Conditions applicable to Figure 6C: D2

1) Equipment contains a method for limiting current energy to 100 A^2-s max. for Test Condition 1. A circuit or component that complies with the Standard for Secondary Protectors for Communications Circuits, UL 497A, or CSA C22.2 No. 226, Protectors in Telecommunication Networks, shall be considered to comply with this requirement. D2

2) Equipment contains a method for limiting current to 1,3 A max. steady state (e.g. a fuse rated 1,0 A maximum) that also complies with the Standard for Secondary Protectors for Communications Circuits, UL 497A, or CSA C22.2 No. 226, Protectors in Telecommunication Networks. D2

3) Minimum No. 26 AWG telecommunication line cord, either supplied with the equipment or described in the safety instructions. See Annex NAA. D2

4) The telephone line is adequately isolated from earth for the operating mode being considered at a voltage of 120 V. This may be determined by complying with the test of 6.1.2, Figure 6A, using a minimum voltage of 120 V, or an electric strength test of 120 V. The test is applicable to PLUGGABLE EQUIPMENT TYPE A, PLUGGABLE EQUIPMENT TYPE B and PERMANENTLY CONNECTED EQUIPMENT. D2

5) In addition to the requirements for a FIRE ENCLOSURE, including consideration of HWI (4.7.3.2), both of the following requirements apply for parts in TNV CIRCUITS that might ignite under overvoltage conditions: D2

a) the parts shall be separated from internal materials of FLAMMABILITY CLASS V-2 or lower by at least 25 mm of air or a barrier of FLAMMABILITY CLASS V-1 or better. The exceptions of 4.7.3.4 apply, except that 25 mm shall be substituted wherever 13 mm is found. D2

b) the parts shall be separated from openings in the top or sides of the ENCLOSURE by at least 25 mm of air or a barrier of FLAMMABILITY CLASS V-1 or better unless the openings comply with one of the following: D2

– not exceed 5 mm in any direction; or D2

– not exceed 1 mm in width regardless of length. D2

6) Test Condition 2 is not required for equipment containing a method for limiting current to 1,3 A max steady state (e.g., a fuse rated 1,0 A maximum). D2

7) Test Conditions 3 and 4 are not required for equipment whose application (because of system function, design limitations, etc.) is limited to connections to outside cable not exceeding 1 000 m (for example, equipment that connects to ISDN S/T reference points and certain proprietary telephone sets). D2

7 Connection to cable distribution systems

NAD
NAE

7.1 General

If the equipment is to be connected to a CABLE DISTRIBUTION SYSTEM, the requirements of Clause 7 apply in addition to the requirements of Clauses 1 to 5 of this standard.

NOTE 1 Unless the connection uses coaxial cable, the circuit is not a CABLE DISTRIBUTION SYSTEM, and Clause 6 applies.

NOTE 2 It is assumed that adequate measures have been taken to reduce the likelihood that transient overvoltages presented to the equipment exceed the following values:

– 10 kV for equipment to be connected only to an outdoor antenna;
– 4 kV to other equipment, see ITU-T Recommendations K.20, K.21 and K.45.

In installations where overvoltages presented to the equipment may exceed these values, additional measures such as surge suppression may be necessary.

NOTE 3 Legal requirements may exist regarding the connection of information technology equipment to a CABLE DISTRIBUTION SYSTEM operated by a public network operator.

NOTE 4 The AC MAINS SUPPLY system, if used as a communication medium, is not a CABLE DISTRIBUTION SYSTEM (see 1.2.13.14) and Clause 7 does not apply. For equipment to be connected to such systems, the other clauses of this standard will apply to coupling components, such as signal transformers and capacitors, connected between the mains and other circuitry. The requirements for DOUBLE INSULATION or REINFORCED INSULATION will generally apply. See also Annex Z of this standard and IEC 60664-1 for overvoltages to be expected at various points in the AC MAINS SUPPLY system.

NOTE 5 It is assumed that the cable shield will be earthed in accordance with the installation requirements of IEC 60728-11.

7.2 Protection of cable distribution system service persons, and users of other equipment connected to the system, from hazardous voltages in the equipment

Circuitry intended to be directly connected to a CABLE DISTRIBUTION SYSTEM shall comply with the requirements for a TNV-1 CIRCUIT, a TNV-3 CIRCUIT or a HAZARDOUS VOLTAGE SECONDARY CIRCUIT, depending on the normal operating voltage.

Where protection of the CABLE DISTRIBUTION SYSTEM relies on protective earthing of the equipment, the installation instructions and other relevant literature shall state that the integrity of the protective earth must be ensured, see also 1.7.2.1.

Compliance is checked by inspection and by measurement.

NOTE For requirements in Finland, Norway and Sweden, see 6.1.2.1, Note 2 and 6.1.2.2, Note. The term TELECOMMUNICATION NETWORK in 6.1.2 is replaced by CABLE DISTRIBUTION SYSTEM.

7.3 Protection of equipment users from overvoltages on the cable distribution system

The requirements and tests of 6.2 apply except that the term "TELECOMMUNICATION NETWORK" is replaced by "CABLE DISTRIBUTION SYSTEM" throughout 6.2. When applying 6.2 to CABLE DISTRIBUTION SYSTEMS, the separation requirements apply only to those circuit parts that are directly connected to the inner conductor (or conductors) of the coaxial cable; the separation requirements do not apply to those circuit parts that are directly connected to the outer screen or screens.

However, the separation requirements and tests of 6.2.1 a), b) and c) do not apply to a CABLE DISTRIBUTION SYSTEM if all of the following apply:

– the circuit under consideration is a TNV-1 CIRCUIT; and

– the common or earthed side of the circuit is connected to the screen of the coaxial cable and to all accessible parts and circuits (SELV, accessible metal parts and LIMITED CURRENT CIRCUITS, if any); and

– the screen of the coaxial cable is intended to be connected to earth in the building installation.

NOTE 1 In Sweden, there are many buildings where the screen of the coaxial cable is normally not connected to the earth in the building installation.

NOTE 2 For installation conditions in Norway, see IEC 60728-11:2005.

Compliance is checked by inspection and the application of the relevant requirements and tests of 6.2.

7.4 Insulation between primary circuits and cable distribution systems

7.4.1 General

Except as specified below, the insulation between the PRIMARY CIRCUIT and the terminal or lead provided for the connection of a CABLE DISTRIBUTION SYSTEM shall pass either:

– the voltage surge test of 7.4.2 for equipment intended to be connected to outdoor antennas; or

– the impulse test of 7.4.3 for equipment intended to be connected to other CABLE DISTRIBUTION SYSTEMS.

If an equipment is intended for connection to both an outdoor antenna and another CABLE DISTRIBUTION SYSTEM, it shall pass the tests of 7.4.2 and 7.4.3.

The above requirement does not apply to any of the following:

– equipment intended for indoor use only, provided with a built in (integral) antenna and not provided with a connection to a CABLE DISTRIBUTION SYSTEM;

– PERMANENTLY CONNECTED EQUIPMENT, or PLUGGABLE EQUIPMENT TYPE B, in which the circuit intended to be connected to the CABLE DISTRIBUTION SYSTEM is also connected to protective earth in accordance with 2.6.1 e);

– PLUGGABLE EQUIPMENT TYPE A, in which the circuit intended to be connected to the CABLE DISTRIBUTION SYSTEM is also connected to protective earth in accordance with 2.6.1 e); and either

- is intended to be installed by a SERVICE PERSON and has installation instructions that require the equipment to be connected to a socket-outlet with a protective earthing connection; or

- has provision for a permanently connected PROTECTIVE EARTHING CONDUCTOR, including instructions for the installation of that conductor.

Compliance is checked by inspection and if necessary by the voltage surge test of 7.4.2 or impulse test of 7.4.3.

NOTE Minimum CLEARANCES are determined by the requirements of 2.10.3 (or Annex G). It may be necessary to increase the CLEARANCES between PRIMARY CIRCUITS and SECONDARY CIRCUITS intended for connection to CABLE DISTRIBUTION SYSTEMS so that the circuits can pass the tests of 7.4.2 or 7.4.3.

7.4.2 Voltage surge test

The test is applied between the supply circuit terminals and the main protective earthing terminal, if any, joined together, and the connection points for the CABLE DISTRIBUTION SYSTEM, excluding any earthed conductor, joined together. All components connected between the connection points for the CABLE DISTRIBUTION SYSTEM and the main protective earthing terminal are disconnected before the test. If an on/off switch is provided, it is in the "ON" position.

Conditioning pulses are applied between

– the connection points for the CABLE DISTRIBUTION SYSTEM, excluding any earthed conductor, joined together, and

– the supply circuit terminals and the main protective earthing terminal, if any, joined together.

Fifty discharges are applied from the impulse test generator reference 3 of Table N.1, at a maximum rate of 12 pulses per minute, with U_c equal to 10 kV.

After the above conditioning, the relevant electric strength tests of 5.2.2 are applied.

7.4.3 Impulse test

The test is applied between the supply circuit terminals and the main protective earthing terminal, if any, joined together, and the connection points for the CABLE DISTRIBUTION SYSTEM*, excluding any earthed conductor, joined together. All components connected between the connection points for the* CABLE DISTRIBUTION SYSTEM *and the main protective earthing terminal are disconnected before the test. If an on/off switch is provided, it is in the "ON" position.*

Ten conditioning pulses of alternating polarity are applied from the impulse test generator reference 1 of Table N.1. The interval between successive impulses is 60 s, and U_c is equal to

- *5 kV for power-fed repeaters;*
- *4 kV for all other terminal and network equipment.*

After the above conditioning, the relevant electric strength tests of 5.2.2 are applied.

Annex A
(normative)
Tests for resistance to heat and fire

It should be noted that toxic fumes may be given off during the tests. Where appropriate the tests should be conducted either under a ventilated hood or in a well-ventilated room, but free from draughts that could invalidate the tests.

A.1 Flammability test for fire enclosures of movable equipment having a total mass exceeding 18 kg and of stationary equipment (see 4.7.3.2)

A.1.1 Samples

Three samples, each consisting of either a complete FIRE ENCLOSURE *or a section of the* FIRE ENCLOSURE *representing the thinnest significant wall thickness and including any ventilation opening, are tested.*

A.1.2 Conditioning of samples

Prior to being tested, the samples are conditioned in a circulating air oven for a period of 7 days (168 h), at a uniform temperature 10 K higher than the maximum temperature reached by the material measured during the test of 4.5.2, or 70 °C, whichever is the higher, and then cooled to room temperature.

A.1.3 Mounting of samples

Samples are mounted as they would be in actual use. A layer of untreated surgical cotton is located 300 mm below the point of application of the test flame.

A.1.4 Test flame

The test flame according to IEC 60695-11-3 is used.

A.1.5 Test procedure

The test flame is applied to an inside surface of the sample, at a location judged to be likely to become ignited because of its proximity to a source of ignition. If a vertical part is involved, the flame is applied at an angle of approximately 20° from the vertical. If ventilation openings are involved, the flame is applied to an edge of an opening, otherwise to a solid surface. In all cases, the tip of the inner blue cone is to be in contact with the sample. The flame is applied for 5 s and removed for 5 s. This operation is repeated, whether or not the sample is flaming, until the sample has been subjected to five applications of the test flame to the same location.

The test is repeated on the remaining two samples. If more than one part of the FIRE ENCLOSURE *is near a source of ignition, each sample is tested with the flame applied to a different location.*

A.1.6 Compliance criteria

During the test, the sample shall not release either flaming drops or particles capable of igniting the surgical cotton. The sample shall not continue to burn for more than 1 min after the fifth application of the test flame, and shall not be consumed completely.

A.2 Flammability test for fire enclosures of movable equipment having a total mass not exceeding 18 kg, and for material and components located inside fire enclosures (see 4.7.3.2 and 4.7.3.4) *P.2*

A.2.1 Samples

Three samples are tested. For FIRE ENCLOSURES, *each sample consists of either a complete* FIRE ENCLOSURE *or a section of the* FIRE ENCLOSURE *representing the thinnest significant wall thickness and including any ventilation opening. For material to be located within the* FIRE ENCLOSURE, *each sample of the material consists of one of the following:*

– *the complete part; or*

– *a section of the part representing the thinnest significant wall thickness; or*

– *a test plaque or bar of uniform thickness representing the thinnest significant section of the part.*

For components to be located within the FIRE ENCLOSURE, *each sample is to be a complete component.*

A.2.2 Conditioning of samples

Prior to being tested, the samples are conditioned in a circulating air oven for a period of 7 days (168 h), at a uniform temperature 10 K higher than the maximum temperature of the part measured during the test of 4.5.2, or 70 °C, whichever is the higher, and then cooled to room temperature.

A.2.3 Mounting of samples

Samples are mounted and oriented as they would be in actual use.

A.2.4 Test flame

The test flame according to IEC 60695-11-4 is used.

A.2.5 Test procedure

The test flame is applied to an inside surface of the sample at a point judged to be likely to become ignited because of its proximity to a source of ignition. For the evaluation of materials located within the FIRE ENCLOSURE*, it is permitted to apply the test flame to an external surface of the sample. For the evaluation of components to be located within the* FIRE ENCLOSURE*, the test flame is applied directly to the component.*

If a vertical part is involved, the flame is applied at an angle of approximately 20° from the vertical. If ventilation openings are involved, the flame is applied to an edge of an opening, otherwise to a solid surface. In all cases, the tip of the flame is to be in contact with the sample. The flame is applied for 30 s and removed for 60 s, then reapplied to the same location for 30 s, whether or not the sample is flaming.

The test is repeated on the remaining two samples. If any part being tested is near a source of ignition at more than one point, each sample is tested with the flame applied to a different point that is near a source of ignition.

A.2.6 Compliance criteria

During the test, the samples shall not continue to burn for more than 1 min after the second application of the test flame, and shall not be consumed completely.

A.2.7 Alternative test

As an alternative to the apparatus and procedure specified in A.2.4 and A.2.5, it is permitted to use the apparatus and procedure specified in Clauses 5 and 9 of IEC 60695-11-5. The manner, duration and number of flame applications are as specified in A.2.5 and compliance is in accordance with A.2.6.

NOTE Compliance with the method of either A.2.4 and A.2.5 or of A.2.7 is acceptable; it is not required to comply with both methods.

A.3 Hot flaming oil test (see 4.6.2)

A.3.1 Mounting of samples

A sample of the complete finished bottom of the FIRE ENCLOSURE *is securely supported in a horizontal position. Bleached* CHEESECLOTH *of approximately 40 g/m^2 is placed in one layer over a shallow, flat-bottomed pan approximately 50 mm below the sample, and is of sufficient size to cover completely the pattern of openings in the sample, but not large enough to catch any of the oil that runs over the edge of the sample or otherwise does not pass through the openings.*

NOTE Use of a metal screen or a wired-glass partition surrounding the test area is recommended.

A.3.2 Test procedure

A small metal ladle (preferably no more than 65 mm in diameter), with a pouring lip and a long handle whose longitudinal axis remains horizontal during pouring, is partially filled with 10 ml of a distillate fuel oil which is a medium volatile distillate having a mass per unit volume between 0,845 g/ml and 0,865 g/ml, a flash point between 43,5 °C and 93,5 °C and an average calorific value of 38 MJ/l. The ladle containing the oil is heated and the oil ignited and permitted to burn for 1 min, at which time all of the hot flaming oil is poured at the rate of approximately 1 ml/s in a steady stream onto the centre of the pattern of openings, from a position approximately 100 mm above the openings.

The test is repeated twice at 5 min intervals, using clean CHEESECLOTH.

A.3.3 Compliance criterion

During these tests the CHEESECLOTH *shall not ignite.*

Annex B *P.2*
(normative)
Motor tests under abnormal conditions
(see 4.7.2.2 and 5.3.2)

B.1 General requirements

Motors, other than d.c. motors in SECONDARY CIRCUITS*, shall pass the tests of Clauses B.4 and B.5 and, where applicable, Clauses B.8, B.9 and B.10, except that the following motors are not required to pass the test of Clause B.4:*

– motors that are used for air-handling only and where the air propelling component is directly coupled to the motor shaft; and

– shaded pole motors whose values of locked-rotor current and no-load current do not differ by more than 1 A and have a ratio of not more than 2/1.

DC motors in SECONDARY CIRCUITS *shall pass the tests of Clauses B.6, B.7 and B.10 except that motors, which by their intrinsic operation normally operate under locked-rotor conditions, such as stepper motors, are not tested.*

B.2 Test conditions

Unless otherwise specified in this annex, during the test the equipment is operated at RATED VOLTAGE*, or at the upper voltage of the* RATED VOLTAGE RANGE*.*

The tests are conducted either in the equipment or under simulated conditions on the bench. It is permitted to use separate samples for bench tests. Simulated conditions include:

– any protection devices that would protect the motor in the complete equipment; and

– use of any mounting means that may serve as a heat sink to the motor frame.

Temperatures of windings are measured as specified in 1.4.13. Where thermocouples are used they are applied to the surface of the motor windings. Temperatures are determined at the end of the test period where specified, otherwise when the temperature has stabilized, or at the instant of operation of fuses, THERMAL CUT-OUTS*, motor protection devices and the like.*

For totally enclosed, impedance-protected motors, the temperatures are measured by thermocouples applied to the motor case.

When motors without inherent thermal protection are tested under simulated conditions on the bench, the measured winding temperature is adjusted to take into account the ambient temperature in which the motor is normally located within the equipment as measured during the test of 4.5.2.

B.3 Maximum temperatures

For the tests in Clauses B.5, B.7, B.8 and B.9, the temperature limits, as specified in Table B.1, shall not be exceeded for each class of insulating material.

Table B.1 – Temperature limits for motor windings (except for running overload test)

	Maximum temperature °C							
Method of protection	**Thermal class**							
	105 (A)	**120 (E)**	**130 (B)**	**155 (F)**	**180 (H)**	**200**	**220**	**250**
Protection by inherent or external impedance	150	165	175	200	225	245	265	295
Protection by protective device that operates during the first hour	200	215	225	250	275	295	315	345
Protection by any protective device:								
– maximum after first hour	175	190	200	225	250	270	290	320
– arithmetic average during the 2nd hour and during the 72nd hour	150	165	175	200	225	245	265	295
The designations A to H, formerly assigned in IEC 60085 to thermal classes 105 to 180, are given in parentheses.								

The arithmetic average temperature is determined as follows:

The graph of temperature against time (see Figure B.1), while the power to the motor is cycling on and off, is plotted for the period of test under consideration. The arithmetic average temperature (t_A) is determined by the formula:

$$t_A = \frac{t_{max} + t_{min}}{2}$$

where:

t_{max} *is the average of the maxima;*

t_{min} *is the average of the minima.*

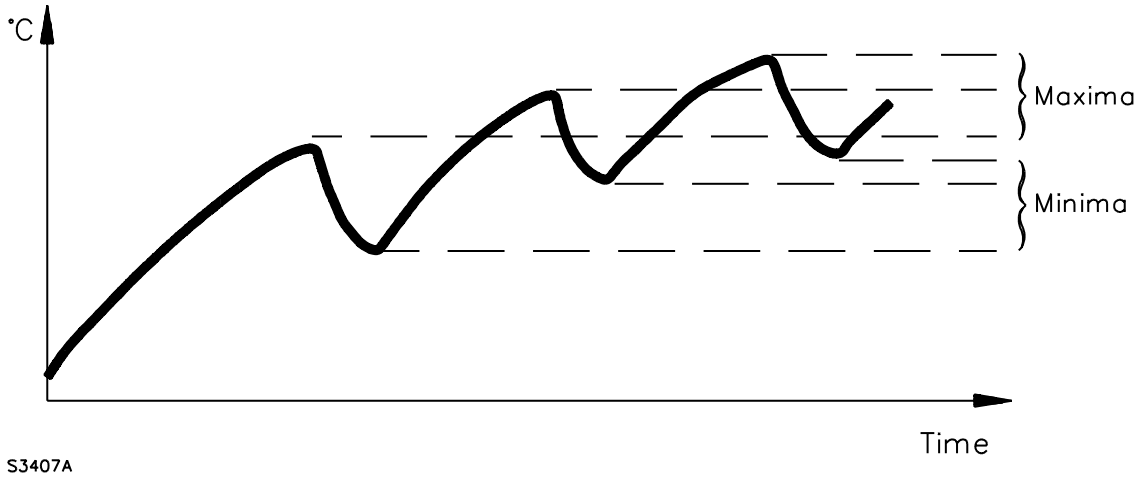


Figure B.1 – Determination of arithmetic average temperature

For the tests in Clauses B.4 and B.6, the temperature limits, as specified in Table B.2, shall not be exceeded for each class of insulating material.

B.4 Running overload test

A running overload protection test is conducted by operating the motor under NORMAL LOAD. The load is then increased so that the current is increased in appropriate gradual steps, the motor supply voltage being maintained at its original value. When steady conditions are established, the load is again increased. The load is thus progressively increased in appropriate steps but without reaching locked-rotor condition (see Clause B.5), until the overload protection device operates.

The motor winding temperatures are determined during each steady period and the maximum temperature recorded shall not exceed the values specified in Table B.2.

Table B.2 – Permitted temperature limits for running overload tests

Maximum temperature °C							
Thermal class							
105 (A)	120 (E)	130 (B)	155 (F)	180 (H)	200	220	250
140	155	165	190	215	235	255	275
The designations A to H, formerly assigned in IEC 60085 to thermal classes 105 to 180, are given in parentheses.							

B.5 Locked-rotor overload test

A locked-rotor test is conducted starting at room temperature.

The duration of the test is as follows:

– a motor protected by inherent or external impedance is operated with its rotor locked for 15 days except that testing may be discontinued when the windings of the motor, of either the open or totally enclosed type, reach a constant temperature, provided that the constant temperature is not more than that specified in 4.5.3, Table 4B for the insulation system used;

– a motor with an automatic reset protection device is cycled with its rotor locked for 18 days;

– a motor with a manual reset protection device is cycled with its rotor locked for 60 cycles, the protection device being reset after each operation as soon as possible for it to remain closed, but after not less than 30 s;

– a motor with a non-resettable protection device is operated with its rotor locked until the device operates.

Temperatures are recorded at regular intervals during the first three days for a motor with inherent or external impedance protection or with an automatic reset protection device, or during the first ten cycles for a motor with a manual reset protection device, or at the time of operation of a non-resettable protection device.

The temperatures shall not exceed the values specified in Table B.1.

During the test, protective devices shall operate reliably without breakdown of insulation to the motor frame or permanent damage to the motor, including excessive deterioration of the insulation.

Permanent damage to the motor includes:

– severe or prolonged smoking or flaming;

– electrical or mechanical breakdown of any associated component part such as a capacitor or starting relay;

– flaking, embrittlement or charring of insulation.

Discoloration of the insulation is permitted but charring or embrittlement to the extent that insulation flakes off or material is removed when the winding is rubbed with the thumb is not permitted.

After the period specified for temperature measurement, the motor shall withstand the electric strength test in 5.2.2 after the insulation has cooled to room temperature and with test voltages reduced to 60 % of the specified values. No further electric strength test is required.

NOTE Continuation of the test of an automatic reset protection device beyond 72 h, and of a manual reset protection device beyond 10 cycles, is for the purpose of demonstrating the capability of the device to make and break locked-rotor current for an extended period of time.

B.6 Running overload test for d.c. motors in secondary circuits

B.6.1 General

The running overload test is conducted only if a possibility of an overload occurring is determined by inspection or by review of the design. The test need not be conducted, for example, where electronic drive circuits maintain a substantially constant drive current.

Motors shall pass the test in B.6.2, except that, if difficulty is experienced in obtaining accurate temperature measurements, due to the small size of unconventional design of the motor, the method of B.6.3 can be used instead. Compliance may be established by either method.

B.6.2 Test procedure

The motor is operated under NORMAL LOAD. The load is then increased so that the current is increased in appropriate gradual steps, the motor supply voltage being maintained at its original value. When steady conditions are established the load is again increased. The load is thus progressively increased in appropriate steps until either the overload protection device operates or the winding becomes an open circuit.

The motor winding temperatures are determined during each steady period and the maximum temperature recorded shall not exceed the value in Table B.2.

B.6.3 Alternative test procedure

The motor is placed on a wooden board which is covered with a single layer of WRAPPING TISSUE*, and the motor in turn is covered with a single layer of* CHEESECLOTH*.*

At the conclusion of the test, there shall be no ignition of the WRAPPING TISSUE *or* CHEESECLOTH*.*

Compliance with either method is acceptable; it is not necessary to comply with both methods.

B.6.4 Electric strength test

Following the test of B.6.2 or B.6.3, as applicable, if the motor voltage exceeds 42,4 V peak, or 60 V d.c., and after it has cooled to room temperature, the motor shall withstand the electric strength test in 5.2.2, but with test voltages reduced to 60 % of the specified values.

B.7 Locked-rotor overload test for d.c. motors in secondary circuits

B.7.1 General

Motors shall pass the test in B.7.2, except that, where difficulty is experienced in obtaining accurate temperature measurements, due to the small size or unconventional design of the motor, the method of B.7.3 can be used instead. Compliance may be established by either method.

B.7.2 Test procedure

The motor is operated at the voltage used in its application and with its rotor locked for 7 h or until steady conditions are established, whichever is the longer. Temperatures shall not exceed the values specified in Table B.1.

B.7.3 Alternative test procedure

The motor is placed on a wooden board which is covered with a single layer of WRAPPING TISSUE*, and the motor in turn covered with a single layer of bleached cotton* CHEESECLOTH *of approximately 40 g/m^2.*

The motor is then operated at the voltage used in its application and with its rotor locked for 7 h or until steady conditions are established, whichever is the longer.

At the conclusion of the test there shall be no ignition of the WRAPPING TISSUE *or* CHEESECLOTH*.*

B.7.4 Electric strength test

Following the test of B.7.2 or B.7.3, as applicable, if the motor voltage exceeds 42,4 V peak, or 60 V d.c., and after it has cooled to room temperature, the motor shall withstand the electric strength test in 5.2.2 but with test voltages reduced to 60 % of the specified values.

B.8 Test for motors with capacitors

Motors having phase-shifting capacitors are tested under locked rotor conditions with the capacitor short-circuited or open-circuited (whichever is the more unfavourable).

The short-circuit test is not made if the capacitor is so designed that, upon failure, it will not remain short-circuited.

Temperatures shall not exceed the values specified in Table B.1.

NOTE Locked rotor is specified because some motors may not start and variable results could be obtained.

B.9 Test for three-phase motors

Three-phase motors are tested under NORMAL LOAD, with one line conductor disconnected, unless circuit controls prevent the application of voltage to the motor with one or more supply conductors disconnected.

The effect of other loads and circuits within the equipment may necessitate that the motor be tested within the equipment and with each of the three line conductors disconnected one at a time.

Temperatures shall not exceed the values specified in Table B.1.

B.10 Test for series motors

Series motors are operated at a voltage equal to 130 % of the motor voltage rating for 1 min with the lowest possible load.

After the test, windings and connections shall not have worked loose and no hazard shall be present in the meaning of this standard.

Annex C
(normative)
Transformers
(see 1.5.4 and 5.3.3)

C.1 Overload test

If the tests in this clause are conducted under simulated conditions on the bench, these conditions shall include any protection device that would protect the transformer in the complete equipment.

Transformers for switch mode power supply units are tested in the complete power supply unit or in the complete equipment. Test loads are applied to the output of the power supply unit.

A linear transformer or a ferro-resonant transformer has each secondary winding loaded in turn, with any other secondaries loaded between zero and their specified maxima to result in the maximum heating effect.

The output of a switch mode power supply unit is loaded to result in the maximum heating effect in the transformer.

NOTE For examples of loading to give the maximum heating effect, see Annex X.

Where an overload cannot occur or is unlikely to create a hazard, the above tests are not made.

Maximum temperatures of windings shall not exceed the values in Table C.1 when measured as specified in 1.4.12 and 1.4.13, and determined as specified below:

- *with external overcurrent protection: at the moment of operation, for determination of the time until the overcurrent protection operates, it is permitted to refer to a data sheet of the overcurrent protection device showing the trip time versus the current characteristics;*

- *with an AUTOMATIC RESET THERMAL CUT-OUT: as shown in Table C.1 and after 400 h;*

- *with a MANUAL RESET THERMAL CUT-OUT: at the moment of operation;*

- *for current-limiting transformers: after temperature has stabilized.*

If the temperature of the windings of a transformer with a ferrite core, measured as specified in 1.4.12 exceeds 180 °C, it shall be retested at maximum rated ambient temperature ($T_{amb} = T_{ma}$), and not as calculated according to 1.4.12.

NOTE The above procedure is to ensure that deteriorating Curie characteristics of ferrite at temperatures approaching 200 °C do not cause thermal runaway (unpredictable temperature rise).

Secondary windings that exceed the temperature limits but that become open circuit or otherwise require replacement of the transformer do not constitute a failure of this test, provided that no hazard is created in the meaning of this standard.

For compliance criteria see 5.3.9.

Table C.1 – Temperature limits for transformer windings

	Maximum temperature °C							
Method of protection	**Thermal class**							
	105 (A)	**120 (E)**	**130 (B)**	**155 (F)**	**180 (H)**	**200**	**220**	**250**
Protection by inherent or external impedance	150	165	175	200	225	245	265	295
Protection by protective device that operates during the first hour	200	215	225	250	275	295	315	345
Protection by any protective device:								
– maximum after first hour	175	190	200	225	250	270	290	320
– arithmetic average during the 2nd hour and during the 72nd hour	150	165	175	200	225	245	265	295
The designations A to H, formerly assigned in IEC 60085 to thermal classes 105 to 180, are given in parentheses.								

The arithmetic average temperature is determined as follows:

The graph of temperature against time (see Figure C.1), while the power to the transformer is cycling on and off, is plotted for the period of test under consideration. The arithmetic average temperature (t_A) is determined by the formula:

$$t_A = \frac{t_{max} + t_{min}}{2}$$

where:

t_{max} *is the average of the maxima;*

t_{min} *is the average of the minima.*

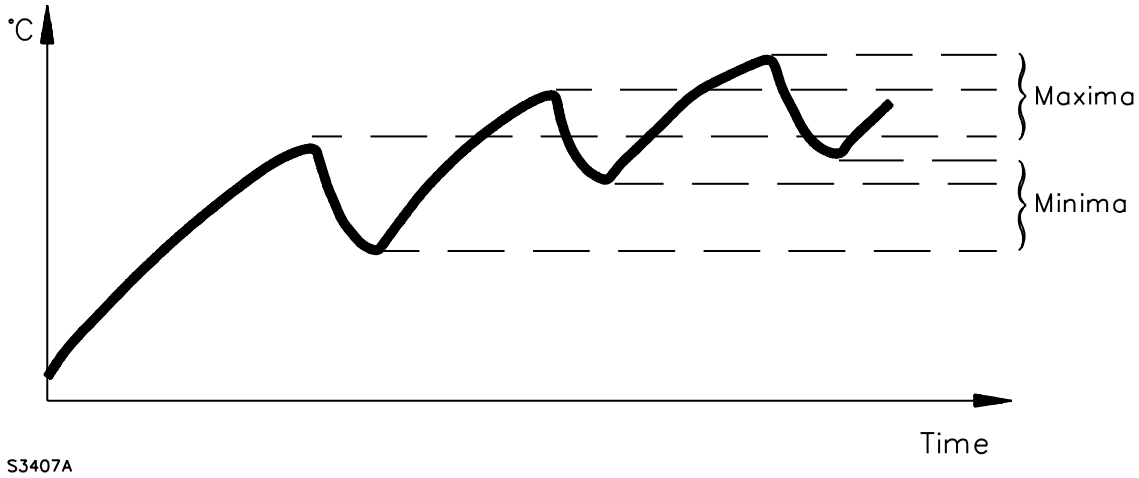


Figure C.1 – Determination of arithmetic average temperature

C.2 Insulation

Insulation in transformers shall comply with the following requirements.

Windings and conductive parts of transformers shall be treated as parts of the circuits to which they are connected, if any. The insulation between them shall comply with the relevant requirements of 2.10 (or Annex G) and pass the relevant tests of 5.2, according to the application of the insulation in the equipment (see 2.9.3).

Precautions shall be taken to prevent the reduction below the required minimum values of CLEARANCES and CREEPAGE DISTANCE that provide BASIC INSULATION, SUPPLEMENTARY INSULATION or REINFORCED INSULATION by:

– displacement of windings or their turns;

– displacement of internal wiring or wires for external connections;

– undue displacement of parts of windings or internal wiring, in the event of rupture of wires adjacent to connections or loosening of the connections;

– bridging of insulation by wires, screws, washers and the like should they loosen or become free.

It is not expected that two independent fixings will loosen at the same time.

All windings shall have the end turns retained by positive means.

Compliance is checked by inspection, measurement, and if necessary, by the following tests.

If the transformer is fitted with a screen for protective earthing purposes that is separated from the primary winding connected to a HAZARDOUS VOLTAGE *circuit by* BASIC INSULATION *only, the screen shall comply with one of the following:*

– meet the requirements of 2.6.3.3;

– meet the requirements of 2.6.3.4 between the earthed screen and the main protective earthing terminal of the equipment;

– pass a test simulating breakdown of BASIC INSULATION *between the screen and the associated primary winding. The transformer shall be protected by any protective device used in the end application. The protective earthing path and the screen shall not be damaged.*

If tests are conducted, a specially prepared sample transformer having an extra lead-out wire from the free end of the screen is used to ensure that the current during the test passes through the screen.

Examples of acceptable forms of construction (see 1.3.8) are the following:

– windings isolated from each other by placing them on separate limbs of the core, with or without spools;

– windings on a single spool with a partition wall, where either the spool and partition wall are pressed or moulded in one piece, or a pushed-on partition wall has an intermediate sheath or covering over the joint between the spool and the partition wall;

– concentric windings on a spool of insulating material without flanges, or on insulation applied in thin sheet form to the transformer core;

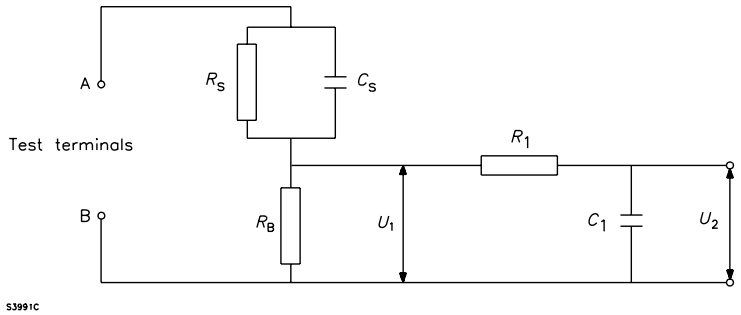
– insulation is provided between windings consisting of sheet insulation extending beyond the end turns of each layer;

– concentric windings, separated by an earthed conductive screen that consists of metal foil extending the full width of the windings, with suitable insulation between each winding and the screen. The conductive screen and its lead-out wire have a cross section sufficient to ensure that on breakdown of the insulation an overload device will open the circuit before the screen is destroyed. The overload device may be a part of the transformer.

Annex D
(normative)
Measuring instruments for touch-current tests
(see 5.1.4)

D.1 Measuring instrument

The measuring instrument of Figure D.1 is from Figure 4 of IEC 60990.

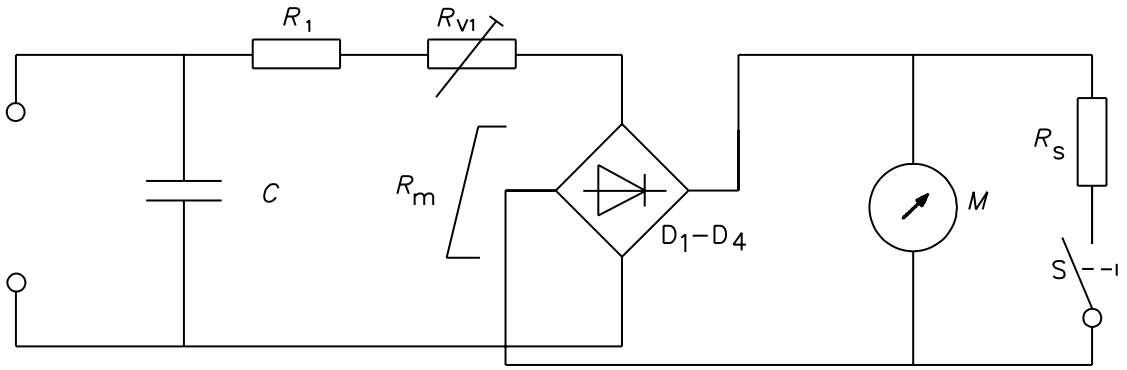


R_S	1 500 Ω	
R_B	500 Ω	
R_1	10 kΩ	
C_S	0,22 µF	
C_1	0,022 µF	
Voltmeter or oscilloscope (r.m.s. or peak reading)	Input resistance:	>1 MΩ
	Input capacitance:	<200 pF
	Frequency range:	15 Hz up to 1 MHz
	(appropriate for the highest frequency of interest, see 1.4.7)	

Figure D.1 – Measuring instrument

The measuring instrument is calibrated by comparing the frequency factor of U_2 with the solid line in Figure F.2 of IEC 60990 at various frequencies. A calibration curve is constructed showing the deviation of U_2 from the ideal curve as a function of frequency.

D.2 Alternative measuring instrument



M	0 mA – 1 mA moving coil movement
$R_1 + R_{V1} + R_m$ at 0,5 mA d.c. =	1 500 Ω ± 1 % with *C* = 150 nF ± 1 % or 2 000 Ω ± 1 % with *C* = 112 nF ± 1 %
D1 – D4	Rectifier
R_S	Non-inductive shunt for × 10 range
S	Sensitivity button (press for maximum sensitivity)

Figure D.2 – Alternative measuring instrument

The instrument comprises a rectifier/moving coil meter with additional series resistance, the two being shunted by a capacitor, as shown in Figure D.2. The effect of the capacitor is to reduce the sensitivity to harmonics and other frequencies above the power frequency. The instrument should also include a × 10 range obtained by shunting the meter coil by a non-inductive resistor. It is also permitted to include overcurrent protection, provided that the method used does not affect the basic characteristics of the instrument.

R_{V1} is adjusted for the desired value of total resistance at 0,5 mA d.c.

The meter is calibrated at the following calibration points on the maximum sensitivity range at 50 Hz to 60 Hz sinusoidal:

0,25 mA, 0,5 mA, 0,75 mA.

The following response is checked at the 0,5 mA calibration point:

Sensitivity at 5 kHz sinusoidal: 3,6 mA ± 5 %.

Annex E
(normative)
Temperature rise of a winding
(see 1.4.13)

The value of the temperature rise of a winding is calculated from the formula:

for a copper winding

$$\Delta t = \frac{R_2 - R_1}{R_1} (234{,}5 + t_1) - (t_2 - t_1)$$

for an aluminum winding

$$\Delta t = \frac{R_2 - R_1}{R_1} (225 + t_1) - (t_2 - t_1)$$

where

Δt *is the temperature rise, in kelvins;*

R_1 *is the resistance of the winding at the beginning of the test, in ohms;*

R_2 *is the resistance of the winding at the end of the test, in ohms;*

t_1 *is the room temperature at the beginning of the test, in degrees Celsius;*

t_2 *is the room temperature at the end of the test, in degrees Celsius.*

At the beginning of the test, the windings are at room temperature.

It is recommended that the resistance of windings at the end of the test be determined by taking resistance measurements as soon as possible after switching off, and then at short intervals so that a curve of resistance against time can be plotted for ascertaining the resistance at the instant of switching off.

For comparison of winding temperatures determined by the resistance method of this annex with the temperature limits of Table 4B, 25 °C shall be added to the calculated temperature rise.

Annex F
(normative)
Measurement of clearances and creepage distances
(see 2.10 and Annex G)

The methods of measuring CLEARANCES and CREEPAGE DISTANCES that are specified in the following figures are used in interpreting the requirements of this standard.

In the following figures, the value of X is given in Table F.1. Where the distance shown is less than X, the depth of the gap or groove is disregarded when measuring a CREEPAGE DISTANCE.

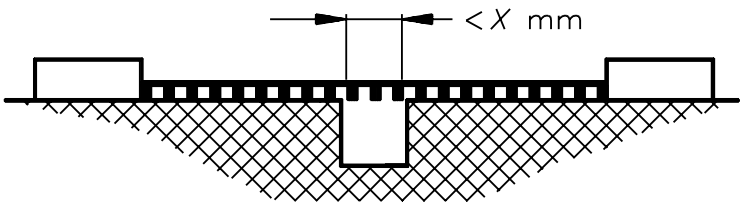
Table F.1 is valid only if the required minimum CLEARANCE is 3 mm or more. If the specified minimum CLEARANCE is less than 3 mm, the value of X is the lesser of:

– the relevant value in Table F.1; or

– one third of the required minimum CLEARANCE.

Table F.1 – Value of X

Pollution degree (see 2.10.1.2)	X mm
1	0,25
2	1,0
3	1,5



Condition: Path under consideration includes a parallel or converging–sided groove of any depth with width less than *X* mm.

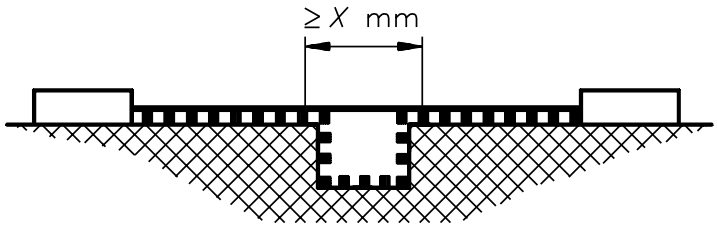
Rule: CLEARANCE and CREEPAGE DISTANCE are measured directly across the groove.

CLEARANCE

CREEPAGE DISTANCE

S4146C

Figure F.1 – Narrow groove



Condition: Path under consideration includes a parallel–sided groove of any depth, and equal to or more than *X* mm wide.

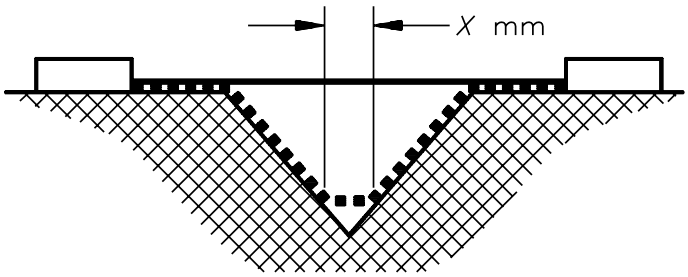
Rule: CLEARANCE is the "line of sight" distance. CREEPAGE DISTANCE path follows the contour of the groove.

CLEARANCE

CREEPAGE DISTANCE

S4147C

Figure F.2 – Wide groove



Condition: Path under consideration includes a V–shaped groove with internal angle of less than 80° and a width greater than *X* mm.

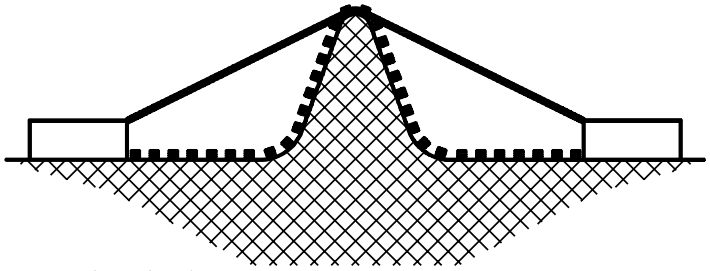
Rule: CLEARANCE is "line of sight" distance. CREEPAGE DISTANCE path follows the contour of the groove but "short circuits" the bottom of the groove by a link X mm long.

CLEARANCE

CREEPAGE DISTANCE

S4148C

Figure F.3 – V-shaped groove



Condition: Path under consideration includes a rib.

