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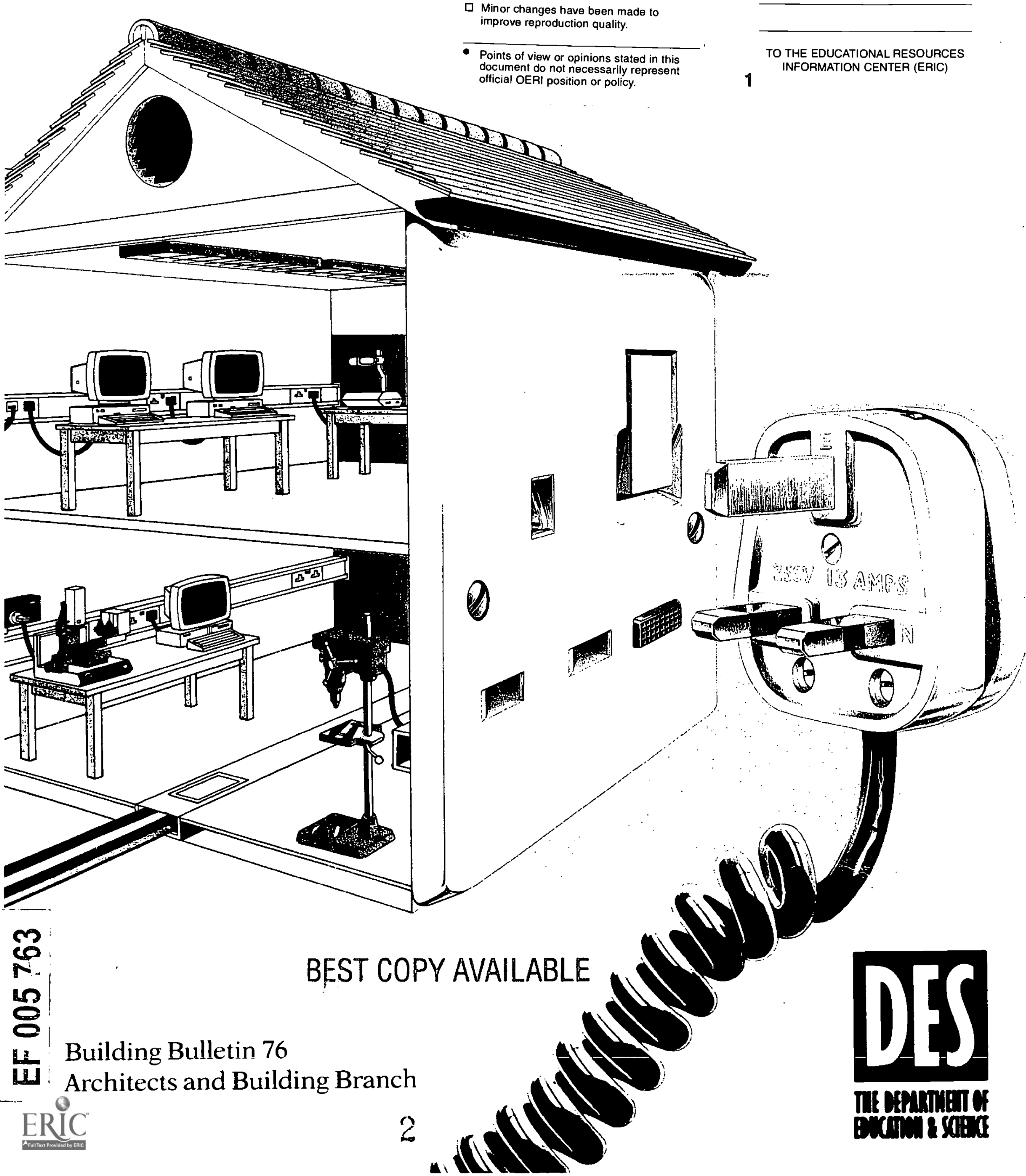
ABSTRACT

This document provides guidance on the overall electrical services and maintenance strategy in educational facilities, the individual components of which are considered in the following sections: record documentation and systems; inspection and testing; condition appraisal; maintenance requirements; and maintenance works procedures. Other sections include discussions on electrical requirements for particular uses, community use, spare capacity, and tasks for school staff. Many specific types of electrical services are considered and their planned maintenance requirements are dealt with in the appendices. (Contains 30 references, 19 figures, and 15 tables.) (GR)

Maintenance and Renewal in Educational Buildings

Maintenance of Electrical Services



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Building Bulletin 76

Maintenance and Renewal in Educational Buildings

Maintenance of Electrical Services

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Thanks are also due to local education authorities (LEAs) that provided details of their maintenance operations and experiences. The Department would also like to thank the Society of Chief Electrical and Mechanical Engineers in local government (SCEME) for their invaluable help during the production of this Bulletin.

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Summary

KEY POINTS

- doing nothing will not ensure safety
- maintaining electrical services is expensive
- planning is required
- a maintenance strategy should be developed

Electricity can be highly dangerous if installations are not designed, installed, used and maintained correctly; consequently there are a number of regulations and much guidance from professional bodies on these aspects. With regard to the maintenance of electrical services the regulations require that 'adequate' maintenance is carried out and, for certain works, that it is recorded.

The reasons for maintenance of electrical services are the same as for any other aspect of property maintenance in the education sector, and are:

- to ensure the health and safety of the occupants
- to prevent further expense/costly damage
- for maintenance other than health and safety, such as energy efficiency
- to provide appropriate facilities for education.

Doing nothing and waiting until a failure has occurred will not ensure safety and will not meet the requirements of the law or published guidance. To comply with these, certain maintenance work must be planned and its actioning recorded. Safety must be given the highest priority.

This Bulletin is intended for LEAs, governing bodies, head teachers, teachers and others involved in electrical services in schools and colleges. It will also be useful to consultants or contractors employed where an LEA does not have a central technical services capability. For grant-maintained establishments, City Technology Colleges and, increasingly, establishments operating under Local Management of Schools (LMS), the responsibility for ensuring adequate maintenance rests with the governing body.

Appendix A gives guidance to governing bodies on these responsibilities. For schools operating under LMS, the division of responsibilities between the LEA and the governing body will be as set out in the authority's approved LMS scheme. Arrangements will be necessary to monitor the maintenance programme to ensure that it is carried out safely and to the appropriate standards.

Maintaining electrical services is an expensive business; it is estimated that approximately £58 million was spent in 1990/91 on installations in public sector schools and colleges.

It is clear that planning is required if adequate maintenance, often at considerable expense, is to be carried out. However, research carried out for the preparation of this Bulletin showed that unplanned (reactive) work is more common than planned maintenance. In some instances this lack of planning may be considered to be at variance with the law or with guidance; in many cases it will not result in the most efficient, economic use of resources.

In order to meet the need for works and for financial provision to be determined and controlled, a maintenance strategy should be developed to establish the maintenance requirement and to strike an appropriate balance between planned and unplanned work.

The DES have already published information on the economic life of components, repair-or-replace decisions, life-cycle costings and the analysis of condition appraisals, in *Building Bulletin 70*[1]. Information pertinent to electrical services is given in the relevant sections of this Bulletin, which builds on the advice given in *Building Bulletin 70*.

Guidance is given on the overall electrical services maintenance strategy, the

individual components of which are then considered in sections such as:

- Record documentation and systems
- Inspection and testing
- Condition appraisal
- Maintenance requirements
- Maintenance works procedures.

Other sections deal briefly with topics such as electrical requirements for particular uses, energy, community use, spare capacity and tasks for school staff.

Many specific types of electrical service have been considered and their planned maintenance requirements are dealt with in the appendices.

1 Introduction

KEY POINTS

- recent electrical maintenance in education has cost £58 million p.a.
- common standards across an estate are desirable
- reasons for maintenance: safety, damage limitation, energy efficiency, appropriate facilities
- responsibilities for maintenance should be understood

Maintenance is expensive. The most recent figures from the Society of Chief Architects of Local Authorities (SCALA) on maintenance expenditure for 1990[2] show that £7.82 per m^2 per annum is the average cost of all maintenance in public sector educational premises and approximately 30% of that figure is the combined cost of mechanical and electrical maintenance. Figures are not available in sufficient detail to differentiate between mechanical and electrical work but it is believed that approximately £58 million per annum is spent on electrical maintenance in educational establishments[3].

A strategy for the maintenance of electrical systems must have safety as the first priority in order to comply with the law. A number of regulations relate to the safe use of electricity in buildings and a wealth of guidance is produced by professional bodies, such as the Institution of Electrical Engineers (IEE), and Government Departments, such as the Health and Safety Executive (HSE) and the Health and Safety Commission (HSC). In April 1990 a number of outdated statutes were replaced by the Electricity at Work Regulations 1989[4]. These regulations make a number of absolute requirements with regard to what work must be done, how it is to be performed and by whom, although they include very few exact technical requirements.

The same standards should be applied across the whole of each site and estate, for both existing and new facilities. If an existing facility is considered unsafe, adequate steps must be taken to rectify the situation immediately. This may mean curtailing the use of a facility until it is brought up to standard.

The major routine maintenance requirements of electrical installations are inspection and testing of the equipment etc to ensure that it is safe to operate. The nature of the materials used and the well-documented design and installation procedures produce systems that inherently have a long life, their limiting factors being capacity and lack of flexibility. To take full advantage of this longevity it is essential that maintenance is planned and recorded.

In cases of vandalism maintenance will obviously be necessary. Every opportunity should be taken to reduce risk of damage through planned maintenance, by the selection of appropriate materials and installation methods.

The need to replace equipment often results from the obsolescence of existing equipment, caused not only through age but also change in manufacturers' ranges when it might not be possible to obtain replacements, and because of revisions to regulations or standards.

There is an increasing use of the electrical systems for teaching purposes. Designers of original installations could not have envisaged the current growth in the use of electricity in educational establishments; consequently a high proportion of future maintenance work will be involved in the modification of electrical installations to provide for current and future teaching needs.

The introduction of LMS, with the LEA assuming a formalised role of landlord, requires adequate arrangements to ensure that acceptable standards are maintained, particularly in the maintenance of records of systems, with responsibilities clearly defined and agreed. The exact allocation of responsibilities will be as set out in the authority's approved LMS scheme. The school's responsibilities will probably accord with the division as set out in Annex A of DES Circular 7/88[5] as a minimum.

The governing body may consider asking parents (for example through Parent Teacher Associations – PTAs) or others to volunteer to carry out expansion or improvement of the electrical installations. This is acceptable in principle, provided that the choice of persons who do the work, the method of doing the work and the final results comply with the law. This will mean only qualified persons may design and carry out the work, i.e. electrical engineers to design and electricians to carry out the work, using suitable materials throughout. They must carry sufficient insurance cover for third party liability whilst carrying out the work and provide 'as-fitted' drawings, records and test certificates on completion of the work. They must also recognise their responsibility for professional liability for the life of the installation. A governing body could be held liable for an incident arising from a substandard installation which had been designed or installed by unqualified personnel. Subsequent maintenance of the work must also be ensured, through negotiation with those responsible. DIY electrical work in schools has in the past produced significant safety hazards because some of the work was carried out by persons without knowledge of, and attention to, the codes of practice and the law, and no records were kept of the work done.

Governing bodies and head teachers will find the summary and Sections 1–3, 8, 13 and Appendix A of this Bulletin of particular interest, and other sections and appendices when dealing with specific aspects. Engineers, architects and those designing and specifying works in schools will find the technical appendices useful together with the practical guidance given in the main text.

Current practice and expenditure

K E Y   P O I N T S

- **most maintenance is reactive and unplanned and therefore not cost-effective**
- **breakdown cannot be prevented completely**

A full analysis was not possible in the preparation of this Bulletin, but the small sample of buildings considered revealed that reactive maintenance is far more prevalent than planned and preventive maintenance; accurate planning, budgeting and control are therefore not attainable in these cases and the targets suggested in *Design Note 40*[6] are not being achieved.

The reliance on maintenance which is largely a response to breakdowns implies that in some cases only manipulation of budgets, and the implementation of unplanned work near the end of the financial year, ensures that actual expenditure and planned budgets correlate. This does not mean that either the budget or the workload should be totally inflexible; however, reacting to circumstances as they arise does seem a poor way of reconciling the forecast with the outcome. It is also recognised that breakdowns cannot be entirely prevented, hence the need for flexibility.

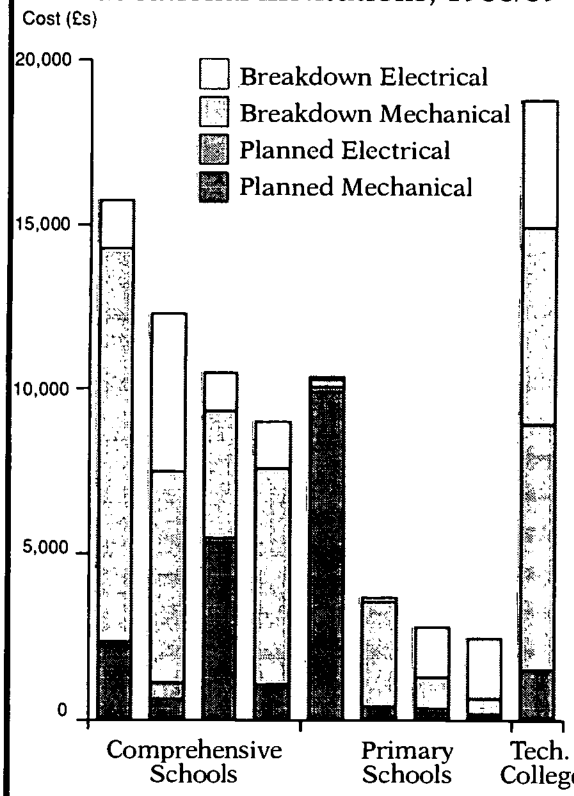
From research carried out in the preparation of this Bulletin, it is apparent that many responsible for maintenance are unable to differentiate between planned and unplanned work in their previous maintenance expenditure, or between mechanical and electrical work; nor could the cost of labour and materials, on-costs or profits be derived for future estimating purposes.

There is still a high reliance on the intrinsic knowledge of a small number of specialist surveyors (building and engineering). This knowledge is extremely valuable but without systematic records it is easily lost, as over time these specialists move on.

The use of computers in maintenance planning appears to be minimal. Consequently accurate maintenance workload and budget planning and information on workloads and cost control for individual properties is expensive to obtain from manual records or is lost.

A few examples of maintenance expenditure are given in Figure 1, which is based on 1988/89 figures submitted for a random selection of four primary schools, four comprehensive schools and one technical college. The figure shows both planned and unplanned expenditure for mechanical and electrical work. Although no reliable extrapolation can be made from this small sample the generally low level of planned expenditure compared to unplanned (breakdown) expenditure is clear.

Figure 1
Mechanical and electrical maintenance expenditure in nine educational institutions, 1988/89



Planned work includes rewiring and major plant repairs. Breakdown is unforeseen work.

3 Strategy

KEY POINTS

- adequate maintenance is essential
- maintenance required will change over time
- planning of maintenance is essential
- the components of a strategy need analysis

Virtually all laws, regulations and published advice relating to electricity have the primary objective of promoting safety in the design, installation and use of electrical systems. Most, such as the Control of Substances Hazardous to Health (COSHH) regulations in respect of local exhaust ventilation and the associated controls, state their requirement for adequate maintenance and that the maintenance carried out is recorded.

The word 'safety' is defined in *BS 3811: 1986*[7] as the freedom from unacceptable risks of personal harm. Having designed and installed electrical services for initial safety, the only way to ensure this continued freedom from unacceptable risks is by adequate inspection and maintenance. This is of particular relevance for children in two ways because of their small size: the effect on them of electric shock is proportionately greater and they can gain access to services that are normally inaccessible to adults.

What constitutes 'adequate' maintenance, the maintenance requirement – what has to be done and how often – can be determined only by a competent person. For many items it will be essential for these factors to be planned.

The maintenance requirement determined at design and specification stages will not necessarily be the same as that required at some later time during the life of the installation. Indeed no fixed period can be defined for the life of an installation, as many unknown factors will influence it, including degree of usage, quality of materials and their life span. Consequently it is necessary to inspect and test electrical services and carry out condition appraisals to assess maintenance needs and determine priorities.

Doing nothing and waiting until a failure has occurred before remedial action is taken will not meet the requirements of the law, regulations or published guidance. Dangerous conditions may arise, catastrophic and costly damage may occur and serious loss of service or facilities may result. There are very few cases where a breakdown policy will suffice, let alone be the best approach; however, in some instances planned maintenance is inappropriate; for example for replacement of tungsten filament lamps (light bulbs) which would be replaced after failure (breakdown).

Whether or not planned maintenance is a requirement from a technical viewpoint, cost efficiency must be considered. Much unplanned work is relatively inexpensive yet the administrative costs of issuing an order and eventual payment are not significantly less than for expensive work. In fact the issue of many small orders for frequent unplanned work represents much lower value for money than one large order for planned maintenance. Planned maintenance should obviate the need for ad hoc works in any case. The ideal case would be no unplanned expenditure; however, this can never be achieved.

By investment in planned maintenance, the value of the asset can be maintained rather than allowing it to deteriorate to such a state that it becomes unfit or unusable. (In this context the value is in its continuing use to perform a function rather than a financial gain.) Often, where there has been under-funding of maintenance, the asset has fallen into a condition where costly repairs are necessary and the premises have to be shut down while the remedial work is carried out.

When planning maintenance, flexibility and spare capacity can be incorporated which is unlikely to be the case for unplanned, reactive maintenance. Thus it may be possible to accommodate to some extent educational requirements, requirements for community use, energy conservation works, etc in the course of routine maintenance.

Works need to be carried out in such a manner as to ensure the safety of both the operative carrying out the task and everyone else who may be associated with the works and their effects. Hence safe, efficient and cost-effective works procedures are essential.

Many authorities choose to deal with energy consumption, energy saving measures, maintenance, refurbishment and the provision of new buildings by having separate management structures and cost centres dealing with each. It is difficult to co-ordinate and plan expenditure if each department has different objectives and working methods. In order to ensure adequate and cost-effective action from all viewpoints, it is essential to have a coherent maintenance strategy, clearly understood and accommodating the objectives of all where possible.

Hence a strategy for maintenance of electrical services must be established which addresses the matters considered above and includes:

- Record Documentation and Systems
- Inspection and Testing
- Condition Appraisal
- Maintenance Requirements
- Works Procedures
- Educational Requirements
- Energy
- Community Use
- Flexibility and Spare Capacity.

Each of these aspects is considered in greater detail in the following sections.

4 Record documentation and systems

KEY POINTS

- some legislation requires work to be recorded
- records substantiate that maintenance has been done
- records allow planning of work and finance
- technical records aid maintenance works

Various statutes, including the Health and Safety at Work Act, require that plant and equipment are maintained in a safe condition. All the safety regulations and advice advocate some system of records. Some legislation including the Electricity at Work Act requires that work done is recorded.

Records are required if for no other reason than as a possible way of demonstrating, in the event of an incident, that all reasonable maintenance has been done. Records are the first thing that authorities investigating incidents or reviewing procedures look for.

However, records have a more useful purpose than this defensive one: they are a useful tool in facilitating planned maintenance, in determining work required, programming, monitoring that work was done, its cost and effectiveness. By providing installation detail and historical data, records can also assist in future inspection and testing, and in fault-finding and repair.

Where a single body is responsible for maintenance such as the governing body of a grant-maintained school, a single set of records kept at the school may suffice. However, when responsibilities for maintenance of electrical services in an establishment are divided, a clearly understood system of documentation is required showing the actions each party should take and the results of that action to ensure that installations are fully maintained. In this latter case all parties should keep records.

Records kept on site should be in sufficient detail for anybody coming to the site to undertake work to be able to form a clear picture of the condition of the installation, and any pertinent points that may affect the safety of any work being contemplated. This is especially important for minor works, where drawings, circuit cards and other records should be amended on completion of the work. Unfortunately, in many cases there are no drawings or circuit cards, or else they are inaccurate. New buildings or those having recently undergone extensive maintenance works like a re-wiring usually have adequate, up-to-date records.

One of the problems facing anyone attempting to justify expenditure on planned maintenance can be a lack of records. Those responsible for maintenance should have available records of historical expenditure (planned and unplanned) for any particular heading, in sufficient detail to allow the costs of labour, materials and contractors' overheads/profits to be easily derived.

For any planned approach to maintenance, records must be kept to allow a history of the installations to be built up, so that future work can be planned. A major part of the quality analysis of contractors' performance is an objective measure of cost-effectiveness. For this to be done, records are needed from which performance indicators can be produced. These would help pin-point areas of work or equipment that have become costly to maintain or where redesign is necessary. There are many possible details for inclusion, but Table 1 lists essential minimum details that should be recorded for each establishment.

