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Switched protective earth portable residual current devices for class I and battery powered vehicle applications (SPE-PRCD)

(IEC 62335:2008, MOD)

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Foreword

Clauses 8 and 9 of the Standard are mandatory, the rest is recommended.

This Standard is drafted according to the rules given in GB/T 1.1-2009.

This Standard modifies and adopts IEC 62335:2008 “Switched protective earth portable residual current devices for class I and battery powered vehicle applications” (English version).

The main difference between this Standard and IEC 62335:2008 is as follows:

The technical requirements and dimension parameters of plugs and socket-outlets comply with the requirements of GB 2099.1-2008 “Plugs and socket-outlets for household and similar purposes - Part 1: General requirements” and GB 1002-2008 “Single phase plugs and socket-outlets for household and similar purposes - Types basic parameters and dimensions”.

This Standard is proposed by China Electrical Equipment Industry Association.

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Switched protective earth portable residual current devices for class I and battery powered vehicle applications (SPE-PRCD)

1 Scope

This Standard specifies the classification, characteristics, marking and product information, standard conditions for operation in service and for installation, and requirements for construction and operation of SPE-PRCDs.

This Standard applies to portable devices intended for use with vehicles having class I insulation and battery powered vehicle applications having battery charging units. They have a switched protective earth (SPE) (hereafter are referred to as SPE-PRCDs).

The SPE-PRCD consists of a plug, a residual current device (RCD) and a portable socket outlet.

This Standard applies to portable devices performing simultaneously the functions of detection of the residual current, of comparison of the value of this current with the residual operating value and of opening of the protected circuit when the residual current exceeds this value.

In addition to the RCD function, the SPE-PRCDs address incorrect supply connections resulting in a hazardous live PE and/or supply failure (for example: loss of supply PE or loss of supply N). These SPE-PRCDs are intended for application only on TN and TT systems.

These SPE-PRCDs will not operate if used on IT or other unearthed systems such as isolated winding generator or isolating transformer. These SPE-PRCDs, due to the PE effectively being an open supply conductor, will not function to close the contacts on an IT system.

NOTE 1: For applications where due to the supply system a SPE-PRCD cannot operate a PRCD according to GB 20044 may be used.

SPE-PRCDs are not required to incorporate overcurrent protection.

SPE-PRCDs are intended to be supplied from single-phase or two-phase circuits with rated currents not exceeding 16 A for rated voltages not exceeding 250 V a.c., or with

rated current not exceeding 32 A for rated voltages not exceeding 130 V a.c. (to earth).

SPE-PRCD have a rated residual operating current not exceeding 30 mA and are intended to provide additional protection against shock hazard in case of direct contact on the circuit downstream of the SPE-PRCD. This protection is additional to that provided by the fixed installations. They will not detect a direct contact of a person from line to neutral and do not substitute for safe installation requirements.

Plugs and socket-outlets will comply with the relevant standards. The use of an integral fuse is permitted, if necessary, for the relevant plug and socket-outlet system.

SPE-PRCD are not intended to be used as part of a fixed installation or permanently connected to equipment. They should be connected by a plug and the outlet should be a portable socket outlet.

If a SPE-PRCD of the incorrect type is used (example an LNSE instead of an LLSE) it should continue to protect.

SPE-PRCDs including batteries are not covered by this Standard.

Additional requirements may be necessary for SPE-PRCDs used in locations having severe environmental conditions.

NOTE 2: The requirements for SPE-PRCDs are in line with the general requirements of GB 16916.1 and GB 20044. SPE-PRCDs are essentially intended to be operated by unskilled persons and designed not to require maintenance.