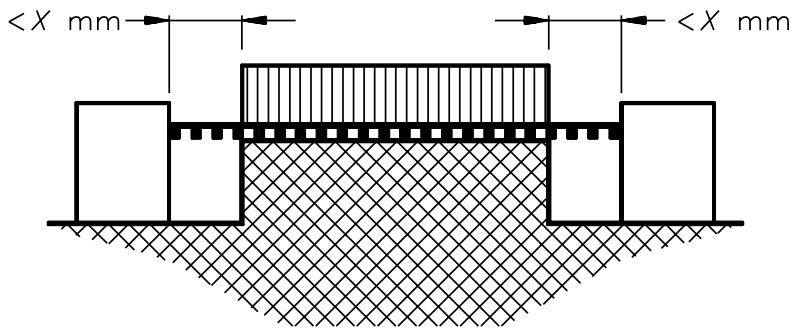
Rule: CLEARANCE is the shortest direct air path over the top of the rib. CREEPAGE DISTANCE path follows the contour of the rib.

CLEARANCE

CREEPAGE DISTANCE

S4149B

Figure F.4 – Rib



Condition: Path under consideration includes an uncemented joint with grooves less than *X* mm wide on either side.

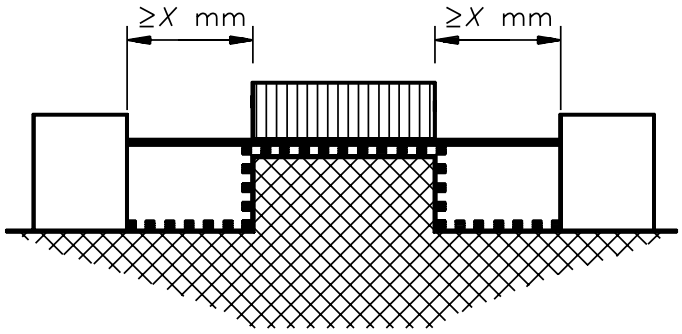
Rule: CLEARANCE and CREEPAGE DISTANCE path is the "line of sight" distance shown.

CLEARANCE

CREEPAGE DISTANCE

S4150C

Figure F.5 – Uncemented joint with narrow groove



Condition: Path under consideration includes an uncemented joint with a groove equal to or more than *X* mm wide each side.

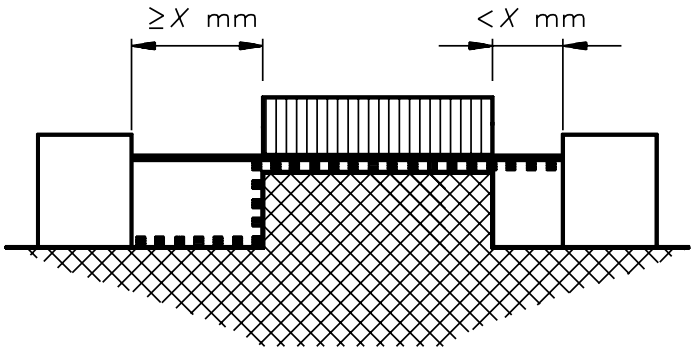
Rule: CLEARANCE is the "line of sight" distance. CREEPAGE DISTANCE path follows the contour of the groove.

CLEARANCE

CREEPAGE DISTANCE

S4151C

Figure F.6 – Uncemented joint with wide groove



Condition: Path under consideration includes an uncemented joint with a groove on one side less than *X* mm wide and a groove on the other equal to or more than *X* mm wide.

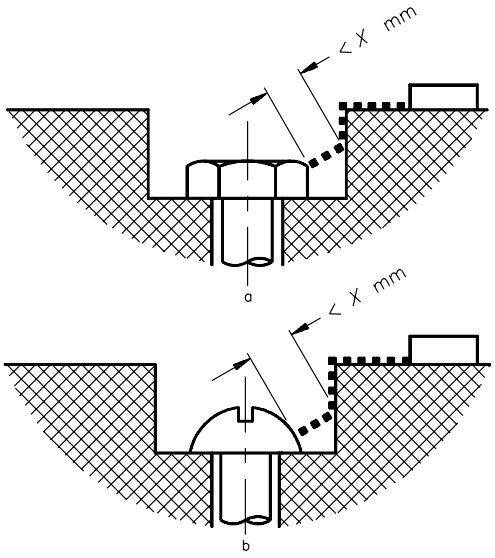
Rule: CLEARANCE and CREEPAGE DISTANCE path are as shown.

CLEARANCE

CREEPAGE DISTANCE

S4152C

Figure F.7 – Uncemented joint with narrow and wide grooves



Gap between head of screw and wall of recess too narrow to be taken into account.

S4153C

Creepage distance

Figure F.8 – Narrow recess

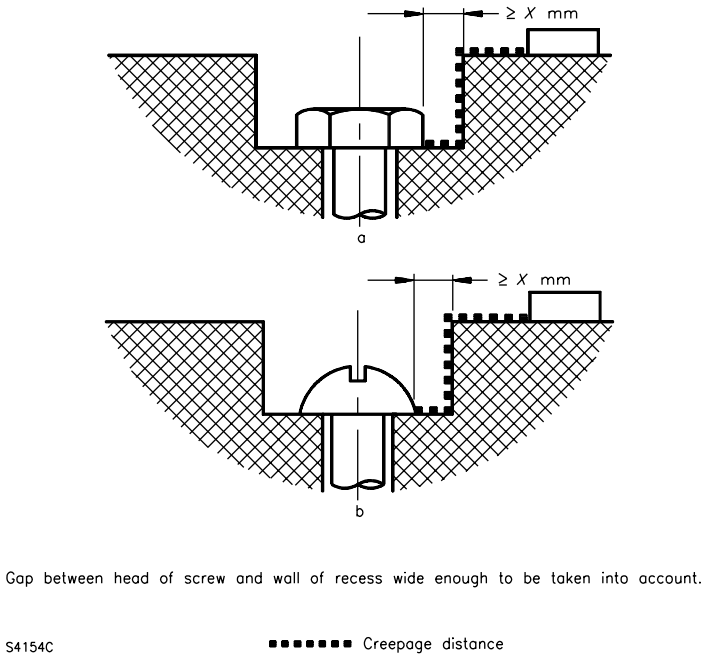


Figure F.9 – Wide recess

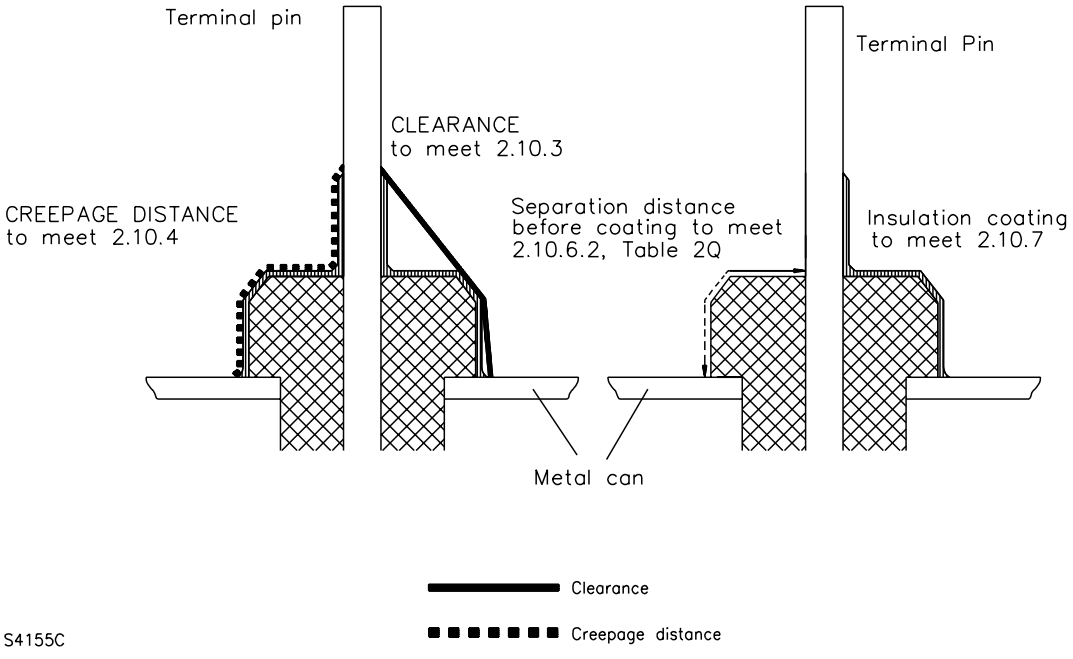


Figure F.10 – Coating around terminals

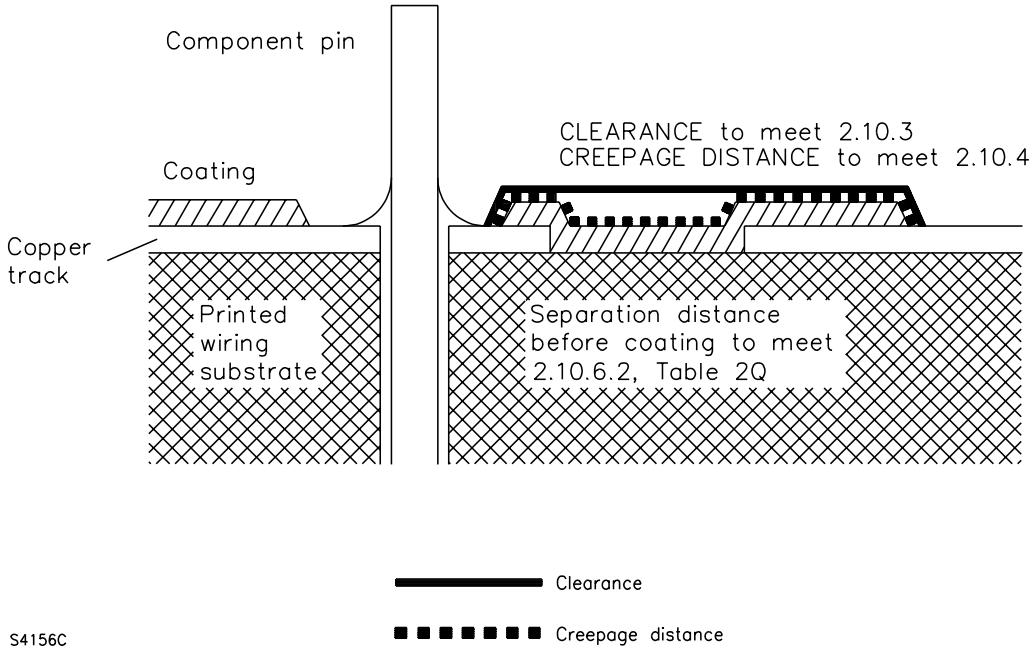
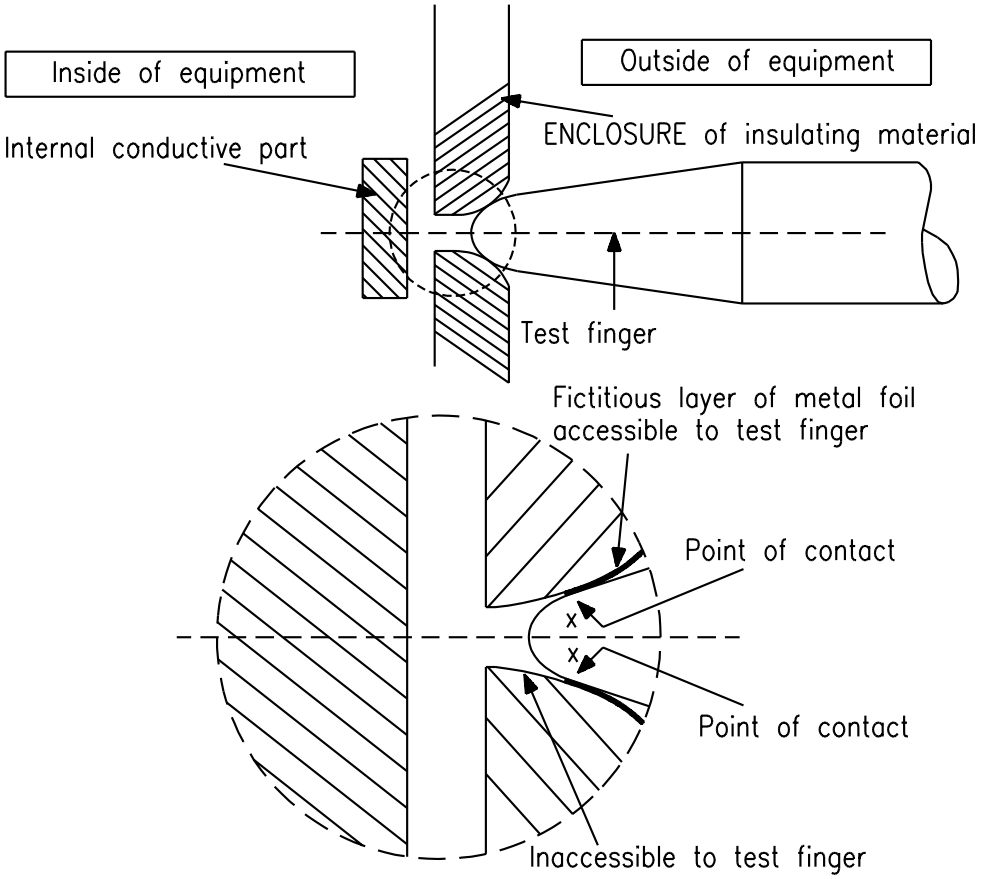


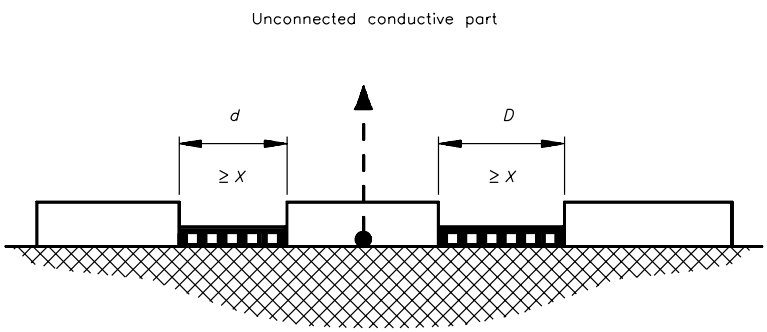
Figure F.11 – Coating over printed wiring



Point X is used for measurements of CLEARANCES and CREEPAGE DISTANCES from the BOUNDING SURFACE of an ENCLOSURE of insulating material to an internal conductive part (see 2.10.3.1 and 2.10.4)

S4932

Figure F.12 – Measurements through openings in enclosures



Condition: Insulation distance with intervening, unconnected conductive part.

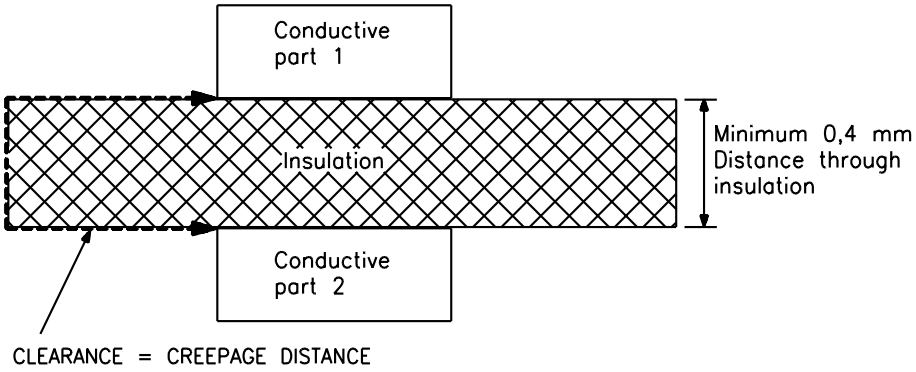
Rule: CLEARANCE is the distance $d + D$.
CREEPAGE DISTANCE is also $d + D$.
Where the value of d or D is smaller than X, it shall be considered as zero.

Clearance

Creepage distance

S4157C

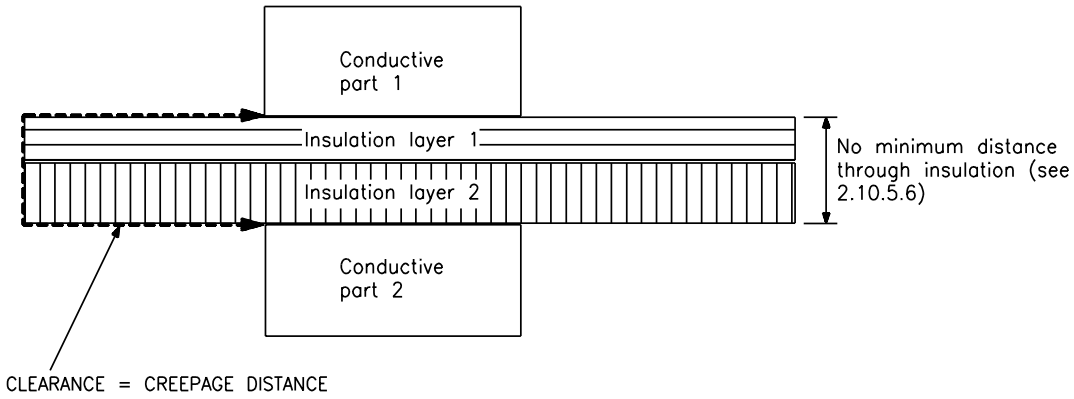
Figure F.13 – Intervening, unconnected conductive part



Thick sheet or solid insulating material as SUPPLEMENTARY INSULATION or REINFORCED INSULATION

S4969A

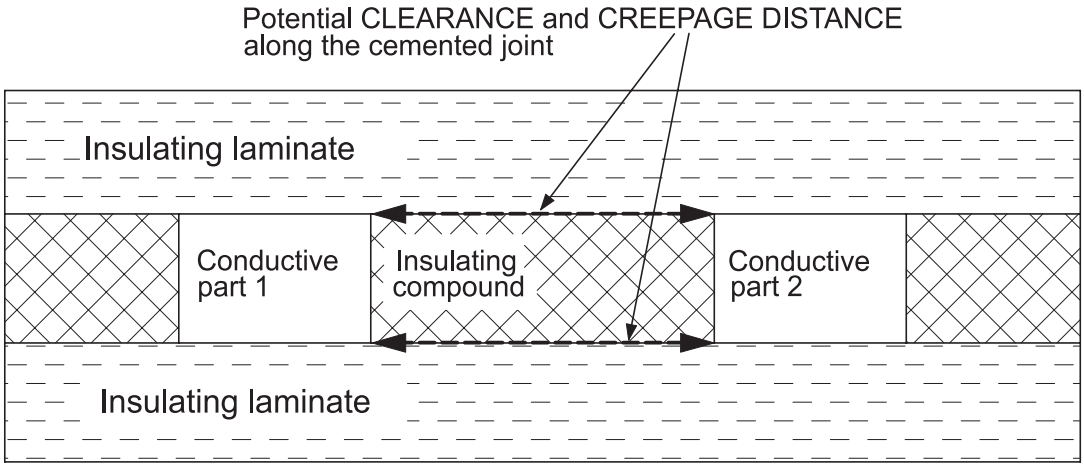
Figure F.14 – Solid insulating material



Two layers of thin sheet material as SUPPLEMENTARY INSULATION or REINFORCED INSULATION

S4970A

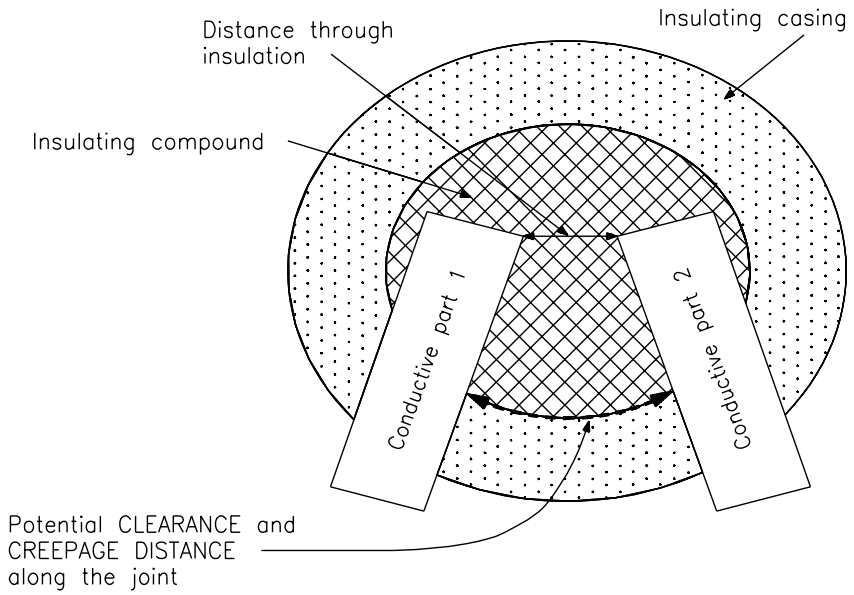
Figure F.15 – Thin sheet insulating material



Insulating compound as SUPPLEMENTARY INSULATION or REINFORCED INSULATION

S4971A

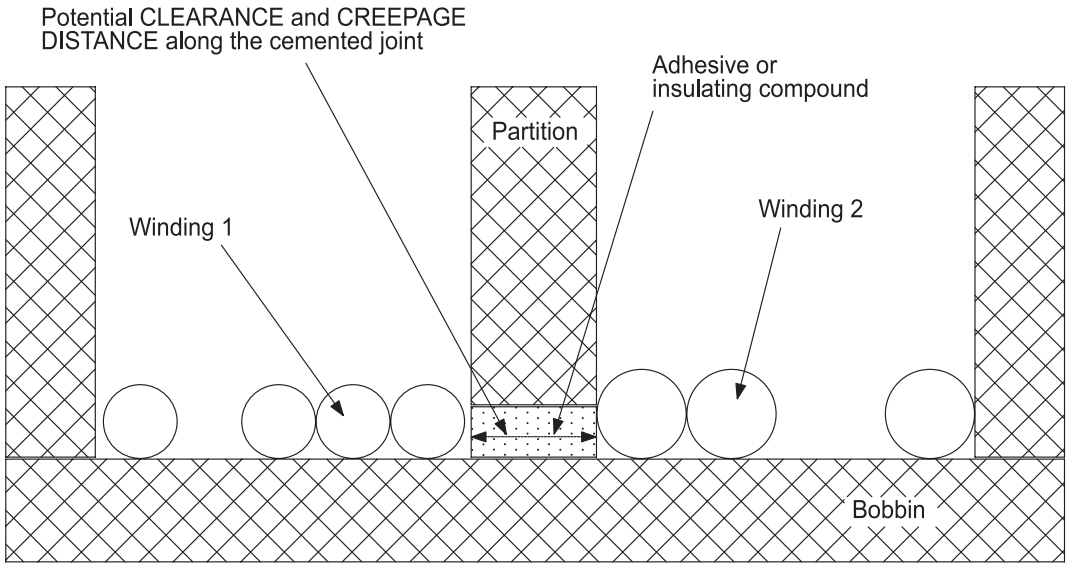
Figure F.16 – Cemented joints in multi-layer printed board



Insulating compound as SUPPLEMENTARY INSULATION or REINFORCED INSULATION inside a component

S4972A

Figure F.17 – Component filled with insulating compound



Cemented joint as SUPPLEMENTARY INSULATION or REINFORCED INSULATION

S4973A

Figure F.18 – Partitioned bobbin

Annex G
(normative)
Alternative method for determining minimum clearances

G.1 Clearances

G.1.1 General

CLEARANCES shall be so dimensioned that overvoltages, including transients, which may enter the equipment, and peak voltages that may be generated within the equipment, do not break down the CLEARANCE.

It is permitted to use either the requirements of 2.10.3 for Overvoltage Category I or Overvoltage Category II, using the PEAK WORKING VOLTAGE, or the requirements in Annex G for Overvoltage Category I, Overvoltage Category II, Overvoltage Category III or Overvoltage Category IV, using the REQUIRED WITHSTAND VOLTAGE, for a particular component or subassembly or for the whole equipment.

NOTE It is considered to be good practice to design SOLID INSULATION for higher transient overvoltages than the associated CLEARANCE.

G.1.2 Summary of the procedure for determining minimum clearances

NOTE 1 The minimum CLEARANCES for FUNCTIONAL INSULATION, BASIC INSULATION, SUPPLEMENTARY INSULATION and REINFORCED INSULATION, whether in a PRIMARY CIRCUIT or another circuit, depend on the REQUIRED WITHSTAND VOLTAGE. The REQUIRED WITHSTAND VOLTAGE depends in turn on the combined effect of the normal operating voltage (including repetitive peaks due to internal circuitry such as switch mode power supplies) and non-repetitive overvoltages due to external transients.

To determine the minimum value for each required CLEARANCE, the following steps shall be used.

(1) Measure the PEAK WORKING VOLTAGE across the CLEARANCE in question.

(2) If the equipment is mains operated:

– determine the MAINS TRANSIENT VOLTAGE (Clause G.2); and

– for equipment to be connected to an AC MAINS SUPPLY, calculate the peak value of the nominal AC MAINS SUPPLY voltage.

(3) Use the rules in G.4.1 and the above voltage values to determine the REQUIRED WITHSTAND VOLTAGE for mains transients and internal repetitive peaks. In the absence of transients coming from a TELECOMMUNICATION NETWORK, go to step 7.

(4) If the equipment is to be connected to a TELECOMMUNICATION NETWORK, determine the TELECOMMUNICATION NETWORK TRANSIENT VOLTAGE (Clause G.3).

(5) Use the TELECOMMUNICATION NETWORK TRANSIENT VOLTAGE and the rules in G.4.2 to determine the REQUIRED WITHSTAND VOLTAGE for TELECOMMUNICATION NETWORK transients. In the absence of mains and internal repetitive peaks, go to step 7.

(6) Use the rule in G.4.3 to determine the total REQUIRED WITHSTAND VOLTAGE.

(7) Use the REQUIRED WITHSTAND VOLTAGE to determine the minimum CLEARANCE (Clause G.6).

NOTE 2 The effect of transients from a CABLE DISTRIBUTION SYSTEM is not taken into account (see G.4.4 and 7.4.1).

G.2 Determination of mains transient voltage

G.2.1 AC mains supply

For equipment to be supplied from the AC MAINS SUPPLY, the value of the MAINS TRANSIENT VOLTAGE depends on the overvoltage category and the AC MAINS SUPPLY voltage. In general, CLEARANCES in equipment intended to be connected to the AC MAINS SUPPLY shall be designed for Overvoltage Category II.

NOTE 1 See Annex Z for further guidance on the determination of overvoltage category.

Equipment that is likely, when installed, to be subjected to transient overvoltages that exceed those for its design Overvoltage Category II, will require additional protection to be provided external to the equipment. In this case, the installation instructions shall state the need for such external protection.

The applicable value of the MAINS TRANSIENT VOLTAGE shall be determined from the overvoltage category and the AC MAINS SUPPLY voltage, using Table G.1.

Table G.1 – AC mains transient voltages

AC MAINS SUPPLY voltage [a] V r.m.s.	MAINS TRANSIENT VOLTAGE [b] V peak			
	Overvoltage Category			
	I	II	III	IV
up to and including 50	330	500	800	1 500
over 50 up to and including 100	500	800	1 500	2 500
over 100 up to and including 150 [c]	800	1 500	2 500	4 000
over 150 up to and including 300 [d]	1 500	2 500	4 000	6 000
over 300 up to and including 600 [e]	2 500	4 000	6 000	8 000

[a] For equipment designed to be connected to a three-phase, three-wire supply, where there is no neutral conductor, the AC MAINS SUPPLY voltage is the line-to-line voltage. In all other cases, where there is a neutral conductor, it is the line-to-neutral voltage.

[b] The MAINS TRANSIENT VOLTAGE is always one of the values in the table. Interpolation is not permitted.

[c] Including 120/208 V or 120/240 V.

[d] Including 230/400 V or 277/480 V.

[e] Including 400/690 V.

NOTE 2 For Japan, the value of the MAINS TRANSIENT VOLTAGES for the nominal AC MAINS SUPPLY voltage of 100 V is determined from the row applicable to an AC MAINS SUPPLY voltage of 150 V.

G.2.2 Earthed d.c. mains supplies

If a DC MAINS SUPPLY is connected to protective earth and is entirely within a single building, the MAINS TRANSIENT VOLTAGE shall be assumed to be 71 V peak. If this connection is within the EUT, it shall be in accordance with 2.6.1 e).

NOTE The connection to protective earth can be at the source of the DC MAINS SUPPLY or at the equipment location, or both (see ITU-T Recommendation K.27).

G.2.3 Unearthed d.c. mains supplies

If a DC MAINS SUPPLY is not earthed and located as in G.2.2, the MAINS TRANSIENT VOLTAGE shall be assumed to be equal to the MAINS TRANSIENT VOLTAGE in the AC MAINS SUPPLY from which the DC MAINS SUPPLY is derived.

G.2.4 Battery operation

If equipment is supplied from a dedicated battery which has no provision for charging from an external MAINS SUPPLY, the MAINS TRANSIENT VOLTAGE shall be assumed to be 71 V peak.

G.3 Determination of telecommunication network transient voltage

If the TELECOMMUNICATION NETWORK TRANSIENT VOLTAGE is known for the TELECOMMUNICATION NETWORK in question, it is permitted to use the known value in G.4.2.

If the TELECOMMUNICATION NETWORK TRANSIENT VOLTAGE is not known, one of the following values shall be used:

– 1 500 V peak if the circuit connected to the TELECOMMUNICATION NETWORK is a TNV-1 CIRCUIT or a TNV-3 CIRCUIT; or

– 800 V peak if the circuit connected to the TELECOMMUNICATION NETWORK is an SELV CIRCUIT or a TNV-2 CIRCUIT.

The effect of a telephone ringing signal is not taken into account for this purpose.

G.4 Determination of required withstand voltage

G.4.1 Mains transients and internal repetitive peaks

In G.4.1, the effect of transients coming from a TELECOMMUNICATION NETWORK is ignored (see G.4.3).

The REQUIRED WITHSTAND VOLTAGE is determined according to Items a), b) or c).

NOTE Items a) and b) apply only for an AC MAINS SUPPLY. Item c) applies only for a DC MAINS SUPPLY.

The following abbreviations are used.

U_{pw} the PEAK WORKING VOLTAGE of the CLEARANCE

$U_{a.c.\ mains\ peak}$ peak value of the AC MAINS SUPPLY voltage in the first column of Table G.1 corresponding to the RATED VOLTAGE or the upper limit of the RATED VOLTAGE RANGE.

$U_{mains\ transient}$ the MAINS TRANSIENT VOLTAGE determined in G.2.1 or G.2.2

$U_{measured}$ the maximum transient voltage from the mains, determined according to G.5 a)

a) PRIMARY CIRCUITS

It is permitted to use a1) or a2).

a1) The following Rules 1) and 2) shall be applied:

Rule 1) If $U_{pw} \leq U_{a.c.\ mains\ peak}$

$$U_{required\ withstand} = U_{mains\ transient.}$$

Rule 2) If $U_{pw} > U_{a.c.\ mains\ peak}$

$$U_{required\ withstand} = U_{mains\ transient} + U_{pw} - U_{a.c.\ mains\ peak.}$$

a2) The above Rules 1) and 2) shall be applied, but $U_{mains\ transient}$ shall be replaced by $U_{measured.}$

b) SECONDARY CIRCUITS whose PRIMARY CIRCUIT is supplied from an AC MAINS SUPPLY

It is permitted to use b1), b2) or b3).

b1) The following Rule 3) shall be applied:

Rule 3) $U_{required\ withstand} = U_{mains\ transient}$ or U_{pw}, whichever is the greater.

b2) The above Rule 3) shall be applied, but with $U_{mains\ transient}$ replaced by $U_{measured.}$

b3) The above Rule 3 shall be applied, but with $U_{mains\ transient}$ replaced by a voltage that is one step smaller in the following list from Table G.1:

330, 500, 800, 1 500, 2 500, 4 000, 6 000 and 8 000 V peak.

This is permitted in the following cases:

– a SECONDARY CIRCUIT, derived from an AC MAINS SUPPLY, that is connected to the main protective earthing terminal in accordance with 2.6.1 e);

– a SECONDARY CIRCUIT, derived from an AC MAINS SUPPLY and separated from the PRIMARY CIRCUIT by a metal screen that is connected to the main protective earthing terminal in accordance with 2.6.1 e).

c) SECONDARY CIRCUIT supplied from a DC MAINS SUPPLY

The above b1) or b3) shall be applied.

G.4.2 Transients from telecommunication networks

In G.4.2, the effect of transients coming from the mains and from internal circuitry is ignored (see G.4.3).

For transients from a TELECOMMUNICATION NETWORK, the REQUIRED WITHSTAND VOLTAGE is:

– the TELECOMMUNICATION NETWORK TRANSIENT VOLTAGE determined in Clause G.3;

– or the value measured in accordance with G.5 b);

whichever is less.

G.4.3 Combination of transients

If the transients described in G.4.1 and those described in G.4.2 affect the same CLEARANCE, the REQUIRED WITHSTAND VOLTAGE is the larger of the two voltages. The two values shall not be added together.

G.4.4 Transients from cable distribution systems

The effect of transients from a CABLE DISTRIBUTION SYSTEM is not taken into account when determining REQUIRED WITHSTAND VOLTAGE (however, see 7.4.1).

G.5 Measurement of transient voltage levels

The following tests are conducted only if it is required to determine whether or not the maximum transient voltage across the CLEARANCE *in any circuit is lower than the* MAINS TRANSIENT VOLTAGE *determined in Clause G.2 (for example, due to the effect of a filter in the equipment). If these tests are not conducted, the maximum transient voltage across the* CLEARANCE *shall be assumed to be equal to the* MAINS TRANSIENT VOLTAGE*. If the situation covered by G.2.2 or the situation covered by G.2.4 applies, the transient voltage across the* CLEARANCE *shall be assumed to be negligible and no test is conducted.*

If necessary, the transient voltage across the CLEARANCE *is measured using the following test procedure.*

During the tests, the EUT is connected to its separate power supply unit, if any, but is not connected to the MAINS SUPPLY*, nor to any* TELECOMMUNICATION NETWORKS*, and any surge suppressors in* PRIMARY CIRCUITS *are disconnected.*

A voltage measuring device is connected across the CLEARANCE *in question.*

***a) Transients from a* MAINS SUPPLY**

To measure the transient voltages across a CLEARANCE *due to transients on a* MAINS SUPPLY*, the impulse test generator reference 2 of Table N.1 is used to generate 1,2/50 µs impulses. U_C is equal to the* MAINS TRANSIENT VOLTAGE *determined in Clause G.2.*

Three to six impulses of alternating polarity, with intervals of at least 1 s between impulses, are applied between each of the following points where relevant:

For an* AC MAINS SUPPLY*:

– *line-to-line;*

– *all line conductors conductively joined together and neutral;*

– *all line conductors conductively joined together and the main protective earthing terminal;*

– *neutral and the main protective earthing terminal.*

For a* DC MAINS SUPPLY*:

– *the positive and negative supply connection points;*

– *all supply connection points conductively joined together and the main protective earthing terminal.*

***b) Transients from a* TELECOMMUNICATION NETWORK**

To measure the transient voltage across a CLEARANCE *due to transients on a* TELECOMMUNICATION NETWORK*, the impulse test generator reference 1 of Table N.1 is used to generate 10/700 µs impulses. U_C is equal to the* TELECOMMUNICATION NETWORK TRANSIENT VOLTAGE *determined in Clause G.3.*

Three to six impulses of alternating polarity, with intervals of at least 1 s between impulses, are applied between each of the following TELECOMMUNICATION NETWORK *connection points of each interface type:*

– *each pair of terminals (for example, A and B or tip and ring) in an interface;*

– *all terminals of a single interface joined together and earth.*

Where there are several identical circuits, only one is tested.

G.6 Determination of minimum clearances

For equipment to be operated up to 2 000 m above sea level, each CLEARANCE shall comply with the minimum dimensions given in Table G.2, using the value of REQUIRED WITHSTAND VOLTAGE determined according to G.4.

For equipment to be operated at more than 2 000 m above sea level, the minimum CLEARANCES shall be multiplied by the factor given in Table A.2 of IEC 60664-1. Linear interpolation is permitted between the nearest two points in Table A.2. The calculated minimum CLEARANCE using this multiplication factor shall be rounded up to the next higher 0,1 mm increment.

The specified minimum CLEARANCES are subject to the following absolute minimum values:

– 10 mm for an air gap serving as REINFORCED INSULATION between a part at HAZARDOUS VOLTAGE and an accessible conductive part of the ENCLOSURE of floor-standing equipment or of the non-vertical top surface of desk-top equipment;

– 2 mm for an air gap serving as BASIC INSULATION between a part at HAZARDOUS VOLTAGE and an earthed accessible conductive part of the ENCLOSURE of PLUGGABLE EQUIPMENT TYPE A.

The above two dashed paragraphs do not apply between a part at a HAZARDOUS VOLTAGE and a BOUNDING SURFACE.

Except as required by 2.8.7.1 the specified minimum CLEARANCES do not apply to the air gap between the contacts of THERMOSTATS, THERMAL CUT-OUTS, overload protection devices, switches of microgap construction and similar components where the air gap varies with the contacts.

NOTE 1 For air gaps between contacts of disconnect devices, see 3.4.2. For air gaps between the contacts of interlock switches, see 2.8.7.1.

The CLEARANCES between the BOUNDING SURFACE of a connector and conductive parts within the connector that are connected to a HAZARDOUS VOLTAGE shall comply with the requirements for REINFORCED INSULATION. As an exception, for connectors that are

– fixed to the equipment; and

– located internal to the outer ENCLOSURE of the equipment; and

– only accessible after removal of a USER-replaceable sub-assembly that is required to be in place during normal operation,

these CLEARANCES shall comply with the requirements for BASIC INSULATION.

NOTE 2 The tests of 2.1.1.1 for access to hazardous parts apply to such connectors after removal of the subassembly.

For all other CLEARANCES in connectors, including connectors that are not fixed to the equipment, the minimum values specified in Table G.2 apply.

The above minimum CLEARANCES for connectors do not apply to connectors that comply with a standard harmonized with IEC 60083, IEC 60309, IEC 60320, IEC 60906-1 or IEC 60906-2. See also 1.5.2.

Table G.2 – Minimum clearances for up to 2 000 m above sea level

CLEARANCES in mm

REQUIRED WITHSTAND VOLTAGE	FUNCTIONAL INSULATION [a]			BASIC INSULATION and SUPPLEMENTARY INSULATION			REINFORCED INSULATION		
V peak or d.c. up to and including	Pollution degree								
	1 [b]	2	3	1 [b]	2	3	1 [b]	2	3
400	0,1	0,2	0,8	0,2 (0,1)	0,2	0,8	0,4 (0,2)	0,4	1,6
800	0,1	0,2	0,8	0,2 (0,1)	0,2	0,8	0,4 (0,2)	0,4	1,6
1 000	0,2	0,2	0,8	0,3 (0,2)		0,8	0,6 (0,4)		1,6
1 200	0,3		0,8	0,4 (0,3)		0,8	0,8 (0,6)		1,6
1 500	0,5		0,8	0,8 (0,5)		0,8	1,6 (1,0)		1,6
2 000	1,0			1,3 (1,0)			2,6 (2,0)		
2 500	1,5			2,0 (1,5)			4,0 (3,0)		
3 000	2,0			2,6 (2,0)			5,2 (4,0)		
4 000	3,0			4,0 (3,0)			6,0		
6 000	5,5			7,5 (5,5)			11		
8 000	8,0			11 (8,0)			16		
10 000	11			15 (11)			22		
12 000	14			19 (14)			28		
15 000	18			24 (18)			36		
25 000	33			44 (33)			66		
40 000	60			80 (60)			120		
50 000	75			100 (75)			150		
60 000	90			120 (90)			180		
80 000	130			173 (130)			260		
100 000	170			227 (170)			340		

Linear interpolation is permitted between the nearest two points, the calculated minimum CLEARANCES being rounded up to the next higher 0,1 mm increment.

The values in parentheses apply only if manufacturing is subjected to a quality control programme that provides at least the same level of assurance as the example given in Clause R.2. DOUBLE INSULATION and REINFORCED INSULATION shall be subjected to ROUTINE TESTS for electric strength.

In a SECONDARY CIRCUIT, a minimum CLEARANCE of 5 mm replaces any higher value, provided that the insulation involved passes an electric strength test according to 5.2.2 using:

– an a.c. test voltage whose r.m.s. value is 106 % of the PEAK WORKING VOLTAGE (peak value 150 % of the PEAK WORKING VOLTAGE), or

– a d.c. test voltage equal to 150 % of the PEAK WORKING VOLTAGE.

If the CLEARANCE path is partly along the surface of insulation that is not Material Group I, the test voltage is applied across the air gap and the Material Group I only. The part of the path along the surface of any other insulating material is bypassed.

[a] There is no minimum CLEARANCE for FUNCTIONAL INSULATION unless it is required by 5.3.4 a).

[b] It is permitted to use the values for Pollution Degree 1 if one sample passes the tests of 2.10.10.

Compliance is checked by measurement, taking into account Annex F. The following conditions apply

– movable parts shall be placed in the most unfavourable position;

– for equipment incorporating ordinary NON-DETACHABLE POWER SUPPLY CORDS, CLEARANCE measurements are made with supply conductors of the largest cross-sectional area specified in 3.3.4, and also without conductors;

NOTE 3 The force tests of 4.2.2, 4.2.3 and 4.2.4 apply.

– when measuring CLEARANCES from the BOUNDING SURFACE of an ENCLOSURE of insulating material through a slot or opening in the ENCLOSURE, or through an opening in an accessible connector, the accessible surface shall be considered to be conductive as if it were covered by metal foil wherever it can be touched by the test finger, Figure 2A (see 2.1.1.1), applied without appreciable force (see Figure F.12, point X).

There is no need to conduct an electric strength test to verify CLEARANCES except as required in Table G.2 if a minimum 5 mm CLEARANCE is used.

Annex H

NAE

(normative)

Ionizing radiation

(see 4.3.13)

Equipment that might produce ionizing radiation is checked by measuring the amount of radiation.

The amount of radiation is determined by means of a radiation monitor of the ionizing chamber type with an effective area of 1 000 mm^2 or by measuring equipment of other types giving equivalent results.

Measurements are made with the equipment on test operating at the most unfavourable supply voltage (see 1.4.5) and with OPERATOR *controls and service controls adjusted so as to give maximum radiation whilst maintaining the equipment operative for normal use.*

Internal preset controls not intended to be adjusted during the lifetime of the equipment are not considered to be service controls.

At any point 50 mm from the surface of the OPERATOR ACCESS AREA *the dose-rate shall not exceed 36 pA/kg (5 µSv/h) (0,5 mR/h) (see Note 1). Account is taken of the background level.*

NOTE 1 This value is consistent with ICRP 60.

NOTE 2 In the member countries of CENELEC, the amount of ionizing radiation is regulated by European Council Directive 96/29/Euratom of 13 May 1996. This directive requires that at any point 10 cm from the surface of the equipment, the dose-rate shall not exceed 1 µSv/h (0,1 mR/h) taking account of the background level.

