

- 1 % of the thermal current rating for every 500 m, or part thereof, exceeding an altitude of 2 000 m; **Amtd 1; amtd 4**
- 1 % of the maximum voltage rating for every 100 m, or part thereof, exceeding an altitude of 2 000 m. **Amtd 1; amtd 4**

5.6 Medical locations

In medical locations it is necessary to ensure the safety of patients who could be subject to the application of medical electrical equipment. For every activity and function in a medical location, the particular requirements for safety have to be considered. In the majority of cases, safety can be achieved by ensuring the safety of the installation. The use of medical electrical equipment on patients while under intensive care (of clinical importance) has called for enhanced reliability and safety of electrical installations in hospitals by improving the safety and continuity of supplies (see 7.7).

5.7 Extra low voltage systems (SELV and PELV)

5.7.1 Shock hazard protection by extra low voltage

5.7.1.1 Protection by extra low voltage is a protective measure that consists of the following two different extra low voltage systems:

- a) SELV (safety extra low voltage), an unearthed system; and
- b) PELV (protected extra low voltage), an earthed system.

5.7.1.2 The use of a SELV or PELV system is considered as a protective measure in all situations and the protection is provided by

- a) the limitation of the voltage in the system to 50 V a.c. r.m.s. or 120 V ripple-free d.c.,
- b) protective separation of the SELV or the PELV system from all circuits other than SELV and PELV circuits, and basic insulation between the SELV or the PELV system and other SELV or PELV systems, and
- c) basic insulation between the SELV system and earth for the SELV systems only.

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NOTE 1 Typical applications are ELV lighting and emergency buttons in a bathroom.

NOTE 2 Additional safety precautions are required when SELV and PELV circuits are used in hazardous locations (see 7.14.2).

5.7.2 Requirements for basic protection and fault protection

5.7.2.1 Basic protection and fault protection are deemed to be provided when

- a) the nominal voltage cannot exceed the upper limit of 50 V a.c. or 120 V d.c.,
- b) the source of supply is one of the sources listed in 5.7.3, and
- c) the conditions of 5.7.4 are fulfilled.

5.7.2.2 If the system is supplied from a higher voltage system by equipment which does not provide at least simple separation between that system and the extra low voltage system, such as in auto-transformers, potentiometers, semiconductor devices, etc., the output circuit is deemed to be an extension of the input circuit and shall be protected by the protective measure applied to the input circuit.

NOTE In a d.c. system with batteries, the battery charging and floating voltages exceed the battery nominal voltage, depending on the type of battery. This does not require any protective provisions in addition to those specified in this clause. The charging voltage would normally not exceed a maximum value of 75 V a.c. or 150 V d.c.

5.7.3 Sources for SELV and PELV

5.7.3.1 General sources

General sources that provide SELV and PELV are the following:

- a) safety isolating transformers that comply with the requirements of SANS 61558-2-6/IEC 61558-2-6;
- b) sources that provide a degree of safety equivalent to that of the safety isolating transformer specified in (a) (for example, a motor generator with windings that provide equivalent isolation);

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8.7.15 Switching devices

Ensure that when switching devices are operated, the circuit is interrupted as intended.

8.8 Test report

8.8.1 Test report for all electrical installations

Amdt 7

Amdt 7

The following is a test report for all electrical installations. This report may be supplemented with the additional test report for a medical location in 8.8.2 or the additional test report for a hazardous location in 8.8.3 (or both):

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8.7.11 Voltage at available load

Select the circuit and point of consumption where the worst voltage drop condition is expected. Switch on the maximum available load, but at least 50 % of the circuit load and not less than 2 A, and measure the voltage at that point of consumption. Record the value on the test report. The voltage drop from the point of supply to the point of consumption shall not exceed 5 % (see annex E).

Amdt 7; amdt 8

8.7.12 Operation of earth leakage units

Ensure that earth leakage protection is installed in each circuit that is required to be so protected. At various points of outlet and for each phase conductor of the outlet, pass an a.c. leakage current equal to the rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ through a resistance connected between a phase conductor and the earth continuity conductor. The circuit is protected if the earth leakage unit trips.

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Repeat the test with a leakage current at 50 % of the rated earth leakage tripping current (rated residual current) $I_{\Delta n}$. The earth leakage unit shall not trip.

Amdt 3

NOTE This test can be carried out only after power is available at the point of supply.

8.7.13 Earth leakage test button

Press the test button to see that the unit trips.

NOTE The test is intended to check whether the earth leakage unit is operating correctly, not to check its sensitivity.

8.7.14 Polarity at points of consumption

Ensure that

- a) all single-pole switching devices, fuses and circuit-breakers have been connected in the phase conductor,
- b) the phase terminals in fixed appliances and in all single-phase socket-outlets have been connected to the phase conductor,
- c) the centre contact of each Edison-screw lamp holder is connected to the phase conductor, and
- d) phase rotation and identification is maintained for three-phase systems on the supply sides of all distribution boards.

