

$PLF(T_j) = 1 - C_d \times (1 - X_1(T_j) - X_2(T_j) - X_3(T_j))$  = the overall part-load factor for outdoor temperature bin j.

$C_d$  = the coefficient of cyclic degradation for heating.  
 $n_j$  = the number of hours in the j<sup>th</sup> outdoor temperature bin.

The steady-state heat pump space heating capacity in the space heating only mode is determined according to:

$$\dot{Q}_h(T_j) = \begin{cases} \dot{Q}_h(17^\circ F) + \frac{\dot{Q}_h(47^\circ F) - \dot{Q}_h(17^\circ F)}{(47-17)^\circ F} \times (T_j - 17^\circ F), & \text{for } T_j \geq 45^\circ F \text{ or } T_j \leq 17^\circ F \\ \text{or} \\ \dot{Q}_h(17^\circ F) + \frac{\dot{Q}_h(35^\circ F) - \dot{Q}_h(17^\circ F)}{(35-17)^\circ F} \times (T_j - 17^\circ F), & \text{for } 17^\circ F < T_j < 45^\circ F \end{cases}$$

The steady-state electrical power input to the heat pump in the space heating only mode is determined according to:

$$\dot{E}_h(T_j) = \begin{cases} \dot{E}_h(17^\circ F) + \frac{\dot{E}_h(47^\circ F) - \dot{E}_h(17^\circ F)}{(47-17)^\circ F} \times (T_j - 17^\circ F), & \text{for } T_j \geq 45^\circ F \text{ or } T_j \leq 17^\circ F \\ \text{or} \\ \dot{E}_h(17^\circ F) + \frac{\dot{E}_h(35^\circ F) - \dot{E}_h(17^\circ F)}{(35-17)^\circ F} \times (T_j - 17^\circ F), & \text{for } 17^\circ F < T_j < 45^\circ F \end{cases}$$

The steady-state heat pump space heating capacity and water heating capacity in the combined heating/water heating mode is determined according to:

$$\dot{Q}_{hcw}(T_j) = \begin{cases} \dot{Q}_{hcw}(17^\circ F) + \frac{\dot{Q}_{hcw}(47^\circ F) - \dot{Q}_{hcw}(17^\circ F)}{(47-17)^\circ F} \times (T_j - 17^\circ F), & \text{for } T_j \geq 45^\circ F \text{ or } T_j \leq 17^\circ F \\ \text{or} \\ \dot{Q}_{hcw}(17^\circ F) + \frac{\dot{Q}_{hcw}(35^\circ F) - \dot{Q}_{hcw}(17^\circ F)}{(35-17)^\circ F} \times (T_j - 17^\circ F), & \text{for } 17^\circ F < T_j < 45^\circ F \end{cases}$$
  

$$\dot{Q}_{wch}(T_j) = \begin{cases} \dot{Q}_{wch}(17^\circ F) + \frac{\dot{Q}_{wch}(47^\circ F) - \dot{Q}_{wch}(17^\circ F)}{(47-17)^\circ F} \times (T_j - 17^\circ F), & \text{for } T_j \geq 45^\circ F \text{ or } T_j \leq 17^\circ F \\ \text{or} \\ \dot{Q}_{wch}(17^\circ F) + \frac{\dot{Q}_{wch}(35^\circ F) - \dot{Q}_{wch}(17^\circ F)}{(35-17)^\circ F} \times (T_j - 17^\circ F), & \text{for } 17^\circ F < T_j < 45^\circ F \end{cases}$$

Where:

$$\dot{Q}_{hcw}(35^\circ F) = \left[ \dot{Q}_{hcw}(17^\circ F) + \frac{\dot{Q}_{hcw}(47^\circ F) - \dot{Q}_{hcw}(17^\circ F)}{(47-17)^\circ F} \times (35-17)^\circ F \right] \times \frac{\dot{Q}_h(35^\circ F)}{\dot{Q}_h(17^\circ F) + \frac{\dot{Q}_h(47^\circ F) - \dot{Q}_h(17^\circ F)}{(47-17)^\circ F} \times (35-17)^\circ F}$$

and:

$$\dot{Q}_{wch}(35^\circ F) = \left[ \dot{Q}_{wch}(17^\circ F) + \frac{\dot{Q}_{wch}(47^\circ F) - \dot{Q}_{wch}(17^\circ F)}{(47-17)^\circ F} \times (35-17)^\circ F \right] \times \frac{\dot{Q}_h(35^\circ F)}{\dot{Q}_h(17^\circ F) + \frac{\dot{Q}_h(47^\circ F) - \dot{Q}_h(17^\circ F)}{(47-17)^\circ F} \times (35-17)^\circ F}$$

The total steady-state electrical power input to the heat pump in the combined heating/waterheating mode is determined according to:

$$\dot{E}_{hcw}(T_j) = \begin{cases} \dot{E}_{hcw}(17^\circ F) + \frac{\dot{E}_{hcw}(47^\circ F) \times PLF(\text{Test10}) - \dot{E}_{hcw}(17^\circ F)}{(47-17)^\circ F} \times (T_j - 17^\circ F), & \text{for } T_j \geq 45^\circ F \text{ or } T_j \leq 17^\circ F \\ \text{or} \\ \dot{E}_{hcw}(17^\circ F) + \frac{\dot{E}_{hcw}(35^\circ F) - \dot{E}_{hcw}(17^\circ F)}{(35-17)^\circ F} \times (T_j - 17^\circ F), & \text{for } 17^\circ F < T_j < 45^\circ F \end{cases}$$