GOOD PRACTICE GUIDE 287

The design team's guide to environmentally smart buildings

– energy-efficient options for new and refurbished offices

BEST PRACTICE PROGRAMME

ENERGY EFFICIENCY

GOOD PRACTICE GUIDE 287

If you are a member of a design team responsible for designing a new office building, or refurbishing an existing one, this Guide is for you! It is written for everyone involved in the design and specification of new offices.

This Guide is organised broadly around the stages of the RIBA Plan of Work. It outlines the key actions that need to be taken at each of the relevant stages to ensure a new or refurbished office building is designed, constructed and managed to be energy efficient. The advice contained in the Guide is applicable to office buildings constructed under any procurement route, not only those which follow the Plan of Work.

CONTENTS

1 INTRODUCTION

The aim of this Guide is to help you, as a design team, to provide energy-efficient offices for your clients. It contains advice about identifying client requirements, developing an energy strategy, designing and specifying the fabric, services and controls systems, inspecting work on site, commissioning the services, fitting-out, bringing the building into operation, keeping it running, and monitoring and improving its performance in use. By applying the advice contained in the Guide, you will be helping to ensure offices are designed, constructed, and managed in an energy-efficient way.

Clients who procure and occupy offices often need to be convinced of the advantages of energy-efficient design at the start of the process. Therefore, this Guide contains material to help you – as a design team – to explain to clients the benefits they can expect from an energy-efficient, environmentally smart office.

Who should read this Guide?

- Project managers
- Architects
- Building services engineers
- Lighting engineers
- Quantity surveyors
- Building surveyors
- Project managers
- Space planners
- Interior designers
- Installers of heating, lighting and cooling
- Fit-out contractors

One of the most valuable actions the design team should take is to develop jointly with the client a well-structured energy strategy as part of the brief for the building. The Guide shows how to develop such a strategy, and suggests the key issues it should address, including defined objectives and performance targets.

An energy-efficient office is always in the client's interest

INTRODUCTION

The energy performance of an office depends not only on how the building is designed, but on how it is constructed, brought into use, occupied and managed. The team's involvement should continue beyond handover and fitting-out into the early phases of occupation. The team should provide training about efficient operation procedures, and be involved in monitoring and fine-tuning of the building's systems.

Equipment in offices accounts for a significant amount of energy use, particularly computer suites and their services. Air-conditioning for these spaces, though vital, is often wasteful and should merit careful design consideration. Other items that should not be overlooked include the servicing of kitchens and dining areas, catering equipment, and lighting of external areas and car parks.

Offices designed in accordance with the approach recommended in this Guide can provide a comfortable and controllable environment that meets the needs of occupants while minimising energy use.

WHAT MAKES AN ENVIRONMENTALLY SMART OFFICE?

Environmentally smart buildings make intelligent use of resources, such as energy and water, while minimising waste. Among other features, they not only have a reduced need for mechanical plant but also outperform conventionally designed buildings in many areas, including heating, lighting and ventilation. A building's overall environmental performance can be independently assessed under the BRE Environmental Assessment Method (BREEAM) – see page 21 for details.

The key items for intelligent use of energy are:

- exploiting the potential contribution to performance offered by the site and its surroundings
- a plan form which places functions in locations that minimise the need for applied energy
- a shape which encourages the use of daylight and natural ventilation, and reduces heat losses
- an orientation that takes account of the potential benefits from solar gains while reducing the risk of glare and overheating
- effective use of natural daylight combined with the avoidance of glare and unwanted solar gains
- high-efficiency artificial lighting with effective user-friendly controls
- natural ventilation wherever practical and appropriate, with mechanical ventilation and/or air-conditioning used only to the extent they are actually required
- good levels of thermal insulation and prevention of unwanted air infiltration through the building envelope
- intrinsically efficient and well-controlled building services, well-matched to the building fabric and to the expected use
- controls systems appropriate to the organisation's needs and capabilities offering, where possible, local – and preferably individual – control of the internal environment
- metering systems that encourage effective monitoring and management of energy use.

RIBA Stage A

2 CONVINCING YOUR CLIENT

Clients for new offices and office refurbishments are increasingly expecting:

- improvements in quality and value for money
- reduced global impact and greater sustainability
- a healthy, comfortable and safe environment, offering high occupant satisfaction and productivity, together with low costs in use.

Rather than regarding these as single issues or optional extras, the design team should treat them as contributors to the so-called triple bottom line, in which building facilities create simultaneous economic, social and environmental benefits. Such buildings – sometimes known as 'environmentally smart' – have many advantages (see the box on the right). You can use these points to influence your clients. Help them to see 'what's in it for them', and convince them to include energy efficiency and other environmental requirements as part of their brief for the building. Some clients will need reminders about the energy objectives periodically during the design process.

The benefits of energy efficiency for developers are described in Good Practice Guide (GPG) 258, and those for the managers of organisations that occupy buildings are given in GPG 285 (see page 22).

Further details about life-cycle costs and benefits as they apply to institutional investors, developers, tenants and owner-occupiers are given in GPG 274 (see page 22).

COST SAVINGS

Energy Consumption Guide (ECON) 19 (see page 22) indicates that, by using proven methods, heating energy costs can be almost halved and electrical costs cut by more than 30% for a given office type. Further savings in capital and running costs can be made if careful design allows client needs to be met with fewer, simpler, building services.