Record systems should be of a type that is easy to update. They should also make possible easy monitoring of trends in the condition of installations. Without a system, record documents quickly become obsolete and of little use. This is particularly important where they concern circuit details and drawings, often a problem area, especially when small

Table 1
Minimum requirements for an equipment record

Manufacturer's details and name plate details of any equipment

Manufacturer's maintenance recommendations

Manufacturer's spare parts list

Details of fuse link ratings and relay settings

Drawings giving 'as-fitted' details and design data such as circuit and conductor size

History of what work has been carried out and what faults have occurred

Condition assessments

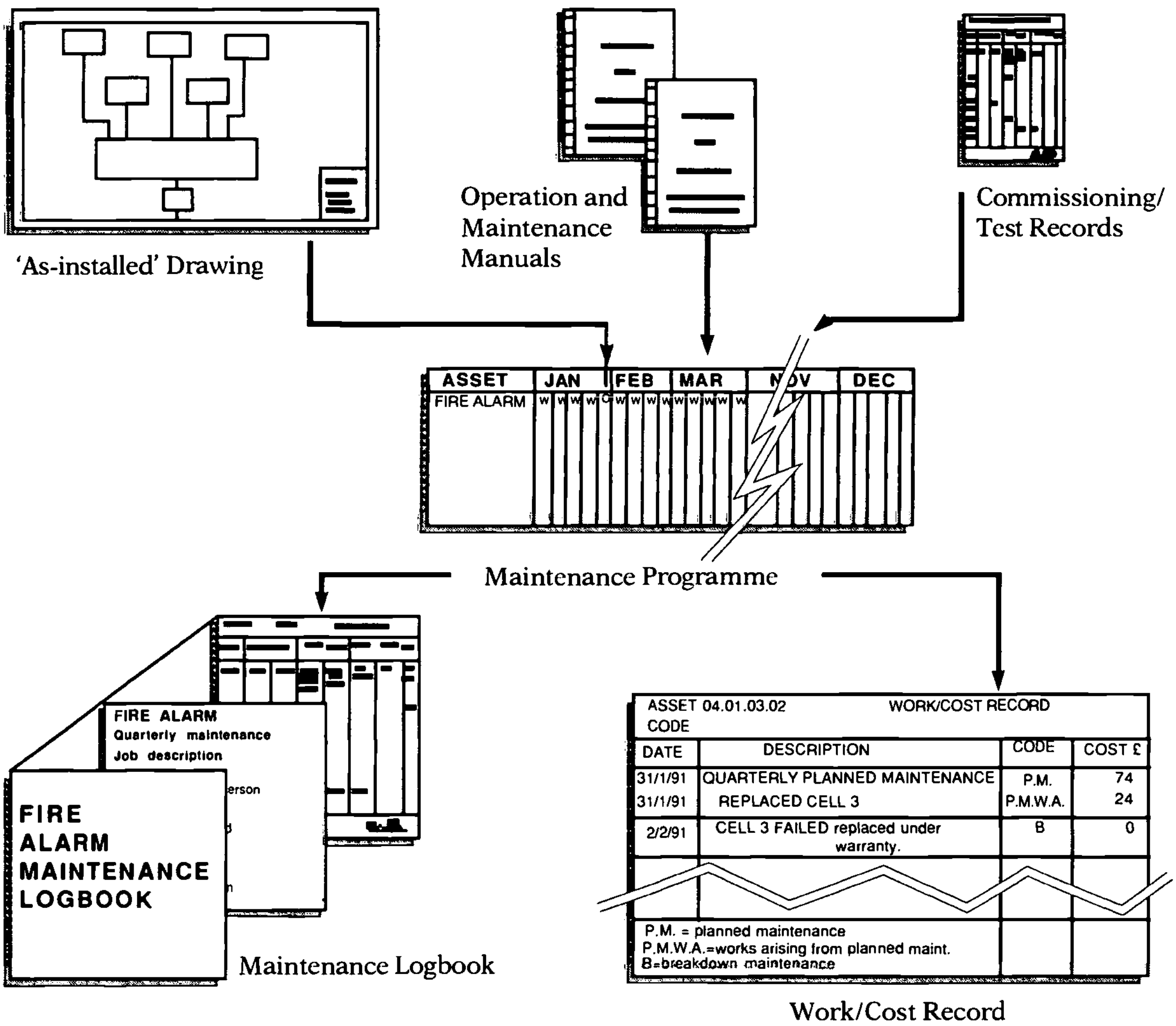
improvements are undertaken or DIY work is carried out by a PTA. Unless proper records are kept, maintenance will become a larger problem.

The record system thus allows the planning and implementation of maintenance, storing of information on maintenance carried out, and monitoring of the information to determine subsequent action.

Records will typically include:

- Hand-over Documentation: Operation and Maintenance Manuals
- The Asset Register
- The Planned Maintenance Programme
- Maintenance works carried out
- Maintenance expenditure itemised by asset
- Operation and maintenance manuals.

Figure 2
Maintenance records



The record system should be built around the Operation and Maintenance Manual(s) which are more fully described in *Building Bulletin 70*[1]. For existing installations where such manuals do not exist it is recommended that a programme to prepare them be instigated.

These manuals contain full details of what each service comprises including 'as-installed' drawings, the results of initial inspection, testing and commissioning of the service, device ratings and settings, the planned maintenance necessary to sustain the service safely, and the frequency of such maintenance.

Experience shows that many contractors are reluctant to provide these manuals, or that when they do the documents are of dubious quality. Many organisations are now employing third party specialist organisations to prepare these documents.

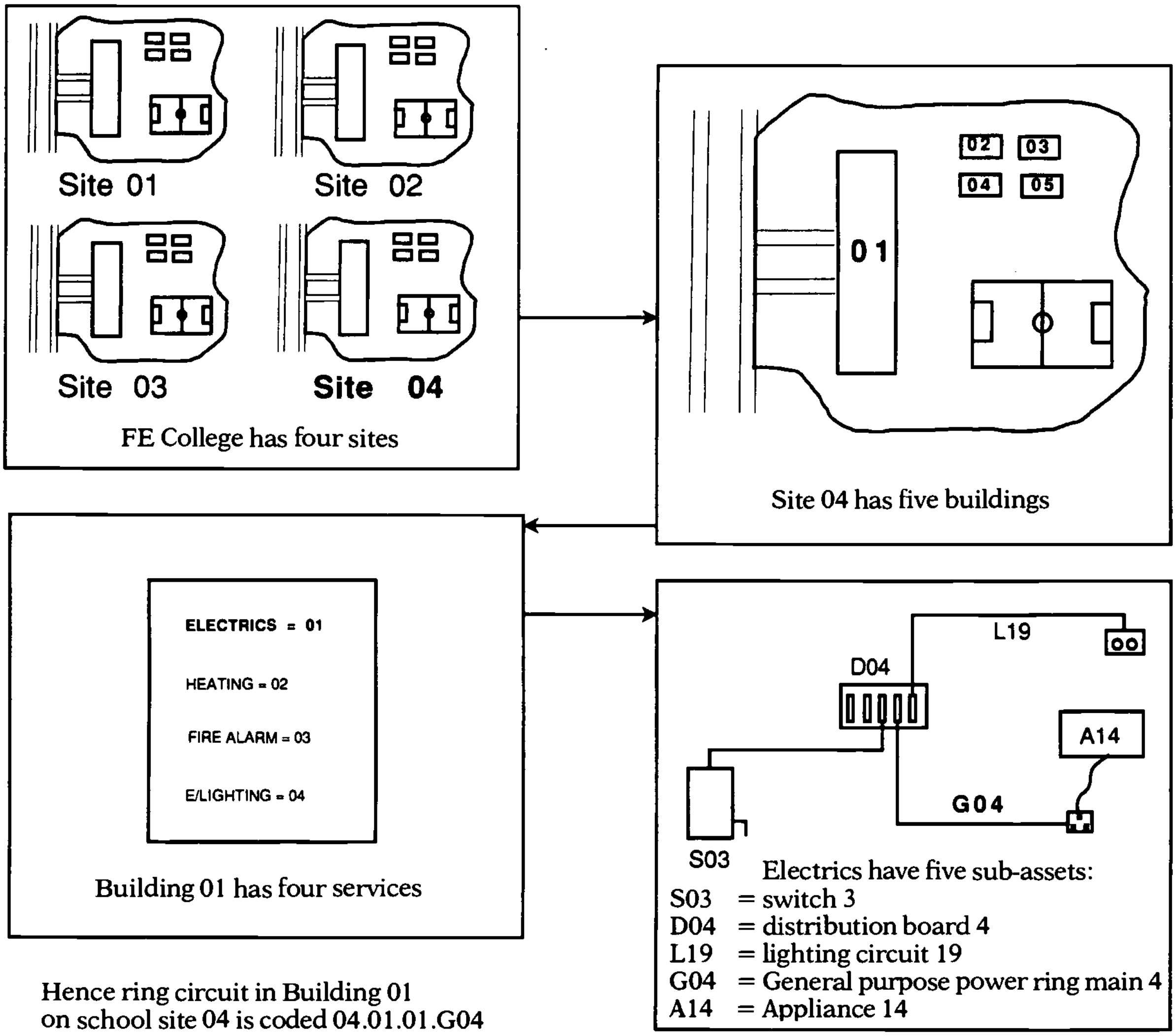
Asset Register

From the operation and maintenance manual, or from a survey of existing installations, an Asset Register is prepared which records all the assets, or component parts, of the various electrical services together with the particular details of each, such as make, model, serial number, specialist maintenance contractor, etc.

Each component part of a service which will require maintenance should be identified as a separate asset or sub-asset. To assist in future identification for storing, retrieving and analysis of information, each asset and sub-asset is given a unique reference number (asset code).

When setting up the system it may be useful to include in the asset coding an

Figure 3
An example of Asset Coding



element to identify the person responsible for maintenance costs. For example maintenance of the fixed electrical installation may be the responsibility of the LEA, whereas a particular appliance may fall to another department or the establishment itself.

For a small establishment, in a single building where each individual electrical service is of the same age, type, etc the asset coding philosophy may need to include only references to the service and item.

For larger properties with many buildings, each with installations of differing types, ages, etc it will be necessary to further divide the main assets (the services) into sub-assets for each building.

For registers covering many sites, such as those of further education colleges, it will be necessary to include identification of the site as well. The extent of subdivision will depend on the complexity of services on the site.

Asset coding principles should be as simple as possible whilst containing all necessary information; unwieldy codes are difficult to use. Figure 3 gives an example of coding.

Planned maintenance programme

On the basis of the information contained in the operation and maintenance manual a programme can be prepared, detailing when individual maintenance tasks for each asset need to be carried out together with job descriptions of the work involved in each task.

Where responsibilities for maintenance are divided it is recommended that an overall programme be prepared and agreed between the parties, clearly showing the division of responsibilities.

Maintenance works

This record will contain details of all planned action including the task, the date it was carried out, who carried it out and details of any other action shown to be necessary. For some tasks a test results sheet will also be needed.

This record will also contain details of all unplanned action necessitated by breakdown or failure. It should include the symptoms and succinct details of the remedial works carried out.

Expenditure

This record comprises an itemised record of all expenditure for each asset. In addition to facilitating financial control, this record will assist in future financial planning. Expenditure will need to identify planned or day-to-day expenditure.

Record methodology

Records can be kept manually with a card system containing:

- the Asset Register, maintenance work and expenditure records
- a wall chart detailing the maintenance programme
- a logbook (file/folder) containing task job descriptions and test result sheets.

Figure 4 illustrates such a system. For simple discrete records for a small school this type of system may suffice.

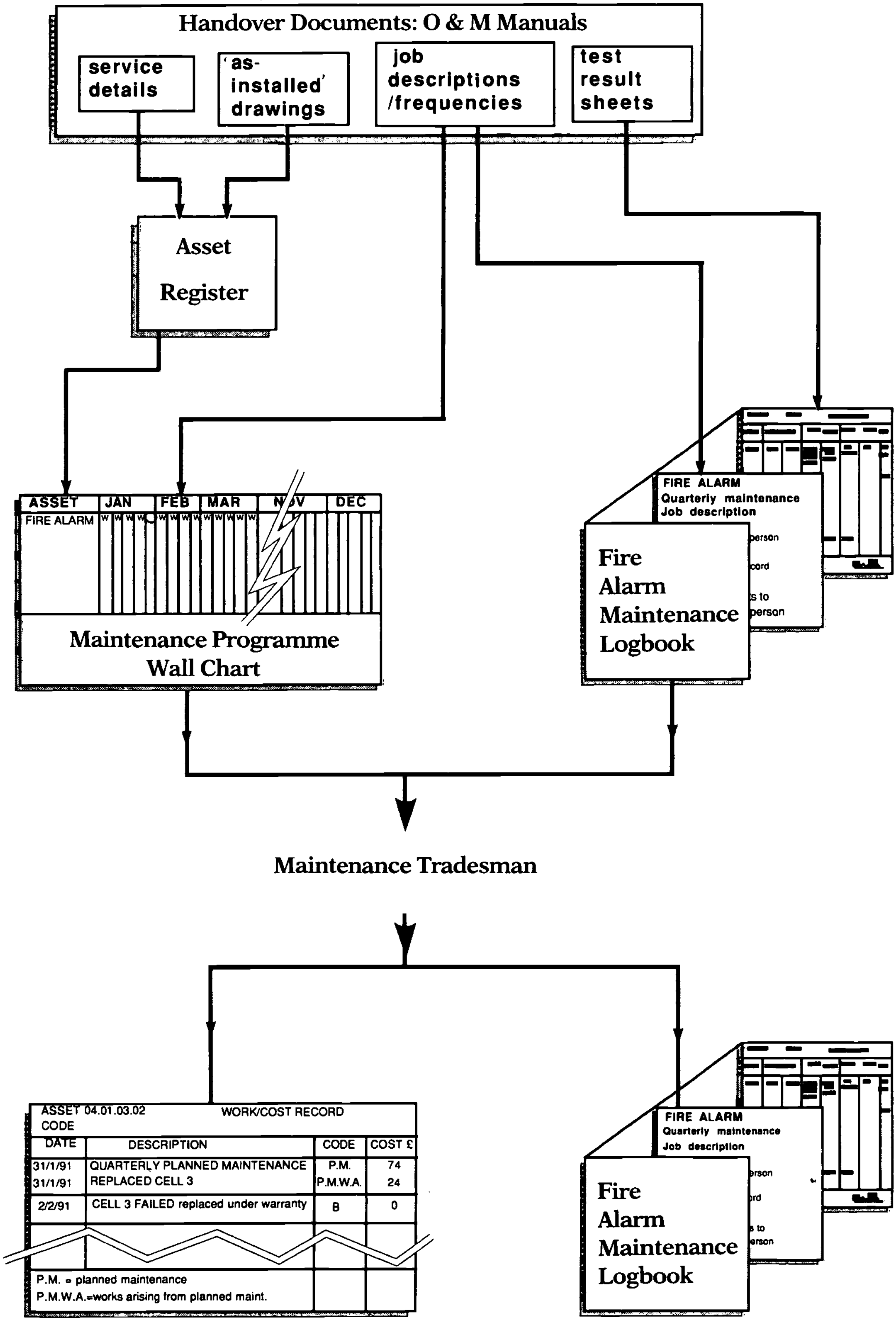
However, for larger and multiple site institutions it is likely that a computer-based system will be better suited. It allows analysis of all data contained in the system and can produce reports on criteria selected by the user, for example:

- all sites due for a particular planned maintenance task in a year
- all installations containing a particular component (if for instance a manufacturer has notified a defect)
- the number of disposable items required for planned maintenance in a year (such as 1800mm fluorescent lamps)
- sites where day-to-day expenditure was greater than 40% of total maintenance expenditure.

A combination of computer and manual systems might be the most suitable form of record:

- the computer to manage by keeping the Asset Register, generating the programme and recording the work done and costs
- a logbook (file) to contain job descriptions and test result sheets which may need to be taken to the job task location, to be used and completed by any contractor working on the system.

Figure 4
Maintenance record system



5 Inspection and testing

KEY POINTS

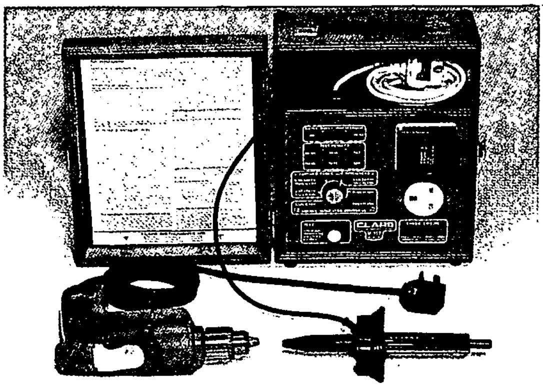
- all electrical services need to be monitored for deterioration
- inspection and testing are fundamental to electrical maintenance
- frequencies need to be determined by a competent person

Many electrical services comprise items which do not require regular routine attendance, e.g. cables, miniature circuit breakers, accessories, etc in the same way as is required for mechanical services such as boilers, pumps, etc. However, all electrical services require to be continually monitored on a regular basis to detect deterioration so that timely repair can be carried out and any need for replacement, of part or all, identified.

Consequently, monitoring is the fundamental and major part of the maintenance of electrical services. This is achieved by visual inspection and electrical testing.

Figure 5
Inspection and test equipment

a. Portable appliance tester
b. Earth electrode and lightning conductor test set
c. Residual current device tester
d. Insulation and continuity tester
e. Prospective short circuit current and earth fault loop impedance tester



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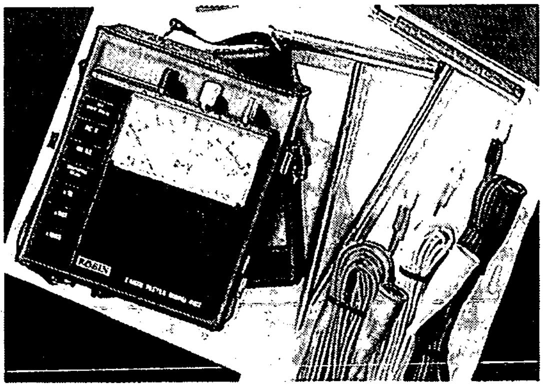

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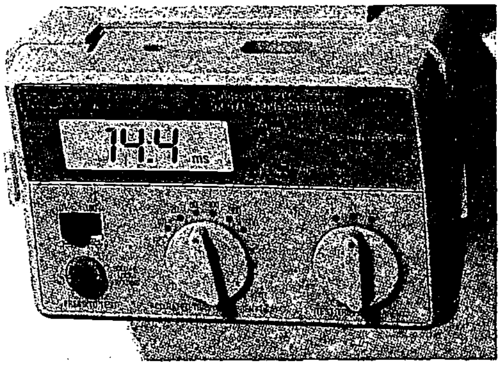

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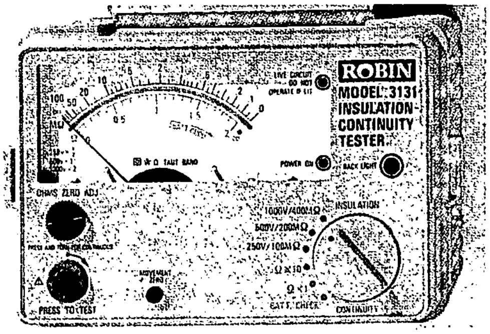

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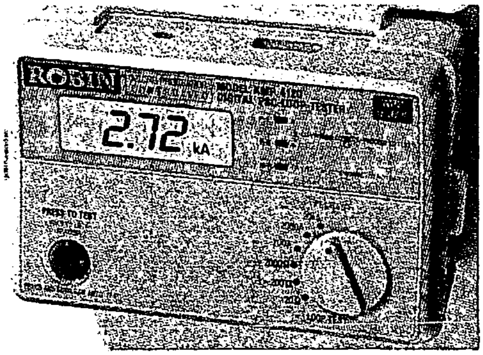


e

Because of the potential danger from electricity those responsible for maintenance will have inspection and testing regimes planned or in place; however, there is a need to explain why these regimes are necessary and how they can be continued where responsibilities are to be transferred or divided, for example to governors who might in turn allow parents to do some work on a voluntary basis.

With regard to the safety of electrical installations, a great deal depends on inspections, tests and keeping of records. The frequency of inspection and testing varies according to the usage and type of installation. Table 2 shows typical requirements. A competent person should determine how frequently inspection and testing are needed.

Parts of an electrical system will be concealed: for example, a luminaire may be perfectly operational and electrical tests indicate satisfactory values but the concealed wiring insulation on the control gear may be in a serious state of decay. It is not suggested that every luminaire is demounted for visual inspection from the ceiling but a representative sample must be. Similarly a representative sample of all concealed parts should be examined.

Records of inspections and tests should be entered in the log and incorporated in the record system as has been considered elsewhere. A typical test result sheet is shown in Figure 6.

Where the result of the inspection and/or test reveals a dangerous situation which is likely to produce a risk of injury, the equipment/installation must be immediately taken out of service.

Table 2
Inspections and tests

Frequency	Description
Weekly	Fire alarm functional test
Monthly	Emergency lighting functional test RCDs* functional test 'Stop' button systems test
every 3 months (and after every alteration)	Stage lighting comprising portable dimmer racks with no fixed cabling: test as for temporary installation by competent person Fire alarm: maintenance by competent person
every 4 months	Inspect portable appliances
every 6 months	Emergency lighting: 1 hour duration test Central systems: batteries and power supplies checked Lifts: thorough examination by competent person Intruder alarms: routine maintenance by installers
Annually	Fire detection and alarm systems: maintenance by competent person Emergency lighting, inspection and test (after 3 years) Stage lighting: inspection and test by competent person Lightning protection: inspection and test by specialist contractor Portable equipment: inspection and test by competent person Pottery kilns: inspection and test by competent person Swimming-pool installations: inspection and test by competent person.
every 3 years	Kitchens, laboratories, pottery, CDT, metal and woodworking areas: inspection and test by competent person Emergency lighting: inspection and test by competent person Electrical controls associated with mechanical plant: inspection and test by competent person
every 5 years (or more frequently as determined by competent person)	All other parts of electrical installation to be inspected and tested by competent person.

