ENERGY STAR® Program Requirements Product Specification for Central Air Conditioner and Heat Pump Equipment

Eligibility Criteria Draft 2 Version 6.0

Following is the Draft 1 Version 6.0 product specification for ENERGY STAR certified central air conditioner and heat pump equipment. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1) Definitions: Below are the definitions of the relevant terms in this document.

A. Central Air Conditioner (CAC) or Central Air Conditioning Heat Pump (HP)[1]: A product, other than a packaged terminal air conditioner or packaged terminal heat pump, which is powered by single phase electric current, air cooled, rated below 65,000 Btu per hour, not contained within the same cabinet as a furnace, the rated capacity of which is above 225,000 Btu per hour, and is a heat pump or a cooling unit only.

A central air conditioner or central air conditioning heat pump may consist of: A single-package unit; an outdoor unit and one or more indoor units; an indoor unit only; or an outdoor unit with no match. In the case of an indoor unit only or an outdoor unit with no match, the unit must be tested and rated as a system (combination of both an indoor and an outdoor unit).

B. Single-package unit[2]: Any central air conditioner or heat pump that has all major assemblies enclosed in one cabinet.

C. Split System[2]: Any air conditioner or heat pump that has at least two separate assemblies that are connected with refrigerant piping when installed. One of these assemblies includes an indoor coil that exchanges heat with the indoor air to provide heating or cooling, while one of the others includes an outdoor coil that exchanges heat with the outdoor air. Split systems may be either blower coil systems or coil-only systems.

D. Ducted System[2]: An air conditioner or heat pump that is designed to be permanently installed equipment and delivers conditioned air to the indoor space through a duct(s). The air conditioner or heat pump may be either a split-system or a single-package unit.

E. Non-ducted Indoor Unit[2]: An indoor unit that is designed to be permanently installed, mounted on room walls and/or ceilings, and that directly heats or cools air within the conditioned space.

F. Gas/Electric Package Unit: A single package unit with gas heating and electric air conditioning that is often installed on a slab or roof.

G. Basic Model[1]: All units of a given type of covered product (or class thereof) manufactured by one manufacturer and which have the same primary energy source and, which have essentially

[1] 10 CFR part 430, Subpart A, § 430.2 Definitions

[2] 10 CFR part 430, Subpart B, Appendix M1

identical electrical, physical, or functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption or water efficiency.

H. Heating Seasonal Performance Factor 2 (HSPF2)[3]: HSPF2 is the total space heating required in region IV during the space heating season, expressed in Btu, divided by the total electrical energy consumed by the heat pump system during the same season, expressed in watt-hours. The represented value of HSPF determined in accordance with Appendix M1 is HSPF2, and the represented value in accordance with Appendix M is HSPF.

I. Seasonal Energy Efficiency Ratio 2 (SEER2)[3]: SEER2 is the total heat removed from the conditioned space during the annual cooling season, expressed in Btu, divided by the total electrical energy consumed by the air conditioner or heat pump during the same season, expressed in watt-hours. The represented value determined in accordance with Appendix M1 is SEER2, and the represented value in accordance with Appendix M is SEER.

J. Energy Efficiency Ratio 2 (EER2)[3]: EER2 is the ratio of the average rate of space cooling delivered to the average rate of electrical energy consumed by the air conditioner or heat pump. This ratio is expressed in Btu per watt.h (Btu/W.h). The represented value determined in accordance with appendix M1 is EER2, and the represented value determined in accordance with Appendix M is EER.

Note: The above definitions have been updated to match or align with those contained in the Code of Federal Regulations Title 10 part 430, Subparts A and B. Note that due to the change in the DOE definition, the specification throughout has been amended to refer to Central Air Conditioners and Heat Pumps (CAC/HP), rather than the previous term, Air-Source Heat Pump.

K. Coefficient of Performance (COP)[2]: COP means the ratio of the average rate of space heating delivered to the average rate of electrical energy consumed by the heat pump. These rate quantities must be determined from a single test or, if derived via interpolation, must be determined at a single set of operating conditions. COP is a dimensionless quantity.

L. Percentage of Heating Capacity @ 5°F: The heating capacity of a given unit at 5°F, divided by the heating capacity at 47°F, expressed as a percentage.

Note: EPA has revised the definition of "Percentage of Heating Capacity @ 5°F" to be independent of specific test methods.

M. Independent Coil Manufacturer (ICM)[2]: A manufacturer that manufactures only the indoor unit (coil) in a Central Air Conditioner or Air-Source Heat Pump Split System.

N. System Manufacturer (SM): A manufacturer that manufactures all the major assemblies in an Air-Source Unitary Heat Pump and/or Unitary Air-Conditioner.

O. Communication Link: As shown in Figure 1, the mechanism for bi-directional data transfers between the connected CAC/HP system and one or more external applications, devices or systems.