Annex J
(normative)
Table of electrochemical potentials (see 2.6.5.6)

Table J.1 – Electrochemical potentials (V)

	Magnesium, magnesium alloys	Zinc, zinc alloys	80 tin/20 Zn on steel, Zn on iron or steel	Aluminium	Cd on steel	Al/Mg alloy	Mild steel	Duralumin	Lead	Cr on steel, soft solder	Cr on Ni on steel, tin on steel, 12 % Cr stainless steel	High Cr stainless steel	Copper, copper alloys	Silver solder, Austenitic stainless steel	Ni on steel	Silver	Rh on Ag on Cu, silver/gold alloy	Carbon	Gold, platinum
Gold, platinum	1,75	1,25	1,2	1,05	0,95	0,9	0,85	0,75	0,7	0,65	0,6	0,5	0,4	0,35	0,3	0,15	0,1	0,5	0
Carbon	1,7	1,2	1,15	1,0	0,9	0,85	0,8	0,7	0,66	0,6	0,55	0,45	0,35	0,3	0,25	0,1	0,05	0	
Rh on Ag on Cu, silver/gold alloy	1,65	1,15	1,1	0,95	0,85	0.8	0,75	0,65	0,6	0,55	0,5	0,4	0,3	0,25	0,2	0,5	0		
Silver	1,6	1,1	1,05	0,9	0,8	0,75	0,7	0,6	0,55	0,5	0,45	0,35	0,25	0,2	0,15	0			
Ni on steel	1,45	0,95	0,9	0,75	0,65	0,6	0,55	0,45	0,4	0,35	0,3	0,2	0,1	0,15	0				
Silver solder, Austenitic stainless steel	1,4	0,9	0,85	0,7	0,6	0,55	0,5	0,4	0,35	0,3	0,25	0,15	0,05	0					
Copper, copper alloys	1,35	0,85	0,8	0,65	0,55	0,5	0,45	0,35	0,3	0,25	0,2	0,1	0						
High Cr stainless steel	1,25	0,75	0,7	0,55	0,45	0,4	0,35	0,25	0,2	0,15	0,1	0							
Cr on Ni on steel, tin on steel, 12 % Cr stainless steel	1,15	0,65	0,6	0,45	0,35	0,3	0,25	0,15	0,1	0,05	0								
Cr on steel, soft solder	1,1	0,6	0,5	0,4	0,3	0,2	0,2	0,1	0,5	0									
Lead	1,05	0,55	0,5	0,35	0,25	0,2	0,15	0,05	0										
Duralumin	1,0	0,5	0,45	0,3	0,2	0,15	0,1	0											
Mild steel	0,9	0,4	0,35	0,2	0,1	0,05	0												
Al/Mg alloy	0,85	0,35	0,3	0,15	0,05	0													
Cd on steel	0,8	0,3	0,25	0,1	0														
Aluminium	0,7	0,2	0,15	0															
80 tin/20 Zn on steel, Zn on iron or steel	0,55	0,05	0																
Zinc, zinc alloys	0,5	0																	
Magnesium, magnesium alloys	0																		

Ag Silver
Al Aluminium
Cd Cadmium
Cr Chromium
Cu Copper
Mg Magnesium
Ni Nickel
Rh Rhodium
Zn Zinc

NOTE - Corrosion due to electrochemical action between dissimilar metals that are in contact is minimized if the combined electrochemical potential is below about 0.6 V. In the table the combined electrochemical potentials are listed for a number of pairs of metals in common use; combinations above the dividing line should be avoided.

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Annex K
(normative)
Thermal controls
(see 1.5.3 and 5.3.8)

K.1 Making and breaking capacity

THERMOSTATS and TEMPERATURE LIMITERS shall have adequate making and breaking capacity.

Compliance is checked by subjecting three samples either to the tests of Clauses K.2 and K.3, or to the tests of K.4, as appropriate. If the component is T-marked, one sample is tested with the switch part at room temperature, and two samples with the switch part at a temperature in accordance with the marking.

Components not marked with individual ratings are tested either in the equipment or separately, whichever is more convenient, but, if tested separately, the test conditions are to be similar to those occurring in the equipment.

During the tests, no sustained arcing shall occur.

After the tests, the samples shall show no damage impairing their further use. Electrical connections shall not have worked loose. The component shall withstand an electric strength test as specified in 5.2.2, except that the test voltage for the insulation between the contacts is twice the voltage applied when the equipment is operated at RATED VOLTAGE or at the upper voltage of the RATED VOLTAGE RANGE.

For test purposes the switching frequency can be increased above the normal switching frequency inherent to the equipment, provided that no greater risk of failure is induced.

If it is not possible to test the component separately, three samples of the equipment in which it is used are tested.

K.2 Thermostat reliability

THERMOSTATS are caused, thermally, to perform 200 cycles of operation (200 makes and 200 breaks) when the equipment is operated at a voltage equal to 110 % of the RATED VOLTAGE or to 110 % of the upper voltage of the RATED VOLTAGE RANGE, and under NORMAL LOAD.

K.3 Thermostat endurance test

THERMOSTATS are caused, thermally, to perform 10 000 cycles of operation (10 000 makes and 10 000 breaks) when the equipment is operated at RATED VOLTAGE or at the upper voltage of the RATED VOLTAGE RANGE, and under NORMAL LOAD.

K.4 Temperature limiter endurance

TEMPERATURE LIMITERS are caused, thermally, to perform 1 000 cycles of operation (1 000 makes and 1 000 breaks) when the equipment is operated at RATED VOLTAGE, or at the upper voltage of the RATED VOLTAGE RANGE, and under NORMAL LOAD.

K.5 Thermal cut-out reliability

THERMAL CUT-OUTS shall operate reliably.

Compliance is checked while the equipment is operating under the conditions specified in 4.5.2.

AUTOMATIC RESET THERMAL CUT-OUTS are caused to operate 200 times; MANUAL RESET THERMAL CUT-OUTS are reset after each operation and thus caused to operate ten times.

After the tests, the samples shall show no damage impairing their further use.

Forced cooling and resting periods are permitted to prevent damage to the equipment.

K.6 Stability of operation

THERMOSTATS, TEMPERATURE LIMITERS and THERMAL CUT-OUTS shall be so constructed that their setting is not changed appreciably by heating, vibration, etc., occurring in normal use.

Compliance is checked by inspection during the abnormal operation tests of 5.3.

Annex L
(normative)
Normal load conditions for some types of electrical business equipment
(see 1.2.2.1 and 4.5.2)

L.1 Typewriters

Typewriters are energized with no load applied until steady conditions are established. Manually keyed machines are then operated at a rate of 200 characters per minute, with a line transport operation after each 60 characters including spaces, until steady conditions are established. Automatically operated machines are operated at the maximum typing speed recommended in the manufacturer's instruction sheet.

L.2 Adding machines and cash registers

For adding machines and cash registers, four digit numbers are entered or set and the repeat key or operating bar activated 24 times per minute, until steady conditions are established, the four digit number to be used being that which loads the machine most heavily. If the cash register has a drawer which opens every time an item is rung up, the cash register is operated at a rate of 15 operation cycles per minute, the drawer being shut after each operation, until steady conditions are established. For an adding machine or cash register, an operation consists of the OPERATOR *setting or inserting the figures with which the machine is to operate and then pressing the operating bar, repeating key or the like for each operation.*

L.3 Erasers

Erasers are operated continuously at no load for 1 h.

L.4 Pencil sharpeners

For a pencil sharpener, five new pencils are each sharpened eight times according to the following timetable. Except for new pencils, the point is broken off before each sharpening.

Sharpening period	*4 s*	*for a new pencil*
	2 s	*for subsequent sharpenings*
Interval between sharpenings	*6 s*	
Interval between pencils	*60 s*	

All times are approximate.

L.5 Duplicators and copy machines

Duplicators and copy machines are operated continuously at maximum speed until steady conditions are established. It is permitted to introduce a rest period of 3 min after each 500 copies if this is compatible with the design of the machine.

L.6 Motor-operated files

Motor-operated files are loaded to simulate a condition of unbalance caused by uneven distribution of the contents. During operation, the unbalanced load is moved approximately one-third of the total carrier travel of the path that will impose maximum loading during each operation. The operation is repeated each 15 s until steady conditions are established.

A load caused by the non-uniform distribution of the contents is permitted to be simulated as follows.

In the case of vertical transport, three-eighths of the filing area are to be loaded, without leaving clearances, with three-eighths of the admissible load. The entire transport way is to be travelled with this load. The transport cycle is to be repeated, at intervals of 10 s, until the temperature has stabilized.

In the case of a different transport, for example horizontal or circular mode of transport, the total load is moved over the whole transport way. The transport cycle is to be repeated, at intervals of 15 s, until the temperature has stabilized.

L.7 Other business equipment

Other business equipment is operated according to the most unfavourable way of operation given in the operating instructions.

Annex M
(normative)
Criteria for telephone ringing and other signals DE
(see 2.3.1)

M.1 Introduction

The two alternative methods described in this annex reflect satisfactory experience in different parts of the world. Method A is typical of analogue telephone networks in Europe, and Method B of those in North America. The two methods result in standards of electrical safety that are broadly equivalent.

M.2 Method A

This method requires that the currents I_{TS1} and I_{TS2} flowing through a 5 000 Ω resistor, between any two conductors or between one conductor and earth do not exceed the limits specified, as follows.

a) For normal operation, I_{TS1}, the current determined from the calculated or measured current for any single active ringing period t_1 (as defined in Figure M.1), does not exceed:

1) for cadenced ringing ($t_1 < \infty$), the current given by the curve of Figure M.2 at t_1;

2) for continuous ringing ($t_1 = \infty$), 16 mA.

Continuous ringing signals shall: D2

• be located in SERVICE ACCESS AREAS; D2

• be so located and guarded that unintentional contact with such parts is D2
unlikely during service operations, or be provided with a marking to warn D2
SERVICE PERSONNEL of the presence of continuous ringing signals; and D2

• not become OPERATOR accessible under single fault conditions. D2

I_{TS1}, in mA, is as given by

$$I_{TS1} = \frac{I_p}{\sqrt{2}} \quad for \quad (t_1 \leq 600\ ms)$$

$$I_{TS1} = \frac{t_1 - 600}{600} \times \frac{I_{pp}}{2\sqrt{2}} + \frac{1\ 200 - t_1}{600} \times \frac{I_p}{\sqrt{2}} \quad for\ (600\ ms < t_1 < 1\ 200\ ms)$$

$$I_{TS1} = \frac{I_{pp}}{2\sqrt{2}} \quad for\ (t_1 \geq 1\ 200\ ms)$$

where:

I_P is the peak current, in mA, of the relevant waveform given in Figure M.3;

I_{pp} is the peak-to-peak current, in mA, of the relevant waveform given in Figure M.3;

t_1 is expressed in ms.

b) For normal operation, I_{TS2}, the average current for repeated bursts of a cadenced ringing signal calculated for one ringing cadence cycle t_2 (as defined in Figure M.1), does not exceed 16 mA r.m.s.

I_{TS2} in mA is as given by:

$$I_{TS2} = \left[\frac{t_1}{t_2} \times I_{TS1}^2 + \frac{t_2 - t_1}{t_2} \times \frac{I_{dc}^2}{3{,}75^2} \right]^{1/2}$$

where:

I_{TS1} in mA, is as given by item a) of Clause M.2;

I_{dc} is the d.c. current in mA flowing through the 5 000 Ω resistor during the non-active period of the cadence cycle;

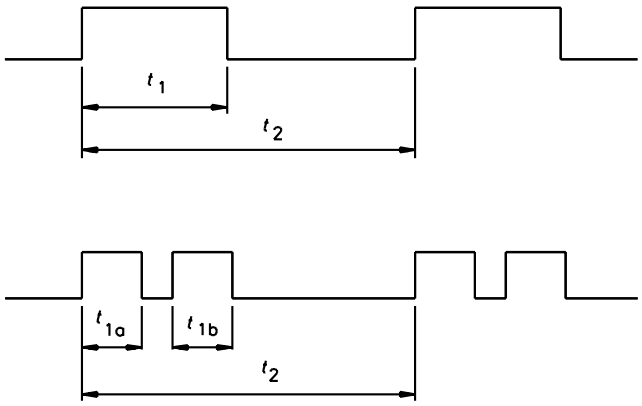
t_1 and t_2 are expressed in milliseconds.

NOTE The frequencies of telephone ringing voltages are normally within the range of 14 Hz to 50 Hz.

c) Under single fault conditions, including where cadenced ringing becomes continuous:

– I_{TS1} shall not exceed the current given by the curve of Figure M.2, or 20 mA, whichever is greater;

– I_{TS2} shall not exceed a limit of 20 mA.



t_1 is:

- *the duration of a single ringing period, where the ringing is active for the whole of the single ringing period;*
- *the sum of the active periods of ringing within the single ringing period, where the single ringing period contains two or more discrete active periods of ringing, as in the example shown, for which $t_1 = t_{1a} + t_{1b}$;*

t_2 is the duration of one complete cadence cycle.

Figure M.1 – Definition of ringing period and cadence cycle

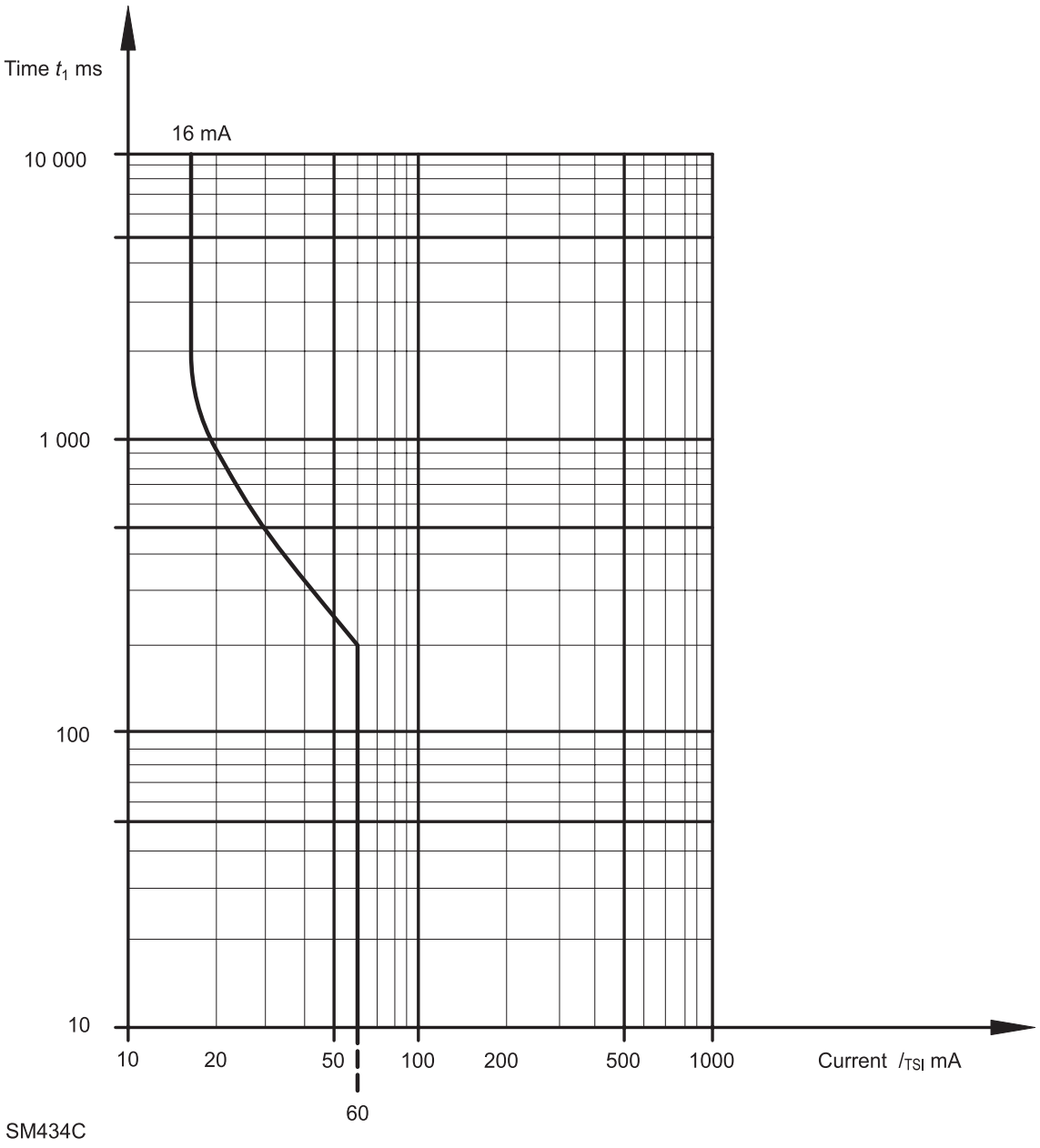


Figure M.2 – I_{TS1} limit curve for cadenced ringing signal

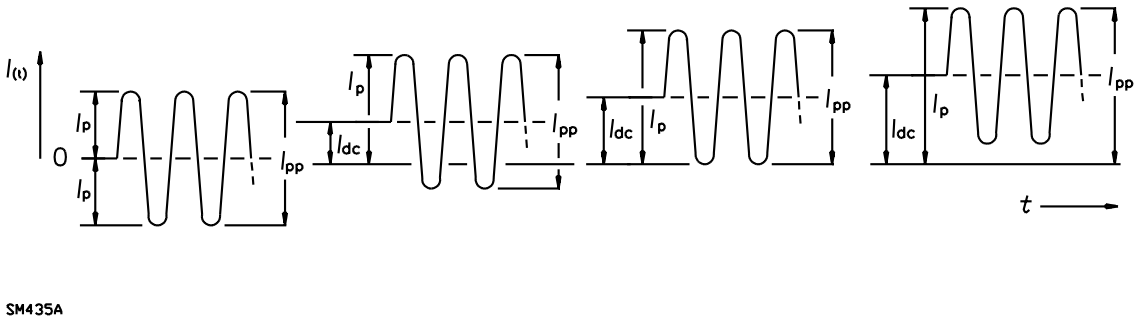


Figure M.3 – Peak and peak-to-peak currents

M.3 Method B

NOTE This method is aligned with USA CFR 47 (″FCC Rules″) Part 68, Sub-part D, with additional requirements that apply under fault conditions.

M.3.1 Ringing signal

M.3.1.1 Frequency

The ringing signal shall use only frequencies whose fundamental component is equal to or less than 70 Hz.

M.3.1.2 Voltage

The ringing voltage shall be less than 300 V peak-to-peak and less than 200 V peak with respect to earth, measured across a resistance of at least 1 MΩ.

M.3.1.3 Cadence

The ringing voltage shall be interrupted to create quiet intervals of at least 1 s duration separated by no more than 5 s. During the quiet intervals, the voltage to earth shall not exceed 60 V d.c.

M.3.1.4 Single fault current

Where cadenced ringing becomes continuous as a consequence of a single fault, the current through a 5 000 Ω resistor connected between any two output conductors or between one output conductor and earth shall not exceed 56,5 mA peak-to-peak, as shown in Figure M.3.

M.3.2 Tripping device and monitoring voltage

M.3.2.1 Conditions for use of a tripping device or a monitoring voltage

A ringing signal circuit shall include a tripping device as specified in M.3.2.2, or provide a monitoring voltage as specified in M.3.2.3, or both, depending on the current through a specified resistance connected between the ringing signal generator and earth, as follows:

– if the current through any resistor of 500 Ω or greater, does not exceed 100 mA peak-to-peak, neither a tripping device nor a monitoring voltage is required;

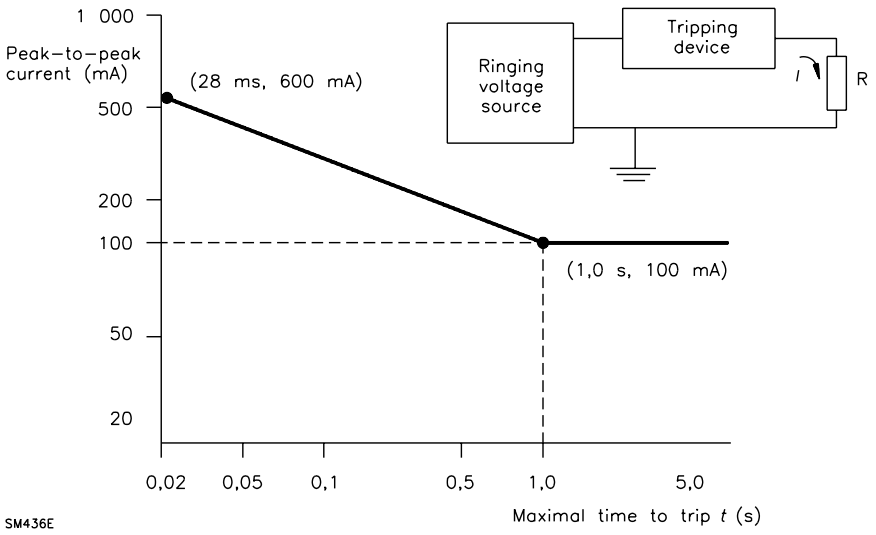
– if the current through any resistor of 1 500 Ω or greater, exceeds 100 mA peak-to-peak, a tripping device shall be included. If the tripping device meets the trip criteria specified in Figure M.4 with any resistor of R = 500 Ω or greater, no monitoring voltage is required. If, however, the tripping device only meets the trip criteria with any resistor of R = 1 500 Ω or greater, a monitoring voltage shall also be provided;

– if the current through any resistor of 500 Ω or greater, exceeds 100 mA peak-to-peak, but the current through any resistor of 1 500 Ω or greater, does not exceed this value, either:

- a tripping device shall be provided, meeting the trip criteria specified in Figure M.4 with any resistor of R = 500 Ω or greater, or
- a monitoring voltage shall be provided.

NOTE 1 Tripping devices are, in general, current-sensitive and do not have a linear response, due to the resistance/current characteristics and time delay/response factor in their design.

NOTE 2 In order to minimize testing time, a variable resistor box should be used.



NOTE 1 *t* is measured from the time of connection of the resistor R to the circuit.

NOTE 2 The sloping part of the curve is defined as $I = 100/\sqrt{t}$.

Figure M.4 – Ringing voltage trip criteria

M.3.2.2 Tripping device

A series current-sensitive tripping device in the ringlead that will trip ringing as specified in Figure M.4.

M.3.2.3 Monitoring voltage

A voltage to earth on the tip or ring conductor with a magnitude of at least 19 V peak, but not exceeding 60 V d.c., whenever the ringing voltage is not present (idle state).

M.4 Other telecommunication signals D2

Telecommunication signaling systems (e.g., some message waiting systems) using voltages or current, or both, greater than those specified in 2.3.1 shall be permitted if they comply with the following: D2

NOTE 1 A part may rely on different requirements for different time intervals. D2

NOTE 2 These requirements are based on small area contact; parts are not grippable. D2

– continuous signal: For a signal of duration greater than 5 s, the current through the measuring instrument shown in Figure D.1 shall be not greater than 7.1 mA peak a.c., or 30 mA d.c., or the limit shown in Figure M.5 for combinations of a.c. and d.c., when measured in accordance with Annex D. D2

– intermittent signal: For a signal of duration less than 5 s, the current through the measuring instrument of Figure D.1 shall be not greater than the limit specified in Figure M.6. The signal shall be followed by a quiet interval of at least 1 s before the next intermittent signal. During the quiet interval, either the voltage is less than 56,6 V d.c., or the current measured is less than 0,5 mA. D2

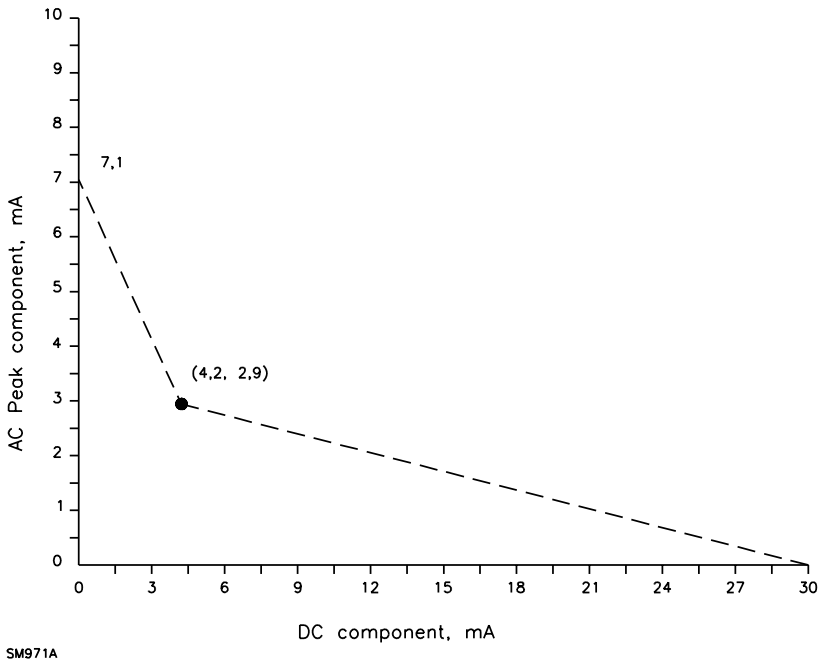


Figure M.5 – Maximum a.c. and d.c. current of less than 100 Hz D2

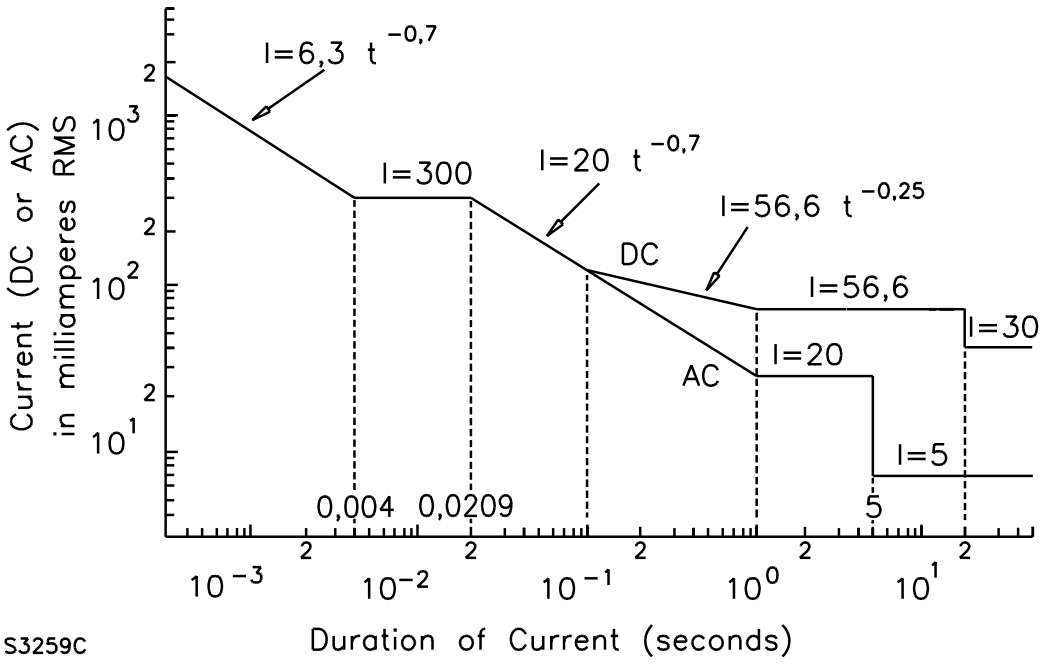


Figure M.6 – Maximum current as a function of duration

Annex N
(normative)
Impulse test generators
(see 1.5.7.2, 1.5.7.3, 2.10.3.9, 6.2.2.1, 7.4.2, 7.4.3 and Clause G.5)

NOTE Extreme care is necessary when using these test generators due to the high electric charge stored in the capacitor C1.

N.1 ITU-T impulse test generators

The circuit in Figure N.1, using the component values in references 1 and 2 of Table N.1, is used to generate impulses, the C_1 capacitor being charged initially to a voltage U_c

Circuit reference 1 of Table N.1 generates 10/700 µs impulses (10 µs virtual front time, 700 µs virtual time to half value) as specified in ITU-T Recommendation K.44 to simulate lightning interference in the TELECOMMUNICATION NETWORK.

Circuit reference 2 of Table N.1 generates 1,2/50 µs impulses (1,2 µs virtual front time, 50 µs virtual time to half value) as specified in ITU-T Recommendation K.44 to simulate transients in power distribution systems.

The impulse wave shapes are under open-circuit conditions and can be different under load conditions.

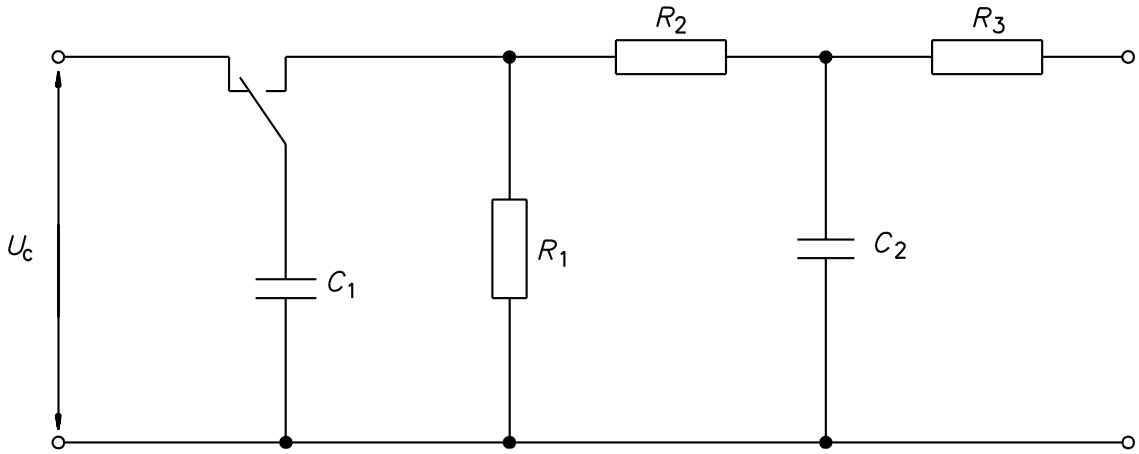


Figure N.1 – ITU-T impulse test generator circuit

N.2 IEC 60065 impulse test generator

The circuit in Figure N.2, using the component values reference 3 in Table N.1, is used to generate impulses, the C_1 capacitor being charged initially to a voltage U_c. The switch used in Figure N.2 is a critical part of the circuit. See 10.1 of IEC 60065, for further information.

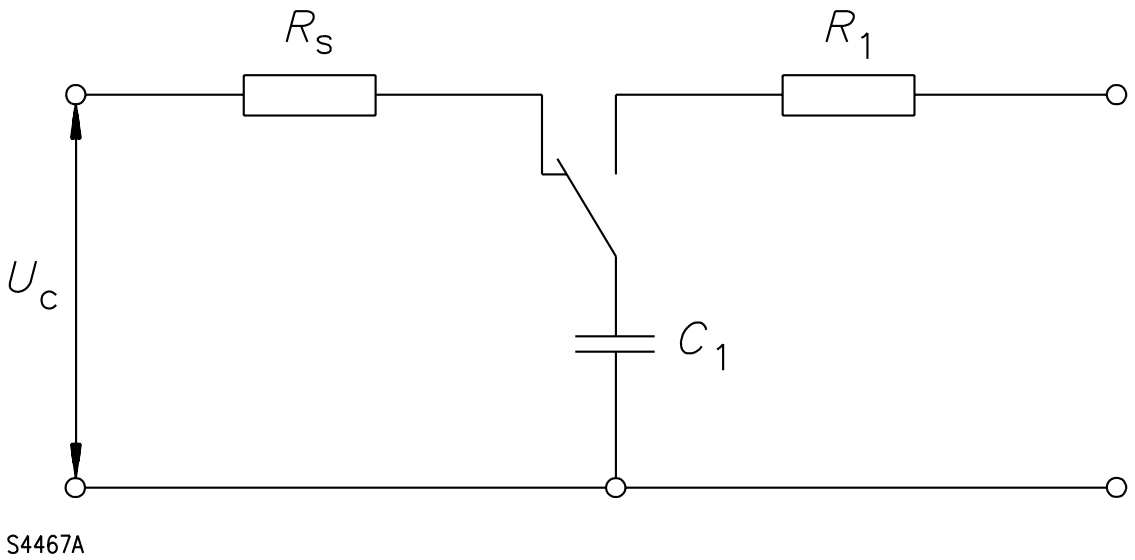


Figure N.2 – IEC 60065 impulse test generator circuit

Table N.1 – Component values for Figures N.1 and N.2

Reference	Test impulse	Figure	C_1	C_2	R_1	R_2	R_3	R_s	See
1 [a]	10/700 µs	N.1	20 µF	0,2 µF	50 Ω	15 Ω	25 Ω	–	1.5.7.3, 2.10.3.9, 6.2.2.1, 7.4.3 and item b) of Clause G.5
2 [b]	1,2/50 µs	N.1	1 µF	30 nF	76 Ω	13 Ω	25 Ω	–	1.5.7.2, 2.10.3.9 and item a) of Clause G.5
3 [c]	–	N.2	1 nF	–	1 kΩ	–	–	15 MΩ	1.5.7.3 and 7.4.2

[a] Reference 1 impulse is typical of voltages induced into telephone wires and coaxial cables in long outdoor cable runs by nearby lightning strikes to earth.

[b] Reference 2 impulse is typical of earth potential rises caused by either lightning strikes to power lines or by power line faults.

Table N.1 – Component values for Figures N.1 and N.2 Continued on Next Page

Table N.1 – Component values for Figures N.1 and N.2 Continued

Reference	Test impulse	Figure	C_1	C_2	R_1	R_2	R_3	R_s	See
[c] Reference 3 impulse is typical of voltages induced into antenna system wiring caused by nearby lightning strikes to earth.									

Annex P
(normative)
Normative references

The following reference documents are indispensable for the application of this standard. If the date of the reference document is given, only that edition applies, excluding any subsequent corrigenda and amendments. For undated references, the latest edition of the referenced document applies, including any corrigenda and amendments.

Further information on the reference documents, including how to obtain copies, can be found on the following internet sites:

http://www.iec.ch

http://www.iso.org

http://www.itu.int

For the locations in the standard where these documents are mentioned, see the Index.

IEC 60065:2001, *Audio, video and similar electronic apparatus – Safety requirements* Amendment 1 [2)]

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60073, *Basic and safety principles for man-machine interface, marking and identification – Coding principles for indication devices and actuators*

IEC 60083, *Plugs and socket-outlets for domestic and similar general use standardized in member countries of IEC*

IEC 60085:2004, *Electrical insulation – Thermal classification*

IEC 60112, *Method for determination of the proof and the comparative tracking indices of insulating materials*

IEC 60216-4-1, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 4: Ageing ovens – Section 1: Single-chamber ovens*

IEC 60227 (all parts), *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V*

IEC 60245 (all parts), *Rubber insulated cables – Rated voltages up to and including 450/750V*

IEC 60309 (all parts), *Plugs, socket-outlets and couplers for industrial purposes*

IEC 60317 (all parts), *Specifications for particular types of winding wires*

IEC 60317-43, *Specifications for particular types of winding wires – Part 43: Aromatic polyimide tape wrapped round copper wire, class 240*

IEC 60320 (all parts), *Appliance couplers for household and similar general purposes*

IEC 60364-1:2001, *Electrical installations of buildings – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60384-14:1993, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*
Amendment 1 (1995)

IEC 60417-DB:2002[3)], *Graphical symbols for use on equipment*

IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*[4)]
Amendment 1 (2000) Amendment 2 (2002)

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

IEC 60695-2-20, *Fire hazard testing – Part 2-20: Glowing/hot wire based test methods – Hotwire coil ignitability – Apparatus, test method and guidance*

IEC 60695-10-2, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test*

IEC 60695-11-3, *Fire hazard testing – Part 11-3: Test flames – 500 W flames: Apparatus and confirmational test methods*

IEC 60695-11-4, *Fire hazard testing – Part 11-4: Test flames – 50 W flames – Apparatus and confirmational test methods*

IEC 60695-11-5:2004, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60695-11-20, *Fire hazard testing – Part 11-20: Test flames – 500 W flame test methods*

IEC 60730-1:1999, *Automatic electrical controls for household and similar use – Part 1: General requirements*[5)]
Amendment 1 (2003)

IEC 60747-5-5, ____[6)], *Discrete semiconductor devices – Part 5-5: Optoelectronic devices – Photocouplers, optocouplers*

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification, requirements and user's guide*

IEC 60825-2, *Safety of laser products – Part 2: Safety of optical fibre communication systems*

IEC 60825-9, *Safety of laser products – Part 9: Compilation of maximum permissible exposure to incoherent optical radiation*

IEC 60825-12, *Safety of laser products – Part 12: Safety of free space optical communication systems used for transmission of information*

IEC 60851-3:1996, *Winding wires – Test methods – Part 3: Mechanical properties*[7)]
Amendment 1 (1997)

IEC 60851-5:1996, *Winding wires – Test methods – Part 5: Electrical properties*[8)]
Amendment 1 (1997) Amendment 2 (2004)

IEC 60851-6:1996, *Winding wires – Test methods – Part 6: Thermal properties*

IEC 60885-1:1987, *Electrical test methods for electric cables – Part 1: Electrical tests for cables, cords and wires for voltages up to and including 450/750 V*

IEC 60906-1, *IEC system of plugs and socket-outlets for household and similar purposes – Part 1: Plugs and socket-outlets 16 A 250 V a.c.*

IEC 60906-2, *IEC system of plugs and socket-outlets for household and similar purposes – Part 2: Plugs and socket-outlets 15 A 125 V a.c.*

IEC 60947-1:2004, *Low voltage switchgear and control gear – Part 1: General rules*

IEC 60990:1999, *Methods of measurement of touch current and protective conductor current*

IEC 61051-2:1991, *Varistors for use in electronic equipment – Part 2: Sectional specification for surge suppression varistors*

IEC 61058-1:2000, *Switches for appliances – Part 1: General requirements*

ISO 178, *Plastics – Determination of flexural properties*

ISO 179 (all parts), *Plastics – Determination of Charpy impact properties*

ISO 180, *Plastics – Determination of Izod impact strength*

ISO 261, *ISO General-purpose metric screw threads – General plan*

ISO 262, *ISO General-purpose metric screw threads – Selected sizes for screws, bolts and nuts*

ISO 527 (all parts), *Plastics – Determination of tensile properties*

ISO 3864 (all parts), *Graphical symbols – Safety colours and safety signs*

ISO 4892-1, *Plastics – Methods of exposure to laboratory light sources – Part 1: General guidance*

ISO 4892-2, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc sources*

ISO 4892-4, *Plastics, Methods of exposure to laboratory light sources – Part 4: Open-flame carbon-arc lamps*

ISO 7000-DB:2004[9)], *Graphical symbols for use on equipment – Index and synopsis*

ISO 8256, *Plastics – Determination of tensile-impact strength*

ISO 9772, *Cellular plastics – Determination of horizontal burning characteristics of small specimens subjected to a small flame*

ISO 9773, *Plastics – Determination of burning behaviour of thin flexible vertical specimens in contact with a small-flame ignition source*

ITU-T Recommendation K.44, *Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation*

ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials* DE

ASTM E 162, *Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source* DE DE

Code of Federal Regulations (CFR), Title 21, Part 1040, *Performance Standards for Light-Emitting Products* DE DE

CSA C22.1, *Canadian Electrical Code, Part I* DE

CSA C22.2 No. 0, *General Requirements – Canadian Electrical Code, Part II* DE

CSA C22.2 No. 0.4, *Bonding of Electrical Equipment* DE

CSA C22.2 No. 0.15, *Adhesive Labels* DE

CSA C22.2 No. 31, *Switchgear Assemblies* DE

CSA C22.2 No. 94, *Special Purpose Enclosures* DE

CSA C22.2 No. 226, *Protectors in Telecommunication Networks* DE

CSA C22.2 No. 233, *Cords and Cord Sets for Communication Systems* DE

CSA CAN3-C235, *Preferred Voltage Levels for AC Systems, 0 to 50,000 V* DE

CSA E60825-1, *Safety of laser products – Part 1: Equipment classification, requirements and user's guide* DE DE

IEEE C2, *National Electrical Safety Code* DE

IEEE 269-2002, *Standard Methods for Measuring Transmission Performance of Analog and Digital Telephone Sets, Handsets, and Headsets* DE DE

IEEE 487, *Recommended Practice for the Protection of Wire-Line Communication Facilities Serving Electric Power Locations* DE DE

NFPA 70, *National Electrical Code* DE

NFPA 75, *Standard for the Protection of Information Technology Equipment* DE

REDR C1370, *Canadian Radiation Emitting Devices Act* DE

UL 50 , *Enclosures for Electrical Equipment* DE

UL 497 , *Protectors for Paired Conductor Communications Circuits* DE

UL 497A , *Secondary Protectors for Communications Circuits* DE

UL 723 , *Test for Surface Burning Characteristics of Building Materials* DE

UL 891 , *Switchboards* DE

UL 969 , *Marking and Labeling Systems* DE

UL 1863 , *Communications-Circuit Accessories* DE

UL 2043 , *Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces* DE
DE

[2] To be published.

[3] "DB" refers to the IEC on-line database.

[4] A consolidated edition 1.2 exists, including IEC 60664-1:1992 and its Amendments 1 (2000) and 2 (2002).

[5] A consolidated edition 3.1 exists, including IEC 60730-1:1999 and its Amendment 1 (2003).

[6] To be published.

[7] A consolidated edition 2.1 exists, including IEC 60851-3:1996 and its Amendment 1 (1997).

[8] A consolidated edition 3.2 exists, including IEC 60851-5:1996 and its Amendments 1 (1997) and 2 (2004).

[9] "DB" refers to the IEC and ISO on-line database.

