Managing your building services

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Contents

Introduction

This guidance provides facilities managers, and others interested in the management and maintenance of building services, with an introduction to the specialist area of engineering services maintenance within buildings, to assist in the task of managing buildings and their services effectively.

It addresses two distinct areas: first, the technical features of building services and secondly the managerial aspects of their operation and maintenance, including compliance with legislation and other regulatory responsibilities placed on the facilities manager. The publication also provides detailed direction to further sources of information that offer more comprehensive, specialised coverage if required.

An outline of common building services and an overview of their primary maintenance requirements are followed by an introduction to the different planned maintenance approaches that can be used for services, explaining common terminology and introducing approaches used to help formulate a maintenance policy. A section on managing and running your building services covers subjects such as comfort criteria and energy consumption, together with guidance on the selection and appointment of professional maintenance advisers and contractors, and monitoring and auditing building services performance. The next section provides a detailed overview of relevant legislation and regulations together with compliance requirements and the final section provides direction on further sources of information. There is also a comprehensive bibliography and a list of further contacts.

Maintenance

Maintenance is the combination of all technical and administrative actions, including supervision, intended to retain an item in, or restore it to, a state in which it can perform a required function.

Cost of maintenance

The cost of maintenance of building services systems represents a significant proportion of total building operating costs. Maintenance needs to be planned and be done efficiently and effectively.

Building services overview

Introduction to building services

Building services, sometimes called engineering services, are primarily used to create a comfortable and safe working or living environment for people and processes by providing warmth, cooling, light, electrical power, water, sanitation, drainage, transport, communication, noise control, security and fire protection. They play a significant part in creating a successful indoor environment. When working properly they often tend to be ignored or taken for granted, whilst poor performance can cause discomfort and occupant dissatisfaction and contribute to reduced productivity.

Effective, reliable operation of the building services requires a managed maintenance regime to be in place. The energy used by the building services will be a significant cost to the business operation and also needs to be managed. Some 50% of UK energy consumption is used within buildings and therefore facilities managers can have a considerable impact on the overall

When should maintenance start?

Building services systems require maintenance from the moment they are commissioned and put into operation to the end of their operating lives.

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UK energy saving programme. Operation and maintenance of specific building services, such as lifts, pressure vessels, fire protection systems and gas fired heating equipment, will involve compliance with a range of statutory regulations, and failure to do this can mean the facilities manager being at risk of fines or imprisonment.

Primary maintenance requirements for common building services

Table 1:
Basic maintenance requirements for building services systems

Table 1 provides a summary of common building services systems, with an overview of their primary maintenance requirements.

System type	Application	Maintenance requirements
Heating (wet systems):		
— radiators	Generally used in naturally ventilated buildings. Simple and compact, good temperature control. Slow thermal response. May have uneven temperature gradient in occupied space due to convective heat output.	Low
— convectors	Quicker warm up than radiators, fan convectors provide high heat output and air movement, casing can reduce risk of burning.	Periodic cleaning to remove dust; regular inspection of fan convectors
— underfloor	Public spaces, foyers, tall spaces. Invisible system freeing floor space, heat output largely self regulating. Slow response to change in temperature setting.	Low, assuming no leaks.
Heating (air systems):		
— warm air/mech. ventilation	Commercial and industrial applications, particularly where constant and reliable ventilation is required. Allows air movement to be controlled. Fans can consume significant amount of energy. Occupants have less control of environment.	Regular inspection of air handling unit, including fans and motors, and replacement of filters
Cooling:		
— air conditioning	Full control of internal air temperature, humidity, freshness and air cleanliness. In practice the term air conditioning also applies to 'comfort cooling' systems which have no humidity provision.	See Appendix A1 Table A1.1 for information on relative maintenance costs of different types
Domestic hot and cold water:		
— central supply and distribution	Most commercial and residential buildings. Provides on-site storage, accommodates peak loads.	Monitoring of water quality and storage/distribution temperatures; visual inspection of storage tanks
Lighting:		
— tubular fluorescent	Commercial, retail, leisure	Periodic clean and lamp replacement; lamp life of order of 10 000 hours (e.g. 3 years at 10 h per day, 6 days per week)
— compact fluorescent	Work stations; low levels of lighting	Periodic cleaning and replacement; lamp life of order of 8000 hours
— high bay luminaires	Industrial, commercial; normally above 5 m mounting height	Periodic cleaning and lamp replacement; lamp life 12 000 to 22 000 hours, depending on type
— low bay luminaires	Industrial, commercial; mounting height 3–5 m	Periodic cleaning and lamp replacement. Lamp life 5000 to 10 000 hours depending on type
— emergency lighting	Commercial and industrial premises and places of entertainment	Inspection and testing 6-monthly in accordance with BS 5266 and ICEL 1008
Electric power:		
— single phase	Domestic, small commercial	Inspection and testing to BS 7671*
— 3-phase	Larger buildings, e.g. commercial, industrial	Inspection and testing to BS 7671*

Table 1 — *continued*

System type	Application	Maintenance requirements
Controls and building management systems:		
— controls	Time, temperature, air velocity, humidity, electrical voltage and current, status etc.	Dependant on requirements, e.g. annual check of set points
— BMS	Supervision of controls, remote access, central alarm monitoring	Dependant on requirements, e.g. annual check of set points
Communications:		
— unshielded twisted pair	Voice systems, low speed data systems	Minimal
— foil screened twisted pair	Voice systems, low speed data systems needing some protection from electromagnetic interference (e.g. industrial environment with power cables or electrical equipment causing interference)	Minimal
— shielded twisted pair	Voice and higher speed data systems, provides better resistance to electromagnetic interference	Minimal
Transportation:		
— lifts	Vertical transport of people and goods	Regular inspection regime by competent persons including 6-monthly inspection for passenger lifts
— escalators	Transportation of people	Regular inspection regime by competent persons including 6-monthly inspection (non-mandatory)
Security:		
— intruder detection	Deterrent to potential intruders and raises alarm should access be gained by unauthorised persons	Routine inspection of sensors and sounders to confirm normal operation
— closed circuit television	Deterrent to intruders and vandalism	Routine inspection of cameras, recorders and screens to confirm normal operation
— access control	Controlled regulation of entry to a property	Routine inspection of door locks, keypads, sensors etc. to ensure normal operation
— all systems	Electrical wiring	Inspection and testing to BS 7671*
Fire protection:		
— manual systems	Sounders activated by call points	Inspection and testing to BS 5839: Part 1
— automatic systems designed to protect life	Sounders activated by fire, smoke and heat detectors	Inspection and testing to BS 5839: Part 1
— automatic systems designed to protect property	Sounders activated by fire, smoke and heat detectors	Inspection and testing to BS 5839: Part 1
— all systems	Electrical wiring	Inspection and testing to BS 7671*

* Professional advice should be sought before commencing a programme of inspection and testing. Inspection and test frequencies can vary from 12 monthly for the most critical installations to five yearly for the most secure.

Maintenance overview

Maintenance policy

Maintenance policy

Maintenance should be planned and organised to achieve the overall objectives of the owner as set out in the maintenance policy.