THE BENEFITS TO THE CLIENT OF ENVIRONMENTALLY SMART OFFICES

- They have lower running costs (see the box on the left) and reduce the environmental cost of building occupation.
- They are better equipped to meet future UK and European environmental targets, and regulatory and fiscal measures.
- They make intelligent use of resources, such as energy and water, while minimising waste.
- They need not cost more to build – particularly where the need for mechanical services can be minimised or deferred until the need is proven, for instance by adopting a mixed-mode approach.
- They may be easier to let or re-let in the future, as awareness of green issues becomes more widespread and demand for simpler, environmentally smart buildings increases.
- They demonstrate the commitment of both the client and the design team to the environment – providing marketing and PR opportunities, and strengthening the corporate identity of all who are involved.
- They show the tenant organisation's concern for its employees – offering a more responsive environment for occupants and contributing to their health, comfort and productivity.
- Where the services are simpler, and the controls more user-friendly, they are easier to understand, maintain and control, thus reducing downtime (which disrupts the core business) and complaints to the facilities manager.
- They can have a higher net-to-gross ratio where simple services occupy less of the building's volume.
- Replacement costs will be lower because less plant is required.

CONVINCING YOUR CLIENT

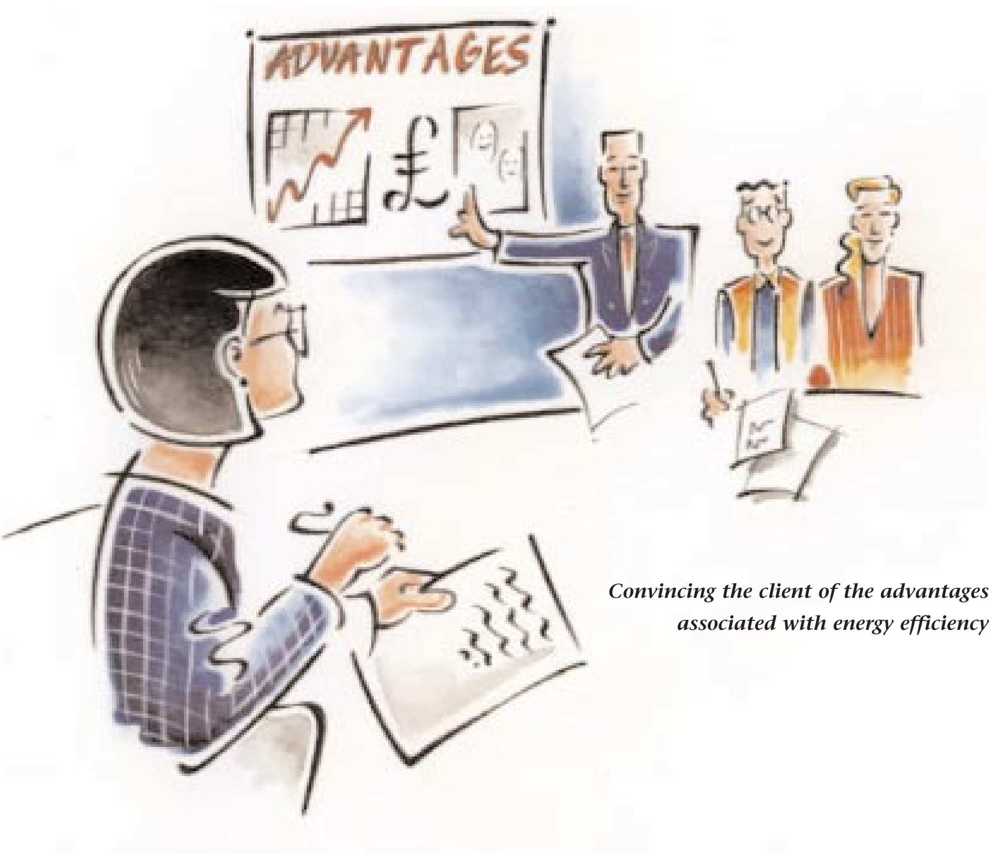
Not only are simple effective measures to improve energy efficiency always in the client's interest, they can also benefit the team. Building a reputation for delivering projects that have low environmental impact and provide a healthy, comfortable environment for occupants will provide publicity opportunities for the design team and lead to repeat work.

DESIGN TEAM APPOINTMENT

Energy-efficient design is not solely the responsibility of any one individual in the design team, but results from the successful integration of decisions made by various team members.

Key members of the design team need to be appointed at an early stage. This will enable them to develop the brief, including the energy strategy, and contribute to the major strategic decisions.

It is far better for the team to anticipate energy implications early on, than to provide 'technical fixes' later.



Convincing the client of the advantages associated with energy efficiency

RIBA Stage A

3 BRIEFING, AND DEVELOPING AN ENERGY STRATEGY

Briefing is the time when a client's requirements in relation to energy-related issues need to be investigated. An energy strategy, drawn up by the client and an interdisciplinary team at the start of a project, can be valuable in bringing together a wide range of performance-related issues. Such a strategy can also act as a reference against which the emerging design – and the completed building – can be checked. The energy strategy should address three areas: the process; the product; and management in use.

DESIGN PROCESS

A well-programmed process will help to ensure the members of the design team work together effectively to determine the client's requirements, and to identify the best way to meet them. Locating the team members together, even for a few days at the start of a project, can encourage interdisciplinary teamwork, the development of a shared vision, and a spirit of common ownership of the total project across the whole team. The design programme should include review and audit points at which the emerging proposals can be checked against the design standards, objectives and targets. Conversely, the nature of the emerging solution may itself influence client requirements.

DESIGN PRODUCT

A comprehensive description is needed of the nature of the activities and equipment which the building is to contain. Where these are unknown, a range of possibilities should be drawn up, and contingency plans made accordingly. Similarly, a client requirement for 'flexibility' should not be met by over-specifying, but by contingency planning.

Appropriate objectives and targets for the building need to be set for issues such as air infiltration and leakage rates, fresh air requirements, cooling loads, acceptable internal temperatures and humidity levels, noise levels, and lighting levels (see 'Sources of information' on page 21).