[3] Based on definition in 10 CFR part 430, Subpart B, Appendix M and M1

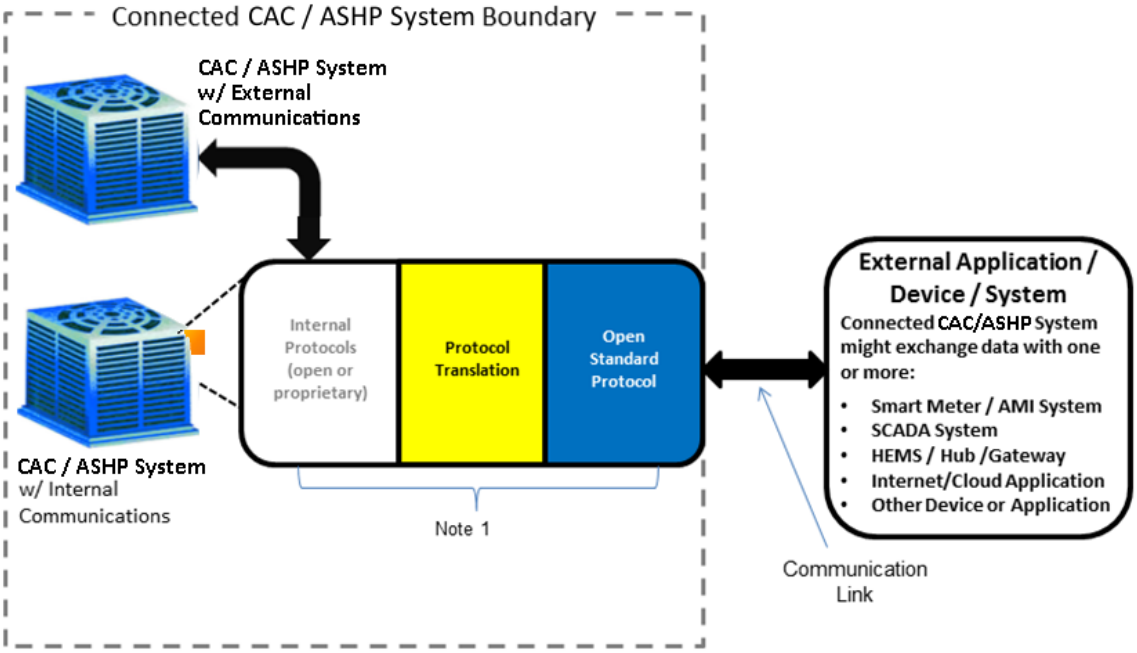

Figure 1. Connected CAC/HP System (CCS)

P. Connected CAC/HP System (CCS): Includes the ENERGY STAR certified Central Air Conditioner or Heat Pump product, integrated or separate communications hardware, and additional hardware and software required to enable connected functionality, including controllers/thermostats. In the case of a CCS that implements Open ADR 2.0 with a virtual end node (VEN) in the cloud, that VEN is part of the CCS for purposes of this specification. For products implementing CTA-2045A, the module is not considered part of the CCS for purposes of this specification. A product implementing both using a communication module in a CTA-2045 port could be tested both ways and identified as implementing both standards for the purposes of the ENERGY STAR product finder.

Q. Consumer Authorized Third Party: Any entity for which the consumer has provided explicit permission to access the CCS connected functionality, in whole or in part, via a communication link.

R. Demand Response (DR)[4]: Changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.

S. Demand Response Management System (DRMS): The system operated by a program administrator, such as the utility or third party, which dispatches signals with DR requests and/or price signals to the CCS products and receives messages from the CCS product.

T. Interface Specification: A document or collection of documents that contains detailed technical information to facilitate access to relevant data and product capabilities over a communications interface.

[4] Federal Energy Regulatory Commission, https://www.ferc.gov/industries/electric/indus-act/demand-response/dr-potential.asp. This definition does not cover all aspects of how load flexibility is being used by utilities. For instance, it does not cover behavioral DR, dispatch to prevent spilling wind resources, or reducing peak demand for natural gas. EPA intends to address any and all of these use cases in our criteria in addition to the more traditional DR in the FERC definition.

U. Load Management Entity: DRMS, home energy management system, and the like.

V. Open Standards: Communication with entities outside the CCS that use, for all communication layers, standards:

• included in the Smart Electric Power Alliance (SEPA) Catalog of Standards[5], and/or

• included in the NIST Smart Grid Framework Tables 4.1 and 4.2[6], and/or

• adopted by the American National Standards Institute (ANSI) or another well-established international standards organization such as the International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), International Telecommunication Union (ITU), Institute of Electrical and Electronics Engineers (IEEE) or Internet Engineering Task Force (IETF).[7]

W. On-Premises: Refers to a function that relies only on equipment present at the physical installed location of the ENERGY STAR certified device/equipment.

X. Consumer Override (of DR events): Choosing to opt out of a scheduled and/or active DR event the product would otherwise respond to, without cancelling program enrollment.

Note: EPA proposed definitions O – X in the Limited Topic Proposal on July 29, 2019 to support criteria for connected CAC/HP. EPA received no comments on those definitions.

2) Scope:

A. Included Products: Single package, split system, and gas/electric package units that meet the definitions of a central air conditioner or heat pump as specified herein are eligible for ENERGY STAR certification, with the exception of products listed in Section 2.B. Units may be intended for installation into a duct system, or may be ductless.

B. Excluded Products: Three phase central air conditioners and heat pumps, and products rated at 65,000 Btu/h or above are not eligible for ENERGY STAR.

3) Certification Criteria:

A. Climates: ENERGY STAR requirements for heat pumps are divided into the following two climate applications.

a. Cold Climate – Criteria designed for applications where performance should be optimized for peak heating and part-load cooling performance.

b. Moderate and Hot Climate – Criteria designed for applications where performance should be optimized for peak cooling performance.