* Residual current devices.

Figure 6
Specimen inspection and test record with hypothetical condition assessment

PREMISES............ Any School..................................
..........................Any Road..................................
..........................Anyshire..................................
....

ELECTRICAL INSTALLATION INSPECTION/TEST RECORD

ASSET CODE.....01.06.02.D45..........
~~HRC/BS88~~/Type..2....MCB*
Isc at distribution board...3.1....kA

CIRCUIT NUMBER & PHASE	CIRCUIT OR FIXED APPLIANCE DESCRIPTION	LOWEST INSULATION RESISTANCE(MOHMS): BETWEEN CONDUCTORS STATE R-Y,R-B,B-Y or RYB-N		LOWEST INSULATION RESISTANCE(MOHMS): ALL CONDUCTORS TO EARTH STATE R,Y,B &N		EARTH ELECTRODE RESISTANCE (OHMS)	PROTECTIVE DEVICE: RATING (A)	PROTECTIVE DEVICE: Zs MAXIMUM (OHMS) +	PROTECTIVE DEVICE: Zs CALCULATED (OHMS)	PROTECTIVE DEVICE: Zs MEASURED (OHMS)	RESIDUAL CURRENT DEVICE: RATED TRIP CURRENT (MA)	RESIDUAL CURRENT DEVICE: MEASURED TRIP CURRENT (A)	RESIDUAL CURRENT DEVICE: RATED TRIP TIME (S)	RESIDUAL CURRENT DEVICE: MEASURED TRIP TIME (S)	RING CIRCUIT RESISTANCE (OHMS)	C.P.C. RESISTANCE (OHMS)	POLARITY (IF CORRECT)	CONDITION ASSESSMENT: SWITCHGEAR	CONDITION ASSESSMENT: CABLES	CONDITION ASSESSMENT: ACCESSORIES	CONDITION ASSESSMENT: APPLIANCE	CONDITION ASSESSMENT: EARTHING	CONDITION ASSESSMENT: £ COST TO CONDITION 4	REMARKS
1R	4 Luminaires, G11	RYB-N	>100	R-E	>100		5	6.8	1.17	1.21						0.33	✓		5	3	3	5	100	3 Switch plates cracked, 2 diffusers missing
1Y	6 Luminaires, G12	RYB-N	>100	Y-E	>100		5	6.8	1.24	1.29						0.37	✓		5	4	3	5	30	2 Diffusers broken
1B	4 Luminaires, G13	RYB-N	>100	R-E	>100		5	6.8	1.32	1.35						0.39	✓		5	4	3	5	10	3 x 1800mm tubes u/s
2R	Spare																							
2Y	Spare																							
2B	Spare																							
3R	4 Sockets, G11	RYB-N	>100	R-E	>100		30	1.1	0.57	0.59	30	25	40	26	0.31	0.4	✓		5	4		2	15	Earth bonding required to sink
3Y	6 Sockets, G12	RYB-N	>100	Y-E	>100		30	1.1	0.58	0.6	30	22	40	31	0.33	0.44	✓		5	3		3	20	Socket plate burnt
3B	4 Sockets, G13	RYB-N	>100	R-E	>100		30	1.1	0.6	1.0	30	23	40	32	0.36	0.47	✓		5	4		2	50	High Zs
4R	Spare																							
4Y	Spare																							
4B	Spare																							
															Total C.A. Actual				30	22	9	22		
															Total C.A. Possible				36	36	18	36		* delete as applicable
															% Cond. Assess				83	61	50	61		+ from tables 41A1 - A2

Sheet...1...of....1....
tested by.....A.N.Other (Qualified electrician).......
of....An electrical Company................................
witnessed by.....A competent person..................

6 Condition appraisal

KEY POINTS

- appraisal allows maintenance/ replacement to be planned
- systematic, uniform and objective methods should be adopted
- on-the-spot estimates are useful for financial planning

Condition appraisal requires some objective measure of the current condition of an asset. With electrical installations the assessment will be carried out by reference to two sets of information. The first is the results of inspection by a suitably qualified person of those parts of the installation that are accessible; it is the nature of electrical installations that much is hidden, either buried in walls and floors or installed within voids, and to maximise safety much of the installation is deliberately inaccessible. The second set of information is the results of tests designed and carried out to ascertain the electrical integrity of the system as a whole or in part.

This appraisal leads to a determination as to whether the asset, equipment or installation is fit for further service or requires some maintenance, either immediately to avoid danger and risk of injury, or at some time in the future. That future time may be in days, weeks or years. A decision whether to repair or replace an item of equipment or installation is a further process determined on practical and economic grounds.

Where no risk of injury exists it might still be economic to repair or replace equipment to prevent excessive maintenance costs in the future and forestall breakdown of equipment. Good records enable such decisions to be made objectively. Replacement might also provide an opportunity for the use of more energy efficient equipment. An investment appraisal of such decisions should always be made and entered on the records for future monitoring.

Reference is also made to *Building Bulletin 70*[1] and *Design Note 40*[6]. These explain more fully the basic theory, which is equally applicable to electrical systems.

Life of equipment and systems

It is not possible to give precise information on the length of life of components of electrical systems because of the vast diversity of equipment in any one of the broad categories discussed in this section. Manufacturers in the United Kingdom produce equipment generally in accordance with British Standards but it must be remembered that a BS sets only a minimum standard. Many items of equipment exceed these minimum standards but these are not necessarily more expensive than others; careful review of manufacturers' specifications should always be undertaken to determine best value for money.

A number of lists of equipment life are available; on the basis of these, and of additional information provided by manufacturers, the following summary has been prepared:

Table 3
Notional equipment life

Equipment	Years
Main switch gear	15–25
Main distribution wiring	25 +
Distribution boards	25 +
Final sub-circuits	25 +
Local isolators	15
Socket outlets	15
Lighting	10–15
Mechanical equipment controls	10
Energy management control systems	7–10
Alarm systems	5–10

There can be a considerable difference between the maximum life achievable and what is economically realistic. In many types of electrical equipment, the life is dependent on the number of operations it has undergone, both under normal load conditions and under fault conditions; it is thus inappropriate to assign a life in terms of time. The practical difficulty in determining the number of operations an item of equipment has undergone may be the reason that in many cases there is no maintenance plan and a policy of breakdown maintenance is pursued.

Condition assessment

Systematic, uniform and objective methods should be adopted for evaluating maintenance needs and determining priorities, on the basis of the assessed condition of the electrical services. The aim of the assessment is to provide information from which it should be possible to extract the data necessary to prepare the planned maintenance schedule for up to five years, together with management information for general budgeting and planning.

One of the main criteria for assessment of the equipment or system under consideration is a knowledge of how long it would take for any item of equipment to deteriorate to a condition which would either pose safety hazards or give rise to other types of trouble under normal conditions of use. It is therefore essential to monitor and record the condition of equipment continuously.

It is suggested that the assessment be carried out in conjunction with the routine inspection and test, by the competent person, and that the assessment is recorded on the composite sheet (see Figure 6). The information which is gathered must be as accurate as possible whilst at the same time giving the overall picture of each element; for example the hidden services must be examined, where possible, not merely given a superficial inspection. However, it should be noted that assessors will not take unnecessary risks.

Common standards in assessment of electrical services are essential. Varying standards will result in (widely) differing assessments of needs and result in inconsistency and confused priorities. Where more than one assessor is involved techniques should be employed to overcome this, such as regular meetings between assessors to discuss guidelines, particularly where a contractor acts as an assessor as part of the routine inspection and test.

Careful definition of the various grades of condition is required. A system of condition classification, based on six grades, is outlined in the example shown in Table 4.

Table 4

Example of condition grading

Grade 1 Dangerous: hopefully rare. Failure of insulation on electrical systems. No earth, bare conductors, double pole fusing etc. Fire alarm not operative. Installation test values exceed limits.

Grade 2 Poor Condition: brittle insulation, mixture of cable type (VIR, lead, PVC etc). Installation test values on limits.

Grade 3 Fair Condition: various minor defects, none necessarily significant in themselves but which together need attention on a planned basis, e.g. broken accessories etc. Installation test results: trend indicates limits will be exceeded soon.

Grade 4 Satisfactory: elements are performing their job correctly but minor repairs are required, e.g. missing junction box lids. Installation test results satisfactory.

Grade 5 Good Condition: self-explanatory, generally the top mark. (Good condition for its age is not necessarily a valid grade 5.) Switchgear recently replaced, scheme rewired etc.

Grade 6 Excellent: top mark and should be reserved for suitable situations. All cables neatly dressed and supported, everything colour coded, labelled etc. Good instrumentation etc. Generally for new installations of a very high standard.

Where some work is necessary, it may be helpful if assessors provide a cost estimate. It should be emphasised that these estimates can only be for initial planning purposes, as they are based on the assessors' first impressions.

7 Maintenance requirements

KEY POINTS

- maintenance needs can be determined from adequate records
- electrical systems last many years
- direct replacement may not be economic, or appropriate
- life-cycle costing allows informed decisions

Earlier sections have dealt with the necessity of carrying out regular inspections and tests to assess the safety and electrical integrity of installations. Given that the primary requirement for maintenance of electrical systems is safety, followed by optimisation of economic life, it is not possible to make precise recommendations for the inspection intervals required under all circumstances.

From the records and condition assessments obtained as part of the inspection and test activities, objective decisions can be made and priorities set for the replacement of equipment that has reached its economic service life but does not pose a danger. Obviously any dangerous conditions revealed in the inspection and test must be attended to immediately.

Building Bulletin 70[1] contains a generalised approach to these decisions, the various factors being considered in detail. The same considerations apply to electrical systems and components. There are further factors directly applicable to electrical systems.

The nature of the materials used and the codes of practice which govern electrical installations work tend to produce equipment and systems that will last many years with little or no maintenance requirement. An additional factor that will influence the repair-or-replace decision is the system capacity. The use of electrical equipment in teaching has increased dramatically, as has the need for flexibility in the teaching areas, both of which result in an increased requirement for electrical power outlets. This may lead to a decision to replace with new equipment which will upgrade the system to the latest standards and will increase the system capacity available, even though the old equipment may still be repairable.

In many cases replacement or renewal on a like-for-like basis may neither give the best electrical service nor be the most cost-effective solution. Integration of maintenance and improvement works can ensure that work is cost-effective and that common standards are secured.

Part of the evaluation will be a consideration of life-cycle costs in order that an informed decision can be made; and the method and an example are included in Appendix I of *Building Bulletin 70*. There are many different methods of accounting for costs during the life of an item of equipment; other examples may be found in the Chartered Institution of Building Services Engineers publication *CIBSE Guide*[8], Section B18: 'Owning and operating costs'.

It should be borne in mind that a simple repair of part of a system or item of equipment is always likely to be initially cheaper than a repair that involves renewal or replacement. However, replacement could significantly lower the cost of maintaining the system or equipment and introduce other savings, on energy costs for instance, or provide other benefits such as greater capacity or utility. Investment appraisal of the cost and benefits, not all of which are quantifiable, should enable a sound decision to be made.

8 Maintenance works procedures

KEY POINTS

- people involved must be competent to carry out the task
- procedures must ensure the safety of all
- live working should not be necessary in schools
- related non-electrical safety matters must be considered

There are two aspects to maintenance work: the specific maintenance task to be performed, and the procedure by which the task is carried out. It is essential to consider the competence required of personnel who will carry out electrical maintenance work from both viewpoints, and how safety, standards and quality will be ensured.

It must be clearly understood that the requirement for a competent person to carry out electrical work applies as much to voluntary work as to paid work.

Technical competence

The extent of work that may be undertaken by school staff is likely to be restricted by their technical competence. It will largely be limited to observation and recording of information, simple functional tests with the results of the tests being recorded and acted upon, reporting on breakages and basic safety checks. With adequate training the checking and fitting of plugs and replacement of failed lamps should be within the competence of school staff, but will depend upon employment conditions.

The use of qualified employees and contractors is necessary for the majority of work. This will generally mean that operatives will have completed a recognised apprenticeship (or other appropriate training) and be in possession of some qualifications attesting to their ability. The Electrical Contractors' Association (ECA), in conjunction with the Electrical, Electronic, Telecommunications and Plumbing Union (EETPU) via their Joint Industry Board (JIB), have defined job titles and grades of:

Labourer
Electrician
Approved Electrician
Electrical Technician.

Each operative should be able to provide proof of his or her grade.

In quality terms there are organisations such as the National Inspection Council for Electrical Installation Contracting (NICEIC) and the ECA, through which firms can be approved; the main objective of this approval is to provide an independent indication of the quality of workmanship produced by the employees and a measure of consumer protection. A number of client organisations only use these approved contractors. A firm must fulfil a number of requirements before it is approved, and in the case of many very small contracting companies the financial cost may preclude their participation. Objective assessment of small firms is more difficult and the scope of the work they could deal with may be limited. However, within their limitations they may well be capable of cost-effective quality work, although an objective method of measuring the quality must be established and a record of their work kept.

Procedures

Procedures for carrying out maintenance work must ensure the safety of all, including the operative performing the task.

Although planning will ensure that best use is made of holiday periods, much electrical maintenance work will have to be carried out while the school is in use. This raises practical problems such as keeping the work area safe and preventing unauthorised persons from coming into contact with, or even approaching, live conductors. This will mean the use of barriers to segregate staff and pupils from work areas.

It is the responsibility of the competent person in charge of the work to ensure that the electricity supplies are securely isolated before and during work. A considerable danger is an uninformed and unauthorised person gaining access to a switchroom or fuse board and energising a circuit that another person is working upon; this problem is exacerbated when the work area is far from the point of isolation.

Where the LEA is organising work they should send formal written notification to the Head of the school, detailing what work is to be carried out and how it will affect the premises.

Before any work can be carried out the safety of the operatives must be ensured. Live working is unlikely to be necessary in schools, with the possible exception of fault-finding on complex control panels, but for work to be carried out on or near live conductors, four conditions must be satisfied:

i. It is unreasonable in all circumstances for the conductor to be dead (de-energised).

ii. It is reasonable in all circumstances for the operative to be at work on or near the conductor whilst it is live.

iii. Suitable precautions are taken to prevent injury.

iv. The person carrying out the work is competent to do so or is under adequate supervision.

All other work should be carried out while the supplies are de-energised and isolated.

In addition to matters directly related to the electrical services, procedures need to take account of other matters which can arise through the carrying out of electrical works. For example, some school buildings may contain asbestos insulation, or asbestos cement partitions or ceiling panels, and each authority will have developed policies for dealing with them. Some fluorescent luminaires beyond a certain age will very possibly contain poly-chlorinated biphenyls (PCBs) within the capacitor fitted to the gear tray and need to be safely disposed of (see Appendix C).

For some works, such as lift maintenance, it will be necessary to ensure the exclusion of all but the maintenance operatives from the work area by the erection of barriers.

9 Educational requirements

K E Y P O I N T S

- planned maintenance can improve teaching facilities
- safety can be improved
- the need for temporary measures can be obviated
- planned maintenance can facilitate future change

Where possible, maintenance works should be planned and directed, not only to enhance the safety of the installation, but also to provide for the increasing educational demands on the electrical installation. This section deals briefly with general matters it may be possible to address during maintenance.

Curriculum development and use of information technologies have increased workplace demands for electrical equipment in the classroom. Many changes in education reflect the increased demands, experienced by businesses and commerce a few years ago, for equipment requiring electrical and signal cabling. As in these cases, the use of such equipment improves the range of opportunities available in education. The keynote in this change is flexibility in the learning spaces, be this in forms of teaching, layout of spaces or amount of equipment. This requires a number of services, particularly the electrical installation, to be flexible.

Many recent DES Architects and Building Branch publications have illustrated this need to continually respond to change and include guidance for primary, secondary and tertiary accommodation. The National Curriculum is the latest initiative to increase the need for a flexible, well serviced learning environment. Architects and Building Branch plans to publish guidance on the design implications of the individual subjects of the National Curriculum such as Information Technology, Science and Electronics, starting in 1992 with (design) technology.

The problem is often that of insufficient power outlets within the teaching areas and/or the inappropriate location of existing outlets. This applies equally to normal classroom and specialist areas.

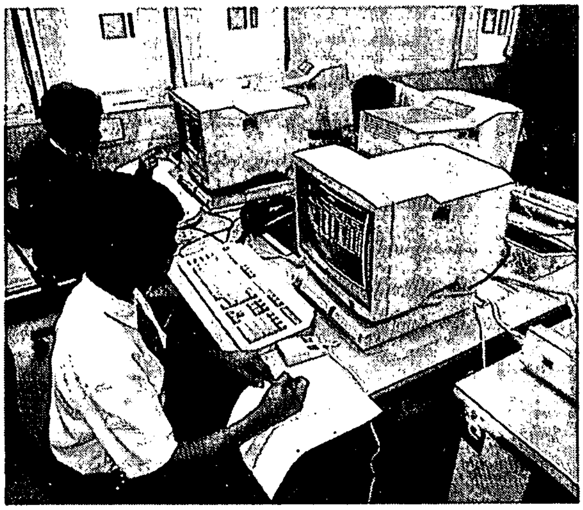
In some establishments there has been a proliferation of extra socket outlets, often installed on an ad hoc basis. The results can be adequate but the provision does not conform to the standards or methods of the remainder of the installation. It would be better if flexibility and spare capacity to cater for curriculum needs were built into the system through design and/or planned maintenance, although this type of ad hoc permanent installation work is likely to be safer than extension leads. Appendix B suggests socket outlet provision for a variety of spaces and gives advice on aspects of installation. Socket outlets must be located for flexibility of use of the space and not for ease of installation.

Another solution is the use of extension leads with a multiple outlet termination, typically four outlets. This provides sufficient outlets for most computer stations, which may require an outlet for the processor and separate outlets for the screen display, disc drive and printer. The total consumption is well within the capacity of the fixed installation single socket outlet. However, the lead creates a danger of tripping, which could cause injury or the equipment being pulled off the desk with resulting costly damage; there is also the obvious danger that the lead may become worn and live conductors exposed. In addition, as the equipment becomes more mobile with extension leads it may be used in unsafe areas. As this type of installation is temporary in nature it becomes very difficult to maintain in a safe condition or even keep track of its location. The use of loose extension leads is not recommended.

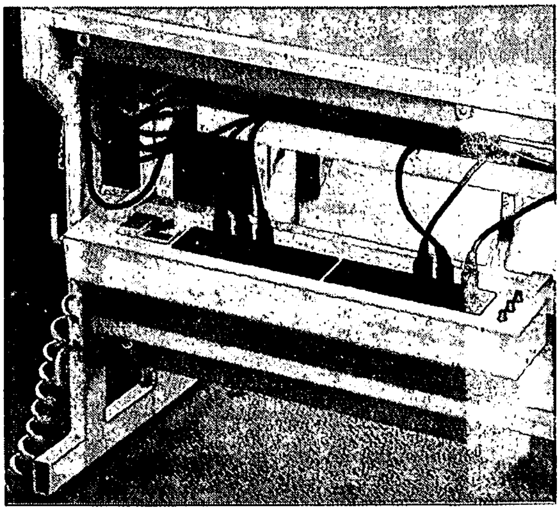
However, computer and similar equipment is often on mobile (wheeled) desks and in these instances a multiple outlet extension lead securely fixed to the desk with a short extensible (curly) cable, and fused at the

Figure 7
Typical computer workstations

A group of work stations



A mobile work station



outlet end as well as the plug top end, can be used to good effect. This means the equipment has a certain permanence, can be adequately supervised for safety and retains the flexibility, so that it can be used wherever there is a single socket outlet (see Figure 7).

Serviced furniture is available; this is primarily intended for use in laboratory and technology accommodation. For laboratories the furniture comprises benches, and pedestals with gas, water, electricity, etc, for permanent installation, either freestanding or against a wall. When siting against a wall consideration must be given to the space needed above the worktop for services (for example where there are windows). As services are permanently installed and fixed they would be covered by building services installations regulations or codes.

However, for technology, electronics and similar subjects serviced furniture may comprise movable tables with mains electricity, extra-low voltage ac and dc supplies etc provided at fixed outlets on the furniture. All power supply equipment (such as transformers, rectifiers, regulators etc) is inside the furniture, and only requires a connection via a plug to a fixed socket outlet. However, in addition to the requirements for fixed installations, there are specific limitations or requirements for the use of electrically serviced furniture which are dealt with in *BS 6396: 1990*[9].

In areas where there are a number of computer visual display units consideration must be given to the lighting installation. The lighting levels and controllers used must be suitable for the work carried out, and sited so as to prevent damaging glare being reflected by the screen. The Chartered Institution of Building Services Engineers publication *Lighting Guide LG3*[10] provides guidance.

A continually growing area in education is the use of information technologies. This has long involved video and television; it currently includes considerable expansion of computers, particularly personal computers, and will soon involve interactive video systems as well as laptop computers with re-chargeable batteries, which will require socket outlets for chargers in store rooms or other designated areas. Often the use of information technology includes installation of networks of communication cables around educational establishments, carried out on an ad hoc basis. Some form of cable management is needed to deal with the proliferation of cables at the workplace, such as those for interconnecting dedicated items (PC processor, keyboard, screen, etc) and also for network, telephone, television and so on.

Furniture which incorporates a cable tray is available; alternatively trays or trunking can be added to existing furniture in many instances. Architects and Building Branch plans to publish advice in the near future on the special servicing and furnishing aspects of the use of information technology in educational establishments. Similar regulations to those for electrical power apply to low voltage communications cabling and a responsible attitude to cable management must be developed, learning from the costly pitfalls experienced in the business community. Circuits supplying a number of computers should comply with Section 607 of the *IEE Wiring Regulations*[11] with respect to earth leakage currents.