Standards for internal conditions in the building should include acceptable tolerances on comfort conditions. Unnecessarily tight control over temperature or humidity ranges may lead to energy penalties, whereas, for example, higher internal summer temperatures may be acceptable to occupants if they have the freedom to open the windows – and will lead to energy savings.

Target energy consumption levels should be set that are ambitious but realistic. Annual energy consumption levels in various types of existing offices are given in ECON 19. It is important for designers to start at the roots of energy consumption by considering, for example, the installed power density of lighting, and including these in the briefing requirements, together with, say, assumptions about occupation densities and operating hours. This approach is introduced in section 6 of ECON 19 and developed further in CIBSE TM22 (see page 21).

Payback periods for high-efficiency plant and equipment should be agreed with the client. Many energy-efficient features can be incorporated at little or no extra cost if properly considered in the context of the whole building. Others will require initial investment, but this is often quickly repaid. A further discussion on the costs and benefits of such features is given in GPG 274.

BRIEFING, AND DEVELOPING AN ENERGY STRATEGY

MANAGEMENT IN USE

Certain types of building suit certain types of organisation and it is important to achieve a good match. Many buildings and systems require more expertise or management commitment than occupiers are prepared to give. Figure 1 shows four approaches to the building and its future management, and may be used as the basis of a discussion between the client and design team. The energy strategy should reflect the required level of complexity and ease of management for the chosen approach.

Clients should be encouraged to think carefully about how the building will be used and operated, and to designate suitable operating staff at an early stage. They should be involved in commenting on the proposals, witnessing commissioning, and preparing for handover and occupancy.

Clients should also consider whether a 'sea trials' period is appropriate (see page 17) and to allow for this in the brief and in the fee agreement with the design team.

Buildings can be more or less complex technologically, and have higher or lower management input. Four main types can be identified, as shown in figure 1.

Type A

A complex building with well-resourced management. This suits organisations where the extra management is regarded as an investment in staff comfort and productivity, thus improving the business and enhancing the corporate image.

Type B

A simply serviced building that needs only low management input will suit most occupiers, if the design team can achieve it.

Type C

Clients often feel that new buildings should be able to 'look after themselves' but, in practice, complex buildings with inadequate fine tuning of innovative systems and insufficient management input are likely to operate very inefficiently.

Type D

Rarely found in practice, this category is exemplified by buildings occupied and managed by the designers themselves, where high levels of commitment and enthusiasm can make simple, but not necessarily user-friendly, systems perform well.

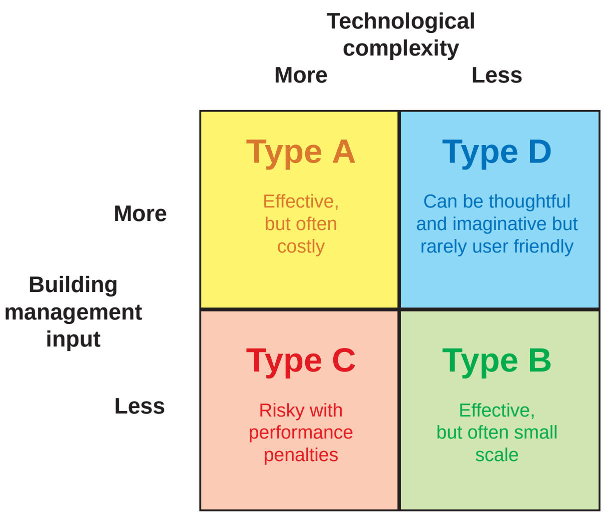


Figure 1 Complexity and management options for the building

RIBA *Stage B*

4 REVIEWING THE OPTIONS FOR NEW BUILD AND REFURBISHMENT

REFURBISHMENT PROJECTS

Many older buildings have potentially good natural light and ventilation, but may suffer problems such as:

- excessive heat losses through the walls, windows and roof
- excessive solar gains if the building is overglazed
- high infiltration losses and draughts, plus cold radiant effects in winter for staff near windows – particularly if perimeter heating is not fitted
- poorly located and or poorly operating services
- poorly positioned and inadequate controls
- inadequate briefing or supervision of fit-out designers and contractors whose installations have compromised energy-efficient operation.

If available, the findings of staff surveys may help identify specific weaknesses, and will help to establish the refurbishment requirements. A condition survey should address the fabric, the services and the achieved conditions. Try to identify, retain and develop the good features while eliminating or minimising the bad ones.

NEW BUILD – SITE SELECTION AND ASSESSMENT

If the client is choosing a new site, make sure energy issues are considered. Location and screening can help reduce noise levels; orientation and massing can minimise energy demands by making effective use of sun, light, air, and shelter; trees can provide some protection from unwanted solar heat and glare; and soft landscaping can lower peak temperatures. In any case, an assessment should be made of the opportunities and constraints implied by the site in terms of microclimate, sunshine, overshadowing, views, noise and external pollution.

VENTILATION OPTIONS

Natural ventilation should be the preferred option for an environmentally smart office. The need for mechanical ventilation or air-conditioning depends on:

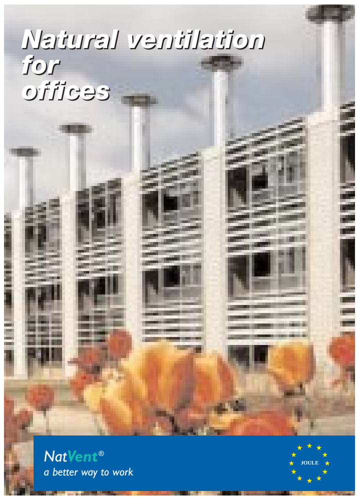
- solar gains, predominantly through windows
- heat gains from lights, equipment and people
- the ability of the building fabric to absorb surplus heat during the day and for this to be removed at other times
- limits in using natural ventilation on sites that suffer from external noise or air pollution.