Note: EPA received comments supporting the effort to develop climate-based criteria and to require additional low temperature criteria for Cold Climate heat pumps. EPA also received feedback from stakeholders that a state-based label would be confusing and may not always be helpful in identifying the appropriate unit for an installed location. EPA agrees and prefers the climate-based approach as proposed in this draft. By establishing different criteria for Moderate/hot Climates versus Cold Climates, EPA can

[5] https://sepapower.org/knowledge/catalog-of-standards/

[6] https://www.nist.gov/sites/default/files/documents/smartgrid/NIST-SP-1108r3.pdf

[7] http://www.gridstandardsmap.com/

recognize products that are optimized for either climate and allow utilities and consumers to identify products that will better meet their needs. Under this proposal, EPA would identify those heat pumps meeting Cold Climate requirements with a modified ENERGY STAR certification mark designating those units as "ENERGY STAR Cold Climate." All other qualifying HP units would comply with the SEER2, EER2, and HSPF2 requirements specified below for Moderate and Hot Climate (but not the additional COP or Percentage of Heating Capacity requirements applied to Cold Climate products) and use an "ENERGY STAR Moderate and Hot Climate" designation. EPA seeks additional feedback about specific terms describing climates that would resonate with consumers. We invite stakeholders with survey or focus group information to share it with us, and also are working to develop such information ourselves.

EPA recognizes that there may be very efficient heat pumps that will meet both the Cold Climate performance criteria and the higher EER requirement for Moderate and Hot Climates. As these units will be an appropriate choice for consumers in all climates, EPA is considering whether an "all climates" label is needed, or recognizing them with the traditional ENERGY STAR label, without a climate modifier will communicate clearly.

The designations tailored for this purpose are intended to inform consumers and contractors of the suitability of a heat pump to their climate without imposing strict requirements associated with installed or sold location. This has the advantage of providing better information for consumers in the many states with a range of climate zones. Manufacturers would only be responsible for ensuring that the correct label is associated with the correct unit. There is no requirement that a physical label be installed on the unit itself.

CACs would continue to use the standard ENERGY STAR label.

B. Energy Efficiency Requirements:

a. Certification Metric Criteria

Table 2: Energy-Efficiency Criteria for Certified Residential Central Air Conditioners

Product Type	SEER2	EER2
CAC Split Systems	≥ 16.0	≥ 12.0
CAC Single Package Equipment[1]	≥ 16.0	≥ 11.5

1. Including gas/electric package central AC units.

Table 3: Energy-Efficiency Criteria for Certified Residential Heat Pumps

For purposes of ENERGY STAR certification, a Heat Pump model may be designated as either Moderate and Hot Climate or Cold Climate as per the associated requirements in Table 3.

Product Type	Moderate and Hot Climate			Cold Climate		
	SEER2	EER2	HSPF2	SEER2	EER2	HSPF2
HP Split Systems	≥ 16.0	≥ 12.0	≥ 7.8	≥ 16.0	≥ 11.0	≥ 8.5
HP Single Package Equipment[1]	≥ 16.0	≥ 11.5	≥ 7.5	≥ 16.0	≥ 10.6	≥ 8.1

1. Including gas/electric package heat pumps, which are only eligible for the Moderate and Hot Climate designation.

i. Cold Climate Heat Pumps Low Ambient Performance: To earn the Cold Climate designation, heat pumps must demonstrate low ambient performance by meeting the following:

- COP at 5° F ≥ 1.75, measured in accordance with Appendix M1.[8]
- Percent of Heating Capacity at 5° F ≥ 70%, with both the 5° F and 47° F capacities measured in accordance with Appendix M1.[8]
- Perform a controls verification procedure (CVP) to confirm that the settings used/performance for the low ambient test point at 5° F are achieved by the native controls operating as they would in a customer's home.

Note: In response to stakeholder feedback, EPA is proposing a significant delay to the effective date of this specification such that it aligns with the compliance date for the forthcoming DOE standard. Recognizing the investment being made in improving efficiency in light of these standards, and the value more time provides partners, EPA is coupling this later effective date with more stringent criteria. This includes higher SEER2 and HSPF2 requirements from the levels proposed in Draft 1. These criteria maintain differentiation above minimum efficiency standards in the 2023 market and achieve the long-term savings goals of the ENERGY STAR program.

EPA had extensive conversations about the need for a heating capacity maintenance criterion, with opinions expressed on both sides of the issue even within the same stakeholder group. Those supporting the requirement affirmed EPA's understanding that for homes heated exclusively by a heat pump, sufficient capacity at low temperatures protects against excessive use of expensive, inefficient electric resistance backup heat. On the other hand, it was pointed out that where heat pumps are currently being installed in cold climate regions, they are often supplementary to an existing heating system. In fact, for many homeowners the main draw of a new system may be the provision of air conditioning. In many cases studied with realistic assumptions, the current cost to heat with a heat pump may be higher than heating with gas or oil, even at temperatures well above 5°F.

However, EPA notes this specification will not be effective until 2023, by which time the situation may have changed. Furthermore, the units installed in 2023 are likely to still be operating in 2035, by which time we expect the situation to have changed significantly. In light of the range of different factors at play, ensuring reasonably anticipated heating performance at lower temperatures appears to be the best course consistent with the ENERGY STAR promise of no trade-offs in performance for efficiency. For this reason, EPA has maintained the requirement, albeit at a somewhat lower level with the aim of reducing cost but ensuring a minimum performance. We welcome further discussion.

In response to draft 1, manufacturers raised a concern that the heating capacities at 5F and 47F needed to be measured according to the same test method, which EPA has allowed for. They were also concerned that the 5°F testing in Appendix M1 is specified in such a way as to be unrealistic, in that they thought the compressor speed for the 47F test must also be used for the 5F condition. EPA is satisfied this is not the case and invites other parties to send questions directly to DOE at ApplianceStandardsQuestions@doe.gov for clarification.

