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SEAWARD

Tried. Tested. Trusted.

A GUIDE TO
Portable Appliance Testing

Contents

SEAWARD
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In safety testing, the bottom line is human life. So it's our business to know your work inside out. This guide is what we know about the procedures of PAT testing.

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Acts, Regulations and Directives
The Electrical Equipment (safety) Regulations 1994 ("the 1994 Regulations"), which are made under section 11(1) of the Consumer Protection Act 1987 ("the Act") and section 2(2) of the European Communities Act 1972 implement into UK law the modified Low Voltage Directive. The 1994 Regulations apply to all electrical equipment and cover domestic electrical equipment and equipment that is intended for use in the workplace.

The Health and Safety at Work Act 1974 (HSW Act 1974) Sect 6.1 (c) requires that it shall be the duty of any person who designs, manufacturers, imports or supplies any article for use at work to supply adequate information about the use for which the article is designed and has been tested, and about any conditions necessary to ensure that it will be safe when being used, cleaned, set, maintained, dismantled and disposed of.

The Electricity at Work Regulations 1989 apply to every type of electrical equipment and state: "As may be necessary to prevent danger, all systems shall be maintained so as to prevent, so far as is reasonably practical, such danger" (Regulation 4(2)).

The EC "Provision and Use of Work Equipment Regulations 1998" places general duties on employers and lists minimum requirements for work equipment to deal with selected hazards whatever the industry.

The Regulations implement an EC Directive aimed at the protection of workers and the "general duties" will require the need to:

(a) Make sure that equipment is suitable for the use for which it is provided.
(b) Take into account the working conditions and hazards in the workplace.
(c) Ensure equipment is used only for the operations for which, and under conditions for which, it is suitable.
(d) Ensure that equipment is maintained in an efficient state, in efficient working order and in good repair.
(e) Provide equipment that conforms to EC product safety directives
(f) Plus certain other general duties and specific requirements etc.

The words "Work equipment" broadly define everything from a hand held tool to machines of all kinds.

The Approved Code of Practice and Guidance document to the Provision and Use of Work Equipment Regulations 1998 (LL2) states that 'efficient' relates to how the condition of the equipment might affect health and safety; it is not concerned with productivity.

Objectives of this guide
The objectives of this Practical Guide are to provide the information required to ensure the safety of the test person whilst conducting the tests and to assist that person to manage the test location to prevent danger to others who may be affected by their activities.

This Guide does not replace the requirement for the test person to be competent to test, but is designed to assist that competent person to conduct the testing activity in a safe manner under a variety of circumstances.

Such a competent person will be able to utilise this Guide by successfully adapting the principles described to ensure safety in his particular test environment and circumstances.

The duties of manufacturers, hirers and maintainers are each considered in addition to those of the user and where necessary references will be made to Statutory Law and Approved Codes of Practise (ACoP).

The booklet will explain logically the legal requirement to test, who should perform the tests and what equipment should be tested. It is also necessary to examine where and how the tests may be performed safely and how often they should be carried out.

Record keeping is outlined and guidance is given on the interpretation of results under Section 11 "RECORD KEEPING".

PAT SYSTEM

SEAWARD
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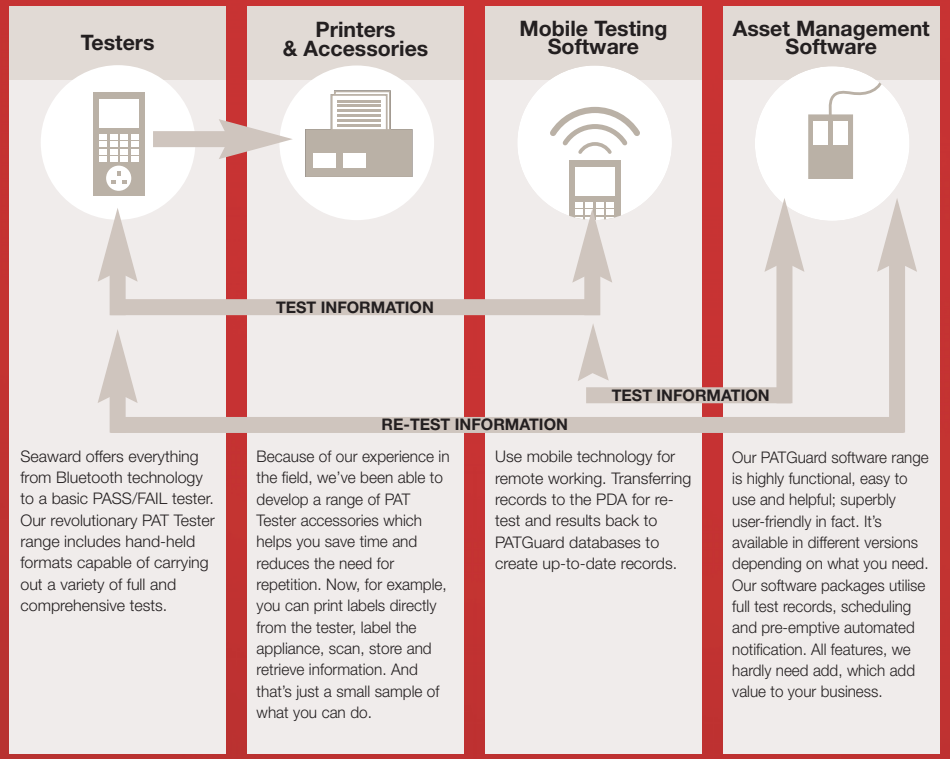
Smart technology and an intimate knowledge of the job result in Testers designed for easier work and better profits.

Today's world moves at an unprecedented pace: things change every day. Everything's smarter, smaller and faster. This is good news for us, and for you. It means we're developing and manufacturing better equipment and can incorporate technologies like Bluetooth data transfer and PDA test management databases. And we're not confined to supplying test equipment. We can now help your business or institution become more efficient and effective. We call it PATSolutions. This groundbreaking process involves everything from choosing your PAT Tester to following up with calibration services and training courses. It streamlines your processes, reduces costs, increases productivity and improves profits.



Testers

Seaward offers everything from Bluetooth technology to a basic PASS/FAIL tester. Our revolutionary PAT Tester range includes hand-held formats capable of carrying out a variety of full and comprehensive tests.

Printers & Accessories

Because of our experience in the field, we've been able to develop a range of PAT Tester accessories which helps you save time and reduces the need for repetition. Now, for example, you can print labels directly from the tester, label the appliance, scan, store and retrieve information. And that's just a small sample of what you can do.

Mobile Testing Software

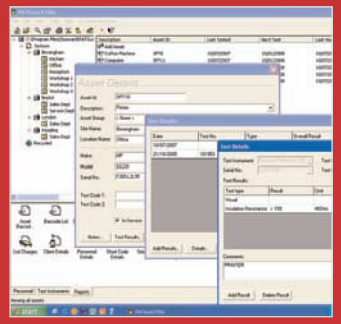
Use mobile technology for remote working. Transferring records to the PDA for re-test and results back to PATGuard databases to create up-to-date records.

Asset Management Software

Our PATGuard software range is highly functional, easy to use and helpful; superbly user-friendly in fact. It's available in different versions depending on what you need. Our software packages utilise full test records, scheduling and pre-emptive automated notification. All features, we hardly need add, which add value to your business.

PAT SOFTWARE

PATGuard 2. New generation software that takes the stress out of the Testing process.



SEAWARD
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At Seaward, we focus on more than tester improvement. We offer a total solution, which makes PAT Testing a lot quicker and easier. From test and measurement equipment, right through to software and accessories. Our PATGuard 2 software is functional, easy to use and helpful. It comes in three versions, each providing an optimum solution to a particular requirement. PATGuard 2 and our Work About 2 software bring added value to your customer offer. Proactive and user friendly, it presents you with a totally connected system which lets its various parts 'talk to each other'. It can email you to warn you when it's time to re-test, for instance. Features like this cut admin time and let you get on with what you're good at.