Typically, an air-conditioned building uses twice as much energy as one without air-conditioning. A combination of measures can often make air-conditioning technically unnecessary, at least in some parts of the building. Heavy, insulated walls and shading devices can reduce solar gains; while exposed thermal mass (with appropriate means of heat removal, often by natural or mechanical night ventilation) can lower peak temperatures. Effective control systems, efficient lamps and luminaires, and direct heat extraction can lessen gains from lighting. Heat gains from office equipment may be reduced by selecting appropriate products, and locating shared items (such as file servers, communications equipment, copiers, vending machines and printers) in separately ventilated or cooled areas. A realistic assessment should be made of the heat gains from office equipment, as conservative assumptions can lead to oversizing and/or unnecessary plant and services (see page 22, GPG 118).

REVIEWING THE OPTIONS FOR NEW BUILD AND REFURBISHMENT

Mixed-mode buildings deliberately combine natural and mechanical systems for ventilation and cooling. The fabric of the building is designed as far as possible to create good internal conditions, while mechanical ventilation and cooling are provided, and used, only where, when, and to the extent they are actually required. A 'contingency' approach to mixed-mode makes provision for future addition or removal of mechanical systems, depending on changing requirements. Mixed-mode designs typically save energy and satisfy occupants, while also being adaptable to a wide range of future requirements and providing enduring value to owners and occupiers (see page 22, General Information Report (GIR) 56).

If there is a commercial demand for air-conditioning, it should be designed as energy efficiently as possible (see page 22, GPG 71). Targets should be set for the intrinsic efficiency of the plant, and attention should be paid to controllability, submetering, and the user client's capability to manage the systems provided.



The NatVent® Guide (see page 22) contains advice on building shape, window design, glazing options, daylight and internal temperatures. A computer-based assessment tool is also available. Either can be used to assess the main strategic options at an early stage

KEY CONSIDERATIONS AT THIS STAGE

- Site constraints and the implication for the building footprint, its orientation and overall form.
- Internal requirements, size of floor-plate, office depth, the maximum desirable distance of staff from a window, the potential for cross (and night) ventilation, and the avoidance of potential conflict between this and partitioning strategies.
- Window areas, and floor-to-ceiling and floor-to-floor heights, and their impact on using daylight and natural ventilation while avoiding glare and solar gain problems.
- Use of features such as atria to allow daylight penetration, and to act as circulation spaces and buffer zones.
- Assessment of internal heat gains and solar gains, and means to reduce them at source.
- Levels of servicing, including the choice of natural or mechanical ventilation, air-conditioning or mixed-mode operation.
- Means of stabilising internal temperatures, for example by using high thermal capacity, often in the form of exposed soffits.
- Means of removing warm air rising to high level, for example by extract mechanical ventilation, natural buoyancy, or wind stacks.
- The potential for cost saving trade-offs between the fabric and building services (see GPG 274).

RIBA Stage C/D

5 OUTLINE PROPOSALS AND SCHEME DESIGN

Outline proposals involve developing the general approach to the layout of the building, its design and construction. The scheme design stage translates the outline proposals into a scheme, in which the spatial arrangements, materials and appearance are developed.

BUILDING SHAPE AND FORM

Imaginative use of three-dimensional form can give occupants access to natural light and ventilation, and help to reduce electric lighting, heating, cooling and ventilation loads, even where the building needs to be air-conditioned. Spaces with low occupancy or requiring mechanical ventilation or air-conditioning for functional reasons can be located internally.

Deep-plan buildings tend to be highly energy-dependent. Courtyards, light-wells or atria can introduce light and air deep into the building. They may be used to protect adjacent areas from climatic extremes, to preheat ventilation air, or be warmed by exhaust air.

THERMAL CAPACITY

The thermal capacity of roofs, walls, floor-slabs and internal partition walls can help stabilise internal temperatures and delay peak solar heat gains until after the occupied period, reducing the need for, and capacity of, any air-conditioning. Exposing ceilings and passing air over or through the floor-slabs, especially cool night air, can remove the absorbed heat later.

WINDOWS AND SHADING DEVICES

Windows have a wide range of functions, providing views, daylight and sometimes ventilation, while avoiding glare, draughts, noise and solar radiation, and keeping out dust, fumes, insects and intruders. They should be designed to admit sufficient daylight without causing uncontrollable glare and solar heat gains. Glare and draughts may be worse, particularly in open-plan buildings, for those at a distance from the perimeter, as they are often affected by several windows, none of which is under their direct control.

New designs which attempt to make good use of natural light may also encounter glare problems, particularly if furniture arrangements are unsympathetic, for example where VDU screens are positioned at 45º to window walls.

Alternative forms should be assessed for their energy efficiency potential

OUTLINE PROPOSALS AND SCHEME DESIGN

SERVICING THE BUILDING EFFICIENTLY

Intrinsically efficient technology should be used wherever possible, and the services should be designed to meet demands simply and effectively. They should be zoned and controlled in accordance with the influence of climate and the intended patterns of use. Close control of spaces such as circulation corridors, which could be free-running, is wasteful. Simple solutions should always be sought, for example, exhausting or redistributing excess heat is often preferable to removing it with refrigeration. Free or cheap sources of cooling, such as ambient air or groundwater, should be used before resorting to mechanical cooling. Ensuring safe and adequate access to mechanical items can help to encourage good installation and commissioning, and adequate and timely maintenance.

EFFECTIVE EASY-TO-USE CONTROL SYSTEMS

Many control systems do not work as well as, or even in the manner, intended. Weaknesses experienced include poor sequencing of boilers and chillers, excessive hours of pump operation, heating and humidification running in warm weather, poor user interfaces with poor feedback, and poor responsiveness to changes in demand, causing systems to default to ON. Close attention needs to be paid to operational requirements, user capabilities, and the engineering specification of control systems. Careful consideration of documentation, commissioning, handover and in-use checking of performance is also vital.

