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ENERGY STAR Version 6.0 Residential Air Source Heat Pump (ASHP) and Central Air Conditioner (CAC) Equipment

EPRI Comments

Link to the full discussion guide:
https://www.energystar.gov/sites/default/files/CAC_ASHP_Version%206_Discussion%20Guide.pdf

Regionally-Specific Performance Requirements

1. Is EER used to predict seasonal efficiency anywhere outside the U.S. Southwest region?

> It is our understanding that EER is not being used to predict seasonal efficiency. It is being used to predict impacts during peak cooling conditions. EER is a fundamental characteristic in building modeling software and as such influences building design. The link of EER to building performance is not straightforward. However, the impact of EER seems to reach diminishing returns around 14 EER.

2. How widespread is the need to control peak load by incentivizing high EER systems?

> Historically, incentives for energy efficiency and demand response are not included together because they are valued separately because they provide different services to the grid. But the need to control peak load is well established in several areas of the country, and there is growing interest for more areas. High EER systems do not necessarily manage peak (and there is data to show that). However, high EER systems can substantially impact energy efficiency and indoor comfort.

3. Are there other opportunities a regional specification would present?

> Regional specifications would present opportunities to target regional issues such as addressing load balancing for decarbonization (e.g., pre-cooling control, load shed in the evenings, load absorption in the mornings, etc.). This can be achieved by remote set point control as has been proven successfully with smart thermostats. However, other control options are also possible (e.g., AHRI 1380).

4. EPA is aware of ongoing efforts to define northern climate heat pump performance and establish a test method, for instance the Northwest Energy Efficiency Alliance (NEEA) effort and work that the Canadian Standards Association (CSA) is doing with a Canadian utility. What are the relative advantages and disadvantages of those efforts, for instance repeatability, testing burden, and capturing real world effects? Should other methods of establishing this performance be considered?

> Ideally, group collaboration would lead to development of unified performance criteria. On the other hand, setting burdensome test methods will be difficult for manufacturer buy-in. We recommend working with the procedures that DOE has established for now (which go into effect January 2023), and in parallel working with DOE and manufacturers during the next round of revisions to modify the federal test method and metrics as appropriate (post 2023).

Optional Connected/Grid-aware Criteria

5. Would it be reasonable for products with DR capability to have lower EER requirement (aside from where needed for seasonal energy) than those without?

The answer depends on the requirements that define "DR capability." If a manufacturer could implement the DR requirements into a product with an EER lower than the specified level, then it's appropriate to offer options by which the manufacturer's non-reoccurring engineering (NRE) and per-unit cost increase could be recovered. It would be appropriate to offer options to recover costs only if the DR capabilities can be accessed by the consumer or a third-party of their choosing at time of purchase and independent of the original manufacturer. If you consider having lower EER requirements for products with DR capability, then the tradeoff would need to be carefully analyzed to determine impacts.

6. Are there any problems with relying on AHRI 1380 for demand responsiveness criteria?

The AHRI 1380P draft defines the requirements for how variable capacity HVAC systems (less than 65,000 BTU/hr) communicate and respond to information shared though an open interface. Variable capacity systems include discretely-variable (multi-stage) systems, as well as continuously-variable capacity systems. AHRI 1380 is not applicable to single-speed equipment. The original intent of the working group was to create a standard by which manufacturers could embed demand responsive behaviors into products and make them accessible by the consumer or a third-party of their choosing at time of purchase and independent of the original manufacturer. During the standard development process, some requirements were changed, removed or made optional to make it easier for products to meet the standard, but also causing the standard to fall short of its original intent.

As for demand responsive criteria, the AHRI 1380P draft includes well-thought-out demand response criteria. EPRI recommends that the connected criteria section of *ENERGY STAR Version 6.0 Residential Air Source Heat Pump (ASHP) and Central Air Conditioner (CAC) Equipment* align with the demand response criteria defined in AHRI 1380P.

AHRI 1380P supports power limiting functionality for demand response, but with a secondary limit for maximum temperature offset from setpoint (capacity is allowed to increase to maintain the max specified temperature offset). Moreover, temperature-offset type demand response may be achieved by calling an "OFF Mode (grid emergency)" curtailment and sending a "Max indoor temperature offset" payload to define the maximum temperature variation from the original setpoint temperature. This is analogous to achieving temperature setpoint change with a conventional single-speed air conditioner or heat pump. Moreover, the EPA may also consider adopting the following changes, to supplement the AHRI 1380P specification:

Change to Section 6.1

Summary of Operating and Physical Requirements. DR-Ready HVAC equipment shall meet the communication and equipment performance requirements as itemized in Table 1. The communication interface meets the requirements defined in ANSI/CTA-2045-A or OpenADR 2.0 or both and must be integrated into the equipment. Compliance with all requirements shall be verified by tests in accordance with Section 5.

