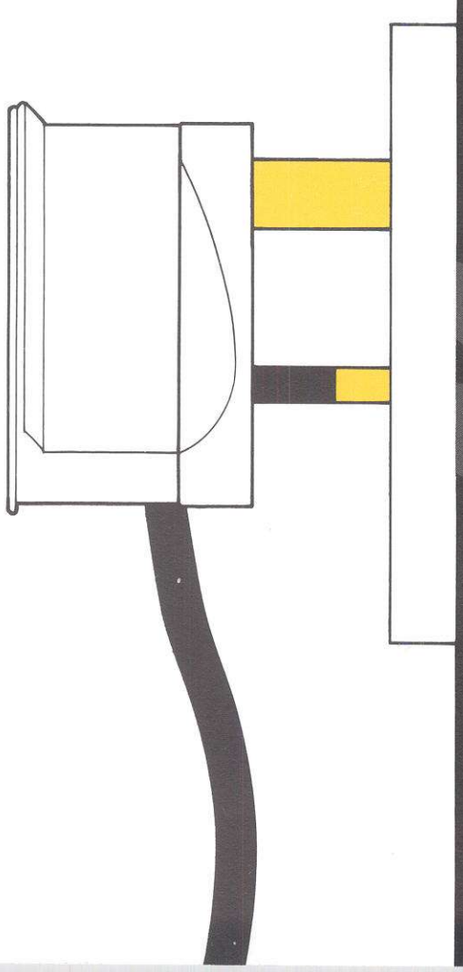
PORTABLE APPLIANCE TESTING



CONTENTS

IMPORTANT

To get the best from this booklet you will need access to:

- suitable test equipment
- various electrical appliances to test.

If you are in any doubt about the equipment to use, you should:

- read through the entire book
- obtain suitable test equipment and appliances
- repeat the work on the tests using the actual equipment.

INTRODUCTION

The Health and Safety Executive (HSE) have found that a quarter of reportable electrical accidents are due to faulty portable appliances. In this booklet we look at the inspection and testing of such appliances, with a view to reducing the number of accidents. It follows on from our 'Electricity in the Workplace' book and explores some of the practical implications of the Electricity at Work Regulations 1989. In particular it looks at the preventive maintenance and testing needed to satisfy the regulations.

As a bonus, this testing should help extend the life of your appliances, and reduce the disruption caused by equipment malfunction and consequent 'down-time'.

We will assume that your workplace electrical installation and wiring already complies with current IEE Wiring Regulations.

The treatment given is aimed primarily at those persons with specific responsibility for carrying out electrical safety checks, and consequent testing, within a company or organisation. Much of the material in the booklet may be of interest to other people concerned with safety in the workplace, but if you intend to actually ***carry out*** the tests which are described you must be competent to do so.

We discussed the issue of competence in the 'Electricity in the Workplace' book. You must have enough technical knowledge, experience and skills to be able to carry out tests in this field, without causing danger or injury before, during or after the work is completed. The level of competence needed for the optional tests is higher than that needed for the essential tests.

The layout of the booklet is as follows:

- safety fundamentals
- implementing a safety test programme
- essential tests
- optional tests.

Included with the book are:

- a suitable form for recording your test results
- suitable equipment labels.

We have used the same activity based style that was used in the 'Electricity in the Workplace' book. This usually involves you in reading a little, thinking a little, and then doing something yourself - either written or practical work. The written questions are separated from the rest of the text and highlighted.

Where appropriate, we have left space on the page for you to write your responses to questions. When you have finished a question you should read our response and compare this to your answer. We recommend that you always read the response.

The activity based approach has been adopted for two reasons. Firstly because you learn by ***doing*** things rather than just reading about them, and secondly because ***you*** have an important input to the course. We can point you in the right direction, but only you can apply the material to your specific situation.

SAFETY FUNDAMENTALS

We have included this discussion of safety fundamentals mainly for the benefit of those who are not electrical specialists, but are responsible for safety in companies or organisations.

For those of you who are electrical specialists the material is likely to be somewhat elementary, but we suggest that you should read through it quickly to remind yourselves of the basics. You may find the explanations helpful if you are called upon to explain these basics to other members of staff.