DESIGN ADVICE

The Design Advice service is a Government-sponsored initiative that offers design teams and their clients independent and objective advice on all aspects of energy-efficient and environmentally conscious design. Subject to a simple eligibility criterion, a one-day consultation is available, paid for by a cash-back scheme. It will be undertaken by a consultant registered with the service, who will provide a brief written report detailing design recommendations. Design Advice can be contacted on 01923 664258. The website address is: **http://www.bre.co.uk/designadvice**

BEST PRACTICE PROGRAMME

DESIGN ADVICE

RIBA *Stage E*

6 DETAIL DESIGN

The purpose of the detailed design stage is to make final decisions on matters related to design, specification, construction and cost. The importance of this stage is sometimes overlooked, but it is crucial in terms of the integration between the building services and the fabric.

For good decisions to be made, effective communication and collaboration are required between all members of the design team to review options and negotiate solutions, as well as keeping one another informed of progress.

The role of the quantity surveyor (QS) is sometimes interpreted as providing 'the least capital cost option for every element'. However this approach may be inappropriate where an integrated solution is being sought, and several measures need to be in place for the full energy benefits to be obtained. Payback periods should be considered for a package of measures, not as a means of discriminating between measures. The QS will best serve the client by obtaining best value for money overall, rather than least capital cost for each element. This is explained in greater depth in GPG 274 'Environmentally smart buildings – a quantity surveyor's guide to the cost-effectiveness of energy-efficient offices'.

RIBA *Stage F*

7 PRODUCTION INFORMATION

This stage involves making final decisions and generating production information in the form of drawings, specifications and bills of quantities, so that the building can be constructed. Appendix 1 of this Guide lists some design measures which can help to ensure that the building meets its performance targets and the requirements of the energy strategy.

SUPPLIER AND CONTRACTOR RESPONSIBILITIES

It is important to communicate the energy efficiency objectives of the project to those who will be responsible for procuring equipment and constructing the building. This can be done by:

- including efficiency requirements in the specification – for example, boiler and refrigeration plant efficiency, specific fan power for ventilation systems and installed power density for lighting
- pointing out features of the design which may need particular attention; for example, assembly and quality control for airtightness and insulation integrity (including pressure testing where necessary), and controls and building management system (BMS) design development for usability.

Make it clear that these matters will be checked, and any element which underperforms will not be accepted.

MAINTENANCE DURING THE DEFECTS LIABILITY PERIOD

Consideration should be given to making the contractor responsible for routine maintenance (and perhaps even management) during the defects liability period. This has the advantage of providing a single point of responsibility during the early months of the operation of the building, and helps to remove uncertainty about what is a defect and what is a maintenance issue.

8 OPERATIONS ON SITE, COMMISSIONING AND FIT-OUT

RIBA Stage K

SITE WORK

The contractor and sub-contractors are key to the delivery of a finished product which achieves the goals in the energy strategy for the project. It is important that they are made aware of, and share, the energy efficiency aims of the scheme. They should be given the opportunity to contribute positively to the design and to help identify products and methods to ensure the delivery of energy efficiency. Their attention should be drawn to any details that require special attention.

Regular site inspections by the members of the design team will help ensure that work on site is being carried out in accordance with drawings and specifications, and that problems are rapidly identified and tackled.

COMMISSIONING

Most buildings are prototypes. Commissioning is required to ensure that they operate satisfactorily prior to occupation, and that their anticipated performance is met in practice. Inadequate commissioning may prevent an otherwise good design from meeting its full potential and, in turn, affect the success of the whole project. Sufficient time for proper commissioning needs to be included in the job programme and protected against the effects of slippage elsewhere. Self-balancing or pre-commissioned solutions will help to minimise commissioning time on site.

The design team should identify those elements that require commissioning. Typically, priority should be given to design features which are most critical to performance. In buildings where performance depends partly on the interaction between services and the building fabric – for example, windows, ventilation stacks and/or external blinds – commissioning needs to include both fabric and services elements together. See the box on the right for commissioning elements relevant to energy efficiency.

SPACE PLANNING AND FIT-OUT

Where space planning and fitting-out will be undertaken by others after completion of the shell and primary services, the design team should provide guidance to those responsible. This will help to protect and enhance the performance of the building, which might otherwise be undermined by lack of interest and awareness. The team should explain the building's energy strategy and the features that are critical to achieving the expected performance standards. Typically, the team should give advice on:

- the logic of systems and controls zoning, with 'dos' and 'don'ts' for making changes
- the potential of different parts of the building to accept alterations – for example, some may be more tolerant of internal heat gains than others, or may have services which are more tolerant of alterations; or have space for possible additions
- furniture layouts that will avoid glare
- the importance of preserving paths for cross ventilation, and how to achieve them
- the need to maintain access for occupants to windows and controls
- preserving access for maintenance purposes.

Fit-out contractors should be encouraged to see themselves as part of the team responsible for achieving the expected performance of the building, thus enhancing their reputation and providing PR opportunities.

INTERNAL ALTERATIONS

Apparently minor changes, such as moving partitions to positions where they block natural ventilation paths, can have disproportionate impacts on performance. The design team should draw such issues to the attention of the premises manager and occupants.

Elements relevant to energy efficiency that need commissioning may include the following.

Building elements

- Window and ventilation openings.
- Fixed or moving solar shading devices.
- Airtightness of building envelope (pressure tested if appropriate).
- Natural ventilation paths and velocities.
- Air paths through passive cooling structures.
- Dampers which control natural or stack effect air movement.

Mechanical services

- Distribution pipework and ductwork systems.
- Performance of central plant.
- Heat emitters and air-conditioning terminals.
- Automatic controls and the building energy management systems (BEMS).
- User interfaces.

