



IN SERVICE INSPECTION AND TESTING OF ELECTRICAL EQUIPMENT

THE INSULATION TEST

by John Ware

Electrical equipment must be maintained so as to prevent danger. The IEE's Code of Practice for In-Service Inspection and Testing recommends that maintenance of electrical equipment is carried out in four stages: Visual inspection, Test to verify earth continuity, Test to verify insulation, and Functional test. In this article we discuss the insulation test.

Safety

Electrical testing must be performed by a person who is competent to perform the test without putting themselves or others at risk, who is able to use the test equipment safely and who knows how to interpret the results obtained. Refer to the HSE's publication HSR25 *Memorandum of guidance on the Electricity at Work Regulations 1989*. This person should be capable of inspecting the equipment and, where necessary, dismantling it to check the cable connections. Care should always be exercised when conducting tests. Inappropriate tests can damage equipment. Appliances should not be touched whilst carrying out insulation resistance tests as exposed metalwork may reach the test voltage which, whilst not dangerous, could be uncomfortable and risk causing injury by involuntary movement. It is important to ensure that the connections between the test instrument and the equipment under test are properly made. A poor earth connection, particularly for appliances with relatively high protective conductor current, may cause a perceived 'electric shock' from the appliance frame which whilst not dangerous, could be uncomfortable and risk causing injury by involuntary movement.

Sequence of testing

The sequence of inspection and testing of electrical equipment such as a portable appliance should always be

- 1 Visual inspection
- 2 Earth continuity test, for Class I equipment



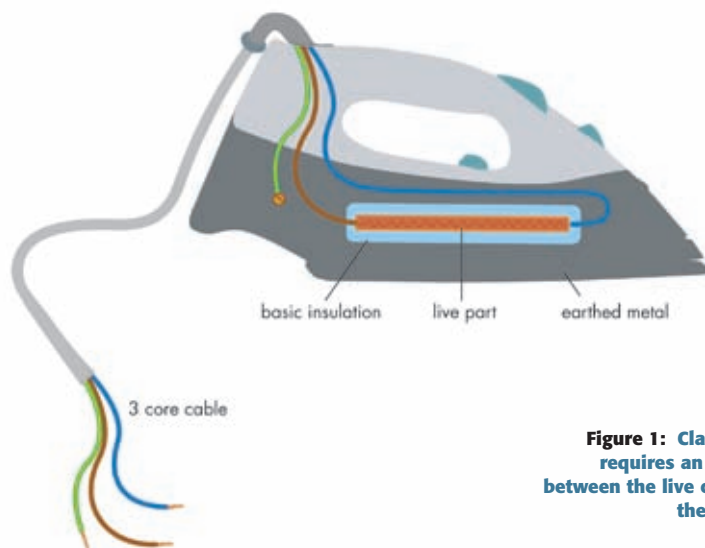


Figure 1: Class I equipment requires an insulation test between the live conductors and the earthed metal

- 3 Insulation resistance test, if appropriate
- 4 Protective conductor current and/or touch current test or substitute/alternative leakage test, if appropriate and
- 5 Functional test.

Persons performing testing should be aware that it may not be possible to perform some of the tests prescribed by the IEE's Code of Practice for In-Service Inspection and Testing of Electrical Equipment, for example, in this particular case, electrical equipment should not be subjected to test voltages and currents that would result in damage. Some electrical test devices apply tests which are inappropriate and may even damage equipment containing electronic circuits, possibly causing degradation to safety. In particular, whilst the Code of Practice includes insulation resistance tests, equipment should not normally be subjected to dielectric strength testing (also known as flash testing or hi-pot testing) because this may damage insulation and may also indirectly damage low voltage electronic circuits unless appropriate precautions are taken.

Insulation resistance testing may be substituted by a protective conductor

current/touch current measurement where insulation resistance testing is not appropriate due to the possibility of the item of equipment being damaged by the test voltage.

Alternatively insulation resistance testing may be inappropriate because of voltage limiting devices in the equipment under test or the fact that the equipment under test has an electronic switch which requires mains power to close the switch.

An insulation test should be carried out before any powered tests as it may detect a potentially dangerous insulation failure. Only then should other tests such as a protective conductor or touch current be performed, if appropriate.

The insulation resistance test

Insulation resistance is normally measured by applying a test voltage of 500 V d.c. and recording the resistance measured. This test, a so-called 'hard test', may not always be suitable as it may damage IT equipment or other equipment containing electronic components and the protective conductor/touch current measurement test, a so-called 'soft' test, or substitute/alternative leakage current test, or insulation resistance test at a reduced voltage, such as