On October 1, 2019, the ASRAC Working Group for variable refrigerant flow systems reached consensus on a term sheet that included a "controls verification procedure". The CVP is intended to confirm that fixed settings used in the IEER rating test could be achieved by the products' native controls when set up in a field configuration. While that procedure is intended for commercial variable capacity products, a similar principle is applicable to residential variable capacity products. The CVP addresses persistent concerns that the capability of controls for variable capacity systems are not currently accounted for in ratings, though they may significantly affect the experience of owners of the equipment. EPA proposes that a simplified CVP, designed for low ambient performance of residential variable capacity equipment, be required for certification. EPA will release a draft of this procedure for stakeholder feedback before releasing any

[8] 10 CFR part 430, Subpart B, Appendix M1 – Section 3.6 Heating mode tests for Different Types of Heat Pumps, Including Heating-Only Heat Pumps

subsequent specification drafts.

Please note that EPA is aware of a variety of efforts to improve testing for low ambient performance. The low ambient performance metrics make use of a finalized, published test method and will provide some assurance of performance in combination with the CVP. However, as other methods to demonstrate low ambient performance become ready, EPA may add them as alternatives.

b. Early Certification Alternate Metric Criteria:

For products certifying to Version 6.0 prior to the specification effective date, the Appendix M test method and associated metrics may be used, and products should meet the criteria below. Note that for products that certify early to Version 6.0 using the Appendix M test method, test data according to Appendix M1 using the SEER2, EER2, and HSPF2 metrics must be provided by January 1, 2023 in order for that product to remain certified after this specification effective date.

Table 2A: Energy-Efficiency Criteria for Certified Residential Central Air Conditioners

Product Type	SEER	EER
CAC Split Systems	≥ 17.00	≥ 12.50
CAC Single Package Equipment[1]	≥ 17.00	≥ 12.00

1. Including gas/electric package units.

Table 3A: Energy-Efficiency Criteria for Certified Residential Heat Pumps

For purposes of ENERGY STAR certification, a Heat Pump model may be designated as either Moderate and Hot Climate or Cold Climate and meet the associated ***requirements in Table 3****A.*

Product Type	Moderate and Hot Climate			Cold Climate		
	SEER	EER	HSPF	SEER	EER	HSPF
HP Split Systems	≥ 17.0	≥ 12.5	≥ 9.2	≥ 17.0	≥ 11.5	≥ 10.0
HP Single Package Equipment[1]	≥ 17.0	≥ 12.0	≥ 8.8	≥ 17.0	≥ 11.0	≥ 9.5

1. Including gas/electric package units.

i. Early Certification Cold Climate Heat Pumps Low Ambient Performance: Products certifying as Cold Climate Heat Pumps before the specification effective date may demonstrate low ambient performance by meeting the following:

- COP at 5° F ≥ 1.75, based on manufacturer provided application data.

- Percent of Heating Capacity at 5° F ≥ 70%, with the heating capacity at 5° F based on manufacturer provided application data, and the heating capacity at 47° F measured in accordance with Appendix M.[9]

- Perform a controls verification procedure (CVP) to confirm that the settings used/performance assumed for the 5° F application data are achieved by the native controls operating as they would in a customer's home.

Note: Products that certify early to version 6.0 may be designated as cold climate, as well as connected (see Section 4) before the effective date of the specification. However, EPA learned that given how many combinations must be redesigned and/or re-rated before 2023 and limitations in design and laboratory capacity, few units will be ready to use the M1 test method through 2021. To account for this, EPA has provided criteria in terms of the metrics defined by Appendix M and will allow 5°F application data such as manufacturers currently provide to be used for cold climate heat pumps. The two sets of criteria were selected to be equivalent, and if stakeholders feel these values are not entirely aligned, EPA appreciates further information on crosswalks for these metrics.

Prior to 2023, the CVP will be consistent, to the extent possible, with Appendix M provisions. After the 2023 effective date, the CVP will be consistent, to the extent possible, with Appendix M1 provisions.

C. Staged or Variable Capacity Requirement: To earn the ENERGY STAR, the unit must be capable of operating at two or more distinct capacities or must have a capacity which is continuously variable.

Note: EPA received multiple comments supporting this requirement or supporting requiring fully variable capacity as well as comments that no prescriptive requirement should be added. EPA believes that requiring staged or variable capacity units have distinct efficiency and performance advantages over fixed capacity. Firstly, they can mitigate inefficiency in installations where the home needs more airflow than the ducts were built for, which is very common. They will provide lower-noise operation most of the year, and in humid climates will control indoor humidity better; in general, providing excellent performance over a wider variety of conditions. Furthermore, the difference in performance may widen as control algorithms for variable capacity units continue to improve. On the other hand, EPA is also aware that the higher SEER2 requirements may de facto ensure that only staged or variable capacity units are certified in any case.

D. Installation Capabilities: To certify as ENERGY STAR, CAC/HPs must be capable of providing at least three of the following capabilities to aid in quality installation. For purposes of this section, a thermostat or controller can be considered part of the system. Items a, b, and c are understood to be measured at maximum fan speed and capacity.

a. Refrigerant charge – System can verify that the refrigerant charge is within manufacturer recommended tolerances at a range of conditions including outdoor temperatures at least as low as 55ºF.

b. Airflow measurement or external static pressure – System shall have some capability to display airflow and confirm that it is within the OEM recommended settings, or to display external static pressure and fan speed setting. (Not relevant to ductless units,)

c. Blower fan power draw – System shall have the capability to measure and report the watt draw of the blower fan.

d. If systems DO NOT include any of the capabilities in a, b, or c, and have multiple or variable capacities, the system provides an easily accessible test mode that locks the system into the

[9] 10 CFR part 430, Subpart B, Appendix M – Section 3.6 Heating Mode Tests for Different Types of Heat Pumps, Including Heating-Only Heat Pumps

highest fan speed and compressor capacity setting available in that installation, such that a technician can measure the quantities in a, b, and c with external equipment.

e. Automatic system discovery – System is capable of automatically recognizing compatible communicating indoor/outdoor units, furnaces. Automatic discovery of humidifiers and dehumidifiers is encouraged.

f. Preprogrammed system tests – System shall automatically prompt the installer to run preconfigured system tests following the initial setup. These tests should verify, at a minimum, fan blower, cooling-mode, defrost mode, heat pump only heating, and auxiliary heating tests as applicable to the product. The test should require installer verification of the results before exiting test mode.