Electrical services

- Power and lighting distribution system.
- Illumination levels.
- Operation of sensors, switches and controls.

RIBA Stage L

9 PRACTICAL COMPLETION AND HANDOVER

OPERATING AND MAINTENANCE (O&M) MANUALS

O&M manuals should include:

- descriptions of the overall design strategy, the environmental systems, and the concepts underlying the control systems
- an account of the operating modes of the building, at various times of year and under various climatic conditions, and how to make the most of the energy efficiency features
- the requirements for day-to-day management and operation of the building services, with checklists of the actions required daily, monthly, seasonally and annually
- where the space is fitted-out, guidelines for individual occupants on how systems work and how to get the most out of them
- manufacturers' instructions for proprietary plant and equipment, with clear indications of the equipment installed in the building
- commissioning records, including demonstration of compliance with specified energy efficiency standards, for example, for specific fan power
- a description of the metering and sub-metering facilities and how to use them to understand and improve performance.

The design team should provide tabular estimates of energy consumption, updated to reflect the performance of the actual installation, and in a form that permits easy comparison with facilities management and sub-metering data.

ON-SITE TRAINING AND ADVICE TO OCCUPANTS

Occupants can benefit from being briefed by the design team about what is being provided and how things work. Such briefings can usefully be provided during the design phase as well as after handover. They will help occupants to know how best to control the building to achieve comfortable conditions efficiently, help to avoid misunderstandings and false expectations, and demonstrate the team's commitment to meeting their needs. The premises manager should also be encouraged by the design team to help occupants understand how the local controls work and how to use the building efficiently. A layman's introductory handout to how the building works would be helpful to the premises manager and would involve the occupants in keeping the building operating efficiently.

Briefing occupants to use the building effectively

PRACTICAL COMPLETION AND HANDOVER

Maintenance staff and the premises manager should also be given training by members of the design and building teams, based on the contents of the O&M manuals, to enable them to operate the building in accordance with the design concept. This may require specialist assistance from controls and BEMS suppliers.

Those responsible for purchasing energy-consuming items (such as office equipment) should be briefed to select equipment which is inherently energy efficient. Users should be advised on how to operate equipment so as to minimise waste, for example, by switching it off when not required.

FINE TUNING AND 'SEA TRIALS' AFTER HANDOVER

It is often impossible to complete all aspects of commissioning until after the building has been handed over. Reasons for this include:

- the commissioning period having been reduced to compensate for delays elsewhere in the programme
- design conditions not encountered during the commissioning period
- changes in actual occupancy and usage compared with design intentions
- unexpected behaviour of complex or innovative systems.

Few buildings are operationally complete when they are physically complete. Even after successful commissioning, in-use checking of controls performance and fine tuning of the building services can often be rewarding. While 'right first time' is a commendable ambition, many buildings can benefit from a period of 'sea trials' or 'running in' during which:

- an understanding can be obtained of how the building responds to control actions
- systems can be fine tuned
- problems in performance can be identified, investigated and resolved.

A survey of occupants, co-ordinated by the premises manager, will help to identify perceptions of achieved conditions, providing valuable input to the fine-tuning process.

Sub-metered energy consumption figures, if available, will also assist with diagnosis and fine tuning, and enable comparison with the design estimates. Where consumption levels are higher than design estimates, the causes should be investigated and remedial actions taken as necessary. Commissioning specialists may need engaging to review particular aspects of system performance.

Sea trials are not part of normal design services and they will need to be paid for. However, they will:

- increase the client's understanding of how the building works
- encourage an attitude of continuous improvement in performance and energy management
- help to make a building more comfortable, cheaper to run and easier to manage
- enable the design team to learn from feedback (see the box below).

DESIGN TEAM REVIEW

Design teams rarely spend enough time debriefing at the conclusion of a project. The team should carry out a systematic review of its effectiveness, to learn from feedback and improve performance on subsequent projects. Doing so will increase the confidence of clients in the team's professional approach to customer service in energy-efficient building projects.

Success in achieving an energy-efficient building project should be fed back to clients, together with areas requiring future attention in briefing, design, installation and management. This will encourage clients to maintain the ethos of energy efficiency in the present building, and to seek an equally good or better performance in their subsequent projects.

APPENDIX 1 – DESIGN MEASURES

FABRIC INSULATION AND AIR INFILTRATION

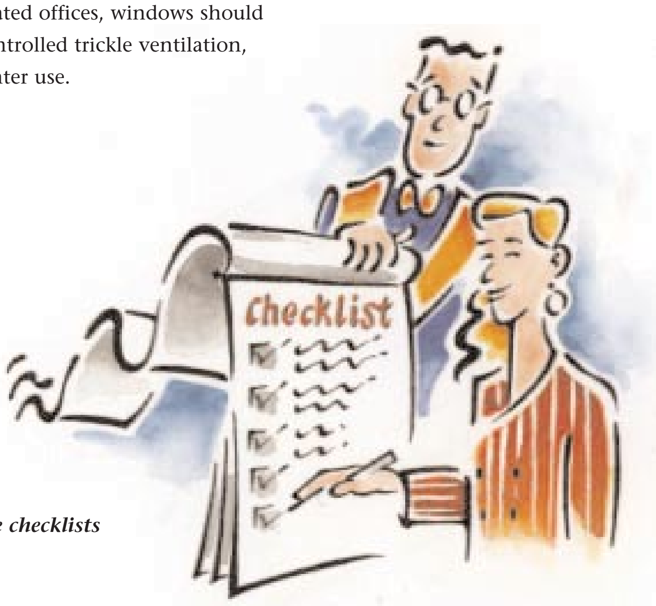
- In refurbishments, improve roof and wall insulation where possible. Opportunities are greatest in pitched roof spaces and when reroofing and recladding.
- Avoid unwanted air infiltration by attention to detailing, specification and site quality control, particularly at junctions between components, for example, roof and walls, windows and reveals, and construction joints between cladding systems. Specify air leakage rate and pressure testing where appropriate.

