PAT (Portable Appliance Testing)

Introduction

PAT or portable appliance testing is an important part of any health & safety policy . This online guide is intended as a guide to both the legal implications and to the technical requirements.

The Health & Safety Executive states that 25% of all reportable electrical accidents involve portable appliances. The Electricity at Work Regulations place a legal responsibility on employers, employees and self-employed persons to comply with the provisions of the regulations and take reasonably practicable steps to ensure that no danger results from the use of such equipment. This in effect requires the implementation of a systematic and regular program of maintenance, inspection and testing.

The Health & Safety at Work Act (1974) places such an obligation in the following circumstances:

1. Where appliances are used by employees.

2. Where the public may use appliances in establishments such as hospitals, schools, hotels, shops etc.

3. Where appliances are supplied or hired.

4. Where appliances are repaired or serviced.

The level of inspection and testing required is dependant upon the risk of the appliance becoming faulty, which is in turn dependant upon the type of appliance, the nature of its use and the environment in which it is used.

Who Is Responsible

The Provision and Use of Work Equipment Regulations 1998 (PUWER) requires, every employer to ensure that work equipment is suitable for the purpose for which it is provided, only used in the place and under the provisions for which it is provided. It also requires every employer to ensure work equipment be efficiently maintained and kept fit and suitable for its intended purpose. It must not be allowed to deteriorate in function or performance to such a level that it puts people at risk. This means that regular, routine and planned maintenance regimes must be considered if hazardous problems can arise.

Regulation 3 of the Electricity at Work Regulations 1989 recognises a responsibility that employers and many employees have for electrical systems.

"It shall be the duty of every employer and self employed person to comply with the provisions of the Regulations in so far as they relate to matters which are within his control.

It shall be the duty of every employee while at work:

(a) to co-operate with his employer so far as is necessary to enable and duty placed on that employer by the provision of the Regulations to be complied with: and

(b) to comply with the provision of these regulations in so far as they relate to matters which are within his control."

Types Of Appliance

Portable Appliance Equipment

There are many European standards and guidance notes regarding portable appliances and equipment, though they do not establish a common and specific definition of such equipment. Even so, there does seem to be a consensus of opinion that such equipment is either hand held whilst being connected to the supply, or is intended to be moved whilst connected to the supply, or is capable of being moved without undue difficulty whilst connected to the supply.

It is usual for this equipment to be connected to the supply via a plug and socket, however this is not a requirement for electrical equipment to be deemed portable or transportable. It is common to define a portable appliance by saying that it is 'anything with a plug top on the end of it'. This is a mistake as it may mean that there are some appliances in the system that are never tested.

The National Association of Professional Inspectors and Testers (napit) define a portable appliance as 'any electrical item which can or is intended, to be moved whilst connected to an electrical supply.'

The IEE Code of Practice gives guidance on the various equipment types:

Portable Appliance

An appliance of less than 18kg in mass that is intended to 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.

Movable Equipment (transportable)

This equipment is either:

18 kg 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

Hand Held Equipment Or Appliances

This is portable equipment intended to be held in the hand during normal use, e.g. hair dryer

Stationary Equipment Or Appliances

This equipment has a mass exceeding 18kg and is not provided with a carrying handle, e.g. refrigerator

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

Appliances/Equipment For Building In

This equipment is intended to be installed in a prepared recess such as a cupboard or similar. In general, equipment for building in does not have exposure on all sides because one or more of the sides, additional protection against electrical shock is provided by the surroundings, e.g. built in electric cooker

Information Technology Equipment

Information technology equipment includes electrical business equipment such as computers and mains powered telecommunications equipment, and other equipment for general business use, such as mail processing machines, VDU's photo-copiers.

Assessing The Frequency Of Testing

The Health & Safety Executive offers no absolute rules on the frequency of the testing and inspection of portable appliances. The Memorandum of Guidance on the Electricity at Work Regulations suggests that 'regular inspection of equipment is an essential part of any preventative maintenance program', but no attempt is made to specify the intervals of time implied by the word 'regular'. The reason for this omission is obvious; different situations require different measures in order to meet the requirement that the danger is prevented. The factors which effect the frequency of testing must be assessed by the duty holder who thereby makes the judgement.

