject to federal preemption are listed in *Tables 1* and *2*.

TABLE 1 DOE Preemptive Residential Products.

Single-phase residential split systems <65K	Instantaneous electric water heaters <2 gal
Single-phase residential split system HPs <65K	Grid enabled water heaters
Single packaged air conditioners	Pool heaters
Small duct high velocity	Room air conditioners
Space constrained air conditioners	Residential furnaces <225K
Space constrained heat pumps	Electric furnaces <225K
Gas-fired storage water heaters <100 gal	Gas-fired hot-water boilers
Oil-fired storage water heaters <50 gal	Gas-fired steam boilers
Electric storage water heaters <55 gal	Electric hot-water boilers
Tabletop water heaters	Electric steam boilers
Instantaneous gas-fired water heaters <50K	Large-diameter ceiling fans

TABLE 2 DOE Preemptive Commercial Products.

3-phase commercial split systems <760K	Commercial electric furnaces <225K
3-phase commercial split system HPs <760K	Warm air gas duct furnace
Packaged air conditioners <760K	Warm air gas and oil unit heaters
HP packaged air conditioners <760K	Hot water gas and oil boilers
Commercial split system <760K	Steam gas and oil boilers
HP commercial split systems <760K	Commercial fans
3-phase space constrained air conditioners	VRF
3-phase space constrained heat pumps	Computer room air conditioners
PTAC	Water source heat pumps
PTHPs	Commercial refrigerators and freezers
SPVAC	Dedicated outdoor air units
SPVHP	Commercial electric storage water heaters

Efficiency tables are included in Section 6 for HVAC&R products, Section 7 for Service Water Heating, and Informative Appendix F for DOE-defined and controlled products. Equipment efficiency requirements are unique in that many are federally controlled and preempt efficiency levels that may be listed in local building code efficiency requirements. ASHRAE Standard 90.1 standards are updated and released every 3 years and then adopted by states, cities, and local building codes—but this can take anywhere from 1 to 8 years. Once the federally approved efficiencies go into effect, manufacturers can no longer produce the equipment to the older efficiency levels. Standard 90.1 users should understand how this can impact product specification during the job planning phase, even if local building codes have not been updated accordingly. However, with the exception of <65,000 Btu/h (5.4 ton, or 19 kW) single-phase air conditioners, equipment that was already built prior to the efficiency updates now in effect can still be installed. The products that fall into this category are listed in *Tables 1* and *2*.

In terms of specific changes, the efficiency requirements for <65,000 Btu/h (5.4 ton, or 19 kW) split systems and packaged air conditioners and heat pumps have been adjusted in Standard 90.1-2022. Both the metric and the required efficiency has been increased, effective January 1, 2023, except for three-phase products where the equipment efficiency is increased effective January 1, 2025. The metrics changed from SEER to SEER2 for the annualized cooling metric, EER to EER2 for the full load cooling metric, and HSPF to HSPF2 for heat pumps. With the change in metrics, the stringency increased about 8% for cooling and 11% for heating. In Standard 90.1-2022, these changes are documented in Table 6.8.1-1 for cooling equipment, Table 6.8.1-2 for heat pumps, and in Table F1 (Appendix F) for federally defined and controlled products.

For commercial rooftops and split systems as defined in Tables 6.8.1-1 and 6.8.1-2, the rating metric has changed from IPLV to IEER according to a 2010 AHRI test procedure that resulted in better representation of annualized building performance. In 2018, as part of a negotiated ruling, the DOE switched the primary preemptive regulatory metric from the full load EER to IEER for air cooled products and adopted Standard 90.1 levels effective January 1, 2018. The rulemaking also increased IEER efficiency levels by an additional 14%; those values went into effect on January 1, 2023.

Tables 6.8.1-8 and 6.8.1-9 of Standard 90.1-2022 cover the minimum efficiencies for variable refrigerant flow (VRF) products. For the small duct free products, the previous metric was SEER. As of January 1, 2023, it was changed to SEER2. For the larger VRF products, the DOE completed a negotiated ruling in 2021 on the AHRI 1230 test procedure, resulting in a decrease in the full load EER by 4.2% to 6.7% and a drop in the IEER by 12%. The levels for IEER were not changed in the 2022 standard, so effectively this resulted in a 12% minimum efficiency increase.