WINDOWS – HEAT LOSSES, VENTILATION AND THE USE OF BLINDS

- Windows should be double glazed or better. Where solar gains are a problem, triple-glazed windows with a blind protected by the outer single pane can be a practical and cost-effective choice. The inner double-glazed units also tend to last longer because their seals are protected from rainwater.
- Low-emissivity sealed units, preferably with inert gas filling, should be considered. Tinted or reflective glass reduces daylight so the lights are used more. Clear glass with shading may be better.
- Window frames should normally be at least as well-insulating as the glass. Provide good door and window seals. Consider revolving doors.
- In naturally ventilated offices, windows should have means for controlled trickle ventilation, particularly for winter use.
- Where natural ventilation is retained, review the design of the windows and the selection of window furniture to give good control and performance. Openable windows need accessible handles. If blinds are used, make sure they can be used when the windows are open for ventilation.
- Use window designs that encourage night cooling without being a security risk. Insect and bird screens may sometimes be required.
- Maintenance costs for external blinds can be high; they can also be subjected to local turbulence near corners, which can cause damage and prevent them from being used above relatively modest wind speeds – leading to annoyance for occupants.

HEATING, VENTILATION AND AIR-CONDITIONING (HVAC) SYSTEMS

- Choose intrinsically efficient plant, eg condensing boilers.
- Where loads are small, provide separate local systems, for example independent water heaters with time controls, in preference to long pipe runs to central plant.
- Consider whether full air-conditioning is necessary. Consider 'free-cooling' systems using outside air, groundwater or indirect evaporative cooling instead of chillers.



Using the checklists

APPENDIX 1 – DESIGN MEASURES

- With air-conditioning, annual fan energy consumption usually exceeds chiller consumption. Minimise specific fan power (Watts per litre/sec (W/l/sec) of air handled for supply and extract systems combined). A target benchmark for energy-efficient systems is an average 1 W/l/sec. Also minimise the hours of operation.
- Reconcile outside air free-cooling benefits with extra fan power and operating hours.
- Separate systems which serve summertime and daytime loads from those serving 24-hour loads to avoid excessive fan and pump energy and low part-load efficiencies.
- If standby generation plant is required by the client, check whether it can be operated to help cut the peak demand for electricity, or whether it is worth installing a combined heat and power system which can meet some of the base electrical and heating loads; or even – where there is surplus heat and a large steady enough cooling load – for absorption chilling.

Once systems have been designed to be intrinsically efficient, heat recovery may be appropriate, particularly for 100% fresh air systems in which recirculation is not available or appropriate, as these require the most heat, sometimes even on summer mornings. Simple and cost-effective opportunities include:

- preheating fresh air with computer air-conditioning condenser air
- using packaged heat recovery ventilation plant
- cascading air from high-quality to lower-quality requirements together with any necessary fresh air (eg exhaust office air to atria, toilets, store rooms and car parks)
- drawing in air where appropriate through atria and sunspaces.

Review the cost of any extra electricity used due to higher air resistance against the value of heat saved, and consider bypassing the heat exchangers when not required.

LIGHTING

- Choose appropriate standards but do not over-light. Special needs for additional lighting should be met locally and not for the entire area.
- Choose light-coloured finishes, where possible, that improve internal reflections.
- Select efficient lamps and fittings. Most areas can be lit using no more than 2.5 W/m^2 of installed lighting power (including control gear) per 100 lux of maintained illuminance.
- Use electronic control gear (for example, high-frequency ballasts), particularly for lights which will be on for extended hours.
- Where considering high-intensity discharge lighting, remember the lamps often take several minutes to warm up and longer to restart and so will tend to be left on unless special provision is made. A rapid restrike option is sometimes available at extra cost.
- Use tungsten or tungsten-halogen lighting very sparingly for essential accent lighting only.
- Provide intrinsically efficient lighting – not only in the offices themselves but also in corridors, WCs, etc, where running hours may be longer. With manual and automatic systems, make sure also that these lights are not switched on unnecessarily. Daylight-linked control in circulation areas can be very effective.
- Consider automatic controls, particularly for lights in open office areas. Try to adopt a policy of manual ON/OFF but with automatic OFF (or dim-down) providing a reminder/backup. Integrate automatic controls with daylight where possible. Provide local switches so that users can easily control their own lighting. Remember that there is a range of users and circumstances (see BRE IP 6/96, details on page 21).
- Consider occupancy-sensing controls in intermittently used areas where lights will tend to be left on.

APPENDIX 1 – DESIGN MEASURES

CONTROLS

- Provide effective central, zone and room controls for health and safety, energy efficiency, prolonging plant life, and responding to the needs of occupants and management.
- Make sure that devices requiring regular resetting and reprogramming are readily accessible to the people responsible.
- Provide feedback devices, so that the status of the installation and compliance with design intentions can be readily monitored, for example to warn if heating boilers are operating when average outside temperatures are high, if heat recovery and free cooling are operating effectively, if refrigeration and heating are operating together in conflict, or if air mechanically supplied for night cooling is significantly warmer than outside.
- Avoid excessive complication, beyond the normal capabilities of site staff and maintenance contractors.
- All default states should be to low energy.

BUILDING ENERGY MANAGEMENT SYSTEMS

Well-designed electronic BEMSs can be very powerful in large buildings or estates, but they should be regarded as an adjunct to good management not a substitute for it. In smaller buildings, BEMSs must not be too complicated for the level of management skills available. In rented buildings, the different requirements and responsibilities of landlord, tenant and maintenance contractor must be addressed.