Protection of Users

Using electricity always involves some degree of danger, but manufacturers make every effort to make electrical appliances as safe as possible, particularly for non-specialist users. There are two basic approaches to protection:

- insulation
- earthing

Both methods protect the user by preventing them coming into contact with a 'live' part at a dangerous voltage. Since these are fundamental to the whole philosophy of portable appliance safety, you might like to clarify in your mind how they actually work.

Insulation

An insulator is a material that is a poor conductor of electricity, even when high voltages are present. Insulation works by providing a physical barrier between 'live' areas and areas with which the user may come into contact.

A common form is that used for electrical cables, where the metal inner is enclosed in an insulating plastic sleeve.

List the dangers posed by cuts or breaks in the insulation around a mains cable.

Insulation acts as a physical barrier to electricity. Thus it may be used to stop selected metalwork in an appliance from becoming 'live'.

Earthing

If an exposed metal part of an appliance accidentally touches a 'live' voltage source, the metal itself becomes 'live'. A user touching the 'live' metal may receive an electric shock - current flows through the user to Earth.

Earthing an appliance means *bonding* all the exposed metalwork of the appliance to the protective (earth) conductor of the electrical supply. Bonding means making a good electrical connection between the metalwork and the protective conductor.

Earthing protects the user because it provides an alternative, much easier, path for the electricity to flow under fault conditions from the 'live' metalwork to earth. Hence no current flows through the user - so no electric shock.

If such a fault occurs the fuse, or circuit breaker, in the 'live' line operates - isolating the dangerous voltage. Note that if the exposed metal work is not earthed the fuse will not protect the user from shock.

Question 2

Look at a standard three pin mains plug. You will probably find that the earth pin is longer than the other two pins. Why do you think this is?

Response on page 17

Note that earthing is only as good as the installation power socket earth!

Appliance Classification

Electrical appliances are divided into two categories based upon the principle methods of protecting the user. These are:

Class 1 or earthed appliances

Here any exposed metalwork is 'bonded' to the supply earth.

Class 2 or double insulated appliances

These rely on two lots of insulation to protect the user. That is, any metalwork that the user may touch, which might potentially become live, is separated from any dangerous voltages by two distinct layers of insulating material. These appliances do not have an earth lead fitted.

Class 2 appliances should carry a clear label shown in Figure 1:

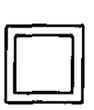


Figure 1: Double Insulation (Class 2) Symbol

Some appliances have both earth and double insulation protection. These are classified as Class 1/Class 2.

The way the electrical appliance has been designed and constructed to protect the user affects the safety tests that should be applied. So your first task is always to classify the appliance to be tested.

Have a look around your workplace and identify as many appliances as you can as Class 1, Class 2 or Class 1/Class 2.

As you may have found, it is not always obvious which appliances are in which category, but to perform sensible tests you ***must*** be certain.

Connections

The mains lead and plug couple the appliance to the fixed mains supply. They are the most vulnerable links in the chain. It is essential that the correct type of plug be used and that it is correctly wired, fused, and securely fitted to the lead. Plugs with plastic sleeved pins are best, because they prevent the pins being touched whilst partially inserted in the socket.

Don't forget extension leads; these suffer a lot of physical abuse. It is best to avoid using extension leads if at all possible - it is better to install a supply point nearer the appliance. If an extension lead is being used it must be checked in the same way as the appliance lead and plug.

Supply Voltages

Generally the lower the voltage being used the safer the equipment. Throughout this booklet we will assume that the standard UK single-phase mains supply of 240 V a.c. is being used. You should bear in mind that even higher voltages may be generated within the equipment.

Equipment Modifications

It is imperative that you do not make unnecessary modifications to equipment. If modifications are essential then you must implement them in such a manner that safety is not jeopardised. If you modify equipment you place the onus of responsibility on your shoulders if anything goes wrong at a later date.

IMPLEMENTING A SAFETY TEST PROGRAMME

In the book 'Electricity in the Workplace' we discussed the broad strategy of testing programmes. Here we look at the detailed implementation of the strategy for portable appliances. The suggested programme consists of the following:

- regular visual inspection
- regular essential tests (earth bond and insulation)
- optional tests, such as the flash, operational and earth leakage tests.