Science departments increasingly rely on electrical power for the new initiatives, and again the opportunities should be taken during major maintenance (or adaptation) to improve the safety of these systems. A higher standard of electrical protection can be achieved through the use of residual current devices (RCDs), 1:1 isolating transformers, or earth free areas. The HSE produce a *Guidance Note*[12] which includes advice on these matters; the Consortia of Local Education Authorities for the Provision of Science in Schools (CLEAPSS) have also produced guidance[13].

Food areas, where electrical outlets are in close proximity to general damp and water and where there is likely to be much extraneous metalwork, require particular attention to earth and equipotential bonding. RCD protection should be a strong consideration. It is likely that more than half the number of cookers will be electric; careful consideration will need to be given to the means of getting electricity supplies to them. The numbers and sizes of cables will necessitate a large cable trunking; alternatively, it may be beneficial to use busbar trunking to facilitate future change. Table top cookers rated at less than 3kW should be permanently wired to a fused outlet; larger cookers rated at more than 3 kW should have a dedicated supply.

Music departments are using ever-increasing amounts of electrical equipment such as keyboards and synthesizers etc and need generous socket outlet provision. Power requirements are likely to be minimal, but large numbers of sockets will be needed. Dedicated ring circuits with twin socket outlets at regular intervals around the perimeter of the music room will be sufficient. Practice rooms need ample provision as they may contain extensive electrical equipment such as mixers, equalisers, tape decks and personal computers.

Facilities for drama studies need careful consideration, in particular when providing stage lighting installations. Staff and students will be in close contact with electrical systems when altering lighting arrangements to suit different sets. Consequently safety features such as RCDs, permanent wiring of as much of the installation as practical to minimise temporary wiring, and other measures are of paramount importance.

Certain statutory regulations, such as the COSHH Regulations, will require the installation of extra electrically driven equipment such as local exhaust ventilation (LEV). According to the COSHH Regulations, LEV must be regularly maintained and records kept of work done.

It is a requirement of licensing authorities that for public performances the power supplies for the performers' equipment must be protected by RCDs. This is a direct result of a number of fatal accidents caused by poorly maintained equipment. There is no evidence that equipment of this type in the education sector is any better maintained, and a policy of fitting RCDs in all halls in educational premises should be adopted, if the hall is to be used for public performances, discos etc.

When providing showers it should be borne in mind that some LEAs have reported that they have been advised by the HSE of the need to install earth equipotentially bonded metallic grids set within the concrete floor of showers for premises with protective multiple earth (PME) electricity supplies.

10 Energy

KEY POINTS

- energy savings are possible through maintenance
- establishments are now responsible for energy costs
- lighting is a major consumer of energy
- electric controls save other forms of energy

One common problem is that in many establishments energy invoices are settled and priorities for energy conservation work set separately from the planning and carrying out of maintenance works. Expenditure on maintenance has a direct link to expenditure on energy. One of the prime objectives of maintenance should be to promote energy efficiency.

This division of responsibility increases the risk of duplication of effort and removes some of the motivation for the inclusion of energy-saving measures with maintenance work.

The following is a very broad breakdown of the expenditure on utilities in schools on the basis of BSRIA survey work carried out in 1989:

Table 5
Cost of utilities

Average total cost per unit area (£/m²): £5.94

Breakdown of cost:

Electricity	: 40%
Heating fuel	: 45%
Water	: 15%

Obviously these are subject to variation, according to the age and size of the school, type of building and construction, heating system and fuel used, whether the premises has a swimming-pool or not, type of use of premises, location, degree of site exposure and many other factors.

The actual extent of use of each utility will vary from building to building. Where electricity is not the primary heating fuel, the majority of the electrical component of the total cost will be from lighting: a typical duration is 400 hours per annum.

Now that establishments are responsible for the payment of these costs, governing bodies should have a greater awareness of energy costs and the need for simple conservation measures like turning off unnecessary lighting.

Any inspection and testing which indicates that remedial work is necessary should be carefully considered; cost and usage benefits can be obtained by replacement of existing systems by designs employing equipment and systems which use energy more efficiently.

A high priority should be to replace any existing filament lamps with compact fluorescent types, followed by replacement of standard fluorescent fittings with newer, more efficient types. Where rewiring is considered necessary, the lighting design should be reviewed as the availability of new lamps and fittings may mean that the requirements of lighting levels and glare index (as set out in *Design Note 17*[14]) can be met with fewer or more efficient fittings.

Lighting controls are available; however, they need to be very flexible and sophisticated to be able to achieve real energy efficient use and provide the occupant with the right quality of lighting environment. Achievement of the energy benefits would require considerable programming to cater for every use to which a school may be put, often on a day-to-day basis, and it is unlikely that this type of control would realise a true cost-benefit. Much can be achieved with simple time switches and key switches. *Building Bulletin 73*[15] describes various measures and includes case studies of their successful implementation.

Heating controls are now generally electronic based and range in sophistication. Good practice suggests that a single control thermostat will work only in small premises. In a school environment the sensors must be such that they are immune to tampering and adjustment by unauthorised persons. As with lighting controls, they may require some re-programming to cater for variations in day-to-day usage; however, an assumption must be made that the site staff have little technical expertise, so this programming must be kept to a minimum. Generally, environmental controls will achieve cost benefits only if they are correctly programmed and calibrated, therefore they must be regularly maintained. This can generally be done only by trained personnel such as a specialist contractor. This service cost must be regarded as an investment to prevent costly energy wastage.

The changes in the electricity supply industry and their tariff structures will affect all premises in due course; these should always be kept under review, especially where there are electric heating systems.

Many premises are likely to be charged for electricity on a maximum demand tariff, where costs are based on the highest electrical demand register over any half-hour period. For some tariffs this maximum demand will be used in the calculations of energy accounts for a year; for others it will be used for a shorter period, but still for months. Thus, if a portable heater is used for half-an-hour at a time of peak demand, additional demand charges will be incurred for a period whether the heater is used again or not. Therefore, wherever possible the use of electricity should be spread to minimise demand and hence costs; for example by using large electrical loads, such as kilns, one at a time rather than simultaneously. Stage lighting should preferably not be used at all at times of peak demand, and in any event any lanterns no longer required should be turned off before turning on others. Equipment not requiring supervision could be put on timed supplies to operate overnight.

Awareness of Legionnaires' disease and the potential for hot water systems to become infected if allowed to operate at low temperatures have an effect on energy costs. However, systems are often being run at excessively high temperatures. There is of course a need to ensure protection of the occupants from scalding if the water is too hot; and there will be increased energy losses through higher storage and distribution temperatures. In maintenance of domestic hot water systems, consideration should be given to decentralising water heating plant or installing instantaneous water heaters at the point of use. The point should be made that some schools may have special tariff structures associated with kitchens and hot water, which might be affected by installing electric point-of-use heaters.

Apart from a zone approach for both lighting and heating controls, consideration should also be given to the installation of more detailed metering of both heat and electricity consumption, particularly if the premises are used by other organisations outside normal school hours. This detailed metering would help in energy management by the school's staff in the early identification of poor control, as well as allowing accurate cost recovery from other users. However, a cost-benefit evaluation must be undertaken.

As well as energy consumption, water consumption can be a large proportion of the total utility costs, and therefore consideration should be given to the many electrically powered water saving devices, such as variable time period flushing of urinals, the frequency being increased to coincide with peaks in their usage.

11

Community use

KEY POINTS

- facilities are being increasingly used by the community
- safety should always be the highest priority
- additional services/zoning of services may be required

Increasingly, school facilities are being used outside normal hours for community use. These uses include PTAs for social and sports activities, for adult education courses, or for religious use, polling stations or other community activities.

As governing bodies gain increasing or total control over the running of their premises, some may plan to increase their use particularly for recreational purposes. Some method of ensuring the safety of equipment brought in, and use of permanent installations, is needed.

The safety of facilities, whilst always the highest priority, is particularly important when they are to be used by members of the public not familiar with them. Arrangements, clearly understood by all parties, are needed to ensure safety standards are maintained.

There may be different requirements of the systems for community use and for educational needs; and it is unlikely that the entire premises will need to be used for community activities. In all future maintenance works on the electrical systems, consideration should be given to this type of change in use. In particular, the lighting system should be adaptable for use only in those parts of the premises that will be used in the evenings, such as a small number of classrooms and the corridors and toilets that are associated with them.

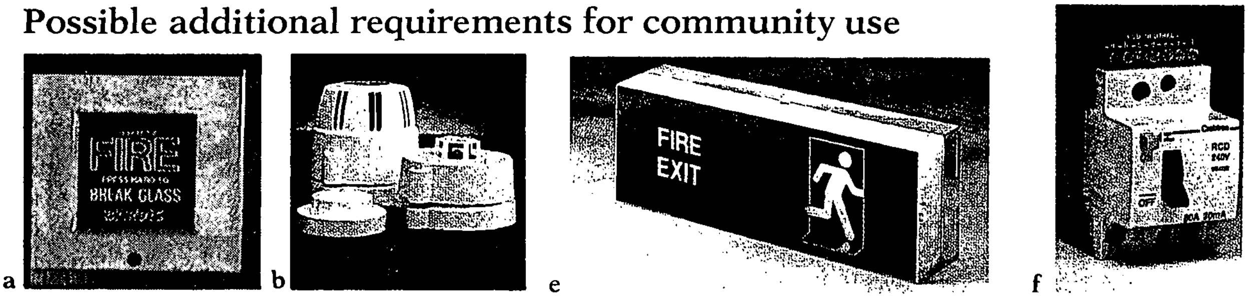
Specific areas where there may be a need to upgrade an installation for public use are stage lighting, power installations, emergency lighting and fire alarm systems. This work may be necessary to obtain a performance licence.

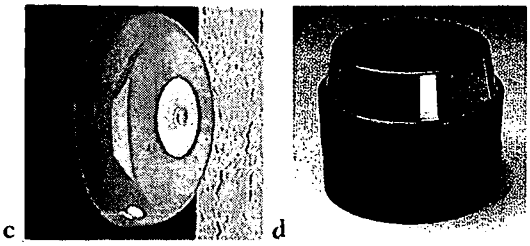
Zoning of intruder alarm systems and environmental controls should also be considered, to take into account part use of the buildings.

To allow accurate costing of these community uses, the electrical systems should be adequately metered.

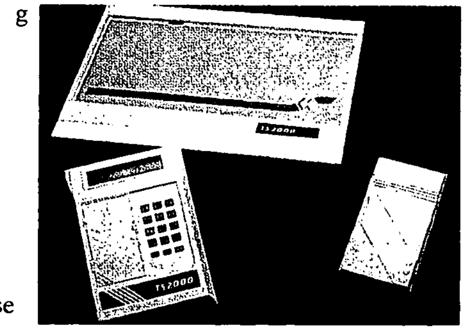
Figure 8

Possible additional requirements for community use





a.-d. Fire alarm systems may need to be upgraded to include fire detection or visual alarm warning (strobe lights) for areas with high background noise levels, or may be required for deaf children.



e. Emergency lighting may be required for evening use of premises.
f. Residual current devices may be required for the protection of performers, the public etc.
g. Security arrangements may need to be reviewed; for example, to allow the partial setting of any system.

12 Flexibility and spare capacity

KEY POINTS

- electrical services have very long lives
- flexibility and expandability (spare capacity) will extend useful life
- spare capacity is not necessarily costly

In the past there has been less need for the use of electricity for teaching, and often the existing distribution and location of the small power installation are now inappropriate. Maintenance should, wherever possible, take account of the potential increase in loading together with the distribution, number and type of consumer points (socket outlets or similar).

As has been noted, the flexibility required of teaching spaces has increased in recent years with the greater use of computers and other audio-visual and electronic teaching aids.

As has also been noted, to allow improvement in the energy efficient use of buildings, the building services need to allow the user to be selective in the use of the services to correspond with partial occupancy of the premises, particularly for community use.

The products used in electrical installation are of an inherently durable nature. There are many examples of PVC insulated cable still in use after 30 years with no obvious signs of deterioration, with every possibility that it could still be serviceable for many years to come. Most distribution switchgear is infrequently operated and, provided it is not subjected to overload or fault currents, it will remain serviceable for many years. Electrical control equipment such as relays and contactors have lives measured in thousands of operations. This durable nature means that an installation can last for a considerable time, even though other factors will change with regard to the use and capacity of the equipment.

Changes in the curriculum, particularly craft, design and technology and use of computers, are placing a greater demand upon the existing installations. For this reason, and because of changes in safety standards over a number of years, parts of the electrical systems are quite often extended or equipment replaced even though it is technically still serviceable.

It is considered unlikely that all areas of a school will be able to be used for all teaching activities, and therefore, careful attention must be given to the provision for specialist areas such as:

- computers
- sciences
- cookery
- craft, design and technology
- music.

These areas will have particular requirements of the electrical systems for the provision of:

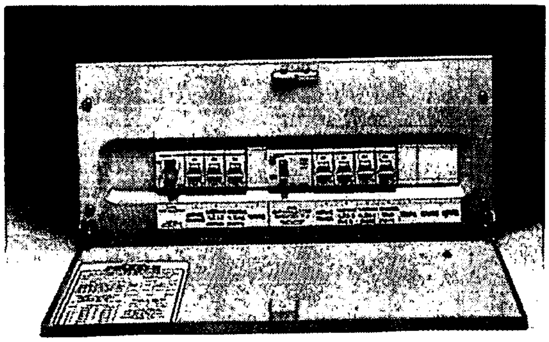
- communication networks
- contactor-controlled safety stop systems
- audio, radio and television circuits
- specialist lighting.

All planned maintenance work and some unplanned work should be carried out with a view to providing greater flexibility of the systems, to allow for changes in teaching methods and subjects, as well as more general use of the buildings.

Any planned maintenance work which will involve the replacement of parts should be designed so as to allow for higher demands in future, while keeping within reasonable cost constraints. An additional 25% capacity in the electrical installation should provide for reasonable expansion without incurring undue costs.

While a short-term drop in school rolls may result in the rationalisation of buildings and sites, the durable nature of electrical installations requires that a long-term view should be taken. This may be a simple decision to use conduit rather than mineral insulated copper covered (MICC) cable and

Figure 9
Possible areas to incorporate spare capacity

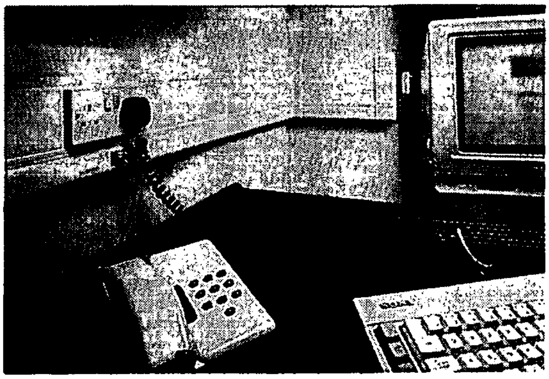


a

a. Provision of spare ways on distribution boards for connection of future circuits.

b. Using perimeter wiring methods to facilitate breaking-in to provide additional points.

c. Installing over-size conduit/trunking to accommodate future wiring.



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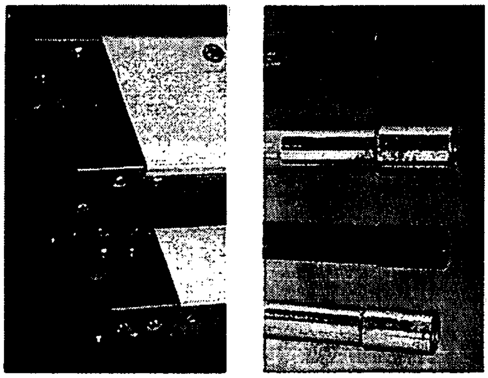


c

to use a larger size of conduit than is indicated by the present circuit size and loadings. Any oversizing of equipment and cables has a direct cost implication which could be very considerable if an entire estate is considered. However, it is important to remember that the cost difference between installing a 12-way distribution unit to provide spare ways, rather than an 8-way unit, may be as little as £20, compared to the cost of replacing the distribution board (perhaps £200) which may have to be spent at some time in the future to provide additional ways.

The *IEE Wiring Regulations*[11] provide for the diversity of use to be taken into account during the design process which generally results in smaller sub-main cable sizes being installed. To provide future expansion capability it may be sensible to include a contingency factor in the total assessed demand, or to include an assessment of the likely future additions. The IEE Regulations stipulate the maximum areas to be served by one circuit, be it a radial or ring circuit; however, no stipulation is made over the number of outlets on a circuit. They state that portable equipment should be fed from a nearby and accessible socket outlet.

In areas where the future use is uncertain and very likely to result in either disposal of a site or major refurbishment with change of use, deliberately building in spare capacity would not be prudent.

13 Maintenance tasks for staff

KEY POINTS

- staff will require training
- the person carrying out the task must be competent to do so

It must be stressed that anybody carrying out work on or near electrical systems and equipment must be competent to do so. This is an absolute requirement of the Electricity at Work Regulations 1989. It is of particular relevance to work carried out on a voluntary basis, perhaps by a parent.

If staff are to contribute to the maintenance requirements safely, it will be necessary for them to undergo suitable training and to provide for each location short but detailed instructions, particularly about action to take in typical or emergency situations. Staff should remain vigilant over any obvious signs of damage, vandalism or incorrect operation.

Table 6 lists the general tasks which staff may carry out:

Table 6
Basic staff maintenance tasks

Observations

Recording of information, meter readings etc

Easily performed functional tests

Basic safety checks

Reporting of failures and breakages

Fitting of plug tops (after suitable training)

Inspection and test of portable equipment (after suitable training)

Replacement of lamps (after suitable training)

Table 7 (p.28) lists typical tasks for each type of equipment or system. These tasks are specified in technical terms only; other employment matters have not been considered.

Table 7

Possible staff maintenance tasks (after suitable training)

Equipment or System	Task
Main switchgear	1. Inspection of switchgear/switch room on daily basis with emphasis on cleanliness, potential hazards such as water leakage, abnormal noise or overheating and security of the location. 2. Record meter readings for energy analysis by others. Look for any indicating lights that have changed status/appear to have failed, check the actual status if possible and take appropriate action. 3. Carry out any functional safety tests such as checking RCD self test every month. 4. Provide assistance to maintenance contractors whilst on site. This could involve remaining with the contractor's operative whilst work is carried out and will certainly entail providing access to secured areas such as switchrooms.
Distribution wiring	1. Observation for mechanical damage and reporting back of problems. Particular attention should be paid to equipotential earth bonding. 2. Providing maintenance operatives with any personally known information.
Distribution boards	1. Check to ensure security, functional test of RCD test button or other safety system.
Final subcircuits	1. Observation and reporting of faulty or damaged circuit accessories like socket outlets, light switches etc. Switching off/making safe damaged equipment.
Lighting: stage	1. Alteration to installation of lamps etc.
main	1. Isolation of lighting circuit and replacement of lamps. This could be either a simple replacement on failure or a bulk relamping. 2. Cleaning of diffuser/controller, in conjunction with Item 1. 3. Disposal of small quantities of failed lamps.
emergency	1. Regular functional testing and recording of tests.
Control systems	1. Programming of controls for different uses of building. 2. Changing over from British Summer Time to Greenwich Mean Time and vice versa. 3. Resetting time switch after power failure. 4. Noting and reporting of faults. 5. Recording of energy readings. 6. Overriding of system/manual control.
Mechanical services controls	1. Cleaning exterior of cabinets. 2. Simple functional tests. 3. Simple safety tests. 4. Recording of plant settings and energy information. 5. Setting and overriding of time switches.
Fire alarms	1. Daily inspection of control panel. 2. Recording and reporting faults. 3. Weekly test, each initiation point to be checked every 13 weeks.
Intruder alarms	1. Setting and turning off system. 2. Identification of simple zone faults. 3. Maintain secure, accurate records. 4. Partial setting to allow out-of-hours use.
Portable equipment	1. Fitting of plugs. 2. Brief visual inspection each time equipment is used. 3. Record keeping associated with annual inspection and test.
Lightning protection	1. Observation and report of damage.
Lifts	1. Observation and report of damage. 2. Simple safety and functional tests.

APPENDICES

The responsibilities of governing bodies for electrical maintenance have increased in recent years and now range from a partial responsibility under LMS, where there is a division of maintenance responsibilities between the establishment management (e.g. governors and/or teaching staff) and LEAs, to complete responsibility for grant-maintained establishments and City Technology Colleges. This appendix seeks to provide guidance for governing bodies who have full maintenance responsibilities.

Safety

An absolute requirement of the Electricity at Work Act (1989) is that anybody carrying out work on or near electrical services is competent to do so.

The headteacher and governing body should ensure that:

- design of electrical installations for new buildings, extensions and alterations, and the assessment of the maintenance requirements are carried out by a **qualified engineer.**
- actual installation work, maintenance work, and the design of minor works are carried out by a **qualified electrician.**
- staff asked to carry out any electrical work, even a simple task like fitting a plug, are **properly trained.**

Maintenance requirement

It is essential that a qualified engineer has assessed the total maintenance requirement of the establishment and has documented it. Where there is a division of responsibilities these must be documented and clearly understood.