Provides clear information on test user activity

Bluetooth technology for wireless data transfer

TEST N TAG SYSTEM

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Fast, automatic printing of appliance test labels direct from the test instrument.

Work is hard enough without the complications of using inferior products. Which is why at Seaward everything we do is designed to make your work easier and more efficient. Our new generation Test n Tag printers are perfectly equipped to help. Up to the minute Bluetooth technology means information can be transferred immediately from your tester. Moments later, a tamper and waterproof label can be printed, with or without your logo. Of course we ensure your new printer is tough enough to last a very long time and clever enough to manage its own power usage.

Printers like these will not only shorten the time you spend at each test site, they will make the process of test n tagging much easier.

1 – THE LEGAL REQUIREMENT TO TEST

The 1994 Regulations affect all persons who supply electrical equipment. They affect:

- manufacturers;
- importers into the EEA;
- wholesalers, distributors;
- retailers (including mail order traders);
- persons who hire out electrical equipment in the course of business;
- persons (including auctioneers) who supply second hand electrical equipment in the course of business;
- persons who, in the course of business, let accommodation which contains electrical equipment.

The legal reference requiring testing to be carried out will vary in accordance with the tester's occupational function.

The Manufacturer
The 'manufacturer' is the person, whether established in the EEA or not, who is primarily responsible for designing and manufacturing equipment so that it complies with the safety requirements of the 1994 Regulations.
A manufacturer may suitably locate the testing function at the end of a production line and the tests performed should demonstrate that the 'article' meets his published specification which in turn should comply with applicable harmonised, international or national standards.
Should the manufacturer operate corrective feedback loops to both the design and production departments then the safety testing function could form part of a quality assurance system.

The Supplier
The 'supplier' of electrical equipment has a duty to test under the HSW Act 1974 Section 6. This requires that every supplier should ensure that the article he supplies is designed and constructed to be safe and he should carry out or arrange for testing or examination of the item to verify that the design safety standards have been met.

The term 'supplier' refers to the designer and/or manufacturer or to the hirer of an article and the responsibility for safety is corporate. If the supplier of an article has imported the item, then he bears full responsibility for the safety of the article as if he were the manufacturer.

The Importer
The 'importer' of an article may rely on assurances that the equipment is made to international safety standards if those standards are equivalent to the required UK standards. However; the foreign manufacturer should be able to demonstrate safety by supplying details of his national standard. If a suitable equivalent foreign standard does not exist, the foreign manufacturer should be able to state the safety test parameters to which the article has been subjected in order that the importer may compare such data with the required UK standards.

It should be noted that whilst the importer may refer the testing activity back to the foreign manufacturer or engage a suitable UK testing establishment, this does not transfer the responsibility for the product's safety. In cases of doubt over safety performance, the importer should be prepared to undertake the testing himself or engage a competent organisation to test on his behalf.

The Hirer
The 'hirer' of equipment has a general responsibility under the HSW Act 1974 (Section 6) to ensure that the article remains safe for each customer to use; the hirer also has a specific duty with regard to electrical equipment under the Electricity at Work Regulations 1989 (EAWR 1989).

Regulation 2 (EAWR 1989)
– An Electrical System
Regulation 2 (EAWR 1989) defines an electrical system as all equipment which is or can be connected to a source of electrical energy and the term includes both the source and the equipment.

The same Regulation defines electrical equipment as anything used, intended to be used or installed for use to generate, provide, transmit, transform, rectify, convert, conduct, distribute, control, store, measure or use electrical energy.

Regulation 4(2) (EAWR1989)
– Maintenance of a system
Regulation 4(2) (EAWR 1989) requires that all systems are maintained where this will prevent danger. Regulation 29 states that it shall be a defence if it can be proved that all reasonable steps were taken and all due diligence was exercised to avoid the commission of an offence under certain regulations.

The clear intention of the (EAWR 1989) is to ensure that a managed system is installed and maintained to prevent an accident, hence a prospective approach is required.
The prime method to accurately decide when maintenance is necessary to prevent danger is to perform regular inspections and testing of the equipment concerned; consequently there is a legal requirement to inspect and test any equipment which may be connected to an electrical supply.

A similar requirement falls upon the repairer of electrical equipment to perform safety testing after repair to ensure that any repair activity has not inadvertently introduced a danger to the subsequent user.

Users of Electrical Equipment
The 'user' of an article may be an employee. Users of electrical equipment have a responsibility to ensure that equipment they use has no obvious visual damage or defects. The employer has a responsibility to provide and maintain a safe plant for every employee to use (HSW Act 1974 Section 2(a)). This requirement is endorsed by the (EAWR 1989) Regs 4(1) and 4(2) with specific reference to electrical equipment. The (EAWR 1989) Reg 3(1) also places the same duties upon the self-employed.

It can be seen that the duty to test in order to ensure safety is extremely comprehensive and includes all work situations where electrical equipment is present, but there is no definitive requirement for a record book kept of the user's inspections.

Administrators
The IET Code of Practice gives advice to persons managing maintenance schemes. Administrators or managers of premises are required to understand and apply the legislation and assess the risks in respect of electrical equipment and appliances within their charge. Administrators have

a legal responsibility to ensure that the electrical equipment in their charge is safe.

The Test Operative
The person performing the inspections and tests on an item of equipment should be competent to carry out the inspections and tests, assess the results and the conditions in which the item is being used and state whether the item is safe for continued use. Training and experience will both be necessary.

2 - THE IDENTIFICATION OF EQUIPMENT

Definitions
Several types of electrical equipment are defined in the IET Code of Practice for In-service Inspection and Testing of Electrical Equipment.

Portable Equipment
An appliance of less than 18kg in mass that is intended to be moved whilst in operation, or an appliance which can be easily be moved whilst in operation, or an appliance which can easily be moved from one place to another e.g. vacuum cleaner, toaster, food mixer, etc.

Hence it may be regarded that portable equipment is designed to be carried or moved from place to place between periods of use and the power connection will be made by a "flexible cord" which will terminate in a plug for connection to the fixed supply.

Movable Equipment (Transportable)
This equipment is either:

- 18kg or less in mass and not fixed, e.g. electric fire or:
- Equipment with wheels, castors or other means to facilitate movement by the operator as required to perform its intended use e.g. air conditioning unit.

Such equipment may be considered "transportable" rather than portable, but will still be connected to its supply where applicable by a flexible cord and plug. The risk of damage which may cause the safety of transportable equipment to be compromised can be high. Also, the use of some transportable equipment carries a high risk due to the very nature of its use (e.g. a high pressure steam/water cleaner) and in such circumstances transportable equipment can present a greater hazard than most portable equipment, therefore the requirement to periodically test must also apply to transportable equipment.

Hand Held Equipment or Appliances
This is portable equipment intended to be held in the hand during normal use e.g. drill, hair dryer.

The risk of damage which may cause the safety of hand held equipment to be compromised can be high. Also, the use of some hand held equipment carries a high risk due to the very nature of its use i.e. the user is in direct contact with the equipment

Stationary Equipment or Appliances
This equipment has a mass exceeding 18kg and is not provided with a carrying handle e.g. refrigerator, washing machine.

Fixed Equipment/Appliances
This is equipment or an appliance which is fastened to a support or otherwise secured in a specific location e.g. bathroom heater, towel rail.

Appliances or Equipment for Building-in
This equipment is intended to be installed in a prepared recess such as a cupboard e.g. built-in cooker.

Information Technology Equipment
This equipment includes electrical business equipment such as computers, mains powered telecommunications equipment and other equipment for general business use e.g. printers, photo-copiers, typewriters etc.

Extension Leads and RCD Extension Leads
Extension leads are used where an item of equipment requires connection to a mains supply but a convenient outlet is not available. An RCD extension lead is an extension lead that is fitted with a residual current device.

Multiway Adaptors and RCD Adaptors
Multiway adaptors are used where sufficient mains outlets are not available. RCD adaptors are used to provide protection for users of portable equipment, particularly when used outdoors.

