

TECHNICAL REPORT



**Audio/video, information and communication technology equipment –
Part 2: Explanatory information related to IEC 62368-1**

Withdrawn



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**Audio/video, information and communication technology equipment –
Part 2: Explanatory information related to IEC 62368-1**

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ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

AUDIO/VIDEO, INFORMATION AND COMMUNICATION TECHNOLOGY EQUIPMENT –

Part 2: Explanatory information related to IEC 62368-1

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IEC 62368-2, which is a technical report, has been prepared by subcommittee TC108: Safety of electronic equipment within the field of audio/video, information technology and communication technology.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
108/439/DTR	108/452/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

In this standard, the following print types are used:

- notes/explanatory matter: in smaller roman type (also in green if colour is available);
- tables and figures that are included in the rationale have linked fields (shaded in grey if “field shading” is active).

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 62368 series can be found, under the general title *Audio/video, information and communication technology equipment*, on the IEC website.

In this document, only those subclauses considered to need further background reference information or explanation of their content to benefit the reader are included. Therefore, not all numbered subclauses are cited. Unless otherwise noted, all references are to clauses, subclauses, annexes, figures or tables are located in IEC 62368-1:2010.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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AUDIO/VIDEO, INFORMATION AND COMMUNICATION TECHNOLOGY EQUIPMENT –

Part 2: Explanatory information related to IEC 62368-1

Clause 0 Introduction – Principles of this product safety standard

Clause 0 is informational and provides a rationale for the normative clauses of the standard.

0.5.7 Equipment safeguards during skilled person service conditions

Purpose: To explain the intent of requirements for providing safeguards against involuntary reaction.

Rationale: By definition, a skilled person has the education and experience to identify all class 3 energy sources to which he may be exposed. However, while servicing one class 3 energy source in one location, a skilled person may be exposed to another class 3 energy source in a different location.

In such a situation, either of two events is possible. First, something may cause an involuntary reaction of the skilled person with the consequences of contact with the class 3 energy source in the different location. Second, the space in which the skilled person is located may be small and cramped, and inadvertent contact with a class 3 energy source in the different location may be likely.

In such situations, this standard may require an equipment safeguard solely for the protection of a skilled person while performing servicing activity.

Clause 1 Scope

Purpose: To identify the purpose and applicability of this standard and the exclusions from the scope.

Rationale: The scope excludes requirements for functional safety. Functional safety is addressed in IEC 61508-1. Because the scope includes computers that may control safety systems, functional safety requirements would necessarily include requirements for computer processes and software. The TC108 experts are experts in hardware safety, and have little or no expertise to properly address functional safety requirements.

Clause 3 Terms and definitions

Rationale is provided for definitions that deviate from IEC definitions or from pilot standard definitions.

3.3.2.1 electrical enclosure

Source: IEC 195-06-13

Purpose: To support the concept of safeguards as used in this standard.

Rationale: The IEC definition is modified to use the term “safeguard” in place of the word “protection”. The word “safeguard” identifies a physical “thing” whereas the word “protection” identifies the act of protecting. This standard sets forth requirements for use of physical safeguards and requirements for those safeguards. The safeguards provide “protection” against injury from the equipment.

3.3.5.1 basic insulation

Source: IEC 195-06-06

Purpose: To support the concept of safeguards as used in this standard.

Rationale: The IEV definition is modified to use the term “safeguard” in place of the word “protection”. The word “safeguard” identifies a physical “thing” whereas the word “protection” identifies the act of protecting. This standard sets forth requirements for use of physical safeguards and requirements for those safeguards. The safeguards provide “protection” against injury from the equipment.

3.3.5.2 double insulation

Source: IEV 195-06-08

Purpose: To support the concept of safeguards as used in this standard.

Rationale: See 3.3.5.1, basic insulation.

3.3.5.5 solid insulation

Source: IEC 60664-1:2007, 3.4

Purpose: To support the concept that safeguards are interposed between an energy source and a body part.

Rationale: IEC 60664-1 defines insulation as material interposed between two conductive parts. The IEC 60664-1 definition is modified by adding that insulation is also “between a conductive part and a body part.” For safety purposes, solid insulation is not only used between conductors, but is also used between a conductor and a body part. For example, a Class II equipment employs solid insulation in this manner.