The maintenance requirement must be arranged to show the level of competence required for each aspect or task:

a. Those aspects for which specialist maintenance staff (e.g. qualified electrician) will be needed (e.g. testing).

b. Those which may be carried out by school staff after technical training (e.g. installing a plug).

c. Those which may be carried out by staff without technical training (e.g. routine fire alarm tests).

Particular aspects that staff are likely to be responsible for, after appropriate training, include the routine inspection and functional testing of:

- portable equipment
- fire alarms
- emergency lighting
- residual current devices
- stage lighting.

Table 2 (p.12) and Table 6 (p.27) give further guidance.

Staff must be encouraged to remain vigilant over any obvious signs of damage, vandalism, incorrect operation, etc; systems must be in place for these matters to be reported for corrective maintenance action to be initiated.

Maintenance programme

All work must be planned to ensure safe working procedures, to ensure the safety of the operative, staff and pupils in the school.

Planning allows for all the opportunities for improvement and energy conservation to be taken during maintenance, and for maintenance items to be grouped where possible to make them more economic.

Systems must be in place to ensure that routine inspection and testing takes place at the intervals detailed elsewhere in this Bulletin, by staff/competent people as appropriate, and to confirm that all test certificates etc. are current.

Where work has to be carried out by contractor, the programme must initiate maintenance action required including tendering or renewing of specialist maintenance contracts. Schools may find it economic and convenient to let a 'term contract' for maintenance work in their

Table 8

Obtaining the services of qualified engineers and electricians

Qualified Engineer

Such engineers are often either partners in, or employed by, consultancy practices; also contractors often employ such engineers. They should be Chartered Engineers (C.Eng) and Members of the Institution of Electrical Engineers (MIEE).

The larger consulting practices are often members of the Association of Consulting Engineers who are able to give advice on the selection of a practice to suit particular requirements.

Smaller practices may not be members of the association. Objective assessment is difficult; one measure of their standing would be whether their staff included a Chartered Engineer, together with assessment of previous similar schemes that they have carried out.

Qualified Electrician

The services of a qualified electrician would normally be obtained through the use of an electrical contractor. Larger contractors are often members of organisations such as the National Inspection Council for Electrical Installation Contracting (NICEIC) and the Electrical Contractors' Association (ECA). Membership of these bodies should ensure the quality of workmanship and provide a measure of consumer protection.

Smaller contractors may not be members of such organisations, which makes assessment more difficult. However, all qualified electricians will have a card issued by the Joint Industry Board (JIB) to indicate their grade. There are four main grades:

- **Labourer: (unskilled) assists a qualified person.**
- **Electrician: qualified to carry out installation work**
- **Approved Electrician: has 2+ years' post-qualification experience.**
- **Technician: has 5+ years' post-qualification experience, including 3+ at supervisory level.**

premises. Such contracts should be for at least a year but not longer than three years, and should be entered into after a competitive tendering exercise, undertaken with the help of a qualified engineer.

Records

Systems must be in place for all maintenance works, including alterations and additions, to be recorded both financially (for budgeting purposes) and technically (for future reference). Existing records (e.g. drawings, circuit charts etc) must be updated if they are to remain usable. The *IEE Wiring Regulations* require that those carrying out any new electrical installation works, or alterations to existing installations, issue a completion certificate as prescribed therein.

Records should be monitored; for example, monitoring for unusual figures on the energy consumption record may indicate some problem on a control system.

APPENDIX B

Planned maintenance of fixed electrical installations

The fixed electrical installation comprises all cabling, wiring, switchgear, electrical equipment, distribution boards, accessories, local isolators, etc between the incoming electricity service and the final point of electricity use.

The *IEE Wiring Regulations* require that inspections and tests are carried out at the completion of any work and recommend that the installation be further inspected at regular intervals. The maximum recommended interval is five years, although for specific types of installation or location shorter intervals are recommended, as determined by the competent person.

The sequence of inspection and testing is important; it must be carried out in such a manner as to ensure safety. First of all, all visual examinations must be satisfactory; then tests are carried out on the 'unlivened' installation. All these tests must then be satisfactory before the installation is 'livened' and the tests are completed.

The IEE Regulations require that a completion certificate is issued by the contractor, or person responsible, for the installation work following satisfactory inspection and test, and recommends that this should be accompanied by an inspection certificate. They also require that an inspection certificate should be issued following every periodic inspection and test. The form of both certificates is set out in an appendix to the Regulations.

Most of the manufacturers of equipment associated with electrical installations recommend that periodic maintenance is carried out on an annual basis. This is a general statement intended to encompass the harshest conditions under which the equipment is intended to operate. Equipment used in schools is not likely to be operating to the limits of its durability, therefore a longer time interval between inspections may be appropriate.

Switchgear

Switchgear is a generic term that covers some or all of the components listed in Table 9.

Table 9

Switchgear components

Enclosure
Locking devices
Earthing provisions
Busbars
Insulation
Disconnector and main switches
Circuit breakers
Fuses
Contactors
Relays
Timing devices
Current transformers
Other transformers
Meters
Instruments
Powerfactor correction capacitors

Many of these items will have specific maintenance requirements at time intervals dictated generally by the design and quality of the equipment, its operating environment, duty and other factors. Some items are not intended to be maintained, and need only to be replaced; for example, moulded case circuit-breakers (MCCBs).

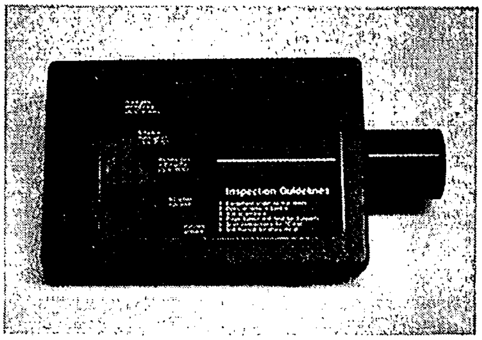
BS 6423: 1983[16] contains detailed requirements for all of the above types of equipment and many more.

There is debate as to whether cable and busbar connections should be checked for tightness on a regular basis. It is a fact that bolted connections can become loose over a period of time, as a result of temperature variation, vibration, poor installation or other factors. A loose connection may become a high-resistance joint generating heat, etc, which could become more serious as well as causing a failure of service. Stranded cable is susceptible to developing a permanent set under the pressure exerted by a cable clamp, which too can become a loose contact. Checking of every connection, bolt, terminal screw etc within switchgear would be very time-consuming and might cause other problems.

An alternative is the use of thermography to detect the heat generated by electrical faults. Using an infrared sensitive camera, the electrical system can be viewed while live and in operation, and any high temperature spots can be observed and noted for later investigation. The use of this technology is well proven within the industrial and commercial building sector for accuracy and time-saving. The simpler cameras can be obtained for under £1000 and the equipment has other uses in the realm of building maintenance and energy conservation. The more expensive types of equipment are capable of producing video tapes for record purposes and can be hired with operatives.

Figure 10
Hand-held infrared scanner

Hand-held infrared scanner with inspection guidelines printed on the outside and action needed shown by a colour coded LED display.



More recent hand-held scanners (see Figure 10) compare the temperature of the equipment with ambient temperature and have a colour-coded LED and temperature display indicating if there is a fault and how potentially serious it is. These are available for under £350 and are easier to use than infrared camera systems.

The maintenance of instrumentation, metering and complex protective equipment should be tackled only by the original manufacturer or a specialist contractor. Care must be taken with protective equipment that any variable settings determined accurately by design engineers are properly set on installation and maintained.

Distribution boards

A number of components within main switchgear are also common to distribution boards (notably fuses and MCBs). The distribution boards are fed with power by the sub-mains distribution; they consist of an enclosure, which may be surface- or flush-mounted, and contain a number of fuses, MCBs and a main switch. They may also contain one or more RCDs. Table 10 describes the types of RCD and their sensitivities.

Table 10
Types of RCD and sensitivities

Types of RCD

RCD fitted into distribution board to provide earth-fault protection to all or selected circuits.

Combined MCB/RCD used to protect individual circuits from fault conditions combining the function of the two devices.

Combined RCD/socket outlet provides earth-fault protection to appliances, supplied adjacent to the socket.

Portable RCD, plug or adaptor incorporating an RCD. Adaptor type can provide earth-fault protection to a number of appliances using one RCD. Depends upon the integrity of the user.

Sensitivities of RCDs

5 or 10mA* Very sensitive. Often used in school laboratories.

30mA Ideal for personal protection. Particularly useful on ring main circuits which supply portable appliances. The most commonly used rating in schools.

100mA Used in instances where a lower degree of personal protection is acceptable.

300mA Used for fire risk protection only.

NB. Ideally RCDs should incorporate protection against pulsating dc fault currents and have immunity to 'nuisance' tripping conditions.

*** mA=milliamps.**

One of the most important parts of the distribution board is the circuit chart that should be fitted to the distribution board, often inside the door or cover, showing details of which fuse, MCB or RCD feeds which circuit and the type and capacity of each. This chart should be permanently fixed to the enclosure in such a manner that it is accessible for updating information as and when circuits are modified or changed and should be durable. It would be useful to ensure that,

Table 11
Cable systems

☐ PVC insulated/PVC sheathed cable (twin and earth)
Generally installed in voids, ducts, etc and used for final circuits.
If buried in building fabric, out of obvious line, would need protection by earthed metallic screen.
Additional mechanical protection needed if exposed to mechanical stress/damage.
Sheath can deteriorate if in contact with polystyrene insulation.
Can be attacked by vermin.

☐ Armoured cable (PVC/PVC/SWA, PILCSWA, etc)
Generally used for sub-mains and external cabling.
Can be buried or run on the surface.
Stranded conductors facilitate bending of cable.
Cable failures can be repaired using proprietary joints.

☐ Mineral insulated copper conductor (MICC) cable
Can be used for sub-mains and final circuits.
Larger sizes more difficult to bend because of solid conductors.
Can fail due to moisture penetration at terminations.
Need to fit surge suppressors when connected to high inductive loads.
Can dress cable to produce neat installation.
May need additional mechanical protection, e.g. when installed at low level.

☐ PVC insulated cables (singles) in conduit
Generally used for final circuits and small sub-mains.
Two-stage installation process: 1. Installing conduit, and 2. Pulling in cables.
Non-metallic conduit needs a separate earth conductor.
Can be buried in the building fabric: non-metallic conduit will need earthed metallic shield if run out of obvious line.

☐ PVC insulated cables (singles) in trunking
Used for larger cables (sub-mains) or when there are too many cables for conduit.

☐ Busbar systems
Comprise solid conductors (bars) in trunking.
Has similar maintenance requirements to switchgear.
Rare in educational premises.

☐ Overhead cabling
Cable is suspended overhead, on a catenary system, between buildings.
Open to vandalism.
Cheaper to install than burying cable underground.
Unsightly.

on conclusion of any work carried out on the distribution boards and final sub-circuits, the person who has done the work enters this vital information.

The inspection and test routine should identify any maintenance work required within the distribution board other than that made necessary by changes due to expansion or changes of use of the areas that they feed.

Maintenance should ensure that correctly rated fuses etc are fitted, and that their connections are tight. In the case of rewirable fuses, the condition of the arc-quenching tape should be checked, but care must be taken with old equipment as the tape may have a high asbestos content. Rewirable fuses should be considered for replacement with HRC cartridge types or MCBs when any other work is contemplated, as they provide a much-improved degree of accuracy and protection. MCBs do not have any user serviceable parts and are normally manufactured for a given number of operations, often 10,000 or more.

The fusing factor of an MCB or cartridge fuse is considerably higher than that of a rewirable fuse, which may mean in new work that a smaller (and cheaper) cable could be used for the same duty. Care must be taken, when designing and carrying out maintenance or upgrading works, that prospective fault current levels are not raised above the capabilities of the protective equipment fitted in distribution boards. Checks on prospective fault current levels resulting from new works or alterations are essential if safety is to be ensured.

A number of spare ways should be provided in distribution boards to allow for future expansion. A figure of 25% is recommended.

Sub-main cables

From the main intake the electrical power is distributed to the various distribution boards or subsidiary control centres via a cabling system, normally referred to as the sub-mains. These can take one of six basic forms (or a combination), which are shown in Table 11.

The extent of maintenance is generally limited to either repairs after failure or replacement shown to be necessary as a result of the inspection and test, or improvement to increase capacity. No maintenance tasks on sub-main cables can be carried out by staff but they can regularly look out for any mechanical damage and report it promptly to the appropriate authority.

Isolators

There is often confusion among non-technical personnel as to the function of an isolator. The purpose of an isolator is to provide for cutting off an electrical installation, circuit or item of equipment from all sources of electrical energy by positive physical separation of electrical contacts. Isolators are not intended to be operated under load conditions, that is while current is flowing.

The Electricity at Work Act 1989 requires that there is a means of ensuring isolation before work is carried out. In the case of a local isolator (for example for kiln, pump motor or boiler burner) the best means of ensuring this isolation is to provide a unit which has the means of being locked in the off or isolated position. Therefore, in all maintenance works involving replacement of plant, etc, attention should be given to meeting this requirement.

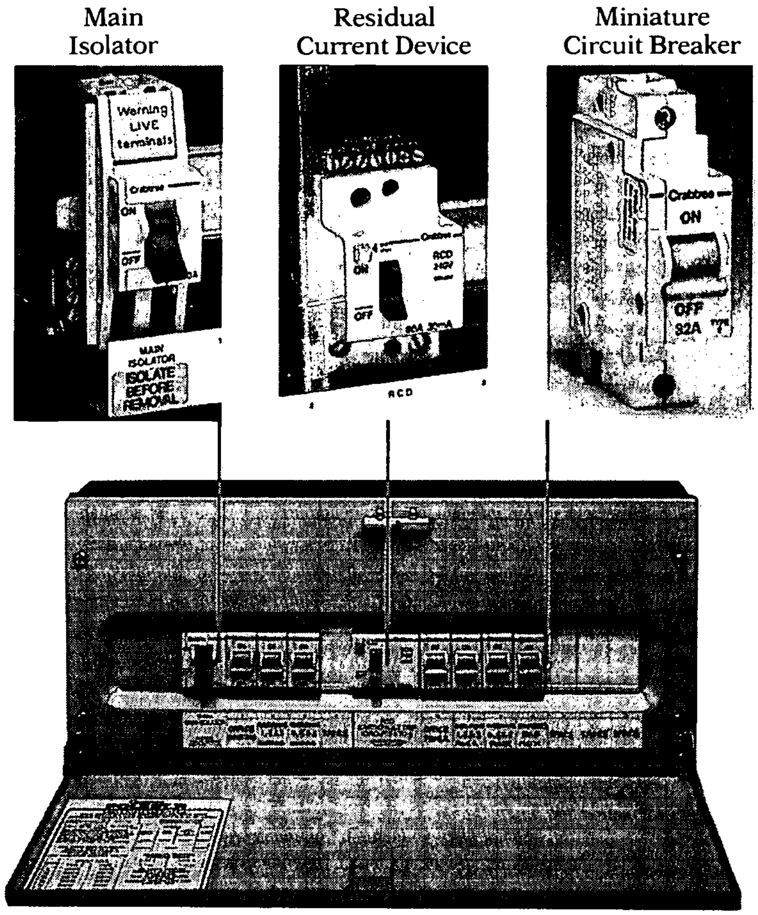
As with a great deal of switchgear, the maintenance tasks require that the unit is inspected internally for cleanliness, security of connections and operation. This is of particular importance as the unit has to be sited near the equipment it serves and may have been subjected to vandalism. The type of enclosure used may vary depending upon the actual site (external or internal, subject to damp, water sprays, etc) and inspection of the integrity of this mechanical protection is important.

Generally speaking, the isolator is provided for the use of trained maintenance personnel. It may also be installed for safety reasons in connection with workshop machinery, science laboratories and home economics departments. In these cases it may be intended for use of the teaching personnel to ensure the safety of the students.

Final circuits and accessories

There is no regular maintenance to be carried out to final circuits and accessories such as light switches, sockets and fused

Figure 11
Distribution boards



Circuit list: It is often considered that there is insufficient space to record the detail required and larger circuit charts, in glazed frames or plastic wallets, are mounted beside the distribution board.

Circuit Number	MCB/Fuse Rating	Cable size	Description
1	10A	1.5mm2	Office lighting
2	10A	1.5mm2	Classrooms 1,2&3 Lighting
3	10A	1.5mm2	Classrooms 4,5&6 Lighting
4	-	-	Spare
80 Amp, 30mA earth fault trip protection on circuits a to g			
a	32A	2.5mm2	Office Power
b	32A	2.5mm2	Classrooms 1,2&3 Power
c	32A	2.5mm2	Classrooms 4,5&6 Power
d	32A	2.5mm2	Computers ring main
e	-	-	Spare
f	-	-	Spare
g	-	-	Spare

outlets other than the inspection and test routines.

Users should be vigilant over observable faults or damage, and they should ensure these are attended to by a competent person very quickly. This is of particular importance with regard to accessories in that this is the one point in the electrical system where the consumer comes into intentional close contact with electricity and has control over the release of energy. Because these accessories are visible and accessible they may often be subjected to abuse, in particular to the shutter mechanism that is intended to prevent objects other than an appropriate plug from being inserted in the socket outlet.

Replacement/improvement

When planning major rewiring works, consideration should be given to:

a. co-ordination with other maintenance works such as cleaning, repairs to fabric and decorations.

b. likely disruption to the premises operation during the work.

c. disturbance of materials that might create a hazard, such as asbestos.

d. future teaching needs.

e. the existence of a suitable trunking/conduit system.

f. cost-benefit of in-built spare capacity and flexibility.

Proprietary systems for distributing power to socket outlets are available but they are not recommended for general use, where plugs and socket outlets complying with *BS 1363: 1984*[17] should be used internally and with *BS 4343: 1968*[18] for external positions.

Consideration should be given to the installation of RCDs, although care is needed. Equipment in general, and for information technology, control, etc in particular, increasingly contains semiconductor devices which can result in the normal ac sinusoidal waveform being modified, for example rectified or chopped. These modified waveforms are said to contain a pulsating dc component. Consequently, in the event of an earth fault on the equipment it is probable that the earth fault current waveform will contain a pulsating dc component. Not all RCDs will respond to such a fault current and may thus not provide the intended degree of protection; however, there are many devices which will respond to fault currents with pulsating dc components and thus care is needed in selection. All external socket outlets – those which will supply equipment used outdoors and those in plant areas – should be protected by an RCD.

The design of final circuits supplying computers and data-processing equipment where the total earth leakage current in normal service exceeds 10mA is covered in Section 607 ('Earthing requirements for the installation of equipment having high earth leakage currents') of the *IEE Wiring Regulations*[11], which gives particular requirements relating to the earth leakage currents of such equipment.

Although flush (buried) services may give a better appearance, surface installations can be more economic and necessitate little or no building or redecoration works. In addition, surface mounting allows modifications or extensions to be more easily carried out. With careful design and installation, cable routes can be selected to facilitate future tapping-in to provide additional points.

For a primary school, it is recommended that one double switched socket outlet with neon indicator should be fitted to each wall of a conventional classroom, at a height where they would be visible by the teacher (1m above floor level). The precise siting of each socket outlet should be agreed with the school staff, within specified constraints. This work can be incorporated when any other electrical work is found to be necessary. Advice should be sought from staff as to the priorities for the different areas.

For a new secondary school, typical numbers of socket outlets are shown in Table 12; these may require local modification for various areas. Existing schools will generally have fewer socket outlets but the table can be used as a guide when rewiring or upgrading. As with primary schools, discussions should be held with school staff to set priorities.

If there is a fixed teacher position within the classroom it will be useful to provide an additional twin socket outlet beside it.

Table 12
Socket outlets in a new secondary school

Area	No of double outlets
General purpose classroom	As primary school (4)
Art/Pottery/Science/Food Technology	24
Preparation areas for Art etc	5
CDT and computer/business studies	30
Music room	16
Library	7
Librarian's office	5
Drama studio storage space	3
General office/reception	10
Administrative offices	4
Staff room	4
Staff work areas/tutorial spaces	10
Reprographics	10
Medical/rest room	3
Caretaker's office/stores	3
Central stores	3
Kitchens	10
Cloakrooms	2
Gymnasia	Single outlet every 4m of perimeter

Staff should have access to drawings and plans as, during contemplated changes of use necessitated by changing teaching demands, consideration of the existing electrical installation should be an integral part of the decision process. This will ensure that best use of the existing facilities can be made.

Planned maintenance of lighting installations

The CIBSE *Code for Interior Lighting*[19] states that maintenance of lighting systems keeps the performance of the system within design limits, promotes safety, and if considered at the design stage can help minimise electrical load and capital costs. The Code gives guidance on the design and maintenance of lighting installations.

Effect of planned maintenance on design

At the design stage the designer takes the future maintenance of the installation into account by the inclusion of the light loss factor (LLF) in his or her calculations.

$$E = \frac{F_{in}.n.N.UF.LLF}{A}$$

where

F_{in} = initial luminous flux of light source

n = no. of lamps per luminaire

N = no. of luminaires

A = area to be lit

UF = utilisation factor for luminaire in room

LLF = light loss factor.

LLF is the ratio of the illuminance produced by the installation at some specified time to that produced by the installation when new, and is the product of three factors:

- LLF = LLMF x LMF x RSMF.
- LLMF (lamp lumen maintenance factor) allows for the depreciation of lamp light output with use. Various manufacturers have done a great deal of work on this subject, to the extent that their catalogues generally include data to determine this depreciation.
- LMF (luminaire maintenance factor) allows for the reduction in luminaire output through dirt.
- RSMF (room surface maintenance factor) allows for reduction in reflected light through dirty decor.