Of the essential tests, the insulation test is always carried out but the earth bond test is only performed on a Class 1 appliance. The essential tests are very simple to perform and should be carried out at regular intervals.

The optional tests should be performed at the discretion of the responsible person, perhaps because there is some reason to think the appliance may have become unsafe. Some optional tests should not be carried out more than is necessary as they may weaken the insulation of the appliance. We will discuss this in more detail later.

Documentation

In the 'Electricity in the Workplace' book we emphasised the need for good documentation of all testing. Supplied with this booklet is a suitable form which you may like to use as it stands, or modify to suit your particular needs. Use a copy of this form, and fill it in as you work through the practical tests.

You will see that we have provided space for both essential and optional tests. Where a particular test is not required, or is likely to damage the equipment, the appropriate space should be marked "NOT TO BE CARRIED OUT". The optional tests may be documented separately as these should only be carried out under special circumstances. However, we would prefer to see them on the same form.

Equipment Labelling

When a sequence of tests is completed the appliance should be clearly labelled with the date of the next test. We have supplied with this booklet a sheet of test labels suitable for this task as shown in Figure 2.

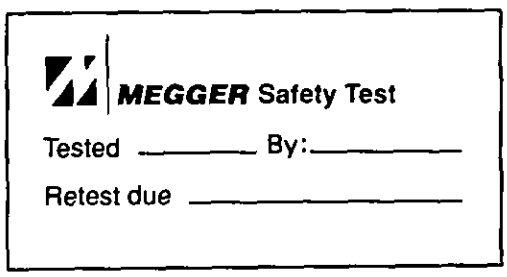


Figure 2: Equipment label

The label should be fitted on the appliance in such a position that is easy to examine without undoing covers or moving the appliance from its normal operating position. The user can then readily check when the next test is due.

Test Precautions

It is essential that the electrical tests are carried out in a safe manner, and this is your responsibility. You should always observe the following guidelines.

Essential tests

a) Check the 'Test Results Sheet' and identify the class of the appliance, its operating voltage, and any special precautions that should be observed.

b) Check that the environment in which the tests are to be performed is free from hazards. For example, the earth bond test or insulation test may produce a spark which would ignite flammable vapours or fine dust.

c) Disconnect all other equipment from the item under test. This not only guards against potential hazards, but also against spurious results.

d) Ensure no one, including you, touches the appliance under test, during testing. They may receive an electric shock if the appliance is faulty.

e) Ensure any test equipment is plugged into a properly earthed mains supply.

f) Some tests require that the appliance under test is switched on. You may need to clamp the ON/OFF button on some appliances. Ensure that no damage is possible due to the operation of the appliance. For example, an electric drill would need to be suitably secured during the test.

g) If an appliance fails a test STOP. Do not go on to the next test because the appliance may be in a dangerous state.

h) Always do the tests in this order:

- visual inspection
- earth bond test (Class 1 appliances only)
- insulation test.

Optional tests

All the precautions mentioned above apply to the optional tests, plus those given below.

i) Check the Initial Test Results Sheet and ensure that any given test may be applied to the appliance.

For example some computers have interference suppressors which will not withstand the flash test voltages. You may have to remove them before the test is carried out.

Motors, such as inductively stalled types, will not pass the low voltage load test, because they effectively present a short circuit at low voltages.

j) Take particular care when performing a flash test as the very high voltages can be dangerous. It is best to have a second person on hand so that if you receive a shock they can remove the power and resuscitate you.

Test Equipment Needed

To perform the essential tests a purpose designed Portable Appliance Tester (PAT) such as a MEGGER PAT3 is recommended. Such testers are simple to use and enable the testing process to be carried out safely and efficiently.

The tests are very quick and easy to perform, and they can usually be carried out in the appliances' normal location. Preferably, inform the appliance user in advance that the test will be carried out at a specific date and time. This minimises the down-time of the equipment, and reduces user irritation if they happen to be in the middle of a 'rush job' when you arrive to perform the tests.