For a project to deliver a successful building capable of proper and adequate operation and maintenance the future maintenance requirements need to be considered at the earliest project stages from inception to design brief, ideally in the form of a maintenance policy statement by the client when briefing the design consultant. If the client does not have the necessary expertise then a policy should be formulated in conjunction with the client, design consultant and other professional advisors.

Role of the client

The most important aspect of the role of the client in maintenance is to define requirements clearly and express these as the maintenance policy.

An initial maintenance policy is therefore often set at the design stage. During installation, the specified maintenance policy can ensure that appropriate and safe means of access and isolation are provided, proper means of identification and test facilities are available, and information such as maintenance requirements is to hand, which will also facilitate testing and commissioning.

The maintenance policy for any installation is likely to be unique. The following questions are intended to help formulate a policy:

— What are the implications of failure?

— How is the plant likely to fail?

— What is the probability of failure?

— Are standby facilities available?

— What level of usage is envisaged?

— What level of technical expertise is available?

— Will spares be available on site?

— Can equipment be purchased or rented locally?

— Will all necessary documentation be provided?

— Will adequate financial resources be available to provide the level of maintenance envisaged?

Maintenance strategy

Maintenance strategy

The maintenance strategy will set out detailed information on specific maintenance needs and requirements including labour and material requirements, schedules, monitoring, audits etc.

The maintenance strategy for a building moves beyond the initial maintenance policy to establish more specific detail on the level of operation and maintenance that needs to be carried out to match the expectations and needs of the organisation, including :

— compliance with the requirements of legislation and authoritative bodies

— improving the health and safety of the building users and those who operate and maintain the plant

— functions of plant and equipment that are critical to company objectives

— optimising plant reliability and availability to sustain those critical to company objectives

— optimising the utilisation of resources

— satisfying other key objectives of the organisation

— safeguarding assets.

A building operator needs to determine the most appropriate choice of maintenance procedures when a building is eventually handed over and put into full operational use. The strategy may closely follow the original maintenance policy established by the client in conjunction with the designer but, as the project progresses to completion, other factors may need to be considered. The usage pattern of any functioning building is likely to be continually changing and the maintenance procedures will need to adapt to suit the circumstances.

For example, in the early years it may be appropriate to keep an installation close to its original condition but, as wear becomes more pronounced and the needs of the occupants change and technology improves, there is likely to be an increasing demand for extensive replacement and refurbishment. In many cases it may be left to the person responsible for carrying out maintenance to recommend a course of action, perhaps solely on the grounds of cost without fully appreciating the implications of alternatives. Whichever approach is finally adopted, it should take account of anticipated future requirements of a building and its services, the current physical performance and functional suitability of plant, proposed changes of use (particularly where they affect plant and services), statutory and legal requirements, and any standards of maintenance specified by the building operator.

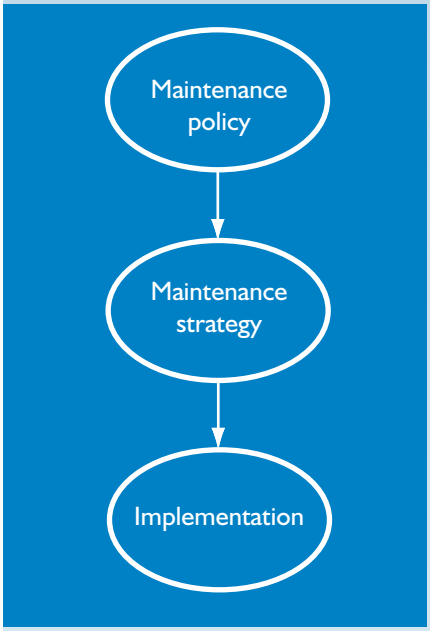

Figure 1:
Stages in implementing a maintenance policy

Planned maintenance

It is good practice for all maintenance to be planned rather than unplanned. Unplanned maintenance tends to be reactive and disorganised and can result in prolonged breakdowns and continuing poor performance. Planned maintenance is organised, controlled and follows a recognisable procedure.

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It is good practice for all maintenance to be planned. Planned maintenance is organised, controlled and follows a recognisable procedure.

Planned maintenance can take several forms, such as:

(*a*) *Preventive maintenance*: carried out at predetermined intervals or corresponding to prescribed criteria intended to reduce the probability of failure.

(*b*) *Corrective maintenance*: work done once a fault has occurred.

(*c*) *Reactive maintenance*: when plant and equipment is adjusted or repaired once it fails to perform to acceptable standards.

(*d*) *Immediate maintenance*: necessitated by unforeseen breakdowns.

(*e*) *Scheduled maintenance*: preventive maintenance carried out to a predetermined scheme or programme.

(*f*) *Opportunity maintenance*: work done as and when possible.

(*g*) *Design-out maintenance*: where maintenance needs are designed out. to achieve the required level of reliability.

(*h*) *Condition based maintenance*: work is initiated by trends highlighted by routine or continuous monitoring of plant condition.

(*i*) *Run to failure*: the consequences are such that plant can be safely and cost effectively run to destruction.

Whichever maintenance plan is adopted, it is likely to consist of a mixture of these methods. It needs to start with an assessment of what is effective, followed by a decision as to what is desirable and a consideration of the resources available.

Main principles of a planned maintenance system

The following checklist itemises the details that need to be established for a planned maintenance system:

(*a*) Items to be maintained.

(*b*) Maintenance appropriate to each item.

(*c*) Labour required.

(*d*) Material resources required.

(*e*) When the work is to be done.

(*f*) How frequently the work is to be done.

(*g*) How the maintenance system will be administered.

(*h*) How the results will be analysed and monitored.

Operating and maintaining your building services

Requirements and benchmark data

There are many criteria used to judge the performance and condition of building services systems; for example, whether they are delivering the correct internal conditions as laid down in the original brief. Energy use and other data from system monitoring can also be used to provide feedback. As part of a maintenance regime it is therefore necessary to have the initial design brief data, such as initial design parameters, as well as system descriptions, equipment schedules etc. The principal source of maintenance and operation information for a particular building should be the operating and maintenance manual (see also *Sources of maintenance guidance*, page 24).

Tables 2, 3 and 4 provide some useful reference data such as comfort criteria, floor space allocations and annual energy consumption benchmark data.

Table 2:
Comfort criteria (based on CIBSE Guide A and SLL *Code for Lighting*)

Building type	Winter dry resultant temp. / °C	Summer dry resultant temp. / °C	Air supply rate / (litre/s)	Maintained illuminance / lux
Offices	21–23	22–24	8	300–500
Retail:				
— shopping mall	19–24	21–25	8	100–200
— supermarket	19–21	21–23	8	300–500
— packing areas	19–21	21–23	8	300–500
Bank/building society	19–21	21–23	8	300–500
Computer room	19–21	21–23	8	300–500
Education buildings	19–21	21–23	8	300–750
Commercial kitchens	15–18	18–21	See CIBSE Guide B2	200–500
Corridors, changing rooms, bulk stores	Dependent on use	Dependent on use	Dependent on use	100–200
Rest rooms	19–21	19–21	8	300
Lecture theatres, lecture halls	19–21	21–23	8	300–500

Notes:

1 The maintained illuminances are recommendations and should be adjusted to the particular tasks. Further information is contained in the SLL *Code for Lighting*.

