



D9: Electrical safety tests

Length: 90 minutes

Theory

Learning outcomes

- Understand which items require inspection prior to testing
- Know how to carry out an Earth Continuity check
- Be able to carry out an Earth Continuity check
- Know how to carry out a Short circuit check
- Be able to carry out a Short circuit check
- Understand the purpose of an Earth fault loop impedance check
- Know the hazards when measuring live voltage
- Understand the readings expected when measuring live voltage
- Understand the testing of protection systems

Agenda Module D – Electrical safety tests



Electrical safety tests

Inspection

The following items (where applicable) should be inspected to make sure that the work has been carried out correctly, using the appropriate materials:

- ✓ connection of conductors - are all connections mechanically sound and in the right terminals?
- ✓ identification of conductors - are the cores the correct colours and suitably labeled?
- ✓ routing of conductors - are these subject to mechanical damage?
- ✓ selection of conductors - are these the right size?
- ✓ insulation - are all live parts suitably covered?
- ✓ enclosures - are all live parts inaccessible?
- ✓ protective conductors - is everything earthed that needs to be?
- ✓ bonding conductors - is everything bonded that needs to be?
- ✓ external influences - is there protection against water, heat, smoke, fumes, dust, etc.?

Testing

- If you are involved in connecting and reconnecting electrical equipment you will need to carry out more formal electrical safety tests as part of the commissioning process.
- These tests must be performed in the order given and, unless the test requires it, with the equipment isolated from the electrical supply.

Electrical Safety Tests: **Earth continuity check**

This check is carried out after safe isolation. It ensures that all the metallic parts of the system are satisfactorily earthed and that all Earth connections are good.

- Set the multi-meter on the lowest ohms range.
- Connect one lead of the test meter to the Earth pin on the plug or, if not connected by a plug, then the main incoming Earth terminal.
- The other test meter lead should now be moved around the system to make a connection with all the Earth terminals and the metallic components involved (for example, compressor housing, pipework, pump, etc.)
- In all instances the resulting reading should be less than one ohm.
- A reading in excess of one ohm indicates a poor Earth connection, and this must be investigated.

Electrical Safety Tests: **Short circuit check**

This check is also carried out after safe isolation. It ensures that there are no short circuits between live and neutral.

- Set the multi meter on the lowest ohms range and ensure that all switches and controls are selected for cooling.
- Connect one meter lead to the main incoming neutral terminal.
- The other lead should now be connected, in turn, to all the live connections on the terminal strip (this ensures that all the components are tested even if they are not switched in).
- A reading of less than one ohm indicates a short circuit.

Electrical Safety Tests: Resistance to earth check

This check is again carried out after safe isolation. It tests the quality of the insulation of the wiring and components in the system. A failure on this check means the system is dangerous and therefore it must not be connected to the electrical supply until the problem has been rectified.

- Set the multi meter on the highest ohms range and ensure that all switches and controls are selected for cooling.
- Connect one meter lead to the main incoming Earth terminal.
- The other lead should now be connected, in turn, to all the live connections on the terminal strip (this ensures that all the components are tested even if they are not switched in).
- An infinitely high reading should be achieved in all instances. Any reading less than $2M\Omega$ must be investigated.

Once all of the above tests have been carried out with successful results, the system can be energized and the live testing can begin.

Electrical Safety Tests: **Measuring the earth fault loop impedance**

- This test is used to test if the fuse or circuit breaker works fast enough in case of a fault in the installation to prevent fires.
- The loop impedance measured must satisfy local regulations.
- The loop impedance (Z_s) is the sum of all the resistances of the distribution network, (Z_e) and the conductors in the final circuit (R_1 resistance of the line conductor plus R_2 resistance of the circuit protective conductor {earth}). i.e. $Z_s = Z_e + R_1 + R_2$
- The resistance must be low enough to allow enough current to flow in the event of a short circuit to trip the fuses.
- In practice, the loop impedance is a maximum of 1Ω .
- The loop impedance can also be greater than 1Ω , as long as the short-circuit current is still large enough to trip the circuit protector.
- It is usually determined with multi-function measuring devices (e.g. Fluke), which directly display the short-circuit current and the loop impedance.

Electrical Safety Tests: **Measuring the earth fault loop impedance**



© Fluke

Typical multi-function measuring device

Electrical Safety Tests: **Measuring the operating voltages**



All safety measures must be taken prior to measuring voltage. High risk activity.

Measure all required voltages after switching on the system to ensure safe operation. Use an approved two-pole voltage tester or multi-meter.

For example, in the household networks common in the EU:

- Line conductor against line conductor 400 V,
- Line conductor against neutral conductor 230 V,
- Line conductor against protective conductor 230 V,
- Neutral conductor against protective conductor 0 V

Electrical Safety Tests: **Testing of protection systems**

Protection and alarm systems such as RCDs, insulation monitors and emergency stop devices have to be tested regularly to make sure they operate properly.

Examples for these tests are:

- Operation of the test buttons on RCDs and insulation monitoring devices
- Proof of the function of emergency stop devices (using the test button)
- Functional check of signalling units

Electrical Safety Tests: **Testing of protection systems**



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By pressing the test button of an RCD device, only the function of the device itself is tested. The function of the protective measure as a whole and its effectiveness cannot be proved hereby; measurements are absolutely necessary for this purpose.



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IEC 61557-8:2014 specifies the requirements for insulation monitoring devices (IMD) which permanently monitor the insulation resistance (R_f) to earth of unearthed a.c. IT systems.

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