For the optional tests, we recommend a more sophisticated Portable Appliance Tester, such as the MEGGER PAT2 or PAT101. We also recommend that such tests should be carried out only by properly qualified or specially trained staff, preferably under workshop conditions.

Whatever test equipment you use, you must be able to rely on the results that it gives you. If your company has a Quality Assurance (QA) department, they should be able to check and calibrate your test equipment. Otherwise contact your supplier who will be pleased to put you in touch with a suitable testing body. Don't forget that although your test equipment is inherently reliable, it needs to be tested for safety like any other appliance!

Physical Inspection

Before any electrical tests are performed a careful physical inspection should be carried out. As we said in the accompanying book "Electricity in the Workplace", the appliance user should be encouraged to do this as a matter of routine.

Question 4

What things would you look for during a physical examination of an electrical appliance?

Response on page 18

If the appliance fails a physical inspection it must be taken out of service immediately. If it passes then the electrical tests may be carried out.

ESSENTIAL TESTS

These tests should be carried out regularly, as discussed in the "Electricity in the Workplace" book, and the results logged. We will assume you are using a MEGGER PAT3, although the procedure will be similar for other suitable instruments.

Before starting any tests you should make sure the appliance fuses are intact, particularly the mains plug fuse. If the appliance is working normally prior to the test, then this may be assumed. For convenience the PAT3 has a 'continuity test' facility for this purpose.

Test 1: Earth Bond Test (First Test for Class 1 Appliances)

This test is intended to ensure that any exposed metalwork on the appliance under test is securely connected to a safe earth potential. During the test a high current (typically 25 A) is passed through a circuit comprising the appliance earth conductor of the supply lead, the exposed metal on the appliance and the temporary test lead from the PAT. If the exposed metalwork is securely connected electrically to the earth conductor, the resistance of the above circuit will be low. To be acceptable it must be between 0 Ω and 0.1 Ω (0.5 Ω for low current appliances).

If the appliance is Double Insulated (Class 2) then the test is meaningless and so should be missed out. Start at Test 2. If the appliance is Class 1 or Class 1/Class 2 then the test must be carried out on all exposed metalwork (these test points should be listed on the Test Results Sheet when the appliance is first tested).

The procedure for a Class 1 appliance is described in the operating instructions book supplied with the PAT3. The essential points are here for completeness.

Plug the PAT3 into the mains supply and switch on. Firmly attach the test lead hook connector to the Earth Bond terminal on the PAT3 front panel. Ensure the test lead does not drape across the meter face.

Plug the appliance under test into the 13 A socket on the PAT3.

Use the test lead crocodile clip to attach the lead to the appliance metalwork. This is shown in Figure 3.

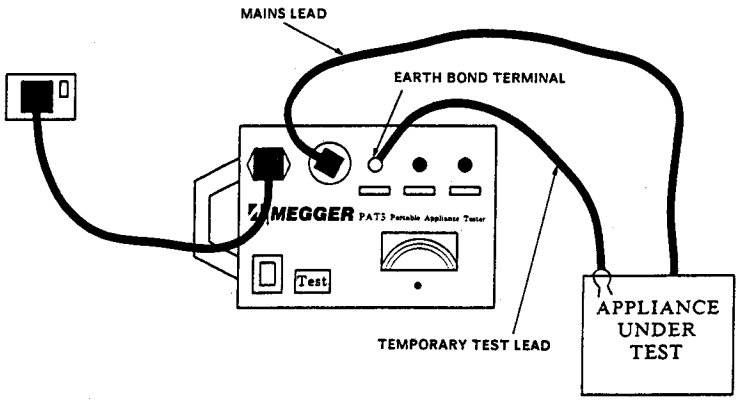


Figure 3: Earth Bond Test

If there is nowhere to clip the test lead, you should use an alternative probe lead and hold it onto the metalwork. Take care: when the high test current flows arcing can occur - welding the probe to the metalwork or giving you a burn.

Before performing this test, you must establish whether an appliance is a 'light current' type. For the present purpose you can assume the appliance to be light current if any of the following apply:

- it has a 3 or 5 A fuse fitted
- it has a power rating less than 1 kW
- the appliance cable is thinner than the normal mains lead.