Identification Numbers
Each item of portable or transportable, hand held or stationary equipment should carry its own unique identification number. If the supply cord is non-detachable, then the cord will automatically be tested with the equipment. If a detachable supply cord is used, then it may either be identified with the number of its associated appliance or if the cord is likely to be moved between appliances or is one of a central pool of leads it should bear its own unique identification number.

Whichever system is used, it is important that supply cords can be identified or are traceable to a particular appliance and can thus be regularly tested.

'Private' Equipment
It should be noted that 'private' equipment used at work (e.g. electric fires, mains radios, electric kettles, coffee makers etc.) will carry an equal potential for danger to those items owned by the employer and if such equipment is allowed on site, its safety becomes the responsibility of the employer (i.e. the duty holder) and such equipment should be added to the list of items to be regularly tested.

3 – TESTING STANDARDS AND THE TESTS REQUIRED

Type Approval Tests
Electrical equipment that is constructed to meet the safety provisions of one of the following in an accepted hierarchy of standards and requirements will be taken to satisfy the safety requirements of the Regulations.

Harmonised Standards
Electrical equipment which complies with the safety provisions of Harmonised Standards will be presumed to comply with the safety requirements

of the Regulations.

The EEC body responsible for the “harmonisation” of member country’s standards is the ‘Comitee Europeen de Normalisation Electrotechnique’ (CENELEC) who issue harmonised standards (EN) which are then implemented identically in the eighteen member countries.

International Standards
Where no relevant harmonised standard exists, electrical equipment which complies with the specification of a standard published by the International Electrotechnical Commission (IEC) (details of which have been published by the European Commission in the Official Journal) will be presumed to comply with the safety provisions of the Regulations

The international authority with regard to electrical standards is the International Electrotechnical Commission (IEC). An IEC Standard expresses, as nearly as possible, an international consensus of opinion on the subject dealt with and the wish is expressed that all National Committees should adopt the text of the Standard for their national rules in so far as national conditions will permit.

There is therefore no compulsion placed on a National Committee to adopt any IEC Standard. Nevertheless while the IEC standard work is very important in its own right there is a further aspect which makes it more so. IEC Standards are more usually the “reference document” for the basis of harmonisation of the corresponding National Standards.

National Standards
Where no relevant harmonised standard or international standard exists, electrical equipment will be presumed to comply with the safety provisions of the 1994 Regulations, if it is constructed to conform to the safety provisions of either:

- A published British standard: **or**
- A published standard of the Member State of the manufacturer.

Routine In-Service Testing
UK legislation does not specify the requirements for in-service testing. Subsequently, a practical 'commonsense' approach is required. The tests performed should reflect the Type Approval tests applicable to the type of unit being tested. Routine safety inspections and tests should be designed to show that the unit's original design safety features are still operative and are of such integrity that the equipment is likely to remain safe at least until the next scheduled test date. The IET Code of Practice for In-service Testing and Inspection of Electrical Equipments give guidance on suitable tests.
This prospective assessment may require an element of judgment on behalf of the test person and guidance on this matter and on the level of competence required to make the judgement is covered in Section 4 "COMPETENCE AND TRAINING".
A few standards relevant to more common equipment are detailed in Appendix I. The system of national and international standards is displayed in Fig 1.

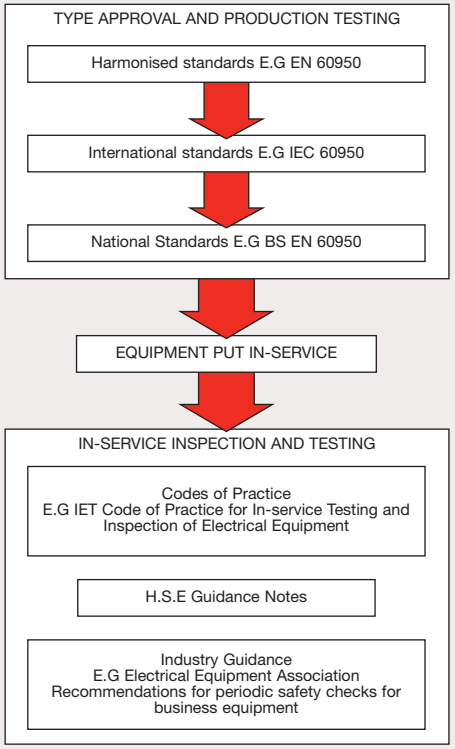

Fig 1.

IT Equipment
The standards noted in Fig 1 show how the harmonised standard EN 60950, ‘The safety of information technology equipment including electrical business equipment’, is applied by various member countries. It should be noted that the standards quoted are design standards and do not address in-service safety testing. Some Type Approval (TA) tests require the removal of certain types of components and all TA tests are conducted under laboratory conditions. Whilst the TA tests will provide reference data, they cannot be emulated in the field or on a routine basis and such adherence is not expected.

The Electrical Equipment Association (EEA) has written a guidance document covering recommendations for periodic safety checks for business equipment built to EN 60950/IEC60950/ BS EN 60950. The application of the recommendation is examined in Sections 6 and 13.

Essential Type Approval Safety Tests
The Type Approval Safety tests required by various design standards are essentially:

(a) Protective conductor (earth) continuity.
(b) High voltage withstand test (dielectric strength, hipot or ‘flash’ testing).
(c) Touch current or protective conductor current.
(d) Insulation resistance (not common to all standards).

When the equipment under test contains integrated circuits or other sensitive components, high voltage testing may damage these components. It can therefore be seen that the tests required will vary according to the type of equipment being tested and a full explanation is given in Section 6 “THE INSPECTION PROCESS”.

4 – COMPETENCE AND TRAINING

The User
Users may require training in identification of defects that can occur in electrical equipment.

Users should be aware that:

a) Equipment that is faulty or suspected of being faulty should not be used.
b) Equipment that is faulty should be labelled and removed from service immediately.
c) The administrator or manager should be notified.

The Administrator or Manager

Administrators or managers of premises are required to know their legal responsibilities as laid down in the Electricity at Work Regulations 1989 and have a legal responsibility to ensure that equipment in their charge is safe.

Administrators may require training to allow them to carry out risk assessments, maintain records of inspections, tests and repairs of equipment and manage the inspections and tests at appropriate intervals. Administrators are required to interpret the recorded results and take appropriate actions or to provide relevant information and reports to a more senior person within the organisation. Competence to interpret records and results is achieved by appropriate training and experience.

The Test Operative

In the context of safety testing, the term "competence" refers to a person's ability to perform the task without danger to themselves or others and to make a valid judgement based on the results, as to whether the unit under test is safe to use and is likely to remain safe at least until the next scheduled test date.

It will be appreciated that the test person will require certain knowledge and information to enable such valid prospective judgements to be made. In addition the test person will require both the knowledge and the information necessary to make judgements regarding the testing process and its safety and the skill and ability to put such judgements into practice, thus producing a safe system of work. Training and experience will both be necessary.

It is suggested that the following criteria are considered:

(a) An adequate knowledge and practical experience of electricity and its hazards
(b) A clear understanding of precautions required to avoid danger
(c) The ability to recognise at all times whether it is safe for work to continue
(d) The ability to identify equipment and appliance types to determine the test procedures and frequency of inspection and testing
(e) Adequate understanding of the operating principles of both the test equipment and the unit under test
(f) The ability to create test records and take responsibility for the work
(g) Adequate knowledge of the required safety standards
(h) Adequate knowledge of possible hazards at a "strange" site

The tester's skill and ability should encompass:

(a) Adequate experience of relevant electrical work
(b) Adequate experience of appliance testing and the test equipment
(c) Adequate training where (b) cannot be otherwise satisfied
(d) Experience in the interpretation of results
(e) Practical "technical" experience of the type of equipment being tested

Suitable sources of information may include:

(a) Employer's safety manuals or instructions
(b) Equipment manufacturer's handbooks
(c) British Standards (see Appendix 1)
(d) Health and Safety Executive (HES) Guidance Notes (see Appendix 2)
(e) IET Guidance e.g. "Code of Practice for In-Service Inspection and Testing of Electrical Equipment"

Managers and Supervisors responsible for testing personnel should adjust their degree of supervision to take into account any inadequacy of the test person. The (EAWR 1989) Reg. 3 places a duty on the self employed to assess their own competence and subsequently to work within their limitations.