Note: Comments received on the Draft 1 specification and discussions during stakeholder meetings indicated that as ENERGY STAR criteria increase, they may approach a point where investment in installation quality becomes a more cost-effective path to efficiency. EPA recognizes the importance of proper installation and has proposed these requirements to align with the efforts of the Residential Energy Services Network (RESNET) to develop an installation rating system for CAC/HPs. The requirements above are aligned with tasks specified by either the ENERGY STAR certified homes program or the ACCA/ANSI Quality Installation Verification Protocols. EPA is proposing to require three of the above capabilities but includes this broader list to forecast the Agency's interest in all of these capabilities.

EPA understands that in the determination of airflow, external static pressure, and blower fan power, only two of these quantities need to be reported for a technician to calculate the third (with a manufacturer provided fan table). With the understanding that there is not an industry standard or preferred quantities to report, EPA has structured this section to allow for any two of these to be reported by the unit.

Mirroring the RESNET installation grading work, measurement of the system operation (refrigerant charge, blower fan watt draw, airflow, and/or external static pressure) should be done at the maximum fan speed and compressor capacity the system will experience as installed. Systems that display one or more of these quantities are assumed to have such a "test mode" for the measurement. We note that having such an easily accessible "test mode" would on its own be a useful feature, such that whatever the unit doesn't display itself can conveniently be measured by a technician. This is the original of d.

EPA has proposed additional automatic setup capabilities (system discovery and installer system tests) that are currently on the market but accomplished through the interface of a thermostat. For this section of the specification, a thermostat will be considered as within the product boundary, but EPA would like input on whether these capabilities would be accomplishable through an installer app, or the unit itself.

E. Multiple Assemblies: For split system central air conditioners and heat pumps, ENERGY STAR certification shall be determined by the rated performance of the particular combination of indoor and outdoor units as tested in accordance with the appropriate regional test procedure, regardless of the fact that the components may be used in other combinations.

F. Gas/Electric Package Units: To certify as ENERGY STAR, gas/electric package units shall meet the cooling portion of the single package specification requirements in Table 2 for CACs, or in Table 3 for HPs, above. Gas/electric heat pumps may only achieve the Moderate and Hot Climate heat pump label.

Note: For gas/electric package heat pumps that are subject to the weatherized gas furnace Federal minimum AFUE requirements, EPA will allow these units to be recognized under the Moderate and Hot Climate label only. Through stakeholder outreach, EPA has determined this to be a small portion of the market and these units generally do not meet the intent of the Cold Climate label. If stakeholders are aware of products that should be recognized under the Cold Climate label, EPA welcomes that feedback.

G. ICM coil combinations: To certify as ENERGY STAR, ICM coil combinations shall meet the Central Air Conditioner and Heat Pump Split System specification requirements in Tables 2 and 3, above

and include a condensing (outdoor) unit listed in the ENERGY STAR program by a system manufacturer.

H. The HSPF2 and SEER2 (or HSPF and SEER) ratings for split systems shall be identical to the levels reported to DOE and appropriately reflected on the current Federal Trade Commission (FTC) Energy guide label. For packaged units, the HSPF2 and SEER2 ratings shall be identical to the levels reported on the Federal Trade Commission (FTC) Energy guide label and to those reported to DOE. For all units where EER2 (or EER) is reported to DOE, the EER2 reported to EPA shall be identical.

I. Significant Digits and Rounding:

a. All calculations shall be carried out with actual measured or observed values. Only the final result of a calculation shall be rounded. Unless otherwise directed below, calculated results shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.

b. Unless otherwise specified, compliance with specification limit shall be evaluated using exact values without any benefit from rounding.

c. As specified in 10 CFR, 430.23(m)(3), SEER2, and HSPF2 shall be rounded off to the nearest 0.025 Btu/W.h. Similarly, EER2 should also be rounded off to the nearest 0.025 Btu/W.h.

d. As specified in 10 CFR, 430.23(m)(3), capacity shall be expressed in accordance with Table 4, below:

Table 4: Rounding Requirements for Capacity

Capacity Ratings, Btu/h	Multiples, Btu/h
< 20,000	50
≥ 20,000 and < 38,000	100
≥ 38,000 and < 65,000	250

Note: The rounding requirements have been updated to be in alignment with the rounding requirements found in 10 CFR § 430.23.

4) Connected Product Criteria:

This section presents connected criteria for ENERGY STAR certified Central Air Conditioners and Heat Pumps. Compliance with Section 4 criteria is optional. ENERGY STAR certified products that comply with all Section 4 criteria will be identified on the ENERGY STAR website as having 'Connected' functionality.

A. Communications

a. The CCS Communication Link, in Figure 1, shall use Open Standards for all communication layers to enable functions listed in Section 4C).

b. An Interface Control Document (ICD), Application Programming Interface (API), or other documentation shall be made available to interested parties that, at minimum, allows access to the functions listed in Section 4C) and is recommended for Section 4B).