HVAC Equipment Efficiency Ratings

New SEER2 and HSPF2 Metrics: SEER2 (cooling performance during the cooling season) and HSPF2 (heating performance during the heating season) are still calculated in much the same way as with the previous performance metrics, SEER and HSPF. What's new is that the input values are now obtained under more realistic testing conditions—higher static pressures that better simulate the effect of ductwork, resulting in greater fan energy use and lower numeric ratings for both SEER2 and HSPF2. In addition, for HSPF2, more low-temperature hours are included in the heating performance testing. This results in a much greater percentage drop in efficiency values for HSPF2 than for SEER2, compared to the previous SEER/HSPF metrics. The change in SEER to SEER2 results in about a 5% drop in the rating and the change in HSPF to HSPF2 decreases by about 16%.

IEER Metric: The IEER metric is an annualized metric based on a U.S. climate zone weighted average for mechanical cooling operating hours and weighted performance at 100%, 75%, 50% and 25% of mechanical cooling capacity (excluding economizer performance benefits.) It provides a more accurate representation of mechanical cooling efficiency in a building but does not encompass the system impacts of economizers or ventilation for IAQ. The industry is working on further changes to the metric for future updates.

ISMRE Metric: ISMRE is a metric that was developed for DOAS and is covered by the AHRI 920 standard. It is an annualized metric similar to IEER but is targeted to reflect the moisture removal efficiency of the DOAS unit expressed in lb of moisture/kW·h. The metric is annualized based on four weighted average part-load rating points. ISMRE2 reflects the changes in test procedure issued through a DOE negotiated ruling and documented in the AHRI 920 standard.

Test procedures are the procedures that defined the testing and rating requirements for products. As part of the DOE ruling, several AHRI 1230 test procedures were revised:

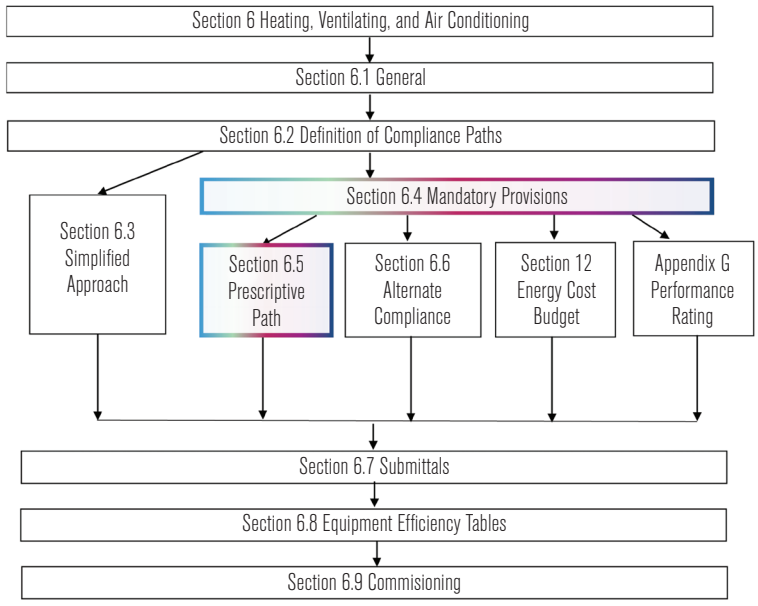
- Requirements for a new maximum Sensible Heat Ratio requirement at 100% and 75% load;
- Addition of a control's verification test requirement;
- Change in the DOE air-cooled metric for >65,000 Btu/h from EER to IEER.

With the growing interest in electrification to reduce environmental emissions, the use of larger chiller-based heat pumps has been growing. This has prompted AHRI 550/590 to add standardized rating conditions for chiller heat pumps and heat recovery chillers. Similarly, ASHRAE Standard 90.1-2019 included new requirements for heat chiller heat pumps in Table 6.8.1-16. In Standard 90.1-2022, in addition to making some necessary corrections to the table, the table was modified with expanded rating conditions to account for data centers. Similar changes were made to standard chillers to cover the higher chilled water temperatures now being used by data centers.

Another equipment category that is getting more use and interest is dedicated outdoor air units (DOAS). DOAS products are covered by AHRI 920; the minimum efficiencies are defined in Tables 6.8.1-13 and 6.8.1-14 of Standard 90.1-2022. As part of another DOE negotiated ruling, some of the test and rating requirements for DOAS equipment were changed and improved; for example, static conditions. Subsequently, the ISMRE metric was changed to ISMRE2, and the associated efficiency tables were updated. These changes were implemented in Addendum *cv* to Standard 90.1-2022, now available for download at ashrae.org.