5 - ON-SITE TESTING HAZARDS

Where safety testing has to be carried out "on-site", care will be required to avoid possible hazards both to the test person and others in the vicinity. Where these hazards could cause a danger during testing, the equipment should be transferred to an alternative location or to a properly designated test area as defined by EN 50191 'Erection and Operation of Electrical Test Installations'.

Safety in Area of Work Activity

The HSW Act 1974 Section 2 requires every employer to maintain a safe place of work and a safe system of work for his employees. The (EAWR 1989) Reg. 4(3) requires that every work activity on or near a system shall be carried out in such a manner as not to give rise, so far as is reasonably practical, to danger. This Regulation has a wide application and includes work of a non-electrical nature where there is a risk of electrical injury.

It can be seen that both the person conducting on-site testing and the supervisor of the area where the testing takes place, have a clear legal responsibility to ensure both the test person's safety and that of other persons who may be in the area. It should be remembered that the (EAWR 1989) Sect 3 addresses such duties to the employee, the employer and the self-employed in so far as they relate to matters which are "within their control".

The safety of 'other persons' in the area is best achieved by excluding them from the immediate vicinity of the test process. This Controlling action may require physical barriers and warning notices to EN 50191 or other means such as control of the area by a second person.

The EAWR 1989 Reg. 4(4) requires that all protective equipment such as special tools, protective clothing and insulating materials shall be suitable for the use for which they are provided, and should be properly used and maintained.

6 -THE INSPECTION PROCESS

This section of the Guide is intended to supplement the Operating Instructions of a Portable Appliance Tester and should be used in conjunction with those instructions.

Warning

Modern electronic equipment may employ semi-conductor devices which could be damaged by certain tests. Before such equipment is tested the equipment manufacturer should be asked to define which tests should not be undertaken.

Reasons for the Tests

The aim of this section is to explain the fundamental reasons for the tests performed and to offer practical guidance on test procedures. Such guidance can only be given in general terms and appropriate training is essential in order to address specific problems. Inspection and testing should only be carried out by persons competent to do so.

The tests to be performed should reflect the Type Approval tests applicable to the type of unit to be tested. Routine Safety tests should confirm that the original design safety still exists and is of such integrity; that the unit under test is likely to remain safe at the very least until the next scheduled test date. This latter criterion may require the test person to make a prospective judgement; this action is considered in Section 12 "INTERPRETATION OF RESULTS".

User Check

User checks are performed before equipment is plugged in and switched on. The check involves a visual inspection of the mains plug, mains flex and the appliance for obvious signs of damage or degradation. An assessment should also be made of the suitability of the environment and the purpose for which the equipment is to be used. User checks are an important safety precaution as the user of the equipment is most familiar with its operation. User checks do not need to be recorded unless a problem is discovered, in which case the equipment should be labelled to show it is not to be used and removed from service as soon as possible. The administrator or manager should be notified.

Formal Visual Inspection

In practice, many equipment defects can be found during a formal visual inspection. Many potential hazards arise due to the way in which a piece of equipment is used or abused. For example, portable equipment may be prone to being dropped, or a piece of movable equipment with a long trailing mains flex may be damaged as the equipment is moved around. Potential hazards such as enclosure damage, damage to the mains flex, signs of over heating, incorrectly fitted mains plugs, incorrect fuses etc. can be identified by a thorough visual examination.

A formal visual inspection carried out by a person competent will make the greatest contribution to minimising risk and eliminating potential safety hazards. Advice on the frequency of formal visual inspections is given in Table D.

A formal visual inspection should include an inspection of the following:

1) Manufacturer's instructions
a. The equipment should be installed and used in accordance with the manufacturer's instructions.
b. The correct voltage, frequency and current requirements should be verified.
c. Requirements for ventilation or heat dissipation should be met.

2) Environment
a. Suitability of the equipment for the environment or purpose for which the equipment is being used e.g. risk of mechanical damage, exposure to weather, temperature, fluids, corrosives, flammable materials.

3) Switching of equipment
a. The inspector should determine whether there are suitable means of disconnecting the equipment from the mains supply under normal use, to carry out maintenance and in the event of an emergency (if applicable to the equipment).

4) User feedback
a. Where possible the user of the equipment should be consulted as to whether there are any known problems or faults. The user may be aware of intermittent problems that may not be apparent during the inspection.

5) The equipment enclosure/casing
a. Physical damage such as cracks or chemical corrosion. Particular attention should be paid to areas around switches, fuses, protective covers and mains couplers where damage may result in live parts becoming exposed.
b. Signs of overheating.
c. Signs of ingress of fluids or foreign bodies.

6) Mains plugs
a. Correct fit in the mains outlet – not loose and can be removed without difficulty.
b. Cracks or damage.
c. Signs of overheating.
d. Properly tightened terminal screws on rewirable plugs.
e. Correct wiring on rewirable plugs.
f. Mains flex is properly secured by the cable grip.
g. Correct fuse rating and type.

7) Mains cords
a. Damage, cuts or fraying. Extension leads should be checked along the entire length.
b. Joints or connections which are unsafe e.g. taped joints.
c. Appropriate length.
d. Correct rating for the equipment.

8) RCD protected adaptors or extension leads
a. Operation of the RCD should be confirmed.

Operator accessible fuses on the outside of the equipment should be checked for correct type and rating. If the equipment manufacturer has specified a particular rating for the plug fuse, this should also be checked. If the manufacturer has not specified a fuse rating for the plug the preferred fuse size is detailed in Table H related to the cross-sectional area of the cord conductors. Ensure that properly manufactured cartridge fuses are used and that fuses have not been replaced with a metal bar, wrapped in metallic foil or similar non standard method.

Note: The requirements of a formal visual inspection will vary according to the equipment being inspected and the environment in which it is used. The 'prompts' built into Seaward Portable Appliance Testers (Supernova Plus, Europa Plus and PrimeTest range) are intended to provide guidance and should not be taken as a comprehensive list of items to be checked during a formal visual inspection.

Classes of Equipment Construction

Before an item of equipment can be tested the construction class must be determined in order to identify the appropriate tests. The equipment to be tested will normally be constructed in one of three basic classes, designated Class I, II or III. Constructional methods are summarised below, full details can be found in BS2754.

Class I equipment is constructed such that protection against electric shock does not rely on basic insulation alone. In addition to basic insulation around live internal parts, exposed conductive parts are connected to the protective conductor in the supply. Class I equipment relies upon a connection to the protective conductor to prevent exposed conductive parts becoming live in the event of an insulation failure.

Class II equipment is constructed such that protection against electric shock does not rely on basic insulation alone. In addition to basic insulation around live internal parts, supplementary insulation is provided, there being no provision for connection of exposed conductive parts to the protective conductor. Such equipment is often described as "double insulated" and should carry the symbol ⧈

Class III equipment is equipment in which protection against electric shock relies on a supply from a separated extra-low voltage source (SELV). In a SELV supply the voltage is less than 50V rms and no exposed conductive parts are connected to the protective conductor.

Note: Not all double insulated equipment bears the ⧈ mark, however, if the mark is applied the equipment must be double insulated. For the purposes of electrical safety testing, if a piece of equipment does not bear the ⧈, it should be treated as Class I.

7 - COMBINED INSPECTION AND TESTING PROCEDURE

Safety Considerations

Inspection and testing should only be carried out by a person who is competent to perform the inspection and testing and interpret the results obtained.

Preliminary Inspection

Before inspection and testing is carried out the test operative should obtain a copy of any previous test records if they are available. This will allow an assessment to be made of any degradation of the equipment under test.