In arriving at a judgement as to the frequency of testing, a duty holder is likely to assess the following factors:

1. The environment - equipment installed in a benign environment will suffer less damage than equipment in an arduous environment

2. Users - if the users report damage as and when it becomes evident, hazards will be avoided. Conversely, if equipment is likely to receive unreported abuse, more frequent inspection and testing is required

3. The equipment construction - the safety of a Class 1 appliance is dependant upon a connection with earth of the electrical installation. If the flexible cable is damaged the connection with earth can be lost. Safety of Class 2 equipment is not dependent upon the fixed electrical installation

4. The equipment type - appliances which are hand held are more likely to be damaged than fixed appliances. If they are Class 1 the risk of danger is increased, as the safety is dependant upon the continuity of the protective conductor from the plug to the appliance.

Estimate Of Risk Level

This is a simple calculation to give an estimate of the level of risk of items of electrical equipment.

Start with a BASE RISK of 0 POINTS then add:

• 2 points if the item is used in a wet or corrosive environment OR uses water or a corrosive substance in its operation. (e.g. Kettle)

• 2 points if it has a flexible supply cord that is subject to flexing OR that is subject to harsh treatment.
• 1 point if it has a heating element OR 240V electric motor.

If the sum is 2 points or more it is GROUP A, High Risk

If the sum is 1 point it is GROUP B, Medium Risk

If the sum is 0 points it is GROUP C, Low Risk

In Service Testing

The IEE Code of Practice recognises four test situations.

1. Type Testing to an appropriate standard
2. Production testing
3. In-Service testing
4. Testing after repair

This section is limited in covering topics concerned with In Service Testing only.

This is the testing carried out as a routine to determine whether the equipment is in a satisfactory condition.

In-Service testing will involve the following:

(a) Preliminary inspection
(b) Earth continuity tests (for Class 1 equipment)
(c) Insulation testing (Which may sometimes be substituted by earth leakage measurement)
(d) Functional checks.

Electrical testing should be performed by a person who is competent in the safe use of the test equipment and who knows how to interpret the test results obtained. This person must be capable of inspecting the equipment and, where necessary, dismantling it to check the cable connections.

If equipment is permanently connected to the fixed installation, e.g. by a flex outlet or other accessory, the accessory will need to be detached from its box or enclosure so that the connections can be inspected. Such work should only be carried out by a competent person.

Who Should Carry Out The Inspection & Testing

The Electricity at Work regulations states that:

"No person shall be engaged in any work activity where technical knowledge or experience is necessary to prevent danger, or where appropriate, injury, unless he possesses such knowledge or experience, or is under such degree of supervision as may be appropriate having regard to the nature of the work"

The IEE Code of Practice states, those carrying out the inspection and testing must be competent to undertake the inspection and, where appropriate, testing of electrical equipment and appliances having due regard of their own safety and that of others.

What should be considered is that the 'danger' to be prevented, includes not just the dangers which may arise during the testing procedure to the tester and others, but also the dangers which may arise at a later date as a result of using equipment which has not been effectively tested.

The tester must have an understanding of the modes of electrical, mechanical or thermal damage to electrical equipment and appliances and their flexes which may be encountered in any environment.

Training must include the identification of equipment and appliance types to determine the test procedures and frequency of inspection and testing. Persons testing must be familiar with the test instruments used and in particular their limitations and restrictions so as to achieve repeatable results without damaging the equipment or the appliance.

Visual Inspection

Formal visual inspections should only be carried out by persons competent to do so. The results of the inspection must be documented.

The following must be considered when carrying out the inspection:

Suitability Of The Equipment/Environment

The equipment should be assessed for its suitability for the environment or the nature of the work being undertaken. When the work environment is harsh or hazardous particular care needs to be taken when selecting the equipment and assessing the frequency of inspection and testing.