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- c) electrochemical sources (for example, a battery) or other sources independent of a higher voltage circuit (for example, a diesel-driven generator); and
- d) certain electronic devices that comply with appropriate standards where provisions have been taken to ensure that, even in the case of an internal fault, the voltages at the outgoing terminals cannot exceed the values specified in 5.7.2. Higher voltages at the outgoing terminals are, however, permitted if it is ensured that, in the case of contact with a live part or in the event of a fault between a live part and an exposed conductive part, the voltages at the output terminals are immediately reduced to the values in 5.7.2 or less.

NOTE 1 Examples of such electronic devices include insulation testing equipment.

NOTE 2 Where higher voltages exist at the outgoing terminals, compliance with this clause may be assumed if the voltages at the outgoing terminals are within the limits specified in 5.7.2 when measured with a voltmeter that has an internal resistance of at least 3 000 Ω .

5.7.3.2 Mobile sources

Mobile sources that provide SELV and PELV, for example, safety isolating transformers or motor generators, shall be selected or erected in accordance with the requirements for protection by using double or reinforced insulation.

5.7.4 Requirements for SELV and PELV circuits

5.7.4.1 SELV and PELV circuits shall have

- a) protective separation of live parts from the live parts of other circuits (except for other SELV and PELV circuits), which shall be provided by
 - 1) double insulation, or
 - 2) reinforced insulation for the highest voltage present, or
 - 3) basic insulation and protective screening according to the highest voltage present, and
- b) basic insulation between live parts and the live parts of other SELV or PELV circuits.

5.7.4.2 SELV circuits shall have basic insulation between live parts and earth not less than that provided between the input and the output windings of a safety isolating transformer.

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NOTE The earthing of PELV circuits can be achieved by an appropriate connection to earth within the source itself.

5.7.4.3 Protective separation of the wiring systems of SELV and PELV circuits from the live parts of other circuits can be achieved by one of the following arrangements:

- a) SELV and PELV circuit conductors shall be enclosed in a non-metallic sheath or non-metallic enclosure in addition to basic insulation; or
- b) SELV and PELV circuit conductors shall be separated from conductors of circuits at different voltages by an earthed metallic sheath or earthed metallic screen; or
- c) circuits at different voltages can be contained in a multi-conductor cable or other grouping of conductors if the SELV and PELV conductors are insulated for the highest voltage present.

5.7.4.4 Plugs and socket-outlets for SELV and PELV systems shall comply with the following requirements:

- a) plugs shall not be able to enter socket-outlets of other voltage systems;
- b) socket-outlets shall not admit plugs of other voltage systems; and
- c) socket-outlets in SELV systems shall not have a protective conductor.

5.7.4.5 Live parts of SELV circuits shall not be connected to

- a) earth, or
- b) live parts that form part of other circuits, or
- c) protective conductors that form part of other circuits.

5.7.4.6 Exposed conductive parts of SELV circuits shall not be connected to

- a) earth, or
- b) protective conductors, or
- c) exposed conductive parts of another circuit.

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- b) ensure that all fuses are in place and switches and circuit-breakers are in the closed positions. Loads may be disconnected.

NOTE To prevent damage, ensure that voltage-sensitive electronic equipment such as dimmer switches, touch switches, time delay devices, power controllers, electronic starters for fluorescent lamps, earth leakage units, surge arresters and certain appliances are disconnected so that they are not subjected to the test voltage.

8.7.8.2 The insulation resistance, measured as follows, shall be at least 1,0 MΩ:

- a) to measure the insulation resistance to earth, apply the test voltage between the earth continuity conductor and the whole system of live conductors, or any section of it; and
- b) to measure the insulation resistance between the conductors, apply the test voltage
 - 1) between the phase conductors, and, when relevant,
 - 2) between the phase conductors and the neutral conductor.

8.7.8.3 When there are sub-distribution boards and the total insulation resistance is less than 1,0 MΩ, the insulation-resistance test may be carried out by

- a) isolating and testing the wiring between the main supply and the sub-distribution boards, and
- b) testing, as a separate section, each sub-distribution board connected to all the circuits that it feeds, but the insulation resistance in each section shall be at least 1,0 MΩ.

8.7.9 Voltage, main distribution board — no load

With all load switched off, measure the voltage at the point of control. Notify the supplier (see annex K) if the voltage is outside the standard voltage limits (see 5.3.2).

8.7.10 Voltage, main distribution board — on load

Switch on the maximum available load (see 8.7.11) and measure the voltage at the point of control. Notify the supplier (see annex K) if the voltage is outside the regulatory limits (see 5.3.2). **Amtd 8**