Before attempting to carry out any electrical safety tests, the following preliminary inspection should be carried out:

(a) Ensure that the equipment can be disconnected from the mains supply and other power sources. If permission is received, disconnect the equipment from the supply.
(b) Disconnect the equipment for all other equipment, communication links and telecom lines.
(c) Where the equipment under test has the provision to supply mains power to other accessories (for example a monitor powered from PC base station) the mains connection can remain in place during the tests.
(d) Ensure that equipment is not in contact with extraneous metalwork such as parts of office furniture.
(e) Thoroughly inspect the equipment under test for damage, as described in Formal Visual Inspection.
(f) Inspect the mains plug as described in Formal Visual Inspection.
(g) Inspect the mains cord as described in Formal Visual Inspection.
(h) Assess the suitability of the equipment for the environment.
(i) Where possible, consult the user as to whether there are any known problems with the equipment.

Note: Special care should be taken where equipment is powered from an uninterruptible power supply (UPS) or has internal battery backup.

In-Service Tests

The IET "Code of Practice for In-Service Inspection and Testing of Electrical Equipment" recommends a system of periodic inspection and testing, with up-to-date records, as a means of demonstrating compliance with the Electricity at Work Regulations 1989. Most companies and organisations that wish to comply with the requirements of the Electricity at Work Regulations 1989 will carry out in-service tests.

The order in which the tests are performed is important to the safety of the test operative. The testing sequence of Seaward Portable Appliance Testers is designed to contribute towards a safe system of work. The sequence should always be:

1. Earth continuity test
2. Insulation resistance test
3. Protective conductor/touch current test or alternative/substitute leakage test
4. Functional check

An insulation test should always be carried out before attempting any tests which involve applying mains power to the equipment under test as it may detect a dangerous insulation failure.

The recommendations given by the IET Code of Practice for In-Service Testing of Electrical Equipment are as follows:

Class I Appliances

- Earth continuity test
- Insulation resistance test or protective conductor current test or alternative/substitute leakage
- Functional checks

Class II Appliances

- Insulation resistance test or touch current test or alternative/substitute leakage test
- Functional checks

Appliance cord tests

A 3-core appliance cord should be tested as a Class I appliance and the following tests should be made:

- Earth continuity
- Insulation resistance
- Wiring polarity check

A 2-core appliance cord should be tested as a Class II appliance and the following tests should be made:

- Insulation resistance
- Wiring polarity check

Note: Seaward portable appliance testers are equipped with appliance cord tests that automatically perform all of the recommended tests, including wiring polarity.

Extension leads, multiway adaptors and RCD adaptors.

Extension leads and multiway adaptors are tested as a Class I appliance and the following tests should be performed:

- Earth continuity
- Insulation resistance
- Wiring polarity check

When the extension lead or multiway adaptor is fitted with an RCD, the RCD must have a rated residual operating current (the current at which the RCD is designed to operate) not exceeding 30mA.

The IET Code of Practice for In-Service Testing of Electrical Equipment also recommends that the operation of the RCD should be checked using an RCD test instrument to determine that the trip time is within the limits specified below:

	Rated residual operating current	Satisfactory result
RCD to BS 4293 and RCD-protected-socket-outlets to BS 7288	30mA	Device should trip in less than 200ms
RCDs to BS EN 61008	30mA	Device should trip in less than 300ms

Note: Many Seaward portable appliance testers are equipped with an RCD trip time test for testing the operation of RCDs in accordance with the recommendations of the IET Code of Practice for In-Service Testing of Electrical Equipment.

Testing After Repair

The IET Code of Practice for In-Service Testing of Electrical Equipment recommends that equipment which has been repaired should be inspected and tested either in accordance with the manufacturer's production tests or in-service tests. The decision is based upon the type of equipment and the nature of the repair.

Class I Appliances

- Earth continuity test
- Insulation resistance test
- Dielectric strength test
- Protective conductor current test
- Functional checks

Class II Appliances

- Insulation resistance test
- Dielectric strength test
- Touch current test
- Functional checks

Testing after repair is performed to ensure that the repair has not compromised the electrical safety of the electrical equipment and this is reflected by the recommended electrical tests. For example, the earth continuity test will demonstrate that all protective earth connections have been replaced when the appliance is reassembled. Similarly, the dielectric strength test is a useful means of ensuring that all insulating materials has been correctly reassembled and that the insulation on live conductors has not been damaged during reassembly, for example, when wires are trapped or damaged by fixing screws.

8 - ELECTRICAL TESTS

Earth Continuity

This test is performed on Class I equipment or mains cords and is used to verify the integrity of the connection between the protective conductor and all exposed metal parts intended to be connected to the protective conductor.

The IET Code of Practice for In-service Inspection and Testing of Electrical Equipment recommends either of the following:

A continuity measurement with a short circuit test current within the range 20mA to 200mA.

or

A continuity measurement with a test current not less than 1.5 times the rating of the fuse and no greater than 25A for a period of between 5 and 20 seconds.

Note: Some appliances, for example IT equipment, may have accessible metal parts which are connected to earth for functional or shielding purposes only. If the high current test option above is used, the test current will flow through sensitive components or wiring not intended to provide a protective earth connection. In appropriate use a high test current may damage the equipment under test. If in doubt, a low test current should be used.

The continuity test is made between all accessible earthed metal parts of the equipment and the earth pin of the plug when testing equipment with a mains cord and between the earth pin of the mains input socket and all exposed metal parts when testing equipment without a mains cord. The resistance measurement should be observed while flexing the cable and an inspection of the flexible cable terminations at the equipment and the plug or flex outlet should be made. Variations in measured resistance should be investigated.
The measured resistance should not exceed the values given below:

For appliances with a supply cord	(0.1) + R ohm where R is the resistance of the protective conductor of the supply cord
For appliances without a supply cord	0.1 ohm
Appliance mains cords	(0.1) + R ohm where R is the resistance of the protective conductor of the supply cord

Note: Nominal values for resistance of the protective conductor of the supply cord are given in Table E.

Where possible it is advisable to test equipment together with its supply cord. If the mains cord is not detachable, no practical alternative exists.

Care should be taken to ensure that test connections to the equipment under test make clean metal-to-metal contact otherwise contact

resistance may introduce significant errors.
It is possible for Class I equipment to have conductive metal parts which are not accessible to the operator, accessible metal parts with protection against electric shock being provided by double or reinforced insulation or to have 'unearthed' metal parts which are in casual or fortuitous contact with earthed metal. In this case no earth continuity test is specified.

Insulation Resistance
Insulation resistance is measured by applying a test voltage of 500V DC and measuring the resistance. When testing a Class I appliance the voltage is applied between both live conductors (phase and neutral) and the protective conductor (earth). When testing a Class II appliance, the test voltage is applied between both live conductors (phase and neutral) and a test probe. The test probe should be applied to any exposed metal parts or any suspect parts of the enclosure where conductive material may have accumulated. Multiple tests may be required.

Modern portable appliance testers produce a test voltage which is current limited. The voltage is not dangerous but could be uncomfortable. Appliances should not be touched during an insulation test.

This test may not be suitable for certain types of appliance. In the case of equipment fitted with mains filters, voltage limiting devices or surge protection it may not be possible to obtain a satisfactory insulation resistance measurement with a 500V DC test voltage. IT equipment which does not comply with BS EN 60950 may be damaged by the 500V DC test voltage.

An alternative/substitute leakage, an insulation resistance test at a reduced test voltage such as 250V DC or a protective conductor/touch current measurement, may be more appropriate.

TABLE A
INSULATION RESISTANCE LIMITS

Appliance class	Insulation Resistance
Class I heating and cooking with a rating greater than or equal to 3kW	0.3Mohm
All other Class I equipment	1.0Mohm
Class II equipment	2.0Mohm
Class III equipment	0.25Mohm

This test should be performed with the equipment switch ON. Some electronic equipment may contain mains filter circuits connected between live/neutral and earth. Such devices could cause the insulation resistance to be less than specified. The manufacturer/supplier must be consulted in these cases as to the acceptable value of insulation resistance.

