Data Sheet

Portable Appliance Testing

Why is appliance safety inspection and testing required?

A quarter of all serious electrical accidents involve portable electrical appliances. There is a requirement for an employer, and those renting, re-selling or repairing portable appliances to take adequate steps to protect the users of those appliances from both electrical shock and fire hazards. The HSE claim nearly 2000 fires in 1991 were caused by faulty leads to appliances.

To meet the requirements of the 1989 'Electricity at Work Regulations' it is widely regarded to be necessary to implement a programme of planned inspection and testing of portable appliances. This application note should help to implement such a programme.

Who is responsible for portable appliance safety?

The responsibility for safety applies equally to small firms (including the self employed) as to the larger organisations. In addition to being responsible for the safety of their own portable applications they are also responsible for those bought onto site by employees or contractors.

The 'Electricity at Work Regulations' place a duty upon employers, the self-employed and employees, to ensure that the risks associated with the use of electrical equipment are controlled. The HSE 'Memorandum of Guidance on the Electricity at Work Regulations' implies that the above 'duty holders' have a responsibility to 'maintain' electrical equipment to ensure that it remains safe.

The requirement upon 'duty holders' with regard to portable appliances, have been enlarged upon by the HSE guidance note HS(G)107 'Maintaining Portable and Transportable Electrical Equipment' and their leaflets 'Maintaining Portable Electrical Equipment in Offices and Other Low Risk Environments' and 'Maintaining Portable Electrical Equipment in Hotels and Tourist Accommodation'. The HSE recommend in these documents that a three level system of inspection can give cost effective maintenance of portable appliances, these are:

1. User checking
2. Formal visual inspections by an appointed person
3. Combined inspection and testing by a competent person or contractor.

Safety of appliances

The user of an electrical appliance is protected from electrical shock using basic methods, insulation and earthing. These are used to prevent the user coming into contact with a live electrical part.

For insulation to be effective it must offer a high resistance at high voltages.

For earthing to be effective it must offer a low impedance to any potentially high fault current that may arise.

A principle of electrical safety is that there should be two levels of protection for the user. This leads to two classes of portable appliances: **Class 1** which uses earthing + insulation (earthed appliance) and **Class 2** using insulation + insulation (commonly called double insulated).

The inspection and testing for **Class 1** and **Class 2** appliances therefore differ to suit the type of protection.

What levels of inspection and testing are required?

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

The HSE indicate the following factors to consider in making such a risk assessment:

- The type of equipment and whether or not it is hand held
- Manufacturer's recommendations
- Initial integrity and soundness of equipment
- Age of the equipment
- Working environment in which the equipment is to be used (e.g. wet or dusty) or likelihood of mechanical damage
- Frequency of use and the duty cycle of the equipment
- Foreseeable abuse of the equipment
- Effects of any modification or repairs to the equipment
- Analysis of previous records of maintenance, including both formal inspection and combined inspection and testing.

Where a duty holder is unable to make a judgement on the above criteria the HSE have provided guidance of the initial frequencies of inspection and testing that can be used to implement a maintenance programme. Alternately advice can be sought from a competent person.

Note: Extension leads should be treated as electrical appliances.

Table 1 HSE suggested initial internals

Type of business	Formal visual inspection	Combined inspection and electrical tests
Equipment hire	Before issue/ After return	Before issue
Construction	Before initial use- 1 month	3 months
Industrial	Before initial use- 3 months	6-12 months
Offices and other low risk environments	See table 2	

Table 2 HSE suggested initial intervals for offices and other low risk environments

The guidance given in these tables is accompanied by a note to the effect that the inspection and test intervals should be reviewed in the light of experience, as information on faulty equipment is accumulated.

Where equipment is repaired testing is considered to be necessary to re-affirm its safety.

