INTERPRETATION IC 90.1-2007-09 OF
ANSI/ASHRAE/IESNA STANDARD 90.1-2007
Energy Standard for Buildings Except Low-Rise Residential Buildings

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Reference: This request for interpretation refers to the requirements presented in ANSI/ASHRAE/IESNA Standard 90.1-2007, Section G3.1.3.1, regarding heat pump operation.

Background: We have received several comments from LEED regarding the application of Appendix G 3.1.3.1 and what G3.1.3.1 actually means. Section G3.1.3.1 states

G3.1.3.1 Heat Pumps (Systems 2 and 4). Electric air-source heat pumps shall be modeled with electric auxiliary heat. The systems shall be controlled with multistage space thermostats and an *outdoor air* thermostat wired to energize auxiliary heat only on the last thermostat stage and when outdoor air temperature is less than 40°F.

We understand heat pumps in real world applications are capable of operating below 40°F, however when the outdoor coil begins to freeze due to heat absorption from the outdoors the heat pumps go into reverse cycle to defrost the outdoor coil when ice starts to build up.

LEED 2009 Building Design & Construction specifically lists on page 342 of the as "Approved Energy Simulation Software" Carrier HAP, Trane Trace 700, and eQuest (DOE-2). Avaliable inputs for heat pump and condenser shutoff are described below.

Carrier HAP input is only the Cutoff OAT temperature: The point at which the heat pump is no longer in operation and the auxiliary heat is used for 100% heating. (No defrost cycle or heat pump operation below 40°F)

Trane Trace 700 input is on the cooling equipment and has a minimum operating temperature for the condenser.

eQuest version 3.64 has the most options with regards to the heat pump heating and auxiliary heat, however none of the information for these inputs is provided in ASHRAE 90.1 Appendix G. eQuest provides options for the minimum Heat Pump Heat Temperature, and Maximum Defrost Temperature.

The specific comment from the USGBC/LEED reads "It is unclear if the packaged rooftop heat pumps in the Baseline model were modeled according to Section G3.1.3.1, which requires that the electric air-source modeled with electric auxiliary heat that only energizes on the last thermostat stage and when the outdoor air temperature is less than 40°F. ... If any changes are necessary, ensuring that the main heat pumps continue to run after the outside temperature is less than 40°F and are supplemented by the electric auxiliary heat."

My specific questions with regards to ASHRAE 90.1 Appendix G, Section G3.1.3.1:

1. When the outside air temperature is below 40°F, is the auxiliary heat the only source of heating?
2. If the answer to question 1 is no, how is the defrost cycle supposed to be modeled? This is not stated in 90.1 Appendix G.
3. If a defrost cycle is supposed to be modeled, what is the outside air temperature cutoff for the heat pump operation?

Interpretation No.1: Because Appendix G is for computer software simulation, the heat pump heating operation should turn off completely when the outside air temperature is less than 40°F and the auxillary heat is the only heating source available. Reasons for interpretation:

1. Software programs can not accurately account for the defrost cycle,
2. Setting the number at 40°F instead of 32°F, when water freezes accounts for radiant and convective cooling effects thus limiting freezing potential on the outdoor heat pump evaporator coil in the heating cycle.
3. Appendix G does not provide any guidance in modeling the defrost cycle.

Question No.1: Is this interpretation correct?

Answer No.1: No

Comments: The air-source heat pumps efficiencies required in Table 6.8.1B are greater than the efficiency of electric resistance heating even at these outside air conditions. As a result, Appendix G requires a combination of heat pumps and auxiliary heat at low temperature conditions, with the compressor as the lead machine. Appendix G does not dictate the heat pump defrost cycle or outside air cutoff; these should be modeled consistent with manufacturer control recommendations for a heat pump that meets the low temperature heating efficiency requirements of Table 6.8.1B.

Interpretation No.2: If the heat pump unit shuts off at 40°F, the defrost cycle is negligible. This means that a heat pump system in the energy modeling software operates when the outdoor temperature is 40°F or greater. The heat pump system shuts off when the outdoor temperature is below 40°F and 100% of the heating is provided by the auxiliary heat.

Question No.2: Is this interpretation correct?

Answer No.2: No

Comments: As noted in Answer No. 1 above, the heat pump is assumed to be the lead machine at these temperatures. The defrost cycle is modeled consistent with manufacturer control recommendations for a heat pump that meets the low temperature heating efficiency requirements of Table 6.8.1B.