Insulation Resistance Heating and Cooking Appliances
For equipment such as portable cookers the insulation resistance when cold can be very low. Switching on the appliance for a period of time drives out any absorbed moisture enabling more realistic resistances to be obtained.

Alternative or Substitute Leakage Measurement
Alternative or substitute leakage is measured using a technique similar to that used when measuring insulation resistance. A test voltage is applied between both live conductors (phase and neutral) and the protective conductor (earth) during a Class I test or a test probe connected to the equipment enclosure during a Class II test. The resultant current is measured and then scaled to indicate the current that would flow at the nominal supply voltage.

The test voltage is 50Hz AC and normally in the range of 40V to 250V. The test voltage is current limited and so there is no hazard to the test operative. As the test voltage has the same nominal frequency as the mains supply the leakage paths are similar to those found when the equipment is in operation. Similarly, because the test voltage is not greater than the nominal supply voltage of the equipment under test measurements are not affected by transient suppressors, MOVs or other voltage limiting devices.

Portable appliance testers automatically make the necessary connection between the live and neutral conductors and apply the correct scale factor to the measured current. The equipment under test must be switched ON during the test.

Dielectric Strength Test
This test is also known as the "high voltage leakage test", "hipot test" or "flash test" and is a Type Approval test or Production test. Test voltages of 1500V AC and 3000V AC are available on selected Seaward testers that include this test. The 1500V AC is applied at the mains plug of the appliance under test, between the protective earth conductor and the live/neutral conductors connected together. The 3000V AC test is applied between the live/neutral conductors connected together at the mains plug and a high voltage test probe

TABLE B
DIELECTRIC STRENGTH TESTS

Standard	Basic Insulation	Supplementary Insulation	Reinforced Insulation
EN 60335 Safety of Household Electrical Appliances EN 60065	1000V	2500V	2500V
Audio, Video and Similar Electronic Apparatus – Safety Requirements	1500V	2500V	2500V
EN 60950 Safety of Information Technology Equipment, Including Electrical Business Equipment	1500V	1500V	3000V

Table B defines the test voltages for a range of appliances.

Warning: During flash testing, close proximity to the high level of charge present could cause damage to certain types of electronic equipment which incorporate semi-conductor devices. The advice of the equipment manufacturer should always be sought before testing when such conditions are suspected.

applied to the enclosure of the appliance under test. No other connection is necessary.
EN 60335 "Safety of household and similar electrical appliances" allows a high voltage leakage current of 0.75m A/kW with an overall maximum of 5mA. As Seaward testers are intended to test equipment with a maximum power consumption of approximately 3kVA the pass level defaults to 3mA. Equipment to BS 2769 "Hand held electric motor operated tools" requires a 'flash' test voltage of 1.5kV and the maximum permitted leakage is 0.75mA. The test should be conducted with the unit under test switched ON.
For In-service testing as defined by the IET 'Code of Practice for In-service Inspection and Testing of Electrical Equipment' this test is not recommended.

Preload Check
Seaward portable appliance testers automatically perform a pre-check before tests which involves applying mains power to the equipment under test. This is included to protect the test person from potential hazards produced by a very low impedance or short circuit being present between LIVE and NEUTRAL. The test should be conducted with the equipment switched ON.

Load Test
A Load test is again not a 'required' safety test, however it can provide useful information regarding the operation of the equipment under test. The PAT will apply the supply voltage to the equipment under test and measure the power consumption in kVA or load current in amperes.

The test is included since a higher power than expected from the specification may indicate reduced functional efficiency. A significant change from a previously recorded figure may provide an early warning of bearing failure in an electrical machine or shorted turns within a transformer, both conditions indicating the need for maintenance. Abnormally low power could be the indication of an open circuit, ruptured fuse or other form of fault.

Protective Conductor/
Touch Current Measurement
The protective conductor / touch current is measured from live parts to protective earth for Class I equipment, or from live parts to accessible metal parts of the enclosure on Class II equipment under normal operating conditions. This test is an alternative to the insulation test where the insulation test is inappropriate. This test will provide evidence of possible deterioration of certain components under load and may indicate that the method of connection of the equipment to the supply is inappropriate.

TABLE C

PROTECTIVE CONDUCTOR/TOUCH CURRENT LIMITS

APPLIANCE CLASS / MAXIMUM CURRENT
Portable or hand-held Class I equipment/ 0.75 mA
Class I heating appliances/ 0.75 mA or 0.75 mA per kW, whichever is greater, with a maximum of 5 mA
Other Class I equipment/ 3.5 mA
Class II equipment/ 0.25 mA
Class III equipment/ 0.5 mA

Note: Should the equipment contain a mains interference suppression capacitor or filter, some residual leakage will be measured; this will not necessarily indicate a fault condition.

Warning: Special care should be taken during tests where the equipment under test is energised. Portable tools and rotating machines etc. should be rendered safe before the complete test sequence begins. All such machines should therefore be physically secure and have their cutting, grinding, drilling bits etc. removed where possible; where guards are provided they should be in place.

9 – SPECIAL EQUIPMENT

(i) Transformers
Modern low voltage transformers should be manufactured to EN 61558 which allows either Class I or Class II construction. The transformer should be treated as any other piece of portable equipment and tested as previously described. An additional test may be required to ensure that the primary voltage does not appear on the secondary winding by carrying out a primary to secondary Insulation Test.

The two methods of construction:

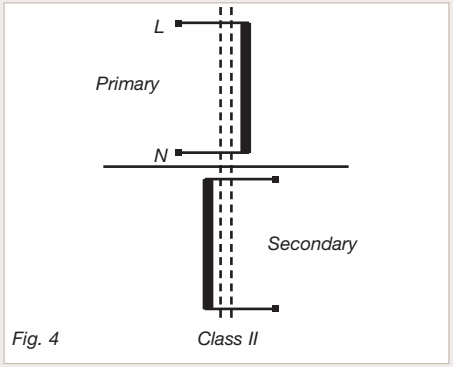

Fig. 4

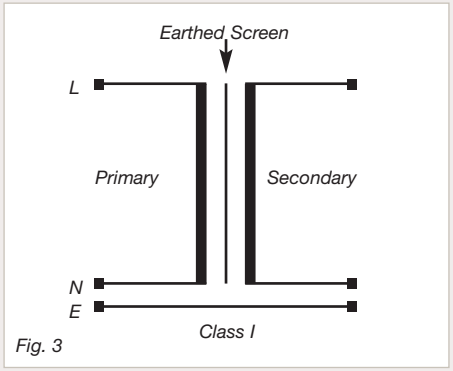

Fig. 3

Note: The insulating barrier should be labelled.

It will be noted that the flash test conducted on a Class I transformer will have additionally proved the insulation between the primary winding and the earthed screen, thus ensuring primary/secondary isolation.

The flash test conducted on a Class II transformer will not have tested the integrity of the insulating barrier between primary and secondary windings. An Insulation test will therefore be required between the input and output connections.

(ii) TEST EQUIPMENT
Safety test equipment such as the PAT is in itself an item of portable equipment and will therefore require safety testing in accordance with the criteria described under the heading "FREQUENCY OF TESTING".

The PAT should be calibrated annually or in accordance with the manufacturer's instruction. A calibration certificate states that the test instrument is within specification at the time the calibration is performed. The certificate does not guarantee the

performance of the test equipment at any time after that.

In addition, the IET Code of Practice for In-Service Inspection and Testing of Electrical Equipment recommends that test equipment is checked at regular intervals using a verification device such as the Seaward PAT Checkbox. A record of the performance checks should be kept.

10 – FREQUENCY OF TESTING

REGULAR TESTING RESPONSIBILITIES

There are no absolute rules regarding how often an item of electrical equipment should be tested. HSE Guidance Notes advise "regular testing" and this is generally interpreted as a requirement for annual testing. However, circumstances and conditions of use will vary. The competent test person should be able to advise on the frequency of testing resulting from his own experience and discussions with the user or duty holder (who may be a non-technical person) regarding the "lifestyle" of the equipment.

