In – service inspection and testing of electrical equipment

Basic essentials from the IET's 4th edition code of practice

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Introduction

A good proportion of electrical accidents occur as a result of faulty or damaged portable electrical equipment, regular inspection and where appropriate testing can significantly reduce the risks of this happening.

The IEE Code of Practice (COP) 4th edition 2012 gives advice and guidance to carry out this maintenance. It is strongly recommended that you should aquire your own copy of this publication. ISBN 978-1-84919-626-0

The official title of the subject is 'in-service inspection and testing of electrical equipment' as stated by The Institute of Engineering and Technology (IET), and is a means of reducing the risk of injury by the use of portable appliances.

It is applicable to the following circumstances

1. Appliances used in the work place
2. Where the public may use appliances in places such as hospitals, schools, hotels, shops etc.
3. Where appliances are supplied in rented premises or hired
4. Where appliances are repaired or serviced

Legal requirement

The Health and Safety at Work Act 1974 puts a 'duty of care' upon both employer and the employee to ensure the safety of all persons using the work premises and equipment. Under this Statutory Act are various regulations which point towards a continuous regime of inspection and testing.

The most relevant Regulation is 4(2) of The Electricity at Work Regulations 1989 which state;

> *As may be necessary to prevent danger, all systems shall be maintained so as to prevent, so far as reasonably practicable, such danger.*

And Regulation 5 of the Provision and Use of Work Equipment Regulations 1998 which state;

> *Every employer shall ensure that work equipment is maintained in an efficient state, in efficient working order and in good repair.*

There is no law that specifically requires Portable Appliance Testing, but by implication it is a legal requirement, Portable Appliance Testing is a way of compliance.

What is a portable appliance

Generally, Portable Appliances can be thought of as electrical goods that can be plugged into a power socket (however some wired-in equipment is considered; see page 14 of COP). This includes 240V, 110V and 415V equipment.

There are three 'classes' of equipment construction (see section 11 of COP)

Class I – equipment that ***must be earthed*** for safety reasons, usually has metal casing. Eg toasters, fridges and extension leads etc.

Class II – equipment that does ***not have*** an earthing facility, usually has plastic casing. (This is identified by a 'square within a square' symbol). Eg most modern hand drills, TVs, hairdryers etc.

Class III – equipment that operates from Safety Isolating Transformer (SELV), a maximum 50V a.c. or 120V d.c. Eg 12V table lamps, telephone base units etc.

There are several 'types' of equipment (see section 5 of COP)

Portable (P) – no more than 18kg and not held during use eg. Kettles, extension leads and cord sets (IEC leads)

Movable (M) – no more than 18kg not fixed, or heavier but with wheels eg. compressors

Hand-held (H) – held during use eg. irons

Stationary (S) – exceeds 18kg and is not intended to be moved eg. Washing machines

Fixed (F) – wired in equipment eg. Hand dryers

Built-in (B) – Built in ovens

Information technology (IT) – computers and sensitive electronic equipment etc

How often is testing required (see section 11 of COP and page 10)

Basically the more hazardous the environment, or the more abusive use, the more frequent the testing should be.

Class I equipment generally requires more frequent testing because the integrity of the earth connection is paramount to it's safety.

Equipment used on a building site requires more frequent testing because of the bad conditions likely to be encountered, and the abuse it will receive, recommended every three months.

Class II office equipment will require the least frequent inspection and testing.

The frequency chart in the 'code of practice' is a general guide only where initial set up of the PAT regime is being carried out, the fourth edition of the COP has been written to emphasise the need to 'risk assess' in consultation with the duty holder to save un-necessary over-compliance ie blanket annual testing irrespective of conditions, use and location.

Carry out a risk assessment on the following items of equipment and decide on the frequency of inspection and testing, using the form below;

I. A washing machine used by a family in a single occupancy rented house, the machine is in a dry basement.

II. A washing machine used by students in a multiple occupancy hall of residence, there are no signs of damage, but it does have a high usage, the machine is in a dry basement.

III. Class I Soldering irons used by children in a school, many of the irons have damaged flexes by contact with the hot iron, previous records also show high fail rate.

IV. Class I Soldering irons used by electricians in the workshop, previous records do not show regular problems.

V. An industrial Class I portable battery charger used in a well maintained, clean car workshop.

VI. An industrial Class I portable battery charger used in a very poorly maintained and dirty car workshop.

Initial frequency from table 7.1 (page 10)	Increased risk	Decreased risk	Revised frequency or other action required
I			
II			
III			
IV			
V			
VI			

First step: raise equipment register

Using a suitable form such as the sample form on page 126 of the COP, record the details of the equipment to be inspected and tested. It is important that each item is uniquely identified using a method of registration number or code.

Obviously if you already have records previously raised you do not need to repeat the work, but changes and new equipment need to be added.

Appliance cord sets to IT (kettle leads or IEC leads) need to be entered as separate items in case of interchanging.

NOTE: there is no requirement to inspect and test new equipment, but they will need registering as soon as they enter service, and will need a pass label.

Second step: inspection (see section 13 & 14 & page 117 of COP)

Inspection is always done before testing and with the equipment DISCONNECTED from the supply for safety reasons.

Check:

- Plug for damage, correct connection, cable clamp, fuse rating – generally under 700W = 3A, over 700W = 13A (the COP does not mention 5A but an appliance of between 700W and 1000W would suit a 5A fuse).
- Cable for damage, correct size (uncoil extension reels)
- Equipment for damage
- Suitability of the equipment to the environment
- Record the result on the inspection and test record form

Once inspection is satisfactory then carry on into any relevant tests.