Equipment/ Environment	User checks	Formal visual inspection	Combined inspection and testing
Battery-operated (less than 20 Volts)	No	No	No
Extra low voltage: (less than 50Vac) e.g. telephone equipment, low voltage desk lights	No	No	No
Information technology: e.g. desktop computers, VDU screens	No	Yes, 2-4 years	No if double insulated - otherwise up to 5 years
Photocopies, fax machines: NOT hand-held. Rarely moved	No	Yes, 2-4 years	No if double insulated - otherwise up to 5 years
Double insulated equipment: NOT hand-held. Moved occasionally, e.g. fans, table lamps, slide projectors	No	Yes, 2-4 years	No
Double insulated equipment: HAND-HELD e.g. some floor cleaners	Yes	Yes, 6 months - 1 year	No
Earthed equipment (Class 1): e.g. electric kettles, some floor cleaners	Yes	Yes, 6 months - 1 year	Yes, 1 - 2 years
Cables (leads) and plugs connected to the above. Extension leads (mains voltage)	Yes	Yes, 6 months - 4 years depending on the type of equipment it is connected to	Yes, 1 - 5 years depending on the type of equipment it is connected to

Who is able to undertake the inspection and testing?

Since there are three levels of maintenance action in the HSE recommendation there are implications with regard to the level of knowledge required by those undertaking the responsibility.

User checks

Since users are expected to visually check that the equipment they intend to use appears safe, they will need to be aware of the possible signs that might indicate a defect. Use of a potentially hazardous appliance can then be avoided by having it bought to management attention. This may require some initial training. Users of portable appliances should be aware of the following possible dangers:

- Damage to the power lead insulation
- Damage to the plug i.e. bent pins, signs of overheating or cracked case
- Poor cable retention i.e. cable is loose at either end or the inner insulation is showing
- Badly made joints within the power lead
- Damage to the casing of the equipment i.e. cracks, loose parts, screws missing, melted plastic
- Excessive dirt on equipment or water on equipment
- Evidence of overheating e.g. burn marks or discolouration.

Formal visual inspections

These require a competent person who has been trained to carry out a visual inspection, and possibly capable of checking the fuse and wiring within the plug. The HSE recommend that simple written guidance is given relating to this visual inspection, and that the person carrying out these tasks should know the limit of their knowledge so as to avoid danger. Such formal visual inspection for potentially dangerous appliances, enables the effectiveness of 'user checks' to be monitored.

Combined inspection and testing

Since not all dangerous faults on equipment can be found with just visual inspection, appliance testing is often also necessary.

- If there is a suspicion that an appliance is not safe, but it looks OK visually
- After any repairs, modifications, or other similar work
- At a scheduled inspection and test (after a period determined by a risk assessment).

Such inspection and testing should not only include testing with a portable appliance tester but should include:

Checking the polarity, the fusing and termination of the mains flex. Inspection and testing also affords the opportunity to review again the suitability of the appliance to its environment and the frequency of inspection and testing.

The HSE defines two levels of competency for appliance testing, dependant on the type of appliance tester used.

When a person is using a pass/fail style appliance tester (PAT) and no interpretation of the readings is required, the person need not be skilled in electrical work, but must understand how to operate the PAT correctly and understand acceptance criteria.

The other level of competence is where a PAT with a readout requiring interpretation is used. When the person would need to be technically competent through knowledge or experience.

Documentation of the inspection and testing

Although there is no specific requirement for maintenance records to be documented, within the 'Electricity at Work Regulations' it is widely accepted that some form of recording results is necessary to implement a control system.

The control system recommended should include:

1. Ensuring that appliance inspection and testing is someone's specific responsibility
2. Keeping a log book or register of portable appliances and keeping a record of inspection/test results, in order to ensure that all equipment is inspected when due
3. Labelling equipment when tested with a due date for its next inspection or test.

It is essential that any appliance that fails a safety inspection or test is removed from circulation, and labelled as not suitable for use. Some form of record system using a computer or index cards may be required to ensure a workable system when a large numbers of appliances are to be registered.

Appliance testing log sheet

A sample log sheet is shown later in this data sheet. The log sheet is free of copyright and may be copied for use in a regular planned inspection and testing system.

