

Final Draft ENERGY STAR Cold Climate Heat Pump Controls Verification Procedure (CVP)

1 **Purpose:**

2 The purpose of this procedure is to validate the certified performance of ENERGY STAR central heat
3 pumps using the unit under test's Native Controls at the 5°F conditions specified by the ENERGY STAR
4 test method for CAC/HP.

5 **Scope:**

6 ENERGY STAR scope (i.e., central CAC/HP meeting the criteria for ENERGY STAR Cold Climate Heat
7 Pump)

8 **Definitions:**

9 Refer to Appendix M1 and ENERGY STAR definitions.

10 *Native Controls* means configuring the unit under test with settings specified for field use and removing
11 the unit from "test mode" used for steady-state tests. Native Control settings shall be determined from
12 manufacturer Installation and Operations manual shipped with the unit. In the event that control settings
13 required to operate the unit are not present in the manufacturer I&O manual, the hierarchy shall be
14 product label instructions, then manufacturer default settings. The unit under test shall be operated using
15 these settings without overriding its system controls. For units shipped with a control device (i.e.
16 thermostat or remote-controller), the control device is considered an integral component of Native Control
17 and should be used for testing. For units that are intended to be used with a communicating control but
18 the control device is not shipped with the unit, the manufacturer must specify the communicating control
19 device that is most commonly installed with the unit to be used during testing. For dual or fixed-capacity
20 systems, the laboratory may define a standard control used for those types of products.

21 **Note:** EPA received feedback that the process for setting the unit under test to operate under Native
22 Controls may be different depending on the type of unit and thermostat it is paired and has revised the
23 definition above. EPA believes that the cold climate designation will mostly be achieved by variable speed
24 units with remote controls or with communicating thermostats that should be considered part of the native
25 control. If single stage or two stage units are tested to the CVP, they should be able to complete the CVP
26 with a laboratory specified control.

27 **Testing Apparatus and Setup:**

28 Refer to Appendix M1 for setup unless otherwise modified by this document.

29 **Test Procedure:**

- 30 1. *Setup.* Configure the unit under test to operate under Native Controls (i.e., removed from "test
31 mode" used for steady state tests). Set the indoor unit thermostat(s) to the maximum achievable
32 set point and the airflow-control settings of the unit under test shall be the same as those used for
33 the Appendix M1 H₄ test.
- 34 2. *Pretest Interval for Steady-state Determination.* Allow the system to operate until either steady-
35 state requirements are achieved or until four (4) hours have elapsed. Steady-state shall be
36 considered to have been met when the test operating and test condition tolerances listed in Table
37 1 are met for at least 30 minutes. If the system is unable to attain steady-state operation within
38 the four-hour pretest interval, then dynamic equilibrium criteria shall apply during the official test
39 period.

Table 1. Test Tolerance for H4x Test		
	Test operating tolerance	Test condition tolerance
Indoor dry-bulb, °F:		
Entering temperature	4.0	2.0
Leaving temperature	4.0	-
Indoor wet-bulb, °F:		
Entering temperature	2.0	-
Outdoor dry-bulb, °F:		
Entering temperature	4.0	2.0
Leaving temperature	-	-
Outdoor wet-bulb, °F:		
Entering temperature	2.0	1.0
Leaving temperature	-	-
External resistance to airflow, inches of water	0.05	0.02(1)
Electrical voltage, % of rdg	2.0	1.5
Nozzle pressure drop, % of rdg	8.0	

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(1) Applies to non-ducted units only.

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Note: Per discussions in the Draft CVP webinar and comments received, EPA has specified a maximum pre-test interval of four hours. If the system is unable to attain steady-state operation within four hours the dynamic equilibrium criteria shall be used.

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3. *Defrost Period.* At conclusion of pre-test interval, conduct a defrost cycle following the provisions of Appendix M1 section 3.10. This defrost cycle may be manually or automatically initiated. Terminate the defrost sequence using the heat pump's defrost controls.