Additional recommended requirements to supplement the AHRI 1380P specification are found in the following tables.

Table 1. Communication and Discovery with ANSI/CTA-2045

Function	ANSI/CTA-2045.A Message	ANSI/CTA-2045.A Reference	AHRI Usage and Purpose
Instantaneous and Benchmark Power	Commodity Read – sent from the communication module to the HVAC unit, with response	Section 9.3.1 Section 9.3.1.1 (request) and Section 9.3.1.2 (response)	Enables remote systems to determine power (Watt) benchmarks and reductions during events. Equipment shall support the following: 1. Commodity code 0 (electricity consumed). Reported values shall be instantaneous and shall be measured or estimated Commodity code 8. For HVAC products, the Benchmark Power for the current state of operation should be reported.

Table 2. Management with ANSI/CTA-2045

Function	ANSI/CTA-2045.A Message	ANSI/CTA-2045.A Reference	AHRI Usage and Purpose
Load-up	Load Up (request) and Basic Application ACK (response) Messages.	Table 8-2	Directs HVAC equipment to increase energy consumption. 1. If unit is in cooling mode, decrease temperature set point by 4˚F. 2. If unit is in heating mode, increase temperature set point by 4˚F, with backup resistance heat turned off. Equipment shall process this command for 2 hours unless it receives instructions to extend or terminate the event. HVAC shall respond with an application "Acknowledge (ACK)", verifying receipt and support of the request.
Variable Demand Limiting	Request for Power Level	Table 8.2	Directs HVAC equipment (both heat pump and cooling-only types) to variable curtail energy consumption: 1. For Continuously-variable Capacity Equipment in cooling mode: the unit shall limit demand to the percent included in the Request for Power Level command, see table below.

Power Level Signal	Demand Limit	Function (see Table 1 in AHRI 1380)
5% or less	Unit should turned off	Turn Off
5% to 40%	Do not exceed 40%	Critical Curtailment
40% to 70%	Vary limit using Power Level Signal	Variable demand limiting
70% to 100%	Do not exceed 70%	General Curtailment

Where,
Demand Limit = (Request for Power Level) x (maximum Benchmark Power. See Section 3.1 definitions).

2. For Discretely-variable Capacity Equipment in cooling mode: not-applicable, NAK response with reason code = 0x01(Opcode not supported) and take no action. Note that the utility demand response administrator system, upon receipt of a NAK from Discretely-variable Capacity Equipment may then automatically

Table 2. Management with ANSI/CTA-2045			
Function	**ANSI/CTA-2045.A Message**	**ANSI/CTA-2045.A Reference**	**AHRI Usage and Purpose**
			send a "General Curtailment" or "Turn off" signal depending on the agreement with the customer. Note: This curtailment is subject to indoor temperatures remaining within the "Maximum Indoor Temperature Offset", if set. Either Continuously-variable or Discretely-variable Capacity Equipment, if in the heating mode, shall turn off resistance heating elements unless indoor temperature is below 62˚F. HVAC shall respond with an application "Acknowledge (ACK)", verifying receipt and support of the request.

Table 5. Status Data Reported in a TELEMETRY (STATUS) Report				
Structure			**Value**	**Interval**
Report Name			x-AHRI_STATUS	
Report Description				
1.		rID	Inst Power	1 Min
		Report Type	Reading	
		Reading Type	Direct Read	
		Units	W	
2.		rID	Operational State	1 Min
		Report Type	Reading	
		Reading Type	Direct Read	
		Units	Integer	
3.		rID	Override State	1 Min
		Report Type	Reading	
		Reading Type	Direct Read	
		Units	Discrete	

6.1.2.4 Description and use of status data fields for the telemetry report.

6.1.2.4.1 *Inst Power*

Reported values associated with the power consumption of the system's components and controls shall be measured or estimated. Power shall be an instantaneous measurement. DR Program Administrators are advised that to obtain an accurate power measurement that avoids brief compressor "speed-ups" to ensure proper oil return to the compressor, twenty instantaneous power measurements, shall be taken, at the rate of one measurement per minute. Power measurement shall be the average of the 20 readings.

6.1.2.4.2 *Operational State*

0 = "Idle Normal" Indicates that no DR event is in effect and the HVAC system has no/insignificant energy consumption.

1 = "Running Normal" Indicates that no DR event is in effect and the HVAC system is running normal under local control.