The procedure is then as follows:

For a light current device - press and hold down the PAT3 TEST button for 5 or 6 seconds, note the reading on meter scale [2] and then release the button. Do not hold it down for any longer than 6 seconds, otherwise you may melt the insulation on the cable and introduce possible hazards.

For other appliances - press and hold down the PAT3 TEST button for 6 to 8 seconds, note the reading on meter scale [2] and then release the button.

Repeat this test, for both light current and normal appliances, for each separate piece of exposed metal work specified on the Test Results Sheet.

Logging the Results

The reading should be in the green area on scale [2] giving a resistance reading of between 0 and 0.1 Ω. If the reading is more than 0.1 Ω you must investigate why.

First check the logged value for the equipment, it may be a low current appliance. If your reading is the same as the previously recorded value then you may accept it. (The resistance of thin mains leads can be appreciable. For example, 2.5 m of 0.5 mm^2 is around 0.1 Ω.) A particularly long lead or extension cable may also have an appreciable resistance. If this is the case, you should get advice as to whether a circuit breaker should be fitted at the appliance end of the cable. If the resistance is too high the protection afforded by earthing will be limited.

Then check the security of the connections in the mains plug, although this should have been done already in the physical inspection.

DO NOT progress with further tests until this fault has been cleared.

Use a pen (not pencil) to note the resistance reading in the column headed 'Earth Bond Test' on the Test Results Sheet. A tick is not acceptable - enter the actual reading.

It is possible to use equipment other than a purpose built Portable Appliance Tester to carry out an earth bond test, but it must be capable of supplying 25 A. A normal continuity tester is NOT suitable. Test equipment which does not supply 25 A may give an invalid result, and a false sense of security.

Test 2: Insulation Test (First Test for Class 2 Appliances)

This is a standard test which is used to ensure that a breakdown of the insulation cannot occur between any live parts within the appliance and the parts of the casing that the user may touch. The appliance tester must be able to deliver a 500 V d.c. test voltage across load resistances of 2 MΩ and greater, otherwise the test is invalid. The test may be performed as many times as you like without causing undue stressing to the appliance under test.

Although this test must be applied to all types of appliance the test procedure is slightly different for Class 1 and Class 2 appliances.

**** MAKE SURE THE APPLIANCE UNDER TEST IS SWITCHED ON ****

Class 1 Appliance

If the appliance is earthed, then the insulation test is carried out between the earth pin and the combined live and neutral pins on the plug. This relies on a satisfactory result to Test 1. If the earthing is faulty this test should not be performed, as the results would be totally invalid.

We will assume you are progressing from Test 1. Remove the test lead, plug the appliance into the 13 A socket on the PAT3, and switch the appliance on. Hold down the PAT3 TEST and INSULATION buttons for 5 seconds, note the reading on meter scale [3] after this time, then release both buttons.

Go to 'Logging the Results' opposite.

Class 2 Appliance

If the appliance is double insulated, then the insulation test is carried out between the combined live and neutral pins on the plug and a probe that is applied to the outside of the appliance case.

As this is the first test for a Class 2 appliance and although the procedure is described in the operating instructions supplied with the PAT3, we will describe the procedure here for completeness.

Plug the PAT3 into the mains supply and switch on. Firmly attach the test lead hook connector to the Earth Bond terminal on the PAT3 front panel. (The Earth Bond terminal is used for all temporary test lead connections.) Ensure the test lead does not drape across the meter face.

Turn on the appliance at its ON/OFF switch, if necessary clamp the ON/OFF switch to the ON state.

**** MAKE SURE THE APPLIANCE UNDER TEST IS TURNED ON ****

Use the test lead crocodile clip to attach the test lead to the appliance casing. Hold down the PAT3 TEST and INSULATION buttons for 5 seconds, note the reading on meter scale [3] after this time, then release both buttons.

If there is nowhere to clip the test lead, you should use an alternative probe lead and hold it onto the casing.

Logging the Results

Whether you are testing a Class 1 or Class 2 appliance the results should be the same. The reading should be in the green area on scale [3] of the meter giving a resistance reading of at least 2 MΩ If the resistance reading is less than 2 MΩ you must investigate why. ***Do not*** use the appliance until the fault has been cleared.

