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Energy efficiency in housing —

Part 1: Code of practice for energy efficient refurbishment of housing

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Foreword

BS 8207 sets out the basic principles to follow in the pursuit of energy efficient, economical buildings. This Part of BS 8211, which has been prepared under the direction of the Basic Data and Performance Criteria for Civil Engineering and Building Structures Standards Committee, shows how the principles of BS 8207 may be applied to the renovation of housing.

This standard does not attempt to lay down absolute criteria for comfort, services, performance and efficiency as these have to be decided according to the circumstances of each application, it does set out the factors which influence these criteria, and methods for making energy efficient decisions.

Energy use in housing depends on a number of factors. These include the location of the building, its specification, its heating system and other energy using services, the climate, and the way in which the dwelling is used (including patterns of space and water heating and the use of lighting and appliances).

Because of the close relationship of this subject with the provision of ventilation and the control of humidity and condensation in housing, this Part of BS 8211 should be read in conjunction with BS 5250, BS 5720 and BS 5925.

It is also important to avoid risks of rain penetration through walls, and this Part of BS 8211 should be read in conjunction with BS 5618, BS 6232-1 and BS 6232-2, BS 6676-1 and BS 6676-2 and BS 8208-1 and BS 8208-2, where appropriate.

Many energy efficiency measures are simply improvements or extensions to existing practice, while others are novel in one way or another. Whatever their origin, proposed energy efficiency measures should be evaluated in terms of their buildability, durability and their possible side effects on ventilation and condensation.

A calculation method, suitable for estimating energy use and costs, is included as Appendix A. It is based on BREDEM ¹⁾ a model developed from extensive research in occupied housing by the Building Research Establishment. Development of the model is continuing and it will be updated periodically.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 16, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

¹⁾ *The BRE Domestic Energy Model Background, philosophy and description.* BRE Report BR 66, 1985. Anderson B.R., Baldwin R., Clark A.J., Milbank N.O.

Section 1. General

1 Scope

This Part of BS 8211 gives guidance for achieving energy efficient design in the renovation or improvement of existing housing.

The factors which influence energy use are listed together with procedures which enable the relationship between energy use, internal and external environment, and capital and running costs to be explored and evaluated.

A calculation method for estimating energy use and costs in housing is given in Appendix A, which can be used for evaluating designs.

A bibliography, containing some of the more important sources of information relevant to this topic, is given in Appendix B.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 8211, the definitions given in BS 3533 apply together with the following.

2.1

energy efficiency

economic use of energy having regard to capital, running and maintenance costs

2.2

energy efficient design

design that achieves optimal or near optimal energy efficiency

3 Factors affecting energy use

3.1 General

The factors listed in 3.2 to 3.6 under the headings of weather, user behaviour and requirements, building design, space heating system and services, all have a bearing on energy use, internal environmental conditions, and the standard of services.

It should be noted that comfortable living accommodation requires adequate internal air and surface temperatures, adequate air quality and freedom from problems of condensation, mould growth, pattern staining and draughts. Sufficient levels of ventilation and thermal insulation should be provided to meet these objectives.

The designer has, within the constraints of his brief and the existing building structure, control over the specification of the building and its integral services such as heating, domestic hot water and lighting. The designer, however, has to proceed on the basis of given weather data and assumptions concerning user requirements and appliance use. By contrast the occupier has control over the use of the services but limited scope to alter the design.

The designer should bear in mind that some aspects of the building design, such as integration of insulation with the structure, should where possible reflect its anticipated lifetime. On the other hand the heating system (or components of it) could be replaced after 10 years to 20 years, whilst the user requirements may change over a much shorter timescale.

Many of the factors listed in 3.2 to 3.6 are interrelated; for example, ventilation rates depend on the building itself (leakage cracks and ventilation openings), on the weather (wind velocity), and on the user (opening of windows). Similarly, a change in one variable may affect another; for example, a change in heating period may affect the usefulness of the solar gains.

3.2 Weather

The following factors vary with locality, exposure, building height and the local microclimate:

- external temperature which affects fabric and ventilation losses;
- solar radiation which affects solar gain;
- wind which affects ventilation losses and surface resistances;
- rain which can affect thermal conductivities and subsequent evaporation can reduce outside surface temperatures.