P.1 UL and CSA Component Requirements (mandatory) DC

Annex P.1 DC

NOTE 1 The complete text of Annex P.1 is a DC national difference. DC

NOTE 2 Please note that underlining to indicate text added to IEC 60950-1 is not used in this portion of Annex P. DC

All IEC component standard requirements in this standard are replaced by the relevant requirements of CSA and UL component standards as listed in this annex. DC DC

Products that are determined to comply with Clauses 1 – 7 and applicable annexes of this standard are considered to comply with UL and CSA requirements, except that some components will require additional evaluation to determine compliance with IEC 60950-1 requirements. DC DC DC DC

Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard. DC DC

If no standard is listed, requirements are assumed to be those in IEC 60950-1. DC

The following components shall comply with the requirements specified below. All IEC standard requirements in this standard are either replaced or modified, as noted, by the relevant requirements of either CSA or UL or both component standards as listed in this annex. DC DC DC

Annex P.1 DC

Subclause from this standard	Component type	UL standard	CSA standard	IEC publication (shall be replaced by UL and/or CSA Standard)
1.1.2, 4.2, Annex T *	Enclosures for electrical equipment	UL 50 *Enclosures for Electrical Equipment*	CAN/CSA-C22.2 No. 94 *Special Purpose Enclosures*	
1.1.3 *	Uninterruptible power supplies	UL 1778 *Uninterruptible Power Systems*	CSA C22.2 No. 107.1 *General Use Power Supplies*, or CAN/CSA C22.2 No. 107.3 *Uninterruptible Power Supply Equipment*	
1.5.2 *	Edison-base lampholders	UL 496 *Lampholders*	CSA C22.2 No. 43 *Lampholders*	
1.5.2 *	Ground-fault circuit-interrupters	UL 943 *Ground-Fault Circuit-Interrupters*	CAN/CSA C22.2 No. 144 *Ground Fault Circuit Interrupters*	
1.5.2 **	Surge suppressors, except varistors or MOVs (See P.2 (1.5.9)	UL 1449 *Transient Voltage Surge Suppressors*	Certification Notice No. 516 (Where the surge suppressor is relied upon to achieve Overvoltage Category 1, UL 1449 requirements apply)	
1.5.2	Printed-wiring boards	UL 796 *Printed-Wiring Boards*		

Annex P.1 Continued on Next Page

Annex P.1 Continued

DC

Subclause from this standard	Component type	UL standard	CSA standard	IEC publication (shall be replaced by UL and/or CSA Standard)
1.5.5	Interconnecting cables (non LPS, 3,05 m or less)	UL 758 *Appliance Wiring Material*	CAN/CSA C22.2 No. 210 *Appliance Wiring Material Products*	
2.7 *	Circuit breakers	UL 489 *Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures*	CSA C22.2 No. 5 *Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures*	
2.7 *	Fuseholders	UL 512 *Fuseholders*	CSA C22.2 No. 39 *Fuseholder Assemblies*	
2.7 *	Fuses (branch circuit applications)	UL 248-1 *Low-Voltage Fuses – Part 1: General Requirements* UL 248-4 *Low-Voltage Fuses – Part 4: Class CC Fuses* UL 248-5 *Class G Fuses* UL 248-8 *Low-Voltage Fuses – Part 8: Class J Fuses* UL 248-10 *Low-Voltage Fuses – Part 10: Class L Fuses* UL 248-12 *Low-Voltage Fuses – Part 12: Class R Fuses* UL 248-15 *Low-Voltage Fuses – Part 15: Class T Fuses*	CSA C22.2 No. 248 *Series Low-Voltage Fuses* CSA C22.2 No. 248.1 *Low-Voltage Fuses – Part 1: General Requirements* CSA C22.2 No. 248.4 *Low-Voltage Fuses – Part 4: Class CC Fuses* CSA C22.2 No. 248.5 *Low-Voltage Fuses – Part 5: Class G Fuses* CSA C22.2 No. 248.8 *Low-Voltage Fuses – Part 8: Class J Fuses* CSA C22.2 No. 248.10 *Low-Voltage Fuses – Part 10: Class L Fuses* CSA C22.2 No. 248.12 *Low-Voltage Fuses – Part 12: Class R Fuses* CSA C22.2 No. 248.15 *Low-Voltage Fuses – Part 15: Class T Fuses*	IEC 60127-1 *Miniature fuses – Part 1: definitions for miniature fuses and general requirements for miniature fuse-links.*
2.7 *	Supplementary protectors	UL 1077 *Supplementary Protectors for Use in Electrical Equipment*	CAN/CSA C22.2 No. 235 *Supplementary Protectors*	
2.8.4 *	Solid-state controls	UL 244A *Solid-State Controls for Appliances*	CSA C22.2 No. 156 *Solid-State Speed Controls*	
2.8.7 *	Limit controls	UL 353 *Limit Controls*	CSA C22.2 No. 24 *Temperature-Indicating and Regulating Equipment*	

Annex P.1 Continued on Next Page

Annex P.1 Continued

DC

Subclause from this standard	Component type	UL standard	CSA standard	IEC publication (shall be replaced by UL and/or CSA Standard)
2.8.7, 3.4	Switches	UL 20 *General-Use Snap Switches* UL 917 *Clock-Operated Switches* UL 1054 *Special-Use Switches* UL 61058-1 *Switches for Appliances – Part 1: General Requirements*	CSA C22.2 No. 55 *Special Use Switches* CSA C22.2 No. 111 *General-Use Snap Switches* CAN/CSA C22.2 No. 177 *Clock-Operated Switches* CAN/CSA C22.2 No. 61058-1 *Switches for Appliances – Part 1: General Requirements*	IEC 61058-1: *Switches for Appliances – Part 1: General Requirements*
2.9.1 *	Insulating tubing	UL 224 *Extruded Insulating Tubing*	CSA C22.2 No. 198.1 *Extruded Insulating Tubing*	
2.9.1 **	Insulating tape	UL 510 *Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape*	CSA C22.2 No. 197 *PVC Insulating Tape* (For other than PVC tape, UL 510 applies)	
2.10.5.4, Annex U *	Insulated transformer winding wiring (supplements requirements in 2.10.5.4/Annex U)	UL 2353 *Single- and Multi-layer Insulated Winding Wire*	CAN/CSA C22.2 No. 210 *Appliance Wiring Material Products*	
3.1 *	Wires and cables	UL 44 *Thermoset-Insulated Wires and Cables* UL 83 *Thermoplastic-Insulated Wires and Cables* UL 758 *Appliance Wiring Material*	CSA C22.2 No. 35 *Extra-Low-Voltage Control Circuit Cables, Low-Energy Control Cable, and Extra-Low Voltage Control Cable* CSA C22.2 No. 127 *Equipment and Lead Wires* CAN/CSA C22.2 No. 210.2 *Appliance Wiring Material Products*	
3.2.4, 3.2.5, 4.3.6 *	Attachment plugs, receptacles, and connectors	UL 498 *Attachment Plugs and Receptacles* UL 1682 *Plugs, Receptacles, and Cable Connectors, of the Pin and Sleeve Type*	CSA C22.2 No. 42 *General Use Receptacles, Attachment Plugs, and Similar Wiring Devices* CSA C22.2 No. 182.1 *Plugs, Receptacles, and Connectors of the Pin and Sleeve Type* CSA C22.2 No. 182.2 *Industrial Locking Type, Special Use Attachment Plugs, Receptacles, and Connectors* CSA C22.2 No. 182.3 *Special Use Attachment Plugs, Receptacles, and Connectors*	IEC 60083: 1997 *Plugs and socket-outlets for domestic and similar general use* IEC 60309: 1988, 1989 *Plugs, socket-outlets and couplers for industrial purposes* IEC 60320: 1981 *Appliance couplers for household and similar general purposes*

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Annex P.1 Continued

DC

Subclause from this standard	Component type	UL standard	CSA standard	IEC publication (shall be replaced by UL and/or CSA Standard)
3.2.5 *	Cord sets and power supply cords	UL 817 *Cord Sets and Power-Supply Cords ("solid green" protective earthing conductor acceptable)*	CSA C22.2 No. 21 *Cord Sets and Power Supply Cords ("solid green" protective earthing conductor acceptable)*	
3.2.5 *	Flexible cords and cables	UL 62 *Flexible Cord and Fixture Wire*	CSA C22.2 No. 49 *Flexible Cords and Cables* CAN/CSA C22.2 No. 96 *Portable Power Cables*	IEC 60227: 1979 *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V* IEC 60245: 1980, 1985 *Rubber insulated cables of rated voltages up to and including 450/750 V* IEC 60885-1: 1987 *Electrical test methods for electric cables. Part 1: Electrical tests for cables, cords, and wires for voltages up to and including 450/750 V*
3.2.5, 4.3.6 *	Direct plug-in units	See 4.3.6		
3.3 *	Wire connectors (for field wiring)	UL 486A-486B *Wire Connectors* UL 486E *Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors*	CSA C22.2 No. 65 *Wire Connectors*	
3.4	Industrial control equipment	UL 508 *Industrial Control Equipment*	CSA C22.2 No. 14 *Industrial Control Equipment*	
3.4, 2.8.7 *	Switches	See 2.8.7		
4.2,1.1.2, Annex T *	Enclosures for electrical equipment	See 1.1.2		
4.3.5 *	Connectors (used for current interruption in non-LPS circuits)	UL 1977 *Component Connectors for Use in Data, Signal, Control and Power Applications (current interruption requirements)*	CSA C22.2 No. 182.3 *Special Use Attachment Plugs, Receptacles, and Connectors (current interruption requirements)*	
4.3.6, 3.2.5 *	Direct plug-in units	UL 1310 *Class 2 Power Units* (Mechanical Assembly Requirements Only)	CAN/CSA C22.2 No. 223 *Power Supplies With Extra-Low-Voltage Class 2 Outputs* (Mechanical Assembly Requirements Only)	

Annex P.1 Continued on Next Page

Annex P.1 Continued

DC

Subclause from this standard	Component type	UL standard	CSA standard	IEC publication (shall be replaced by UL and/or CSA Standard)
4.3.6, 3.2.5, 3.2.5 *	Attachment plugs, receptacles, and connectors	See 3.2.4		
4.3.8	Secondary (Rechargeable) Battery Packs (used with Transportable Equipment)	UL 2054 *Household and Commercial Batteries*		
4.7.3.1 *	Enclosure materials (large surface areas)	UL 723 *Test for Surface Burning Characteristics of Building Materials*	CAN/CSA C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials*	
4.7.3.1	Enclosure materials (environmental air space)	UL 2043 *Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces*		
5.3.7 *	Thermal cutoffs	UL 60691 *Thermal-Links – Requirements and Application Guide*	CSA C22.2 No. 209 *Thermal Cut-Offs*	
5.3.7 *	Thermostats	UL 873 *Temperature-Indicating and -Regulating Equipment*	CSA C22.2 No. 24 *Temperature-Indicating and Regulating Equipment*	
6.4 *	Communication circuit protectors and accessories	UL 497 *Protectors for Paired Conductor Communications Circuits* UL 497A *Secondary Protectors for Communications Circuits* UL 497B *Protectors for Data Communications and Fire Alarm Circuits* UL 1863 *Communications-Circuit Accessories*	CAN/CSA C22.2 No. 182.4 *Plugs, Receptacles, and Connectors for Communication Systems* CAN/CSA C22.2 No. 226 *Protectors in Telecommunication Networks* CAN/CSA C22.2 No. 233 *Cords and Cord Sets for Communication Systems*	
Annex T, 1.1.2, 4.2	Enclosures for electrical equipment	See 1.1.2		
Annex U, 2.10.5.4	Insulated transformer winding wiring	See 2.10.5.4		
* Indicates UL, CSA or both standards having requirements providing equivalent levels of safety within the meaning of this standard. Requirements of either UL or CSA standard may be used.				
** Standards are equivalent except under conditions specified in parentheses in the table.				

DC
DC
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P.2 UL and CSA Component Requirements (alternative) DC

Annex P.2 DC

NOTE 1 The complete text of Annex P.2 is a DC national difference. DC

NOTE 2 Please note that underlining to indicate text added to IEC 60950-1 is not used in this portion of Annex P. DC

All IEC component standard requirements in this standard are replaced by the relevant requirements of CSA and UL component standards as listed in this annex. DC DC

Products that are determined to comply with Clauses 1 – 7 and applicable annexes of this standard are considered to comply with UL and CSA requirements, except that some components will require additional evaluation to determine compliance with IEC 60950-1 requirements. DC DC DC DC

Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard. DC DC

If no standard is listed, requirements are assumed to be those in IEC 60950-1. DC

In the U.S. and Canada, any of the following components that comply with either the specified UL or CSA standards are considered as an acceptable alternative to the referenced IEC component standard and comply with the requirements of this standard. DC DC DC

Annex P.2 DC

Subclause from this standard	Component type	UL standard	CSA standard	IEC publication (may be replaced by UL or CSA Standard)
1.2.12.2, 1.2.12.3, 1.2.12.4 †	Plastic materials V-0, V-1, V-2	UL 94 *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*	CAN/CSA C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials*	IEC 60695-11-10:1999 *, Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*
1.2.12.5, 1.2.12.6 †	Plastic materials 5VA, 5VB	UL 94 *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*	CAN/CSA C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials*	IEC 60695-11-20:1999 *, Fire hazard testing – Part 11-20: Test flames – 500 W flame test methods*
1.2.12.7, 1.2.12.8, 1.2.12.9 †	Plastic materials HF-1, HF-2, HBF	UL 94 *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*	CAN/CSA C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials*	ISO 9772:1994, *Cellular plastics – Determination of horizontal burning characteristics of small specimens subjected to a small flame*
1.2.12.10, 1.2.12.11 †	Plastic materials HB40, HB75	UL 94 *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*	CAN/CSA C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials*	IEC 60695-11-10:1999, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

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Subclause from this standard	Component type	UL standard	CSA standard	IEC publication (may be replaced by UL or CSA Standard)
1.2.12.12, 1.2.12.13, 1.2.12.14 †	Plastic materials VTM-0, VTM-1, VTM-2	UL 94 *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*	CAN/CSA C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials*	ISO 9773:1998, *Plastics – Determination of burning behaviour of thin flexible vertical specimens in contact with a small-flame ignition source*
1.5.2 †	Battery chargers	UL 1236 *Battery Chargers for Charging Engine-Starter Batteries*	CAN/CSA C22.2 No. 107.2 *Battery Chargers*	
1.5.2	Connectors	UL 1977 *Component Connectors for Use in Data, Signal, Control and Power Applications*	CSA C22.2 No. 182.3 *Special Use Attachment Plugs, Receptacles and Connectors*	
1.5.2	EMI filters	UL 1283 *Electromagnetic Interference Filters*	CSA C22.2 No. 8 *Electromagnetic Interference (EMI) Filters*	
1.5.2	Motor construction	UL 1004 *Electric Motors* UL 507 *Electric Fans*	CSA C22.2 No. 100 *Motors and Generators* CSA C22.2 No. 113 *Fans and Ventilators*	
1.5.2 †	Power supplies	UL 60950-1 *Information Technology Equipment – Safety – Part 1: General Requirements* First Edition UL 1310 *Class 2 Power Units*	CAN/CSA C22.2 No. 60950-1 *Information Technology Equipment – Safety – Part 1: General Requirements* First Edition CAN/CSA C22.2 No. 223 *Power Supplies with Extra-Low-Voltage Class 2 Outputs* (Direct plug-ins, with a mounting tab, are not acceptable)	
1.5.4, 5.3.3	Transformers	UL 1585 *Class 2 and Class 3 Transformers*	CSA C22.2 No. 66 *Specialty Transformers*	
1.5.5	Interconnecting cables (LPS, 3,05 m or less)	UL 758 *Appliance Wiring Material*	CAN/CSA C22.2 No. 210 *Appliance Wiring Material Products*	
1.5.6, 1.5.7	X1, Y1 and Y2 capacitors	UL 1414 *Capacitors and Suppressors for Radio- and Television-Type Appliances* (X1, Y1 and Y2, used per conditions in 1.5.6 and 1.5.7)	CSA C22.2 No. 1 *Audio, Video and Similar Electronic Equipment*, or CAN/CSA E384-14 *Fixed Capacitors for User in Electronic Equipment – Part 14: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*	IEC 60384-14:1993 *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

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Subclause from this standard	Component type	UL standard	CSA standard	IEC publication (may be replaced by UL or CSA Standard)
1.5.9	Varistors or MOVs (see P.1 (1.5.2))	UL 1449 *Transient Voltage Surge Suppressors*	Certification Notice No. 516 (Where the surge suppressor is relied upon to achieve Overvoltage Category 1, UL 1449 requirements apply)	IEC 61051-2 *Varistors for use in electronic equipment - Part 2: Sectional specification for surge suppression varistors*
1.7.11	Marking and labeling	UL 969 *Marking and Labeling Systems*	CSA C22.2 No. 0.15 *Adhesive Labels*	
2.5, 2.7	Fuses (supplementary applications)	See 2.7		
2.5, 6.3	PTC	UL 1434 *Thermistor-Type Devices* UL 60730-1A *Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements*	Informs Component Acceptance No. CA-18A and associated TIL No. CA-3A *Component Acceptance Requirements for PTC Thermistors for Overcurrent Protection in Electrical and Electronic Equipment*	IEC 60730-1 *Automatic electrical controls for household and similar use. Part 1: general requirements*
2.7, 2.5	Fuses (supplementary applications)	UL 248-14 *Low-Voltage Fuses – Part 14: Supplemental Fuses* UL 1417 *Special Fuses for Radio- and Television-Type Appliances*	CSA C22.2 No. 248.14 *Low Voltage Fuses – Part 14: Supplemental Fuses*	IEC 60127-1 *Miniature fuses – Part 1: definitions for miniature fuses and general requirements for miniature fuse-links*
2.7	Fusing resistors	UL 1412 *Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances* UL 60730-1A *Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements*	CSA C22.2 No. 1 *Audio, Video and Similar Electronic Equipment*	IEC 60730-1 *Automatic electrical controls for household and similar use. Part 1: general requirements*

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Subclause from this standard	Component type	UL standard	CSA standard	IEC publication (may be replaced by UL or CSA Standard)
2.9.1	Insulating materials	UL 746C *Polymeric Materials – Use in Electrical Equipment Evaluations* (Sections 8 and 9) The following materials are considered acceptable for the support of uninsulated live parts: slate, porcelain, phenolic, or cold-molded composition, unfilled polycarbonate, unfilled nylon, nylon filled with inorganic compounds, melamine, melamine-phenolic, urea formaldehyde, or other material acceptable for the support of parts that are judged to comply with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. These materials should withstand the most severe conditions likely to be met in service. – A material need not comply with the requirements in UL 746C if it meets the insulation requirements applicable to the component. – Laminate material in printed wiring boards need not comply with the requirements in UL 746C. – Vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts if shrinkage, current leakage, or warpage can result in a risk of fire, electric shock, injury to persons, or electrical energy – high current levels.	CAN/CSA-C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials* The following materials are considered acceptable for the support of uninsulated live parts: slate, porcelain, phenolic, or cold-molded composition, unfilled polycarbonate, unfilled nylon, nylon filled with inorganic compounds, melamine, melamine-phenolic, or other material acceptable for the support of parts that are judged to comply with the standard for polymeric materials – Evaluation of Properties of Polymeric Materials, CSA 0.17. These materials should withstand the most severe conditions likely to be met in service. – A material need not comply with the requirements in CSA 0.17 if it meets the insulation requirements applicable to the component. – Laminate material in printed wiring boards need not comply with the requirements in CSA 0.17. – Vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts if shrinkage, current leakage, or warpage can result in a risk of fire, electric shock, injury to persons, or electrical energy – high current levels.	

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Annex P.2 Continued

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Subclause from this standard	Component type	UL standard	CSA standard	IEC publication (may be replaced by UL or CSA Standard)
2.9.1, 4.5.2 †	Insulating systems	UL 1446 *Systems of Insulating Materials – General*	CAN/CSA C22.2 No. 0 *General Requirements – Canadian Electrical Code, Part II*	IEC 60085 *Electrical insulation – Thermal classification*
2.10.5.4	Optical isolators	UL 1577 *Optical Isolators*	CSA Certification Notice, Component Acceptance Service No. 5A (Announcement of Extension of the Component Acceptance Service for Optocouplers and Related Devices)	
2.10.5.13	Magnet wire	ANSI/NEMA MW 1000 Magnet Wire (Heavy Build)	ANSI/NEMA MW 1000 Magnet Wire (Heavy Build)	IEC 60317 Specifications for particular types of winding wires (Grade 2)
2.10.6.2, Annex R †	Conformal coatings	UL 746C Polymeric Materials – Use in Electrical Equipment Evaluations	CSA Electrical Bulletin 1402C	
3.2.3	Outlet boxes	UL 514A *Metallic Outlet Boxes*; or UL 514B *Conduit, Tubing and Cable Fittings*; or UL 514C *Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers*	CAN/CSA C22.2 No. 18 *Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware*; or CAN/CSA C22.2 No. 85 *Rigid PVC Boxes and Fittings*	
3.3 †	Terminal blocks	UL 1059 *Terminal Blocks*	CSA C22.2 No. 158 *Terminal Blocks*	
4.2.8 *	Cathode ray tubes	UL 1418 *Cathode-Ray Tubes* UL 61965 *Mechanical Safety for Cathode Ray Tubes*	CAN/CSA C22.2 No. 60065 *Audio, Video and Similar Electronic Apparatus – Safety Requirements* , Clause 18 CAN/CSA E61965 *Mechanical Safety of Cathode Ray Tubes*	
4.3.4	Wire connectors	UL 486A-486B *Wire Connectors* UL 486C *Splicing Wire Connectors* UL 486E *Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors*	CSA C22.2 No. 65 *Wire Connectors*	
4.3.12	Flammability of liquids	UL 340 *Tests for Comparative Flammability of Liquids*		

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Annex P.2 Continued

DC

Subclause from this standard	Component type	UL standard	CSA standard	IEC publication (may be replaced by UL or CSA Standard)
4.3.13.3	Materials subjected to UV exposure	UL 746C *Polymeric Materials – Use in Electrical Equipment Evaluations* Sections 25 (UV Exposure) and 57 (UL Light Exposure Test)	CAN/CSA C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials*	
4.5.2, 2.9.1 †	Insulating systems	See 2.9.1		
4.6.5	Adhesives	UL 746C *Polymeric Materials – Use in Electrical Equipment Evaluations*	CAN/CSA C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials*	
4.7 †	Polymeric materials	UL 746A *Polymeric Materials – Short Term Property Evaluations*; or UL 746B *Polymeric Materials – Long Term Property Evaluations*; or UL 746C *Polymeric Materials – Use in Electrical Equipment Evaluations*; or UL 746D *Polymeric Materials – Fabricated Parts*	CAN/CSA C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials*	
4.7.3 †	Flammability of plastic materials	UL 94 *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*	CAN/CSA C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials*	
4.7.3.1 †	Glow wire test	UL 746A *Polymeric Materials – Short Term Property Evaluations*	CAN/CSA C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials*	IEC 60695-1-1 *Fire Hazard Testing – Part 1-1: Guidance for Assessing the Fire Hazard of Electrotechnical Products – General Guidelines*
4.7.3.5	Air filter units	UL 900 *Air Filter Units*		
4.7.3.6	High-voltage components	UL 1413 *High-Voltage Components for Television-Type Appliances*	CSA C22.2 No. 1 *Audio, Video and Similar Electronic Equipment*	
5.3.3, 1.5.4	Transformers	See 1.5.4		
6.3, 2.5	PTC	See 2.5		
A.2 †	Small plastic materials flame tests	UL 1694 *Tests for Flammability of Small Polymeric Component Materials*	CAN/CSA C22.2 No. 0.17 *Evaluation of Properties of Polymeric Materials, Appendix C*	IEC 60695-2-2 *Fire Hazard Testing – Part 2: Test Methods – Section 2: Needle Flame Test*

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Annex P.2 Continued

DC

Subclause from this standard	Component type	UL standard	CSA standard	IEC publication (may be replaced by UL or CSA Standard)
Annex B †	Motor protection	UL 2111 *Overheating Protection for Motors*	CSA C22.2 No. 77 *Motors with Inherent Overheating Protection* or CSA C22.2 No. 100 *Motors and Generators*	
Annex R, 2.10.6.2 †	Conformal coatings	See 2.10.6		
† Indicates CSA or UL standard having requirements that meet or exceed the relevant IEC requirements				

DC

Annex Q
(normative)
Voltage dependent resistors (VDRs)
(see 1.5.9.1)

A VDR used in a PRIMARY CIRCUIT shall comply with IEC 61051-2, with the following details.

a) Preferred climatic categories (2.1.1 of IEC 61051-2)

Lower category temperature: - 10 °C

Upper category temperature: + 85 °C

Duration of damp heat, steady state test: 21 days

b) Maximum continuous voltage (2.1.2 of IEC 61051-2)

The maximum continuous a.c. voltage is selected from the list of preferred voltages and shall be at least 120 % of

– the RATED VOLTAGE of the equipment or

– the upper voltage of the RATED VOLTAGE RANGE of the equipment

c) Pulse current (Table I group 1 of IEC 61051-2)

Combination pulses of 6 kV/3 kA of alternating polarity are used, having a pulse shape of 1,2/50 µs for voltage and 8/20 µs for current.

In addition to the performance requirements of Table I group 1, the clamping voltage after the test shall not have changed by more than 10 % when measured with the manufacturer's specified current.

Annex R

P.2

(informative)

Examples of requirements for quality control programmes

NOTE This annex gives examples of requirements for quality control programmes as specified in 2.10.6.2 for minimum separation distances for coated printed boards and in 2.10.3 and Clause G.2 for reduced CLEARANCES.

R.1 Minimum separation distances for unpopulated coated printed boards (see 2.10.6.2)

A manufacturer wishing to use the reduced separation distances permitted by 2.10.6.2, Table 2Q, shall implement a quality control programme for those features of the boards that are listed in Table R.1. This programme shall include specific quality controls for the tools and materials that affect conductor spacing, adequate inspection of pattern and spacing, cleanliness, coating thickness, electrical tests for short-circuits, insulation resistance and electric withstand voltage.

The manufacturer shall also identify and plan the protection and, where applicable, installation processes which directly affect quality and shall ensure that these processes are conducted under controlled conditions. Controlled conditions shall include the following:

– documented work instructions defining process, equipment, environment and manner of production where the absence of such instructions would adversely affect quality, use of suitable production and installation equipment, suitable working environment, compliance with reference standards, specifications and quality plans;

– monitoring and control of suitable processes and product characteristics during production and installation in the equipment;

– criteria for workmanship stipulated to the extent necessary in written specifications or by means of representative samples;

– records maintained for qualified processes, equipment and personnel as appropriate.

Table R.1 provides the sampling plan for attributes and tests necessary to conform to the requirements of 2.10.6.2. The number of samples of production boards shall be based on IEC 60410 or ISO 2859-1 or equivalent national standards.

Table R.1 – Rules for sampling and inspection – coated printed boards

Tests	BASIC INSULATION	SUPPLEMENTARY INSULATION	REINFORCED INSULATION
Spacing mm [a]	Sampling S2 AQL 1,0	Sampling S2 AQL 1,0	Sampling S2 AQL 1,0
Electric strength test [b]	Sampling S2 AQL 2,5	Sampling S2 AQL 2,5	ROUTINE TEST; one failure requires evaluation for cause
Abrasion resistance	Sampling S1 AQL 2,5	Sampling S1 AQL 2,5	Sampling S1 AQL 2,5
Thermal ageing [c]	Sampling S3 AQL 4	Sampling S3 AQL 4	Sampling S3 AQL 4
Thermal cycling [c]	Sampling S1 AQL 1,5	Sampling S1 AQL 1,5	Sampling S1 AQL 1,5
Insulation resistance [d]	Sampling S2 AQL 2,5	Sampling S2 AQL 2,5	Sampling S2 AQL 2,5
Visual inspection of coating [e]	ROUTINE TEST	ROUTINE TEST	ROUTINE TEST

[a] To minimize test and inspection time, it is permitted to replace measurement of separation distances by measurement of breakdown voltage. Initially the breakdown voltage is established for ten uncoated boards for which the correct spacing measurements have been confirmed. The breakdown voltage of subsequent uncoated production boards is then checked against a lower limit equal to the minimum breakdown voltage for the ten initial boards minus 100 V. If breakdown occurs at this lower limit, a board is considered a failure unless direct measurement of the spacing conforms with the requirement.

[b] The electric strength test shall be conducted according to 5.2.2 except that the duration shall be 1 s to 5 s.

[c] The thermal ageing and thermal cycling tests shall be done whenever the type of coating material, printed board material, or the process is changed. It is recommended that it should be done at least once a year.

[d] The insulation resistance shall be not less than 1 000 MΩ.

[e] Visual inspection without optical magnification or automated optical inspection with equivalent resolution shall show no cracks, no bubbles, no pinholes, or detachment of the coating in the area of reduced spacings. Any such defects shall be reason for rejection of the printed board.

R.2 Reduced clearances (see 2.10.3)

A manufacturer wishing to use reduced CLEARANCES permitted by 2.10.3, Tables 2J, 2K, 2L and G.2, shall implement a quality control programme for those features of the construction listed in Table R.2. This programme shall include specific quality controls for the tools and materials that affect CLEARANCES.

The manufacturer shall also identify and plan the protection and, where applicable, installation processes that directly affect quality and shall ensure that these processes are conducted under controlled conditions. Controlled conditions shall include the following:

– documented work instructions defining process, equipment, environment, and manner of production where the absence of such instructions would adversely affect quality, suitable working environment, compliance with reference standards or specifications and quality plans;

– monitoring and control of suitable processes and product characteristics during production and installation in the equipment;

– criteria for workmanship stipulated to the extent necessary in written specifications or by means of representative samples;

– records maintained for qualified processes, equipment and personnel as appropriate.

Table R.2 provides the sampling plan for attributes and tests necessary to conform to the requirements of 2.10.3. The number of samples of production parts or assemblies shall be based on IEC 60410 or ISO 2859-1 or equivalent national standards.

Table R.2 – Rules for sampling and inspection – reduced clearances

Tests	BASIC INSULATION	SUPPLEMENTARY INSULATION	REINFORCED INSULATION
CLEARANCE [a]	Sampling S2 AQL 4	Sampling S2 AQL 4	Sampling S2 AQL 4
Electric strength test [b]	No test	No test	ROUTINE TEST; one failure requires evaluation for cause

[a] To minimize test and inspection time, it is permitted to replace measurement of CLEARANCES by measurement of breakdown voltage. Initially the breakdown voltage is established for ten samples for which the correct CLEARANCE measurements have been confirmed. The breakdown voltage of subsequent parts or assemblies is then checked against a lower limit equal to the minimum breakdown voltage of the initial ten samples minus 100 V. If breakdown occurs at this lower limit, a part or assembly is considered a failure unless direct measurement of the CLEARANCE conforms to the requirement.

[b] The electric strength test for REINFORCED INSULATION shall consist of one of the following alternatives:

– six impulses of alternating polarity, using a 1,2/50 µs impulse with a magnitude equal to the peak of the test voltage in accordance with 5.2.2;

– a three-cycle pulse of a.c. power frequency with a magnitude equal to the test voltage in accordance with 5.2.2;

– six impulses of alternating polarity, using a 10 ms d.c. impulses with a magnitude equal to the peak of the test voltage in accordance with 5.2.2.

Annex S
(informative)
Procedure for impulse testing
(see 6.2.2.3)

S.1 Test equipment

Impulse generator according to Annex N.

Storage oscilloscope with a bandwidth of a few MHz.

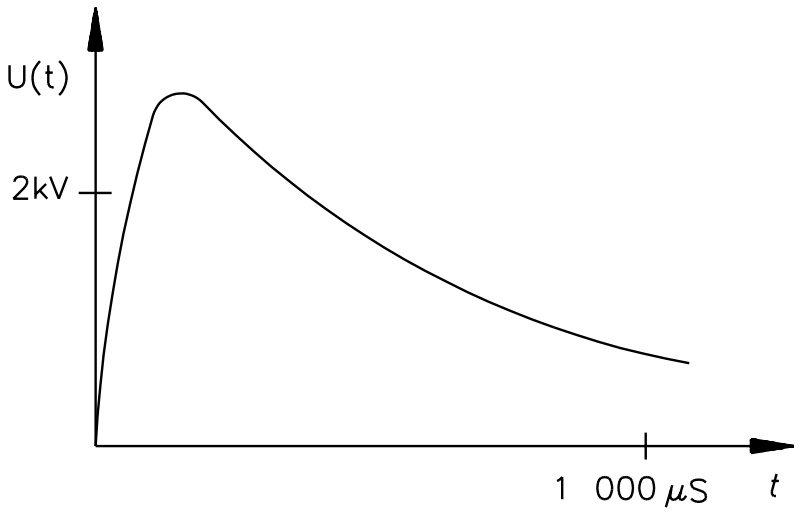
High voltage probe with compensating elements.

S.2 Test procedure

Apply the required number of impulses to the equipment under test and record the waveform patterns.

Examples are given in S.3 to assist in judging whether or not a surge suppressor has operated or insulation has broken down.

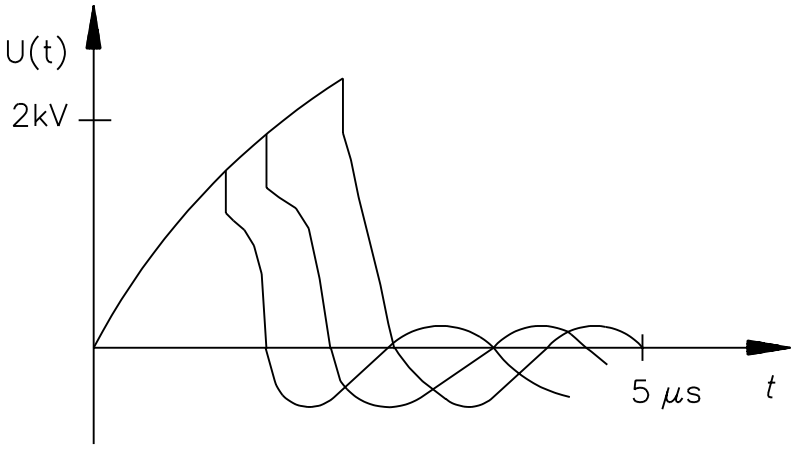
S.3 Examples of waveforms during impulse testing



Consecutive impulses are identical in their waveforms.

SM438A

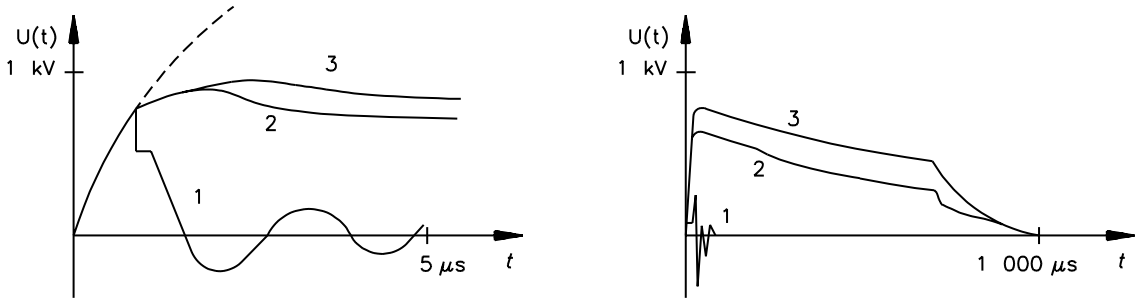
Figure S.1 – Waveform on insulation without surge suppressors and no breakdown



SM439B

Consecutive impulses are not identical in their waveforms. The pulse shape changes from pulse to pulse until a stable resistance path through the insulation is established. Breakdown can be seen clearly on the shape of the pulse voltage oscillogram.

Figure S.2 – Waveforms on insulation during breakdown without surge suppressors



SM440B

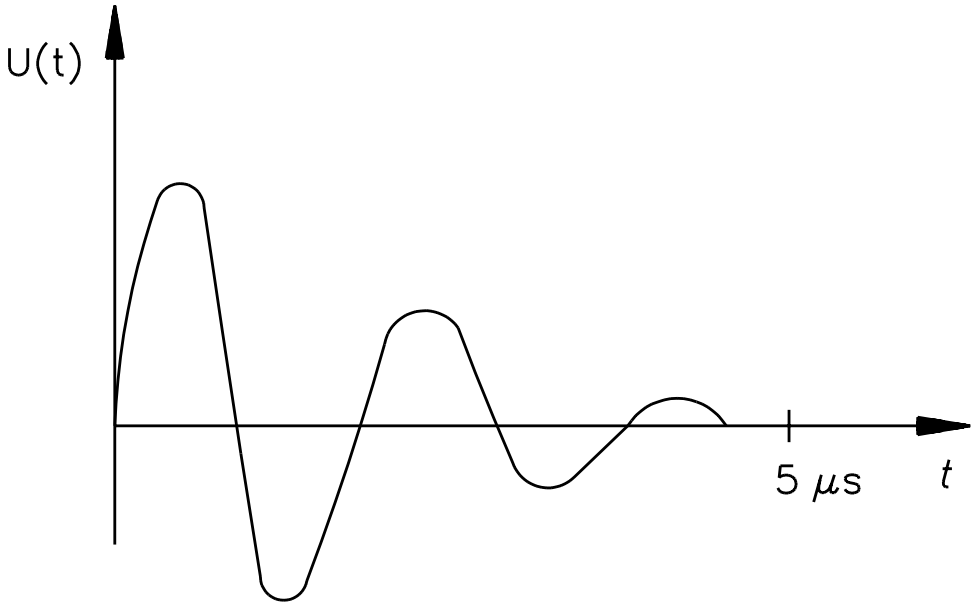
1 – gas discharge type

2 – semiconductor type

3 – metal oxide type

Consecutive impulses are identical in their waveforms.

Figure S.3 – Waveforms on insulation with surge suppressors in operation



SM441B

Figure S.4 – Waveform on short-circuited surge suppressor and insulation

Annex T

P.1

(informative)

Guidance on protection against ingress of water

(see 1.1.2)

When the intended application is such that ingress of water is possible, an appropriate degree of protection other than IPX0 should be selected by the manufacturer from IEC 60529, an extract from which is included in this annex.

Additional design features should then be included to ensure that ingress of water does not affect insulation.

IEC 60529 gives test conditions for each degree of protection other than IPX0. The conditions appropriate to the selected degree of protection should be applied to the equipment, immediately followed by an electric strength test as specified in 5.2.2 on any insulation that may have become wet, and inspection should show that water has not created a risk of personal injury or fire. In particular, there should be no trace of water on insulation that is not designed to operate when wet.

If the equipment is provided with drain holes, inspection should show that any water that enters does not accumulate and that it drains away without affecting compliance.

If the equipment is not provided with drain holes, account should be taken of the possibility of build-up of water.

Where equipment is only partly exposed to water, for example when it is to be installed through an opening in an outside wall, only the exposed parts should be subjected to the IEC 60529 test conditions. For these tests, such equipment should be installed in an appropriate test assembly, simulating actual conditions of installation according to the installation instructions, including the use of a kit of sealing parts where required.

It should not be possible to remove, without the aid of a TOOL, parts that ensure the required degree of protection against ingress of water.

The information in Table T.1 is extracted from IEC 60529.

Table T.1 – Extract from IEC 60529

Second characteristic numeral	Degree of protection	
	Brief description	Definition
0	Non-protected	–
1	Protected against vertically falling water drops	Vertically falling water drops shall have no harmful effects
2	Protected against vertically falling water drops when enclosure tilted up to 15°	Vertically falling drops shall have no harmful effects when the enclosure is tilted at any angle up to 15° on either side of the vertical
3	Protected against spraying water	Water sprayed at an angle up to 60° on either side of the vertical shall have no harmful effects
4	Protected against splashing water	Water splashed against the enclosure from any direction shall have no harmful effects
5	Protected against water jets	Water projected in jets against the enclosure from any direction shall have no harmful effects
6	Protected against powerful water jets	Water projected in powerful jets against the enclosure from any direction shall have no harmful effects
7	Protected against the effects of temporary immersion in water	Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is temporarily immersed in water under standardized conditions of pressure and time
8	Protected against the effects of continuous immersion in water	Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is continuously immersed in water under conditions which shall be agreed between manufacturer and user but that are more severe than for numeral 7

Annex U

P.1

(normative)

Insulated winding wires for use without interleaved insulation

(see 2.10.5.4)

This annex specifies winding wire whose insulation may be used to provide BASIC INSULATION, SUPPLEMENTARY INSULATION, DOUBLE INSULATION or REINFORCED INSULATION, in wound components without interleaved insulation.

This annex covers round winding wires having diameters between 0,5 mm and 5,00 mm.

U.1 Wire construction

If the wire is insulated with overlapping spirally wrapped tape, the overlap shall be adequate to ensure continued overlap during manufacture of the wound component. The overlaps shall be sufficiently secured to maintain the amount of overlap.

U.2 Type tests

The wire shall pass the tests of U.2.1 to U.2.4, conducted at a temperature between 15 °C and 35 °C and a relative humidity between 45 % and 75 %, unless specified otherwise.

U.2.1 Electric strength

The test sample is prepared according to 4.4.1 of IEC 60851-5 (for a twisted pair). The sample is then subjected to the test of 5.2.2 of this standard. The test voltage shall be not less than twice the appropriate voltage in accordance with 5.2.2 of this standard, with a minimum of

– *3 000 V a.c. r.m.s. for BASIC INSULATION or SUPPLEMENTARY INSULATION, or*

– *6 000 V a.c. r.m.s. for REINFORCED INSULATION .*

U.2.2 Flexibility and adherence

Test 8 in 5.1.1 of IEC 60851-3 is applied using the mandrel diameters of Table U.1. The test sample is then examined in accordance with 5.1.1.4 of IEC 60851-3, followed by the test of 5.2.2 of this standard except that the test voltage is applied between the wire and the mandrel. The test voltage shall be not less than the appropriate voltage in accordance with 5.2.2 of this standard, with a minimum of

– *1 500 V a.c. r.m.s. for BASIC INSULATION or SUPPLEMENTARY INSULATION, or*

– *3 000 V a.c. r.m.s. for REINFORCED INSULATION.*

Table U.1 – Mandrel diameter

Nominal conductor diameter mm	Mandrel diameter mm ± 0,2 mm
0,05 – 0,34	4,0
0,35 – 0,49	6,0
0,50 – 0,74	8,0
0,75 – 2,49	10,0
2,50 – 5,00	four times the nominal conductor diameter [a]
[a] In accordance with IEC 60317-43.	

The tension to be applied to the wire during winding on the mandrel is calculated from the wire diameter to be equivalent to 118 MPa ± 10 % (118 N/mm^2 ± 10 %).

U.2.3 Heat shock

Test 9 of IEC 60851-6, followed by the electric strength test of 5.2.2 of this standard except that the test voltage is applied between the wire and the mandrel. The voltage shall be not less than the appropriate voltage in accordance with 5.2.2 of this standard, with a minimum of

- *1 500 V a.c. r.m.s. for BASIC INSULATION or SUPPLEMENTARY INSULATION, or*
- *3 000 V a.c. r.m.s. for REINFORCED INSULATION.*

The oven temperature is the relevant temperature for the thermal class of insulation in Table U.2.

The mandrel diameter and tension applied to the wire during winding on the mandrel are as in U.2.2.

The electric strength test is conducted at room temperature after removal from the oven.

Table U.2 – Oven temperature

Thermal class	Oven temperature °C ± 5 °C
105 (A)	200
120 (E)	215
130 (B)	225
155 (F)	250
180 (H)	275
200	295
220	315
250	345
The designations A to H, formerly assigned in IEC 60085 to thermal classes 105 to 180, are given in parentheses.	

U.2.4 Retention of electric strength after bending

Five samples are prepared as in U.2.2 above and tested as follows. Each sample is removed from the mandrel, placed in a container and positioned so that it can be surrounded by at least 5 mm of metal shot. The ends of the conductor in the sample shall be sufficiently long to avoid flash over. The shot shall be not more than 2 mm in diameter and shall consist of balls of stainless steel, nickel or nickel plated iron. The shot is gently poured into the container until the sample under test is covered by at least 5 mm of shot. The shot shall be cleaned periodically with a suitable solvent (for example, 1,1,1-trichloroethane).

NOTE The above test procedure is reproduced from 4.6.1 c) of IEC 60851-5 (second edition including amendment 1), now withdrawn. It is not included in the third edition of that standard.

The test voltage shall be not less than the appropriate test voltage in accordance with 5.2.2 of this standard, with a minimum of

– *1 500 V a.c. r.m.s. for* BASIC INSULATION *or* SUPPLEMENTARY INSULATION*, or*

– *3 000 V a.c. r.m.s. for* REINFORCED INSULATION*.*

The test voltage is applied between the shot and the conductor.

The mandrel diameter and tension applied to the wire during winding on the mandrel are as in U.2.2.

U.3 Test during manufacture

The wire shall be subjected by the wire manufacturer to electric strength tests during manufacture as specified in U.3.1 and U.3.2.

U.3.1 Routine testing

The test voltage for ROUTINE TESTING *shall be the appropriate voltage in accordance with 5.2.2 of this standard, with a minimum of*

– *1 500 V a.c. r.m.s for* BASIC INSULATION *or* SUPPLEMENTARY INSULATION*, or*

– *3 000 V a.c. r.m.s for* REINFORCED INSULATION*.*

U.3.2 Sampling tests

Twisted pair samples shall be tested in accordance with 4.1.1 of IEC 60851-5. The minimum breakdown voltage shall be twice the appropriate test voltage in accordance with 5.2.2 of this standard, with a minimum of

– *3 000 V a.c. r.m.s for* BASIC INSULATION *or* SUPPLEMENTARY INSULATION*, or*

– *6 000 V a.c. r.m.s for* REINFORCED INSULATION*.*

Annex V
(normative)
A.C. power distribution systems
(see 1.6.1)

V.1 Introduction

In 3.1.2 of IEC 60364-1, a.c. power distribution systems are classified TN, TT and IT, depending on the arrangement of current-carrying conductors and the method of earthing. The classes and codes are explained in this annex. Some examples of each class are given in the figures; other configurations also exist.