The efficiency requirements for commercial dry type transformers, as defined in Table 8.8.4, were also updated to reflect new DOE-defined values. Additionally, Table 6.8.1-5 for furnaces was updated and reformatted to improve clarity. Lastly, gas hot-water boiler systems for space heating in new buildings (with a total system input of at least 1,000,000 Btu/h [293 kW] but not more than 10,000,000 Btu/h [2931 kW]) must now have a minimum thermal efficiency of 90% (condensing) and a maximum return water temperature of 120°F (48.9°C).

FIGURE 1 Compliance Map for Standard 90.1-2022 Mechanical.



Other Mandatory and Prescriptive Changes to Section 6 HVAC&R Requirements

There were also a multitude of updates to the Mandatory (Section 6.4) and Prescriptive (Section 6.5) portions of the Standard 90.1-2022 HVAC requirements. As shown in *Figure 1*, Section 6.4 is required for all Standard 90.1-compliant paths except for the "Simplified Approach" outlined in Section 6.3.

Alternatives to prescriptive compliance (Section 6.6, Section 12, and Appendix G) will be the subject of future articles, including the brand-new total system performance path (TSPR) in Section 6.6 that enables performance-based compliance without energy modeling.

The following is a summary of the Section 6 changes that appear in the 2022 edition of Standard 90.1:

Demand control ventilation. Table 6.4.3.8 defines the floor area thresholds requiring the use of demand control ventilation based on climate zone, ventilation, and use of exhaust air energy recovery. This topic has gained importance in recent years given the variable occupancy now seen in office buildings as a result of the COVID-19 pandemic.

Small unit setback controls. Section 6.4.3.3.2 was updated to require setback thermostats for residential spaces as this type of control has become a cost-effective and readily available option to achieve energy savings.

Exception to optimum start for residential spaces. Residential spaces are now exempt from the optimum start requirement for systems with direct digital control (DDC) defined in Section 6.4.3.3.3.

Garage exhaust ventilation. Requires garages with multiple sections separated by solid walls to have separate exhaust systems and controls. This prevents vehicle activity in one section from unnecessarily exhausting to other sections and improves safety by ensuring controls are provided in each section.

Shaft ventilation damper requirements. Requires motorized dampers in shaft vents used for temperature control with the exception of warm climates zones 0, 1, 2, and 3.

Simplified building updates. Specifies that verification of equipment efficiency (Section 6.4.1.5) is required for compliance with the Simplified Path (Section 6.3).

Ceiling fan efficiency. The requirements for large ceiling fans were modified to align with Section 1008 of the Energy Act of 2020. The Act requires large-diameter ceiling fans to have a CFEI greater than or equal to 1.00 at high speed and greater than or equal to 1.31 at 40% speed or the nearest speed that is not less than 40% speed.

Compressed air systems. Standard 90.1-2022 introduced new requirements for compressed air systems in Section 10.4.6. The following aspects of compressed air systems are now addressed:

- Trim compressors and storage;
- Advanced controls;
- Leak testing;
- Monitoring;
- Pipe sizing.

Dehumidification control. ASHRAE Standard 62.1-2019 implemented an off-hour dewpoint control limit of 60°F (16°C) to control mold issues. ASHRAE Standard 90.1-2022 includes revised language throughout the standard to align with the updated humidity requirements of Standard 62.1. The updates also address efficient humidification and dehumidification, with the goals of minimizing simultaneous heating and cooling and encouraging use of site recovered energy.

Guideline 36 controls reference. ASHRAE Guideline 36, *High-Performance Sequences of Operation for HVAC Systems*, was created to develop and maintain best-in-class standardized HVAC control sequences. ASHRAE Standard 90.1 was updated to make references to sequences of operation described in ASHRAE Guideline 36 in appropriate sections of Section 6 where control requirements are stated but lack specificity in how the sequences can be implemented.

Energy recovery ventilation (ERV) bypass requirements. In the prescriptive Section 6.5.6, there are requirements for the use of exhaust air energy recovery with ventilation air systems. Standard 90.1-2022 provides revised language to clarify the requirements for bypass when economizers are being used for both the outside air and exhaust air. The pressure drop is limited to 0.4 in water, and there is an additional requirement to limit energy exchange to 10% when in bypass mode.