2 = "Running Curtailed" Indicates that a curtailment type DR event is in effect and system is running in General Curtailment mode?
3 = "Running Heightened" Indicates that a heightened-operation type of DR event. is in effect and system is running in Critical Curtailment mode?
4 = "Idle Curtailed" Indicates that a curtailment type DR event is in effect and the HVAC system is in off mode. .
5 = "SGD Error Condition" Indicates that the HVAC system is not operating or is in some way disabled (for example, no response to the grid)
6 = "Idle Heightened" Indicates that a heightened-operation type of DR event is in effect and the HVAC system is in off mode.
7 = Unused code.
8 = Unused code.
9 = Unused code.
10 = Unused code.
11 = "Idle, Opted Out" Indicates that the HVAC system is presently opted out of any DR events and the system is in off mode.
12 = "Running, Opted Out" Indicates that the SGD is presently opted out of any DR events and the SGD Is operating normal under local control

6.1.2.4.3 *Override State*

Set to "1" if in override
Set to "0" if not overridden

Table 6. Management with OpenADR			
Function	**Message**	**OpenADR Reference**	**AHRI Usage and Purpose**
Load-up (includes advanced notification)	oadrDistributeEvent – sent from VTN to VEN, with response (oadrCreatedEvent)	Section 8.1, OpenADR 2.0b EiEvent Service Figures 4 & 5, EiEvent Patterns Section 8.2.2, OpenADR 2.0b Signal Definitions Table 1, Signals	Directs HVAC equipment (both cooling-only and heat-pump) to increase energy consumption. 1. If unit is in cooling mode, decrease temperature set point by 4˚F. 2. If unit is in heating mode, increase temperature set point by 4˚F, with backup resistance heat turned off. Equipment shall process this command for 2 hours, unless it receives instructions to extend or terminate the event. The VTN shall send an oadrDistributeEvent carrying an oadrEvent element with a signalName:signalType of "SIMPLE:level" set to "0" to indicate a "Load-up Signal" Note: This event message also informs the HVAC equipment of the timing and status of future DR events. The VTN's oadrDistributeEvent includes a start time, an event duration, as well as an eventStatus element that is set to "NEAR" or "FAR" (the transition from FAR to NEAR occurs at the start of the ramp period for an event). Name: SIMPLE Type: level Units: None Payload: 0

7. What value does connectivity bring to CAC/ASHP customers (aside from grid value)?

Remote control and connectivity could offer convenience to the consumer and added comfort as a result of enhanced control options. Consumer value is an important aspect to be further evaluated and better understood.

8. How would one consider connectivity for products intended to work with a proprietary controller that is not part of the unit itself, but instead takes the place of a thermostat?

Traditional 24 Volt alternating current (24Vac) thermostats have been used for decades as on-off control devices that simply signal a furnace, air conditioner, or heat pump to turn on or off, or to switch between stages based on temperature setpoints. Variable capacity HVAC systems do not simply turn on and off, but rather adjust their output with the goal of matching the load. By operating at a capacity closer to the load, the variable capacity system is able to provide significantly higher energy efficiency. In many of these systems, the controller is not a traditional thermostat. In place of the thermostat are a user interface and temperature/ humidity sensors linked to controls in the equipment (source: "Smart" Systems, November 14, 2013 AHRI).

The alternative to a 24Vac thermostat described above is a proprietary controller that's typically designed to connect with other proprietary controllers embedded in variable capacity air

conditioners, heat pump and other HVAC equipment. This is possible because the manufacturers of this equipment depend on the services provide by a temperature sensor (thermostat) and build their products with a physical interface (terminals) that enable temperature sensors (thermostats) to connect to the equipment. To improve interoperability at time of install, the industry has also established a convention for associating terminals with a specific function with a colored conductor. Variable capacity systems and the control services that a typical 24Vac thermostat provides are incompatible, in that the on-board variable capacity controller manages zone temperature. So there is no need for two temperature controllers (i.e., there is no need for a thermostat switch closure and another internal system controller).

The terminal-color convention (open interface) used in the industry has enabled third-parties to build devices that can connect to proprietary controllers. If manufacturers of variable capacity units were to adopt a similar open interface, third-party manufacturers of thermostats, gateways, home energy management systems, etc. could develop technologies to provide value-added services.

Energy Efficiency Metrics

9. Would it be possible to establish parallel SEER2, EER2, and HSPF2 criteria?

DOE changes to start using SEER2, EER2 and HSPF2 are approved and ready for implementation in January 2023. We are not aware of the method for converting from SEER to SEER2, but suspect that it isn't a direct simple calculation. In January 2023, both the test method and metrics will change. And, manufacturers won't start publishing the alternate values and using the different test method until very close to January 2023. Consequently, rather than establishing parallel criteria for SEER2 etc. at this time, EPRI recommends to revisit and modify as appropriate in 2022.

10. If so, would any manufacturers be interested in using this option?

It is highly doubtful to find many manufacturers interest before 2023.