NOTE 3: The RCD part of the SPE-PRCD is not intended to provide isolation, which may be provided by the plug.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB 1002 Single phase plugs and socket-outlets for household and similar purposes
- Types basic parameters and dimensions

GB 2099.1-2008 Plugs and socket-outlets for household and similar purposes - Part 1: General requirements (IEC 60884-1:2006, E3.1, MOD)

GB/T 2423.4 Environmental testing - Part 2: Test methods - Test Db: Damp heat, cyclic (12 + 12 h cycle) (GB/T 2423.4-2008, IEC 60068-2-30:2005, IDT)

GB/T 2424.2 Environment tests for electric and electronic products - Guidance for damp heat tests (GB/T 2424.2-2005, IEC 60068-3-4:2001, IDT)

GB/T 4207 Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions (GB/T 4207-2003, IEC 60112:1979, IDT)

GB 4208 Degrees of protection provided by enclosure (IP code) (GB 4208-2008, IEC 60529:2001, IDT)

GB 4343 (all parts) Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus [IEC/CISPR14 (all parts)]

GB/T 5013 (all parts) Rubber insulated cables of rated voltages up to and including 450/750 V (IEC 60245)

GB/T 5023 (all parts) Polyvinyl chloride insulated cables of rated voltages up to and including 450/750V [IEC 60227 (all parts)]

GB/T 5169.10-2006 Fire hazard testing for electric and electronic products - Part 10: Glow/hot-wire based test methods - Glow-wire apparatus and common test procedure (IEC 60695-2-10:2000, IDT)

GB/T 5169.11-2006 Fire hazard testing for electric and electronic products - Part 11: Glowing/hot-wire based test methods - Glow-wire flammability test method for end-products (IEC 60695-2-11:2000, IDT)

GB/T 5465.2-2008 Graphical symbols for use on electrical equipment - Part 2: Graphical symbols (IEC 60417DB:2007, IDT)

GB 8898 Audio, video and similar electronic apparatus - Safety requirements (GB 8898-2011, IEC 60065:2005, MOD)

GB 10963 (all parts) Electrical accessories - Circuit-breakers for overcurrent protection for household and similar installation [IEC 60898 (all parts)]

GB 13539.1 Low-voltage fuses - Part 1: General requirements (GB13539.1-2008, IEC 60269-1:2006, IDT)

GB/T 14472 Fixed capacitors for use in electronic equipment - Part 14: Sectional specification - Fixed capacitors for electromagnetic interference suppression and connection to the supply mains (GB/T 14472-1998, idt IEC 60384-14:1993)

GB 16895 (all parts) Low-voltage electrical installations [IEC 60364 (all parts)]

GB 16916.1-2003 Residual current operated circuit-breakers without integral

overcurrent protection for household and similar uses (RCCB) - Part 1: General rules (IEC 61008-1:1996, MOD)

GB/T 16935.3 Insulation coordination for equipment within low-voltage systems - Part 3: Use of coating, potting or moulding for protection against pollution (GB/T 16935.3-2005, IEC 60664-3:2003, IDT)

GB 18499-2008 Residual current operated protective devices (RCD) for household and similar use - Electromagnetic compatibility (IEC 61543:1995, IDT)

GB 20044-2005 Electrical accessories - Portable residual current devices without integral overcurrent protection for household and similar use (PRCDs) (IEC 61540:1997, MOD)

IEC 61249-2 (all parts) Materials for printed boards and other interconnecting structures

3 Terms and definitions

For the purposes of this document, the following terms definitions apply.

NOTE 1: Where the terms “voltage” and “current” are used, they imply r.m.s. values, unless otherwise specified.

NOTE 2: Throughout this Standard, the word “earthing” is used for “protective earthing”.

NOTE 3: The term “accessory” is used as a general term covering plugs and socket-outlets. The term “portable accessory” covers plugs and portable socket-outlets. The use of the accessories is shown in Figure 1a) of GB 2099.1-2008.

3.1 Definitions relating to plugs and socket-outlets

3.1.1 plug

Accessory having pins designed to engage with the contacts of a socket-outlet, also incorporating means for the electrical connection and mechanical retention of flexible cables or cords.

3.1.2

socket-outlet

Accessory having socket-contacts designed to engage with the pins of a plug and having terminals for the connection of conductors.