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4. *Official Test Period.* Consistent with ASHRAE 37 requirements, the official test period shall not begin until 10 minutes after the conclusion of the defrost period, and test tolerances shall not apply during that time. Once the official test period begins, continuously monitor all instrumentation as required by Appendix M1 (equal intervals that span 5 minutes or less), except for power which shall be recorded each second unless using an integrating power meter. The official test period shall be one hour. For systems that attain the steady-state determination during the pretest interval, test condition and operating tolerances from Table 1 shall apply during the official test period. For systems that were unable to meet the steady-state determination, dynamic equilibrium criteria shall apply during the official test period. Dynamic equilibrium is attained when dynamic behavior does not exceed the frequency response capability of the capacity measurement instrumentation (e.g. psychrometers) and both the capacity and system power input measured in successive 30-minute intervals are within 2 percent of each other.

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5. *Optional adjustments for units having a variable-speed compressor.* If the Percentage of Heating Capacity exceeds 70% and the COP is less than 1.75, the following adjustments are allowed. Control the total sensible cooling addition to the indoor room such that the heating load approaches and eventually equals the certified 5° Heating Capacity. (Note: Heating tests are sensible only. Therefore, no latent addition to the indoor room shall be made). In tandem, incrementally reduce the indoor unit thermostat set point as needed such that the air entering the indoor units approaches the target indoor room dry bulb temperature until the criteria as specified in section Validation Criteria are met or Percentage Heating Capacity drops below 70% with COP that is still lower than 1.75, which would constitute a failure.

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68 **Note:** EPA received feedback that the proposed method may result in indoor room dynamic conditions
69 that are difficult to control, and that the adjustment procedure should be vetted using CVP test data to
70 warrant its inclusion. EPA believes that issues related to control dynamics are de minimis and expects
71 that most test chambers will be capable of manual control. During the adjustment procedure, the
72 temperature delta between the indoor room return air and the indoor unit thermostat set point is likely to
73 remain larger than the indoor unit control deadband, and not result in cyclical fluctuations in room
74 conditions. As a result, the adjustment procedure has been left unchanged, but language has been
75 amended to highlight the optional nature of the method to provide an additional path for heat pumps to
76 meet the Cold-Climate Validation Criteria.

77 **Data to be Recorded During Official Test Period:**

78 Continuously record all required parameters and calculate the space heating capacity $Q_{h,x}^{k=2}(5)$ and total
79 electrical power consumption $E_{h,x}^{k=2}(5)$ as specified in Appendix M1 (section 3.10). Evaluate the Coefficient
80 of Performance (COP) accordingly.

81 Calculate Percentage Heating Capacity @ 5°F using heating capacity $Q_{h,x}^{k=2}(5)$ measured during the CVP
82 divided by heating capacity @ 47°F $Q_{h,x}^{k=2}(47)$ certified to ENERGY STAR (i.e., determined from Appendix
83 M1 H1_N test for units having variable-speed compressors where the compressor speed shall be the
84 maximum speed that the system controls would operate at 47°F, otherwise from Appendix M1 H1₂ test).

85 **Validation Criteria:**

86 COP and Percentage Heating Capacity @ 5°F obtained as described in this procedure must be equal or
87 greater than the criteria below to earn the ENERGY STAR Cold Climate Heat Pump designation:

88 (Table 4A in Certification Criteria section of the ENERGY STAR specifications)

COP @ 5°F	Percentage of Heating Capacity @ 5°F
1.75	70%

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90 **Note:** These validation criteria are being applied as a screen for purposes of ENERGY STAR certification
91 in order to ensure a broad range of products with superior cold climate field performance are able to earn
92 the label. There is no requirement that manufacturer-certified or advertised values for COP or Heating
93 Capacity be equivalent to or within a tolerance of the values measured per the CVP, In order to reduce
94 burden, EPA has opted not incorporate elements of consistency or accuracy sufficient to validate CCHP
95 performance within a tolerance of certified/advised values. Such a CVP would likely include additional
96 elements of a load-based test (which have not been proved to be repeatable or reproducible).