Software for a testing programme

For medium and large sites where portable appliances are more numerous, the requirements of the 'Electricity at Work Regulations' can be more easily implemented by the use of a computerised system. One such is 'Safety 1st' (**RS** stock no. 203-079), which runs on an IBM PC/AT/PS2 or compatible computer with 640k of RAM and a hard disk. This system holds a description of each appliance plus the inspection and test frequencies. The system can than schedule both formal visual inspections and combined inspection and testing.

It can produce monthly and/or weekly check lists of appliances due for testing for each location on site. A record of test results is then compiled from information keyed into the PC from the visual inspection or test report sheets, which are originated by the system and subsequently filled in by the person responsible for the inspection or testing. Additionally, test data can be input directly via an RS-232 interface from computerised portable appliance testers such as the Seaward PAT 1000, the Edgecumbe Micro-PATs or the Robin Smart PAT 5000. The 'Safety First' system is able to produce a variety of reports to enhance the implementation of an appliance safety programme. These include equipment register, check lists, equipment history, failed equipment report and overdue inspection/test reports.

The portable appliance tester

The procedures for portable appliance safety testing require that electrical tests are carried out upon the appliances to confirm the integrity of the earthing and the insulation. To simplify this task a competent person can use a portable appliance tester (PAT) to perform these tests safely.

Note: When testing an electrical appliance, for a test to be valid, ensure that it is switched on and that the fuse is intact.

The unit under test is plugged into the socket on the PAT. Some tests are carried out through the plug, others through both the plug and an auxiliary probe to the casing of the appliance.

The tests

Two basic tests are offered by all appliance testers, these are:

Earth bond test. Applies a substantial test current, typically around 25A*, down the earth pin of the plug to an earth probe which should be connected by the user to any exposed metalwork on the casing of the unit under test. From this the resistance of the earth bond is determined by the PAT.

*Alternative lower current tests are offered on some appliance testers allowing low current consumption appliances to be tested without stressing the smaller earth conductors. A 100mA earth continuity test is offered by some PATs to enable shielding and non-functional earths to be verified without damage.

Insulation test. Applies a test voltage, typically 500Vdc, between the live and neutral bonded together and earth, from which the insulation resistance is calculated by the PAT.

Other tests offered include the following:

Flash test. Tests the insulation at a higher voltage, typically 1.5kV for Class 1 appliances and 3kV for Class 2 appliances. From this test the PAT derives a leakage current indication. This is a more stringent test of insulation, that should be used with caution since it can cause damage to electronic equipment and may over-stress insulation. Load test, measures the load resistance between live and neutral to ensure that it is not too low for safe operation.

Operation test. A further level of safety testing which proves the preceding tests were valid (i.e. the unit was switched on), ensures that an excessive current level is not drawn by the appliance and avoids the embarrassment of passing a non-working appliance.

Earth leakage test. This is carried out during the 'Operation test' as a further test of the insulation under its true working conditions. This test can also be useful to ensure that appliances are not responsible for nuisance tripping of RCDs.

Fuse continuity test. This will test that the fuse is intact and that the appliance is switched on prior to carrying out other tests.

Testing earthed (Class 1) appliances

The **earth bond test** is only used when testing earthed (Class 1) appliances. A test lead is clipped onto an exposed metal part of the unit under test. The test is then carried out by the PAT, usually at the press of a button. The test result should then be noted and recorded.

The **insulation test** on an earthed appliance requires no additional test lead and is carried out via the plug. Again the test result should be noted and recorded.

If a **flash test** is carried out this is also done via the plug once selected and activated.

Double insulated (Class 2) appliances

The **earth bond test** is not required.

The **insulation test** uses a clip or probe which is held against the appliance body whilst the test is in progress. The results must again be read and recorded.

A **flash test** if carried out uses an external probe held against the appliance body whilst the test is in progress. Once more the reading must be noted and recorded.

Operating procedures are detailed fully in operators manuals supplied with the PATs.