The better the maintenance of the installation, the closer the factor is to unity and hence the smaller the installation requirements with lower capital, energy and maintenance costs. Owners should ensure that lighting designers include LLFs in their calculations which reflect actual maintenance practices.

Figure 12 sections (a)–(c) show the graphical representation of typical factors against time, while sections (d)–(h) show typical effects of varying the frequency of individual maintenance tasks on the overall LLF.

Effect of maintenance on efficiency

Although many educational premises are primarily used during daylight hours, the cost of the energy consumed by the lighting installation can be 30–40% of the energy bills in a secondary school.

The DES *Design Note 17*[14] recommends that the minimum illuminance levels on the working plane (desk) should not be less than 150 lux, and if fluorescent lamps are used 300 lux.

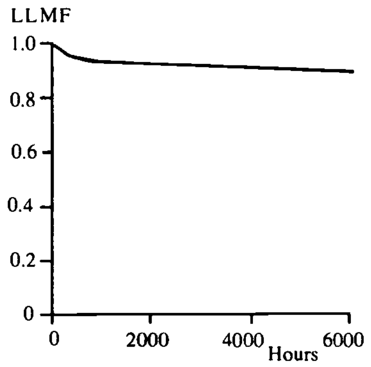
Design Note 17 also refers to the low usage of lighting installations in schools which are daylit and estimates that it could be 400 hours/annum. For simplicity Figure 12 is based on an example with an annual lighting installation usage of 1000 hours; actual comparisons would need to be based on particular installation parameters.

From Figure 12 the data shown in Table 13 can be extracted for the example:

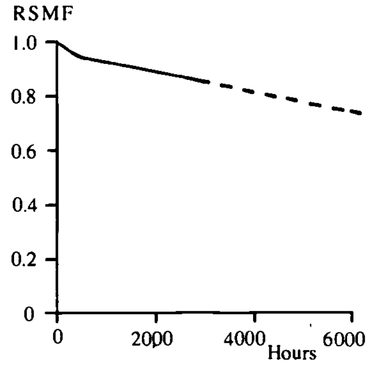
Table 13
Light loss factors for the example in Figure 12

Period between luminaire clean	Period between room clean	Open diffuser luminaire LLF	Dust-tight luminaire LLF
1 year	1 year	0.58	0.72
1 year	2 years	0.56	0.68
1 year	3 years	0.53	0.63
2 years	2 years	0.45	0.63

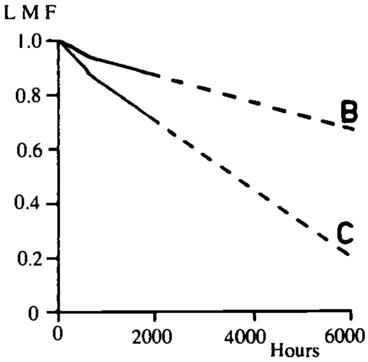
Figure 12
Light loss factors: components and their effects



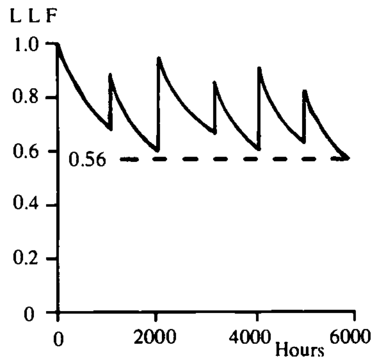
a. LLMF – Depreciation of lamp output with use (typical)



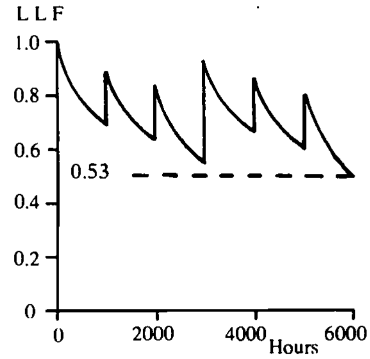
b. RSMF – Depreciation of illuminance due to dirt or decor (typical), assumes 1000 hours/annum



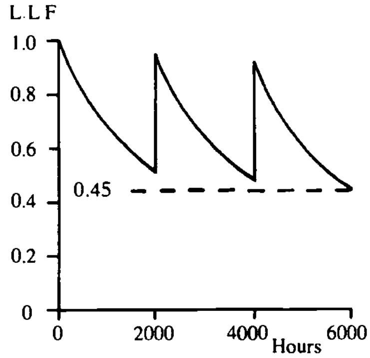
c. LMF – Depreciation in light output due to dirt on luminaire (typical)
B Dust-tight
C Open diffuser assumes 1000 hours/annum



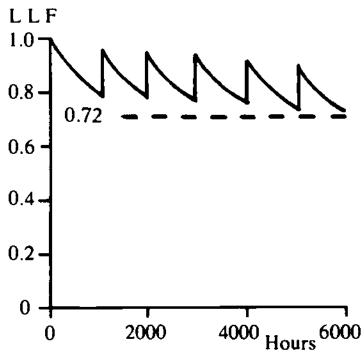
d. Open diffuser luminaire
Annual luminaire clean
Two-yearly room surface clean.



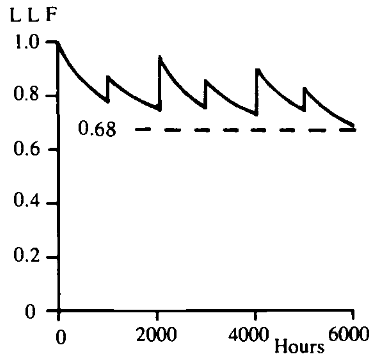
e. Open diffuser luminaire
Annual luminaire clean
Three-yearly room surface clean.



f. Open diffuser luminaire
Two-yearly luminaire and room surface clean.



g. Dust tight luminaire
Annual luminaire and room surface clean.



h. Dust tight luminaire
Annual luminaire clean
Two-yearly room surface clean.

From the data it can be deduced that for the example:

□ increasing frequency of luminaire cleaning from every two years to annually improves efficiency by approximately 20%

□ increasing frequency of room surface cleaning from every three years to annually improves efficiency by approximately 5%

□ changing from open diffuser to dust-tight luminaires (with same utilisation factor) improves efficiency by approximately 18%

□ changing from open diffuser to dust-tight luminaires and increasing maintenance from every two years to annual clean of luminaires and room surfaces improves efficiency by approximately 37%.

Effect of better quality equipment and maintenance on life-cycle costs

If economic luminaire life is 20 years and usage is 400 hours/annum, on the basis of fluorescent lamp life of over 6000 hours the lamp would have to be replaced only once during the life of a luminaire.

Consequently, for new and replacement installations it will be worth considering the life-cycle economics of using higher quality luminaires and lamps to take advantage of:

□ The more efficient polyphosphor krypton-filled fluorescent lamps. These produce approximately 10% more light than the conventional argon-filled halophosphate lamp and use approximately 8% less energy. They are, however, more expensive and can be used only in some switch and electronic start luminaires.

□ The possibilities for reduction in maintenance costs. In consideration of the length of time between lamp replacements, when diffusers would have anyway to be removed, it may be economic to use dust-sealed luminaires. These reduce luminaire cleaning to wiping the external surfaces, which can be done by the caretaker. This will be far less time-consuming, and hence cheaper, than removing an open diffuser, taking it down, washing it internally and externally and replacing it.

□ Compact fluorescent lamps in preference to tungsten lamps.

Figure 13 sets out an example life-cycle costing for a sample installation which shows that, in this case, a life-cycle cost saving of 30% can be achieved through the use of better luminaires with better maintenance.

It is impossible to generalise as each installation has its own set of operating and maintenance parameters which will need to be considered; accurate life-cycle costing is essential.

Maintenance

Thus maintenance of lighting systems falls into three distinct types of work:

1. Breakdown maintenance for the replacement of failed lamps or luminaires.

2. Planned preventive maintenance for cleaning and for the bulk relamping of installations that have reached the end of their useful lives, before failures cause problems.

3. Planned maintenance for the replacement of fittings that the inspection and tests have shown to be necessary.

(The planned maintenance of the electrical aspects of the lighting installation is dealt with in Appendix B.)

Where school staff carry out the cleaning of luminaires and replacement of lamps, it may be sensible to generate a rolling programme.

Care is needed when disposing of lamps. LOW-PRESSURE SODIUM (SOX, SLI, SOI) LAMPS MUST BE TREATED WITH EXTREME CAUTION AS THE SODIUM THEY CONTAIN BURSTS INTO FLAMES ON CONTACT WITH WATER.

When breaking up lamps for disposal, protective clothing, including goggles and gloves, must be worn, and precautions taken against flying glass, etc (including the re-use of replacement lamp wrappers to contain flying pieces). This should be done out-of-doors or in a well ventilated area.

Tungsten, fluorescent and discharge (other than SOX) lamps should be broken in a container and disposed of as glass waste. There is no need to break the tough inner arc tube of mercury and high-pressure sodium lamps.

Low-pressure sodium lamps should be placed in a dry metal container up to a quarter full (not more than 20 lamps) and be broken into small pieces. The container should immediately be half filled with water from a hose, the operator standing at a safe distance. After a few minutes the liquid should be decanted as foul waste and the remainder disposed of as glass waste.

Figure 13
Life-cycle costing for a lighting installation

Room Data

Light Level	300 Lux	Room Height	3 metres
Annual usage	1000 hours	Working Plane	0.6 metres
Electricity cost	0.06 £/kwh	Reflectance	20/70/50 %
Room Length	8 metres	Room Index	1.43
Room Width	6 metres	Discount Factor	0.05

Lamp Data	LUMENS	kVA
58 WATT KRYPTON TUBE	5000	0.082
58 WATT POLYPHOSPHOR TUBE	5400	0.082

OPEN DIFFUSER LUMINAIRE - CLEANED BI-ANNUALLY,
CLEANED & RELAMPED EVERY 6 YEARS.

OPEN DIFFUSER LUMINAIRE WITH 2 x 58watt KRYPTON LAMPS

No. of Luminaires	5.71	Utilization factor	0.56
	say 6	Light loss factor (from Table 9)	0.45
Costs for one fitting:-		Costs for 6 fittings:-	
Installation	£ 143	Installation cost	£ 858.00
Cleaning	£ 0.41	Cleaning cost	£ 2.46
Cleaning/Relamping	£ 6.58	Cleaning/Relamping cost	£ 39.48
		Annual Energy Cost	£ 59.04

YEAR	0	1	2	3	4	
Capital cost	£ 858.00					
Energy cost	£ 59.04	£ 59.04	£ 59.04	£ 59.04	£ 59.04	
Discounted energy cost	£ 59.04	£ 56.23	£ 53.55	£ 51.00	£ 48.57	
Maintenance cost	£ 0.00	£ 0.00	£ 2.46	£ 0.00	£ 2.46	
Discounted maint. cost	£ 0.00	£ 0.00	£ 2.23	£ 0.00	£ 2.02	
Cumulative total cost	£ 917.04	£ 973.27	£ 1,029.05	£ 1,080.05	£ 1,130.65	
YEAR	5	6	7	8	9	
Capital cost						
Energy cost	£ 59.04	£ 59.04	£ 59.04	£ 59.04	£ 59.04	
Discounted energy cost	£ 46.26	£ 44.06	£ 41.96	£ 39.96	£ 38.06	
Maintenance cost	£ 0.00	£ 39.48	£ 0.00	£ 2.46	£ 0.00	
Discounted maint. cost	£ 0.00	£ 29.46	£ 0.00	£ 1.67	£ 0.00	
Cumulative total cost	£ 1,176.91	£ 1,250.42	£ 1,292.38	£ 1,334.01	£ 1,372.07	
YEAR	10	11	12	13	14	
Capital cost						
Energy cost	£ 59.04	£ 59.04	£ 59.04	£ 59.04	£ 59.04	
Discounted energy cost	£ 36.25	£ 34.52	£ 32.88	£ 31.31	£ 29.82	
Maintenance cost	£ 2.46	£ 0.00	£ 39.48	£ 0.00	£ 2.46	
Discounted maint. cost	£ 1.51	£ 0.00	£ 21.98	£ 0.00	£ 1.24	
Cumulative total cost	£ 1,409.82	£ 1,444.34	£ 1,499.20	£ 1,530.51	£ 1,561.57	
YEAR	15	16	17	18	19	20
Capital cost						
Energy cost	£ 59.04	£ 59.04	£ 59.04	£ 59.04	£ 59.04	£ 59.04
Discounted energy cost	£ 28.40	£ 27.05	£ 25.76	£ 24.53	£ 23.36	£ 22.25
Maintenance cost	£ 0.00	£ 39.48	£ 0.00	£ 2.46	£ 0.00	£ 2.46
Discounted maint. cost	£ 0.00	£ 18.09	£ 0.00	£ 1.02	£ 0.00	£ 0.93
Cumulative total cost	£ 1,589.97	£ 1,635.11	£ 1,660.86	£ 1,686.42	£ 1,709.78	£ 1,732.96

DUST TIGHT LUMINAIRE - CLEANED ANNUALLY,
CLEANED & RELAMPED EVERY 6 YEARS.

DUST TIGHT LUMINAIRE WITH 2 x 58watt POLYPHOSPHOR LAMPS

No. of Luminaires	3.70	Utilization factor	0.53
	say 4	Light loss factor (from Table 9)	0.68
Costs for one fitting:-		Costs for 4 fittings:-	
Installation	£ 152	Installation cost	£ 608.00
Cleaning	£ 0.16	Cleaning cost	£ 0.64
Cleaning/Relamping	£ 12.58	Cleaning/Relamping cost	£ 50.32
		Annual Energy Cost	£ 39.36

YEAR	0	1	2	3	4	
Capital cost	£ 608.00					
Energy cost	£ 39.36	£ 39.36	£ 39.36	£ 39.36	£ 39.36	
Discounted energy cost	£ 39.36	£ 37.49	£ 35.70	£ 34.00	£ 32.38	
Maintenance cost	£ 0.00	£ 0.64	£ 0.64	£ 0.64	£ 0.64	
Discounted maint. cost	£ 0.00	£ 0.61	£ 0.58	£ 0.55	£ 0.53	
Cumulative total cost	£ 647.36	£ 685.46	£ 721.74	£ 756.29	£ 789.20	
YEAR	5	6	7	8	9	
Capital cost						
Energy cost	£ 39.36	£ 39.36	£ 39.36	£ 39.36	£ 39.36	
Discounted energy cost	£ 30.84	£ 29.37	£ 27.97	£ 26.64	£ 25.37	
Maintenance cost	£ 0.64	£ 50.32	£ 0.64	£ 0.64	£ 0.64	
Discounted maint. cost	£ 0.50	£ 37.55	£ 0.45	£ 0.43	£ 0.41	
Cumulative total cost	£ 820.54	£ 887.46	£ 915.89	£ 942.96	£ 968.74	
YEAR	10	11	12	13	14	
Capital cost						
Energy cost	£ 39.36	£ 39.36	£ 39.36	£ 39.36	£ 39.36	
Discounted energy cost	£ 24.16	£ 23.01	£ 21.92	£ 20.87	£ 19.88	
Maintenance cost	£ 0.64	£ 0.64	£ 50.32	£ 0.64	£ 0.64	
Discounted maint. cost	£ 0.39	£ 0.37	£ 28.02	£ 0.34	£ 0.32	
Cumulative total cost	£ 993.30	£ 1,016.69	£ 1,066.63	£ 1,087.84	£ 1,108.04	
YEAR	15	16	17	18	19	20
Capital cost						
Energy cost	£ 39.36	£ 39.36	£ 39.36	£ 39.36	£ 39.36	£ 39.36
Discounted energy cost	£ 18.93	£ 18.03	£ 17.17	£ 16.35	£ 15.58	£ 14.83
Maintenance cost	£ 0.64	£ 0.64	£ 0.64	£ 50.32	£ 0.64	£ 0.64
Discounted maint. cost	£ 0.31	£ 0.29	£ 0.28	£ 20.91	£ 0.25	£ 0.24
Cumulative total cost	£ 1,127.28	£ 1,145.61	£ 1,163.06	£ 1,200.32	£ 1,216.15	£ 1,231.23

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APPENDIX F

Planned maintenance of building services controls

Introduction

There are many published papers and articles on the correct maintenance of environmental controls. Many documented cases show that incorrectly adjusted controls and settings cause considerable increase in energy consumption rather than saving this costly commodity. In many cases the energy management equipment has been installed incorrectly; for example, cases have been cited of compensators (which are designed to adjust the temperature of the water flowing to the radiator system in accordance with changes in the outside temperature) where no outside thermostat was installed. Another case was the same type of equipment where the outside thermostat was fitted to a chimney, giving a completely unrepresentative temperature. In both these cases the installation was faulty and could never have been correctly commissioned; therefore, any anticipated energy savings had never been achieved. In addition, no maintenance was being carried out (or if it was, not by a competent person) as correct maintenance would have revealed these types of fault.

Items in the category of building services controls include the electronic building energy management systems and controls associated with the use of energy in buildings such as lighting control systems, compensator/optimisers, time switches, valves, dampers, sensing equipment like thermostats, motor control centres, starter boxes, boiler burner control units, isolators, contactors, electro-mechanical and electronic relays, thermal overloads, microprocessors, timers, multiple cam units, indicator lamps, push buttons and metal enclosures, many of which are common to main switchgear.

Environmental conditions can be controlled and energy savings realised only if they are fully and correctly used; they should therefore be relatively easy to operate and monitor. A great danger is that if they are too complicated to use, they will remain in the overridden positions.

Designed environmental conditions and efficient energy use will not be sustained unless controls are regularly maintained. As sensors age, wear with use, become soiled, etc they require cleaning and adjustment if they are to operate at design conditions.

Now that establishments have to fund fuel usage it is important that adequate maintenance of controls is carried out to avoid unnecessary expenditure.

Maintenance

The maintenance of building services controls is a specialist area of expertise, which in many instances will require both electrical and mechanical services skills such as exhaust gas analysis, measurement of air/water flow rates etc. Although it is acknowledged that the typical labour rates for a skilled controls technician are likely to be 30–60% more than for a single trade craftsman, the time taken by a skilled man for fault location and rectification will often be much less than using a general tradesman, and a positive repayment through correctly adjusted controls should be achieved.

The cost of maintenance is not likely to exceed 1% of the total fuel bill. This would provide for a single visit to check settings to ensure that correct temperatures are being reached and control equipment is operating correctly (both controller and actuator), and to make minor adjustments. More complex sites may warrant more frequent visits. Work beyond the process of checking and minor adjustment would be the subject of an additional quotation. Such procedures would be cost-effective, in that money spent on regular maintenance would have an identifiable payback and lead to future savings, i.e. investment for increased efficiency.

It has already been stated that sensors are often incorrectly located at installation, or circumstances have changed and rendered their location inappropriate. Consequently it is useful, as part of planned maintenance, to check conditions both externally and within the controlled environment, at locations other than where sensors are located, to evaluate the suitability of sensor location.

The extent to which a non-electrically trained person can carry out maintenance on this type of equipment is limited to cleaning exteriors, visually inspecting the exterior of the equipment and cabling and testing the function of the equipment. It is recommended that for each site a checklist of normal running conditions is provided. It should detail what equipment and associated indicators should be operating, and at what times, for the school personnel to check; it should also show the settings of time switches (see following paragraph). The purpose of indicator lamps is to show the operating condition and it is obviously necessary to ensure that bulbs are replaced as soon as they fail.

Much energy is wasted simply through incorrect setting of controls, e.g. time switches. As a minimum, each establishment should have a list of all settings of all time switches, etc and instructions for the adjustment and setting of each type, specific to the site. Staff should be able to carry out this adjustment and setting. One of the problems with this type of equipment is that it is generally fitted with an override mechanism, which is often activated and then left on indefinitely. The costly, energy-wasting consequences of this type of action should be brought to the attention of the staff and consideration given to installation of remote indicators to show when time switches are being overridden.

Replacement/improvement

Thought should be given to the introduction or improvement of zoning to allow controls to respond to areas of differing demand, aspect, etc and for the provision of heating and lighting for partial occupation of buildings, for example for extracurricular activities. There may be the possibility of partial funding from the organisation using the facilities. Metering would make possible direct charging for these sorts of activity.

Only qualified people should determine the use of compensator/optimisers, zoning and controls in general, otherwise unacceptable conditions can occur due to a bad or inappropriate controls strategy.

Where bulk relamping is contemplated, there are a number of specialist contractors who offer a range of services including cleaning of fittings, relamping, minor repairs, supply of lamps and disposal of expended units.

In whatever way the work is carried out it should be properly planned and programmed, with completed work recorded. An 'as-installed' lighting installation drawing, with each luminaire given a unique reference, should help.

Although there is a variety of areas where it may be possible to employ uplighting designs, these are of limited use because of the potential for vandalism, particularly debris being thrown up and entering the reflectors, dirtying them and possibly producing a fire hazard.

Precautions

PCB, a chemical which was previously used in the manufacture of capacitors for fluorescent light fittings, has been found to be highly carcinogenic. Fluorescent light fitting capacitors manufactured in the United Kingdom after 1976 are unlikely to contain PCB and are supposed to be date-coded. Government regulations published in 1986 banned the sale of PCB-filled capacitors. This type of capacitor is now generally of a different type of construction, that is dry. However, high-capacity discharge lighting (floodlights) have capacitors as part of the control gear, often filled with a liquid, normally with a vegetable oil base, not PCB.