2 There are no statutory maximum temperatures; CIBSE Guide A sets down upper temperatures that are recommended by CIBSE for the comfort of room occupants.

Table 3:
Floor space allocation for occupants

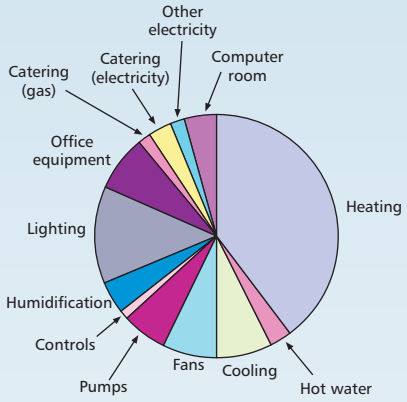
Building type	Floor space per occupant
Office and commercial	5 m² gross
Minimum identified requirements (based on superseded Offices, Shops and Railway Premises Act)	3.72 m² (320 cu. ft.) (i.e. 40 sq. ft. with floor-to-ceiling height of 8 ft.)

Table 4:

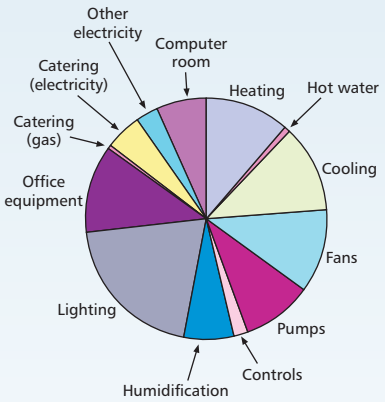
Annual energy consumption in an air conditioned office (based on Energy Consumption Guide ECG19)

Building service	Typical delivered energy consumption per unit treated floor area / (kW·h/m²)	Typical delivered energy cost per unit treated floor area / (£/m²)
Heating	166	1.66
Hot water	12	0.12
Cooling	31	1.71
Fans	30	1.65
Pumps	25	1.38
Controls	5	0.28
Humidification	18	0.99
Lighting	54	2.97
Office equipment	31	1.71
Catering:		
— gas	7	0.07
— electricity	13	0.72
Other electricity	8	0.44
Computer room	18	0.99
Total gas	185	1.85
Total electricity	233	12.82
Total	418	14.67

Note: unit costs: gas 1.0 p/kW·h, electricity 5.5 p/kW·h



Energy consumption / (kW·h/m²)



Energy costs / (£/m²)

Figure 2:

Annual energy consumption and costs for an air conditioned office (based on Energy Consumption Guide ECG19)

Maintenance costs

Benchmark cost data for maintenance of building services are not readily available. The Heating and Ventilation Contractors' Association (HVCA) has published its *Standard maintenance specification for mechanical services in buildings*, which includes schedules for routine inspection and testing of a wide range of plant and equipment. This can provide a good basis for obtaining competitive quotations for such work.

Costs will be affected by geographical area (for example the London area attracts a considerable labour premium). They will also be governed by the specific requirements of the client and the complexity of the engineering services within the building. A building with relatively simple services (e.g. heating, water distribution, electrical power and lighting) will have a much smaller maintenance requirement than one which also has full air conditioning, security systems, lifts, fire protection and standby power facilities.

Other sources of maintenance cost data are BSRIA, RICS, BIFM and Spon.

Implementing a maintenance strategy

Once the maintenance strategy has been decided (see page 4) the responsibility for achieving the specific objectives and carrying out the tasks must be allocated. Examples of the responsibilities associated with maintenance are ensuring that:

- all plant and services to be maintained are identified, together with their maintenance requirements
- adequate manpower exists for maintenance, and that it is properly trained and supervised
- the quality of both the work done and the spares used are satisfactory
- financial control and reporting procedures are established and functioning properly.

The responsibilities of the operational management of the building, i.e. the facilities management team, will be to:

- carry out risk assessments
- establish the health and safety policy (e.g. level of action to achieve the company objectives for health and safety, allocation of responsibilities and establishing action plans)
- establish the operation and maintenance policy (e.g. level of planned versus corrective maintenance, run to failure and condition monitoring)
- develop information systems for operation and maintenance (e.g. method of record keeping such as computer-based, manual, local or archived; nature of records to be kept such as asset registers or planned maintenance log books; and responsibilities for maintaining records)
- procure and manage operation and maintenance activities (e.g. in-house; out-sourcing such as term contracts, lump-sum contracts or facilities management contracts; mix between in-house and external resources)
- set performance targets to meet the benchmarks determined by senior management (e.g. cost, plant availability, response times, quality of records, quality of workmanship)
- set budgets (allocating finance to each function)
- monitor performance
- provide feedback to senior management
- organise improvements or changes to suit evolving business needs.

Responsibilities for maintenance

It is important to allocate clearly the responsibilities for achieving the specific objectives within the maintenance strategy and carrying out the specific maintenance tasks.

Selecting, appointing and managing professional advisors and contractors

It is becoming more common to appoint contractors for the maintenance of building services plant, possibly due to the increasing complexity of equipment and the need for suitably skilled and experienced staff.

Careful assessment of both professional advisors and maintenance contractors is important if satisfactory working relationships are to be established and if service providers of similar competence and capabilities are to be compared before final selection is made. The following aspects may be considered as part of this process:

- operation and maintenance as a major part of core activities
- ability to demonstrate stable business in financial, managerial and resource bases
- effective financial control procedures in place
- necessary labour and skills plus support facilities
- named personnel plus training and skills records
- method and extent of supervision
- membership of recognised professional and trade associations
- formal, written procedures in place for health and safety, equal opportunities and customer complaints, including record keeping
- references available from previous clients
- sufficient technical and managerial capability
- staff training and development programme in place
- adequate means of communication
- resourcing for emergency situations
- transport to match geographical area of contract
- company quality assurance system in place (e.g. BS EN ISO 9001).

Services typically offered by a maintenance contractor

The following is an example of the range of services carried out by a direct labour organisation or maintenance contractor (additions may be appropriate to meet particular requirements):

(*a*) routine inspection and maintenance of engineering plant

(*b*) planned lamp replacement

(*c*) five-yearly electrical inspection

(*d*) portable appliance testing

(*e*) monitoring of plumbing and water services operation (for legionellosis control)

(*f*) inspection and operation of high-voltage electric installation

(*g*) first line response to emergencies and pre-agreed critical alarms (response time agreed with client)

(*h*) ensuring compliance with statutory requirements for services installations

(*i*) provision and control of on-site engineering stores

(*j*) purchase of engineering plant and equipment (consumable spares and materials, client requested items, replacement of minor and major plant)

(*k*) installation of engineering plant and equipment (minor items including response to client requests and major capital plant)

(*l*) energy management by:

- ensuring efficient plant operation
- purchase and, where appropriate, storage of fuel

(*m*) supervision and control of specialist contractors

(*n*) inspection, compliance testing and monitoring of fire systems and equipment

(*o*) trouble-shooting.

Maintenance contracts

Detailed guidance on maintenance contracts may be found in CIBSE *Guide to ownership, operation and maintenance of building services* and various BSRIA publications

Control of maintenance

Controlling operation and maintenance is an ongoing activity. It is the process of continually monitoring the maintenance system and its performance against pre-set goals, and reporting the performance to the management responsible for these functions. Where performances fail to achieve set targets, changes to the maintenance regime should be made to correct any deviations. Alternatively, where failure is consistent, the targets themselves may be unrealistic or unattainable and may need to be reviewed and changed.
A quality management system for the maintenance function will define roles and responsibilities and establish procedures and reporting formats, thereby helping to ensure consistent and effective control.