3.1.3

Unless otherwise stated, the rated insulation voltage is the value of the maximum rated voltage of the SPE-PRCD. In no case shall the maximum rated voltage exceed the rated insulation voltage.

5.2.2 Rated current (I_n)

The value of current, assigned to the SPE-PRCD by the manufacturer, which the SPE-PRCD can carry in uninterrupted duty.

5.2.3 Rated residual operating current ($I_{\Delta n}$)

The value of residual operating current (see 3.2.2.4), assigned to the SPE-PRCD by the manufacturer, at which the SPE-PRCD shall operate under specified conditions.

5.2.4 Rated residual non-operating current ($I_{\Delta no}$)

The value of residual non-operating current (3.2.2.5), assigned to the SPE-PRCD by the manufacturer, at which the SPE-PRCD does not operate underspecified conditions.

5.2.5 Rated frequency

The power frequency for which the SPE-PRCD is designed and to which the values of the other characteristics correspond.

NOTE: The same SPE-PRCD may be assigned more than one rated frequency.

5.2.6 Rated making and breaking capacity (I_m)

The r.m.s. value of the a.c. component of prospective current (see 3.2.4.4), assigned by the manufacturer, which a SPE-PRCD can make, carry and break underspecified conditions.

The conditions are those specified in 9.11.2.2.

5.2.7 Rated residual making and breaking capacity ($I_{\Delta m}$)

The r.m.s. value of the a.c. component of residual prospective current (see 3.2.4.7), assigned by the manufacturer, which a SPE-PRCD can make, carry and break under specified conditions.

The conditions are those specified in 9.11.2.3.

5.2.8 Operating characteristics in case of residual currents comprising a d.c. component

The operating characteristics of a SPE-PRCD are such that tripping is ensured for residual sinusoidal alternating currents and residual pulsating direct currents, whether

8 Requirements for construction and operation

8.1 Mechanical design

SPE-PRCDs shall be so designed and constructed that in normal use their performance is reliable and the risk of danger to the user or surroundings, even in the case of miswiring conditions as defined in this Standard, is minimised.

SPE-PRCDs shall be provided with a terminal exclusively intended for switching the protective earthing path and the marking shall be in accordance with 6.1.

The RCD part shall be in one unit and its correct operation shall not depend on the location of the flexible cables and cords connected to it and shall have a minimum degree of protection after assembly as for normal use (see 8.2.1.2).

A maximum length of cord of 2 m is allowed between the plug of the SPE-PRCD and its RCD enclosure.

For SPE-PRCDs with flexible conductors, the green-yellow conductor shall be used as the PE conductor.

There shall be no provision to alter the operating characteristics of SPE-PRCDs.

The plugs of the SPE-PRCDs shall be mechanically and electrically compatible with the socket-outlet system in which they are intended to be used.

Where reference is made to plugs or sockets in this Standard, the appropriate National Standard such as GB 2099.1 and GB 1002 may be used.

Compliance is checked by inspection and by the tests of the relevant clauses.

8.1.1 Plug part

8.1.1.1 Dimensions of plug

Compliance is checked by the tests of Clause 9 of GB 2099.1-2008.

8.1.1.2 Provisions for earthing

8.1.1.2.1 The earthing contact shall be so constructed that, when inserting the plug, the earth connection is made before the current-carrying contacts of the plug become live.

When withdrawing the plug, the current-carrying pins shall separate before the earth connection is broken.

Compliance is checked by inspection according to 9.6.3.

8.1.2 Mechanism

SPE-PRCD are intended for single phase circuits or for two phases of a three-phase circuit and they shall be provided with three sets of switching contacts, one set of which is exclusively intended for switching the protective earthing path.

The moving contacts of a SPE-PRCD shall be mechanically coupled that they make and break substantially together, whether operated manually or automatically.

SPE-PRCDs shall have a trip-free mechanism.

Means for manual resetting after automatic operation shall be provided.