3.3.5.6 supplementary insulation

Source: IEV 195-06-07

Purpose: To support the concept of safeguards as used in this standard.

Rationale: See 3.3.5.1, basic insulation.

3.3.6.6 restricted access area

Source: IEV 195-04-04

Purpose: To use the concept of “instructed persons” and “skilled persons” as used in this standard.

Rationale: The IEV definition is modified to use the terms “instructed persons” and “skilled persons” rather than “electrically instructed persons” and “electrically skilled persons.”

3.3.7.8 reasonably foreseeable misuse

Source: ISO/IEC Guide 51:1999, definition 3.14

Purpose: To describe that the standard does not generally address foreseeable misuse.

Rationale: The scope excludes consideration of foreseeable misuse that might lead to an injury. Misuse depends on personal objectives, personal perception of the equipment, and the possible use of the equipment (in a manner not intended by the manufacturer) to accomplish those personal objectives. Equipment within the scope of this standard ranges from small handheld equipment to large, permanently installed equipment. There is no commonality among the equipment for readily predicting human behaviour leading to misuse of the equipment and resultant injury. Manufacturers are encouraged to consider reasonably foreseeable misuse of equipment and provide safeguards, as applicable, to prevent injury in the event of such misuse. (Not all reasonably foreseeable misuse of equipment results in injury or potential for injury.)

3.3.8.1 instructed person

Source: IEV 826-18-02

Purpose: To use the terms used in this standard.

Rationale: The IEV definition is modified to use the terms “energy sources”, “skilled person”, and “precautionary safeguard”. The definition is made stronger by using the term “instructed” rather than “advised”.

3.3.8.3 skilled person

Source: IEV 826-18-01

Purpose: To use the terms used in this standard.

Rationale: The IEV definition is modified to use the phrase “to reduce the likelihood of”. IEC 62368-1 does not use the word “hazard”.

3.3.14.5 prospective touch voltage

Source: IEV 195-05-09

Purpose: To properly identify electric shock energy source voltages.

Rationale: The IEV definition is modified to delete “animal”. The word “person” is also deleted as all of the requirements in the standard are with respect to persons.

3.3.14.10 working voltage

Source: IEC 60664-1:2007, definition 3.5

Purpose: To distinguish between r.m.s. working voltage and peak working voltage.

Rationale: The IEC 60664-1 definition is modified to delete “r.m.s.” IEC 62368-1 uses both r.m.s. working voltage and peak working voltage; each term is defined.

3.3.15.2 class II construction

Source: IEC 60335-1:2001, 3.3.11

Purpose: Although the term is not used in the standard, for completeness, it was decided to retain this definition.

Rationale: The word “appliance” is changed to “equipment”.

Clause 4 General requirements

Purpose: To explain how to investigate and determine whether or not safety is involved.

Rationale: In order to establish whether or not safety is involved, the circuits and construction are investigated to determine whether the consequences of possible fault conditions would lead to an injury. Safety is involved if, as a result of a single fault condition, the consequences of the fault lead to a risk of injury.

If a fault condition should lead to a risk of injury, the part, material, or device whose fault was simulated may comprise a safeguard.

Rationale is provided for questions regarding the omission of some traditional requirements appearing in other safety standards. Rationale is also provided for further explanation of new concepts and requirements in this standard.

functional insulation

Purpose: To explain why the standard has no requirements for functional insulation.

Rationale: This standard does not include requirements for functional insulation. By its nature, functional insulation does not provide a safeguard function against electric shock or electrically-caused fire and therefore may be faulted. Obviously, not all functional insulations are faulted as this would be prohibitively time-consuming. Sites for functional insulation faults must be based upon physical examination of the equipment, upon the electrical schematic.

Note that basic and reinforced insulation may also serve as functional insulation, in which case the insulation is not faulted.

functional components

Purpose: To identify the conditions for consideration of functional components as safeguards.

Rationale: This standard does not include requirements for functional components. By their nature, individual functional components do not provide a safeguard function against electric shock, electrically-caused fire, thermal injury, etc., and therefore may be candidates for fault testing. Obviously, not all functional components are faulted as this would be prohibitively time-consuming. Candidate components for fault testing must be based upon physical examination of the equipment, upon the electrical schematic diagrams, and whether a fault of that component might result in conditions for electric shock, conditions for ignition and propagation of fire, conditions for thermal injury, etc.