Exhaust air energy recovery. The current enthalpy recovery ratio (ERR) requirement has caused confusion when applied to systems that require only sensible heating energy recovery. For systems that do not provide humidification, there is no heating energy benefit due to latent energy recovery. Standard 90.1-2022 added language to specify the sensible energy recovery ratio requirement for these systems.

DOAS exemption. This change adds an exception to the DOAS requirements in 6.5.2.6 for units that use only series energy recovery in climate zones 0A, 1a, 2a, 3a and 4a for reheating dehumidified air. The rationale for this section is that when the building needs sensible cooling energy, reheating of the ventilation airstream causes energy to be wasted, even with free condenser reheat.

Hospital heat recovery. Section 6.5.6.3, "Heat Recovery for Space Conditioning," requires heat recovery to be used in most acute inpatient hospitals. The existing language refers to "condenser heat recovery," which has led some users to believe that the heat source can be water leaving the chiller condenser. While this method does recover heat, it does not reduce load on the chillers. Users are now specifically directed to use the chilled water return as the heat source.

Economizer trade-off. Table 6.5.1-2 defines the equipment efficiency level increase necessary to allow for the elimination of economizers. In Standard 90.1-2022, those requirements were clarified.

Expanded airside economizers. Airside economizers can provide significant energy savings during lower temperature cooling, which is common in commercial buildings. Standard 90.1-2022 extended the threshold for requiring an airside economizer from 54,000 Btu/h to 33,000 Btu/h (16 kW to 10 kW) for individual fan-cooling units located outside of the building envelope.

Small fan efficacy. This change established minimum fan efficacy requirements for low-power ventilation fans with a minimum cfm/W as listed in Table 6.5.3.7.

FEI rating clarification. Section 6.5.3.1.3 was revised to clarify that the Fan Energy Index (FEI) requirement applies at the highest design airflow rate.

Occupied standby. Standard 90.1-2022 requires a system-level reset of outdoor air levels to ensure greater energy savings when ventilation air is turned off to unoccupied zones.

Elevators. Changes were made to Section 10.4.3 to improve elevator fan, lighting, and movement efficiency, establishing a minimum energy efficiency target of E or better.

Section 7 New Service Water Heating Requirements

Mechanical systems for Service Water Heating (SWH) are covered in Section 7. There were two major changes to the SWH requirements for Standard 90.1-2022. First was the introduction of insulation requirements for SWH piping, which was based on the structure of current Section 6 requirements for space heating piping.

The new requirements, presented in Table 7.4-2, reflect typical SWH system operation and operating temperatures. The table reports the required insulation thickness and thermal conductivity based on pipe size and temperature range.

Additionally, Section 7.5.3 was modified to require a thermal efficiency (Et) of 92% for high-capacity gas-fired SWH equipment. This applies to single units; the requirement for multiple units connected to the same service remains a weighted total of 90% or more; however, a minimum of 30% of the input in a multi-unit system must now achieve 92% Et.

Conclusion

The HVAC&R updates to Standard 90.1-2022 are the product of 40+ addenda published over a 3-year revision cycle, driven by a diverse group of volunteer members, industry groups like AHRI and CTI, and the DOE, all committed to pragmatically advancing the state of energy efficient buildings. The 2022 updates illustrate that the committee has systematically targeted opportunities throughout the standard to improve efficiency where greater stringency was warranted, and to introduce new requirements where equipment was not yet covered.

The project committee has made a concerted effort to take a more "systems-based approach" to developing requirements, identifying new, but relevant factors for measuring equipment performance that have not previously been included in conventional equipment metrics. This has led to novel approaches for evaluating mechanical performance like the Total System Performance Ratio (TSPR) method—an alternative compliance path that will be covered in a future article. It is also important for Standard 90.1 users to understand how compliance with mechanical provisions in Sections 6 and 7 fits together with other new requirements like Section 11, "Additional Efficiency Requirements," more commonly known as "Energy Credits." This will also be detailed as the Standard 90.1-2022 update series is continued. ■

As we enter the next cycle to develop the 2025 standard, we invite everyone in the ASHRAE community and industry to follow along with the process. You can learn more about getting involved with SSPC 90.1 by contacting ASHRAE staff liaison Emily Toto (etoto@ashrae.org) and/or through the following links where meetings are posted and announced:

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