Good Housekeeping

A check should be made to ensure the equipment is installed and is being operated in accordance with the manufacturers instructions. Notwithstanding the manufacturers instructions, the following are examples of items which should be checked:

(a) Cables located so as to avoid damage
(b) Means of disconnection/isolation readily accessible
(c) Adequate equipment ventilation
(d) Cups, plants and work material correctly placed to avoid spillage
(e) Equipment positioned to avoid strain on cord
(f) Equipment is being operated with the covers in place and any doors are closed
(g) Indiscriminate use of multi-way adaptors and trailing sockets is avoided
(h) No unprotected cables run under carpets

Disconnection Of Equipment

The means of isolation from the electricity supply must be readily accessible to the user, i.e. in normal circumstances it must be possible to reach the plug and socket without too much difficulty.

The Condition Of The Equipment

Prior to the commencement of the users should be asked if they are aware of any faults and if the equipment works correctly. The following items need to be inspected:

(a) The flexible cable
(b) The socket outlet, if known
(c) The appliance
(d) The plug head

Some of the following checks may not be possible for equipment fitted with a non-rewireable plug

(i) Check detachable power cords to Class 1 equipment incorporates a CPC
(ii) Identify signs of overheating
(iii) Internal inspection; cord security, polarity, connections
(iv) If non-rewireable plug; cord security, burning odours
(v) Correct size fuse fitted, BS marked, ASTA marked
(vi) Security of plug cover
(vii) Check the flexible cable connections and anchorage at the equipment, if practical.

Electrical Testing

Electrical testing of portable equipment will involve the following:

(i) Earth bond continuity tests
(ii) Insulation resistance testing
(iii) Functional checks

(a) Earth Bond Test (Class 1 equipment only):

Readings should show less than 0.1+R Ohms (where R is the resistance of the lead) Tested at a current of 1.5 times the rating of the fuse and no greater than 25A for a period of between 5 and 20 seconds or with a short-circuit test current within the range 20mA to 200mA.

(b) Insulation Resistance Test:

The applied test voltage should be approximately 500 Vdc

Class 1 heating equipment < 3kW 0.3M Ohms
Class 1 All other equipment 1M Ohms
Class 2 Equipment 2M Ohms
Class 3 Equipment 250k Ohms

(c) Optional Tests:

Flash Test: No flashover or breakdown shall occur

Operation/Load test: Compare reading with stated details on nameplate

Earth leakage test:
Class 1 Handheld Appliances 0.75mA
Other Class 1 Appliances 3.5mA
Class 2 Appliances 0.25mA

Record Keeping

It has been seen that it is a defence under Regulation 29 of the Electricity at Work Regulations for a duty holder to 'prove that he took all reasonable steps and exercised all due diligence to avoid the commission of that offence'. It seems clear that the most effective method by which a duty holder can prove this in court would be by producing records. Without records it would be extremely difficult to convince the court that the defendant had acted within either the letter or the spirit of the law. Records are essential if a proper and organised system of testing is to be established.

The keeping of suitable records then is essential. They provide evidence for the defence in the event of a prosecution; more practically, such records enable the close monitoring of the equipment highlighting potential faults or adverse trends. They are also essential in forming an accurate assessment of the necessary frequency of testing. For example, if over a number of consecutive test cycles few or no failures were recorded then he duty holder may consider reducing the frequency of tests, obviously the converse may also apply.

Replacement Of Appliance Flexes

For flexes to be protected by the fuse in a BS1363 plug there is no limit to their length, providing their cross-sectional areas are below:

3A 0.5mm 2
13A 1.25mm 2

Other considerations such as voltage drop may limit flex lengths. Smaller CSA's than those given are acceptable if flex lengths are restricted. However, for replacement purposes the above simplified guidance is appropriate.

The maximum lengths recommended for extension leads are not applicable to appliance flexes or cords.

Fuse Ratings

For the convenience of users, appliance manufacturers have standardised on two plug fuse ratings- 3A & 13A and adopted appropriate flex sizes. For appliances up to 700W a 3A fuse is used, for those over 700W a 13A fuse is used.

The fuse in the plug is not fitted to protect the appliance, although in practice it often does this. Appliances are generally designed to European standards for use throughout Europe. In most countries the plug is unfused. If an appliance needs a fuse to comply with the standard it must be fitted within the appliance. The fuse in the plug protects against faults in the flex and can allow the use of a reduced csa flexible cable. This is advantageous for such appliances as electric blankets, soldering irons and Christmas tree lights, where the flexibility of a small flexible cable is desirable.