In the figures:

– in most cases, the power distribution systems apply for single-phase and three-phase equipment, but for simplicity, only single-phase equipment is illustrated;

– the power sources may be transformer secondaries, motor-driven generators or uninterruptible power distribution systems;

– for transformers within a user's building, some of the figures apply, and the building boundary represents a floor of the building;

– some power distribution systems are earthed at additional points, for example, at the power entry points of users' buildings (see 413.1.3.1, Notes 1 and 2 of IEC 60364-4-41).

The following types of equipment connection are taken into account; the numbers of wires mentioned do not include conductors used exclusively for earthing.

Single-phase, two-wire

Single-phase, three-wire

Two-phase, three-wire

Three-phase, three-wire

Three-phase, four-wire

The system codes used have the following meaning:

– First letter: relationship of the power distribution system to earth;

T means direct connection of one pole to earth,

I means system isolated from earth, or one point connected to earth through an impedance.

– Second letter: earthing of the equipment;

T means direct electrical connection of the equipment to earth, independently of the earthing of any point of the power distribution system,

N means direct electrical connection of the equipment to the earthed point of the power distribution system (in a.c. systems, the earthed point of the power distribution system is normally the neutral point or, if a neutral point is not available, a phase conductor).

– Subsequent letters if any: arrangement of neutral and protective conductors;

S means the protective function is provided by a conductor separate from the neutral or from the earthed line (or in a.c. systems, earthed phase) conductor,

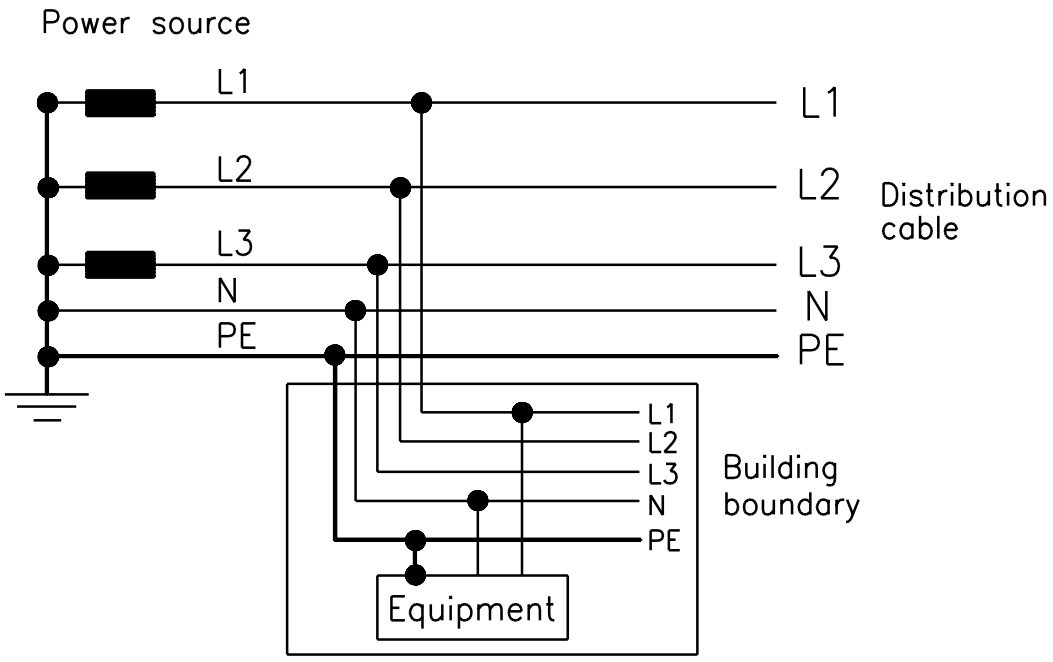
C means the neutral and protective functions are combined in a single conductor (PEN conductor).

V.2 TN power distribution systems

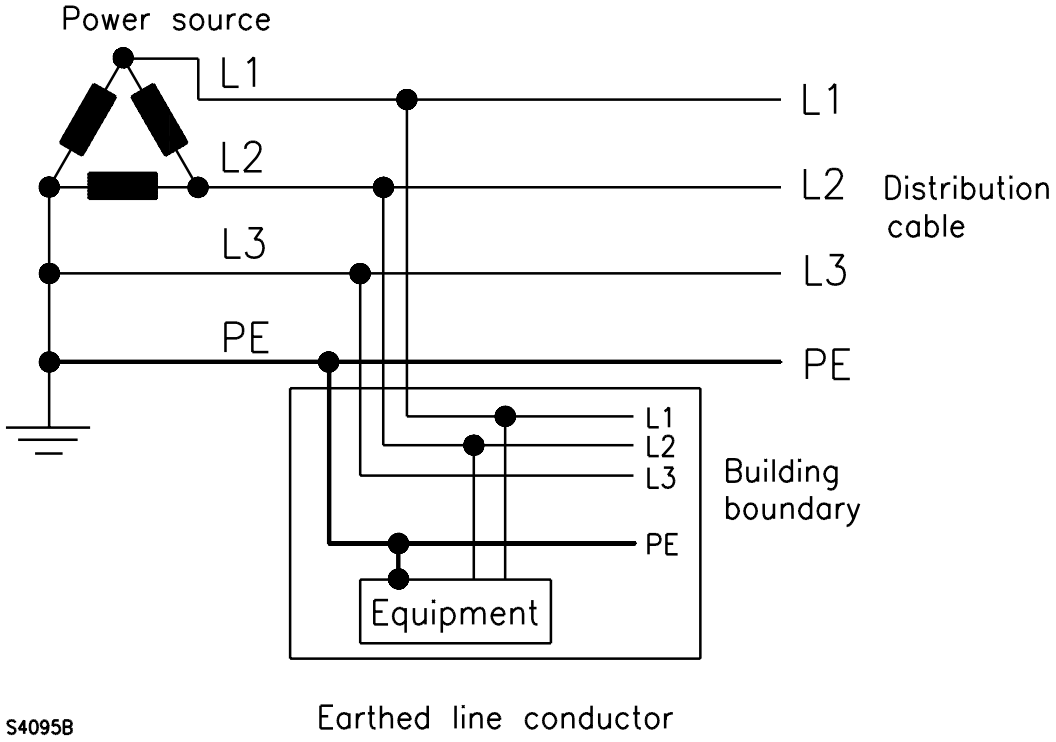
TN power distribution systems are directly earthed, the parts of the equipment required to be earthed being connected by PROTECTIVE EARTHING CONDUCTORS. Three types of TN power systems are considered:

– TN-S power distribution system,	in which a separate protective conductor is used through-out the system;
– TN-C-S power distribution system,	in which neutral and protective functions are combined in a single conductor in part of the system;
– TN-C power distribution system,	in which neutral and protective functions are combined in a single conductor throughout the system.

Some TN power distribution systems are supplied from a secondary winding of a transformer that has an earthed centre tap (neutral). Where the two phase conductors and the neutral conductor are available, these systems are commonly known as ″single-phase, three-wire power distribution systems″.



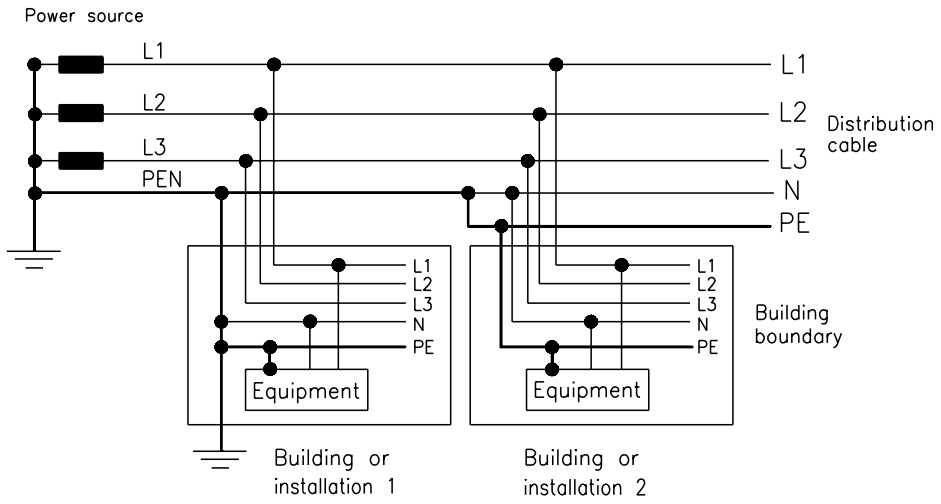
Separate neutral and protective conductors



S4095B

Earthed line conductor

Figure V.1 – Examples of TN-S power distribution systems



NOTE The point at which the PEN conductor is separated into protective earth and neutral conductors may be at the building entrance or at distribution panels within the building.

Figure V.2 – Example of TN-C-S power distribution system

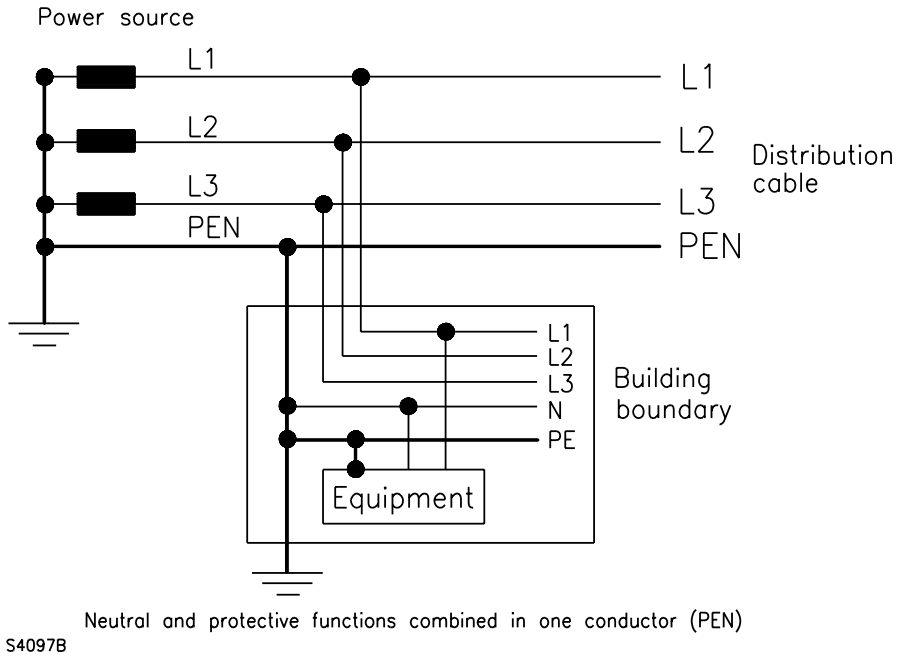


Figure V.3 – Example of TN-C power distribution system

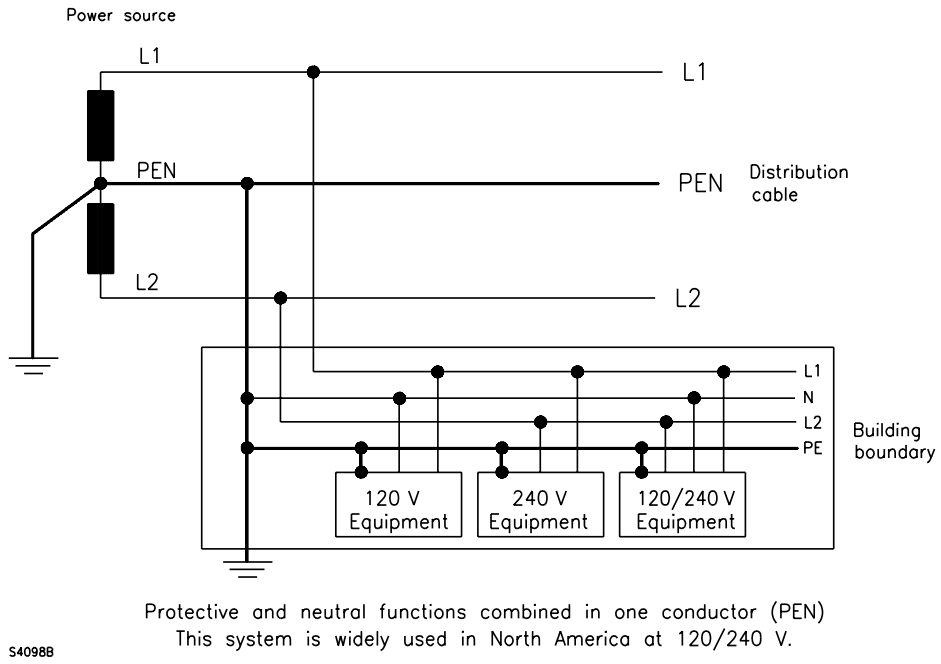


Figure V.4 – Example of single-phase, three-wire TN-C power distribution system

V.3 TT power distribution systems

TT power distribution systems have one point directly earthed, the parts of the equipment required to be earthed being connected at the user's premises to earth electrodes that are electrically independent of the earth electrodes of the power distribution system.

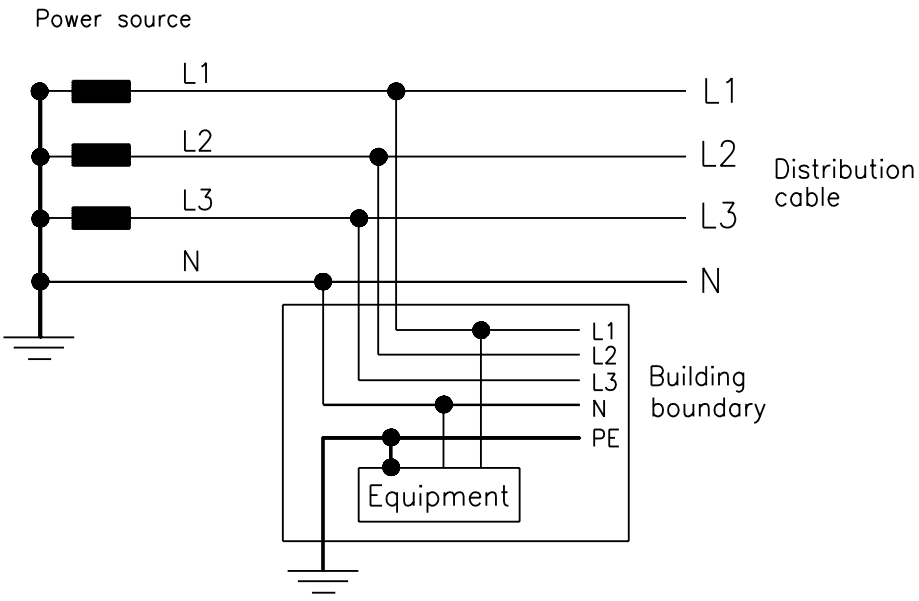


Figure V.5 – Example of three line and neutral TT power distribution system

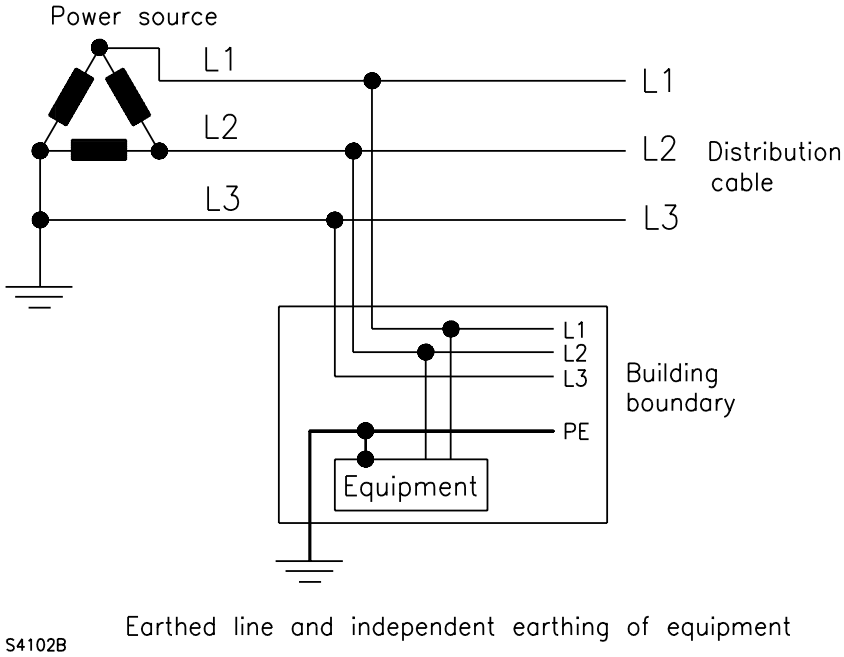
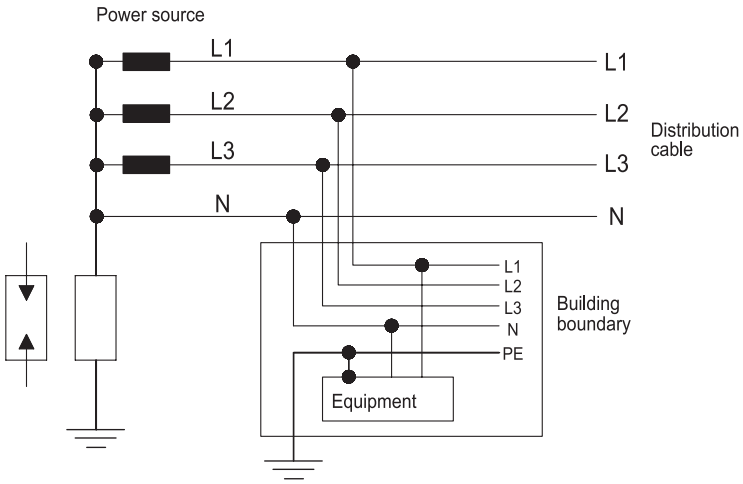


Figure V.6 – Example of three line TT power distribution system

V.4 IT power distribution systems

IT power distribution systems are isolated from earth, except that one point may be connected to earth through an impedance or a voltage limiter. The parts of the equipment required to be earthed are connected to earth electrodes at the user's premises.



This system is widely used isolated from earth, in some installations in France, with impedance to earth, at 230/400 V, and in Norway, with voltage limiter, neutral not distributed, at 230 V line-to-line.

Figure V.7 – Example of three line (and neutral) IT power distribution system

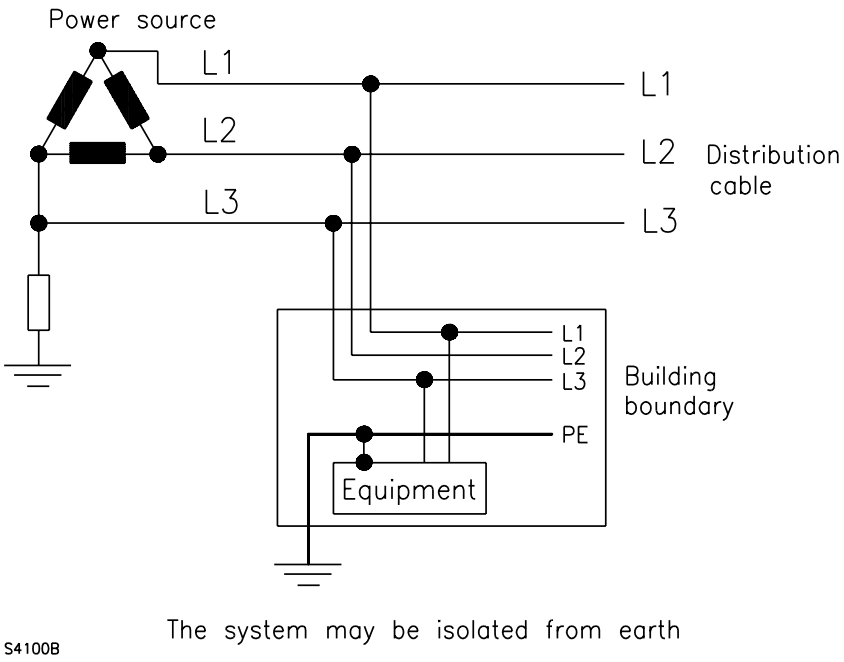


Figure V.8 – Example of three line IT power distribution system

Annex W
(informative)
Summation of touch currents

This annex explains the background to the requirements and tests in 5.1.8.2.

W.1 Touch current from electronic circuits

There are two quite different mechanisms that determine the current through a human body that touches an electronic circuit (or power bus), depending on whether or not the circuit is earthed. This distinction between earthed and unearthed (floating) circuits is not the same as between CLASS I EQUIPMENT and CLASS II EQUIPMENT. Floating circuits can exist in CLASS I EQUIPMENT and earthed circuits in CLASS II EQUIPMENT. Floating circuits are commonly, but not exclusively, used in telecommunications equipment and earthed circuits in data processing equipment, also not exclusively.

In order to consider the worst case, it will be assumed in this annex that TELECOMMUNICATION NETWORKS are floating and that the A.C. MAINS SUPPLY and human bodies (SERVICE PERSONS or USERS) are earthed. It should be noted that a SERVICE PERSON can touch some parts that are not USER-accessible. An ″earthed″ circuit means that the circuit is either directly earthed or in some way referenced to earth so that its potential with respect to earth is fixed.

W.1.1 Floating circuits

If the circuit is not earthed, the current (I_c) through the human body is ″leakage″ through stray or added capacitance (C) across the insulation in the mains transformer (see Figure W.1).

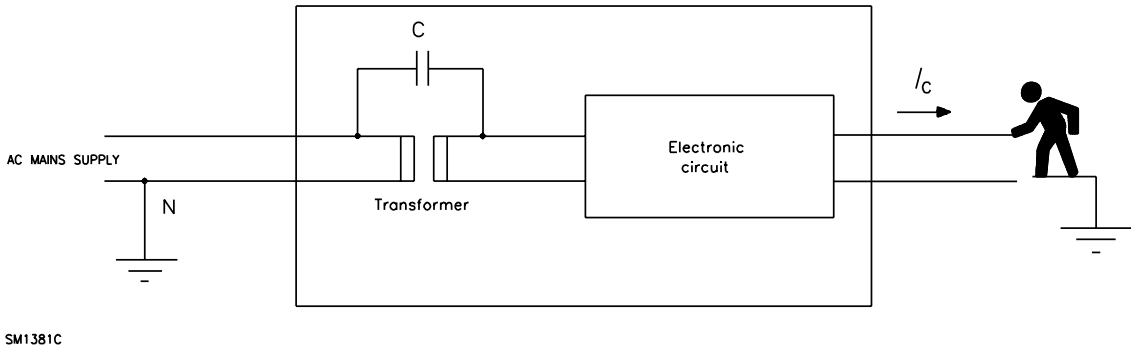


Figure W.1 – Touch current from a floating circuit

This current is coming from a relatively high voltage, high impedance source, and its value is largely unaffected by the operating voltage on the electronic circuit. In this standard, the body current (I_c) is limited by applying a test using the measuring instrument in Annex D, which roughly simulates a human body.

W.1.2 Earthed circuits

If the electronic circuit is earthed, the current through the human body (I_v) is due to the operating voltage (V) of the circuit, which is a source of low impedance compared with the body (see Figure W.2). Any leakage current from the mains transformer (see W.1.1), will be conducted to earth and will not pass through the body.

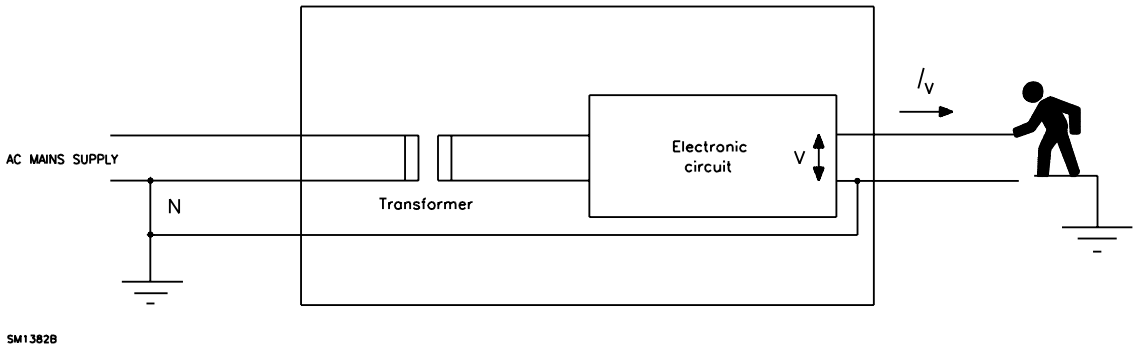


Figure W.2 – Touch current from an earthed circuit

In this standard, the body current (I_V) is limited by specifying maximum voltage values for the accessible circuit, which shall be an SELV CIRCUIT or (with restricted accessibility) a TNV CIRCUIT.

W.2 Interconnection of several equipments

It is a characteristic of information technology equipment, in particular in telecommunication applications, that many equipments may be connected to a single central equipment in a ″star″ topology. An example is telephone extensions or data terminals connected to a PABX, which may have tens or hundreds of ports. This example is used in the following description (see Figure W.3).

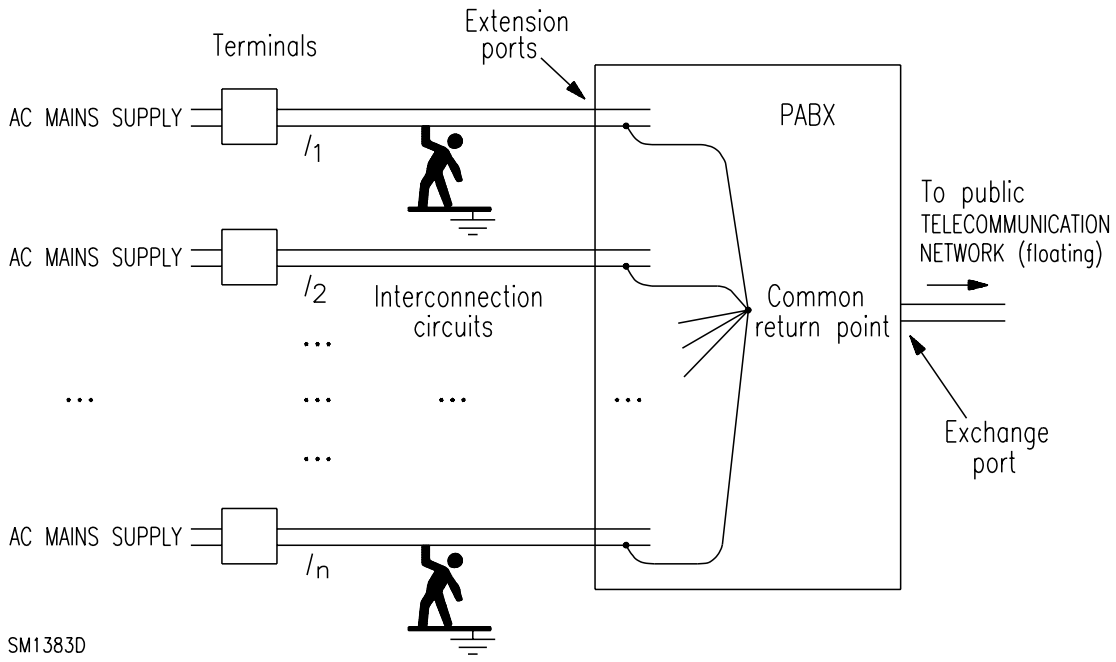


Figure W.3 – Summation of touch currents in a PABX

Each terminal equipment can deliver current to a human body touching the interconnecting circuit (I_1, I_2, etc.), added to any current coming from the PABX port circuitry. If several circuits are connected to a common point, their individual TOUCH CURRENTS will add together, and this represents a possible risk to an earthed human body that touches the interconnection circuit.

Various ways of avoiding this risk are considered in the following subclauses.

W.2.1 Isolation

Isolate all interconnection circuits from each other and from earth, and limit I_1, I_2, etc., as described in W.1.1. This implies either the use in the PABX of a separate power supply for each port, or the provision of an individual line (signal) transformer for each port. Such solutions may not be cost effective.

W.2.2 Common return, isolated from earth

Connect all interconnection circuits to a common return point that is isolated from earth. (Such connections to a common point may in any case be necessary for functional reasons.) In this case the total current from all interconnection circuits will pass through an earthed human body that touches either wire of any interconnection circuit. This current can only be limited by controlling the values I_1, I_2,... I_n in relation to the number of ports on the PABX. However, the value of the total current will probably be less than $I_1 + I_2 +... + I_n$ due to harmonic and other effects.

W.2.3 Common return, connected to protective earth

Connect all interconnection circuits to a common return point and connect that point to protective earth. The situation described in W.1.2 applies regardless of the number of ports. Since safety depends on the presence of the earth connection, it may be necessary to use high-integrity earthing arrangements, depending on the maximum value of the total current that could flow.

Annex X
(informative)
Maximum heating effect in transformer tests
(see Clause C.1)

Clause C.1 requires transformers to be loaded in such a way as to give the maximum heating effect. In this annex examples are given of various methods of producing this condition. Other methods are possible and compliance with Clause C.1 is not restricted to these examples.

X.1 Determination of maximum input current

The value of the input current at rated load is established. This is I_r, see step A of Table X.1. The value may be established by test or from manufacturer's data.

A load is applied to the output winding or to the output of the switch mode power supply unit while measuring the input current. The load is adjusted as quickly as possible to provide the maximum value of input current that can be sustained for approximately 10 s of operation. This is I_m, see step B of Table X.1. The test is then repeated according to step C and, if necessary, steps D to J of Table X.1. The input current at each step is then noted and maintained until either:

a) the temperature of the transformer stabilizes without the operation of any component or protective device (inherent protection) in which case no further testing is conducted; or

b) a component or protective device operates, in which case the winding temperature is noted immediately and the test of Clause X.2 is then conducted depending on the type of protection.

If any component or protective device operates within 10 s after the application of the primary voltage, I_m is the value recorded just before the component or protective device operates.

In conducting the tests described in steps C to J of Table X.1, the variable load is adjusted to the required value as quickly as possible and readjusted, if necessary, 1 min after application of the primary voltage. The sequence of steps C to J may be reversed.

Table X.1 – Test steps

Steps	Input current of the transformer or switch mode power supply unit
A	Input current at rated load = I_r
B	Maximum value of input current after 10 s of operation = I_m
C	$I_r + 0{,}75\ (I_m - I_r)$
D	$I_r + 0{,}50\ (I_m - I_r)$
E	$I_r + 0{,}25\ (I_m - I_r)$
F	$I_r + 0{,}20\ (I_m - I_r)$
G	$I_r + 0{,}15\ (I_m - I_r)$
H	$I_r + 0{,}10\ (I_m - I_r)$
J	$I_r + 0{,}05\ (I_m - I_r)$

X.2 Overload test procedure

If the test of Clause X.1 results in condition X.1 b), the following applies depending on type of protection.

Electronic protection: — *The current is either reduced in steps of 5 % from the current of condition X.1 b) or increased in steps of 5 % from the rated load to find the maximum overload at which the temperature stabilizes without the operation of any electronic protection.*

Thermal protection: — *An overload is applied such that the operating temperature remains a few degrees below the rated opening temperature of the thermal protection.*

Overcurrent protection: — *An overload is applied such that a current flows in accordance with the current versus time trip curves of the overcurrent protective device.*

Annex Y
(normative)
Ultraviolet light conditioning test
(see 4.3.13.3)

Y.1 Test apparatus

Samples are exposed to ultraviolet light by using one of the following apparatus:

– a twin enclosed carbon-arc, (see Clause Y.3), with continuous exposure. The test apparatus shall operate with a black-panel temperature of 63 °C ± 3 °C in a relative humidity of 50 % ± 5 %; or

– a xenon-arc (see Clause Y.4), with continuous exposure. The test apparatus shall operate with a 6 500 W, water-cooled xenon-arc lamp, a spectral irradiance of 0,35 W/m^2 at 340 nm, a black-panel temperature of 63 °C ± 3 °C in a relative humidity of 50 % ± 5 %.

Y.2 Mounting of test samples

The samples are mounted vertically on the inside of the cylinder of the light exposure apparatus, with the widest portion of the samples facing the arcs. They are mounted so that they do not touch each other.

Y.3 Carbon-arc light-exposure apparatus

The apparatus described in ISO 4892-4, or equivalent, is used in accordance with the procedures given in ISO 4892-1 and ISO 4892-4 using a type 1 filter, without water spray.

Materials tested with water spray are also considered acceptable. DC

Y.4 Xenon-arc light-exposure apparatus

The apparatus described in ISO 4892-2, or equivalent, is used in accordance with the procedures given in ISO 4892-1 and ISO 4892-2 using method A, without water spray.

Materials tested with water spray are also considered acceptable. DC

NOTE The wording ″without water spray″ indicates that the samples are not sprayed with water during the test. This should not be confused with water cooling which is necessary for operation of the apparatus.

Annex Z
(informative)
Overvoltage categories
(see 2.10.3.2 and Clause G.2)

The largest peak value of transient overvoltage likely to be experienced at the power input interface of equipment connected to a MAINS SUPPLY is known as the MAINS TRANSIENT VOLTAGE. In this standard, minimum CLEARANCES for insulation in PRIMARY CIRCUITS are based on the MAINS TRANSIENT VOLTAGE.

According to IEC 60664-1, the value of the MAINS TRANSIENT VOLTAGE of an AC MAINS SUPPLY depends on the AC MAINS SUPPLY voltage and the Overvoltage Category, I to IV, see also Table G.1.

The Overvoltage Category therefore has to be identified for each equipment intended to be connected to the AC MAINS SUPPLY.

The Overvoltage Category depends on the manner of connection of the equipment to the building power supply arrangements. It is normally considered to be as shown in Table Z.1. Where transient limiting measures are provided, such as external filters in the AC MAINS SUPPLY, the equipment can be used in a higher Overvoltage Category.

The term Overvoltage Category is not used in connection with DC MAINS SUPPLIES.

Table Z.1 – Overvoltage categories

Overvoltage Category	Equipment and its point of connection to the AC MAINS SUPPLY	Examples of equipment
IV	Equipment that will be connected to the point where the AC MAINS SUPPLY enters the building	Electricity meters Communications information technology equipment for remote electricity metering
III	Equipment that will be an integral part of the building wiring	Socket-outlets, fuse panels and switch panels Power monitoring equipment
II	PLUGGABLE or PERMANENTLY CONNECTED EQUIPMENT that will be supplied from the building wiring	Household appliances, portable tools, home electronics Most information technology equipment used in the building
I	Equipment that will be connected to a special AC MAINS SUPPLY in which measures have been taken to reduce transients	Information technology equipment supplied via an external filter or a motor driven generator

Annex AA
(normative)
Mandrel test
(see 2.10.5.8)

NOTE This test is based on IEC 61558-1 and will give the same results.

Three test samples, each individual sample consisting of three or more layers of non-separable thin sheet material forming REINFORCED INSULATION*, are used. One sample at a time is fixed to the mandrel of the test fixture (Figure AA.1) as shown in Figure AA.2.*

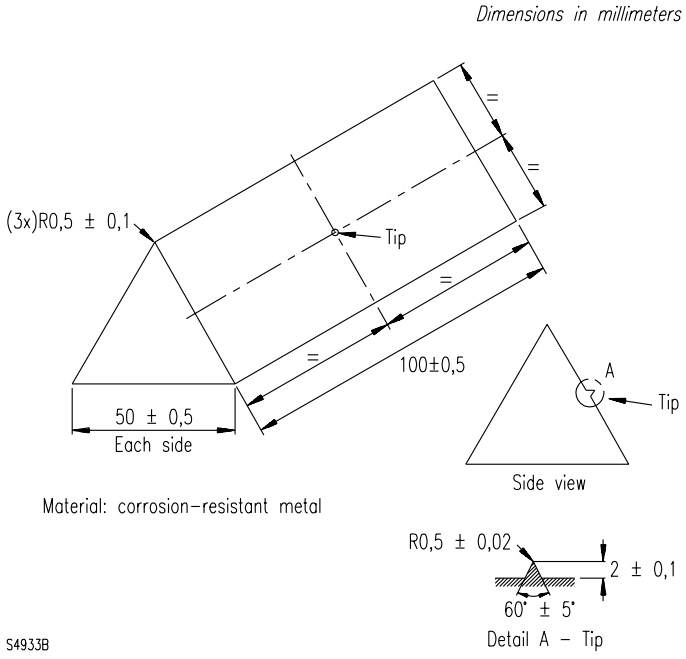


Figure AA.1 – Mandrel

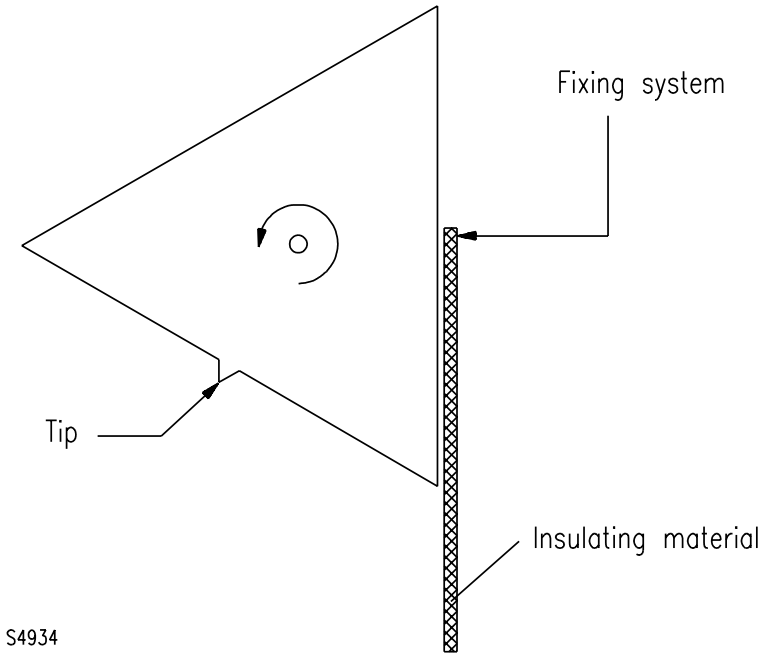


Figure AA.2 – Initial position of mandrel

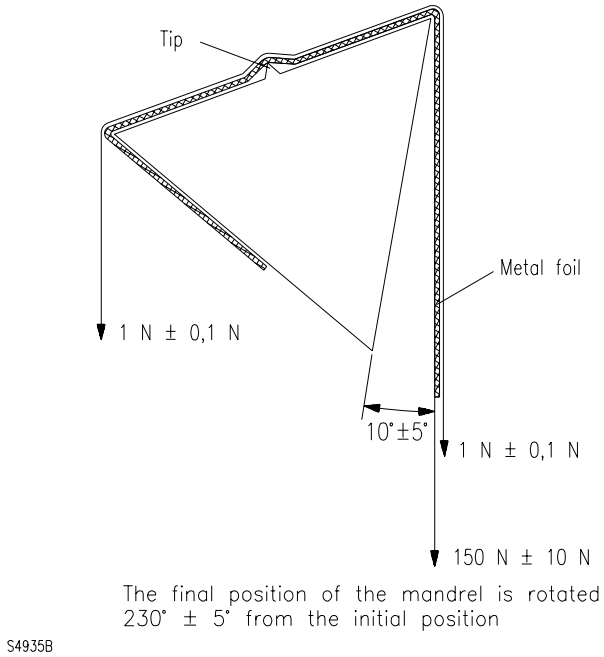


Figure AA.3 – Final position of mandrel

A downward force of 150 N ± 10 N is applied to the free end of the sample (see Figure AA.3), using an appropriate clamping device. The mandrel is rotated

- *from the initial position (Figure AA.2) to the final position (Figure AA.3) and back;*
- *as above for a second time;*
- *from the initial position to the final position.*

If a sample breaks during rotation where it is fixed to the mandrel or to the clamping device, this does not constitute a failure. If a sample breaks at any other place, the test has failed.

After the above test, a sheet of metal foil, 0,035 mm ± 0,005 mm thick, at least 200 mm long, is placed along the surface of the sample, hanging down on each side of the mandrel (see Figure AA.3). The surface of the foil in contact with the sample shall be conductive, not oxidized or otherwise insulated. The foil is positioned so that its edges are not less than 18 mm from the edges of the sample (see Figure AA.4). The foil is then tightened by two equal weights, one at each end, using appropriate clamping devices.

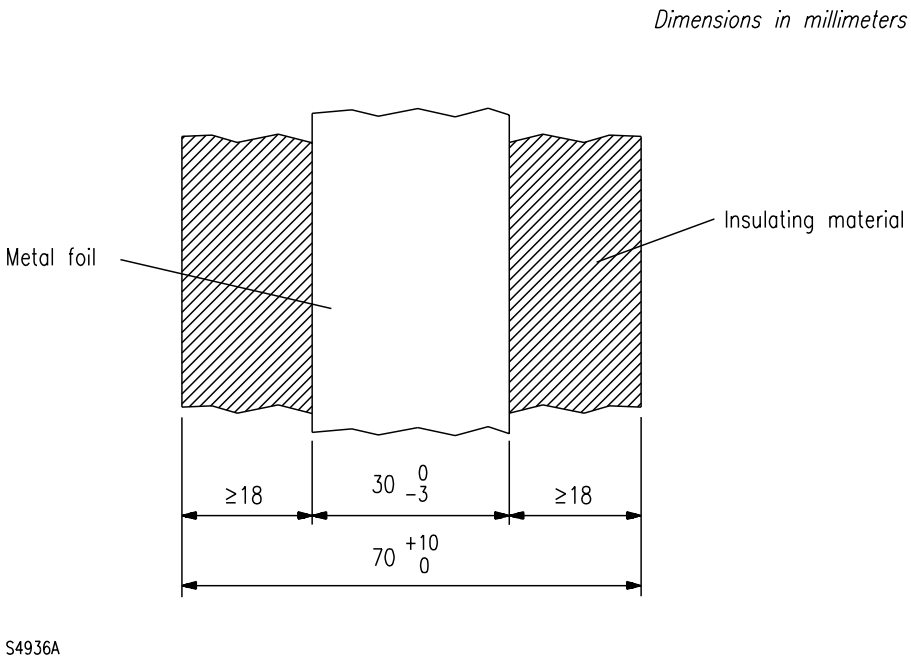


Figure AA.4 – Position of metal foil on insulating material

While the mandrel is in its final position, and within the 60 s following the final positioning, an electric strength test is applied between the mandrel and the metal foil in accordance with 5.2.2. The test voltage is 150 % of U_{test}, but not less than 5 kV. U_{test} is the test voltage specified in 5.2.2 for REINFORCED INSULATION*.*

The entire test procedure is repeated on the other two samples.

Annex BB
(informative)
Changes in the second edition

BB.1 Numbering changes table

The following subclause, annex, figure and table numbers have changed since the first edition of IEC 60950-1.