Use a pen (not pencil) to note the resistance reading in the column headed 'Insulation Test' on the Test Results Sheet. A tick is not acceptable - enter the actual reading.

While you have been doing these tests you should have logged your results on the Test Results Sheet and noted any peculiarities. If you are happy that the equipment is safe, and you do not intend to perform any of the optional tests, sign the Test Results Sheet and insert the date for the next test. Make sure you affix a new TESTED label to the appliance with the next test date filled in.

OPTIONAL TESTS

These tests may be applied in any sequence, but the flash test should only be carried out by fully trained personnel, preferably under workshop conditions. A suitable instrument for carrying out these tests is the MEGGER PAT2 or PAT101. If an appliance has been repaired recently, the essential earth bond and insulation tests ***must*** be repeated first - then the optional tests can be carried out.

Flash Test

For Class 1 appliances, the flash test operates by applying a high a.c. voltage between the combined live and neutral pins and the earth pin. For Class 2 appliances, the voltage is applied between the combined live and neutral pins and the probe tip applied to the exterior of the appliance under test. The current which flows should be in all cases less than 2 mA.

The flash test can be dangerous and can also cause permanent damage to the appliance under test. The voltage flash tests required for type testing are too severe to be applied regularly to appliances. Testing at these high voltage levels can weaken the insulation and cause premature breakdown. Generally, this test is only performed when an appliance has been into the workshop for repair or there is some good reason to think that it is in an unsafe condition. Consult the appliance manufacturer if in doubt as to whether to carry out this test.

The Test Results Sheet should be checked before carrying out this test to see if there are any special precautions that should be undertaken before testing. For example, some equipment contains suppressors that are not designed to withstand the high flash voltages. If these components are fitted they may have to be removed before the test.

*** *MAKE SURE THE APPLIANCE UNDER TEST IS STILL TURNED ON* ***

The procedure used for a flash test varies according to the appliance being tested, and you should consult the PAT instructions for further details.

Logging the Results

Resistive loads will not normally produce a deflection on the meter. However, for capacitive loads, the reading should be in the green area giving a current of between 0 mA and 2 mA. If the current reading is in excess of 2 mA then you must investigate why. The reading should be noted in ink on the Tests Results Sheet.

Load and Operation Tests

Some PATs, such as the PAT2 and PAT101 allow you to test the appliance under normal operating conditions so that the power consumption may be measured. Before operating the appliance with the full operating voltage, the PAT2 provides a low voltage test that should be performed first. This test is a way of assessing the appliance under load conditions without the dangers of applying the full operating voltage. The appliance is supplied from a 6 V a.c. source via the normal mains plug. The test is exactly the same for Class 1 or Class 2 appliances.

Some appliances, such as an inductive stalled motor, act like a short circuit at low voltages so this low voltage test may have to be missed out. Again, you need to know what to expect - this should be indicated on the Test Results Sheet.

Once you are satisfied that the appliance will run safely you may apply the full operating voltage (operation test). Ensure that any rotating equipment, like an electric drill, is held securely before performing this test.

During testing the PAT will indicate the kVA being consumed by the appliance. While the TEST button is held down the PAT will allow a 13 A load to run for a few seconds before tripping out. Normally the PAT will trip out with a 6 A loading.

It's always a good idea to perform the full operation test - an appliance may pass all the safety tests but may not work. It is embarrassing to pass equipment and then find it has some other silly fault.

If the operation test has been carried out with a MEGGER PAT2, it will be possible to identify excesive current consumption by an appliance.

Logging the Results

The kVA may be read directly from the PAT meter scale. This should be compared to the Test Results Sheet and the appliance rating plate.

For some appliances, like electric drills, the reading may be less than the rated load. This is because the rated load for an appliance, such as a drill, is that under stalled conditions. The value on the Test Results Sheet for the new appliance should be the best guide of the off-load values.