Controlling maintenance usually requires two levels of audit:

(*a*) A system audit to check the detailed formal procedures that constitute the maintenance regime (e.g. procedures for planned maintenance, procedures for record keeping and managerial procedures) to ensure that they satisfy legal requirements and company objectives.

(*b*) A performance audit to monitor the performance of the maintenance regime against set bench marks (e.g. cost targets, response times, plant down-time and quality of records).

Monitoring performance

A maintenance audit is likely to be based on subjective assessments since personal judgement and opinion is involved. However, use of standard procedures and formats such as those in CIBSE's *Guide to ownership, operation and maintenance of building services* and BSRIA's *Toolkit for building operation audits* can provide an objective means of performance auditing. This should increase the benefit of the audit process for all parties concerned. An example audit checklist is provided in Appendix A2. It includes a basic scoring system to produce a numerical result which can be used to make like-for-like comparisons and to identify year-on-year changes in performance. A more detailed performance audit procedure is set out in BSRIA's *Toolkit for building operation audits*. The checklist addresses six aspects which are described below.

Maintenance audits

Maintenance audits are an essential element within maintenance control and can form a key part of a maintenance quality management system.

(*a*) Management

This has two elements, client and contractor staff:

— *Client*: this element addresses how the contract is being complied with, whether reports are submitted as required, whether meetings are scheduled and kept to, how productive and positive they are. Contractors should be aware of their role in ensuring buildings remain functional.

— *Contractor staff*: this considers their quality, management and supervision, conduct and appearance, housekeeping, response to work requests, call-outs and emergencies, and standards of training. It is important for maintenance operatives to keep up to date with technical developments, safety awareness and practical training on the wide variety of plant likely to be encountered.

Contractors' role

Contractors should be aware of their role in ensuring buildings remain functional.

(*b*) Maintenance service

Planned preventive maintenance (PPM) is the systematic investigation at predetermined intervals of all the plant items listed on the plant register. This

element assesses whether effective work planning is being applied, the PPM is being carried out at the stated intervals and all the tasks are being achieved to an acceptable quality standard. An important aspect of the contractor's management is to ensure that all maintenance periodicity is under continuous review to minimise tendencies towards either under- or over- maintenance.

(*c*) Communication

Maintenance review meetings

Regular maintenance review meetings between the facilities manager and the contractor are useful to review contract progress, cost forecasts and actions needed.

Maintenance review meetings allow the facilities manager (FM) and the contractor to develop mutual understanding of their respective objectives and requirements. Minutes should be produced of each meeting for reference and to help ensure agreed actions are carried out. It may be appropriate for contractors to prepare cost forecasts for specific review meetings to demonstrate the anticipated contract progress has been achieved. Communication covers that between the FM and contractor, and with the building occupants. Ideally, occupant complaints should be formally recorded, with the FM determining the true nature of the complaint before passing it to the contractor for action.

(*d*) Health and safety

Although the client must accept the ultimate responsibility for health and safety, the implementation of specific procedures may be placed with the contractor, or be made the responsibility of the facilities manager. These aspects should be clearly identified at the start of the contract and monitored to ensure the work is being carried out satisfactorily. Health and safety policy statements should be available from both the client and the contractor. The contractor should have clear and defined health and safety procedures, be actively training the employees, have rigid safety management systems in place and be able to support this with comprehensive records.

(*e*) Technical proficiency

All plant on the asset register should be maintained in accordance with the agreed schedules, which identify the work and frequency. The results of maintenance inspections and follow up work need to be supported by detailed records compiled by the contractor together with other relevant documentation. Spares, replacements and materials will be required during maintenance activities. There will be cost, reliability and quality implications for these, particularly where they are related to standards of performance or manufacture.

(*f*) Invoicing

Invoicing and payment procedures should be agreed between all parties at

the start of the contract. They may include such matters as frequency of submission, payment terms, need for authorisation and expenditure limits. An agreed format in which invoices are to be submitted should be agreed at the start of the contract.

Benchmarking can also provide a means of monitoring performance by establishing key performance indicators (KPIs) or service level agreements (SLAs). These need to set down criteria that can be measured, are achievable and easily recordable. Examples are the number of plant breakdowns in a given period, the number of planned preventive tasks undertaken, the number of reactive maintenance tasks issued and completed and response time to breakdowns.

Benchmarking

Benchmarking can provide a means of monitoring performance by establishing key performance indicators (KPIs) or service level agreements (SLAs).

Risk management

Risk management is an essential part of maintenance. Risk is inherent in any project and can be effectively managed to minimise its impact. Processes can be adapted or developed to identify, analyse, control and mitigate risk to reduce problems and avoid surprises, so increasing the prospects of project success.
Risk is generally magnitude dependent and value based. It can be time dependent, usually on a future event. It is an event associated with a degree of uncertainty, it is impossible to avoid completely, but can be managed or even transferred.

Risk management

The process of managing risk involves:

— *risk identification*: all events which may cause harm to a project

— *risk analysis*: applying qualitative and quantitative tools to ascertain subjective assessments, probabilities, likelihood and severity.

It is important to separate project issues from risk and allocate ownership of risk. The elements to be considered during operation and maintenance will include co-ordination, the supply chain and integration. The risk management process should also allocate contingencies and develop action plans for issues arising from the risk management process. Without an understanding of risk, operating to a cost plan can be particularly difficult with contingency being assessed arbitrarily without consideration for the real risks involved.

Risk mitigation can be undertaken in a number of recognised procedures such as:

— reliability, availability and maintainability assessments

— standardisation of components and specifications

— modularisation

— criticality assessments.

It may also be possible to negotiate the sharing of risk with a maintenance or FM contractor, and arrange agreed service level agreements (SLAs) and financial rewards or penalties for good or bad contractor performance.

Legislation, compliance and good practice

Overview

Consequences of failure to comply with legislation

In the period 2002–3, the Health and Safety Executive issued 778 Improvement Notices and 2772 Prohibition Notices, with the average fine from matters taken to court being £13 500. The largest cause of major injuries was falling from heights. Within the construction sector there were 63 fatal injuries and some 3900 major injuries including 253 relating specifically to work associated with repairs, maintenance and cleaning. (Further information is available on www.hse.gov.uk)

Building owners and operators have a significant challenge ensuring that the engineering services operate satisfactorily to achieve a safe and comfortable environment for building occupants. Coupled with this is the need to control the security of supply of electricity and other energy sources to ensure the building can function.

This means that there is a need for regular inspection and maintenance to provide a measure of certainty that the plant and services will operate safely and reliably, as and when needed. In the past, failures to carry out the essential function of inspection and maintenance have resulted in instances of severe injury and even loss of life. This in turn has led to the formulation of statutory requirements and other recommendations relating to the management of building services.

A recent survey of facilities managers by BSRIA revealed that many had concerns about the ever-increasing volume of legislation, standards and codes of practice with which they had to comply. This section provides an overview of key legislation relevant to building services, although it cannot be fully comprehensive and it is not the intention to identify every item of legislation or code of good practice.