RCD's

RCDs are often known by other names, eg., earth leakage circuit breakers (ELCB) or safety switches.

An RCD is an electrical safety device specially designed to immediately switch the electricity off when electricity "leaking" to earth is detected at a level harmful to a person using electrical equipment. An RCD offers a high level of personal protection

from electric shock. Fuses or overcurrent circuit breakers do not offer the same level of personal protection against faults involving current flow to earth. Circuit breakers and fuses provide equipment and installation protection and operate only in response to an electrical overload or short circuit. Short circuit current flow to earth via an installation's earthing system causes the circuit breaker to trip, or fuse to blow, disconnecting the electricity from the faulty circuit. However, if the electrical resistance in the earth fault current path is too high to allow a circuit breaker to trip (or fuse to blow), electricity can continue to flow to earth for an extended time. RCDs (with or without an overcurrent device) detect a very much lower level of electricity flowing to earth and immediately switch the electricity off.

RCDs have another important advantage - they reduce the risk of fire by detecting electrical leakage to earth in electrical wiring and accessories. This is particularly significant in older installations.

How They Work

RCDs work on the principle "What goes in must come out". They operate by continuously comparing the current flow in both the Active (supply) and Neutral (return) conductors of an electrical circuit.

If the current flow becomes sufficiently unbalanced, some of the current in the Active conductor is not returning through the Neutral conductor and is leaking to earth.

RCDs are designed to operate within 10 to 50 milliseconds and to disconnect the electricity supply when they sense harmful leakage, typically 30 milliamps.

The sensitivity and speed of disconnection are such that any earth leakage will be detected and automatically switched off before it can cause injury or damage. Analyses of electrical accidents show the greatest risk of electric shock results from contact between live parts and earth.

Contact with earth occurs through normal body contact with the ground or earthed metal parts. An RCD will significantly reduce the risk of electric shock, however, an RCD will not protect against all instances of electric shock. If a person comes into contact with both the Active and Neutral conductors while handling faulty plugs or appliances causing electric current to flow through the person's body, this contact will not be detected by the RCD unless there is also a current flow to earth.

On a circuit protected by an RCD, if a fault causes electricity to flow from the Active conductor to earth through a person's body, the RCD will automatically disconnect the electricity supply, avoiding the risk of a potentially fatal shock.

Examples of equipment recomended to be protected by a RCD:

- Hand held electric power tools, such as drills, saws and similar equipment.
- Tools such as jack-hammers, electric lawn mowers.
- Equipment on construction sites.

• Equipment such as appliances which move while in operation, such as vacuum cleaners and floor polishers.
• Appliances in wet areas such as kitchens, including kettles, jugs, frying pans, portable urns, food mixers/blenders.
• Hand held appliances such as hair dryers, curling wands, electric knives etc.
• Cord extension leads.

Testing RCD's

Suggested testing intervals for portable RCD's

Type of environment in which equipment is used	Push-button test(by user)	Test for operation By an Electrician
Factories, workshops and places of work of manufacturing, repair, assembly, maintenance or fabrication	Daily, or before every use, whichever is the longer	12 months
Other commercial environments with no special protection, eg., laboratories, tea rooms, office kitchens, and health care establishments	3 months, or before every use, whichever is the longer	2 years
Office environment where equipment is not subject to constant flexing of the supply cord	3 months	2 years
Hire equipment	Before each hire	Before each hire

Testing of non-portable RCDs on switchboards or inbuilt into socket outlets must be carried out on a regular basis. This includes both push button testing by the user and inspection testing for operation by an electrician. Unless operated from time to time, an RCD may "mechanically freeze" and not trip when required.

Push-button testing by the user only confirms satisfactory mechanical performance of the tripping mechanism of the RCD. It does not replace inspection testing for operation by a licensed electrical worker.

As non-portable RCDs are far less susceptible to damage than portable RCDs, they are not subjected to the same testing and inspection procedures. In the case of non-portable RCDs, push button testing is recommended at three monthly intervals.

After tripping out, an RCD must be re-activated only when the cause of the trip has been established and remedial action taken.

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