First Edition	Action	This edition		First Edition	Action	This edition
1.2.2.3	deleted				new	7.1
	new	1.2.2.3		7.1 to 7.2	renumbered	7.2 to 7.3
				7.3.1 to 7.3.3	renumbered	7.4.1 to 7.4.3
1.2.2.4	deleted				new	B.6.1 to 4
1.2.2.5	deleted				new	B.7.1
	new	1.2.5.3		B.7.1 to B.7.3	renumbered	B.7.2 to B.7.4
1.2.5.3 to 5	renumbered	1.2.5.4 to 6				
	new	1.2.8.3			new	G.1.1
1.2.8.3 to 13	renumbered	1.2.8.4 to 14		G.1	renumbered	G.1.2
	new	1.2.9.7			new	G.2.3
1.2.9.7 to 10	renumbered	1.2.9.8 to 11			new	G.2.4
	new	1.2.10.4		G.4 a)	renumbered	G.4.1
	new	1.2.13.15		G.4 b)	renumbered	G.4.2
	new	1.2.13.16		G.4 c)	renumbered	G.4.3
	new	1.2.13.17		G.4 d)	renumbered	G.4.4
1.5.6, 1.5.7.2	replaced	1.5.6			new	Annex Q
1.5.7	replaced	1.5.7		Annex Q	renamed	Bibliography
	new	1.5.9			new	Annex Z
	new	1.7.2.1 to 3			new	Annex AA
					new	Annex BB
					new	Figure 2D
1.7.10	renumbered	1.7.2.4			new	Figure 2E
1.7.11	renumbered	1.7.10		Figure 2D to Figure 2H	renumbered	Figure 2F to Figure 2K
				Figure F.12	split and renumbered	Figures 2D and F.12
1.7.12	deleted				new	Figure F.14 to F.18
1.7.13 to 15	renumbered	1.7.11 to 13			new	Figure AA.1 to AA.4
1.7.16	renumbered	1.7.2.5			new	Table 1B
1.7.17	renumbered	1.7.14				
	new	1.7.2.6			new	Table 1C
	new	2.1.1.8			new	Table 1D
	new	2.1.1.9			new	Table 2E
				Table 2E to Table 2G	renumbered	Table 2F to Table 2H
					new	Table 2J
2.2.3.1	deleted			Table 2H to Table 2L	renumbered	Table 2K to Table 2N
2.2.3.2	deleted				new	Table 2P

Table Continued on Next Page

Table Continued

First Edition	Action	This edition
2.2.3.3	deleted	
	new	2.3.2.1 to 4
2.6.1 c)	combined with 2.6.1 b)	
2.6.1 d) to g)	renumbered	2.6.1 c) to f)
	new	2.9.4
2.10	replaced	2.10
	new	3.5.4
	new	4.5.1
4.5.1	renumbered	4.5.2
4.5.2	renumbered	4.5.5
	new	4.5.3
	new	4.5.4
	new	4.6.4.1 to 3
	new	5.1.2.1 to 3
	new	5.1.7.1 to 2
	new	5.3.6
5.3.6 to 5.3.8.2	renumbered	5.3.7 to 5.3.9.2

First Edition	Action	This edition
Table 2M	renumbered	Table 2R
Table 2N	renumbered	Table 2Q
Table 4B part 1	renumbered	Table 4B
Table 4B part 2	renumbered	Table 4C
Table 4C	renumbered	Table 4D
Table 4D	renumbered	Table 4E
	new	Table 5C
	new	Table 5D
	new	Table Z.1

BB.2 Changes to this edition

The principal changes in this edition as compared with the first edition of IEC 60950-1 are as follows. Minor changes are not listed.

Audio amplifiers, requirements added for consistency with IEC 60065 (2.1.1.9, 4.5.1).

Ball pressure test, test procedure corrected, different at high ambients (4.5.5).

Batteries, requirements enhanced (4.3.8).

Bibliography moved to a new section after the Annexes

CABLE DISTRIBUTION SYSTEMS, voltage tests clarified (7.4.2, 7.4.3).

Cathode ray tubes, requirements aligned with IEC 60065 (4.2.8).

Connectors, lower minimum CLEARANCES and CREEPAGE DISTANCES (2.10.3.1, 2.10.4.3, G.6).

Data ports for additional equipment, requirements added to limit power output (3.5.4)

Definitions added:

– CHEESECLOTH (1.2.13.15);

– EQUIPMENT, PLUGGABLE (1.2.5.3);

– INSULATION, SOLID (1.2.10.4);

– RATING, PROTECTIVE CURRENT (1.2.13.17);

– SUPPLY, MAINS (1.2.8.3);

– TIME, RATED RESTING (1.2.2.3);

– TISSUE, WRAPPING (1.2.13.16);

– VOLTAGE, RMS WORKING (1.2.9.7).

DC MAINS SUPPLIES, more detailed requirements regarding:

– CLEARANCES [2.10.3.2 b) and c), 2.10.3.7, 2.10.3.9, G.2.2, G.2.3, G.4.1 c), G.5 a)];

– shock hazard (2.1.1.7, 2.1.1.8).

Distance through insulation, requirements clarified (2.10.5) in particular:

– optocouplers, aligned with IEC 60747 (2.10.5.4, Figure F.17);

– non-separable thin sheet material (2.10.5.8).

″Hiccup″ mode of power supplies (2.2.3).

Insulation having starting pulses, requirements added (2.10.1.7, 2.10.2.1, 2.10.3.5).

Insulation in non-separable thin sheets, aligned with IEC 61558-1 (2.10.5.8, 2.10.5.9, Annex AA).

Insulation in wound components, requirements clarified (2.10.5.11, 2.10.5.14, Annex U) including:

– winding wire (2.10.5.12);

– solvent-based enamel on winding wire (2.10.5.1, 2.10.5.13).

Language for marking, requirement for local language removed (1.7.2.1 Note 3).

Limited power sources, tests clarified (2.5).

Mechanical strength, tests clarified (4.2.5, 4.2.6).

Motor test, alternative procedure added (B.6.3).

Non-continuous operation, requirements clarified (1.2.2, 1.7.3, 4.5.2, 5.3.8).

Overcurrent protective devices to be specified if required externally (1.7.2.3).

Overvoltage categories III and IV, requirements added or clarified (2.10.3.1, 5.2.2, G.1.1, Annex Z).

Pollution degrees 2 and 3, CLEARANCES modified to align with IEC 60664-1 (Table G.2).

PROTECTIVE BONDING CONDUCTORS, requirements and test procedure modified (2.6.3.3, 2.6.3.4).

Resistors, bridging insulation (1.5.7).

Ringing signals, test procedure for ″Part 68″ corrected and clarified (M.3).

Scope clarified, this standard can be used for:

– partial compliance of component subassemblies (1.1.1);

– electronic parts of certain other equipment (1.1.1 Note 2).

SELV CIRCUIT and TNV CIRCUIT requirements for separation aligned (2.3.2, 2.3.3, 2.9.4).

Single pole isolators, rules clarified (3.4.6).

Starting pulses, requirements added (2.10.1.7, 2.10.2.1, 2.10.3.5).

Surge suppressors:

– VDRs in PRIMARY CIRCUITS, requirements clarified (1.5.9);

– more detail to determine minimum rated operating voltage (6.1.2.1).

Thermal classes of insulation, classes 200, 220 and 250 added in line with IEC 60085 (Tables 5D, B.1, B.2, C.1, U.2).

TRANSPORTABLE EQUIPMENT, requirements for openings in ENCLOSURES (4.6.4).

TOUCH CURRENT:

– test procedure clarified for equipment with multiple supply connections (5.1.2, 5.1.7.2);

– requirements extended for PLUGGABLE EQUIPMENT TYPE A (5.1.7.1).

Wall-mounted equipment, test procedure modified (4.2.10).

X and Y capacitors bridging insulation, applications clarified, aligned with IEC 60384-14 (1.5.6).

Bibliography

This Bibliography contains information about documents referred to in notes and informative annexes in the standard. Further information on the listed documents, including how to obtain copies, can be found on the following internet sites:

http://www.bsonline.techindex.co.uk

http://www.cas.org

http://www.cenelec.org

http://www.cie.co.at

http://www.icrp.org and (to obtain copies: http://www.elsevier.nl/locate/icrp)

http://www.iec.ch

http://www.iso.org

http://www.itu.int

http://www.standards.com.au

http://wireless.fcc.gov/rules.htm (for CFR 47 Part 68)

For the locations in the standard where these documents are mentioned, see the Index.

IEC 60050-212:1990, *International Electrotechnical Vocabulary – Chapter 212: Insulating solids, liquids and gases*

IEC 60127 (all parts), *Miniature fuses*

IEC 60269-2-1 *Low voltage fuses – Part 2-1: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Sections I to VI: Examples of types of standardized fuses*

IEC 60364-4-41, *Electrical installations of buildings – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60410, *Sampling plans and procedures for inspection by attributes*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-4, *Insulation coordination for equipment within low voltage systems – Part 4: Considerations of high-frequency voltage stress*

IEC 60728-11:2005, *Cable networks for television signals, sound signals and interactive services – Part 11: Safety*

IEC 60896-21, *Stationary lead-acid batteries – Part 21: Valve regulated types – Methods of test*

IEC 60896-22, *Stationary lead-acid batteries – Part 22: Valve regulated types – Requirements*

IEC 61032:1997, *Protection of persons and equipment by enclosures – Probes for verification*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61558-1, *Safety of power transformers, power supply units and similar – Part 1: General requirements and tests*

IEC 61643-21, *Low voltage surge protective devices – Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods*

IEC 61643-311, *Components for low-voltage surge protective devices – Part 311: Specifications for gas discharge tubes (GDT)*

IEC 61643-321, *Components for low-voltage surge protective devices – Part 321: Specifications for avalanche breakdown diode (ABD)*

IEC 61643-331, *Components for low-voltage surge protective devices – Part 331: Specifications for metal oxide varistors (MOV)*

IEC 61965, *Mechanical safety of cathode ray tubes*

IEC Guide 112, *Guide on the safety of multimedia equipment*

IEC TR 62102, *Electrical safety – Classification of interfaces for equipment to be connected to information and communications technology networks* DE DE

ISO 2859-1, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 4046-4, *Paper, board, pulp and related terms – Vocabulary – Part 4: Paper and board grades and converted products*

ISO 4892 (all parts), *Plastics – Methods of exposure to laboratory light sources*

ITU-T Recommendation K.11, *Principles of protection against overvoltages and overcurrents*

ITU-T Recommendation K.20, *Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents*

ITU-T Recommendation K.21, *Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents*

ITU-T Recommendation K.27, *Bonding configurations and earthing inside a telecommunication building*

ITU-T Recommendation K.45, *Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents*

ITU-T Recommendation P.360, *Efficiency of devices for preventing the occurrence of excessive acoustic pressure by telephone receivers and assessment of daily noise exposure of telephone users* DE DE DE

AS/NZS 3112, *Approval and test specification – Plugs and socket-outlets*

BS 1363 (all parts), *13 A plugs, socket-outlets and adaptors*

CAS#110-54-3, *American Chemical Society definition*

CFR 47, Part 68: *Code of Federal Regulations (USA) Part 68: Connection of terminal equipment to the telephone network (commonly referred to as "FCC Rules, part 68")*

CIE Publication 63, *The spectroradiometric measurement of light sources*

EN 50272-2, *Safety requirements for secondary batteries and battery installations – Part 2: Stationary batteries*

EN 60950-1, *Information technology equipment – Safety – Part 1: General requirements*

ICRP 60, *Recommendations of the International Commission on Radiological Protection*

Annex NAA
(normative)
Markings and instructions

This annex identifies the markings and instructions required for Canada and the U.S. Excluding the words ″ WARNING″ and ″ CAUTION,″ wording equivalent to that provided in this annex may be used.

French translations of required markings are considered informative. It is the responsibility of the manufacturer to provide bilingual markings, where applicable, in accordance with local jurisdictional requirements.

NOTE 1 In Canada, there are two official languages, English and French. This annex lists acceptable French translations of the markings specified in this standard.

NOTE 2 Underlining to indicate text added to IEC 60950-1 is not used in this annex.

NOTE 3 The complete text of Annex NAA is a national difference. The national difference types are noted in the margin or in the last column of the table.

Other markings may be required.

Annex NAA

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/instruction	Example of French text for marking/instruction	
1.1.1	Equipment intended for use exclusively outside of a computer room need not be subjected to computer room-based regulatory requirements if the equipment is marked, or provided with installation instructions, indicating that the equipment is not intended for use in a computer room as defined in the Standard for the Protection of Information Technology Equipment, ANSI/NFPA 75.	Not for use in a computer room as defined in the Standard for the Protection of Information Technology Equipment, ANSI/NFPA 75.	Ne peut être utilisé dans une salle d'ordinateurs telle que définie dans la norme ANSI/ NFPA 75 Standard for Protection of Information Technology Equipment	D1

Annex NAA Continued on Next Page

Annex NAA Continued

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/instruction	Example of French text for marking/instruction	
1.5.5	Each detachable external interconnecting cable (with terminations), 3,05 m or less in length and furnished as part of the equipment, shall be marked or similarly identified in the installation instructions with the name, trademark or trade name of the organization that is responsible for the equipment and the organization's identifying number or equivalent designation for the cable. The marking may be applied on the cable at any location. This marking need not comply with the requirements in the Standard for Marking and Labeling Systems, UL 969, or Adhesive Labels, CSA C22.2 No. 0.15. This requirement does not apply to interconnecting cable types which are specified in the National Electrical Code or the Canadian Electrical Code.			D2
1.5.5	The output connectors for other than limited-power and TNV CIRCUITS shall be marked or otherwise described in installation instructions to identify the type of circuit, the intended cable type or the relevant circuit characteristics.	″ DP-1″ or ″ DP-2″	″DP-1″ or ″DP-2″	D2
1.7	In an operator access area, there shall be indicated on or near each lampholder the maximum wattage, or lamp type number, or model designation.			D2
1.7.1	See Table NAA.1 for guidance on information that may be provided to allow for the proper selection of a power supply.			D2

Table NAA.1 (informative) D2
Guidance to allow for proper selection of power supplies D2

1. The following information may be provided:	2. One of the following classification levels may be provided:	3. One of the following classifications may be provided:

a) Rated output voltage(s);
b) Rated output current(s);
c) Rated output frequency or frequency range or symbol for d.c.;
d) Total maximum output power if it is less than the sum of the powers of the individual outputs;
e) Required rating and type of the overcurrent protection to be provided in the end product, if not provided as an integral part of the power supply; and
f) Output short-circuit current(s).
	a) LEVEL 0: Classification Level 0 (L0) for power supplies that require special additional features or that depend on the host equipment to meet the applicable requirements;
	b) LEVEL 1: Classification Level 1 (L1) for power supplies with output circuits that are either not suitable for, or have not been investigated for SELV CIRCUITS;
	c) LEVEL 2: Reserved for future use;
		a) Method 1: Classification M1 for power supplies using method 1 for isolation of SELV or TNV CIRCUITS from the PRIMARY CIRCUIT or HAZARDOUS VOLTAGE circuits;
		b) Method 2: Classification M2 for power supplies using method 2 for isolation of SELV or TNV CIRCUITS from the PRIMARY CIRCUIT or HAZARDOUS VOLTAGE circuits;
		c) Method 3: Classification M3 for power supplies using method 3 for isolation of SELV CIRCUITS from the PRIMARY CIRCUIT or HAZARDOUS VOLTAGE circuits;

	d) LEVEL 3: Classification Level 3 (L3) for power supplies with output circuits that all meet the requirements for SELV CIRCUITS and that, under any condition of output overloading, do not exceed 240 VA (i.e., the outputs are SELV CIRCUITS and at non-HAZARDOUS ENERGY LEVELS);	d) Method 4: Classification M4 to indicate a multiple output power supply having SELV or TNV CIRCUITS isolated from the PRIMARY CIRCUIT or HAZARDOUS VOLTAGE circuits in any combination of methods 1, 2, and 3. NOTE As an example, an output (of a power supply) designated as ″L3M1″ indicates the particular output: – is a SELV CIRCUIT; – does not exceed 240 VA under any condition of overloading; and – is isolated from the PRIMARY CIRCUIT by DOUBLE or REINFORCED INSULATION.
	e) LEVEL 4: Classification Level 4 (L4) for power supplies with outputs suitable for direct connection to the TELECOMMUNICATION NETWORK; NOTE 1 – The output is suitable for direct connection to the TELECOMMUNICATION NETWORK if the output current is limited to 1,3 A by inherent impedance or by an overcurrent protective device rated no more than 1 A (see 6.3).	
	f) LEVEL 5: Classification Level 5 (L5) for power supplies having output circuits that meet the requirements for SELV CIRCUITS;	

Table NAA.1 (informative) Continued on Next Page

Table NAA.1 (informative) Continued D2

	g) LEVEL 6: Classification Level 6 (L6) to indicate a multiple output power supply having output circuits in any combination of Levels 1, 3, 4, and 5. NOTE 2 – Additional markings are allowed, provided they do not give rise to misunderstanding. NOTE 3 – Conditions of acceptability, if any, should be provided in the installation instructions.	

Annex NAA

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/ instruction	Example of French text for marking/instruction	
1.7.4	See 1.7.4	See 1.7.4	VOIR LA NOTICE D'INSTALLATION AVANT DE RACCORDER AU RÉSEAU	DE
1.7.6	A marking shall be located adjacent to the fuse rating marking provided in operator-serviceable areas to identify the need for using the indicated fuse. The marking shall be located so that it is obvious as to which fuse or fuseholder the marking applies. A single marking is acceptable for a group of fuses.	CAUTION: For continued protection against risk of fire, replace only with same type and rating of fuse.	ATTENTION: Pour ne pas compromettre la protection contre les risques d'incendie, remplacer par un fusible de même type et de mêmes caractéristiques nominales.	D2
1.7.7	Connectors and field-wiring terminals involving external Class 2 or Class 3 circuits shall be provided with a marking indicating the minimum class of the wiring that can be used. The marking shall be located adjacent to the terminals and shall be visible during wiring.	″Class 2″ or ″Class 2 Output″	″Classe 2″ or ″Sortie Classe 2″	D1

Annex NAA Continued on Next Page

Annex NAA Continued

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/ instruction	Example of French text for marking/instruction	
1.7.13	See 1.7.13	See 1.7.13	ATTENTION Il y a danger d'explosion s'il y a remplacement incorrect de la batterie. Remplacer uniquement avec une batterie du même type ou d'un type équivalent recommandé par le constructeur. Mettre au rebut les batteries usagées conformément aux instructions du fabricant.	DE
2.7.6	See 2.7.6	See 2.7.6	ATTENTION. Double pôle/ fusible sur le neutre.	DE
3.2.1.2	Equipment where the d.c. supply circuit is connected to the earthing conductor: Equipment that has the earthed conductor of a d.c. supply circuit connected to the earthing conductor at the equipment shall be provided with a permanent marking located near and in plain view of the field wiring terminals and worded as indicated. Alternatively, the wording can be replaced by the ⚠ symbol on the product if the specified wording appears in the installation instructions.	CAUTION: This equipment has a connection between the earthed conductor of the d.c. supply circuit and the earthing conductor. See installation instructions.	Cet appareil comporte une connexion entre le conducteur relié à la terre du circuit d'alimentation c.c. et son conducteur de terre.	D2

Annex NAA Continued on Next Page

Annex NAA Continued

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/ instruction	Example of French text for marking/instruction	
3.2.1.2	Equipment with provisions to connect the earthed conductor of a d.c. supply circuit: Equipment that has provisions to connect the earthed conductor of a d.c. supply circuit to the earthing conductor at the equipment shall be provided with a permanent marking located near and in plain view of the field wiring terminals and worded as indicated. Alternatively, the wording can be replaced by the ⚠ symbol on the product if the specified wording appears in the installation instructions.	CAUTION: This equipment is designed to permit the connection of the earthed conductor of the d.c. supply circuit to the earthing conductor at the equipment. See installation instructions.	Cet appareil est conçu pour permettre le raccordement du conducteur relié à la terre du circuit d'alimentation c.c. au conducteur de terre de l'appareil.	D2

Annex NAA Continued on Next Page

Annex NAA Continued

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/ instruction	Example of French text for marking/instruction	
3.2.1.2	Equipment where the d.c. supply circuit is connected to the earthing conductor: If equipment has the earthed conductor of a d.c. supply circuit connected to the earthing conductor at the equipment, the equipment shall be provided with a permanent marking located near and in plain view of the field wiring terminals and worded as indicated. Alternatively, the wording can be replaced by the ⚠ symbol on the product if the specified wording appears in the installation instructions.	This equipment has a connection between the earthed conductor of the d.c. supply circuit and the earthing conductor. All of the following installation conditions must be met: – This equipment shall be connected directly to the d.c. supply system earthing electrode conductor or to a bonding jumper from an earthing terminal bar or bus to which the d.c. supply system earthing electrode conductor is connected. – This equipment shall be located in the same immediate area (such as adjacent cabinets) as any other equipment that has a connection between the earthed conductor of the same d.c. supply circuit and the earthing conductor, and also the point of earthing of the d.c. system. The d.c. system shall not be earthed elsewhere. – The d.c. supply source shall be located within the same premises as this equipment. – Switching or disconnecting devices shall not be in the earthed circuit conductor between the d.c. source and the point of the connection of the earthing electrode conductor.	Ce matériel doit être raccordé directement au conducteur de la prise de terre du circuit d'alimentation c.c. ou à une tresse de mise à la masse reliée à une barre omnibus de terre laquelle est raccordée à l'électrode de terre du circuit d'alimentation c.c. Les appareils dont les conducteurs de terre respectifs sont raccordés au conducteur de terre du même circuit d'alimentation c.c. doivent être installés à proximité les uns des autres (p.ex., dans des armoires adjacentes) et à proximité de la prise de terre du circuit d'alimentation c.c. Le circuit d'alimentation c.c. ne doit comporter aucune autre prise de terre. La source d'alimentation du circuit c.c. doit être située dans la même pièce que le matériel. Il ne doit y avoir aucun dispositif de commutation ou de sectionnement entre le point de raccordement au conducteur de la source d'alimentation c.c. et le point de raccordement à la prise de terre.	D2

Annex NAA Continued on Next Page

Annex NAA Continued

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/ instruction	Example of French text for marking/instruction	
3.2.1.2	Equipment with provisions to connect the earthed conductor of a d.c. supply circuit: Equipment which has provisions to connect the earthed conductor of a d.c. supply circuit to the earthing conductor at the equipment shall be provided with a permanent marking located near and in plain view of the field wiring terminals and worded as indicated. Alternatively, the wording can be replaced by the ⚠ symbol on the product if the specified wording appears in the installation instructions.	This equipment is designed to permit the connection of the earthed conductor of the d.c. supply circuit to the earthing conductor at the equipment. If this connection is made, all of the following conditions must be met: – This equipment shall be connected directly to the d.c. supply system earthing electrode conductor or to a bonding jumper from an earthing terminal bar or bus to which the d.c. supply system earthing electrode conductor is connected. – This equipment shall be located in the same immediate area (such as adjacent cabinets) as any other equipment that has a connection between the earthed conductor of the same d.c. supply circuit and the earthing conductor, and also the point of earthing of the d.c. system. The d.c. system shall not be earthed elsewhere. – The d.c. supply source shall be located within the same premises as this equipment. – Switching or disconnecting devices shall not be in the earthed circuit conductor between the d.c. source and the point of connection of the earthing electrode conductor.	Cet appareil est conçu pour permettre le raccordement du conducteur relié à la terre du circuit d'alimentation c.c. au conducteur de terre de l'appareil. Pour ce raccordement, toutes les conditions suivantes doivent être respectées: - Ce matériel doit être raccordé directement au conducteur de la prise de terre du circuit d'alimentation c.c. ou à une tresse de mise à la masse reliée à une barre omnibus de terre laquelle est raccordée à l'électrode de terre du circuit d'alimentation c.c. - Les appareils dont les conducteurs de terre respectifs sont raccordés au conducteur de terre du même circuit d'alimentation c.c. doivent être installés à proximité les uns des autres (p.ex., dans des armoires adjacentes) et à proximité de la prise de terre du circuit d'alimentation c.c. Le circuit d'alimentation c.c. ne doit comporter aucune autre prise de terre. – La source d'alimentation du circuit c.c. doit être située dans la même pièce que le matériel. - Il ne doit y avoir aucun dispositif de commutation ou de sectionnement entre le point de raccordement au conducteur de la source d'alimentation c.c. et le point de raccordement à la prise de terre.	D2

Annex NAA Continued on Next Page

Annex NAA Continued

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/ instruction	Example of French text for marking/instruction	
3.2.3	If the wires in a terminal box or compartment intended for power-supply connection of equipment can attain a temperature higher than 60 °C during the normal-temperature test, the unit shall be marked as indicated in this annex. The marking shall be provided at or near the point at which the supply connections are to be made. The temperature to be used in the marking shall be 75 °C if the temperature attained in the terminal box or compartment is 61 – 75 °C, or 90 °C if the temperature attained in the terminal box or compartment is 75 – 90 °C. Refer to Annex NAE for details regarding the regulatory requirements for supply connections.	For supply connections, use wires suitable for at least _____°C.	Utiliser des fils convenant à une température de _____ °C pour les connexions d'alimentation.	D2
3.3.6	Equipment incorporating field wiring terminals intended to be connected to aluminum conductors shall be so identified for the connection of aluminum conductors. This marking shall be independent of all other markings on the terminal connectors and shall be visible after installation. The terminal for the connection of an equipment protective earthing (grounding) conductor shall not be identified for the connection of an aluminum conductor.	″Use Aluminum Conductors Only″ or ″Use Aluminum or Copper-Clad Aluminum Conductors Only″ if the terminal is intended only for connection to aluminum wire. ″Use Copper or Aluminum Conductors″ or ″Use Copper, Copper-Clad Aluminum, or Aluminum Conductors″ if the terminal is intended for connection to both copper and aluminum wire.	″Utiliser seulement des conducteurs en aluminium ″ or ″Utiliser seulement des conducteurs en aluminium cuivré ″ if the terminal is intended only for connection to aluminum wire. ″Utiliser seulement des conducteurs en cuivre ou en aluminium ″ or ″Utiliser des conducteurs en cuivre, en aluminium ou en aluminium cuivré ″ if the terminal is intended for connection to both copper and aluminum wire.	D1

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Annex NAA Continued

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/ instruction	Example of French text for marking/instruction	
4.2.9	A compartment that houses a high-pressure lamp as mentioned in 4.2.9 shall be marked where readily visible during any approach to enter the compartment to indicate the risk of explosion.	CAUTION: High-pressure lamp may explode if improperly handled. Refer to lamp replacement instructions.	ATTENTION: Les lampes à haute pression peuvent exploser si elles sont mal utilisées. Confier l'entretien à une personne qualifiée.	D2
4.2.11.4	Slide/rail mounted equipment shall be marked, in a location visible to operators when the unit is in its fully extended service position, to indicate that slide/rail mounted equipment is not to be used as a shelf or a work space.	Slide/rail mounted equipment is not to be used as a shelf or a work space.	Le matériel monté sur rails/ coulisseaux ne doit pas être utilisé comme étagère ou espace de travail.	D2
4.3.12	Equipment that uses replenishable liquids as indicated in 4.3.12 shall be marked where it will be clearly visible to persons replenishing the liquid with the generic type or the trade name of the liquid to be used.	CAUTION: For continued protection against possible fire, use only: (type of liquid used, for example: alcohol, kerosene and the like) base liquid classed ____ (for example 30 – 40) or lower with respect to fire hazard, or [manufacturer's specific material (trade name) which has been determined to be acceptable for the purpose].	ATTENTION: Pour assurer la protection contre les risques d'incendie, utiliser seulement (type of liquid used, for example: alcohol, kerosene and the like) classé _____ (for example 30 – 40) ou moins en ce qui concerne les risques d'incendie, ou [manufacturer's specific material (trade name) which has been determined to be acceptable for the purpose].	D2
4.3.13.2	Equipment which produces x-radiation and does not comply with 4.3.13 under all conditions of servicing shall be marked where readily visible during servicing to indicate the presence of radiation. Service conditions include the removal of shields, windows, cages and covers, with or without the chassis removed from its enclosure.	CAUTION: Servicing this unit with circuits energized may involve exposure to x-radiation. Refer to service manual for radiation protection procedure.	ATTENTION: L'entretien de cet appareil alors que les circuits sont sous tension peut entraîner l'exposition à des rayons X. Voir le guide d'entretien pour les précautions à prendre.	D2

Annex NAA Continued on Next Page

Annex NAA Continued

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/ instruction	Example of French text for marking/instruction	
4.7.3.1	Equipment evaluated for installation in space used for environmental air as described in Section 300-22(C) of the National Electrical Code, ANSI/ NFPA 70, and Sections 2-128, 12-010(3) and 12-100 of the Canadian Electrical Code, Part 1, CSA C22.1 shall be marked or provided with installation instructions indicating suitability for installation in such locations. Equipment that is not evaluated for installation in areas covered by Section 300-22(C) of the National Electrical Code, and Sections 2-128, 12-010(3) and 12-100 of the Canadian Electrical Code, Part 1, CSA C22.1 shall not be provided with this marking, nor shall its installation instructions describe such installation.	Suitable for use in environmental air space in accordance with Section 300-22(C) of the National Electrical Code, and Sections 2-128, 12-010(3) and 12-100 of the Canadian Electrical Code, Part 1, CSA C22.1.	Peut être utilisé dans des gaines transportant de l'air traité, conformément à la section 300-22(C) du National Electrical Code et aux articles 2-128, 12-010(3) et 12-100 du Code Canadien de l'électricité, Première partie, CSA C22.1.	D1
5.1.7	See 5.1.7	See 5.1.7	COURANT DE FUITE ÉLÉVE Raccordement à la terre indispensable avant le raccordement au réseau	DE
5.1.8.2, 5.1.8.3	For pluggable equipment, if leakage current due to ringing voltage exceeds 3,5 mA, a label bearing the warning indicated in this annex, or similar wording, shall be affixed adjacent to telecommunication ports.	HIGH LEAKAGE CURRENT Connect permanent earthing conductor before connecting telephone lines.	COURANT DE FUITE ÉLEVÉ Raccordement à la terre indispensable avant le raccordement au réseau.	D2

Annex NAA Continued on Next Page

Annex NAA Continued

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/ instruction	Example of French text for marking/instruction	
5.1.8.2, 5.1.8.3	For ringing voltage leakage current in excess of 3.5 mA: Pluggable equipment shall be marked with the complete earthing installation instructions, or with a reference to the earthing installation instructions. Installation instructions furnished with the product shall include prominent mention of the text provided in this annex.	1. A supplementary equipment earthing conductor is to be installed between the product or system and earth, that is, in addition to the equipment earthing conductor in the power supply cord. 2. The supplementary equipment earthing conductor may be not smaller in size than the unearthed branch-circuit supply conductors. The supplementary equipment earthing conductor is to be connected to the product at the terminal provided, and connected to earth in a manner that will retain the earth connection when the power supply cord is unplugged. The connection to earth of the supplementary earthing conductor shall be in compliance with the appropriate rules for terminating bonding jumpers in Part V of Article 250 of the National Electrical Code, ANSI/NFPA 70, and Section 10 of Part I of the Canadian Electrical Code, Part I, CSA C22.1. Termination of the supplementary equipment earthing conductor may be made to building steel, to a metal electrical raceway system, or to any earthed item that is permanently and reliably connected to the electrical service equipment earthed.	1. Un conducteur de terre additionnel doit être installé entre l'appareil ou le réseau et la terre. Ce conducteur de terre s'ajoute à celui du cordon d'alimentation de l'appareil. 2. La section du conducteur de terre additional ne doit pas être inférieure à celle des conducteurs de dérivation non mis à cette fin et raccordé à la terre de façon que la continuité des masses soit maintenue lorsque le cordon d'alimentation est débranché. La connexion à la terre du conducteur de terre additionnel doit être conforme aux exigences pertinentes visant le raccordement à des tresses de mise à la masse indiquées à la partie K de l'article 250 du NEC (norm ANSI/NFPA 70) et à la section du CCE, Première partie. Le conducteur de terre additionnel peut être raccordé à la structure d'acier du bâtiment, à un réseau de canalisation électrique méttallique ou à tout autre point raccordé de façon permanente et sûre à la prise de terre du réseau. 3. Les conducteurs de terre nus, recouverts ou isolés sont acceptables. Le revêtement des conducteurs recouverts ou isolés doit être vert ou vert à rayures jaunes.	D2

Annex NAA Continued on Next Page

Annex NAA Continued

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/ instruction	Example of French text for marking/instruction	
		3. Bare, covered or insulated earthing conductors are acceptable. A covered or insulated earthing conductor shall have a continuous outer finish that is either green, or green with one or more yellow stripes.		
6	The indicated instructions are appropriate for telephones connected to a telecommunication network. In addition, item 3 is appropriate for all telephones, whether wired or wireless. The instructions shall be in the form of a separate booklet or sheet, or shall be part of the instruction manual separated in format from the other instructions and appearing before any operating instructions. Symbols, graphics and illustrations, if used, shall be adequately defined. The instructions shall start with the words, ″IMPORTANT SAFETY INSTRUCTIONS″ or equivalent, emphasized and clearly distinguishable from the rest of the text.	**IMPORTANT SAFETY INSTRUCTIONS** When using your telephone equipment, basic safety precautions should always be followed to reduce the risk of fire, electric shock and injury to persons, including the following: 1. Do not use this product near water, for example, near a bath tub, wash bowl, kitchen sink or laundry tub, in a wet basement or near a swimming pool. 2. Avoid using a telephone (other than a cordless type) during an electrical storm. There may be a remote risk of electric shock from lightning. 3. Do not use the telephone to report a gas leak in the vicinity of the leak. SAVE THESE INSTRUCTIONS	**IMPORTANTES MESURES DE SÉCURITÉ** Certaines mesures de sécurité doivent être prises pendant l'utilisation de matérial téléphonique afin de réduire les risques d'incendie, de choc électrique et de blessures. En voici quelquesunes: 1. Ne pas utiliser l'appareil près de l'eau, p.ex., près d'une baignoire, d'un lavabo, d'un évier de cuisine, d'un bac à laver, dans un sous-sol humide ou près d'une piscine. 2. Éviter d'utiliser le téléphone (sauf s'il s'agit d'un appareil sans fil) pendant un orage électrique. Ceci peut présenter un risque de choc électrique causé par la foudre. 3. Ne pas utiliser l'appareil téléphonique pour signaler une fuite de gaz s'il est situé près de la fuite. CONSERVER CES INSTRUCTIONS	D2
6	Telecommunication-type connectors and terminals, when not used for connection to a telecommunication network, shall be provided with a marking identifying the specific function or circuit characteristics the connector or terminal is used for.			D2

Annex NAA Continued on Next Page

Annex NAA Continued

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/ instruction	Example of French text for marking/instruction	
	Examples of telecommunication connectors are RJ and CA series modular jacks in the U.S. and Canada, respectively, 50 pin ribbon connectors, and insulation piercing terminals.			
6.3	Equipment intended to be remotely powered over telecommunication wiring systems shall be marked as indicated in this annex adjacent to the receptacle or connection.	″Telephone Power″ and the symbol ⚠ or the words ″See instruction manual.″ The instruction manual shall include the following: a) the current limitations and maximum overcurrent protection for telecommunication circuits; b) reference to the specific power supply or current limiting device provided with the product; c) detailed instructions showing the proper method of installation and connections to the telecommunication wiring system.	″Alimentation du système téléphonique″ and the symbol ⚠ or the words ″Voir le manuel d'instructions″	D2
6.4	Where No. 26 AWG line cord is required by Figure 6C, the telecommunication line cord shall either be provided with the equipment or shall be described in the safety instructions.	″CAUTION – To reduce the risk of fire, use only No. 26 AWG or larger telecommunication line cord.″	″ATTENTION – Pour réduire les risques d'incendie, utiliser uniquement des conducteurs de télécommunications 26 AWG au de section supérleure. ″	D2

Annex NAA Continued on Next Page

Annex NAA Continued

Subclause reference from IEC 60950-1	Requirement	Example of English text for marking/ instruction	Example of French text for marking/instruction	
Annex NAC	Equipment intended for use with a generic secondary protector shall be marked as indicated in this annex. The instructions shall include prominent mention of the type of protection or protective device that is required, along with specific information regarding the location of and installation procedures for the protector.	For use only on telephone wiring containing secondary protection. See instruction manual.	Utiliser seulement avec un réseau téléphonique comprenant un dispositif de protection secondaire. Voir le manuel d'instructions.	D2
Annex NAC	Equipment intended for use with a specific primary or secondary protector shall be marked as indicated in this annex. The instructions shall include prominent mention of the manufacturer and type of protective device that is required, along with specific information regarding the location of and installation procedures for the operator.	For use only on telephone wiring protected by a (manufacturer and type of protector) protector. See instruction manual.	Utiliser seulement avec un réseau téléphonique comprenant un dispositif de protection (manufacturer and type of protector). Voir le manuel d'instructions.	D2

Annex NAB D2
(informative)
D.C. powered equipment and centralized d.c. power systems
(see 1.6.1.2)

NOTE 1 Underlining to indicate text added to IEC 60950-1 is not used in this annex.

NOTE 2 The complete text of Annex NAB is a D2 national difference.

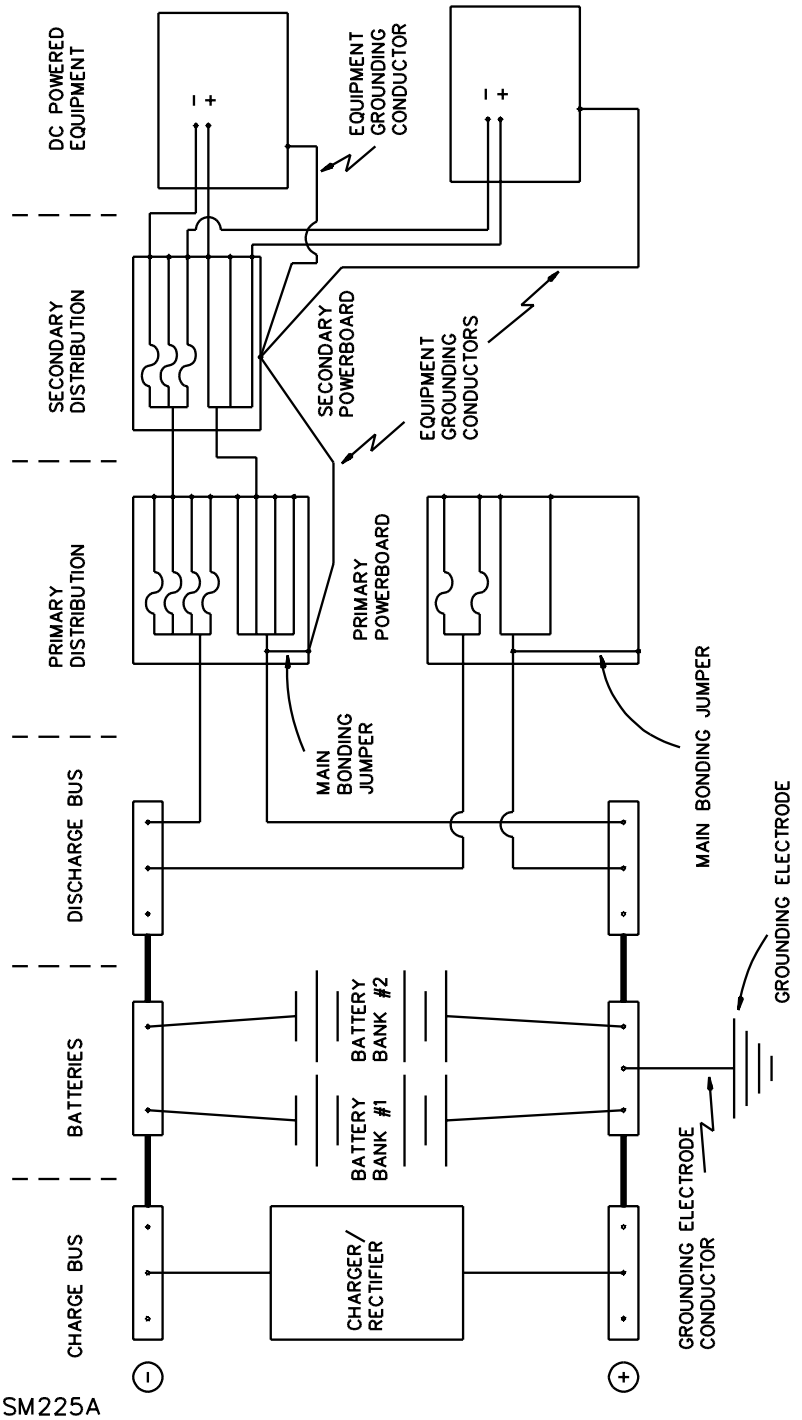
NAB.1 System descriptions

A centralized d.c. power distribution system is a power distribution system consisting of open batteries, charger/rectifier circuits and primary and secondary distribution equipment that is intended to provide power to equipment loads. Systems rated not less than 48 V have one point directly earthed, the exposed conductive parts of the installation being connected to that point by protective earth conductors. Systems rated less than 48 V may have one point directly earthed.

Two types of systems are recognized according to the arrangement of earthed and protective earth (earthing) conductors, as follows:

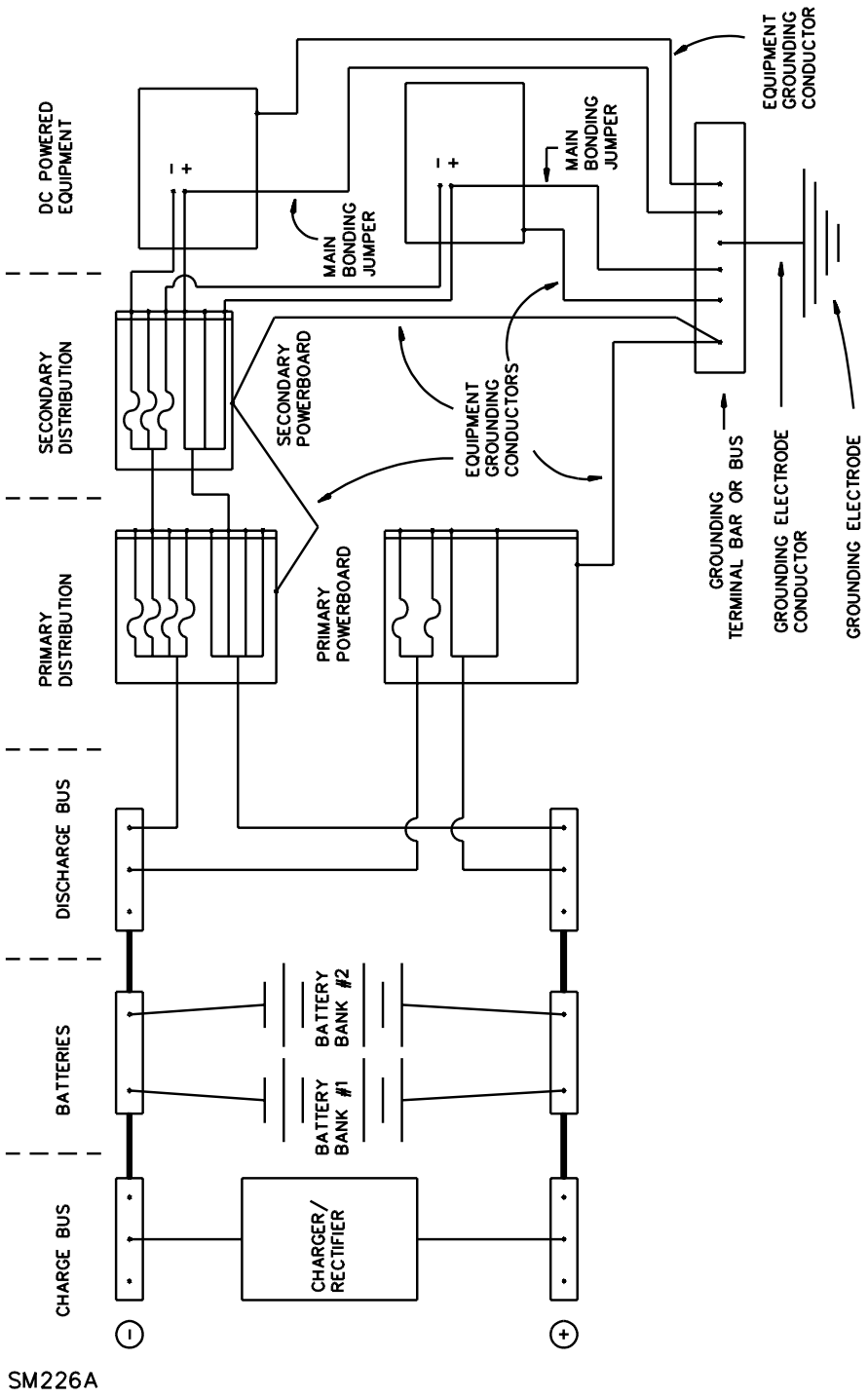
– source earthed d.c. power systems, in which the connection to the earthing electrode is located at the source and separate earthed and protective earth conductors are provided throughout the system. See Figure NAB.1.