B. Consumer Feedback

a. **User Alerts**

The CCS shall be capable of providing at least two types of messages relevant to optimizing its energy consumption, communicating to residents either:

i. On the product (if intended to be installed in conditioned space) or its consumer control interface, and/or

ii. Transmitted to consumers and consumer authorized third parties via a communication link. This link can include open standards protocols used for Demand Response or could use a secondary communication link.

For example, messages relevant to existing fault conditions or energy consumption for CAC/HPs might address a fault condition, a reminder to replace a filter, heat pump refrigerant charge, or a report of energy consumption that is outside the product's normal range.

Note: Products meeting ENERGY STAR Most Efficient criteria for system status and messaging are compliant with this requirement.

b. **Energy Reporting**

The product shall be capable of transmitting measured or estimated instantaneous power draw in current conditions via a communication link to energy management systems and other consumer authorized devices, services, or applications. Provision of this information through the communication link and protocol used for demand response shall meet this requirement. *Example: A CCS uses CTA-2045A to comply with section 4)C, and implements CommodityRead functionality.*

Note: EPA did receive feedback that the ENERGY STAR specification should not require anything beyond the requirements defined in AHRI 1380. The items defined above are typical requirements across all ENERGY STAR connected criteria and serve to ensure basic utility is delivered and consistency is encouraged in ways that foster market development. The energy reporting requirement can be met by the functionality required for demand response below. EPA also realizes that AHRI 1380 details more specific requirements for energy reporting and chooses to maintain the above criteria in alignment with the other Connected specifications, with the understanding that a unit meeting the AHRI 1380 requirements would meet this requirement.

In addition, EPA typically requires that interface control documentation be provided to allow third parties access to functionality in section 4B), for instance for user alerts. In the long term, EPA believes this is in consumer's best interest for CAC/HP products as well – for instance, it would allow a user to give their contractor using a 3rd party management application access to these alerts. As the market does not currently provide this access, EPA is only recommending, rather than requiring it, in this version. We welcome feedback on the advantages and disadvantages of our short-term approach and long-term intentions.

C. Demand Response (DR)

a. **DR Communications Protocols**

The CCS shall meet the communication and equipment performance standards for CTA-2045-A or OpenADR 2.0b, or both.

Note: EPA proposes to align with communication requirements in AHRI 1380, which was developed by industry with considerable involvement by utilities. EPA notes an existing communication module to cloud DR interface (without open standard application layer) can be brought into compliance by connecting the product with an OpenADR 2.0b VEN in the cloud. EPA requests feedback on the feasibility and potential impact of this proposal.

b. **Consumer Override**

The CCS shall provide an easily accessible means for consumers to override demand response events during the event or ahead of time for a scheduled event. When the event is overridden, the CCS shall return to its previous operating mode.

Temporary overrides shall be limited to a maximum duration of 72 hours without additional user input; after this time, the CCS will return to its previous operating mode.

Note: Long term (persistent) overrides are not restricted, as some users may opt to use this functionality. EPA recommends encouraging the use of temporary overrides to consumers when appropriate.

Note: EPA proposes systems to have the capability for consumer override without limitation, as is typical in ENERGY STAR connected criteria. EPA notes that short term overrides with a maximum 72-hour time limit are preferable, as users often forget when a persistent override is used and would de facto un-enroll in a DR program indefinitely. EPA notes that this does not mean that every DR program in which the model is enrolled must allow consumer override. Rather, this is a requirement that the CCS provide the technical capability to implement overrides.

EPA understands this is not included in AHRI 1380 but sees value in including with little downside. EPA does not anticipate this functionality would require direct testing but would look to confirm this functionality through a review of the product, controls, and documentation.

c. **DR Information and Messaging**

The CCS shall support the following upstream messaging from the device as supported by application layer protocol(s) and may support the additional (optional) messaging capabilities. Support for these messaging signals is implemented via the open standards protocol used in the product. Implementation details are described in Appendix A.

<u>Required DR Messaging I/O:</u>

Messaging I/O Operation	Messaging Operation Description
Verifying Connectivity	Ensures target CCS is connected to DRMS and prepared to accept DR signals.
System Capabilities	Requests basic CCS level information on target device, including equipment type response capability.
Operational State(s) *(see c ii. below)*	Requests information on CCS running state, DR conditions operating on product, opt in/out state, and current fault conditions. **Note:** Operational State data structure and layout may vary by application layer protocol, containing the following device state information:

Operational State Codes:

Operational State Code	Operational State Definition
Idle Normal	Indicates that no DR event is in effect and the CCS has no/insignificant energy consumption.
Running Normal	Indicates that no DR event is in effect and the CCS is running normal under local control.
Idle Curtailed	Indicates that a curtailment type DR event is in effect and the CCS is in off mode.
Running Curtailed	Indicates that a curtailment type DR event is in effect and CCS is running in General Curtailment mode
Idle Heightened	Indicates that a heightened-operation type of DR event is in effect and the CCS is in off mode.
Running Heightened	Indicates that a heightened-operation type of DR event is in effect and CCS is running in Critical Curtailment mode.
CCS Error Condition	Indicates that the CCS is not operating or is in some way disabled (for example, no response to the grid).
Idle Opted Out	Indicates that the HVAC system is presently opted out of any DR events and the system is in off mode.
Running, Opted Out	Indicates that the SGD is presently opted out of any DR events and the SGD is operating normal under local control.