A test device shall also be provided (see 8.11) and its manual operating means shall be accessible when the SPE-PRCD is plugged in as in normal use.

It shall be possible to switch off the SPE-PRCD when plugged in and energized as in normal use. This requirement is not considered met by the fact that the plug can be disconnected from its supply source. The test device may be used for that purpose.

For SPE-PRCDs manual operation shall always be possible for values of the voltage between $0.7 U_e$ and $1.1 U_e$. The test device may be used for the opening operation. This requirement does not apply for values of the supply voltage less than 0.7 times the rated voltage.

SPE-PRCDs shall be constructed in such a way that the moving contacts can come to rest only in the closed position (see 3.2.3.8) or in the open position (see 3.2.3.9), even when the operating means is released in an intermediate position.

SPE-PRCDs shall be provided with means for indicating their closed and open position and such means shall be easily discernible from the front of the SPE-PRCD when fitted as in normal use.

Where the operating means is used to indicate the position of the contacts, the operating means, when released, shall automatically take up or keep the position corresponding to that of the moving contacts. In this case, the operating means shall have two distinct rest positions corresponding to the position of the contacts, but in the case of automatic opening, a third distinct position of the operating means may be provided, in which case the SPE-PRCD shall be manually reset before re-closing of the contacts is possible.

If a push-button is used for closing the contacts and is evidently identified as such, its depressed position is sufficient to indicate the closed position.

Compliance is checked by inspection and by the test of 9.5.2.

8.1.5.7 Terminals shall be so designed that they clamp the conductor reliably and between metal surfaces.

Compliance is checked by inspection and by the tests of 9.4 and 9.5.1.

8.1.5.8 Terminals shall be so designed or positioned that a wire of a conductor cannot slip out while the clamping screws or nuts are tightened.

Compliance is checked by the test of 9.5.3.

8.1.5.9 Terminals shall be so fixed or located that, when the clamping screws or nuts are tightened or loosened, their fixing shall not work loose.

These requirements do not imply that the terminals shall be so designed that their rotation or displacement is prevented, but any movement shall be sufficiently limited so as to prevent non-compliance with the requirements of this standard.

The use of sealing compound or resin is considered to be sufficient for preventing a terminal from working loose, provided that:

- the sealing compound or resin is not subjected to stress during normal use;
- the effectiveness of the sealing compound or resin is not impaired by temperatures attained by the terminal under the most unfavourable conditions specified in this Standard.

Compliance is checked by inspection, by measurement and by the test of 9.4.

8.1.5.10 Clamping screws or nuts of terminals intended for the connection of protective conductors shall be adequately secured against accidental loosening and it shall not be possible to unclamp them without a tool.

Compliance is checked by manual test.

In general, the design of terminals of which examples are shown in Annex IC of GB 16916.1-2003 provides sufficient resilience to comply with this requirement.

For other designs, special provisions, such as the use of an adequately resilient part which is not likely to be removed inadvertently, may be necessary.

8.1.5.11 Screws and nuts of terminals intended for the connection of external conductors shall be in engagement with a metal thread and the screws shall not be of the tapping screw type.

Compliance is checked by inspection.

The test device shall comply with the test of 9.16. The protective conductor of the installation shall not become live when the test device is operated.

It shall not be possible to energize the circuit on the load side by operating the test device when the SPE-PRCD is in the open position and connected as in normal use.

The test device may be the sole means of performing the opening operation, in which case it shall also comply with 8.6.

8.12 Limits of the operating voltages

SPE-PRCDs shall operate correctly at any value of the line voltage between $0.7 U_e$ and $1.1 U_e$.

8.12.1 Operation with supply failure and hazardous live PE conditions

The SPE-PRCD shall comply with the additional requirements of 5.1 for supply failures defined in 3.2.1.6, and hazardous live PE conditions defined in 3.2.3.18.

8.12.2 Verification of a standing current in the PE in normal service

The current in the PE circuit under normal operating conditions of the SPE-PRCD shall not exceed 1 mA at $1.1 U_n$ in both the open and closed positions.