The capacitors used in fluorescent lighting that were manufactured prior to 1976 should be considered as likely to contain this material. These capacitors may fail. In certain modes of failure, the PCB may leak out. This material, when warm, has a consistency of light oil and may flow into the body of the luminaire or diffuser or even leak onto the floor. Leakage may show as a brown stain. Should this occur, the light fitting should be switched off and a suitably trained maintenance operative called to change the faulty capacitor. All contact of oil on the skin should be avoided. Guidance issued states that the faulty capacitor, after removal with the use of gloves, should be wrapped in absorbent material and placed in a plastic bag along with any cleaning materials used to clean the luminaire. The NICEIC guidance further states that the bag may then be disposed of as normal waste, unless local requirements specify otherwise. It is recommended that the guidance of the local authority Environmental Health Department is sought on disposal, particularly when considering large-scale replacement.

Special disposal machines are available, but these may not be an economic prospect for a single establishment.

Lighting controls

Lighting control systems are discussed elsewhere; however, the staff should have sufficient information to be able to programme any user controls and, in particular, to know how to adjust time settings to account for holiday periods and changes between Greenwich Mean Time and British Summer Time. Unless these instructions are easy to understand and to implement they will not be used, and any projected energy savings will never be achieved. Often the fitting of simple time switches can realise considerable savings.

A note of caution should be made when considering automated switching operations. The life of a lamp is a function of the running hours and the number of switching operations and other factors. The greater the frequency of switching operations, the shorter the life. At some point the amount of energy and costs saved may in fact fall below the cost of replacing lamps at more frequent intervals; that is, if the lamp only lasts half as long, will the energy saved by switching more often exceed the cost of replacing the lamp twice? No detailed work on this aspect of energy costs is known to Architects and Building Branch. Table 14 shows the relationship between rated lamp life for fluorescent lamps on a three-hour switching cycle and other frequencies. A typical life would be 7000 hours for a three-hour cycle.

Table 14
Fluorescent lamp life (effect of switching)

Switching cycle (hours)	Approximate lamp life (%)
Continuous	+ 150
24	150
8	125
3	100 (7000 hrs)
1	65
0.75 (45 mins)	45
0.1 (6 mins)	20

For incandescent lamps the primary factor affecting their life is voltage level. Table 15 shows rule-of-thumb factors:

Table 15
Incandescent lamp life (effect of voltage variation)

5% Over-voltage	5% Under-voltage
50% shorter life	100% longer life
15% higher luminous flux	15% lower luminous flux
8% higher power consumption	8% lower power consumption
3% higher current	3% lower current
2% higher colour temperature	2% lower colour temperature

These figures highlight the importance of ensuring that maintenance work involving replacement of lighting supply cabling is properly designed. If inspection reveals over-voltages on the existing installation, they should be adequately investigated; this may lead to discussions with the electricity supply authority with a view to their reducing the over-voltage or to considering the installation of voltage regulation on site.

The life of high-intensity discharge lamps (those used for floodlights) is seriously affected by both voltage levels and switching frequency. This type of lamp is very expensive, so attention must be paid to both these factors.

APPENDIX D

Planned maintenance of stage lighting

In areas used for drama performances (which may be public), much of the stage lighting relies upon plug, socket and lead arrangements and is often altered and rearranged by non-competent people (students, pupils and teaching staff). It is potentially one of the greatest sources of danger of electric shock in an educational premises. The entire power system and stage lighting system should be protected by RCDs.

The inspection and testing of these installations need to be as thorough as that of the remainder of the electrical installation and portable equipment, but need to be carried out more frequently.

As with all electrical services, records should be kept. A register should be prepared containing details of all items of equipment such as controls, patch panels, prewired barrels, fittings, etc, with each item given, and preferably labelled with, a unique reference (asset code).

Arrangements should be made for training the responsible person with overall control of stage lighting equipment to carry out alterations to the lighting correctly and safely and the training must be sufficient to enable him or her to correctly and objectively assess when a competent person such as an electrician is required. The responsible person must ensure that inspection and testing are carried out at appropriate times.

It is recommended that stage lighting installations comprising portable dimmers, plugs, sockets, flexible leads, etc are regarded as temporary installations and are inspected every three months, results recorded and action taken to remedy any defect. This includes stage lighting provided specifically for an occasion, whoever arranges the provision.

It is recommended that the installation should be inspected and tested after any changes are made to wiring, connections, fixings/mountings/suspensions, etc and results recorded.

All installations should be inspected and tested annually by a competent person, as for the fixed electrical installation, and a test certificate issued.

One of the biggest potential hazards occurs when ad hoc lighting suspension arrangements are employed. Many examples of misuse of scaffolding equipment have been observed, with little regard to the correct electrical safety or to the safety of the methods of suspension. In many cases electrical flexes have been used to suspend equipment or have been entwined around elements of the building structure, thereby creating a potential hazard.

E

APPENDIX E

Planned maintenance of emergency lighting

Emergency lighting is provided to indicate clearly the escape routes, to illuminate the escape routes and the exits, and to ensure that fire alarm call points and fire-fighting equipment can be readily located in the event of electricity supply failure to the normal lighting.

Emergency lighting therefore is essential to the protection of life and must be maintained to operate correctly. *BS 5266: Part 1: 1988*[20] deals with all aspects of the provision of emergency lighting, detailing the specific maintenance requirements and the intervals at which they should be carried out.

To ensure the satisfactory operation and maintenance of an emergency lighting installation a responsible person should be appointed to supervise the system and ensure that:

- records are kept
- procedures are set out for the routine inspection and testing of the installation
- the system is maintained.

Records should be kept on site in which all pertinent information is entered, including:

- date of completion certificate(s) (including those relating to alterations)
- date and details of each inspection, test or service and associated certificate
- dates and details of defects and remedial actions
- dates and details of any alterations.

It is recommended that these details be kept in a logbook. 'As-installed' drawings could be marked to give each component part a unique reference (its asset code), which would be entered in the logbook and marked on the component itself. The routine inspection and testing of the installation are carried out at two levels:

1. The first is that carried out by the user, without the aid of tools or equipment, such as daily checks of indicating panels, monthly energising of each luminaire by simulating supply failure, etc. The content and intervals should be determined by a competent person and set out in terms which are understandable by a non-technical but responsible person.

2. Other regular maintenance work, such as the three-yearly inspection and test for compliance with *BS 5266: Part 1: 1988*, and issue of the periodic inspection and test certificate, etc, should be carried out by a competent person. A copy of this certificate may be required by the enforcing licensing authority who may specify how frequently the work should be carried out.

Emergency lighting installations also have the same maintenance requirements as those for normal lighting, e.g. cleaning of lamps, luminaires, etc, and the inspection and testing of the electrical installations.

APPENDIX G

Planned maintenance of fire alarm systems

Fire alarm systems are concerned with the protection of life and of property.

Building Bulletin 7[21] deals with the design of fire alarms and refers to relevant British Standards which also deal with maintenance, in particular *BS 5839: Part 1*[22]. In addition to British Standards a great deal of guidance is available from trade and other organisations, including:

The Association of British Insurers

The Electrical Contractors' Association

The Fire Officers' Committee

The Loss Prevention Council.

Guidance should also be sought from the local Fire Brigade.

BS 5839: Part 1 should be carefully considered before setting up the operation and maintenance of a system; it details the particular tasks required to be carried out and specifies the intervals between them.

To ensure the satisfactory operation and maintenance of fire alarm systems, a responsible person should be appointed who should supervise the system and ensure that:

a. Procedures are set out for dealing with alarms, system faults, false alarms, routine inspection and testing, and maintenance.

b. Records are kept.

c. Users of the system are trained.

d. Operation of the system is not impaired.

e. The system is maintained.

Advice on procedures and training and other guidance is given in *BS 5839: Part 1*. These measures should be agreed with the appropriate fire authority. Constant vigilance is required to ensure that the system operation is not impaired, such as by the obstruction of detectors, callpoints etc.

Records should be kept, on site, of all pertinent information regarding the system, including:

□ name and location of the responsible person for the system

□ details of the maintenance contractor

□ dates, times and causes of alarms, including reference of initiating call point/detector

□ dates, times, symptoms and locations of all faults/defects

□ dates, times and description of all maintenance works (routine and call-out)

□ dates, times, and details of periods of system isolation or reduced operation

□ details of all alterations to the system.

These details may be kept in a logbook. *BS 5839: Part 1* gives a sample logbook page, which is reproduced in Figure 14. 'As-installed' drawings could be marked to give each component part a unique reference (its asset code) to which to refer in the logbook; the component could be marked with its reference.

Regular maintenance is carried out at two levels: the first, by the user, without the aid of tools and equipment. This includes routine inspection and testing of the system to ensure satisfactory operation.

Other regular maintenance work must be carried out by a competent person, including the checking of batteries and indicator functions every three months, and the correct operation of any automatic detectors annually. On completion of the works of each service visit, the visit should be recorded in the logbook together with any defects, which should be reported to the responsible person, and arrangements made to remedy them. A test certificate should be given to the responsible person; a model certificate is given in *BS 5839: Part 1*.

To satisfy the requirements for work to be carried out by competent persons, it is recommended that a contract for regular tests and maintenance is taken with a reputable fire alarm service company at the handover of the installation. New systems which may have manufacturer-specific electronic components or software may be capable of being adequately maintained only by the manufacturer (or his/her agents) and this is a factor for consideration when specifying new equipment.

These systems should also be subjected to the same tests and inspections as the main electrical systems, and at the same intervals, as dealt with under Appendix A.

Figure 14
BS 5839: Part 1: 1988: Model logbook page for fire alarm systems

BS 5839 : Part 1 : 1988
Appendix D

D.3 Model log book

Log book

Foreword

It is recommended that this log book is maintained by a responsible executive who should ensure that every entry is properly recorded. An 'event' should include fire alarms (whether real or false), faults, pre-alarm warnings, tests, temporary disconnections and the dates of installing or servicing engineer's visits with a brief note of work carried out and outstanding.

Reference data

Name and address ....

....

Responsible person .... Date ....

.... Date ....

.... Date ....

.... Date ....

The system was installed by ....

and is maintained under contract by .... until ....

Tel. no. .... who should be contacted if service is required.

Event data

Date	Time	Counter reading*	Event	Action required	Date completed	Initials

Expendable component replacement due (list): ....

....

....

*If an event counter is provided (see 28.2.2).

A program controlled system may need a column to record the readings of the failure to correctly execute software counter (see 6.9(d)).

APPENDIX H

Planned maintenance of intruder alarm systems

However well designed and maintained, an intruder alarm system can never be completely reliable or tamper-proof. There will always be a proportion of both false alarms and failures of the system to react to intrusion. The purpose of adequate maintenance is to maximise the effectiveness of the system in detecting unwanted intrusions and minimise the occurrence of false alarms. *Building Bulletin 69*[23] provides guidance on maintenance.

Increased numbers of false alarms and of failures of the alarm system to react to intruders are typical symptoms of inadequately maintained systems. In the case of systems connected to central stations, the police may refuse to respond to alarms if they are activated too often.

The responsible person for the intruder alarm system should be fully conversant with the operation of the system and the action to be taken after an incident, and should ensure that all authorised personnel, such as keyholders, are similarly conversant.

There is little regular maintenance which can be carried out by the non-technical user without the aid of tools and equipment. The main task is to ensure that the fullest information possible regarding any incident is recorded, for example what occurred, when, environmental conditions, zone reference, detector reference, etc, so that a full evaluation can be carried out to determine any remedial action necessary.

To ensure that false alarms are minimised, many police authorities insist that remotely monitored systems are maintained by a specialist contractor and that any alarm must be reset by the maintenance operative. However, resetting by a maintenance operative can become very costly and some LEAs have made arrangements with the police, that, provided they show competence in managing the alarm system and a low incidence of false alarms, the occupier can reset the system.

BS 4737[24] recommends that the original installer or a maintenance company should be contracted to carry out maintenance. It also recommends that preventive maintenance should be carried out every six months for systems with remote signalling and/or with primary batteries, and annually on those with local sounders only and/or rechargeable batteries, and that when corrective maintenance is required an engineer should be on site within four hours of call-out.

On completion of the works of each service visit, the visit should be recorded in the logbook together with any defects, which should be reported to the responsible person, and arrangements made to remedy them. *BS 4737* requires that faults identified on a service visit should be rectified within 21 days. A test certificate should be given to the responsible person.

Maintenance of a system not only involves the servicing of the hardware but also the continual evaluation of the effectiveness of the system. Consequently it must involve both the maintenance company and the customer.

As with the maintenance of all electrical systems, records are of prime importance. However, in the interests of security some of the information stored in the records will be restricted to preserve the integrity of the system, for example 'as-installed' drawings, operation and maintenance manuals, etc and it is essential that unauthorised access to these is prevented. The operating instructions should be clear and concise, including rudimentary fault-finding, to allow the unskilled user to deal with problems within his or her competence.

Records should be kept, on site, of all pertinent information regarding the system, including:

- details of the person responsible for the system
- details of the maintenance contractor and the operative visiting site
- dates, times, and causes of alarms, including reference of initiating point/detector
- dates, times, symptoms and locations of all faults/defects
- dates, times and descriptions of all maintenance works (routine and call-out)

- dates, times and details of periods of system isolation or reduced operation
- details of all alterations to the system.

These details may be kept in a logbook. 'As-installed' drawings could be marked to give each component part a unique reference (its asset code) to which to refer in the logbook; the component could be marked with its reference.

Plans for any work which extends buildings must take into account any required modification of the intruder alarm system. To this end, and taking into consideration the importance of these systems in avoiding costly damage to property, a single point of responsibility is recommended to provide adequate co-ordination of work. Another aspect that needs to be considered is the use of the premises outside normal hours, and whether zoning of the intruder alarm system could provide for protection of unused parts of the buildings while other parts are being used.

I

APPENDIX I

Planned maintenance of electrical equipment

All electrical equipment, including any items of personal equipment used on the property, should be routinely inspected and tested. HSE *Guidance Notes GS23*[12] and *PM 32*[25] give advice.

Prior to the use of any newly acquired electrical apparatus, it should be inspected and tested by a competent person; this applies to all equipment but in particular to custom-built (home-made) or modified equipment and that brought in from home. This latter category is likely to comprise equipment disposed of by parents (this may be broken or dangerous). Modifications to equipment should be carried out only by a competent person, in accordance with manufacturers' instructions. Plugs and sockets must be selected to ensure that they can be connected only to the correct supply, for example it must not be possible to plug 110V apparatus into a 240V socket.

Some electrical apparatus already installed may not have been constructed to modern standards, for example kilns which may have exposed electrical elements that can be touched. While there is no general requirement for such equipment to be updated to current standards, it must be made safe: for example, in the case of the kiln, by fitting guarding to the element or installing an interlock to isolate the element when the door is open, to prevent access to live parts. *BS 5304: 1988*[26] gives guidance.

Some electrical equipment, including some computers, have a continuous earth leakage current. Care needs to be taken when a number of such items are supplied from a single ring main. Earthing requirements for such installations are clearly set out in *IEE Wiring Regulations*[11], Section 607, and should be complied with. The size of the earth leakage current may be available from the equipment supplier. Otherwise it can be estimated or measured.

A register of electrical equipment should be kept. To this end an inventory should be carried out of all electrical apparatus used, whether the equipment is proprietary or custom-built. The details should be kept in a logbook or card system or on computer. Each additional piece of equipment acquired should be added to the records.

Each piece of equipment should be given, and be labelled with, a unique reference (asset code) for future identification and maintenance planning. The asset coding should follow the same principle as that used for the remainder of the electrical services so that it can be integrated as appropriate.

The results of periodic inspections should be recorded for each piece of equipment and show the date, who made the inspection, defects noted and remedial action taken.

The results of the periodic inspection and test by a competent person should be recorded; Figure 16 shows the form given in HSE *Guidance Note GS 23* which could be amended to suit particular needs.

It is recommended that, on satisfactory completion of the inspection and test, the apparatus is labelled with the required date of the next inspection and test.

Portable equipment

General

Equipment of this type falls into two distinct classes, based on the nature of the electrical insulation and construction:

Class 1: Equipment which has basic electrical insulation throughout and is provided with an earthing terminal, contact or conductor.

Class 2: Equipment with double insulation and/or reinforced insulation throughout and no earthing provision. This type of equipment is normally identified by the symbol of a small square set within another square as shown in Figure 15.

Figure 15
The symbol for double insulation of equipment

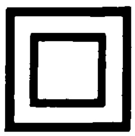

Figure 16
Portable appliance test sheet

Listed below are typical electrical checks for portable apparatus, to be carried out by a suitably competent person.

Note: This checklist is intended as a guide; certain apparatus may need different or additional inspections and tests.
Non-electrical checks are outside the scope of this guidance note.

Equipment:

Make:

Serial No:

Item	Test	Pass condition
1 mains lead	(a) visual inspection	two layers of insulation no damage
	(b) mains plug	correctly connected cable clamp gripped to sheath correct fuse fitted
2 either mains lead or instrument connector (if lead detachable)	(a) visual inspection of instrument male connector	IEC 320 type or equivalent (BS 4491, CEE22)
	(b) attempt to open socket without tool	unopenable
	(c) attempt to pull socket cable from female connector	no movement
	(d) polarity of 3-pin units	as per BS 4491
or: grommet/clamp	(a) inspection of grommet	cable insulation protected
	(b) sharp pull on cable	no appreciable movement
	(c) rotation of cable	no rotation
3 mains on/off switch	(a) visual inspection	correct operation no damage
4 conducting case	(a) visual inspection: (if marked ▣ treat as item 5) earth tester which will check resistance and pass a current of at least twice the fuse rating.	earth resistance 0.1 ohms or earth resistance 0.5 ohms for loads fused at 3 Amps or less
	(b) high voltage insulation 500 V ac minimum test	no fault indicated after 5 seconds
5 insulating case	visual inspection	maker's double insulation mark visible ▣ case undamaged - if in doubt test using portable Appliance Tester
6 accessible fuse holders	visual inspection	no damage removal of carrier does not permit live part to be touched
7 exposed output connection	(a) visual inspection	no voltage greater than 50V
	(b) for outputs greater than 50V*	short-circuit less than 5 mA or short-circuit current greater than 5 mA and labelled 'unsuitable for use by children'.*

* ie live at more than 50 V when in use.
NOTE: at least 25% of all double insulated equipment should be tested each year ie all equipment is tested at least once every 4 years.

Overall result (Delete as necessary)

Unit is passed / failed

Signed: .... Date ....

Reproduced from HSE Guidance Note GS23 'Electrical safety in schools'

66

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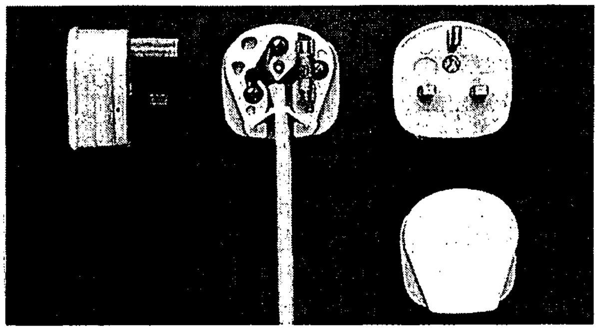
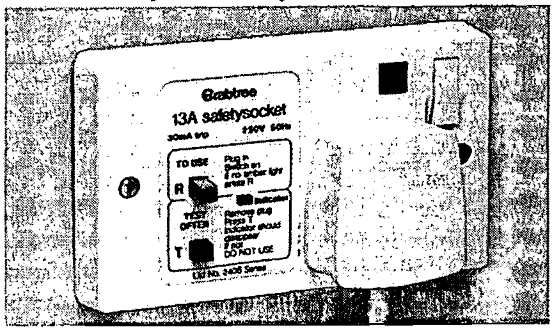
Figure 17
BS 1363 plug and socket outlet

a. BS 1363 plug



b. BS 1363 plug and socket
(in this case protected by a RCD)



Portable 240 volt equipment will be connected to the socket outlet by a plug (see Figure 17), which should be manufactured to BS 1363. Plugs should be fitted to equipment flexible leads only by people trained to do it. The length of the flexible lead should not exceed 2 metres. The earth conductor, left slack in the plug, should be longer than the phase (live) and neutral conductors. This means that should the cable be pulled through the cable grips, the earth conductor will be the last to be pulled from its terminal. (This applies in the case of equipment not double insulated.)

The routine inspections and tests are carried out at three levels:

i. visual inspections for damage or defect by the teacher on each occasion the equipment is to be used

ii. periodic visual inspections by suitably trained staff before each school term; experience of particular equipment may show that more frequent inspection is appropriate

iii. periodic inspection and test by a competent person, at least:

- every 12 months for class 1 equipment
- every four years for class 2 equipment.

The results of periodic inspections and tests should be recorded, as should all defects. Defective equipment should be rendered unusable, for example by disarming and locking away until it has been repaired or is disposed of.

Portable apparatus (appliance) testers are available with which the electrical tests can be carried out (see Figure 5).

Fixed equipment

When electrical equipment is acquired a competent person should assess the frequency of the inspection and test, which will generally be included as part of the inspection and test of the electrical installation (see Appendix A). The extent of the inspection and test will be as detailed for portable equipment as appropriate.

The COSHH Regulations[27] require that local exhaust ventilation and the associated controls are adequately maintained and that the maintenance is recorded. This will include the various dust collection systems associated with craft, design and technology and other craft equipment.