Further reading

This data sheet only offers brief notes on appliance safety and maintenance, the following further reading is recommended for a more adequate understanding.

Health and safety series booklet HS(R)25

Memorandum of guidance on the electricity at work Regulations 1989 (Available from: HMSO)

HS(G) series booklet HS(G)107

Maintaining portable and transportable electrical equipment (Available from: HMSO)

IND(G) series booklet IND(G)160L

Maintaining portable electrical equipment in offices and other low risk environments (Available from: HMSO)

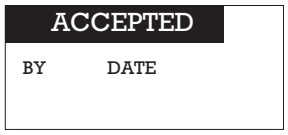
FEI recommendations Issue 2, July 1994 for periodic safety checks for business equipment (Available from: FEI, Russell Square House, 10-12 Russell Square, London WC1B 5EE. Tel: 071-331 2000).

RS supplies a range of self adhesive labels with pre-titled legends. Examples from the range which may be useful when testing portable appliances are pictured below. Labels can be marked with ballpoint pen, typewriter or spirit based inks. Alternatively, partially laminated labels are available providing additional durability. Please see the drafting and marking equipment section in part 2 of the current **RS** Catalogue for stock numbers, prices and ordering information.

RS can also supply pre-printed Bar-code labels for use with Seaward PATs in conjunction with Welch Allyn PAT barcode wand (**RS** stock no. 246-9007).

Note: If used with a Seaward 1000/1500 series, a separate power supply and adaptor cable (**RS** stock no. 246-9057) is required.

Please see the Electrical Test section in part 2 of the current RS Catalogue.



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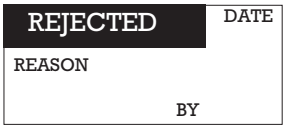

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Portable appliance tester selection guide

A quarter of all serious electrical accidents involve portable electrical appliances. There is a requirement for an employer, and those renting, repairing or re-selling appliances, to take adequate steps to protect the users of these appliances from both electrical shock and fire hazards. **RS** offers a full range of portable appliance testers (PATs) to choose from. This guide will make it easier to select the PAT that best suits your needs.

†Compatible with Welch Allyn Barcode Wand (**RS** stock no. 246-9007)

Note: The **RS** Service*point* Calibration is available for portable appliance testers supplied by **RS** to ensure that you are always testing accurately.

For full details see your latest **RS** Catalogue.