As well as ensuring that all appropriate legislation is being complied with, the necessary records and supporting information must be in place. This then provides a strong and defensible position should an incident occur.

Legislation

Levels of compliance

In many Acts and Regulations non-compliance can result in prosecution. In some cases compliance is 'absolute' and must be observed whatever the cost. In others, compliance is qualified by the phrase, 'as far as is reasonably practicable', where the risk may be assessed against the cost necessary to avoid it.

The following is based in part on BSRIA key fact sheets available free-of-charge from the BSRIA website (www.bsria.co.uk/legislation).

In many of the Acts and Regulations listed below, non-compliance can result in prosecution. A summary of selected compliance requirements is given in the next section.

(*a*) Health and Safety at Work etc. Act 1974

This legislation was the first that applied to all work locations. The act places responsibility on employers and employees to work together to find solutions to problems. It is known as an 'enabling' act, for all British legislation relating to health and safety. Amongst many requirements, the act requires the provision and maintenance of safe systems of work by employers.

(*b*) Building Regulations 2000

The legal framework is provided by the Building Act 1984 and relates to the design and construction of buildings. Where the planned building, or building extension, is subject to the Regulations (and this applies to almost all buildings), then a set procedure must be followed to comply, in conjunction with the local authority building control office. Where buildings governed by these Regulations already exist, then copies of completion certificates must be on file. See also the Construction Regulations, below.

(*c*) Confined Spaces Regulations 1997

Where entry by employees or others to a confined space is unavoidable, the appropriate risk assessments and arrangements for rescue in an emergency are mandatory.

(*d*) Construction Regulations

The Construction Regulations apply to the broadest possible range of work from the most minor internal task to the largest building project and includes general building and engineering work, refurbishment and maintenance. The regulations are grouped under three headings: Construction (Design and Management) Regulations 1994 (CDM), Construction (Head Protection) Regulations 1989 and the Construction (Health, Safety and Welfare) Regulations 1996.

(*e*) Control of Asbestos at Work Regulations 2002

Compliance is mandatory. The approach to dealing with suspect material can be summarised as follows:

— check type of asbestos (use a professional analyst)

— check concentration and extent

— arrange for an approved contractor to strip out the offending material or, if appropriate, seal or encase.

Full records must be kept and the asbestos register shown to all contractors who may work on the fabric of buildings, where asbestos may be found. (See also *A short guide to managing asbestos in premises*.)

(*f*) Control of Substances Hazardous to Health Regulations 2002 (COSHH)

These regulations apply to all business and work related activity where hazardous substances are used. An employer or his/her representative (e.g. facilities manager), has a responsibility to assess all work situations to

establish if employees might be exposed to a hazardous substance, be it a solid, liquid, vapour, dust, gas or biological agent. COSHH data sheets are available from all suppliers of hazardous substances.

(*g*) Electricity at Work Regulations 1989

IEE Wiring Regulations

The IEE Wiring Regulations can be applied not only to the workplace, but also to all electrical installations throughout the UK, including those in residential properties, temporary exhibitions and caravans. Every new installation should be subjected to an inspection and test to establish, as far as is reasonably practicable, that the regulations have been met.

The regulations require that electrical systems should be constructed and maintained at all times to prevent danger or injury, as far as is reasonably practicable. However, some provisions within the regulations are absolute. It is, for example, the employer's responsibility to assess the risks of any tasks utilising electricity or electrical equipment and any tasks on or in the vicinity of electrical power supplies or systems. In certain situations it is stipulated that technical knowledge and experience are a prerequisite to avoiding danger or injury, and there is an obligation placed on the 'duty holder' (usually the facilities manager) to ensure that any electrical operatives employed (even if they work for another company under a contract) are competent to do the required work These regulations provide an example of where, in general terms, compliance can be achieved by observing the requirements of a British Standard, in this case BS 7671 (the IEE Wiring Regulations).
Further information can be found in the HSE's *Memorandum of guidance on the Electricity at Work Regulations 1989*.

(*h*) Emissions into the atmosphere

Air quality and assessment is covered by a number of mandatory items of legislation including the Clean Air Act 1993, the Pollution Prevention and Control Act 1999, the Environmental Protection (Non-refillable Refrigerant Containers) Regulations 1994, and the Air Quality Regulations 2000. European Directives have driven much of this legislation, including the European Council directive on substances that deplete the ozone layer. For facilities managers, the areas requiring greatest attention are in the installation and maintenance of air conditioning, refrigeration and firefighting systems.

(*i*) Environmental Protection Act 1990

Building owners and operators now accept the need to protect the environment from indiscriminate disposal or leakage of waste. Facilities managers should ensure that not only is the company environmental policy in place but that implementation is achieved. Waste products should be accurately identified, transported by an accredited waste carrier and disposed of exactly as planned at approved locations. A responsible person should keep comprehensive records.

(*j*) Fire Precautions Act 1971 and Fire Precautions (Workplace) Regulations 1997 (amended 1999)

Whether or not a building used as a workplace has a fire certificate, employers have a responsibility for carrying out fire risk assessments. They should ensure means of fire detection and giving warning are in place. Escape routes should be marked. Firefighting equipment should be in place and employees given instruction. Fire escape routes should be lit with emergency lighting. Records/log book should be kept of persons responsible, periodic reviews of arrangements and equipment and system tests. Further sources of information include: Building Regulations Approved Document B: *Fire safety*, CIBSE Guide E: *Fire engineering*, and HSE publications: *Fire Safety: an employers guide* and *Fire safety in construction*.

(*k*) Health and Safety (Display Screen Equipment) Regulations 1992

These Regulations are mandatory and relate not just to the operators, computer monitors and VDUs but also to work areas, desks, chairs, the work environment and the task. Regular and well-documented inspections by trained personnel are recommended.

(*l*) Lifts, lifting equipment and escalators

If a lift has the capacity to carry passengers it should be treated as a passenger lift (as opposed to a goods only lift). Passenger carrying lifts are subject to the Lifts Regulations 1997 and the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER). Facilities managers should ensure that appropriate and regular maintenance is carried out, that the statutory thorough examinations are carried out (normally every six months) and that the reports are kept for at least two years for inspection by health and safety inspectors. A lift log in which to record all events, including maintenance and breakdowns, is highly recommended. Escalators are not specifically required to have statutory examinations but the HSE guidance recommends that inspections be undertaken to meet the requirements of the Health and Safety at Work Act.

Lifting machinery and lifting equipment is subject to the Supply of Machinery (Safety) Regulations 1992.

(*m*) Lightning protection systems

Every building having a lightning protection system should have records on file including 'as built' drawings and a log book in which all test dates and test results are recorded. Annual checks are recommended, refer to BS 6651.

(*n*) Maintaining portable and transportable electrical equipment

Periodic inspection and testing is required for all portable and transportable electrical equipment, whether it is used on a construction site, as a maintenance tool or on an office desk. The frequency of inspection and testing should vary according to a deliberate policy and linked to the harshness of the task or the working environment. It would be normal for testing to be carried out by a competent person using appropriate test equipment. Details are given in HSE's HS(G) 107: *Maintaining portable and transportable electrical equipment* and the IEE's *Code of practice for in-service inspection and testing of electrical equipment*.