3.3 User behaviour and requirements

The following factors affect internal temperature levels, internal heat gains and heat losses:

- occupancy, i.e. the number of people in the household and the proportion of time that they normally occupy the premises, their activity levels, age and physical condition;
- space heating, i.e. temperature levels, the duration of periods of heat demand, the proportion of the dwelling that is heated;

- c) water heating requirements;
- d) the use of space and water heating controls;
- e) cooking requirements;
- f) lighting requirements;
- g) the use of appliances;
- h) window opening and the use of ventilation systems;
- i) acceptable running costs.

3.4 Building design

The following factors are relevant in building design:

- a) position on the site and orientation;
- b) area of external envelope;
- c) *U*-values of (and thermal bridges in) the various parts of the external envelope which together with the areas of each part determine the fabric losses;
- d) ventilation openings and air leakage paths, and provision for ventilation control which together with wind speed and window opening determine the ventilation losses;
- e) glass areas and solar transmission characteristics, shading, orientation and also curtains (and the extent to which they are used), which affect glazing *U*-values and the solar gain;
- f) internal heat transfer, by transmission through internal partitions and by air movement between rooms, affected by room layout and internal door opening habits. This factor is most significant when part of the dwelling is unheated;
- g) thermal capacity of materials, particularly those at the interior surfaces of external walls. This affects the rate of heating and cooling of the structure at the beginning and end of heating periods, the plant margin required for intermittent operation of the heating system, and also the usefulness of internal and solar gains. Furnishings also have an influence on thermal mass. Thermal mass can be utilized in passive solar designs (in conjunction with shading and ventilation) to avoid summer overheating;
- h) the areas and construction of party walls and floors in calculations where it is assumed that adjacent dwellings may be at a different temperature level from the one under consideration, e.g. in the sizing of heating systems.

3.5 Space heating system

The following factors are relevant to space heating systems:

- a) the efficiency of the heating system, i.e. the ratio of the heat released into the dwelling to the calorific content of the fuel delivered to the premises. This takes account of heat regain from flues, effects of running at less than maximum output, intermittent operation, and additional losses associated with including the heating elements within the building fabric, e.g. underfloor or ceiling heating;
- b) the provision of sufficient ventilation for conventionally flued appliances which will affect the ventilation heat losses;
- c) the responsiveness of the heating system, i.e. the system's ability to respond to changes in heat demand. Responsiveness affects temperature levels during unheated periods, and also the utilization of internal and solar gains, and consequently affects the energy consumption;
- d) proper sizing of the system as oversizing will usually involve a capital cost penalty, and in some cases a higher running cost if the appliance efficiency is reduced whilst undersizing will result in the required conditions not being achieved in cold weather. For systems designed for intermittent operation, some oversizing is needed for warm-up periods;
- e) the heating system controls, i.e. time switches, thermostats, zone control;
- f) the choice between centralized or decentralized heating and hot water plant, between centralized or individual control, and between centralized or individual metering;
- g) the cost and convenience of fuel and the method of payment for fuel;
- h) the convenience and reliability of the heating system, i.e. ease of use, maintenance frequency and costs, and extent of user knowledge required.

3.6 Services

The following factors are relevant to services:

- a) domestic hot water, i.e. the type of water heating system, the controls, the fuel used, the storage and distribution system, and the insulation of tanks and pipework;
- b) cooking, i.e. the type of cooking equipment and fuel;
- c) lighting, i.e. the number of lamps in use and their luminous efficiency;
- d) appliances, i.e. the number of appliances in use and their efficiency.

4 Energy efficiency

Energy efficiency implies the economic use of resources, and often it is appropriate to subject the energy and maintenance costs and the capital investment costs to a suitable economic analysis. Energy efficiency should form part of an integrated approach to housing costs.

Cost, which theoretically integrates all economic factors, is an essential though imperfect tool for the evaluation of energy efficiency. Many energy efficiency measures may be achieved with little or no extra cost if considered as an integral part of the design. Others have benefits such as improved amenity or improved comfort. Energy efficiency can also improve the marketability of the property.

Calculations usually have to be based on estimates of capital costs, maintenance costs and future energy prices, which are all subject to change, together with less tangible factors such as improved amenity.

The economic objective is normally:

- a) to achieve a required rate of return on investment; or
- b) to obtain the best return for a fixed budget; or
- c) to achieve a stated standard of performance at least cost; or
- d) to meet some other economically measurable criterion.

The basis of assessment should be determined in conjunction with the client or occupant (see clause 6).

NOTE Types of economic analysis are described in BS 8207.

Different cost criteria and constraints may apply in the improvement of existing properties depending on whether energy efficiency measures are incorporated with other renovation work. Energy efficiency could feature in discussions about refurbishment as an alternative to demolition.