		Robin † Smart PAT 3000	Robin † Smart PAT 5000	Edgcumbe Micro PAT+	Seaward† PAT 2000i	Seaward† PAT 1000X	Seaward† PAT 1000S	Seaward† IT 1000
Earth bond test	Tests if the earth is OK. Earth resistance is tested with a test current @ 25A. This test applies to earthed (Class 1) appliances only.	Yes Pass levels <0.1Ω	Yes Pass levels <0.1Ω and selectable	Yes Pass levels <0.1Ω and selectable	Yes Pass levels <0.1 or 0.5Ω	Yes Pass levels <0.1, 0.5 or 2Ω	Yes Pass levels <0.1 or 0.25Ω	Yes Pass levels <0.1 or 0.15Ω
	Alternate low current earth bond test.	Yes 0.1A & 8A	Yes 0.1A & 8A	Yes 0.1Adc and 25Aac	Yes 0.1, 6, 12, 25A	Yes 8A	8A	0.1, 6, 12, 20, 25A
Insulation test	Tests if the insulation is intact. Insulation is tested with a test voltage of 500Vdc at pass level. This test applies to both Class 1 and Class 2 appliances.	Yes Pass levels <2,7MΩ	Yes Pass levels <2,7MΩ	Yes Pass levels 0.5,1.0, 2.0 and 7.0MΩ	Yes Pass levels >2, 7MΩ 0-19.9MΩ	Yes Pass levels >2, 4, 7MΩ	Yes Pass levels >2, 4, 7MΩ	Yes Pass levels >2, 7MΩ
Fuse test	Tests the fuse and also ensures that the appliance is switched on, for subsequent test.	P-N Continuity	P-N Continuity	P-N Continuity				
Flash test	Tests if the insulation will stay OK. Carried out with a 1.5kV test voltage for Class 1 and 3kV test voltage for Class 2 appliances.		Yes selectable	Yes Pass levels <3mA	Yes Pass levels <3 or 5mA	Yes Pass levels <3 or 5mA	Yes Pass levels <3 or 6mA	
Load test	Tests to ensure that the load impedance is safe to connect to the mains, i.e. not a short circuit. Often also used as confirmation the unit is switched on with fuse intact		Yes	Yes	Yes	Yes		
Operation test	A further level of safety checking to ensure an excessive level of current is not drawn. Also avoids embarrassment of passing a		Yes selectable readout up to <4kVA	Yes Pass levels 3.1kVA (240V) 1.43kVA (110V)	Yes Pass levels <0.5, 1, 2, 3.2kW (240V) or 1, 1.8kW (110V)		Yes Pass levels <1, 2 or, 3kW	Yes Functional test only
Earth leakage test	Tests that the earth leakage current is at an acceptable level. Useful to ensure appliance is not deteriorating and liable to become unsafe. Also ensures that tested appliances are not responsible for nuisance tripping of RCDs.		Yes selectable readout 0.1-9.9mA	Yes Pass levels <0.75, 3.5mA	Yes Pass levels <0.75, 3.5mA		Yes Pass levels <0.75, 3.5, 9.9mA	Yes Pass levels <0.75, 3.5mA
Test value readout		Yes Digital display	Yes Digital display	Yes Digital display	Yes Digital display	Yes Digital display	Yes Digital display	Yes Digital display
Pass/Fail indicators		Yes indicated on the display	Yes indicated on the display	Yes indicated on the display	Yes indicated on the display	Yes indicated on the display	Yes indicated on the display	Yes indicated on the display
Automatic test sequence				Yes Selectable	Yes Selectable	Yes Selectable	Yes Selectable	Yes Selectable
Dual 110 and 240 Volt version - **RS** stock number:		847-130	847-124			212-405		
240 Volt version - **RS** stock number:				248-2870				
Extension lead accessory - **RS** stock number:					203-833	203-833	203-833	203-833

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Portable appliance tester selection guide (continued)

* Both LV and HV flash test facilities provide Class 1 testing at 1kV and 2.5kV, and Class 2 testing at 1.5kV and 3.75kV.

Note: **RS** Service*point* Calibration Service is available for portable appliance testers to ensure that you are always testing accurately.

For full details see your latest **RS** Catalogue.

		Megger PAT 32	Megger PAT 2	Seaward PAC 500	Seaward PAT 500H	Seaward PAC 1500xi
Earth bond test	Tests if the earth is OK. Earth resistance is tested with a test current @ 25A.This test applies to earthed (Class 1) appliances only.	Yes Pass levels	Yes Pass level <0.1Ω	Yes Pass level <0.5Ω		YES Pass level
	Alternate low current earth bond test.	Yes 0.1, 10A and 25A			Yes 0.1Amps	Yes 0.1, 6, 12, 20 and 25Amps
Insulation test	Tests if the insulation is intact. Insulation is tested with a test voltage of 500Vdc at pass level. This test applies to both Class 1 and Class 2 appliances.	Yes Pass	Yes Pass level >2,MΩ	Yes Pass level >2MΩ	Yes Pass level >2MΩ, >7MΩ	Yes Pass level >2MΩ, >7MΩ
Fuse test	Tests the fuse and also ensures that the appliance is switched on, for subsequent test.	Yes				Yes
Flash test	Tests if the insulation will stay OK. Carried out with a 1.5kV test voltage for Class 1 and 3kV test voltage for Class 2 appliances.		Yes* Pass level <3mA			
Load test	Tests to ensure that the load impedance is safe to connect to the mains, i.e. not a short circuit. Often also used as confirmation the unit is switched on with fuse intact.		Yes			
Operation test	A further level of safety checking to ensure an excessive level of current is not drawn. Also avoids embarrassment of passing a non-working appliance.		Yes Meter indication 0-3.5kVA			
Earth leakage	Tests that the earth leakage current is at an acceptable level. Useful to ensure appliance is not deteriorating and liable to become unsafe. Also ensures that tested appliances are not responsible for nuisance tripping of RCDs.				Yes Range 0-20mA	
Test value readout		Yes Digital and	Yes Analogue		Yes Digital	Yes Digital
Pass/Fail indicators		Yes indicated on	Via colour bands on	Yes	Yes	Yes Indicated on the display
Automatic test sequence						
Dual 110 and 240 Volt version - **RS** stock number:		219-579				
240 Volt version - **RS** stock number:				287-3068		159-1771
Extension lead accessory - **RS** stock number:		219-585				