During the course of production or after completion of assembly a manufacturer may subject a piece of equipment to a range of tests. Likewise the repairer of equipment should test after repair. A hirer should test each piece of equipment before each hire contract.

Personnel responsible for the safe use of electrical equipment, for example contractors, managers of electrical /electronics laboratories (test equipment and tools) office managers (electrical office machines) are each regarded by the EAWR as 'duty holders' and should operate a routine safety testing programme.

Where an employee is permitted to bring his own portable or transportable electrical equipment onto a site or into a Works, that employee under the H&SW Act 1979 and EAWR 1989 has an additional duty in that the equipment is to some extent "within his control". The employer must, however, monitor the employee's provision and use of such equipment and where applicable, must include the items in the schedule of appliances to be tested.

PRINCIPLE FOR FREQUENCY OF TESTING

The underlying principle for frequency of testing is that the duty holder (i.e. the person with the equipment "within his control") with the advice of the competent test person when necessary must assess the need for testing the equipment against the following:

(1) Type of equipment (portable, hand-held or transportable)
(2) Style of use (continuous, infrequent, rough)
(3) Age of the equipment
(4) If regularly moved or transported and by what means
(5) Type and competence of personnel using the equipment
(6) Environment of usage (outdoors, construction sites, hazardous atmospheres etc)
(7) Results of previous tests
(8) Manufacturer's recommendations
(9) Effect of any modifications or repairs to the equipment

The inspection and test periods recommended by the IET Code of Practice for In-Service Inspection and Testing of Electrical Equipment are defined in Table D.

TABLE D
SUGGESTED INITIAL FREQUENCY OF INSPECTION AND TESTING OF EQUIPMENT

	Type of Premises	Type of Equipment Note 1	User Checks	Class I		Class II Note 4	
			Not recoreded unless a fault is found	Formal Visual Inspection Note 3	Combined Inspection and Testing Note 5	Formal Visual Inspection Note 3	Combined Inspection and Testing Note 5
	1	2	3	4	5	6	7
1	Construction Sites 110V equipment	S IT M# P# H#	None None Weekly Weekly Weekly	1 month 1 month 1 month 1 month 1 month	3 months 3 months 3 months 3 months 3 months	1 month 1 month 1 month 1 month 1 month	3 months 3 months 3 months 3 months 3 months
2	Industrial including commercial kitchens	S IT M P H	Weekly Weekly Before Use Before Use Before Use	None None 1 month 1 month 1 month	12 months 12 months 12 months 6 months 6 months	None None 3 months 3 months 3 months	12 months 12 months 12 months 6 months 6 months
3	Equipment used by the public	S IT M P H	Note 6+ Note 6+ Note 6+ Note 6+ Note 6+	Monthly Monthly Weekly Weekly Weekly	12 months 12 months 6 months 6 months 6 months	3 months 3 months 1 month 1 month 1 month	12 months 12 months 12 months 12 months 12 months
4	Schools	S IT M P H	Weekly Weekly Weekly Weekly Before Use	None None 4 months 4 months 4 months	12 months 12 months 12 months 12 months 12 months	12 months 12 months 3 months 3 months 4 months	48 months 48 months 48 months 48 months 48 months
5	Hotels (See note 7)	S IT M P H	None None Weekly Weekly Before Use	24 months 24 months 12 months 12 months 6 months	48 months 48 months 24 months 24 months 12 months	24 months 24 months 24 months 24 months 6 months	None None None None None
6	Offices and Shops	S IT M P H	None None Weekly Weekly Before Use	24 months 24 months 12 months 12 months 6 months	48 months 48 months 24 months 24 months 12 months	24 months 24 months 24 months 24 months 6 months	None None None None None

Note: (1) S Stationary equipment
IT Information technology equipment
M Movable equipment
P Portable equipment
H Hand-held equipment
(2) User checks are not recorded unless a fault is found
(3) The formal visual inspection may form part of the combined inspection and tests when they coincide and must be recorded.
(4) If class of equipment is not known, it must be tested as Class I
(5) The results of combined inspections and tests are recorded
(6) For some equipment such as children's rides a daily check may be necessary
(7) Equipment in hotels refers to equipment used by hotel staff. Equipment provided in hotel rooms is tested as equipment used by the public.
(+) By supervisor/teacher/member of staff
110V earthed centre tapped supply 230V portable or hand-held equipment must be supplied via a 30 mA r.c.d. and the intervals between inspections and tests reduced

The information on suggested initial frequencies above is more detailed and specific than HSE Guidance, but is not considered inconsistent with it.

Alternatively, a test programme using 'on issue' or 'on return' to or from a central pool or store, could be used where applicable to meet the required objectives.

It must be emphasised that Table D is produced for guidance only, and an individual judgement must be made by considering the actual conditions pertaining to any particular situation, in order to assess the hazard and reduce the subsequent risk of electric shock. For example there is a great deal of equipment used in offices not hand held and the methods of use and the environment in which it is used leads to a lower level of risk than in other sectors such as in industry or construction. There are however types of portable equipment in offices together with their leads and plugs which could result in high levels of risk of electric shock if not inspected and tested and subsequently properly maintained.

LONG TERM SAFETY OF APPLIANCES

The requirement is not only to determine the immediate safety of the unit under test but to ascertain so far is reasonably practicable, that the unit will remain safe under the expected conditions of use at least until the next scheduled test date. Such a judgement may rely heavily upon the competence of the test person to offer sound practical advice.

11 - RECORD KEEPING

IMPLICATION OF REGULATION 29

In any proceedings for an offence consisting of a contravention of the EAWR 1989 Rep 4 (4).5 and 8 to 16 inclusive (i.e. those Regulations requiring "absolute" compliance). Regulation 29 states that it shall be a defence for any person to prove that they took all reasonable steps and exercised all due diligence to avoid the commission of that offence. The most effective method for the duty holder to prove to a Court that he "exercised all due diligence" etc. is to produce proper records of the measures taken to prevent the accident. Hence full and accurate records made at the time of testing become essential, and the managed system designed to achieve this must be in place before the accident.

The HSE Memorandum of Guidance on these Regulations advises that records of maintenance including tests should be kept throughout the working life of the equipment.

Step by Step Approach

A step by step approach would include the following:

(a) Conduct a survey to identify all portable and transportable appliances which exist with the duty holder's control.
(b) Each appliance should be marked with a unique identification code, cross referenc ing test results and inspection details.

A register of all equipment should then be created to include the following details:

1. Identification number
2. Location in which the equipment is kept
3. A description of the appliance
4. Serial number
5. Periods between tests
6. Any other details

Due to the large number of appliances, and the details that must be recorded, a computer database is likely to be the most effective and efficient method of data collection and storage.

A comprehensive software package such as Seaward's PATGuard will enable the user to set up a detailed database of all items at any particular location easily.

By recording the information outlined in (c) above working documents can be produced which are a useful aid to proficiency and safety. For example a work schedule can be generated grouping products by test date, task sheets can be printed providing the person conducting the tests with a list of all items due for testing, together with their location, identification number etc.

Use of Advanced Portable Appliance Testers

Where advanced portable appliance testers such as Seaward's Supernova Plus, Europa Plus, PrimeTest 300 and PrimeTest 350 testers are used, data can be transferred directly from the instrument to the database providing automatic creation or update of records.

In such situations reports of untested appliances and those which failed the tests can be produced and submitted to the duty holder for the appropriate action to be taken, this insures the investigation is thorough and avoids oversight.

Action on Completion of Tests

Any equipment found unsafe must immediately be removed from use, labelled with its fault and transferred to the repair facility and the appropriate person informed.

On successful completion of the tests a label should be attached to the tested equipment showing:

(a) The date tested
(b) The identity of the test person
(c) The date for re-test

Such information will enable the duty holder to manage this aspect of the overall safety of the area with his control.