(*o*) Management of Health and Safety at Work Regulations 1999

Record keeping

Risk assessments, method statements and work permits are best prepared on pre-printed stationery to ensure consistency of approach and adequacy of record keeping.

Much of the content of these regulations is 'absolute' and requires compliance. These regulations extend the employer's responsibilities as contained in the Health and Safety at Work Act. Employers are required to make an assessment of the risks to employees in the workplace (and others including visitors and members of the public, young persons and expectant mothers) and must keep records. If it is found that risks remain high, cannot be eliminated or if precautions are complex, a permit-to-work system should be employed.

(*p*) Manual Handling Operations Regulations 1992

Avoidance is the key when considering the lifting of heavy loads and equipment. If lifting cannot be avoided, irrespective of the nature of the workplace, then the risk of injury must be assessed and reduced to a minimum. Compliance is mandatory and employee consultation should be a matter of course. The risk of injury is to be reduced as far as is reasonably practicable.

(*q*) Pressure Systems Safety Regulations 2000

Pressure systems and equipment that contain fluid or gas under pressure can cause death or serious injury should the contents be released unintentionally. Each year in the UK there are about 150 dangerous occurrences recorded involving unintentional releases. The Pressure Systems and Transportable Gas Regulations 1989 have been replaced by the Pressure Systems Safety Regulations 2000, the aim of which is to prevent risk or injury from the release of stored energy.

Pressure systems are fully described in HSE Approved Code of Practice L122: *Safety of pressure systems*, but most commonly include compressed air systems and pressurisation units in heating systems, but may also include

calorifiers and boilers depending on working pressures. Written schemes of examination and testing must be held on site and are normally drafted by insurance inspectors.

(*r*) Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR)

The Regulations relate to all accidents, injuries, diseases and dangerous occurrences in the workplace. The provisions and responsibilities of employers are extensive but, fortunately, are well documented in a number of publications. Compliance is mandatory. Near misses, where serious injury might otherwise have resulted, are to be included and authorities are to be notified quickly, usually by telephone in the first instance.

There are too many Acts and regulations to list here but comprehensive lists of legislation that apply to work and the workplace are contained in *Principles of health and safety* and *Tolley's Health and Safety at Work Handbook*. Some further examples of UK legislation of which facilities managers should be aware are listed in the adjacent box.

Other UK legislation relevant to facilities managers

Asbestos (Licensing) (Amendment) Regulations 1998
Building Act 1984
Building Regulations 2000
Cinemas Act 1985
Consumer Protection Act 1987
Electricity Act 1989
Energy Act 1983 / 1985
Fire Precautions Act 1971
Gas Act 1986
Health & Safety (First Aid) Regulations 1981
Noise at Work Regulations 1989
Pollution Prevention & Control Act 1999
Personal Protective Equipment Regulations 2002
Utilities Act 2000
Work in Compressed Air Regulations 1996
Working Time (Amendment) Regulations 2003
Workplaces (Health, Safety and Welfare) Regulations 1992

Summary of selected compliance requirements

Table 5 (page 20) gives a summary of a compliance requirements for a selection of the legislation listed above and Table 6 (page 21) identifies some non-statutory requirements.

Examples of inspection and testing necessary to satisfy statutory requirements

There is a considerable amount of routine inspection, maintenance and testing which needs to be seen to be done in order to comply with statutory requirements. That is, maintenance should be evident and records kept of all work activity required by law. Some selected examples are given below.

(*a*) Fire Precautions (Workplace) Regulations 1997

These regulations were made under the European Communities Act 1993 and the UK Fire Precautions Act 1971. Responsibility for fire safety within a building lies with the employer, who is required to make an assessment of the risk from fire and keep a written record of this assessment. The Fire Service is able to offer advice and assistance in meeting this obligation and also can provide guidance to avoid costly over-provision in this area.
Under the Fire Precautions Act there is a requirement for regular testing and inspection of fire alarm systems. This also includes the need to keep records of such tests. The same applies to sprinkler installations and fire extinguishers.

Statute	Requirement	Implication	Means of compliance	Notes
Health and Safety at Work etc. Act	Employer to ensure health, safety and welfare of employees (all persons employed)	Employer to be fully conversant with responsibilities. Arrangements to be in place	Safe place of work and safe working environment. Health and safety policy to be written.	
Management Regulations	Risk assessments, employee training and co-operation between employees (and with temporary workers)	Appointment of competent person(s) from within or outside the organisation	Risk assessments and method statements. Comprehensive record system in place	
Gas Safety Regulations	Only competent and qualified operatives to work on gas systems	All gas fitters must be CORGI registered	Safe installation, maintenance and use of gas systems	
Lifting Operations and Lifting Equipment Regulations (LOLER)	Suitability of equipment to lifting task	Periodic thorough examinations by a competent person	Risk assessment required	
Provision and Use of Work Equipment Regulations (PUWER)	Provision of safe work equipment and safe use irrespective of age or origin	All activities involving work equipment are included	Implementation of schemes of inspection, thorough examination or test	
Fire Precautions Act	Fire risk assessments to be made and recorded	Few buildings are exempt	Provision of a framework for the control of fire safety	See BS 5839
Electricity at Work	To prevent danger and injury from electricity in whatever form	Regulations apply to all places of work and all voltages	All electrical systems to be constructed and maintained to prevent danger at all times	Made under the Health and Safety at Work etc. Act 1974
Environmental Protection Act	Disposal of waste not to harm employees or the environment	Employers to be fully conversant with details of the Act	Written environmental policy, use of registered waste carriers. Documentation of waste disposal activities	

Table 5:
Summary of compliance requirements for a selection of items of legislation

Similarly, smoke extract systems, where they exist, need to be regularly tested to demonstrate their capability.

(*b*) Gas Safety (Installation and Use) Regulations 1998

These regulations were made under the Gas Act 1986. The regulations deal with safety, installation and use of gas fittings and cover gas storage, distribution, supply and use. Work on gas fittings and storage vessels may only be carried out by competent persons who hold a current certificate. The registration of competent persons is the responsibility of the Council of Registered Gas Installers (CORGI), the only body currently recognised by HSE. The regulations require employers to ensure that any gas appliance or system under their control must be maintained in a safe condition. Landlords are required to maintain gas appliances and their flues on an annual basis and provide tenants with a written record to this effect. Where inspections and supporting record documents are not to the required standard, technicians or their employers, can be taken to court and fined or imprisoned.

Standard etc.	Requirement	Implication	Means of compliance	Notes
BS 7671: *Requirements for electrical installations. IEE Wiring Regulations. Sixteenth edition*	Regular inspection of fixed electrical installations	Health and safety	Inspection report signed by a competent person	
BS 5266: *Emergency lighting*	Regular inspection and testing	Confidence in system operation	Inspection certificate signed by a competent person	Certificate format in BS 5266 and SLL Lighting Guide LG12
BS 5839: *Fire detection and alarm systems*	Regular inspection and testing	Confidence in system operation	Inspection certificate signed by a competent person	
BS 6651: *Lightning protection*	Regular inspection and testing	Confidence in system operation	Inspection certificate signed by competent person	
Water quality	Prevent risk of *legionellae* bacteria	Inspection and test regime in place	Regime managed and records in place	See CIBSE TM13

Table 6:
Summary of compliance requirements for some non-statutory guidelines

(*c*) Water quality inspections

Water quality inspections are based around the need to prevent any risk from *legionellae* bacteria. There is considerable guidance available such as HSE Approved Code of Practice L8: *The control of legionella bacteria in water systems*, CIBSE TM13: *Minimising the risk of Legionnaires' disease* and BSRIA AG 20/00: *Guide to legionellosis — risk assessment* explaining the requirements. One important aspect, again, is the need to demonstrate that the inspection and testing regime is properly managed and the results are being recorded and acted upon.