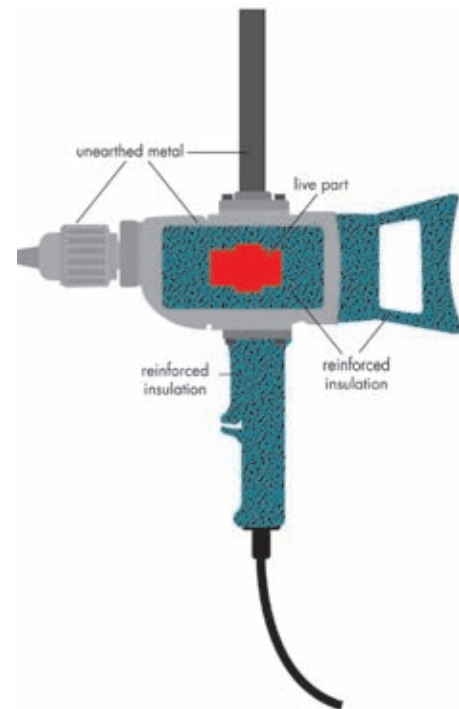


Figure 2: The drill, a Class II appliance, should have an insulation test made between the conductors and the unearthed metal

250 V d.c. may be a more appropriate alternative. The 500 V d.c. insulation test should not be applied to IT (information technology) equipment, unless such equipment complies with the requirements of BS EN 60950: *Specification for safety of information technology equipment including electrical business equipment*. Equipment not constructed to this standard may be damaged by the 500 V d.c. applied during the insulation test.

The live conductors (phase and neutral) should be connected together for the insulation test. This is best achieved either by using special test equipment or by using a special test socket with the phase and neutral connected together. Equipment is not to be returned to service with any phase-neutral connections still in place. It is therefore recommended that the functional test is carried out last.

Before the test, the suitability of

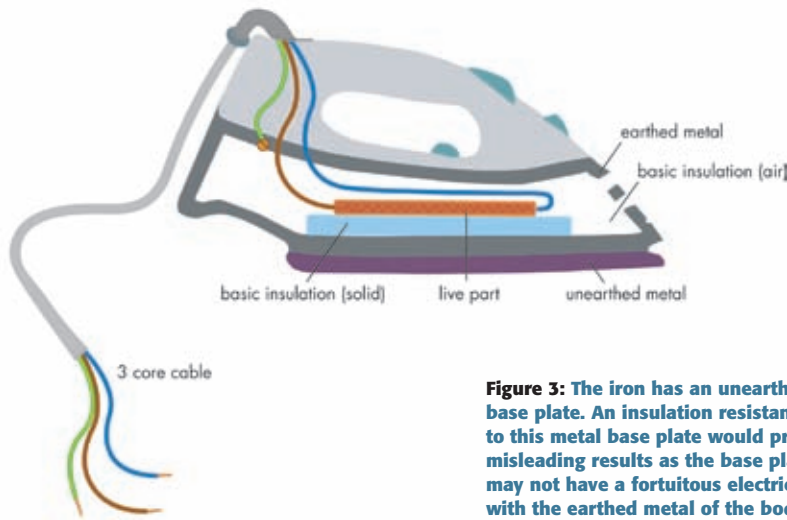


Figure 3: The iron has an unearthed metal base plate. An insulation resistance test made to this metal base plate would probably give misleading results as the base plate may or may not have a fortuitous electrical connection with the earthed metal of the body of the iron

Appliance Class	Minimum insulation resistance
Class I heating and cooking equipment with a rating ≥ 3 kW	0.3 megohm
All other Class I equipment	1.0 megohm
Class II equipment	2.0 megohms
Class III equipment	250 kilohm

Table 1: Insulation resistance readings

fuses in the equipment to be tested should be checked and power switches put in the 'on' position. All covers should be in place. The test is carried out between live conductors, i.e. phase and neutral, connected together and the body of the appliance.

The applied test voltage should be approximately 500 V d.c. The test instrument should be capable of maintaining this test voltage with a load resistance of 0.5 megohm. Insulation resistance readings obtained should be not less than the values shown in Table 1 above.

When testing insulation resistance on a Class II appliance the test probe should be connected to any metal parts or suspect joints in the enclosure where conductive material may have accumulated. This may require multiple tests.

Heating and cooking appliances. Certain heating and cooking appliances may be unable to meet the insulation resistance

requirements above, such as where metal sheathed mineral-insulated heating elements are used. It may be necessary in some cases to switch on the appliance for a period of time to drive off absorbed moisture before commencing testing. Additionally the touch current measurement test may be carried out.

Three-phase equipment. For 3-phase equipment, all three phases and neutral (if applicable) are to be linked together whilst making this test.

Equipment with filter networks. Some equipment may have filter networks or transient suppression devices which could cause the insulation resistance to be less than specified. The manufacturer or supplier is to be consulted in these cases as to the acceptable value of measured insulation resistance. A protective conductor and/or touch current test should be performed in addition to the insulation test. ■

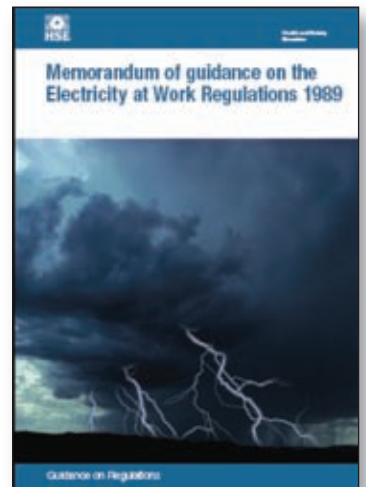


Figure 4: Performing In Service Inspection and Testing? These three publications will help.