APPENDIX J

Planned electrical maintenance of swimming pools

Swimming-pools in educational establishments vary enormously, between those of indoor international competition size, open to members of the public, and very small open-air pools built by voluntary bodies (such as PTAs). Notwithstanding these differences in size (and indoor/ outdoor locations), the requirements of the electrical installations are exactly the same, and are covered by Section 602 of the *IEE Wiring Regulations*[11]: 'Swimming-pools'.

From investigations carried out for the purposes of this Bulletin, it is apparent that many of the smaller installations built by purely voluntary efforts fall below normally accepted standards; this situation must be remedied. If funds do not allow this to happen immediately then the facility concerned should be taken out of use.

Inspection and testing should be carried out to the same standards as other parts of the site electrical installation, but because of the increased hazard it should be done at more frequent intervals.

In the case of swimming-pools in educational establishments, the users are often wet all over, without shoes or outer clothing, and the majority are of course children, of much lighter body weight and therefore more vulnerable to shock than adults. Because of the decrease in resistance of the skin when it is wet, electric shocks are much more harmful than usual.

In addition to the increased hazards associated with electric shock, the methods used to ensure the water conditions are suitable for bathers often use chemicals that can be highly corrosive under certain circumstances.

Where there is a need for electrical equipment near the pool it is essential that the enclosure is of the relevant protection standard. This is normally indicated by the IP number (Ingress Protection); these two digits indicate respectively the degree of mechanical protection and the degree of protection from liquids. For example, IP55 is the minimum standard enclosure to be used for electrical equipment which gives protection against water-jets from any direction.

It is necessary to be able to safely service the lighting installation in indoor pools, particularly fittings above it, and to take account of the effects of condensation and acidic conditions that can occur. This is of particular importance with suspended ceilings.

With regard to the chemical treatment and/or heating plant, again normal installation and maintenance practices should be employed, with particular regard to the possible adverse effects of chemical spillage and the presence of water. These installations also require regular testing; the controls require good quality maintenance to ensure energy efficiency and also that the chemical dosing of the water is of acceptable accuracy. There are a number of documented cases of chlorine poisoning. Other chemicals employed in water treatment can also be poisonous.

APPENDIX K

Planned maintenance of lightning protection systems

The purpose of a lightning protection system is to divert a lightning discharge away from the structure being protected to the system itself, and then to convey the discharge safely to earth via a low electrical resistance path.

The maintenance of these systems involves periodic inspection and testing, with appropriate remedial work then being carried out, to ensure the electrical integrity of the installation and the security of the fixings to the building structure and to eradicate the detrimental effects of corrosion.

If a lightning strike does occur, the values of current flowing through the protection system could be very high; in the range of 2,000–20,000A. This very high current can produce considerable electromagnetic forces, therefore the fixings must be very secure. In addition to these forces produced by the passage of current, a considerable temperature rise can take place which produces further mechanical forces.

Corrosion at any of the joints in the system can produce high-resistance joints, which would increase the heating effect, or in the worst case produce within the system such a high resistance that the protection system would no longer function. This highlights the importance of constructing the system from appropriate materials.

Subsequent maintenance, alteration, remedial works, etc should be in accordance with *BS 6651: 1990*[28] which states that records should be kept and details their content.

Inspection and testing should be carried out at least every 12 months. Weather conditions and the season of the year may affect the soil condition, which in turn affects the resistance to earth of the earth electrodes. Therefore a shorter interval, perhaps 11 months, may be planned in order to vary the seasons in which the test is carried out.

The visual inspection and testing should be carried out by a competent person to ensure the installation complies with *BS 6651: 1985* and to assess the mechanical condition. These observations should be recorded.

If the test results obtained are significantly higher than previous readings the cause should be investigated and remedial action taken as necessary.

The installation and maintenance of these systems are normally carried out by specialist contractors. As with many other aspects of electrical maintenance, the only staff tasks are to observe and to report to the appropriate authorities if damage has occurred. As lightning protection systems are fixed to the external building structure, where the system comes near ground level it can be vulnerable to vandalism or inadvertent damage by vehicles, etc.

If alterations or extensions are to be carried out on a site (such as the erection of a television aerial or of new flues for heating plant or new/extended buildings) any existing system should be extended or otherwise modified as necessary. If there is no protection system an assessment should be carried out to determine if a system is required.

L

APPENDIX L

Planned maintenance of lifts

Lifts are one of the few items of building services equipment for which there is a specific legal requirement to carry out adequate maintenance, although mandatory only when either the Factories Act or the Offices, Shops and Railway Premises Act applies to a premises. However, there is a requirement under the Health and Safety at Work etc Act in other premises, and the guidance issued by the HSE does imply that the same requirements should be adopted. There is also a requirement to have the installation examined by a competent person.

Lifts are complex electrical and mechanical devices which can be exposed to severe vandalism. Consequently it is very important to ensure that they are adequately maintained.

Because of the nature of these installations, it is normal practice to have the maintenance work carried out by a specialist contractor, who is often one of the lift manufacturers, the vast majority of whom provide a variety of services.

HSE *Guidance Note PM7*[29] provides guidance.

Normal commercial practice is to have the thorough examinations carried out by an organisation independent from the maintenance contractor. These specialist examinations are normally carried out by an insurance company surveyor, whose services are provided by the various insurance companies that offer cover for all types of engineering plant. In addition to the mandatory examinations of each lift installation at maximum intervals of six months, a number of other specified aspects of examination and testing are necessary, and although these may be carried out by a contractor, some would normally be witnessed by the insurance company surveyor on behalf of the owner of the installation.

It is the occupier's (or owner's) responsibility to ensure that the required examinations and maintenance are carried out. Contractual relationships between an occupier (or owner) of a building and a specialist insurance company for the thorough examinations, and a specialist contractor for maintenance, to be carried out as prescribed, do not absolve the occupier (or owner) of the responsibility to ensure the examinations are carried out on time.

Legislation requires that records are kept; specifically it requires that a report of the examination is issued within 28 days with a prescribed content and format. The occupier (or owner) of the building is required to retain these reports for a period of two years. Figure 19 shows a typical form.

Maintenance contracts offered by the manufacturers at the highest level of service provide for a planned preventive maintenance programme of work, the replacement of parts and a call-out response. Below this comprehensive service there are other contractual relationships available where time and/or materials are charged for separately.

One factor that should be considered when seeking competitive tenders is that if a contractor being considered is not the manufacturer then the contractor's ability to obtain spare parts must be thoroughly researched. The same observation applies if the lift installation is fairly recent and part of the control system is software controlled. The software may be copyright protected or the original supplier may not release information concerning the software.

Specific assistance and advice concerning contractors and manufacturers can be obtained from the National Association of Lift Manufacturers.

There are a number of British Standards that apply to lifts with regard to design, installation, operation and maintenance, the main one being *BS 5655*[30]; this standard is in a number of component parts. As with any standard it is important to ensure the relevant part is being used and that it is the most recent copy. In addition to the British Standards, the electrical installation and maintenance work should be carried out in accordance with the *IEE Wiring Regulations*[11].

Figure 18

Typical points of a lightning protection system which require attention during planned maintenance

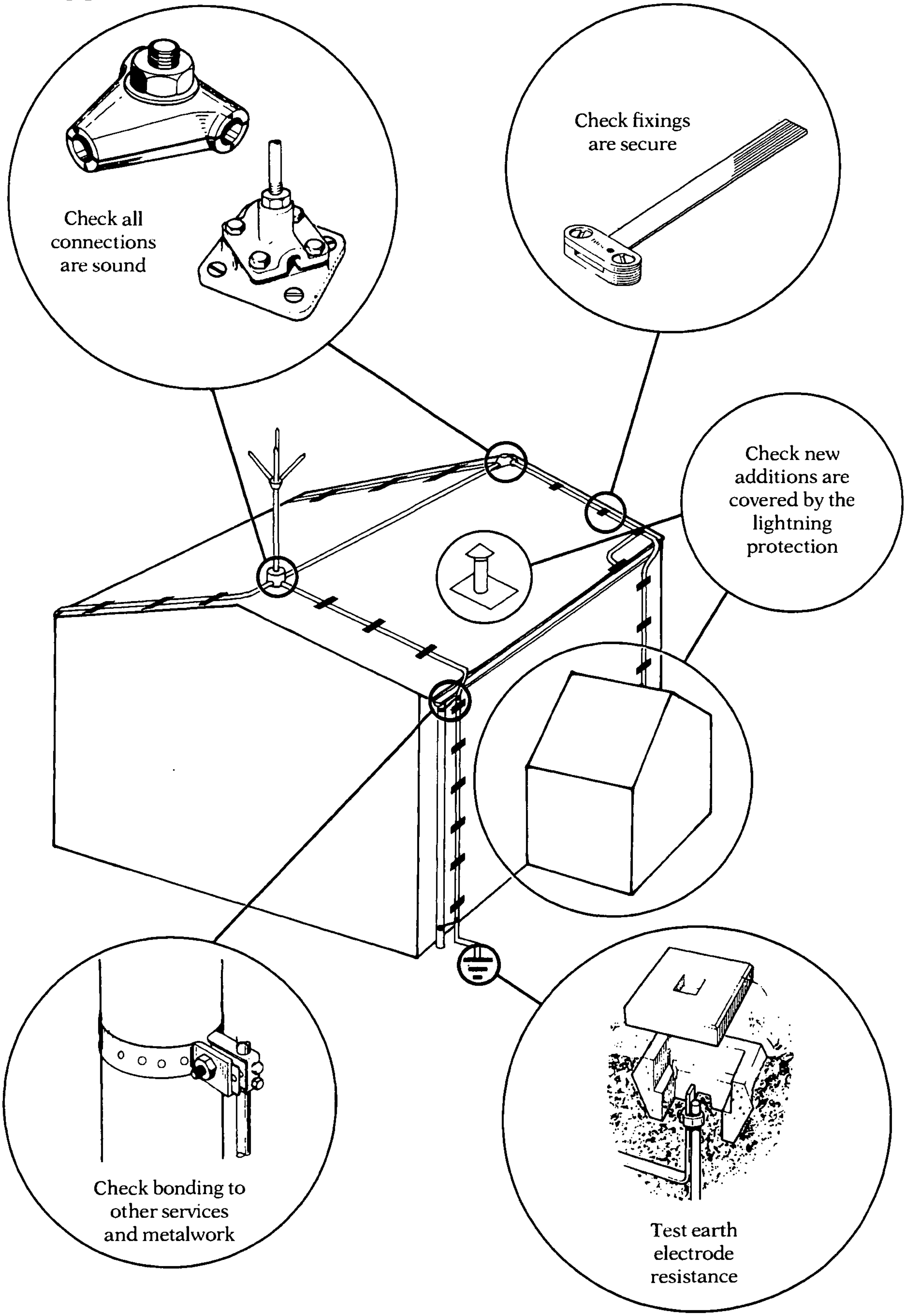


Figure 19
Typical lift inspection form

Health and Safety Executive
The Offices, Shops and Railway Premises (Hoists and Lifts) Regulations 1968 – Regulation 6
Factories Act 1961 – Sections 22, 23 and 25

Form prescribed for the
Report of examination of hoist or lift

Occupier (or owner) of premises

Address

1.a. Type of hoist or lift and identification number and description.

b. Date of construction or reconstruction (if ascertainable)

2. **Design and construction** Are all parts of the hoist or lift of good mechanical construction, sound material and adequate strength (so far as ascertainable)?
Note: Details of any renewals or alterations required should be given in 5 and 6 below.

3. **Maintenance** Are the following parts of the hoist or lift properly maintained and in good working order? If not, state what defects have been found.

a. Enclosure of hoistway or liftway

b. Landing gates and cage gate(s)

c. Interlock on the landing gate and cage gate(s)

d. Other gate fastenings

e. Cage or platform and fittings, cage guides, buffers, interior of the hoistway or liftway

f. Over-running devices

g. Suspension ropes or chains, and their attachments

h. Safety gear, i.e. arrangements for preventing fall of platform or cage.

j. Brakes

k. Worm or spur gearing

l. Other electrical equipment

m. Other parts

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(continued overleaf)

4. What parts (if any) were inaccessible?

5. Repairs, renewals or alterations required to enable the hoist or lift to continue to be used with safety –
a. Immediately.

b. Within a specified time, the said time to be stated

If no such repairs, renewals or alterations are required, enter "none".

6. Defects (other than those specified at 5 above) which require attention.

7. Maximum safe working load subject to repairs, renewals or alterations (if any) specified at 5.

8. Other observations

I/we certify that on __________ I/we thoroughly examined this hoist or lift and that the foregoing is a correct report of that result,

Signature(s)

Qualification

Address(es)

Date

If employed by a company or association give name and address

Notes
The Factories Act 1961 and the Offices, Shops and Railway Premises (Hoists and Lifts) Regulations 1968 provide that every hoist or lift shall be thoroughly examined by a competent person:
a. in the case of a continuous hoist or lift or a hoist or lift not connected with mechanical power – at least once in every period of 12 months.
b. in the case of other hoists or lifts – at least once in every period of six months.

A report of the result of every such examination is required in this prescribed form.

In premises where the Factories Act applies this form must be attached to the General Register. Otherwise it must be kept available for inspection for a period of 2 years.

When the examination shows that the hoist or lift cannot be used with safety unless certain repairs are carried out immediately or within a specified time, a copy of the report must be sent to the appropriate enforcing authority, i.e. the Principal Inspector of Factories, the District Inspector of Mines and Quarries or the local authority, within 28 days of the completion of the examination.

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Glossary

Accessory:	A device such as a socket outlet, light switch, fused connection unit, etc associated with the wiring of the final circuits of an electrical installation.
'As-installed' drawings:	Drawings marked to show the position of plant and equipment and major service routes (e.g. cables, trunking, etc).
Asset:	In the electrical services sense, an electrical system, e.g. a fire alarm system (which will have control panels, call points, sounders etc as sub-assets) or a single item of equipment, e.g. a kiln.
Bonding:	An electrical connection between electrically conductive parts (e.g. water pipes, stainless steel sinks etc). Earth bonding is bonding electrically connected to earth.
Breakdown maintenance:	Repair. Also known as unplanned, or reactive maintenance.
COSHH Regulations:	The Control of Substances Hazardous to Health Regulations 1989 under which the employer has responsibility to ensure that substances and processes are assessed, and exposures limited.
Earth bonding:	see Bonding.
Life-cycle cost:	The total cost of all aspects of an action, e.g. capital, maintenance, energy, depreciation etc over the expected life of the asset.
Luminaire:	The lamp(s), body (housing), light controller (diffuser) and all components necessary for fixing and connecting to the electricity supply. (Previously known as a lighting fitting.)
Maintenance and operating documents:	Records detailing all assets installed, manufacturer's data for each asset, drawings showing where each asset is installed, the maintenance required by each asset, etc.
Miniature circuit-breaker (MCB):	A resettable device used instead of a fuse to protect electrical wiring etc in the event of overload, short-circuit or earth-fault.
Planned maintenance:	Maintenance organised and carried out with forethought and the use of records.
Preventive maintenance:	Maintenance carried out at predetermined intervals to reduce the probability of failure.
Reactive maintenance:	See Breakdown maintenance.
Residual current device (RCD):	A resettable mechanical switching device which cuts the electricity supply to the controlled circuit when a leakage of current to earth (possibly through a person) is detected. Used in addition to MCBs or fuses to provide a higher degree of protection against electric shock and fire due to electrical faults.
Unplanned maintenance:	See Breakdown maintenance.

Addresses of professional associations

The Association of Consulting Engineers
Alliance House, 12 Caxton Street, London SW1H 0QL — Tel. 071-222 6557

Chartered Institution of Building Services Engineers
Delta House, 222 Balham High Road, London SW12 9BS — Tel. 081-675 5211

The Electrical Contractors' Association
ESCA House, 34 Palace Court, London W2 4HY — Tel. 071-229 1266

The Institution of Electrical and Electronics Incorporated Engineers
Savoy Hill House, Savoy Hill, London WC2R 0BS — Tel. 071-836 3357

The Institution of Electrical Engineers
Savoy Place, London WC2R 0BL — Tel. 071-240 1871

National Inspection Council for Electrical Installation Contracting
37 Albert Embankment, London SE1 7UJ — Tel. 071-582 7746

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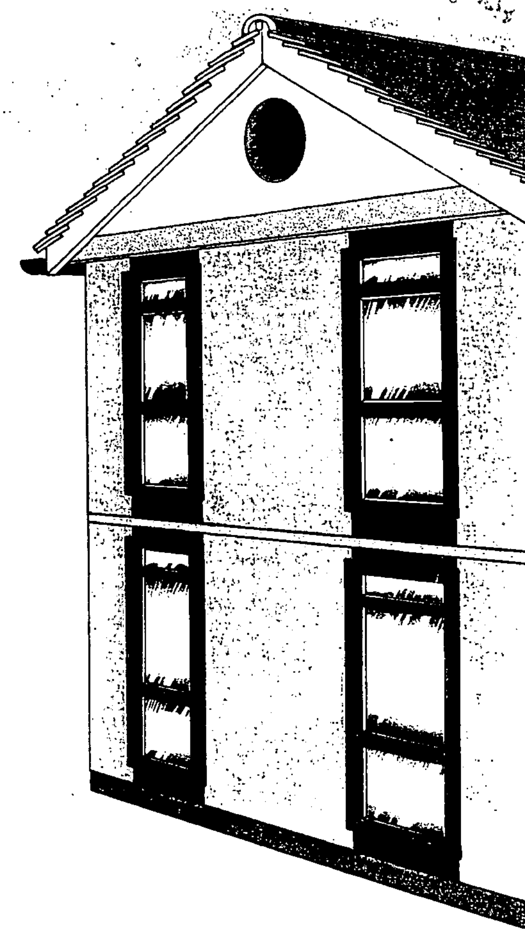
This Bulletin will be helpful to Heads, governing bodies, LEAs, consultants and others involved with the maintenance of electrical services in schools.

It emphasises the importance of safety and gives guidance on the development of an overall strategy to cover record documentation and systems, inspection and testing, condition appraisal, maintenance requirements and maintenance works procedures.

Further sections deal briefly with topics such as educational requirements, energy, community use, spare capacity and tasks for school staff.



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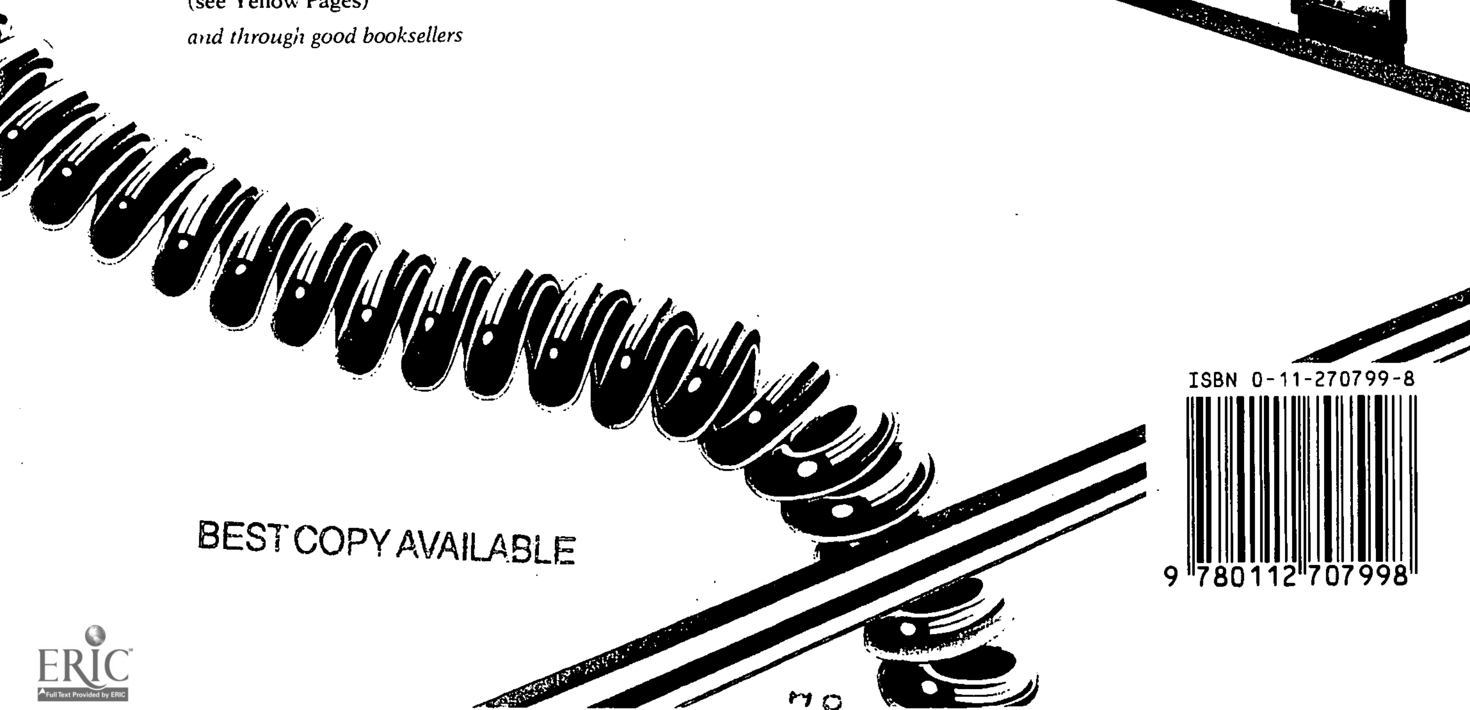

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