(*d*) Lifts and lifting equipment

The need for in-service inspection of lifts and escalators is essential and property owners and operators need to understand the difference between inspection and maintenance. Maintenance is the ongoing servicing (i.e. lubrication, cleaning and adjustment) whereas an inspection is similar to a motor vehicle's 'MOT' test, providing a 'fitness for purpose' certificate for a defined period into the future.

A person carrying out a lift inspection should possess such theoretical and practical abilities as to be able to identify defects and assess their importance. In general, in the UK, independent bodies of inspection engineers or insurance companies carry out inspections. The requirements for competence are described in the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER).

The Safety Assessment Federation Ltd (SAFed) introduced its *Guidelines for the thorough examination and testing of lifts* in 1998. These have superseded the Health and Safety Executive document PM7.

Table 7:
Examples of lifting equipment requiring regular examination

Item	Examination frequency / months
Passenger hoist/lift	6
Goods only hoist	12
Passenger/goods hoist/lift	6
Service lift	12
Home lift	12
Stair lift	6
Scissor lift	6
Patient lift	6
Blocks, ropes, pulleys, hoists etc.	6
Teagle lift	12
Fork lift truck (and attachments)	6
Cradle	6
Safety belts	6
Eyebolts	6
Lifting beams/frames	6
Suspended access equipment	6
Winches/capstans	12

Competent persons

A 'competent person' is one who, by virtue of training and experience, can perform specified tasks satisfactorily and safely.

LOLER requires the planning, supervision and execution of lifting operations to ensure safety, the safe use of lifting plant, and periodic thorough examination by competent persons. The insurance companies recognised the value of guidance on inspection frequencies and provided indicative information shown in Table 7.

(e) The Provision and Use of Work Equipment Regulations 1998

These regulations require the nature and degree of risk associated with equipment and its use, and the means available to reduce those risks, to be identified by a competent person. Again, the insurance companies have provided recommendations (see CIBSE *Guide to ownership, operation and maintenance of building services*, Appendix 7, Table 1). Equipment owners and operators are required to determine the frequency of inspection.

(f) Ventilation duct hygiene

HSC Approved Code of Practice L24: *Workplace health, safety and welfare* states that: 'Mechanical systems (including air conditioning systems) should be regularly and properly cleaned, tested and maintained to ensure they are kept clean and free from anything that might contaminate the air.' This has applied to all workplaces since 1996.

Guidance is available in HVCA DW/TM2: *Guide to Good Practice — Internal cleanliness of new ductwork installations* and CIBSE TM26: *Hygienic maintenance of office ventilation systems*. BSRIA has summarised reference sources and other guidance in BSRIA TN 18/92: *Ventilation system hygiene — a review*. Ductwork is also covered by the HVCA's *Standard maintenance specification for mechanical services in buildings*.

There are several recognised techniques for cleaning ductwork that are described in the above publications and are likely to be used by specialist duct cleaners to address particular situations.

(g) Competency of staff

Building services maintenance is possibly one of the most regulated areas of work. There are many regulating authorities with which 'quality' service providers need to be registered to demonstrate their capability to carry out their work. Clients of these service providers, whether using direct employees or contracting in the service, need to be aware of the importance of using trained and competent staff. If there has been an accident or dangerous occurrence, responsibility rests on the client and his/her professional team, to demonstrate that they have complied with their legal duties.

A competent person is one who, by virtue of training and experience, can perform specified tasks satisfactorily and safely.

Examples of regulating authorities are:

— Council of Registered Gas Installers (CORGI): CORGI registration demonstrates competency for work on gas installations. CORGI certification is provided to employers who register individual employees. The employee carries an identification card showing expiry date and classes of work able to be undertaken. Each employer has to apply for registration; employees do not transfer their registration to a new employer.

— National Inspection Council for Electrical Installation Contracting (NICEIC): the NICEIC is an auditing body for electrical contractors. The NICEIC does not certificate individuals. This is based on the requirements of the Electricity at Work Regulations 1989, under which employers must only employ competent persons to work on electrical installations.

— Heating and Ventilating Contractors' Association (HVCA): the HVCA has agreed with its members to institute a 'Quality Contractor' scheme, under which each participating company is audited every three years by an independent specialist monitoring organisation (e.g. BM TRADA) to check compliance with the scheme. This includes demonstrating that competent and trained staff are employed. This scheme became fully operational in mid-2003 and is intended to reduce the number of unprofessional contractors in the industry.

— Quality Mark: this is a DTI initiative introduced throughout the UK for domestic clients. Contractors wishing to be included are audited annually by an independent auditor (BM TRADA) and have to demonstrate compliance with criteria such as trained and competent staff. This initiative is also aimed at removing 'cowboy' installers. Following a review of the original scheme, a new approach, provisionally called building trades 'Quality Scheme' self-certification competent person scheme, is being encouraged by DTI and ODPM.

Facilities managers need to be fully conversant with the requirements and legislation relating to staff competency. It is important to ensure that contractors or directly employed staff are fully trained and competent to undertake the work, not only to ensure that the installation is safe for the users but also that the employees are fully aware of the need for safe systems of work to protect themselves from possible danger. Examples of applicable legislation are the Health and Safety at Work Act and the Control of Substances Hazardous to Health Regulations 2002 (COSHH).

Demonstrating competency

Facilities managers need to be fully conversant with the requirements and legislation relating to staff competency, and need to be able to demonstrate that the levels of training and competence are adequate for the work being undertaken.

Clients also need to be aware of the environmental implications of work they undertake, particularly concerning the disposal of waste. They should also be aware of the implications of the Working Time Directive, since maintenance work, particularly arising from sudden and unexpected plant failures, can mean operatives are required to work long hours to return plant to normal operation.

Sources of maintenance guidance

The principal source of maintenance and operation information for a particular building should be the operating and maintenance (O&M) manual and 'hands on' equipment training provided at initial handover and following subsequent alterations and refurbishments. Information on the content of O&M manuals is available in BSRIA AG 1/87.1: *Operating and maintenance manuals for building services installations* and BSRIA BG 2/04: *Computer-based operating and maintenance manuals*. Other sources of information are given in Table 8.