Earth Leakage Test

This test measures the difference between current flowing into the appliance along the live lead and the current flowing out from the appliance along the neutral lead. Any difference must therefore be flowing to earth. Recording the earth leakage is a useful way of monitoring the quality of insulation, since the leakage current will increase as the insulation deteriorates.

Logging the Results

A good rule of thumb for most appliances is that the earth leakage current should be less than 3 mA. The subject of earth leakage, however, has a number of complications. For more details, refer to the appendix of the 'Electricity in the Workplace' book.

SIGNING THE FORM

While you have been doing these tests you should have logged your results on the Test Results Sheet and noted any peculiarities. If you are happy that the equipment is safe, you can sign the Test Results Sheet and insert the date for the next test. Make sure you affix a new TESTED label to the appliance with the next test date filled in.

SUMMARY

The main points made in this booklet were as follows.

The safety mechanisms used in portable appliances to protect the user are:

- Class 1: all exposed metal is earthed
- Class 2: high internal voltages are double insulated from the user.

Some appliances use a combination of these two methods.

Appliances should be regularly tested to:

- prevent danger to users and other employees
- increase the useful life through preventive maintenance
- prevent loss of production due to 'down-time' and malfunction.

The tests recommended for portable appliances are:

- visual inspection - to look for physical damage or deterioration. This should include the mains plug and lead.
- essential tests - **Earth Bond Test**
  Class 1 or Class 1/Class 2 only. Resistance should be less than 0.1 Ω at 25 A. Slightly higher values may be allowed for light current appliances.

  Insulation Test
  Resistance should be greater than 2 MΩ at 500 V d.c.
- optional tests - **Flash Test**
  Current should be less than 2 mA

  Load Test
  See PAT instruction book

  Operation Test
  Should be as specified on appliance rating plate.

  Earth Leakage Test
  See PAT instruction book

If the results for an appliance are borderline, you should try to establish why this is the case. Some appliances have special needs, and the basic testing programme may have to be varied.

Testing should be systematically documented. The enclosed Test Results Sheet provides a model for the sort of information which must be recorded. Ideally appliances should be documented and tested after purchase. This allows any special factors to be established before appliances are put into service. The same applies to existing appliances that are being brought into the testing programme.

Finally each appliance should be clearly labelled with its next test date to ensure that testing is done at the due time. Suitable labels are supplied for this purpose.

RESPONSES TO QUESTIONS

Response to Question 1

You should have identified the danger that once the insulation is broken the user is exposed to the danger of electric shock. You may also have noted that other metal parts could touch the 'live' wire, so becoming live themselves - giving rise to an unexpected source of danger.

In the light of our discussion in the main book, you might also have highlighted that arcing could occur from the 'live' wire causing a fire or explosion.

Response to Question 2

Because the earth pin is longer than the live and neutral pins, it is the earth pin which makes the first electrical contact when the plug is inserted into the socket. Conversely, as the plug is withdrawn from the socket, the earth pin is the last pin to break contact. This ensures that there are no circumstances when the plug is connected to the live lead without also being connected to the earth lead.

Response to Question 3

We cannot hope to match your list precisely but these give an indication of the types you may come across. Your appliances may be different, particularly if they are old.

Some examples of Class 1 products are:

- electric typewriter and computer printer
- table or desk lamp.

These are usually Class 2 (they will not have an earth lead fitted):

- sewing machine
- soldering iron with a step-down transformer
- electric drill.

Examples of Class 1/2 products are:

- plastic or metal electric kettle
- Megger Portable Appliance Tester.

Response to Question 4

The list presented here is by no means exhaustive, but as a minimum you should visually check the following:

- the equipment casing for any signs of damage that may give rise to a breakdown of insulation
- the mains supply cable for any signs of damage to the insulation
- the mains supply plug for any damage to the pins or cover, and the security of the cable clamps
- the point of cable entry to the equipment
  - this may be a grommet or clamp entry - ensure it is secure
  - this may be a plug and socket - ensure they are sound.
- the equipment on/off switch for signs of damage or incorrect operation.

You should open up the mains plug and check the security and polarity of the wiring. This test is particularly important if the equipment is regularly moved around.

At the risk of being accused of 'preaching' - these checks take very little time and could easily save a life, so don't take short cuts.