U.S. Department of Energy Guidance: Determining Heat Pump Performance at 5 °F Outdoor Temperature During 2023

Issued: November 22, 2022

Background: These instructions specify how to determine heat pump performance at a 5°F outdoor temperature for the limited purpose of evaluating whether a basic model meets the Consortium for Energy Efficiency (CEE) Electric Equipment Specifications for heat pumps that are effective Jan. 1, 2023. For the duration of the 2023 calendar year, COP at 5°F may be determined using the ENERGY STAR Cold Climate Heat Pump Controls Verification Procedure (CVP) or the calculation methodology in this document based on tests at 5°F, 17°F, and/or 47°F using Appendix M1 to Subpart B of 10 CFR Part 430. Starting January 1, 2024, COP at 5°F must be determined using the ENERGY STAR Cold Climate Heat Pump Controls Verification Procedure (CVP) or by conducting the Appendix M1 test at 5°F. The reporting of such performance is applicable only for heat pumps for which the low-temperature cut-in temperature (expected to be warmer than the low-temperature cut-out temperature) is lower than 5°F. In all cases, compliance with Federal energy conservations standards for heat pumps at 10 CFR 430.32(c) (i.e., SEER2, HSPF2, EER2, as applicable) must be determined using the Appendix M1 test method.

Calculation procedure:

The COP ($COP_h(5)$) for an outdoor temperature of 5°F is calculated by the following equation:

$$\boldsymbol{COP_h(5) = \frac{\dot{Q}_h(5)}{\dot{E}_h\,(5) * 3.412}}$$

Where $\dot{Q}_h(5)$ is the heating capacity at 5 °F in Btu/hour, $\dot{E}_h(5)$ is the power input at 5 °F in Watts, and 3.412 is a conversion from Watts to Btu/hr.

For heat pumps for which the optional 5 °F $H4_2$ test is conducted, $\dot{Q}_h(5)$ and $\dot{E}_h(5)$ are as measured in that test.

For heat pumps for which the optional 5 °F test is not conducted, calculate $\dot{Q}_h(5)$ and $\dot{E}_h(5)$ using the following equations.

$$\boldsymbol{\dot{Q}_h(5) = \dot{Q}_h(17) + \frac{\left[\dot{Q}_h(47) - \dot{Q}_h(17)\right] * (5 - 17)}{47 - 17}}$$

$$\boldsymbol{\dot{E}_h(5) = \dot{E}_h(17) + \frac{\left[\dot{E}_h(47) - \dot{E}_h(17)\right] * (5 - 17)}{47 - 17}}$$

For single-speed heat pumps, $\dot{Q}_h(17)$ and $\dot{E}_h(17)$ are the heating capacity and power input, respectively, measured for the H3 test, while $\dot{Q}_h(47)$ and $\dot{E}_h(47)$ are the heating capacity and power input, respectively, measured for the H1 test.

For two-capacity heat pumps, $\dot{Q}_h(17)$ and $\dot{E}_h(17)$ are the heating capacity and power input, respectively, measured for the $H3_2$ test, while $\dot{Q}_h(47)$ and $\dot{E}_h(47)$ are the heating capacity and power input, respectively, measured for the $H1_2$ test.

For variable-speed heat pumps:

1) $\dot{Q}_h(17)$ and $\dot{E}_h(17)$ are the heating capacity and power input, respectively, measured for the $H3_2$ Test.
2) If the $H1_N$ test is conducted using the same compressor speed as the $H3_2$ test, $\dot{Q}_h(47)$ and $\dot{E}_h(47)$ are the heating capacity and power input, respectively, measured for the $H1_N$ test.
3) Otherwise, if the optional $H1_2$ test is conducted, using the same compressor speed as the $H3_2$ test, $\dot{Q}_h(47)$ and $\dot{E}_h(47)$ are the heating capacity and power input, respectively, measured for the $H1_2$ test.
4) Otherwise, If the $H1_N$ test is not conducted using the same compressor speed as the $H3_2$ test and the optional $H1_2$ test is not conducted, calculate the terms for $\dot{Q}_h(47)$ and $\dot{E}_h(47)$ using equations from Appendix M1 section 3.6.4 as shown below.

$$\boldsymbol{\dot{Q}_h(47) = \dot{Q}_h(17) * (1 + 30°F * CSF)}$$

$$\boldsymbol{\dot{E}_h(47) = \dot{E}_h(17) * (1 + 30°F * PSF)}$$

Where:

1. CSF is the capacity slope factor (0.0204/°F for split systems and 0.0262/°F for single package systems).
2. PSF is the power slope factor (0.00455/°F)