Third step: testing (see section 10 & 15 & page 117 of COP)

Test equipment (see section 10 of COP)

The tester must perform at least;

a) Earth bond test (sometimes called earth continuity) using a maximum of 26A
b) Insulation resistance, normally at 500Vdc

More sophisticated testers have ‘soft tests’ such as earth leakage tests, low current earth continuity tests for sensitive equipment, insulation resistance tests at 250V, touch current tests which operates the equipment during the test.

Test equipment must be annually re-calibrated.

Class I equipment:

Do not touch the equipment during the tests

- **Earth bond test** – use high current for non-sensitive equipment (up to 26A), low current for sensitive IT equipment (no more than 200mA).

  Any value not exceeding 0.1Ω (100mΩ) is a definite pass

  A value above 0.1Ω (100mΩ) is not necessarily a fail if the equipment is for example an extension lead or has a long cord to the equipment, reference to the resistance table needs to be made, (see page 9 of this handout and page 124 of the COP);

  in this case a value not exceeding 0.1Ω + the calculated resistance of the cable is a pass.

  A value exceeding the above requirements is a fail, and should be removed from service, labelled DANGER DO NOT USE, repaired or disposed of and entered in the ‘faulty equipment register’.

- **Insulation resistance test** – use 500V d.c. for non-sensitive equipment, and a soft test for sensitive IT equipment (see section 10 of COP).

A minimum value of 1Mega Ohm is a pass, less is fail unless it is a heating appliance in which a minimum value of 0.3MΩ is acceptable.

Where cookers with certain types of element are used and are likely to fail the test, it is acceptable to switch on the appliance for a while to drive off absorbed moisture before commencing the testing (COP Table 15.2 note 1).

Class II equipment

Do not touch the equipment during the tests

- No earth bond test is required
- Insulation resistance test is required – use 500V d.c.

A minimum value of 2Mega Ohm is a pass, less is fail.

Enter test values in the inspection and test record form.

Passed items: attach a pass label with the relevant information.

Failed items: should be removed from service, labelled DANGER DO NOT USE, repaired or disposed of and entered in the 'faulty equipment register'.

Fourth step: polarity and functional check (see section 15.7 & 15.9 of COP)

A polarity check is required on extension leads particularly homemade items, this can be done by a multimeter set to the ohms range, or use a PAT tester with a polarity test facility.

A functional check can be done by simply plugging the equipment in and checking for correct operation, or some PAT testers have load test facility.

Functional checks are not a safety issue on most equipment so you can leave this for the operator to inform you of any problem, however a check on the micro-wave door shut off facility should be done.

Fifth step: records and labels (see appendix VI of COP)

Complete records including the faulty equipment register and if any repairs are done a repairs register.

Records need to be kept for two reasons; (see section 8.3 of COP)

1. In order to monitor any deterioration in test results
2. To prove that testing has actually been carried out (evidence in a court of law)

Records should be kept secure and readily accessible.

Resistance of flexible cables

Conductor csa	Conductor resistance	Max current carrying capacity	Approx. no. of wires in

(mm²)	(Ω/m)	(Amps)	conductor
0.5	0.039	3	16
0.75	0.026	6	24
1.0	0.0195	10	32
1.25	0.0156	13	40
1.5	0.0133	15	30

Table 7.1 Guidance on the initial frequency of inspection and testing of equipment

Equipment environment	Type of equipment	User check	**Class I** Formal visual inspection	**Class I** Combined inspection and testing	Class II Formal visual inspection and testing	Class II Combined inspection and testing
1 Construction site 110V equipment	S IT M P H	None N/A Weekly Weekly Weekly	1 month N/A 1 month 1 month 1 month	3 months N/A 3 months 3 months 3 months	1 month N/A 1 month 1 month 1 month	3 months N/A 3 months 3 months 3 months
2 Industrial including commercial kitchens	S IT M P H F	Weekly Weekly Before use Before use Before use 3 months	None None 6 months 6 months 6 months 12 months	24 months 24 months 12 months 12 months 12 months 24 months	None None 6 months 6 months 6 months 12 months	24 months 24 months 24 months 12 months 12 months 48 months
3 Equipment used by the public	S IT M P H F	Weekly Weekly Weekly Before use Before use Weekly	Monthly Monthly Weekly Weekly Weekly 12 monthly	12 months 12 months 6 months 6 months 6 months 36 months	12 months 12 months 6 months 6 months 6 months 12 months	24 months 24 months 12 months 12 months 12 months 36 months
4 Schools (used by staff only)	S IT M P H F	Weekly Weekly Weekly Weekly Before use Weekly	None None 6 months 6 months 6 months 12 months	12 months 12 months 12 months 12 months 12 months 36 months	12 months 12 months 12 months 12 months 12 months 12 months	48 months 48 months 48 months 48 months 48 months 48 months
5 Hotels (used by staff only)	S IT M P H F	None None Weekly Weekly Before use Weekly	24 months 24 months 12 months 12 months 12 months 24 months	60 months 60 months 24 months 24 months 24 months 48 months	24 months 24 months 24 months 24 months 12 months 24 months	None None None None None None
6 Offices and shops (used by staff only)	S IT M P	None None Weekly Weekly	24 months 24 months 12 months 12 months	60 months 60 months 24 months 24 months	24 months 24 months 24 months 24 months	None None None None

	H F	Before use 3 months	12 months 24 months	24 months 48 months	12 months 24 months	None None

S – stationary equipment

IT – information technology equipment

M – movable equipment

P – portable equipment

H – handheld equipment

F – fixed equipment

References

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.
GS38 Electrical test equipment for use by electricians

Codes of Practice

IET Code of Practice for In-service Inspection and Testing of Electrical Equipment 4th Edition ISBN 978-1-84919-626-0
Hire Association of Europe (HAE) and Event Hire Association (EHA) document, 'Guidance on Electrical Safety Testing in the Hire Industry' HAEEST2012

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 076603