Compliance is checked by the test of 9.9.5.1.4.

8.13 Resistance of SPE-PRCDs against unwanted tripping due to surge currents to earth resulting from impulse voltages

SPE-PRCDs shall adequately withstand impulse voltages.

Compliance is checked by the test of 9.19.

8.14 Behaviour of SPE-PRCDs in case of an earth fault current comprising a d.c. component

SPE-PRCDs shall ensure tripping both in the case of a residual alternating current and in the case of residual pulsating direct current whether suddenly applied or slowly rising.

Compliance is checked by the tests of 9.21.

8.15 Reliability

SPE-PRCDs shall operate reliably even after long service, taking into account the ageing of their components.

Compliance is checked by the tests of 9.22 and 9.23.

- a) with the SPE-PRCD in the open position, in turn between each pair of the terminals or pins which are electrically connected together when the SPE-PRCD is in the closed position;
- b) with the SPE-PRCD in the closed position, from each pole in turn to the other two connected together, electronic components connected between current paths being disconnected for the test, including the FE circuit between the PE circuit and other circuits;

NOTE 1: Where it is not possible to keep the SPE-PRCD in the closed position, each pole is bridged by an outside connection.

- c) with the SPE-PRCD in the closed position, from each pole in turn to the other two connected together and the frame, including a metal foil in contact with the outer surface of the internal enclosure of insulating material, if any;
- d) between internal metal parts of the mechanism and the frame;

NOTE 2: Access to the internal metal part of the mechanism may be specifically provided for this measurement by the manufacturer.

- e) for SPE-PRCDs with a metal enclosure having an internal lining of insulating material, between the frame and a metal foil in contact with the inner surface of the lining of insulating material, if any, including bushing and similar devices.

The term “frame” includes:

- all accessible metal parts and a metal foil in contact with the surfaces of insulating material which are accessible in normal use;
- screws for fixing covers which have to be removed when connecting the SPE-PRCD.

For the purpose of this test, the protective conductor is connected to the frame.

For the measurements according to b), c), d) and e), the metal foil is applied in such a way that the sealing compound, if any, is effectively tested.

The insulation resistance shall not be less than

- 2 MΩ for the measurements according to a) and b);
- 5 MΩ for the other measurements.

9.7.3 Dielectric strength of the main circuit

Immediately after the SPE-PRCD has passed the tests of 9.7.2, the test voltage

All five measured values shall be between $0.5 I_{\Delta n}$ and $I_{\Delta n}$.

Repeat with S_3 in position 2 and S_4 in position 1 or 2.

All five measured values shall be between $0.25 I_{\Delta n}$ and $I_{\Delta n}$.

NOTE: The term “manual closing” signifies S_1 for SPE-PRCD according to 4.2.1 and the closing means on the device for SPE-PRCD according to 4.2.2

9.9.2.2 Verification of the correct operation at closing on residual current

The procedure is as follows:

- a) With the test circuit calibrated at each value of the residual current specified in Table 2, the SPE-PRCD is closed on the circuit so as to simulate service conditions as closely as possible.

With test switch S_2 closed, and S_3 in position 1 (for LLSE types classified according to 4.1.2, S_4 in position 1).

For SPE-PRCDs according to 4.2.1, close S_1 ;

For SPE-PRCDs according to 4.2.2: with S_1 closed, the manual closing means on the device is used.

The SPE-PRCD may close but shall trip within the relevant specified time and not re-close.

The break-time is measured five times. No measurement shall exceed the relevant specified limiting value.

- b) For SPE-PRCDs classified according to 4.2.2, after the last tripping due to the residual current, the switch S_1 is opened and then re-closed (see Figure 1) without manually resetting.

The SPE-PRCD shall remain in the open position.