A convenient method of labelling equipment may incorporate a bar code. The Seaward Supernova and Europa range of instruments can be used with a Bar Code Reader and collect Appliance number and test codes without the need for manual data input. Another advanced method of data collection from the appliance is the use of Seaward Braincells. This is a revolutionary method which allows the test record to be kept with the appliance and updated by the Seaward PAT. Braincells are small discs attached to the appliance which the Seaward PAT reads from and writes to after test. A full range of labels and data collection accessories are available from Seaward.

Data Transfer Between PAT and PC

Advanced Seaward PAT Testers such as the Supernova Plus, Europa Plus, PrimeTest 300 and PrimeTest 350 range contain output ports which allow the tester to be connected to a PC running PATGuard software. Selected appliances from various locations can have their test data sent directly to the PAT (this is called Upload) which after disconnection from the PC may then be taken to the location where the appliances are to be tested. Simply by inputting the appliance number, the PAT will search the upload memory in an attempt to identify that particular appliance. If the appliance

is identified the pre-determined sequence of tests will be suggested to the user, if this is accepted the instrument will then automatically conduct the tests and record the results.

The advantage of this approach is that it helps avoid uncertainty as to which tests should be conducted on a particular appliance.

12 - INTERPRETATION OF RESULTS

Although the Supernova Plus, Europa Plus, PrimeTest 300 and PrimeTest 350 tester range have been programmed with PASS/FAIL levels, this does not remove the responsibility for final assessment from the test person as PASS/FAIL values are only for general equipment types. These testers allow for other values to be set for specific equipment.

The PAT may indicate that the equipment has "Passed" the required tests, but comparison with previously recorded test figures may show a change in certain individual parameters. A competent test person should be able to judge the significance of such changes, in particular when measured values are close to acceptable limits, and recommend preventative maintenance where danger might otherwise occur.

Such decisions may require an understanding of the methods of construction employed, the characteristics of the supply to which the equipment may be connected and the likely consequence of further deterioration which may depend to an extent upon the conditions under which the equipment could be used.

13 - SPECIAL NOTES

This guide only examines the main aspects to be considered when undertaking electrical safety testing activity. The individual nature of testing activities required by different organisations to solve their specific problems makes a more detailed approach impractical.

Electrical Medical Equipment

"Electrical Medical Equipment" designed to meet the requirements of IEC60601-1 and required to be connected to the human body to diagnose, treat or monitor the patient, is designed to extremely rigid and precise safety standards. The electrical safety testing of such equipment should be left to specialists in that particular field and it is therefore considered to be an inappropriate subject for this booklet which has been written to provide general advice. Seaward's Rigel range of electrical medical safety testers such as the Rigel 288, 266 and 277 are designed specifically for the demanding tests required by electrical medical equipment.

Safety Checking of Business Equipment

The Information Technology Safety Technical Sub-Committee of the EEA, in consultation with the HSE, has issued recommendations regarding the periodic safety checking of business equipment (manufactured to EN 60950). Where the recommendations provide additional information to that of this booklet the issues addressed are noted below:

(a) Do not disconnect fibre optic cables unless required by the manufacturer's instructions
(b) Under no circumstances look directly into the end of a fibre optic cable or connector (although possibly not within the visibly spectrum, the radiation may still cause eye damage).
(c) Do not attempt to electrical safety test an uninterruptible power supply (UPS) without advice from the manufacturer (they are designed to provide mains power at their output after disconnection of the mains input).

Action where "NO TESTING" is discovered

It should be realised that the HSE Factories Inspector or the Local Council Environment Health Officer (EHO) will not normally prosecute an individual or company for making a mistake (e.g. inadequate frequency of testing).
If "no-testing" is discovered, it is usual for the inspector or EHO to issue an Improvement Notice which will require a managed testing system to be installed within a set time (usually one month); alternatively if an accident had been caused by an appliance which had never been tested, a subsequent prosecution is more likely and in such circumstances the company and perhaps individuals may face prosecution.

TABLE E

SUPPLY LEAD RESISTANCE

Nominal resistance of appliance supply cable protective conductors (cables to BS6500).

Nominal conductor c.s.a mm²	Nominal conductor resistance at 20°C mΩ /metre	Length metres	Resistance at 20°C mΩ	Max current carrying capacity A	Max. dia. of individual wire in conductor mm	Approx No. of wires in conductor
0.75	26	1.0 1.5 2.0 2.5 3.0 4.0 5.0	26 39 52 65 78 104 130	6	0.21	24
1.0	19.5	1.0 1.5 2.0 2.5 3.0 4.0 5.0	19.5 29.3 39 48.8 58.5 78 97.5	10	0.21	32
1.25	15.6	1.0 1.5 2.0 2.5 3.0 4.0 5.0	15.6 23.4 31.2 39 46.8 62.4 78	13	0.21	24
1.5	13.3	1.0 1.5 2.0 2.5 3.0 4.0 5.0	13.3 20 26.6 33.3 39.9 53.2 66.5	15	0.26	30
2.5	8	1.0 1.5 2.0 2.5 3.0 4.0 5.0	8 12 16 20 24 32 40	20	0.26	50

Table E gives figures for the nominal resistance of the protective conductor per metre length and for various lengths of cable that may be fitted as supply leads to appliances. Once an Earth Bond Test has been performed the approximate resistance of the protective conductor can be found and deducted from the test results to give a more realistic figure for the resistance of the earth bonding of the appliance.

TABLE F

Cord conductors, plug fuses and earth continuity test currents.

Conductor size (mm²)	0.5	0.75	1.0	1.25	1.5
Recommended fuse (BS1363 Pt 3) (a)	3/(5)	(b)	13	13	13
Recommended max test current taking account of temperature limit (a)	12	20	25	25	25

Notes:

(a) Equipment manufacturers may specify smaller fuses than BS1363 Pt 3. However the earth conductor in a detached cord may be tested at a current up to the maximum test current allowed.

(b) BS1363 Pt 3 recommends a 13A fuse for use with a 0.75mm conductor. However this would require a test current of 25A which would raise the conductor to too high a temperature for the associate insulation. The fuse rating for a 0.75mm2 conductor should therefore not exceed 10A.

APPENDIX 1

EN 60335	Safety of household and similar electrical appliances.
BS1363-1	13A fused plugs
BS2754	Memorandum. Construction of electrical equipment for protection against electric shock.
EN 50144	Hand-held electric motor-operated tools.
EN 60335	Safety of household and similar electrical appliances
EN 61558	Safety of power transformers, power supply units and similar.
EN 60309	Plugs, socket-outlets and couplers for industrial purposes
EN 60320	Appliance couplers for household and similar general purposes.
BS4343	Luminaires
EN 60598	Safety of Luminaires
EN 61010-1	Safety requirements for electronic measuring apparatus.
EN 61557	Electrical safety in low voltage distribution systems. Equipment for testing, measuring and monitoring of protective devices.
BS6500	Flexible cords rated up to 300/500V for use with appliances and equipment intended for domestic, office and similar environments.
EN 60065	Safety requirements for mains-operated electronic and related apparatus for household and similar general use.
EN 60950	Specification for safety of information technology equipment including business machines
EN 50191	Erection and Operation of Electrical Installations

APPENDIX 2

HSE Guidance Notes

HS(G)	13 Electrical Testing
HS(R)	18 Administrative guidance on the application of the EC 'Low Voltage Directive'
HS(R)	25 Memorandum of guidance on the Electricity at Work Regulations 1989
PM29	Electrical hazards from steam/water pressure cleaners
PM32	The safe use of portable electrical apparatus
PM38	Selection and use of portable electric handlamps
GS27	Protection against electric shock
GS37	Flexible leads, plugs and sockets.

IET Documentation

Code of Practice for In-service Inspection and Testing of Electrical Equipment

LEGISLATION

The Health and Safety at Work etc. Act 1974
ISBN 0 10 5437743
The Electricity at Work Regulations 1989
(S.I.1989 No 635)
ISBN 0 11 096635X

The Plugs and Sockets etc. (Safety) Regulations 1987 (S.I.1987 No.603)
ISBN 0 11 0766032

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