As with all fault-condition testing (Clause B.4), upon faulting of a functional component, there shall not be any safety consequence (for example, a benign consequence), or a basic, supplementary, or reinforced safeguard shall remain effective.

In some cases, a pair of functional components may comprise a safeguard. If the fault of one of the components in the pair is mitigated by the second component, then the pair must be designated as a double safeguard. For example, if two diodes are employed in series to protect a battery from reverse charge, then the pair must comprise a double safeguard and the components must be limited to the manufacturer and part number actually tested. A second example is that of an X-capacitor and discharge resistor. If the discharge resistor should fail open, then the X-capacitor will not be discharged. Therefore, the X-capacitor value must not exceed the ES2 limits specified for a charged capacitor. Again, the two components comprise a double safeguard and the values of each component must be limited to values for ES1 under normal operating conditions and the values for ES2 under single fault conditions.

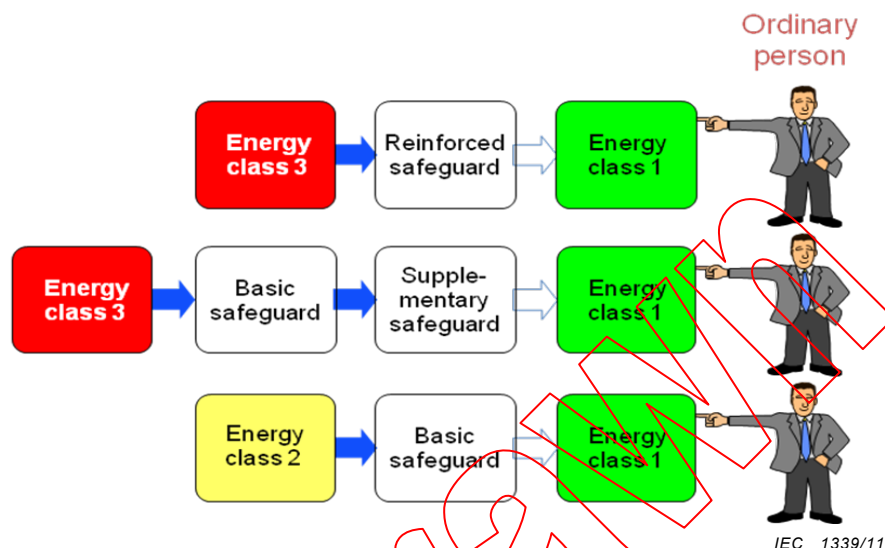
4.1.1 Application of requirements and acceptance of materials, components and subassemblies

Purpose: To accept components as safeguards.

Rationale: This standard includes requirements for safeguard components. A safeguard component is a component specifically designed and manufactured for both functional and safeguard parameters. Examples of safeguard components are capacitors complying with IEC 60384-14 and other IEC component standards.

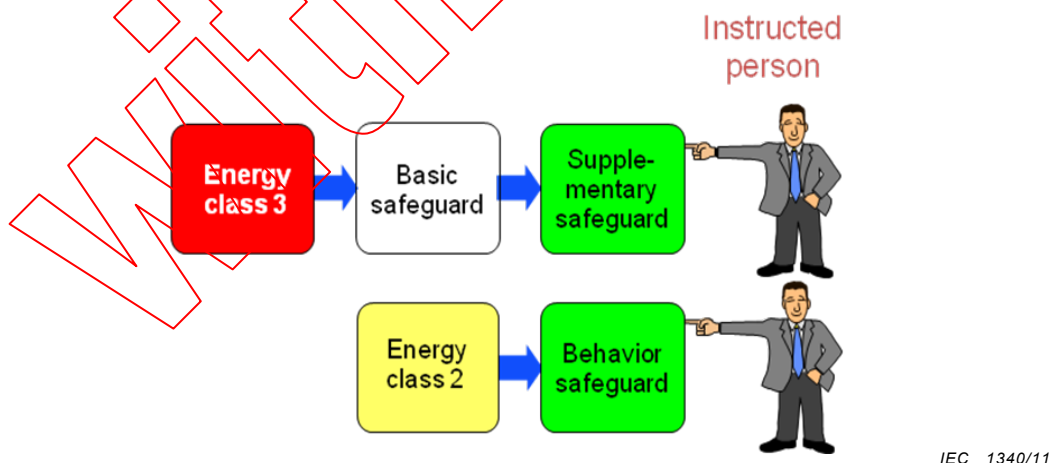
4.3.2 Safeguards for protection of an ordinary person