9.9.2.3 Verification of the correct operation in case of sudden appearance of residual current

With the test circuit calibrated at each value of the residual current specified in Table 2, test switches S_1 closed, S_2 open, S_3 position 1, (S_4 position 1 for LLSE types classified according to 4.1.2) and the SPE-PRCD in the closed position, the residual current is suddenly established by closing the test switch S_2 .

The SPE-PRCD shall trip during each test. Five tests are made at each value of residual current with measurement of break-time.

- damage to the entry holes for the pins that might impair proper working;
- loosening of electrical or mechanical connections;
- seepage of sealing compound.

The samples shall then comply with the requirements of 9.8, the temperature rise at any point not exceeding 45 K. They shall withstand an electric strength test made according to 9.7, the test voltage however being reduced to 1 500 V for SPE-PRCDs having a rated voltage of 250 V and to 1 000 V in the case of SPE-PRCDs having a rated voltage of 130 V.

The tests to check compliance with regard to 8.1.1.5.2, which are described in 9.12 and 9.26 are made after the tests of this subclause.

9.10.2 Test of the RCD part of the SPE-PRCD

The SPE-PRCD is prepared according to 9.2.

Endurance tests are made at the rate of four operating cycles per minute, the ON period having a duration of 1.5 s to 2 s.

9.10.2.1 Test procedure for on-load test

The test is made at rated operational voltage, at a current adjusted to the rated current by means of resistors and reactors in series, connected to the load terminals.

If air-core reactors are used, a resistor taking approximately 0.6 % of the current through the reactors is connected in parallel with each reactor.

If iron-core reactors are used, the iron-power losses of these reactors shall not appreciably influence the recovery voltage.

The current shall have substantially sine-wave form and the power factor shall be between 0.85 and 0.9.

SPE-PRCDs are subjected to 2 000 operating cycles, each operating cycle consisting of a closing operation followed by an opening operation.

The SPE-PRCD shall be operated as for normal use.

The opening operations shall be effected as follows:

- a) the first 500 operations are carried out (by using the manual operating means, if any);
- b) the following 750 operations are carried out by passing a residual operating

- or the rim of a recess for the operating means of a device with recess for the operating means.

The foil should have the following physical properties:

- density at 23 °C (0.92 ± 0.05) g/cm³;
- melting point 110 °C to 120 °C.

The control mechanism for the switching operations shall simulate as closely as possible the normal manual operation.

It shall be verified that the SPE-PRCD under test operates correctly on no-load when it is operated under the specified conditions.

g) Sequence of operations

The test procedure consists of a sequence of operations. The following symbols are used for defining the sequence of operations:

- O: represents an “open” operation, with the SPE-PRCD in the closed position the short-circuit is established by closing the switch S_2 ;
- t: represents the time interval between two successive short-circuit operations which shall be 3 min or such longer time as may be required for resetting or renewing the SCPD, if any;
- CO: represents a “close - open” operation, with the switch S_2 in the closed position the short circuit is initiated by closing the SPE-PRCD. The opening is by operation of the SPE-PRCD or the SCPD (in the case of a SCPD, see 9.11.2.4).

NOTE: If the SPE-PRCD is of the type which automatically closes when the voltage is applied, the test switch S_3 is closed to initiate the “CO” operation.

h) Behaviour of the SPE-PRCD during tests

During tests, the SPE-PRCD under test shall not endanger the operator.

Furthermore, there shall be no permanent arcing, no flashover between poles or between poles and exposed conductive parts, nor operation of the device F.

NOTE: Where an integral fuse is fitted, it may operate during the test.

i) Condition of the SPE-PRCD after tests

After each of the applicable tests the SPE-PRCD under test shall show no

The test is made on one pin of each sample.

After the test, the pins shall show no damage which may affect safety or impair the further use of the plug. In particular, the insulating sleeve shall not have punctured or wrinkled.

9.12.4 Rewirable samples are fitted with the lightest type of flexible cable or cord of the smallest cross-sectional area specified in Table 19

Non-rewirable samples are tested as delivered.