– d.c. power system earthed at the equipment location, in which the connection to the earthing electrode is located in the area where the load equipment is to be installed, typically known as the ″earthing window.″ See Figure NAB.2.



For the purpose of applying this figure, grounded and grounding are equivalent to earthed and earthing, respectively.

Figure NAB.1 – Typical centralized d.c. power system – plant and distribution source-grounded d.c. power system



For the purpose of applying this figure, grounded and grounding are equivalent to earthed and earthing, respectively.

Figure NAB.2 – Typical centralized d.c. power system – plant and distribution d.c. power system grounded at the equipment location

Annex NAC

D2 ***NAA***

(normative)

Power line crosses

(see 6.4)

NOTE 1 Underlining to indicate text added to IEC 60950-1 is not used in this annex.

NOTE 2 The complete text of Annex NAC is a D2 national difference.

NAC.1 Equipment evaluation

Equipment shall be evaluated while in each operating state that affects compliance (usually, on-hook and off-hook).

Equipment that functions as either terminal or series equipment shall be evaluated for both functions.

NAC.2 Test set-up

NAC.2.1 Equipment

Equipment shall be mounted as intended for its use. Tests may be conducted on either the equipment as an assembly, on individual subassemblies, or on a partial assembly containing those components that can be exposed to an overvoltage condition. Two single plies of cheesecloth shall be wrapped tightly around the assembly, subassembly or partial assembly.

NOTE 1 Bleached cotton cheesecloth, running 28 – 30 m/kg and having what is known as a ″count of 32 X 28 inch″ – that is, for any square inch, 32 threads in one direction and 28 threads in the other direction (for any square centimeter, 13 threads by 11 threads), is considered suitable for this purpose.

NOTE 2 Cheesecloth meeting the requirements of CSA C22.2 No. 0 is considered suitable for this purpose.

Functional circuitry shall be used for each test. Circuitry that is damaged during testing may be either repaired or replaced for subsequent tests. After any of the specified tests, equipment may be returned to ambient temperature before performing any additional tests. Alternatively, separate samples may be used for each test.

NAC.2.2 Wiring connections

The following requirements apply:

a) Except where a wiring simulator is required, equipment that has a removable telecommunication line cord shall be connected to the test circuit with a line cord having 0,4 mm (No. 26 AWG) or larger copper wire conductors and not more than 1 Ω total resistance. However, equipment supplied with a line cord having 0,4 mm (No. 26 AWG) copper conductors, and having installation instructions for equivalent replacement cords, shall be evaluated with the line cord provided.

b) Equipment that has a permanently attached telecommunication line cord (one that requires use of a tool to remove) or a permanently attached handset cord that can be subjected to overvoltage conditions, and for which these cords have not been approved as component parts, shall have the cord or cords prepared for testing as described in the Standard for Communications-Circuit Accessories, UL 1863, and CSA C22.2 No. 233, Cords and Cord Sets for Communication Systems.

c) For equipment intended to be field-wired to the telecommunications network, a 300 mm length of 0,4 mm (No. 26 AWG) solid copper wire shall be used to connect the equipment to the test circuit.

NAC.2.3 Wiring simulator

A wiring simulator shall be used in test conditions 1 and 5 where

– a minimum 26 AWG telecommunications line cord is not provided; or

– minimum 26 AWG wiring is not specified for field-wired telecommunications equipment.

The wiring simulator shall be

– a 50 mm length of 0,2 mm (No. 32 AWG) bare or enameled solid copper wire;

– a fuse having a time-current characteristic comparable to a 0,2 mm wire [Bussman Mfg. Co. Type MDL-2 A fuse or equivalent]; or

– for test condition 1 only, a current probe consisting of a 300 mm length of at least 0,5 mm (No. 24 AWG) copper wire to determine the I^2t imposed on the connecting wiring.

Compliance is determined by the 50 mm length of wire or the fuse not interrupting current during the test, or by the current probe measurement indicating an I^2t less than 100A^2-s.

NAC.3 Test conditions

NAC.3.1 General conditions

Test voltages shall be applied to a representative pair or pairs of the equipment's leads that connect to outside cable as indicated (M indicates differential mode, L indicates common mode and F indicates 4-wire test mode):

– Terminal equipment with an earthing connection shall be subjected to common mode (longitudinal) L-type overvoltage test conditions using the test circuit described in Figure NAC.1.

– Terminal equipment shall be subjected to differential mode (metallic) M-type overvoltage test conditions using the test circuit described in Figure NAC.2; if the equipment also has an earthing connection, either tip shall be earthed or ring shall be earthed during testing, whichever is more severe.

– Terminal equipment which connects to a 2-pair (4-wire) TELECOMMUNICATION NETWORK shall be subjected to pair-to-pair F-type overvoltage test conditions using the test circuit described in Figure NAC.3. Four-wire testing is not required provided any of the following conditions are satisfied:

• the equipment circuitry limits the current in each line to an I^2t less than $100A^2$-s and analysis indicates that the test voltages would not cause excessive power dissipation in the affected components; or

• analysis indicates that all circuit elements that would be stressed by the 4-wire test voltages are evaluated in the differential mode or common mode test; or

• a dielectric barrier at the test voltage is provided between the wire pairs.

– Series equipment shall be subjected to:

• all common mode, differential mode and 4-wire tests without terminal equipment being connected; and

• differential mode tests M-2, M-3 and M-4 with terminal equipment connections short-circuited.

PLUGGABLE EQUIPMENT TYPE A that is not installed by SERVICE PERSONNEL shall be evaluated with and without the power-supply cord earthing lead connected to earth if that earthing can affect compliance.

The open circuit voltage at 50 or 60 Hz, and short-circuit current (set before the test voltage is applied) available from the voltage source, are given in the following test requirements.

NAC.3.2 Special conditions

Telecommunication equipment often is used with a primary or secondary protector. A primary protector is a voltage limiting device. A secondary protector is a current limiting device. A secondary protector may, but is not required to, provide voltage limiting acceptable for protecting telephone equipment.

NAC.3.2.1 Primary protectors

On equipment installed by SERVICE PERSONNEL and intended for use only with a specified primary protector that complies with the Standard for Protectors for Paired Conductor Communications Circuits, UL 497, and CSA C22.2 No. 226, Protectors in Telecommunication Networks, the voltage may be adjusted based on the 3-sigma breakdown voltage over life for the protector. Since the test voltage is based on the maximum voltage that will not break down the protector, these tests are performed without the actual protector in place.

NOTE Primary protectors are generally under the exclusive control of the service providers, not the equipment manufacturer. Therefore, unless the equipment is intended to be installed by a service provider and it can be ensured that the manufacturer's recommendation for a specific primary protector will be followed, or the primary protector is provided as part of the equipment construction, equipment should be evaluated without a primary protector in the test circuit.

NAC.3.2.2 Secondary protectors

Equipment installed by SERVICE PERSONNEL and intended for use only with a secondary protector that complies with the Standard for Secondary Protectors for Communication Circuits, UL 497A, and CSA C22.2 No. 226, or both, shall be evaluated either together with the protector(s) or to the let-through voltage and current characteristics of the protector(s). A secondary protector simulator shall be used when the secondary protector does not have a specified current limit.

A secondary protector simulator, intended to simulate the maximum permissible I^2t allowed by a generic secondary protector, shall be used in Test Conditions 1 and 5. The secondary protector simulator shall consist of the test fuse used in the Standard for Secondary Protectors for Communication Circuits, UL 497A, and CSA C22.2 No. 226, Protectors in Telecommunication Equipment, to indicate proper operation of a secondary protector. Test Conditions 2, 3 and 4 shall be evaluated without use of a secondary protector simulator.

NOTE Although the secondary protector simulator may be the same device as the wiring simulator, it serves a different purpose. When the secondary protector simulator is specified for use in the test circuit, it is allowed to interrupt the test current.

NAC.3.3 Tests

Tests M-1, L-1 and F-1 These tests simulate contact between a power system primary and a telecommunications cable.

Test Condition 1: 600 V, 40 A, applied for 1,5 s.

NOTE 1 The L-1 test may be conducted on one lead at a time.

Tests M-2, L-2 and F-2 These tests simulate short-term induction as a result of a power system primary fault to a multi-earth neutral.

Test Condition 2: 600 V, 7 A, applied for 5 s.

Tests M-3, L-3 and F-3 These tests simulate long duration induction as a result of a power system fault to earth.

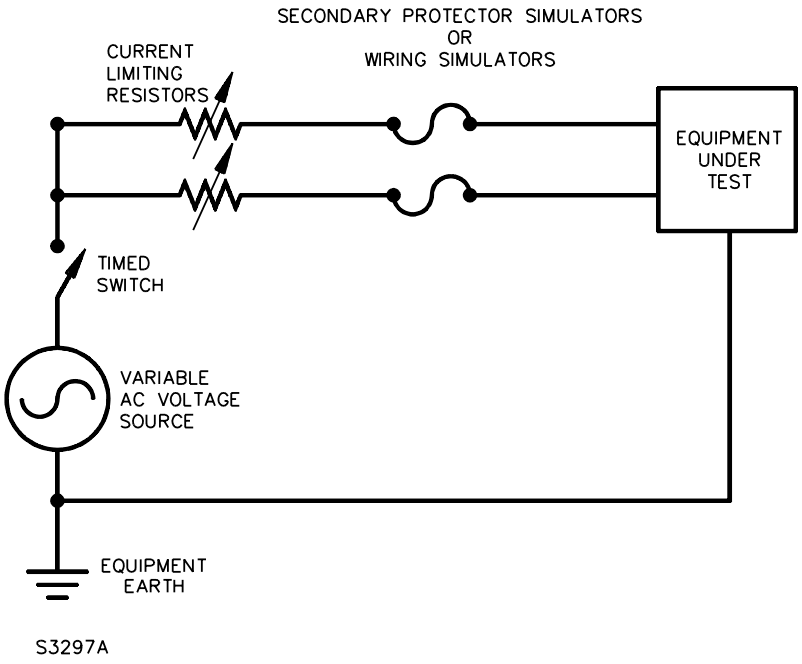


Figure NAC.1 – Circuit for common mode (longitudinal) overvoltage tests

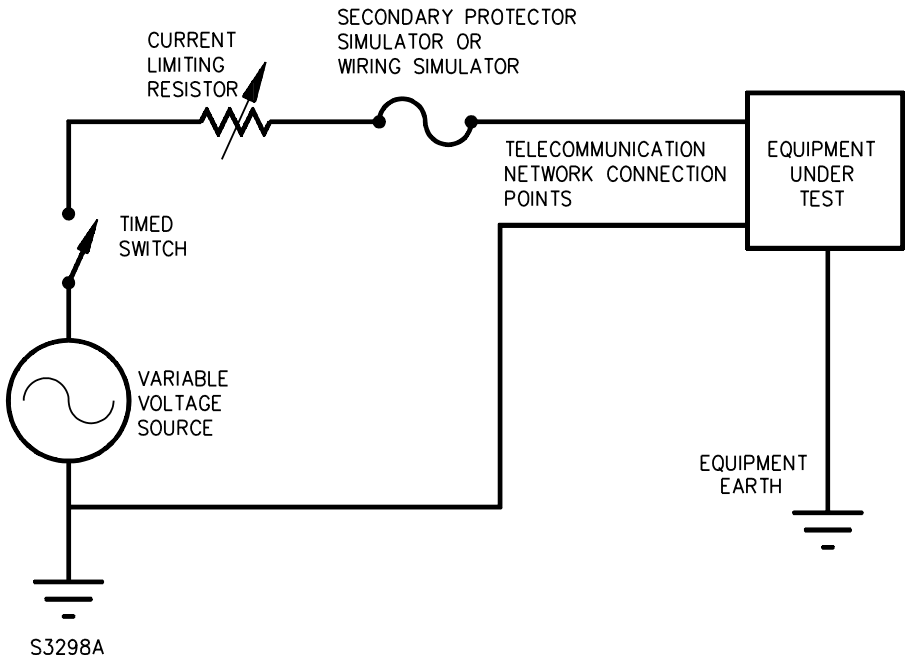


Figure NAC.2 – Circuit for differential mode (metallic) overvoltage tests

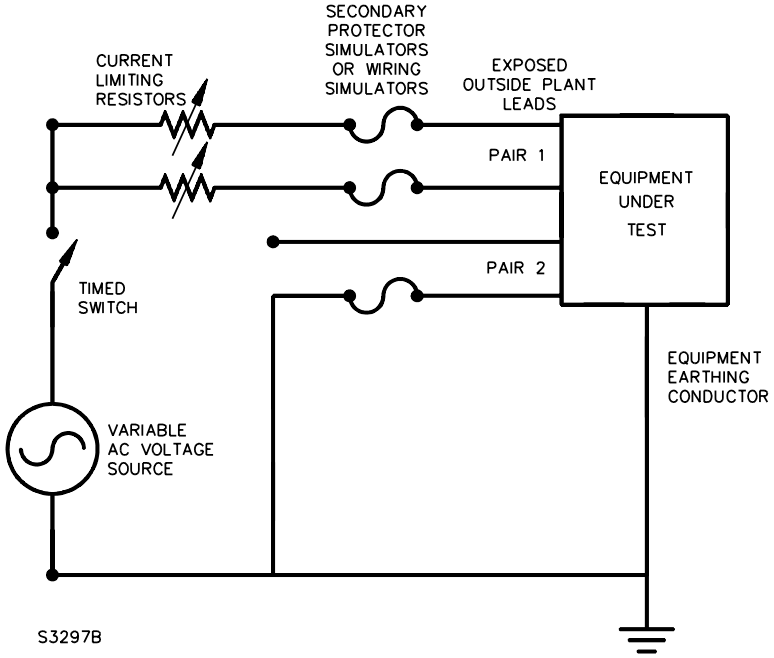


Figure NAC.3 – Circuit for 4-wire overvoltage tests

Test Condition 3: 600 V, 2,2 A, applied per Test Duration.

Test Condition 3A: If an open circuit condition occurs during Test Condition 3, an additional test shall be conducted at 600 V, at a current no greater than 2,2 A, whose value does not result in an open circuit condition and is intended to produce maximum heating, applied per Test Duration.

NOTE 2 Where a fuse causes the open circuit in Test Condition 3, as an alternative to testing the equipment with its fuse in place, a short-circuit current value of up to 135 percent of the fuse rating, with the fuse bypassed, may be used.

Tests M-4, L-4 and F-4 If a voltage limiter rated by the manufacturer to conduct at 285 V peak or more operates during Test Condition 3 or 3A, the following test shall be conducted.

Test Condition 4: A voltage whose peak value is below the conduction voltage, at a current no greater than 2,2 A, whose value does not result in an open circuit condition and is intended to produce maximum heating, applied per Test Duration.

NOTE 3 Where a fuse causes the open-circuit in Test Condition 3, as an alternative to testing the equipment with its fuse in place, a short-circuit current value of 135 percent of the fuse rating, with the fuse bypassed, may be used.

NOTE 4 A voltage limiting device that does not have a breakdown characteristic (such as a metal oxide varistor) is considered to be conducting when the current through it exceeds 5 mA.

Test L-5 This test simulates a contact between a power mains cable and a telecommunication cable.

Test Condition 5: 120 V, 25 A, applied per Test Duration.

Test Duration

Test Conditions 3, 4 and 5 are to be conducted for 30 minutes or until an open circuit occurs through the action of a current limiting device.

NOTE 5 An unacceptable condition will typically manifest itself within 30 minutes; hence, the tests are normally limited to 30 minutes. If at the end of 30 minutes it appears possible that a risk of fire, electric shock or injury to persons will result eventually, the test should be continued until ultimate results are obtained – maximum 7 hours.

NAC.4 Compliance

In addition to the compliance criteria specified for the wire simulator and current probe, compliance is checked by all of the following:

a) There shall be no ignition or charring of the cheesecloth indicator. Charring is deemed to have occurred when threads have been reduced to char by a glowing or flaming condition.

b) After the completion of each overvoltage test, the equipment under test shall continue to comply with the requirements in 6.2.

NOTE In many cases, it will be obvious from the results of the tests that compliance with one or more of these clauses has not been affected by the applied potentials. Where there is doubt or where continued compliance cannot be determined, the appropriate tests in these clauses might need to be repeated.

Annex NAD
(normative)
Acoustic tests

D2

NOTE 1 Underlining to indicate text added to IEC 60950-1 is not used in this annex.

NOTE 2 The complete text of Annex NAD is a D2 national difference.

NAD.1 General

Manufacturers of information technology equipment having acoustic outputs at communication receivers and similar devices used for voice telecommunication, regardless of transmission medium (e.g., TELECOMMUNICATION NETWORK, CABLE DISTRIBUTION NETWORK, wireless network), shall demonstrate that the equipment complies with the appropriate acoustics requirements related to short duration impulses and long duration disturbances as described in NAD.3 and NAD.4.

The compliance tests described in this Annex require simulation of the TELECOMMUNICATION NETWORK or CABLE DISTRIBUTION SYSTEM, or other transmission medium (e.g., wireless) to perform the following functions:

– generation of test signals that produce acoustic output at the communication receiver; and

– provision of d.c. power superimposed on the above signals, as applicable.

Compliance is checked by inspection, by evaluation of the data provided by the manufacturer, and if necessary, by testing in accordance with the specified parts of this Annex. When IEEE 269 (Method 1 of NAD.3 and NAD.4) permits the use of alternate ear simulators, test fixtures, or methods of test, the choice is specified by the manufacturer. It is not required to test using more than one ear simulator.

NAD.2 Acoustic pressure limiting

These requirements apply to equipment that is intended to be connected directly or indirectly to a TELECOMMUNICATION NETWORK or CABLE DISTRIBUTION SYSTEM or other transmission medium, and that contains an earpiece or receiver that is held against or in the ear. The effect on human hearing of impulsive noise or of disturbances that are less than 0,5 s in duration shall be evaluated under NAD.3. The effect of longer disturbances, such as those that might be produced during tone-type dialing, shall be evaluated under NAD.4.

The acoustic pressure limits in NAD.3 and NAD.4 are specified at the ear reference point (ERP), as defined in IEEE 269, and are relative to 20 µPa.

For equipment not intended to be connected to a PSTN (such as connected behind a PABX or connected to a digital TELECOMMUNICATION NETWORK), a test voltage may be applied to the equipment under test that simulates the effect of the PABX interface or the digital TELECOMMUNICATION NETWORK interface between the equipment under test and the PSTN.

NOTE 1 These requirements are based on ITU-T Recommendation P.360, which assumes a 2 s exposure for long-duration disturbances and no more than one incident per day. Authorities might deem it appropriate to use lower limits for specific cases, for instance for the headsets used by operators.

NOTE 2 A PABX or digital TELECOMMUNICATION NETWORK termination can block network voltages, in which case no test voltage is applied. However, signals that can be generated by the system should be considered.

NOTE 3 Where the actual measurement can be made at the drum reference point (DRP), such as for insert type earphones, measurements may be corrected to the ear reference point (ERP) in accordance with IEEE 269 Annex C.

NOTE 4 Special attention is directed to Annex B, Alternative ear simulators, mouth simulator, and test fixture, and its Table B.1, Ear simulator usage, of IEEE 269. Annex B of IEEE 269 permits specialized ear simulators to be used as alternates if the applicable performance specification requires or allows it and the associated application requirements are met. For example, the Type 1 ear simulator may be used for large, supra-aural or supra-concha, hard-cap, conically symmetrical receivers, which naturally seal to the simulator rim, in the band of 100 – 4000 Hz. While IEEE 269 recommends that these receivers "should" also be tested in a realistic unsealed condition using the Type 3.3 or Type 3.4 ear simulator as specified in IEEE 269 Annex B, it is not normative to do so.

NOTE 5 The alternative methods allowed in NAD.3.1 and NAD.4.1 are considered to provide equivalent assessment for ″safety″ of ITE due to acoustic pressure. However since the original purpose of IEEE 269 is to provide standard methods for measuring ″transmission performance″ of analog and digital telephone sets, handsets and headsets, the actual measurements per either option might not provide equivalent ″transmission performance″ results.

NAD.3 Short-duration impulses

The peak acoustic pressure measured at the earpiece or receiver of the communications handset or headset shall be limited to reduce the risk of permanent hearing damage due to short-duration impulses (≤ 0,5 s) that can occur under normal operation.

In addition, the equipment also shall be checked for self-generated acoustic impulses such as those produced by operation of the hook switch or by dialing.

Compliance is checked by following the methods described in NAD.3.1 or NAD.3.2. During the above tests, the peak acoustic pressure level measured in the artificial ear or coupler shall not exceed 136 dB (relative to 20 µPa) at ear reference point (ERP).

NAD.3.1 Method 1

Measurements are made following the methods described in IEEE 269, Clause 5, for test equipment and positioning, Clause 7.10 for analog communication sets, and Clause 8.13 for digital communication sets.

NAD.3.2 Method 2

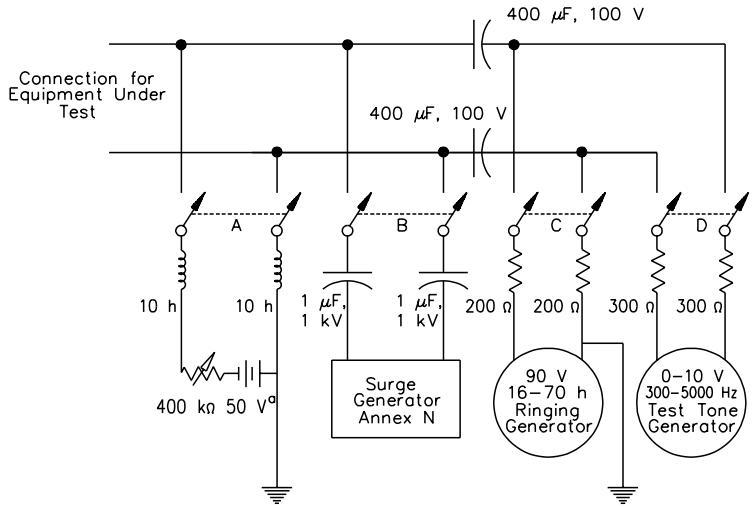
A handset or headset that is of a design compatible with the artificial ear of IEC 60318 shall be placed under normal operating conditions in position for the exchange of calls (such as talking state with the handset raised), and fixed to an artificial ear conforming to the requirements of IEC 60318. The earpiece shall be sealed to the knife-edge of the artificial ear. Holes in the earpiece which partially fall outside the knife-edge of the artificial ear shall be sealed. Other types of handset and headset should use Method 1.

Response for insert type earphones shall be measured with an in-ear coupler as indicated in the American National Standard for Occluded Ear Simulator, ANSI/ASA S3.25-1989, extended by an ear canal simulator consisting of a cylinder 8 mm long and 7,5 mm in diameter. The tip of the earphone shall be inserted until tangent with plane X-X' shown in Figure 1 of ANSI/ASA S3.25-1989.

The artificial ear shall be electrically connected to a precision sound level meter conforming with IEC 60651 or IEC 61672-1:2002, with an unweighted peak-hold response and capable of measuring impulses having a duration less than 50 µs.

The equipment under test shall be connected to a network simulator and impulse generator as shown in Figure NAD.1, by closing switches A and B. An equivalent network simulator may be used.

One positive and one negative polarity impulse shall be applied to the equipment under test with Uc = 1 kV. For analog equipment, the impulses shall be applied to the receive circuit. For digital equipment, the impulses shall be applied to both the transmit and receive circuits.



NOTE Surge generator is 10/700 µs as described in Annex N.

Figure NAD.1 – Example of a line simulator for a two-wire analogue telephone

NAD.4 Long-duration disturbances

The maximum steady-state A-weighted sound pressure measured at the ear simulator for the communications handset or headset shall be limited to reduce the risk of permanent hearing damage due to long-duration disturbances (> 0,5 s) that can occur under normal operation.

The equipment shall also be checked for self-generated acoustic disturbances, such as tone dialing signals fed back to the receiver and paging signals sent to a cordless handset.

NOTE Typical signals considered are alerting (ringing) signals during the on-hook operating condition; and tone-type dialing, network signals and other similar signals generated within the device that can cause excessive acoustic output during the off-hook operating condition.

Compliance is checked by following methods specified in NAD.4.1 or NAD.4.2. During the above tests, the maximum steady-state A-weighted sound pressure coming from the earpiece or receiver shall not exceed 125 dBA for handsets, 118 dBA for headsets, and 121 dBA for insert earphones.

NAD.4.1 Method 1

Measurements shall be made following the methods described in IEEE 269, Clause 5, for test equipment and positioning, Clause 7.10 for analog communication sets, and Clause 8.13 for digital communication sets.

NAD.4.2 Method 2

A handset or headset that is of a design compatible with the artificial ear of IEC 60318 shall be placed under normal operating conditions in position for the exchange of calls (such as talking state or ringing state with the handset raised), and fixed to an artificial ear conforming to the requirements of IEC 60318. The earpiece shall be sealed to the knife-edge of the artificial ear. Holes in the earpiece which partially fall outside the knife-edge of the artificial ear shall be sealed. Other types of handset and headset should use Method 1.

Response for insert type earphones shall be measured with an in-ear coupler as indicated in the American National Standard for Occluded Ear Simulator, ANSI/ASA S3.25-1989, extended by an ear canal simulator consisting of a cylinder 8 mm long and 7,5 mm in diameter. The tip of the earphone shall be inserted until tangent with plane X-X' shown in Figure 1 of , ANSI/ASA S3.25-1989.

The artificial ear shall be electrically connected to a precision sound level meter conforming with IEC 60651 or IEC 61672-1:2002, with A-weighted slow response.

NAD.4.2.1 Off-hook signal source

An off-hook signal source as described below shall be applied to the receive circuit of the equipment under test. The amplitude and frequency is adjusted to produce the maximum acoustic output from the earpiece.

The equipment under test shall be connected to a network simulator and test tone generator as shown in Figure NAD.1, by closing switches A and D. An equivalent network simulator may be used.

The analog signal generator in the simulator circuit produces a sine-wave signal. For the equipment under test with a digital interface, a digital sequence representing minimum to maximum transition square wave at frequencies between 300 Hz and 5 000 Hz may be used.

NAD.4.2.2 On-hook signal source

An on-hook signal source as described below shall be applied to the receive circuit of the equipment under test that contains an alerting device in the handset. The ringing frequency shall be adjusted to produce the maximum acoustic output from the earpiece.

The equipment under test shall be connected to a network simulator and ringing generator as shown in Figure NAD.1, by closing switches A and C. An equivalent network simulator may be used. A signal generator in the simulator circuit produces a sine-wave signal. For equipment under test with a digital interface, a digital sequence that will activate the alerting device at its maximum acoustic output may be used.

Annex NAE D1
(informative)
U.S. and Canadian regulatory requirements

This annex provides examples of and references for regulatory requirements that apply to equipment. Applicability of these requirements is dependent on the construction of the equipment and its intended installation and use.

This annex is not intended to provide a complete list of all of the applicable requirements, only to serve as a reference for requirements that most commonly apply to this type of equipment. For complete requirements, the National Electrical Code, ANSI/NFPA 70-2005, the Canadian Electrical Code, Part I, CSA C22.1-02, or other referenced documents must be consulted.

Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

NOTE 1 Underlining to indicate text added to IEC 60950-1 is not used in this annex.

NOTE 2 The complete text of Annex NAE is a D1 national difference.

Annex NAE D1

Clause No.	Topic/summary	NEC	CEC
1.1.1 (1.5.5)	**Cables used in ITE (computer) rooms** See 1.5.5 (1.1.1).	645.5	4-010(2)(i), 12-020 60-316
1.1.2	**Additional requirements** Special installation methods are required for equipment connected to wire-line communication facilities serving high voltage electric power stations operating at greater than 1 kV. These requirements do not cover the equipment used in the design of such installations. Special system design requirements, such as those covered by ANSI/IEEE 487, Recommended Practice for the Protection of Wire-Line Communication Facilities Serving Electric Power Locations, shall be followed to reduce the risks associated with wire-line communication facilities serving such power stations.	90.2(B)(5) ANSI/IEEE 487	Section 0
1.1.2, Annex T	**Outdoor use equipment** Equipment intended for use outdoors shall be evaluated in accordance with the Standard for Enclosures for Electrical Equipment, UL 50, or Special Purpose Enclosures, CAN/CSA C22.2 No. 94, and shall be marked with a suitable outdoor use enclosure designation compatible with the National Electrical Code, ANSI/NFPA 70, or the Canadian Electrical Code.	110.11	22-102 2-400 2-402
1.1.3 (1.5.5)	**Building wiring** See 1.5.5 (1.1.3).		2-128, Appendix B Note 2-130, Sections 4, 8, 10, 12 and 60

Annex NAE Continued on Next Page

Annex NAE Continued

D1

Clause No.	Topic/summary	NEC	CEC
1.2	**GFCI protection** Receptacles, rated 125-volt, single phase, 15- or 20-ampere accessible to either Users or Service Personnel shall be provided with GFCI Protection for Personnel if the equipment containing the receptacles is installed outdoors.	210.8(B)	24-116 26-700
1.5.5 (1.1.3) (3.5)	**Building wiring** Wires and cables installed as part of building wiring systems (premises wiring, facility wiring, etc.) shall comply with the applicable provisions in the National Electrical Code, ANSI/NFPA 70, and the Canadian Electrical Code, Part I, CSA C22.1, and, except for cables run completely within an ITE (computer) room, are not within the scope of this standard. For example:	110.8	Section 12
	Conductors for general wiring	Article 300, 310	Section 4
	Cables extending beyond an ITE (computer) room	645.6	
	Class 1, 2 and 3 circuits	Article 725	Section 16
	Optical fiber cables	Article 770	Section 56
	Communication circuits	Article 800	Section 60
1.5.5 (1.1.3) (3.5)	**Building wiring and cable used in ducts, plenums and other air-handling space** Building wiring and cable used in ducts, plenums and other air-handling space are subject to special requirements and are not within the scope of this standard.		12-010
	General requirements	300.22	Section 12-010
	Class 2 and 3 circuits	725	Section 16
	Optical fiber cables	770	Section 56
	Communication circuits	800	Section 60
1.5.5 (1.1.1) (3.5)	**Cables used in ITE (computer) rooms** Cables installed within an ITE (computer) room are within the scope of this standard and shall also comply with the applicable provisions of the National Electrical Code, ANSI/NFPA 70, and the Canadian Electrical Code, Part I, CSA C22.1.	645.5	12-020 4-010(2)(i) 60-316
1.5.5	**External interconnecting cables** Type DP or equivalent cable is required for cabling under raised floors in ITE (computer) rooms. Type DP-1 or DP-1P cable is suitable for use in any external circuit operating at 600 volts or less. Type DP-2 or DP-2P cable is suitable for use in any external circuit operating at 300 volts or less. Generally, for ITE (computer) room applications, it is assumed that any cable over 3,05 m in length, coiled or uncoiled, can be used under raised floors. Cables extending beyond the ITE (computer) room are subject to the applicable requirements in the National Electrical Code, ANSI/NFPA 70, and the Canadian Electrical Code, Part I, CSA C22.1, for building wiring.	645.5(C) 645.5(D) NFPA 75 300, 645.6	12-020 60-306 60-318

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Annex NAE Continued D1

Clause No.	Topic/summary	NEC	CEC
	For installations other than ITE (computer) rooms, cables are subject to the applicable requirements in the National Electrical Code, ANSI/NFPA 70, except cables not exceeding 3,05 m may consist of appliance wiring material and may be evaluated as part of equipment. Special constructions may warrant additional considerations.		
	For circuits supplied by limited power sources, Article 725 of the National Electrical Code, ANSI/NFPA 70, permits the use of CL2 or permitted cable substitutions. See Table NAE.1.	725	
	For cabling less than 3,05 m, which are types not specified in the National Electrical Code or Canadian Electrical Code, each detachable external interconnecting cable (with terminations) furnished as part of the equipment shall be marked or similarly identified in the installation instructions with the name, trademark or trade name of the organization that is responsible for the equipment and with the organization's identifying number or equivalent designation for the cable, or the cable must be evaluated separately from the equipment.		
	This marking is required to allow authorities having jurisdiction to identify external interconnecting cables that are evaluated as a part of the system and that are not separately evaluated.		
	Telephone line cords, extension cords and the like shall comply with the requirements of the Standard for Communications-Circuit Accessories, UL 1863, and Cords and Cord Sets for Communication Systems, CSA C22.2 No. 233.	800.113	60-102
1.6 (3.2)	**Connection to a.c. or d.c. mains supplies** See 3.2.		
1.6.1.2 (3.2.1.2)	**Connections to a d.c. power system (d.c. branch circuit)** Connections to the d.c. power system shall meet the requirements for connection to branch circuits. (See connections to primary power, 3.2.)	480.3	80-002
1.6.1.2 (2.6.1)	**Earthing (grounding) of d.c. powered equipment** Equipment intended to be connected to a nominal 48 V d.c. (or higher) power supply source, or systems rated less than 48 V d.c. that have one point directly earthed (grounded), shall have provision for the earthing (grounding) of all exposed dead metal parts that might become energized from the power supply source or from circuits involving a risk of electric shock.	480.3, 250	See 2.5.1 10-102 10-104 10-202 10-404 10-810
1.6.1.2 (1.7.11)	**Overcurrent and earth (ground) fault protection for d.c. powered equipment** See 2.7.1.	480.3	
1.6.1.2 (1.7.7.3, 3.2.1.2)	**Polarity marking for d.c. powered equipment field wiring terminals** Terminals and leads provided for permanent connection to the supply shall be marked to indicate polarity if reverse polarity can result in a hazard.	200.10, 200.11	2-100(1)(m) Individual CSA Part II Standards
1.7.1	**Rated voltage marking**	100, 110.4, 110.21, 220.5 and	2-100, 2-10

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Annex NAE Continued

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Clause No.	Topic/summary	NEC	CEC
	Based on nominal rating conventions, the following marking schemes shall be used: The voltage rating for equipment with more than one phase supply conductor and an earthed neutral supply conductor shall indicate the phase-to-earth RATED VOLTAGE and the phase-to-phase RATED VOLTAGE, separated by a solidus (/), and shall give an indication of the number of phases of the supply. In order to differentiate this marking from multiple voltage ratings, the number of supply wires, including the neutral, shall also be provided. For example: 120/240 V, 3-wire means the voltage is supplied by two phase wires and one neutral wire with 120 V between each phase conductor and the neutral and 240 V between the phase conductors. 120/208 V, 3-phase 4-wire means the voltage is supplied by a three-phase power system and one neutral wire with 120 V between each phase conductor and the neutral and 208 V between phases. For cord connected equipment, the RATED VOLTAGE, specified shall not exceed the rating of the attachment plug. A voltage rating that exceeds the attachment plug cap rating may be acceptable if it does not exceed the extreme operating conditions in Table 2 of Preferred Voltage Levels for AC Systems, 0 to 50,000 V, CSA CAN3-C235, and if it is part of a range that extends into ″Normal Operating Conditions″. The voltage rating shall not be lower than that specified for ″Normal Operating Conditions″ in Table 2 of CSA CAN3-C235 unless it is part of a range that extends into ″Normal Operating Conditions.″ For example, a marking of 100 V would not be allowed, but 100 – 118 V would be acceptable. A marking of 127 V would not be allowed, but 100 – 127 V would be acceptable. See also 1.7.7.	ANSI C84.1-1995	CSA CAN3-C235
1.7.7 (2.5)	**Markings for Class 2 terminals** Wiring terminals intended to supply Class 2 outputs in accordance with Article 725 of the National Electrical Code, ANSI/NFPA 70, or Section 16 of the Canadian Electrical Code, Part 1, CSA C22.1, shall be marked with the voltage rating and ″Class 2″ or the equivalent. The marking shall be located adjacent to the terminals and shall be visible during wiring.	725.42	16-204

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Clause No.	Topic/summary	NEC	CEC
1.7.7.1 (2.6.4.2) (3.3)	**Identification of the protective earthing terminal (terminal for the connection of the equipment grounding conductor or bonding conductor) for permanently connected equipment** The terminal for the connection of the equipment earthing conductor (grounding conductor or bonding conductor) shall be identified by (1) a green-colored, not readily removable terminal screw with a hexagonal head; (2) a green-colored, hexagonal, not readily removable terminal nut; or (3) a green-colored pressure wire connector. If the terminal is not visible, the conductor entrance hole shall be marked with the word ″green″ or ″ground,″ the letters ″G″ or ″GR″ or the grounding symbol (IEC 60417, No. 5019) or otherwise identified by a distinctive green color. The term ″Protective Earth″ or its abbreviation ″PE″ are not commonly used in Canada or the U.S. Therefore, ″G,″ ″GND,″ ″ GROUND,″ or the grounding symbol should be used in conjunction with these terms.	250.126	CSA C22.2 No. 0.4 [Clause 3.5.1.2(c)]
1.7.7.2 (3.3.1)	See 3.3.1		
1.7.7.3 (3.2.1.2) (1.6.1.2)	**Polarity marking for d.c. powered equipment field wiring terminals** See 1.6.1.2 (1.7.7.3) (3.2.1.2).		2-100(1)(m)
2.5 (1.7.7)	**Markings for Class 2 terminals** See 1.7.7 (2.5).		16-204 (supply marking)
2.5	**Overcurrent protection for Class 2 limiting** Where overcurrent protection is required for Class 2 and Class 3 limiting in accordance with the National Electrical Code, ANSI/NFPA 70, the overcurrent device shall not be interchangeable with devices of higher ratings. A marking is not sufficient regardless of the location of the device. Where a limited power source is used to provide current limiting to external wiring in accordance with the National Electrical Code, ANSI/NFPA 70, a fuse, if used, shall not be operator-accessible unless it is not interchangeable.	725.41, Tables 11(A) and 11(B)	16-206
2.6	**Provisions for protective earthing** The terms ″protective earth,″ ″protective earthing″ and ″earthing″ are not commonly used in Canada or the U.S. For connections to the grounding system, the following terms should be applied, as defined in the Canadian Electrical Code(CEC), Part I, CSA C22.1, and/or the National Electrical Code (NEC), ANSI/NFPA 70. These terms appear in parentheses, where appropriate: Bonding Conductor (CEC) — Grounding Conductor (CEC, NEC) Grounded (CEC, NEC) — Grounding Conductor, Equipment (NEC) Grounded Conductor (NEC) — Grounding Electrode Conductor (NEC) Grounding (CEC) — Grounding System (CEC)	Article 100	Section 0
2.6 (2.7)	**Output receptacle circuit earthing (grounding)**	250.30, 250.66, Table 250.66, 645.15	

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D1

Clause No.	Topic/summary	NEC	CEC
	Equipment having output receptacles for alternating current power connections that are generated from an internally derived source (i.e., provided with transformer isolation internal to the equipment, which provides isolation of the output circuit from the mains supply) shall have the earthed (grounded) circuit conductor bonded to the protective earthing (grounding) terminal via a ″system bonding jumper″ considering the maximum fault current of the circuit. For cord-connected equipment, the size of the bonding jumper shall not be less than the current-carrying conductors of the derived output circuit. For permanently connected equipment, the bonding jumper shall not be less than 8 AWG per NEC Table 250.66.		
2.6.1 (1.6.1.2)	**Earthing (grounding) of d.c. powered equipment** See 1.6.1.2 (2.6.1).		
2.6.3.3	**Size of protective bonding conductors** For PLUGGABLE EQUIPMENT TYPE A, and if neither a) or b) of 2.6.3.3 is applicable, the current rating of the circuit shall be taken as 20 A since the Pluggable Equipment Type A configurations described in 1.2.5.1 are protected by maximum 20 ampere branch circuit overcurrent protection.	210.20, 210.23,	10-106 26-710(b)
2.6.4 (2.6.5.7) (3.1.8)	See 2.6.5.7		
2.6.4.2 (1.7.7.1) (3.3)	**Identification of the protective earthing terminal (terminal for the connection of the equipment grounding conductor or bonding conductor) for permanently connected equipment** See 1.7.7.1 (2.6.4.2) (3.3).		CSA C22.2 No. 0.4 [Clause 3.5.1.2(c)]
2.6.4.2 (3.3.4)	**Range of earthing conductor (equipment grounding conductor or bonding conductor) sizes to be accepted by field wiring terminals** Terminals shall be suitable for the wire gauges commonly used in the U.S. and Canada. It is required that current-carrying conductors be rated 125 percent of the equipment rating; therefore, once the equipment rating exceeds 80 percent of the capacity of the wiring in the branch circuit, the next higher capacity wire gauge shall be used. Refer to the appropriate article in the National Electrical Code, ANSI/NFPA 70, and the Canadian Electrical Code, Part 1, CSA C22.1, for ampacity Tables.	250.122 Table 250.122	10-814 Table 16
2.6.5.7 (2.6.4) (3.1.8)	**Screws for protective bonding** Sheet metal (spaced thread) screws shall not be used to connect protective earthing (grounding) and bonding conductors or connection devices to enclosures.	250.8	
2.7	**Branch circuit protection for receptacles** Standard supply outlets and receptacles shall be protected by an overcurrent device in either the equipment or the branch circuit, rated or set at not more than the rating of the outlet or receptacle. The overcurrent device shall be of a type that is suitable for branch circuit protection in accordance with the National Electrical Code, ANSI/NFPA 70, and the Canadian Electrical Code, Part I, CSA C22.1, unless it is supplied by a secondary circuit.	210.20, 210.23, 240.10 406	14-012 14-114 14-600

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Annex NAE Continued D1

Clause No.	Topic/summary	NEC	CEC
	Standard supply outlets and receptacles are considered an extension of the branch circuit. Equipment that can plug into these receptacles is evaluated based on the branch circuit protection normally associated with the type of receptacle. For example, to comply with both U.S. and Canadian Electrical Code requirements, a 15 A, 125 V receptacle is assumed to have branch circuit protection rated 15 A. For NEMA 5-15R receptacles not located in the operator access area of the equipment, and when additional evaluation of the end system shows no hazards in accordance with this standard, a maximum of 20 A branch circuit protection may be used.		
2.7	**Multiple panelboards** For ITE (computer) room applications, power distribution units may have multiple panelboards within a single cabinet/ enclosure, provided that each panelboard has no more than 42 overcurrent devices.	645.17	
2.7	**Overcurrent protection for appliances** This clause contains requirements for sizing branch circuits for appliances. If special overcurrent devices separate from the equipment are required, data for selection of these devices shall be marked on the appliance.	422.11 422.60	14-104 Table 13
2.7 (1.6.1.2)	**Overcurrent and earth fault protection for d.c. powered equipment** Overcurrent and earth fault protection in accordance with 2.7 shall be provided either in the equipment or as part of the building installation. If the protection is provided as part of the building installation, the type and rating shall be provided in the installation instructions. If a protective device interrupts the grounded conductor, it shall also interrupt the supply conductor.	480.3 240.22	 14-016
2.7	**Overcurrent protection for distribution transformers** Special overcurrent protection is required for individual transformers that distribute power to other units over branch circuit wiring. Typically, these requirements apply to transformers rated not less than 10 kVA, with an output of not less than 100 V.	450.3(B) Table 450.3(B)	26-254 26-256
2.7	**Overcurrent protection for panelboards** This clause contains additional requirements for equipment provided with panelboards.	408.35, 408.36	14-606
3.1.1	**Overcurrent protection of wiring** Section 310-15 of the National Electrical Code, ANSI/NFPA 70, and Section 4 of the Canadian Electrical Code, Part I, CSA C22.1, give guidance on the ampacities of conductors. Any overcurrent device is suitable for use with a conductor that meets the following conditions: – The length of the conductor does not exceed 3 m. – The conductor is located completely within the enclosure of the equipment.	240.21(B)(1) 240.21(B)(2) 310.15	4-004 4-014 14-100