	Megger Pat 32	Megger Pat 4DV	Megger Pat 4DVF	Edgcumbe D2112	Seaward Supernova
Earth bond test	Yes Pass levels	Yes Pass levels	Yes Pass levels	Yes Reading	Yes Pass level
	0.1, 0.5mW	selectable 0.05 to 2W	selectable 0.05 to 2W	only range 0-1.99	selectable
	Yes 0.1A, 10A and 25A	Yes 0.1A, 10A and 25A	Yes 0.1A, 10A and 25A	Yes 0.1Adc, 8Aac and 25Aac	Yes 0.1A, 4A 10A and 25A
Insulation test	Yes Pass levels 2 and 2MW	Yes Pass levels 2 and 2MW	Yes Pass levels 2 and 2MW	Yes Reading only	Yes Pass levels selectable
Fuse test	Yes Test plug top and appliance fuses	Yes Test plug top and appliance fuses	Yes Test plug top and appliance fuses		
Flash test			Yes Pass levels 0.2-3mA	Yes Pass levels 19.0mAac	Yes Pass levels selectable
Load test	Yes	Yes Tests to circuit continuity, short circuit and open circuit	Yes Test to circuit continuity, short circuit and open circuit		Yes
Operation test		Yes Pass levels selectable 50-3000VA	Yes Pass levels selectable 50-3000VA	Yes reading only	Yes
Earth leakage test		Yes Pass levels selectable 0.5-15mA	Yes Pass levels selectable 0.5mA	Yes Reading only 0-19.9mA	Yes Pass levels selectable
Test value readout	Yes Digital and analogue	Yes Digital and analogue	Yes Digital and analogue	Yes Digital display	Full graphics on LCD
Pass/fail indicators	Yes Indicated on display	Yes Digital display	Yes Digital display	Reading for interpretati on by user	Yes Indicated on display
Automatic test sequence		Yes User defined	Yes User defined		Yes Selectable
Dual 110 and 240V versions	219-579	287-4415	287-4421	326-7363	
240V version					
Extension lead accessory					203-833

Appliance testing log sheet

Appliance description

Formal visual inspection interval

Serial number

Location

Inspection and testing interval

Inspection date (Delete as applicable)		Visual/Combined	Visual/Combined	Visual/Combined	Visual/Combined	Visual/Combined	Visual/Combined	Visual/Combined
Tested by (block capitals)								
Visual check list	Power lead?							
	Cable retention?							
	Plug intact?							
	Fusing correct?							
	Casing intact?							
	Free of contamination							
Appliance switched on								
PAT test results	Earth bond test Ω							
	Insulation test MΩ							
	*Flash test mA							
	*Load test VA							
	*Earth leakage test mA							
PASS or FAIL								
Recall date Next: Delete as applicable		Visual/Combined	Visual/Combined	Visual/Combined	Visual/Combined	Visual/Combined	Visual/Combined	Visual/Combined
Signature								

*Optional tests which may be carried out if available on your portable appliance tester. This page may be freely copied for recording your appliance inspection and test results.