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d. **DR Requests and Responses**

The CCS shall also support the required DR operational modes listed below and may support additional open standard defined DR signals.

i. Required Operational Mode Functionality:

Operational Mode Function	Operational Mode Description
Maximum Indoor Temp. Rise	Specifies the maximum indoor temperature rise that the equipment must use when processing curtailment and/or price responsive modes.
General Curtailment	Directs equipment to reduce power consumption to a maximum of 70% of rated load power. Applicable to both staged and variable capacity equipment.
Critical Curtailment	Directs equipment to reduce power consumption to a maximum of 40% of rated load power. Staged equipment is not anticipated to respond to this message type; DRMS may substitute a General Curtailment message for this equipment type. Both staged and variable capacity equipment in heating mode shall not use resistance heating while indoor ambient temperature is equal to or above 62° F.

Off Mode	Directs equipment to turn to off mode, while maintaining compressor crankcase heater power and system controls power. Applicable to both staged and variable capacity equipment.
End Active Events	Notifies equipment that current or upcoming DR event(s) are cancelled.
Advanced Notification	Notifies equipment of an upcoming DR event. Equipment may perform preheating / precooling as appropriate. Note: Protocol dependent, may be attached to DR signals in some application layers.
Utility Peak Load Price Signal	Notifies equipment that a peak price period is in effect and contains relative pricing info on this event. Equipment manufacturer may provide user with the means to configure system to automatically respond to peak load price signals.
Customer Override	Notifies DRMS that a consumer has overridden a current / scheduled DR event.

Note: The above contains minor changes in language from the Limited Topic Proposal to align more closely with AHRI 1380.

ii. Operational Requirements:

Variable capacity equipment must ramp up/down changes in power over a minimum of 5 seconds, to decrease transients generated by operation.

D. Additional Information for Consumers

a. If additional modules, devices, services, particular controllers/thermostats, and/or supporting infrastructure are required in order to activate the CCS's communications capabilities, installation instructions and a list of these requirements shall be prominently displayed in the product literature and cut sheets. These instructions shall provide specific information on what must be done to activate these capabilities (e.g. the brochure might include, "This product can participate in utility demand response programs if paired with model XD1124 thermostat, which has Wi-Fi capability and would also require Internet connectivity and a wireless router for this functionality.")

5) Test Requirements:

A. One of the following sampling plans shall be used for purposes of testing for ENERGY STAR certification:

a. A single unit is selected, obtained, and tested. The measured performance of this unit and of each subsequent unit manufactured must be equal to or better than the ENERGY STAR specification requirements. Results of the tested unit may be used to certify additional individual model variations within a Basic Model as long as the definition for Basic Model provided in Section 1, above, is met; or

b. Ratings are determined pursuant to the sampling requirements defined in 10 CFR Part 429, Subpart B § 429.16 either by selecting units for testing or by the application of an alternative rating method (ARM) as defined in 10 CFR Part 429.70. The certified rating must be equal to or better than the ENERGY STAR specification requirements. Results of the tested or simulated unit may be used to certify additional model variations within a Basic Model as long as the definition for provided above and in 10 CFR Part 430.2 is met. Further, all individual models within a Basic Model must have the same certified rating per DOE's regulations in Part 429 and this rating must be used for all manufacturer literature, the

certified product list, and certification of compliance to DOE energy conservation standards.

c. For heat pumps to achieve the ENERGY STAR with the Cold Climate regional label, the testing must include the H4 very low temperature condition as defined in 10 CFR part 430 Subpart B, Appendix M1, Table 11 through Table 15 as applicable. This test condition shall be used to determine COP at 5° F and Percentage of Rated Capacity at 5° F criteria as required by Table 3 in this specification. Alternatively, the manufacturer may provide self-reported test information for performance at 5° F to determine the COP and Percentage Heating Capacity criteria in order to certify as ENERGY STAR Cold Climate before the Appendix M1 effective date on January 1, 2023. After January 1, 2023, all units must report test data to remain certified.

Note: While EPA seeks to eventually add testing rigor to validate cold climate performance, manufacturers may report application data for 5° F performance until the Appendix M1 test method is effective on January 1, 2023. After this time, 5° F performance must be measured per the H4 very low temperature test as defined in this appendix. Manufacturers raised a concern that the 5°F testing in Appendix M1 is specified in such a way as to be unrealistic. EPA is satisfied this is not the case and invites other parties to send questions directly to DOE at ApplianceStandardsQuestions@doe.gov for clarification.

B. When testing central air conditioners and heat pumps, the following test method shall be used to determine ENERGY STAR certification:

Table 5: Test Method for ENERGY STAR Certification

ENERGY STAR Requirement	Region	Test Method Reference
SEER2, EER2, HSPF2 or SEER, EER, HSPF	All Climates	10 CFR part 430 Subpart B Appendix M1 or 10 CFR part 430 Subpart B, Appendix M (Allowed for models certified prior to January 1, 2023)
COP @ 5° F, Percentage of Heating Capacity @ 5° F	Cold Climate	10 CFR part 430 Subpart B Appendix M1 * (Tested results required for models certified beginning January 1, 2023)
Connected Products: Demand Response	All Climates	Evaluation of Demand Response in CAC/HP (in development) or certification to AHRI 1380 ** and examination of product documentation and interfaces
Controls Verification Procedure	Cold Climate	Controls Verification Procedure for Residential Heat Pump Low Ambient Performance (to be developed)

* Prior to the specification effective date, products may certify COP @ 5° F and heating capacity @ 5° F with manufacturer provided application data. Percent Heating Capacity @ 5° F will be heating capacity @ 5° F (based on manufacturer provided application data) divided by heating capacity @ 47° F (as measured by Appendix M).

** Prior to the test method publication date, products may certify as Connected through examination of the product, its control system and its documentation. Recognition as meeting ENERGY STAR connected criteria is optional.