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Clause No.	Topic/summary	NEC	CEC
	– The ampacity of the conductor is not less than the rating of the overcurrent protective device at the termination of the conductor. An overcurrent device rated not more than 3 times the ampacity of the conductors is suitable if all of the following conditions are met: – The length of the conductor does not exceed 7,5 m. – The conductor is protected from mechanical damage by being enclosed in an approved enclosure, raceway or by other approved means. – The conductor terminates at its load end in one or more overcurrent protective devices. – The ampacity of the conductor is not less than the sum of the ratings of the overcurrent protective devices supplied by the conductor. For solid bus bars, the following meets this requirement: Material / Overcurrent protection Copper: Low enough to limit the current density in the bus bar to: 4,65 A/mm^2 of bus bar cross-section Electrical-conductor (EC) grade of aluminum (conductivity is 61 percent of IACS): 3,10 A/mm^2 of bus bar cross-section Aluminum having a conductivity of 55 percent of IACS: 2,75 A/mm^2 of bus bar cross-section		
3.1.8 (2.6.4) (2.6.5.7)	See 2.6.5.7		
3.2 (1.6)	**Connection to a.c. or d.c. mains supplies** Wiring methods used for the connection of the equipment to the AC or DC MAINS SUPPLY shall be in accordance with the National Electrical Code, ANSI/NFPA 70, and the Canadian Electrical Code, Part I, CSA C22.1.	110.8	Section 12
3.2.1	**Methods of connection**		
	Flexible cords and plugs are permitted for portable and STATIONARY EQUIPMENT and for fixed equipment where the fastening means and mechanical connections of the equipment are designed to permit removal for maintenance and repair. (Equipment such as automated teller machines (ATMs) and similar bank equipment, which are typically installed in banks, financial institutions, supermarkets, etc., are examples of such fixed equipment where flexible cords and plugs are permitted.)	400.7, 400.8	4-010
	Flexible cords must be provided with an attachment plug for connection to the branch circuit.	400.7(B)	CSA C22.2 No. 0
	The attachment plug configuration shall be one that is rated not less than 125 percent of the current rating of the equipment (e.g., the maximum rating of equipment that has a NEMA 5-15P plug is 12 A).	210.19(A)(1), 210.23(A)(1), 422.10(A), 422.10(E), 645.5(A)	8-104, 26-722, 8-302(3) 26-1000

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Annex NAE Continued D1

Clause No.	Topic/summary	NEC	CEC
	CLASS II EQUIPMENT provided with 15- or 20-A standard supply outlets, Edison-base lampholders or a single pole disconnect device shall be provided with a polarized-type attachment plug.	422.40	CSA C22.2 No. 42
3.2.1.2	**Special earthing (grounding) conditions for d.c. powered equipment** Equipment that has the earthed terminal (terminal for the grounded conductor) of the power source connected to the frame of the unit is required to have special provisions for earthing (grounding), along with markings and instructions. See Annex NAA. If the equipment provides the means for connecting the supply to the earthing electrode conductor (grounding conductor or grounding electrode conductor), there shall be no switches or overcurrent protective devices located between the point of connection to the supply and the point of connection to the earthing (grounding) electrode.	250, Parts VII and VIII, 480.3 250, Parts III and V, 480.3	10-102, 10-104, 10-202, 10-404, and 10-810
3.2.1.2 (1.7.7.3) (1.6.1.2)	**Polarity marking for d.c. powered equipment field wiring terminals** See 1.6.1.2 (1.7.7.3) (3.2.1.2).		
3.2.3	**Connection of wiring systems (e.g., conduit, raceways, etc.)** Equipment shall have provision for connecting and securing a field wiring system. For certain locations, such as some restricted access locations using low-voltage d.c. systems, open wiring systems may be permitted. Equipment intended solely for installation in such locations need not be provided with a provision for connecting and securing a field wiring system. However, a method of securing wiring or instructions shall be provided to ensure the installed wiring is adequately protected from abuse.	300, including 300.10, 300.11, 300.12	12-914, 12-918, 12-916
3.2.3	**Permanently connected equipment**		
3.2.3	**Sizes of cables and conduits** Trade sizes of different size conduits and the number type and ampacity of cables allowed to be used with different sized conduits are covered in the national codes. Tables NAE.2 and NAE.3 are provided for reference.	300.1(C), Annex C, Chapter 9, Table 4	Section 4 Section 12 Tables 6 – 10
3.2.3	**Terminals and leads for field wiring connections** Equipment shall be provided with either terminals or leads for connection of field-installed wiring. Leads shall not be smaller than No. 18 AWG (0,82 mm^2) and not less than 150 mm in length.	110.14, 300.14,	12-3002(5) CSA C22.2 No. 0 30-404
3.2.5	**Cord-connected equipment** The length of a power supply cord shall not exceed 4,5 m.	400.8, 645.5(B)	4-010(3)

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Clause No.	Topic/summary	NEC	CEC
	The minimum length of a power supply cord shall be 1,5 m unless it is intended for a special installation, such as dedicated equipment intended to be mounted near a receptacle.	210	Individual CSA Part II Standards
	Power supply cords shall have conductors with cross-sectional areas sufficient for the rated current of the equipment. Conductors shall be sized based on the requirements in the National Electrical Code, ANSI/NFPA 70, and the Canadian Electrical Code, Part I, CSA C22.1.	400.5, 400.12, Table 400.5(A)	4-014, Table 11, 4-012
	Power supply cords and cord sets shall incorporate flexible cords suitable for the particular application or shall be of a type at least as serviceable for the particular application. Table NAE.4 lists common applications and associated suitable cord types. Table NAE.5 specifies the allowable ampacity for flexible cords and cables.	400.3, 400.4 Table 400.4	4-010(1), Table 11 Table 12
3.2.9	**Wire bending space at field wiring terminals** There shall be adequate room in a wiring compartment to properly make the field connections. Not applicable to wiring compartments for non-detachable power supply cords.	312.6	C22.2 No. 0.12
3.2.9	**Volume of field wiring compartments** Wiring compartments shall be of sufficient size to provide free space for all conductors enclosed in the box. Not applicable to wiring compartments for non-detachable power supply cords. For certain locations, such as some restricted access locations using low-voltage d.c. systems, open wiring systems may be permitted. Equipment intended solely for installation in such locations need not be provided with a field wiring compartment. However, adequate free space shall be provided for all conductors, and all conductors shall be protected against accidental contact.	314.16	12-3034 and Table 22 CSA C22.2 No. 0.12
3.3 (1.7.7.1) (2.6.4.2)	**Identification of the protective earthing terminal (terminal for the connection of the equipment grounding conductor or bonding conductor) for permanently connected equipment** See 1.7.7.1 (2.6.4.2) (3.3).	250.126	
3.3 (4.5.2)	**Temperature markings for field wiring compartments** If the wires in a terminal box or compartment intended for power supply connection of equipment can attain a temperature higher than 60 °C during normal operation, the unit shall be marked near the point at which the supply connections are made with the minimum temperature rating of the conductors that must be used.	110.14(C), 310.10	12-100(c) Individual CSA Part II Standards
3.3	**Wiring terminals for field wiring connections**		CSA C22.2 No. 0

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Clause No.	Topic/summary	NEC	CEC
3.3	**Wiring terminals for the connection of external conductors** Field wiring terminals provided for interconnection of units by conductors not supplied by a limited power source, or a Class 2 circuit defined in the National Electrical Code, ANSI/NFPA 70, or the Canadian Electrical Code, CSA C22.1, also shall comply with the applicable requirements in 3.3. Interconnection of units by conductors supplied by a limited power source, or a Class 2 circuit defined in the National Electrical Code, ANSI/NFPA 70, or the Canadian Electrical Code, CSA C22.1, may have field wiring connections other than specified in 3.3, such as wire-wrap and crimp-on types, if the limited power source and Class 2 circuits are separated from all other circuits by barriers, routing or fixing.	300.1 725	CSA C22.1
3.3.1 (1.7.7.2)	**Identification of terminals for connection of an earthed (grounded) conductor (neutral)** Terminals for the connection of the earthed (grounded) circuit conductor (neutral) are required to be identified by a distinctive white marking or other equally effective means.	200.9	26-002 CSA C22.2 No. 0.4
3.3.3	**Wire-binding screws** A wire-binding screw may be employed at a wiring terminal intended for connection of a No. 10 AWG (5,3 mm^2) or smaller conductor wire. Upturned lugs, a cupped washer or the equivalent shall be provided to hold the wire in position.	110.14(A)	12-116
3.3.4	**Range of conductor sizes to be accepted by field-wiring terminals** Terminals shall be suitable for the wire gauges commonly used in the U.S. and Canada. It is required that current-carrying conductors be rated 125 percent of the equipment rating. Therefore, once the equipment rating exceeds 80 percent of the capacity of the wiring in the branch circuit, the next higher capacity wire gauge shall be used. Refer to the appropriate article in the National Electrical Code, ANSI/NFPA 70, and the Canadian Electrical Code, Part I, CSA C22.1, for ampacity Tables. For purposes of application of Table 310.16, no Correction Factors shall be used for terminal sizing considerations, unless requested by the manufacturer and documented. A wiring terminal that will not receive a conductor size one size larger than the minimum determined per Table 310.16 shall be marked to restrict its use to the smaller conductor size.	210.19(A), 210.20, Article 310, ampacity Tables	4-004 Tables 1, 5c and 12
3.3.4 (2.6.4.2)	**Range of earthing conductor (equipment grounding conductor or bonding conductor) sizes to be accepted by field wiring terminals**	250.122(A), Table 250.122	10-814 Table 16
3.3.6	**Conductor material markings for field wiring terminals intended for aluminum conductors** Equipment with supply field-wiring terminals intended to be connected to aluminum conductors shall be so identified for the connection of aluminum conductors. This marking shall be independent of all other markings on the terminal connectors and shall be visible after installation. The terminal for the connection of an equipment protective earthing (grounding) conductor shall not be identified for the connection of an aluminum conductor.	110.14	12-118

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Clause No.	Topic/summary	NEC	CEC
3.3.6	**Terminals for field wiring** Field-wiring connections shall be made through the use of suitable pressure connectors (including set-screw type), solder lugs, or splices to flexible leads.	110.14	12-116 12-118
3.4.2	**Motor control devices** For equipment with a primary motor, a motor control device is required, unless (a) – (d) are true: a) the equipment is cord connected; b) the equipment voltage rating is 125 V or less; c) the equipment current rating is 12 A or less; and d) the motor is rated 1/3 hp or less (250 W or less, or locked rotor current of 43 A or less). Although a motor control device is required, the motor control device need not have a 3 mm contact gap if the equipment is provided with a separate suitable disconnect device (such as the plug on a power supply cord).	430.81(B)	28-500(3)
3.4.8	**Orientation of switches and circuit breakers** Vertically mounted disconnect switches and circuit breakers shall be mounted such that the up position of the handle is the ″on″ position.	240.81	14-300 14-502
3.4.11	**Backup battery power sources** For ITE (computer) room applications, batteries integral to equipment shall incorporate a means for battery disconnect and a means for connection to the remote emergency power off circuit that disconnects the battery power source, except for battery circuits for which (1) the product of the open circuit voltage times the rating of the overcurrent protective device does not exceed 750 VA or (2) any resistive load cannot draw more than 750 VA for more than five minutes after the mains power is disconnected. If connection to the remote emergency power off circuit is required, batteries shall be disconnected within five minutes of activating the remote emergency power off circuit.	645.11	
3.5.1	**Interconnection of equipment – general requirements** Interconnecting cables containing more than one type of circuit may be subjected to additional restrictions per the National Electrical Code, NFPA 70, and the Canadian Electrical Code, Part I, CSA C22.1. In particular, restrictions are placed on cables that contain both conductors with Class 2, Class 3 (for U.S. only) or limited power source circuits and conductors with power, Class 1 and other circuits specified in the Code. Such constructions may require additional consideration.	300.3(C)(1) 725.55	12-3032, 16-012, 16-114, 16-212
4.3.12	**Maximum quantity of flammable liquid stored in equipment** The maximum quantity of flammable liquid stored in equipment shall comply with Table NAE.6	NFPA 30	

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Annex NAE Continued D1

Clause No.	Topic/summary	NEC	CEC
4.3.13.5	**Requirements for equipment incorporating lasers** Requirements for lasers are contained in the applicable national codes and regulations. Compliance of laser products with the Code of Federal Regulations (CFR), Title 21, Part 1040, and the Canadian Radiation Emitting Devices Act, REDR C1370, shall be determined by: a) determining the Class of laser (as defined in the CFR) from the manufacturer's required documentation, such as the Center for Devices and Radiological Health (CDRH) report, markings and labels, or similar documentation; b) verifying that the manufacturer' s markings and labels having the information specified in the CFR are affixed on the laser product (as defined in the CFR); c) determining that the corresponding construction features, such as protective housing, interlocks, and similar features, are provided in accordance with the CFR; and d) determining that the resulting construction complies with the construction requirements of this standard.	Code of Federal Regulations, 21 CFR 1040	Canadian Radiation Emitting Devices Act, REDR C1370 or Safety of laser products – Part 1: Equipment classification, requirements and user's guide, CSA E60825-1
4.5.2 (3.3)	**Temperature markings for field-wiring compartments** See 3.3 (4.5.2).		Individual CSA Part II Standards
4.7	**Automated information storage equipment** For ITE (computer) room applications, automated information storage equipment, which is enclosed storage and retrieval equipment that moves recorded media between storage and electronic computer equipment, that is intended to contain more than 0,76 m^3 of combustible media shall have provision for either automatic sprinklers or a gaseous agent extinguishing system with an extended discharge.	NFPA 75 (8.1.4)	
4.7.3.1	**Equipment for use in environmental air space**		

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Clause No.	Topic/summary	NEC	CEC
	Equipment intended for use in environmental air space, other than air ducts or plenums, is required to be provided with a metal enclosure or with a non-metallic enclosure having adequate fire-resistance and low smoke-producing characteristics. Determination of low-smoke-producing characteristics is made in accordance with the Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces, UL 2043.	300.22(C)	12-010
	Equipment is not permitted to be installed in air ducts or plenums used for environmental air.	300.22(B)	12-010
4.7.3.1	**Flammability requirements for large surfaces** For ITE (computer) room applications, an external surface of combustible material having an exposed area of greater than 0,9 m^2 (10 sq ft) or a single dimension greater than 1,80 m (6 ft) shall have a flame spread rating of 50 or less when tested in accordance with either: – the Standard for Tests for Surface Burning Characteristics of Building Materials, UL 723, or ASTM E 84; or, – the radiant panel furnace method in ASTM E 162. The flame spread rating as determined by this method is the average value based on tests of six samples representative of the wall thickness used, with no single sample rating greater than 75. The limits mentioned refer to the exposed surface area of a single unbroken section. If two sides of a single piece are exposed, only the larger side is to be considered in computing the area. A material with a flame spread rating higher than 50 may be used as the exterior finish or covering on any portion of the enclosure, guard or cabinet if the flame spread rating of the combination of the base material and finish or covering complies with the flame spread requirements. For equipment not intended for use in ITE (computer) rooms, materials with a flame spread rating of 200 or less may be used.	NFPA 75 (7.1.4)	
7	**Connection to cable distribution systems** Equipment and accessories associated with the cable distribution system may need to be subjected to applicable parts of Chapter 8 of the NEC and Section 54 of the CEC.		Section 54
	Radio and Television Equipment Equipment connected to cable distribution systems used for connection to antennas and dishes shall be installed in accordance with the applicable provisions of Article 810. These provisions may include:	810	
	Grounding	810.15, 810.21,	
	Antenna Discharge Units	810.20, 810.57	
	Community Antenna Television and Radio Distribution Systems	820	

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Annex NAE Continued

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Clause No.	Topic/summary	NEC	CEC
	Equipment connected to cable distribution systems employed in CATV systems shall be installed in accordance with the applicable provisions of Article 820. These provisions may include:		
	Protection	820.93	
	Cable Grounding	820.100	
	Listing, Marking, and Installation of Coaxial Cables	820.113	
	Installation of Cables and Equipment	820.133	
	Network-Powered Broadband Communication Systems	830	
	Equipment connected to cable distribution systems that are part of a broadband communication system shall be installed in accordance with the applicable provisions of Article 830. These provisions may include:		
	Output Circuits	830.3(D)	
	Network-Powered Broadband Communication Equipment and Cables	830.179	
	Primary Electrical Protection	830.90	
	Cable, Network Interface Unit, and Primary Protector Grounding	830.100	
Annex H	**Ionizing radiation**	21 Code of Federal Regulations (CFR), Part 1020, Section 1020.10	Canadian Radiation Emitting Devices Act, REDR C1370
	In addition to measurement of ionizing radiation during normal operation in accordance with Annex H, measurements are made with the equipment operating under the following abnormal operating conditions, as applicable: – a maximum supply voltage of 130 V if the equipment has a nominal voltage rating between 110 V and 120 V; – a maximum supply voltage of 110 % of the equipment nominal if the nominal is not between 110 V and 120 V; – under conditions identical to those which result from that component or circuit malfunction which maximizes x-radiation while maintaining the equipment operative for normal use.		

Table NAE.1 D1
Circuit and cable types permitted by the National Electrical Code, NFPA 70 D1
(see 1.5.5) D1

Circuit type	Cable type [a]
Class 2 or Limited Power	CL2
Class 3	CL3
TNV	CM
Optical	OFC, OFN
CATV	CATV

[a] Substitution tables in the National Electrical Code, NFPA 70, apply.

Table NAE.2 D1
Conduit sizes and fill (3.2.3) D1

Type	Minimum size, metric designator (inch)	Maximum size, metric designator (inch)	NEC	CEC
Intermediate metal conduit	16 (1/2)	103 (4)	342.20 342.22, Chapter 9, Table 1	– –
Electrical metallic tubing (EMT)	16 (1/2)	103 (4)	358.20, 358.22 Chapter 9, Table 1	12-1400 12-1408, Tables 6 and 8
Flexible metallic tubing	16 (1/2)	21 (3/4)	360.20, 360.22 Chapter 9, Table 1	– –
Flexible metal conduit	16 (1/2)	103 (4)	348.20, 348.22 Chapter 9, Table 1	12-1004 12-1004, 12-1014, Tables 6 and 8
Liquid-tight flexible metal conduit	16 (1/2)	103 (4)	350.20, 350.22 Chapter 9, Table 1	12-1300 Table 8, 12-1304
Liquid-tight flexible non-metallic conduit	16 (1/2)	103 (4)	356.20, 356.22 Chapter 9, Table 1	12-1300 12-1014, Tables 6 and 8
Rigid metal conduit	16 (1/2)	155 (6)	344.20, 344.22, Chapter 9, Table 1	12-1004 12-1014, Tables 6 and 8
Rigid non-metallic conduit	16 (1/2)	155 (6)	352.20, 352.22 Chapter 9, Table 1	12-1100 12-1150 12-1200 12-1014, Tables 6 and 8

Table NAE.3 D1
Throat diameter of inlet hole (3.2.3) D1

Trade size of conduit (metric designator)	Throat diameter of hole, mm (in)			
	Minimum		Maximum	
3/8 (12)	11.28	(0.444)	12.52	(0.493)
1/2 (16)	14.22	(0.560)	15.80	(0.622)
3/4 (21)	18.85	(0.742)	20.93	(0.824)
1 (27)	23.98	(0.944)	26.64	(1.049)
1-1/4 (35)	31.55	(1.242)	35.05	(1.380)
1-1/2 (41)	36.80	(1.449)	40.89	(1.610)
2 (53)	47.24	(1.860)	52.50	(2.067)
2-1/2 (63)	56.44	(2.222)	62.71	(2.469)
3 (78)	70.13	(2.761)	77.92	(3.068)
3-1/2 (91)	81.10	(3.193)	90.12	(3.548)
4 (103)	92.02	(3.623)	102.26	(4.026)
5 (129)	115.37	(4.542)	128.19	(5.047)
6 (155)	138.63	(5.458)	154.05	(6.065)

Table NAE.4 D1
Power supply cords (3.2.5) D1

Type of appliance	Type of cord
Table-model equipment (for use on a table, desk, counter and the like)	SV, SVE, SVO, SVOO, SVT, SVTO, SVTOO SP-2, SPE-2, SPT-2, NISP-2, NISPE-2, NISPT-2 SP-3, SPE-3, SPT-3
Table-model equipment (for use on a table, desk, counter and the like) that is subject to being moved frequently	SV, SVE, SVO, SVOO, SVT, SVTO, SVTOO SP-2, SPE-2, SPT-2, NISP-2, NISPE-2, NISPT-2
Hand-held equipment	TS, TST [a] SV, SVE, SVO, SVOO, SVT, SVTO, SVTOO[b]
Wall-mounted or floor-mounted equipment	SV, SVE, SVO, SVOO, SVT, SVTO, SVTOO[c] SP-2, SPE-2, SPT-2, NISP-2, NISPE-2, NISPT-2 [c] SP-3, SPE-3, SPT-3 [c] SJ, SJE, SJO, SJOO, SJT, SJTO, SJTOO S, SE, SO, SOO, ST, STO, STOO

[a] A tinsel cord is acceptable if all of the following conditions are met:

1. The cord is not longer than 2,5 m.
2. The cord is attached to the equipment directly or by means of a plug which is intended for that purpose.
3. The equipment rating does not exceed 50 W.
4. The nature of the appliance will necessitate the use of an extremely flexible cord.

[b] Type SV and similar cords are acceptable if each conductor is made up of 0,01 mm^2 strands.

[c] Types SP-2, SP-3, SV and similar cords may be provided if the cord is not longer than 2,4 m.

Table NAE.5 D1
Allowable ampacity for flexible cords and cables D1
(Based on ambient temperature of 30 °C) D1
(Extracted from the NEC) D1

Size, AWG	Thermoplastic types	Thermoset types		Types
	TPT, TST	C, E, EO, PD, S, SJ, SJO, SJOW, SJOO, SJOOW, SO, SOW, SOO, SOOW, SP-1, SP-2, SP-3, SRD, SV, SVO, SVOO		HPD, HPN, HSJ, HSJO, HSJOO
		Thermoplastic types ET, ETLB, ETP, ETT, SE, SEW, SEO, SEOW, SEOOW, SJE, SJEW, SJEO, SJEOW, SJEOOW, SJT, SJTW, SJTO, SJTOW, SJTOO, SJTOOW, SPE-1, SPE-2, SPE-3, SPT-1, SPT-1W, SPT-2, SPT-2W, SPT-3, ST, SRDE, SRDT, STO, STOW, STOO, STOOW, SVE, SVEO, SVT, SVTO, SVTOO		
		A [+]	B [+]	
27 [*]	0,5	–	–	–
20	–	5 [**]	7 [***]	–
18	–	7	10	10
17	–	–	12	13
16	–	10	13	15
15	–	–	–	17
14	–	15	18	20
12	–	20	25	30
10	–	25	30	35
8	–	35	40	–
6	–	45	55	–
4	–	60	70	–
2	–	80	95	–

[+] The allowable currents under subheading A apply to 3-conductor cords and other multi-conductor cords connected to utilization equipment so that only 3 conductors are current-carrying. The allowable currents under subheading B apply to 2-conductor cords and other multi-conductor cords connected to utilization equipment so that only 2 conductors are current-carrying.

[*] Tinsel cord.

[**] Elevator cables only.

[***] 7 amperes for elevator cables only; 2 amperes for other types.

Table NAE.6 D1
Maximum quantity of combustible/flammable liquid stored in equipment D1
(4.3.12) D1

Liquid			Closed storage container	
NFPA 30 Class	**Flash point, °C**	**Boiling point, °C**	**Material**	**Size, liters**
Class IA	Below 22,8	Below 37,8	Shall not be used	
Class IB	Below 22,8	Above 37,8	Glass Metal or polyethylene	1 20
Class IC and II	At or above 22,8 and below 60	–	Glass Metal or polyethylene	5 20
Class III	At or above 60	–	Glass Metal or polyethylene	20 20

1) FLAMMABLE LIQUIDS with flash points below 22,8 °C and boiling points below 37,8 °C may not be used or stored within equipment covered by the scope of this standard.

2) Individual reservoirs in equipment shall not be larger than the corresponding sizes for closed storage containers in this table.

Annex NAF D2
(normative)
Household/Home Office Document Shredders

NOTE 1 Underlining to indicate text added to IEC 60950-1 is not used in this annex.

NOTE 2 The complete text of Annex NAF is a D2 national difference.

NAF.1 General

HOUSEHOLD/HOME OFFICE DOCUMENT SHREDDERS shall comply with the additional requirements of this annex.

NOTE Clause/subclause references are aligned with the structure in the body of the standard.

NAF.1.2 Definitions

NAF.1.2.13.18 DOCUMENT SHREDDER, HOUSEHOLD/HOME OFFICE: A product with a plug configuration associated with PLUGGABLE EQUIPMENT TYPE A designed to shred paper or other forms of media, including but not limited to digital video disks, compact disks, flash memory, magnetic strip cards, or magnetic disks, as instructed by the manufacturer.

NOTE Document shredders typically are identified as either strip-cut type or cross-cut type. A strip-cut shredder shreds the paper into long strips using a motor-based shredding mechanism. A cross-cut model shreds paper two or more ways into tiny particles, typically using a more powerful motor and more complex shredding mechanism.

NAF.1.2.13.19 DOCUMENT SHREDDER, COMMERCIAL/INDUSTRIAL: A product with a plug configuration associated with PLUGGABLE EQUIPMENT TYPE B, and PERMANENTLY CONNECTED EQUIPMENT, designed to shred paper or other forms of media, as instructed by the manufacturer.

NAF.1.7 Markings and instructions

NAF.1.7.15 HOUSEHOLD/HOME OFFICE DOCUMENT SHREDDERS

For HOUSEHOLD/HOME OFFICE DOCUMENT SHREDDERS, symbols alerting the USER to the following considerations shall be provided adjacent to the document feed opening:

– product is not intended for use by children (product is not a toy);

– avoid touching the document feed opening with hands;

– avoid clothing touching the document feed opening;

– avoid hair touching the document feed opening; and

– keep aerosol products away (for products incorporating a universal (brush) motor only).

Additionally, the symbol ⚠ (ISO 7000-0434) shall be marked adjacent to the document feed opening to alert the USER to the presence of important operating, maintenance and/or servicing instructions in the USER instructions accompanying the product, and the symbols required above shall be explained in the instructions.

The markings shall be permanent, comprehensible and easily discernible on the equipment when ready for use.

NAF.2.8.3 Inadvertent reactivation

For HOUSEHOLD/HOME OFFICE DOCUMENT SHREDDERS, any accessible SAFETY INTERLOCK that can be operated by means of the articulated accessibility probe (see figure NAF.1) shall be considered to be likely to cause inadvertent reactivation of the hazard.

For HOUSEHOLD/HOME OFFICE DOCUMENT SHREDDERS , the following additional compliance criteria applies:

Compliance is checked by inspection and, where necessary, by a test with the articulated accessibility probe (see figure NAF.1).

NAF.3.4 Disconnection from the mains supply

NAF.3.4.12 HOUSEHOLD/HOME OFFICE DOCUMENT SHREDDERS

An isolating switch complying with 3.4.2 shall be provided to disconnect power to hazardous moving parts. This switch may be a two-position (single-purpose) switch or a multi-position (multi-function) switch (e.g., a slide switch).

The “ON” and “OFF” positions of a two-position switch shall be marked in accordance with 1.7.8. For a multi-position switch, the “OFF” position of the switch shall be marked in accordance with 1.7.8, and the other positions shall be marked with appropriate words or symbols. If symbols are used, they shall be explained in the user instructions.

Compliance is checked by inspection.

NAF.4.4 Protection against hazardous moving parts

NAF.4.4.2 Protection in operator access areas

For HOUSEHOLD/HOME OFFICE DOCUMENT SHREDDERS, a warning statement shall not be used in lieu of construction features that prevent access to hazardous moving parts.

For HOUSEHOLD/HOME OFFICE DOCUMENT SHREDDERS, the following additional compliance criteria apply:

The articulated accessibility probe illustrated in figure NAF.1 shall be inserted into each opening in the MECHANICAL ENCLOSURE, without appreciable force. The probe shall not contact hazardous moving parts. This consideration applies to all sides of the mechanical enclosure when the document shredder is mounted as intended.

The accessibility probe/wedge illustrated in figures NAF.2 and NAF.3 shall be inserted into each opening in the MECHANICAL ENCLOSURE. A force not exceeding 45 N for strip-cut type HOUSEHOLD/HOME OFFICE DOCUMENT SHREDDERS and not exceeding 90 N for cross-cut type HOUSEHOLD/HOME OFFICE DOCUMENT SHREDDERS shall be applied to the probe/wedge in any direction relative to the opening. Before application of the accessibility probe/wedge, any MECHANICAL ENCLOSURES or guards that are removable without the use of a tool shall be removed. The probe/wedge shall not contact hazardous moving parts, including shredding rollers/mechanisms.

NOTE It is permissible for the mass of the accessibility probe/wedge to be factored into the overall applied force specified above.

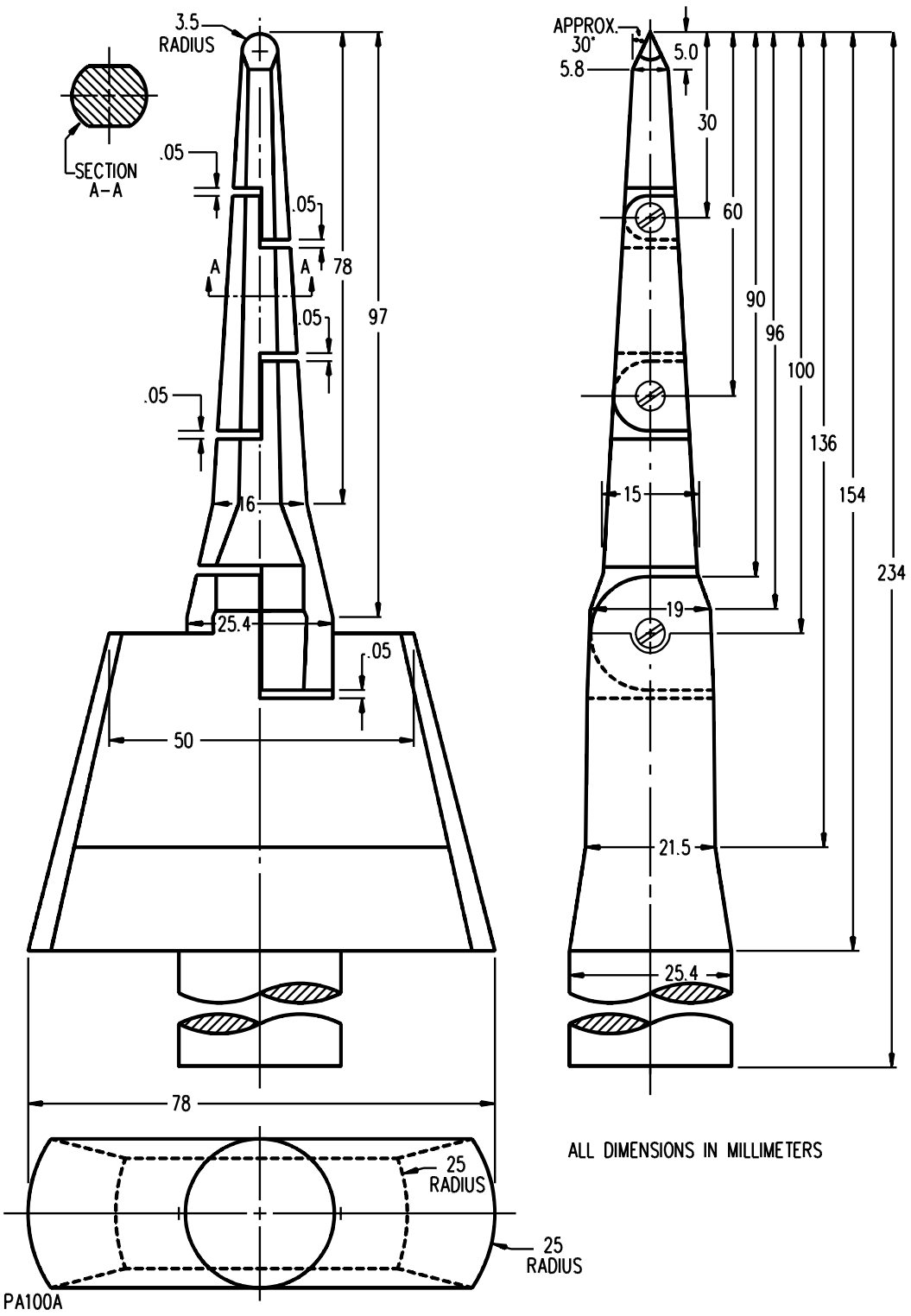
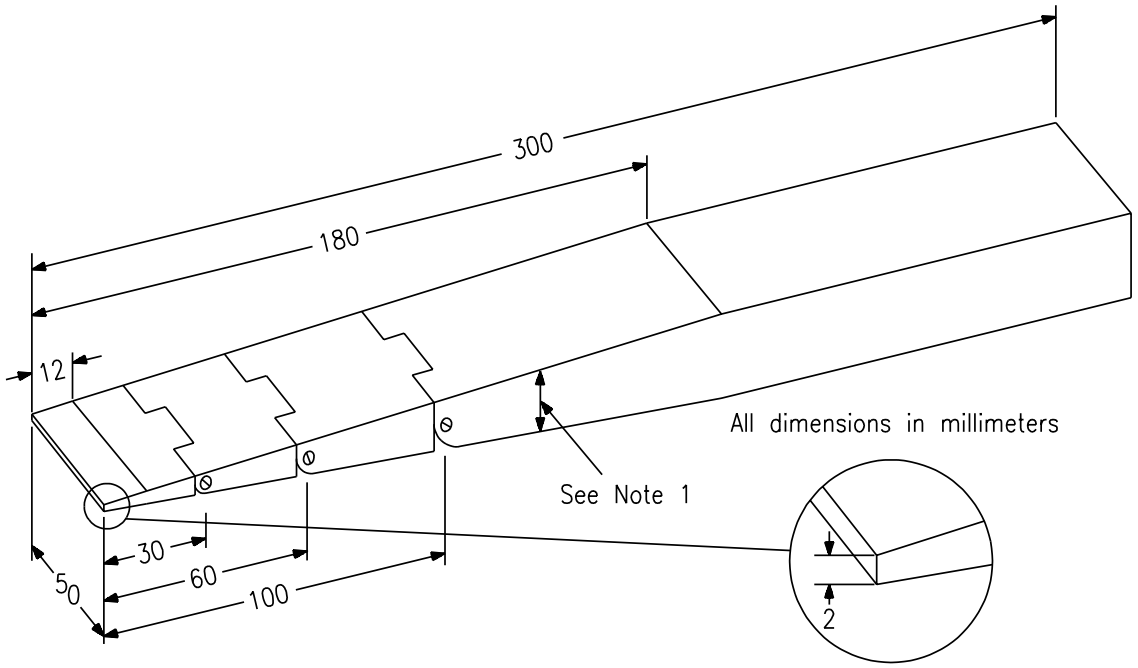


Figure NAF.1 – Articulated accessibility probe

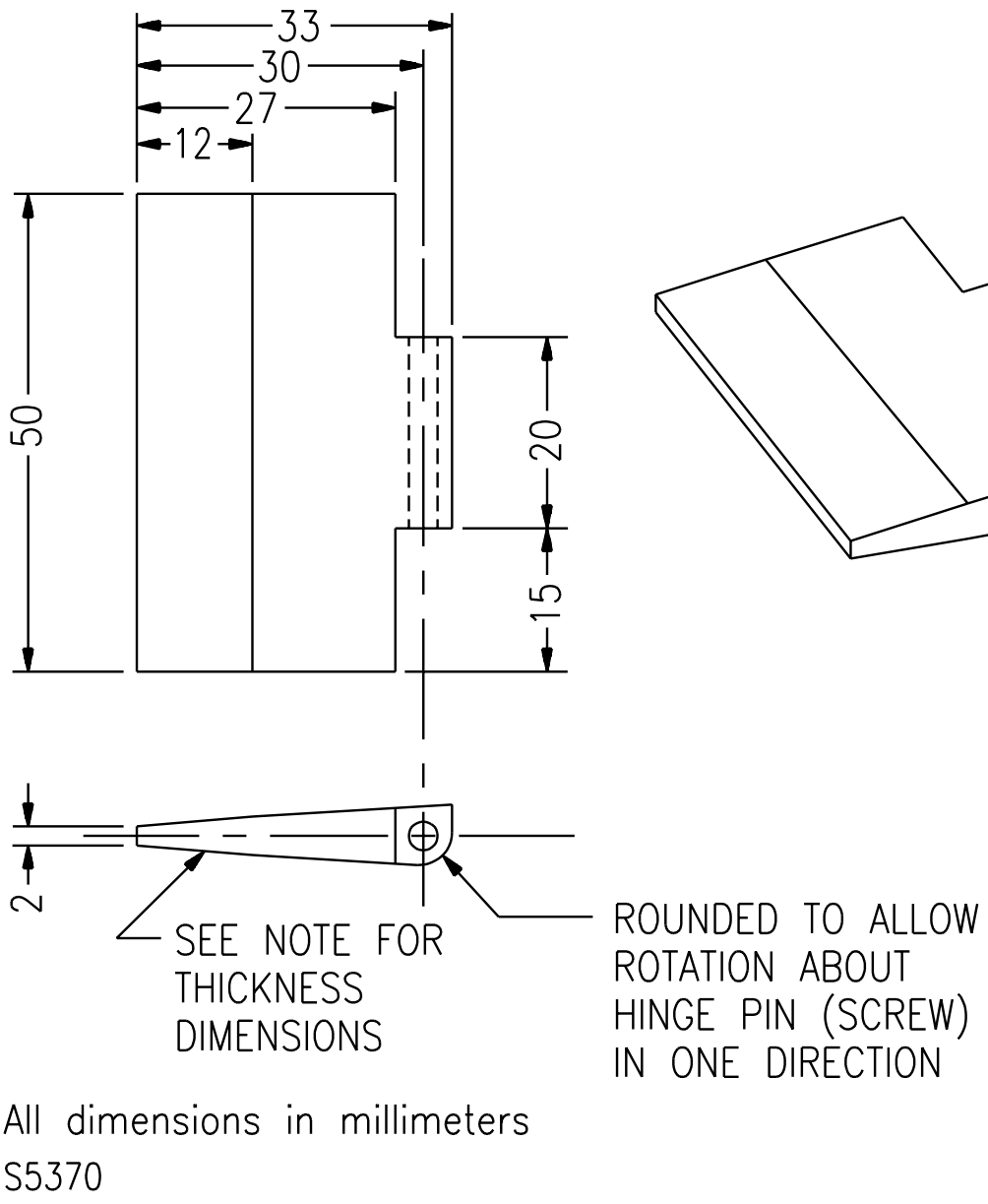


Note 1 The thickness of the probe varies linearly, with slope changes at the following points along the probe:

Distance from probe tip	Probe thickness
0 mm	2 mm
12 mm	4 mm
180 mm	24 mm

Note 2 Tolerances on the probe measurement values are ±0.127 mm.

Figure NAF.2 – Accessibility probe/wedge (overall view)



Note 1 The thickness of the probe varies linearly, with slope changes at the following points along the probe:

Distance from probe tip	Probe thickness
0 mm	2 mm
12 mm	4 mm
180 mm	24 mm

Note 2 Tolerances on the probe measurement values are ±0.127 mm.

Figure NAF.3 – Accessibility probe/wedge (tip details)

INDEX

This index is for information only and does not purport to be a complete guide to the use of this standard. The inclusion or omission of items in the index does not imply any particular importance.

Location references are clause or subclause numbers or annex letters.

In the standard, table numbers and figure numbers are linked to the clause or annex in which they are found, for example:

– Table 2A is the first table in Clause 2;

– Figure F.2 is the second figure in Annex F.

Principal references are printed in **bold** type.

If a term is defined in 1.2 of this standard, its definition is indicated in the index by an asterisk, for example:

– RATED VOLTAGE 1.2.1.1*.

This index is also used to explain some abbreviations, for example:

– EUT EQUIPMENT UNDER TEST.

Country notes are listed, but the contents of country notes are not indexed.

Bib is an abbreviation for Bibliography, which precedes this Index.

A

IEC 60127, 2.7.3 (note), Bib

IEC 60216-4-1, 4.2.7, Annex P

IEC 60227, 3.2.5.1, Annex P

IEC 60245, 3.2.5.1, Annex P

IEC 60269-2-1, 6.3 (note 4), Bib

IEC 60309, 1.2.5.2, 2.1.1.1, 2.10.3.1, 2.10.4.3, 3.2.4, G.6, Annex P

IEC 60317 series, 2.10.5.13, Annex P

IEC 60317-43, U.2.2 (Table U.1), Annex P

IEC 60320, 3.2.5.1 (Table 3B/Footnote b, c, and note 1), 4.3.5, G.6, Annex P

IEC 60364-1, Annex P, V.1

IEC 60364-4-41, Annex P, V.1

IEC 60364-7-707, 5.1.7.1 (note), Bib

IEC 60384-14, 1.5.6, 1.5.8, Annex P

IEC 60410, R.1, R.2, Bib

IEC 60417-1, 1.7.1, 1.7.7.1, 1.7.8.3, 2.6.2, 2.6.5.1, 2.7.6, 4.5.4 (Table 4C/Footnotes a and c), Annex P

IEC 60529, Annex T, Bib

IEC 60664-1, 1.5.9.2 (note 1), 2.10.1 (note), 2.10.3.1, 5.2.2 (note 2), Clause 6 (note 4), 7.1 (note 4), G.6, Annex P, Annex Z

IEC 60664-4, 2.10.1.1 (note), Bib

IEC 60695-2-2, 4.6.2, 4.7.3.6, A.2.7, Annex P

IEC 60695-2-11, 4.7.3.1, Annex P

IEC 60695-2-20, 4.7.3.2, Annex P

IEC 60695-10-2, 4.5.5, Annex P

IEC 60695-11-3, A.1.4, Annex P

IEC 60695-11-4, A.2.4, Annex P

IEC 60695-11-10, 1.2.12.1, 1.2.12.2, 1.2.12.3, 1.2.12.4, 1.2.12.10, 1.2.12.11, Annex P

IEC 60695-11-20, 1.2.12.1, 1.2.12.5, 1.2.12.6, Annex P

IEC 60728-11, 7.1 (note 5), Bib

IEC 60730-1, 2.5, Annex P

IEC 60747-5, 2.10.5.4, Annex P

IEC 60747-5-1, 2.10.5.4, Annex P

IEC 60747-5-2, 2.10.5.4, Annex P

IEC 60747-5-3, 2.10.5.4, Annex P

IEC 60825-1, 4.3.13.5, Annex P

IEC 60825-2, 4.3.13.5, Annex P

IEC 60825-9, 4.3.13.4, Annex P

IEC 60825-12, 4.3.13.5, Annex P

IEC 60851-3, Annex P, U.2.2

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