The SPE-PRCD is arranged with 2.25 m of flexible cord from the pivot point to the support point as shown in Figure 24.

The sample is held so that the cable or cord is horizontal and is then allowed to fall onto a concrete floor, four times (in various orientations).

After the test, the samples shall show no damage within the meaning of this Standard. In particular, no part shall have become detached or loosened.

NOTE: Small chips and dents which do not adversely affect the protection against electric shock are neglected.

If applicable, the SPE-PRCD shall operate when a residual current of $1.25 I_{\Delta n}$ is applied to one pole chosen at random, no measurement of break-time being made.

After this test the protection against electric shock shall not be affected and the sample shall comply with the requirements of 9.6.

9.13 Test of resistance to heat

The tests are made according to 9.13.1, 9.13.2 and 9.13.3 as applicable.

The tests of 9.13.2 and 9.13.3 are not made on parts of ceramic material.

If two or more of the insulating parts referred to in 9.13.2 and 9.13.3 are made of the same material, the test is carried out only on any one of these parts, according to 9.13.2 or 9.13.3, as applicable.

9.13.1 The samples, without removable covers, if any, are kept for 1 h in a heating cabinet at a temperature of $(100 \pm 2) ^\circ\text{C}$.

Removable covers, if any, are kept for 1 h in the heating cabinet at a temperature of $(70 \pm 2) ^\circ\text{C}$.

During the test, they shall not undergo any change impairing their further use, and the sealing compound, if any, shall not flow to such an extent that live parts are exposed.

At the end of these measurements, a voltage equal to the rated voltage is re-applied to the SPE-PRCD and the SPE-PRCD is again reset. The supply voltage is then lowered to a level (U_x) 5 % above the highest of the previously measured voltage value at which the opening occurred, but not less than 50 V. It shall be verified under these conditions that the SPE- PRCD operates within 300 ms when a residual current equal to $1.25 I_{\Delta n}$ is applied.

9.17.1.2 Verification of the behaviour in case of failure of the line voltage (T_u)

The SPE-PRCD, connected in accordance with Figure 1, is supplied on the line side with the rated voltage (or, if relevant, with a voltage having any value within its range of rated voltages) and is closed.

The supply voltage is interrupted for a period of (25 ± 5) ms. The SPE-PRCD shall not open automatically.

Following this test, the supply voltage is interrupted for a period of 0.5 s. The SPE-PRCD shall open automatically.

The SPE-PRCD is then supplied at rated voltage and S_2 is switched on. The SPE-PRCD shall open within 0.3 s.

The above series of tests is performed five times.

The behaviour of the SPE-PRCD is checked for each case of incorrect supply according to 3.2.1.6 to verify:

- automatic opening for SPE-PRCDs classified under 4.2;
- automatic reclosing after line voltage restoration for SPE-PRCDs classified under 4.2.1;
- non-re-closure after line voltage restoration for SPE-PRCDs classified under 4.2.2.

These requirements are covered by the tests of 9.9.2.2 a) and b).

9.17.1.3 Verification of the re-closing of SPE-PRCDs classified according to 4.2.1 at restoration of the line voltage after automatic opening on failure of the line voltage

A slowly rising supply voltage is applied so as to obtain the rated voltage or, in the case of a range of rated voltages, the lowest rated voltage starting from zero within 30 s. The SPE- PRCD shall re-close before the voltage reaches 0.7 times this rated voltage.

of $(25 \pm 3) ^\circ\text{C}$.

3) Description of the 24-hour cycle (see Figure 27)

- The temperature of the chamber shall be progressively raised to the appropriate upper temperature prescribed in 9.22.1.2. The upper temperature shall be achieved in a period of $3 \text{ h} \pm 30 \text{ min}$ and at a rate within the limits defined by the shaded area of Figure 27. During this period, the relative humidity shall be not less than 95 %. Condensation shall occur on the SPE-PRCD during this period.