Note: Prior to January 1st, 2023, products may be certified to Version 6.0 using the Appendix M test procedure and associated metrics, and report 5° F performance criteria based on engineering test and simulation, in accordance with manufacturer provided application data. After the specification effective date, products will need to report tested criteria according to the Appendix M1 test method. EPA seeks to validate cold climate performance with consistent test data but understands that implementation of Appendix M1 prior to the Federal effective date is not practical for manufacturers. This solution is intended to allow products to begin to gain the Cold Climate recognition immediately but with the backing that partners will need to provide tested data in 2023 to maintain certification. Until the effective date of the specification, connected criteria may be certified based on product examination and documentation review. By the effective date, EPA expects that one or both of the other methods to verify product performance will be available and must be used to earn optional recognition as meeting ENERGY STAR connected criteria. Note that per Definition P, the control may be considered within the product boundary for connected purposes, as proposed within the Limited Topic Proposal.

As indicated in section 3B., EPA may consider additional methods to demonstrate low ambient performance for cold climate heat pumps. In that case, the associated test methods would be added to Table 5.

EPA will release a draft of the Controls Verification Procedure shortly with opportunity for stakeholder feedback.

6) **Effective Date**: This ENERGY STAR Central Air-Conditioners and Heat Pump Specification shall take effect on **January 1, 2023.** To certify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on the date of manufacture. The date of manufacture is specific to each unit and is the date (e.g., month and year) on which a unit is considered to be completely assembled.

Note: EPA received strong feedback that manufactures would be unable to comply with the specification before January 1, 2023 due to the extensive need for redesign and retesting for the upcoming Federal test method change. In light of this, EPA has chosen to align the effective dates, allowing for certification prior to 2023 using currently available data, with the potential to gain the Connected recognition or Cold Climate Heat Pump label promptly. EPA aims to finalize the Version 6.0 CAC/HP specification in Q2 of 2020.

Future Specification Revisions: EPA reserves the right to change the specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through industry discussions. In the event of a specification revision, please note that the ENERGY STAR certification is not automatically granted for the life of a product model.

EPA's ENERGY STAR Emerging Technologies program currently recognizes highly efficient air to water heat pumps that have acceptable cold climate performance. As this technology gains a foothold in the US, EPA anticipates it will eventually make sense to include this type of product in the scope of the CAC/HP specification.

Additionally, to align with the ENERGY STAR Certified Homes' effort to develop a standard for grading HVAC installations, ENERGY STAR hopes to encourage the development of controls that could auto-grade equipment installation. Future revisions may include requirements or recognitions for equipment that can verify correct installation, as well other communicating features that can identify faults or send service alerts to the consumer. ENERGY STAR aims to leverage the knowledge and technology of equipment designers to align tested with field performance of central air conditioners and heat pumps.

Appendix A: Demand Response Messaging:

Category	Sub-type	Demand Response Messaging	Response Result	CTA (2045-A)	OpenADR (2.0b)
Basic Signals	Curtailment	**General Curtailment**	Reduce load (moderate)	Shed[10]	oadrDistributeEvent: SIMPLE level 1.[11]
		Emergency Curtailment	Reduce load (major)	Critical Peak Event[10]	oadrDistributeEvent: SIMPLE level 2.[11]
		Off Mode	Turn off (if possible)	Grid Emergency[10]	oadrDistributeEvent: SIMPLE level 3.[11]
	Operational State	**Return to Normal Operation**	Return to defaults	End Shed / Run Normal[10]	oadrDistributeEvent: CANCELLED.[12]
		Advance Notice	No requirement (flexible)	Pending Event Time / Type[10]	oadrDistributeEvent: NEAR / FAR / ACTIVE[12]
Advanced Signals	Device State (in event)	**Maximum Indoor Temp. Offset**	Adjust setpoint for use in curtailment / price response	Get / Set Temperature Offset[13]	oadrDistributeEvent: LOAD_CONTROL, x-loadControlSetpoint[11]
	Device Logic	**Utility Peak Load Price Signal**	Use / do not use energy when appropriate	Present Relative Price[10]	oadrDistributeEvent: ELECTRICITY_PRICE[11]
Device Properties & Enrollment	Opt Out	**Consumer Override**	Skip response to event within opt out time window	Customer Override. Sent each time device is queried while opt out is active[10]	oadrCreateOpt, oadrCancelOpt[14]
	Dev. Info	**Device Information**	Indicates product type	Info Request[13]	ei:eiTargetType (endDeviceAsset)[15]

[10] CTA-2045-A: Table 8-2

[11] OpenADR 2.0b, Section 8.2.2

[12] OpenADR 2.0b, Section 11.2

[13] CTA-2045-A: Table 9-2

[14] OpenADR 2.0b, Section 8.5

[15] OpenADR 2.0b, Annex A

	Status	**State Reporting Requirements**	Provide state information to requestor	Query / State Query Response[13]	EiReport. oadrPayloadResource-Status[12]
	Hardware	**Hardware Requirements**	Design of product & comms.	AC or DC Form Factor physical interface	-
Device Energy	Energy	**Power (Instantaneous)**	Demand of product (W)	Get CommodityRead, code 0[16]	oadrReport: energyReal[12]
		Energy (Cumulative)	Energy used by product (kWh)	Get CommodityRead, code 0[16]	oadrReport: energyReal[12]

Note: EPA is developing the above appendix on DR messaging under common protocols to improve the specificity of DR method definitions in section 4C, Demand Response (DR), and assist with the interoperability and implementation of DR strategies for connected CAC/HP equipment. EPA is requesting feedback on this appendix and encourages stakeholders to engage in a dialogue with EPA to further develop this resource.

[16] CTA-2045-A, Section 9.3.1