Appendix 5.A12: Specification for reference (dynamic) model

In order to satisfy the requirements of the reference (dynamic) model, the features indicated below should be incorporated. This specification is not exhaustive but gives sufficient detail to provide a basis for assessing computer models.

5.A12.1 Analytical method

Calculations should be carried out for time increments not exceeding one hour using appropriate time sequences of climatic data, internal load patterns and required control set points. These may be hourly average values or, if the calculation requires a time increment of less than one hour, measured data corresponding to the time increment should be used or values may be interpolated from hourly data.

5.A12.2 Climatic data

Data for the following parameters are required at time increments not exceeding one hour:

— dry bulb temperature

— moisture content (or equivalent)

— solar irradiation, comprising direct, sky diffuse, ground reflected (taking account of site factors), sky temperature (or other parameter appropriate to the determination of longwave radiation from external surfaces)

— wind speed

— wind direction.

The effect on the convective heat transfer coefficient of wind speed and direction should be taken into account.

The solar component should include longwave radiation transfer to the sky and surroundings.

The conversion of solar irradiance data measured at a particular orientation and slope into values for other orientations and slopes should be achieved using the methods described in the annex to chapter 2 of this Guide: *Solar radiation, longwave radiation and daylight* (CIBSE, 2015).

Solar altitude and azimuth should be determined using the methods contained in the annex to chapter 2 of this Guide: *Solar radiation, longwave radiation and daylight* (CIBSE, 2015).

The conversion of measured climatic data into the form required by the calculation procedure should be achieved using the relationships given in chapter 1 of CIBSE Guide C: *Reference data* (2007).

5.A12.3 Properties of opaque fabric

The following properties should be represented:

— thermal resistance

— thermal capacitance

— surface emissivity (at boundaries and internal cavities)

— surface absorption coefficient for shortwave radiation

— convective and radiant heat transfer characteristics within cavities.

The dynamic response of opaque components may be determined using finite difference techniques or by response factors; other methods may be used provided that it may be demonstrated that they can achieve equal precision (CIBSE, 1998).

5.A12.4 Glazing

The following properties should be represented:

— thermal resistance

— solar absorption

— solar transmission

— surface emissivity

— convective and radiant heat transfer characteristics within internal cavities.

The performance of glazing systems should be based on the values of solar altitude and azimuth calculated at the solar time corresponding to the time for which the calculation is being performed. This may differ due to longitude and/or the effect of local adjustments for daylight saving.

The performance of glazing systems must take account of reflections between the elements comprising the system.

Separate calculations must be made for shaded and unshaded areas of glazed surfaces.

5.A12.5 Shading

Shading devices may consist of purpose built overhangs, side fins adjacent to or part of a window or moveable devices such as blinds, shutters or curtains.

The shading effect should be calculated for time increments not exceeding one hour using values of solar altitude and azimuth at the appropriate solar time. Where shading devices may be adjusted or controlled the effect of such features should be represented.

The model should take account of the effect of shading on glazing performance, as follows:

— in the case of purpose built shades, the determination of the amount and location of shade falling on the glazing; reflected radiation from the shades should also be considered

— for blinds and curtains, the absorbed and transmitted radiation to be calculated, if appro

— priate, as a function of slat angle; the interaction between glazing elements and blinds due to reflection of radiation from blinds must be represented.

Other obstacles to radiation such as shading by adjacent buildings and other site features should also be included, as should self-shading by the building under analysis.

5.A12.6 Internal longwave radiation

Longwave radiant heat transfer between surfaces and convective heat transfer between room air and room surfaces should be modelled using the fundamental heat balance described in Appendix 5.A2.

Longwave interchange between sources of internal heat gain and room surfaces must be modelled. The location of heat emitters should be taken into account.

5.A12.7 Internal shortwave radiation (direct solar gain)

The distribution of shortwave energy should be determined by calculation of the amount of direct and diffuse transmitted solar radiation incident upon each room surface. If a surface transmits shortwave radiation the quantity transmitted must be calculated using the same methods as for the transmission of solar radiation into the building. Reflections of shortwave radiation should be modelled.

The solar distribution must be calculated at the same frequency as that for the climatic data.

5.A12.8 Room air model

Convective heat gains may be assumed to enter directly into the air. The convective heat balance should include a representation of the thermal capacity of the room air. Under some circumstances it may be appropriate to increase the heat storage capacity of the air artificially to take account of furnishings. However, there is little guidance available on when this is necessary.

The convective heat transfer coefficient at room surfaces should be calculated as a function of surface and air temperatures; suitable correlations are given by Alamdari (1980) and Hatton (1995). It is not considered practicable at present to include the influence of room air movement patterns.

5.A12.9 Infiltration and ventilation

The needs of design models and simulation models differ in that, for design purposes, it is usual to specify the value of infiltration whereas simulation techniques require this parameter to be calculated. Furthermore, ventilation to remove excess heat gain is an essential factor in the calculation of overheating risk. One way to determine ventilation rates is by means of a zonal airflow model. See chapter 4 of this Guide for guidance on the calculation of natural ventilation rates. The program supplier should provide details of the method used and be able to justify the assumptions made in the model.

References for Appendix 5.A12

CIBSE (1998) *Building energy and environmental modelling* CIBSE Applications Manual AM11 (London: Chartered Institution of Building Services Engineers)

CIBSE (2000) 'Properties of humid air' ch. 1 in CIBSE Guide C: *Reference data* (London: Chartered Institution of Building Services Engineers)

CIBSE (2015) *Solar radiation, longwave radiation and daylight* Annex to CIBSE Guide A chapter 2 (London: Chartered Institution of Building Services Engineers)

Almadari F and Hammond GP (1980) 'Improved data correlations for buoyancy driven convection in rooms' *Building Serv. Eng. Res. Technol.* **4**(3) 106–112

Hatton A and Awbi HB (1995) 'Convective heat transfer in rooms' *Proc. Building Simulation '95, August 1995, Wisconsin, USA*