Table 8:
Other sources of guidance on maintenance

Organisation	Publication(s)	Summary
CIBSE	*Guide to ownership, operation and maintenance of building services*	Identifies good practice in building services maintenance, covering aspects needing to be addressed by designers, installers, maintainers and building operators
	Commissioning Codes	Industry standards on requirements for commissioning building services installations
	TM31: *Building log book toolkit*	Explains purpose and content of building log books
BSRIA	*Toolkit for building operation audits*	Objective means of auditing maintenance providers to check processes, identify deviations and implement improvements
	Commissioning Application Guides	Procedures, reporting information and documentation for major building services systems
	Specification FMS 8	Specification for the procurement of building services operation and maintenance
HVCA	SFG 20: *Standard Maintenance Specification for Mechanical Services in Buildings*	Detailed inspection and testing requirements for most building services plant and equipment
Fire Protection Association	*Electricity at Work Regulations 1989 — Compliance for firms without electrical staff*	Information on compliance for firms without electrically qualified staff
Health and Safety Executive	HS(G)38: *Lighting at work*	
Institute of Refrigeration	Code of Practice	Minimising refrigeration emissions from refrigeration systems
NHS Estates	Concode: *Guide to building,engineering and grounds maintenance contracts for the NHS estate*	

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Institute of Refrigeration	Code of Practice	Minimising refrigeration emissions from refrigeration systems
NHS Estates	Concode: *Guide to building,engineering and grounds maintenance contracts for the NHS estate*	

Addresses of organisations

Chartered Institution of Building Services Engineers (CIBSE)
222 Balham High Road
London
SW12 9BS
Tel: 020 8675 5211
Website: www.cibse.org

Society of Light and Lighting
222 Balham High Road
London
SW12 9BS
Tel: 020 8675 5211

Building Services Research and Information Association (BSRIA)
Old Bracknell Lane West
Bracknell
Berks RG12 7AH
Tel: 01344 426511
Website: www.bsria.co.uk

Heating and Ventilation Contractors' Association (HVCA)
ESCA House
34 Palace Court
Bayswater
London W2 4JG
Tel: 020 7727 9268
Website: www.hvca.org.uk

Royal Institution of Chartered Surveyors (RICS)
Surveyor Court
Westwood Business Park
Coventry CV4 8JE
Tel: 020 7222 7000
Website: www.rics.org.uk

British Institute of Facilities Management (BIFM)
67 High Street
Saffron Walden
Essex CB10 1AA
Tel: 01799 508604
Website: www.bifm.org.uk

Appendix A1: Air conditioning system types

Table A1.1, based on information in BSRIA's *Illustrated guide to mechanical building services* and gives an overview of air conditioning systems.

System type	Control	Noise level	Air distribution	Energy efficiency	CO_2 emissions / (kg/m^2 p.a.)	Maintenance cost
Constant volume (CV)	Good but limited	Low	Very good	Good to average	No data	Low to average
Variable air volume (VAV)	Good but complex	Low	Very good	Very good	40*	Average to high
Fan coil units	Good	Can be high	Fair to good	Average	50	High
Chilled beams	Good	None	See note below	Very good	No data	Low to average
Chilled ceiling	Good	None	See note below	Very good	No data	Low
Displacement ventilation	Good	Very low or none	Good	Very good	No data	Average
Room-based heat pumps	Very good	Can be high	Good	Very good	No data	Average to high
Split systems	Local only	High	Poor	Poor	75	Average to high
Variable refrigerant flow (VRF)	Good	Can be high	Fair	Fair	50	Average to high

* Based on a system using a variable speed fan

Note: Difficult to categorise because influenced by ventilation system installed

Table A1.1:
Overview of air conditioning systems

Appendix A2: Maintenance audit check sheet

The following check sheet is based on Appendix 15.A1 of CIBSE's *Guide to ownership, operation and maintenance of building services*, and is intended to assist in auditing the performance of maintenance contractors.

Maintenance audit check sheet

Client name:

Client address:

Contract type:

Contractor name:

Contract start date:

Assessment date:

Assessor name:

Aspect	Criterion	Score (1 = poor; 9 = excellent)	Comments
1A: Management	Relationship with client		
1B: Management	Contractor's staff		
2: Maintenance service	Planned preventative maintenance (PPM); service quality; complaints procedure; planning		
3 Communication	Clarity; quality of advice; response time		
4 Health and safety	General approach; knowledge; management		
5 Technical proficiency	PPM performance; records and reports; materials and spares; energy management		
6 Invoicing	Procedure; format; accuracy; timescale		

Bibliography

British Standards

BS 3811: 1993: *Glossary of terms used in terotechnology* (London: British Standards Institution) (1993)

BS 5266: 1999: *Emergency lighting* (6 Parts) (London: British Standards Institution) (1981–1999)

BS 5839: *Fire detection and alarm systems for buildings* (6 Parts) (London: British Standards Institution) (1988–2004)

BS 6651: 1999: *Code of practice for protection of structures against lightning* (London: British Standards Institution) (1999)

BS 7671: 2001: *Requirements for electrical installations. IEE Wiring Regulations. Sixteenth edition* (London: British Standards Institution) (2001)

CIBSE/SSL publications

Code for lighting (London: Society of Light and Lighting) (2004)

Emergency lighting Lighting Guide LG12 (London: Society of Light and Lighting) (2004)

Environmental design CIBSE Guide A (London: Chartered Institution of Building Services Engineers) (1999)

Fire engineering CIBSE Guide E (London: Chartered Institution of Building Services Engineers) (2003)

Guide to ownership, operation and maintenance of building services (London: Chartered Institution of Building Services Engineers) (2000)

Hygienic maintenance of office ventilation ductwork CIBSE TM26 (London: Chartered Institution of Building Services Engineers) (2000)

Lighting for offices Lighting Guide LG7 (London: Society of Light and Lighting) (2004)

Minimising the risk of Legionnaires' disease CIBSE TM13 (London: Chartered Institution of Building Services Engineers) (2002)

Ventilation and air conditioning CIBSE Guide B2 (London: Chartered Institution of Building Services Engineers) (2001)

BSRIA publications

Computer-based operating and maintenance manuals BSRIA BG 2/04 (Bracknell: Building Services Research and Information Association) (2004)

Guide to legionellosis — risk assessment BSRIA AG20/00 (Bracknell: Building Services Research and Information Association) (2000)

Illustrated guide to mechanical building services BSRIA AG 15/2002 (Bracknell: Building Services Research and Information Association) (2002)

Operating and maintenance manuals for building services installations BSRIA AG1/87.1 (Bracknell: Building Services Research and Information Association) (1990)

Toolkit for building operation audits BSRIA AG13/2000 (Bracknell: Building Services Research and Information Association) (2000)

Ventilation system hygiene — a review (8th edn.) (Bracknell: Building Services Research and Information Association) (1996)

Computer-based operating and maintenance manuals BSRIA BG2/04 (Bracknell: Building Services Research and Information Association) (2004)

HSE publications

A short guide to managing asbestos in premises HSE INDG 223 (London: Health and Safety Executive) (2002)

Fire safety in construction work — Guidance for clients, designers and those managing and carrying out construction work involving significant fire risks Health and Safety Guidance series HSG168 (London: HSE Books) (1997)

Legionnaires disease — The control of legionella bacteria in water systems — Approved code of practice and guidance Legislation series Health and Safety Commission L8 (London: HSE Books) (2001)

Maintaining portable and transportable electrical equipment HSG 107 (London: HSE Books) (1999)

Memorandum of guidance on the Electricity at Work Regulations 1989 HSE Health and Safety series HS(R)25 (London: Her Majesty's Stationery Office) (1998)

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