SUB-METERING AND MONITORING

Provide electricity, gas and oil sub-metering to encourage effective monitoring and management, particularly for:

- individual buildings on a multi-building site
- individual tenancies in a building
- areas of high energy intensity, such as kitchens and computer rooms, and their air-conditioning
- larger usage plant items, such as chillers, air-handling units and humidifiers.

Ideally, sub-metering should be at plant item or motor control centre/panel level, and linked to a BEMS if installed. Heat metering should be considered on its merits.

FURTHER INFORMATION

SOURCES OF INFORMATION

The following publications contain advice, targets, and specifications appropriate at the briefing stage.

BREEAM for offices

The BRE Environmental Assessment Method for offices comprises a core assessment of the building fabric and services, and two further optional assessments:

- the design and procurement process
- the management and operating procedures of an occupied building.

The benefits of BREEAM for clients are:

- a ready-made specification tool and design standard which maintains flexibility for the design team
- independent monitoring and advice during the design process
- pre-assessment design support from authorised assessors
- an opportunity to demonstrate and benchmark environmental performance
- a simple, understandable and established market label for environmental performance.

FURTHER READING

BRE publications

Available from CRC Ltd, telephone 020 7505 6622.

- Environmental design guide for naturally ventilated daylit offices
- Solar shading of buildings
- BREEAM 98 for offices
- BREEAM Existing offices
- BREEAM New offices
- The Office Toolkit
- IP 6/96 'People and lighting controls'
- IP 10/95 'Daylighting design for display-screen equipment'

British Council For Offices (BCO)

'Best Practice in the specification for offices'. Second edition. BCO, Reading, 1997. ISBN 0 9524131 24

Chartered Institution of Building Services Engineers (CIBSE) publications

- CIBSE Guide 'Energy efficiency in buildings'
- Applications Manual AM10 'Natural ventilation in non-domestic buildings'
- Technical Memorandum TM22 'Energy Assessment and Reporting Methodology'

See also: W Bordass, R Bunn, R Cohen, P Ruyssevelt, M Standeven and A Leaman, 'The PROBE project: Technical lessons from PROBE 2', CIBSE National Conference, Harrogate, 1999

Building Services Research and Information Association (BSRIA) publication

- BSRIA Environmental Code of Practice

FURTHER INFORMATION

ENERGY EFFICIENCY BEST PRACTICE PROGRAMME PUBLICATIONS

The following Best Practice programme publications are available from the BRECSU Enquiries Bureau. Contact details are given on the back cover.

Energy Consumption Guide

19 Energy use in offices

General Information Leaflet

11 Energy efficiency in offices

General Information Reports

30 A performance specification for the Energy Efficient Office of the Future

31 Avoiding or minimising the use of air conditioning – a research report from the EnREI Programme

40 Heating systems and their control

48 Passive refurbishment at the Open University. Achieving staff comfort through improved natural ventilation

56 Mixed-mode buildings and systems – an overview

Good Practice Case Studies

62 Energy efficiency in offices. BRE Low Energy Office, Garston, Watford

308 Naturally comfortable offices – a refurbishment project

334 The benefits of including energy efficiency early in the design stage – Anglia Polytechnic University

Good Practice Guides

71 Selecting air conditioning systems. A guide for building clients and their advisers

74 Briefing the design team for energy efficiency in new buildings

118 Managing energy use. Minimising running costs of office equipment and related air-conditioning

187 Heating system option appraisal – an engineer's guide for existing buildings

237 Natural ventilation in non-domestic buildings – a guide for designers, developers and owners

245 Desktop guide to daylighting – for architects

257 Energy-efficient mechanical ventilation systems

258 Looking for a new investment angle? A developer's guide to environmentally smart buildings

274 Environmentally smart buildings – a quantity surveyor's guide to the cost-effectiveness of energy-efficient offices

276 Managing for a better environment. Minimising the running costs and impact of office equipment

285 What will energy efficiency do for your business? A guide for business managers to environmentally smart buildings (in preparation by BRECSU)

290 Ventilation and cooling option appraisal – a client's guide (in preparation by BRECSU)

291 Ventilation and cooling option appraisal – a designer's guide (in preparation by BRECSU)

New Practice Case Studies

102 The Queens Building, De Montfort University – feedback for designers and clients

106 The Elizabeth Fry Building, University of East Anglia – feedback for designers and clients

NatVent® Guide

Natural ventilation for offices

This Guide is based on material drafted by Eclipse Research Consultants under contract to BRECSU for the Energy Efficiency Best Practice programme.

The Government's Energy Efficiency Best Practice programme provides impartial, authoritative information on energy efficiency techniques and technologies in industry and buildings. This information is disseminated through publications, videos and software, together with seminars, workshops and other events. Publications within the Best Practice programme are shown opposite.

For further information on:

Buildings-related projects contact:
Enquiries Bureau

BRECSU
BRE
Garston, Watford WD2 7JR
Tel 01923 664258
Fax 01923 664787
E-mail brecsuenq@bre.co.uk

Industrial projects contact:
Energy Efficiency Enquiries Bureau

ETSU
Harwell, Oxfordshire
OX11 0RA
Tel 01235 436747
Fax 01235 433066
E-mail etsuenq@aeat.co.uk

Internet **BRECSU** – http://www.bre.co.uk/brecsu/
Internet **ETSU** – http://www.etsu.com/eebpp/home.htm

Energy Consumption Guides: compare energy use in specific processes, operations, plant and building types.

Good Practice: promotes proven energy-efficient techniques through Guides and Case Studies.

New Practice: monitors first commercial applications of new energy efficiency measures.

Future Practice: reports on joint R&D ventures into new energy efficiency measures.

General Information: describes concepts and approaches yet to be fully established as good practice.

Fuel Efficiency Booklets: give detailed information on specific technologies and techniques.

Introduction to Energy Efficiency: helps new energy managers understand the use and costs of heating, lighting, etc.