NOTE: The condition that condensation occurs implies that the surface temperature of the SPE-PRCD is below the dew point of the atmosphere. This means that the relative humidity has to be higher than 95 %, if the thermal time-constant is low. Care should be taken so that no drops of condensed water can fall on the sample.

- The temperature shall then be maintained at a substantially constant value, within the prescribed limits of $\pm 2 ^\circ\text{C}$ for the upper temperature, for $12 \text{ h} \pm 30 \text{ min}$ from the beginning of the cycle.

During this period the relative humidity shall be $(93 \pm 3) \%$, except for the first and the last 15 min when it shall be between 90 % and 100 %.

Condensation shall not occur on the SPE-PRCD during the last period of 15 min.

- The temperature shall then fall to $(25 \pm 3) ^\circ\text{C}$ within 3 h to 6 h. The rate of fall for the first 1 h 30 min shall be such that, if maintained as indicated in Figure 22, it would result in a temperature of $(25 \pm 3) ^\circ\text{C}$ being attained in $3 \text{ h} \pm 15 \text{ min}$. During the temperature fall period, the relative humidity shall be not less than 95 %, except for the first 15 min when it shall be not less than 90 %.
- The temperature shall then be maintained at $(25 \pm 3) ^\circ\text{C}$ with a relative humidity not less than 95 %, until the 24-hour cycle is completed.

9.22.1.4 Recovery

At the end of the cycles, the SPE-PRCD shall not be removed from the test chamber.

The door of the test chamber shall be opened and the temperature and humidity regulation is stopped.

A period of 4 h to 6 h shall then elapse to permit the ambient conditions (temperature and humidity) to be re-established before making the final measurement.

PRCD, is the same as when supplied from a PRCD of the GB 20044 type, or from a normal plug. Therefore, class I equipment supplied by the SPE-PRCD has the PE connected and hence earthed when in use.

Table 14 gives the tests required for the SPE units. These include tests for a hazardous live PE (with variations of L and N supply), and open circuit N and an open circuit PE.

In some countries, a reversal of the supply polarity of L and N is regarded as hazardous if the L is not switched correctly. An open circuit earth is regarded as a loss of fundamental protection for class I equipment. A loss of the neutral supply may also be considered a hazard and is covered by the SPE-PRCD functional tests.

A hazardous live PE is defined in 3.2.3.18 of this Standard. This can be caused by incorrect supply if miswiring of the socket outlet occurs. This can also occur if the PE is loose and makes contact with the line conductor.

Examples of some common hazardous conditions are included in the Figure E.1 and Figure E.2. See Figure E.2, example 2, for hazardous PE where the PE supply is disconnected and in contact with the supply live conductors (LNL).

The operation on IT systems require consideration. The SPE-PRCD will in effect monitor the resistance to ground and if isolation is such that contact with a live conductor is not hazardous, then the SPE-PRCD will not close and a PRCD is not required. The SPE-PRCD, which has a plug and a portable connector, can then be removed. The system should be verified as safe by other means and expert advice obtained before connection of equipment.

The SPE detection circuit prevents closure if the PE is open circuit, for example when the system is not intentionally impedance connected to earth. The SPE-PRCD will not close to connect a small isolating transformer. In this case a PRCD is not required.

If the system is impedance grounded (such as with a 5 000 Ω impedance) the SPE unit may close. The SPE-PRCD ensures protection for residual currents.

There are two types of SPE to suit different supplies as shown E.3: LNSE (line, neutral, PE) and LLSE (line, line, PE). A test is included in Table 14 to ensure the SPE units still provide additional protection, even if attempts are made to connect to an alternative system, for example LN type to LL supply.

The outcome of the tests ensures that the SPE-PRCD provides additional protection against miswiring faults and that the RCD function is not impaired for a residual current flow from any conductor that is live.

The SPE-PRCD may detect a live PE but in some cases (such as NLL) closure may occur. In such a rare case, it is imperative that the SPE-PRCD still operates on a residual current. A consequence is that the PE may pass through the toroid. The

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