Appendix 5.A7: Derivation of factor for intermittent heating

The symbols used in this appendix are defined in section 5.2.1.

Rearranging equation 5.44 provides the definition of the factor for intermittent heating, F_3:

$$F_3 = \Phi_i / \Phi_t \tag{A7.1}$$

where F_3 is a correction factor for intermittent heating, Φ_i is the plant size for intermittent operation (W), and Φ_t the total heat loss (W).

Assuming that the installed capacity is that required to raise the space temperature from the daily mean space temperature ($\bar{\theta}_i$) to the internal design temperature (θ_i) then, for a design day where the mean outside temperature ($\bar{\theta}_o$) is equal to the design outside temperature:

$$F_3 = \frac{[\Sigma (A\,U) + C_v](\bar{\theta}_i - \bar{\theta}_o) + [\Sigma (A\,Y) + C_v](\theta_i - \bar{\theta}_i)]}{[\Sigma (A\,U) + C_v](\theta_i - \bar{\theta}_o)} \tag{A7.2}$$

Assuming the ventilation rate is constant and equal to the design value:

$$F_3 = \frac{\bar{\theta}_i - \bar{\theta}_o}{\theta_i - \bar{\theta}_o} + \frac{[\Sigma (A\,Y) + C_v]\ (\theta_i - \bar{\theta}_i)}{[\Sigma (A\,U) + C_v](\theta_i - \bar{\theta}_o)} \tag{A7.3}$$

$$F_3 = \frac{\bar{\theta}_i - \bar{\theta}_o}{\theta_i - \bar{\theta}_o} + f_r \left(\frac{\theta_i - \bar{\theta}_i}{\theta_i - \bar{\theta}_o} \right) \tag{A7.4}$$

where f_r is the thermal response factor (see equation 5.14).

It has been shown (Harrington-Lynn, 1998) that:

$$\frac{\bar{\theta}_i - \bar{\theta}_o}{\theta_i - \bar{\theta}_o} = \frac{H f_r}{H f_r + (24 - H)} \tag{A7.5}$$

where H is hours of plant operation including preheat (h).

Therefore, subtracting both sides from θ_i and rearranging gives:

$$\frac{\theta_i - \bar{\theta}_i}{\theta_i - \bar{\theta}_o} = 1 - \frac{H f_r}{H f_r + (24 - H)} \tag{A7.6}$$

Substituting equations A7.6 and A7.5 into equation A7.4 gives:

$$F_3 = \frac{24 f_r}{H f_r + (24 - H)} \tag{A7.7}$$

Reference for Appendix 5.A8

Harrington-Lynn J (1998) 'Derivation of equations for intermittent heating used in CIBSE Building Energy Code Part 2a' *Building Serv. Eng. Res. Technol.* **19**(4)