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Guidance Type: Test Procedures
Category: Consumer Products
Product: Central air conditioners and heat pumps
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Q: How can I determine capacity at a 5°F outdoor temperature for a heat pump if the optional 5°F ($H4_2$) test was not performed?

A: Capacity at 5°F for heat pumps is determined using the DOE test procedure at Appendix M1 to Subpart B of Title 10 of the Code of Federal Regulations (Appendix M1) and can be determined directly by performing the optional 5°F ($H4_2$) test or by calculation using data from the required Appendix M1 tests as described in this document.

These instructions specify how to determine heat pump performance at a 5°F outdoor temperature for evaluating whether a basic model meets specifications for low temperature heat pump performance, such as the Consortium for Energy Efficiency (CEE) Electric Equipment Specifications for heat pumps that are effective Jan. 1, 2023. Use of the calculation method may not necessarily be permitted by other programs with specifications for low-temperature heat pump performance, which may require use of the $H4_2$ test, and 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.

This method 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.

Instructions:

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.

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

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

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.

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

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

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)