Ordinary person safeguard requirements



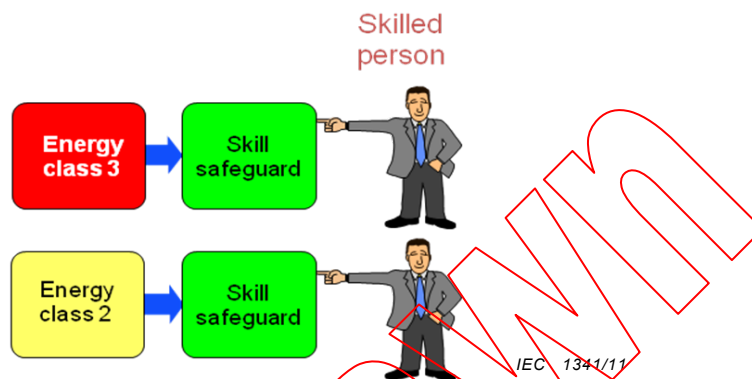
4.3.3 Safeguards for protection of an instructed person

Instructed person safeguard requirements



4.3.4 Safeguards for protection of a skilled person

Skilled person safeguard requirements



4.4.3 Composition of a safeguard

Purpose: To specify design and construction criteria for a single safeguard (basic, supplementary, or reinforced) comprised of more than one element, for example, a component or a device.

Rationale: Safeguards need not be a single, homogeneous component. Indeed, some parts of this standard require a single safeguard be comprised of two or more elements. For example, for thin insulation, two or more layers are required to qualify as supplementary insulation. Another example is protective bonding and protective earthing, both of which are comprised of wires, terminals, screws, etc.

If a safeguard is comprised of two or more elements, then the function of the safeguard must not be compromised by a failure of any one element. For example, if a screw attaching a protective earthing wire should loosen, then the current-carrying capacity of the protective earthing circuit may be compromised, making its reliability uncertain.

4.4.5 Safeguard robustness

Purpose: To require safeguards to be robust.

Rationale: Safeguards must be sufficiently robust to withstand the rigors of expected use throughout the equipment lifetime. Robustness requirements are specified in the various clauses.

Clause 5 Electrically-caused injury

Purpose: Clause 5 classifies electrical energy sources and provides criteria for determining the energy source class of each conductive part. The criteria for energy source class include the source current-voltage characteristics, duration, and capacitance. Each conductive part, whether current-carrying or not, or whether earthed or not, shall be classed ES1, ES2, or ES3 with respect to earth and with respect to any other simultaneously accessible conductive part.

5.2.1 Electrical energy source classifications

Source: IEC/TS 60479-1 and IEC 61201

Purpose: To define the line between hazardous and non-hazardous electrical energy sources for normal and abnormal operating conditions.

Rationale: The effect on persons from an electric source depends on the CURRENT through the human body. The effects are described in IEC/TS 60479-1.

Purpose: ES1 may be accessible to an ordinary person with no safeguards

Rationale: IEC/TS 60479-1:2005 (see Figures 20 and 22, Tables 11 and 13); zone AC-1 and zone DC-1; usually no reaction (Figure 1 and Figure 2, Table 1 and Table 2 in this standard).

Purpose: ES2 may be accessible to an instructed person with no safeguards and to an ordinary person under a fault condition of a basic safeguard.

Rationale: IEC/TS 60479-1:2005 (see Figures 20 and 22; Tables 11 and 13); zone AC-2 and zone DC-2; usually no harmful physiological effects (see Figure 1 and Figure 2, Table 1 in this standard).

Purpose: ES3 is not accessible to an ordinary person nor to an instructed person under normal conditions or under a fault condition of a safeguard. Parts and circuits classed ES3 may be accessible to a skilled person.

Rationale: IEC/TS 60479-1; zone AC-3 and zone DC-3; harmful physiological effects may occur (see Figure 1 and Figure 2, Table 1 and Table 2 in this standard).

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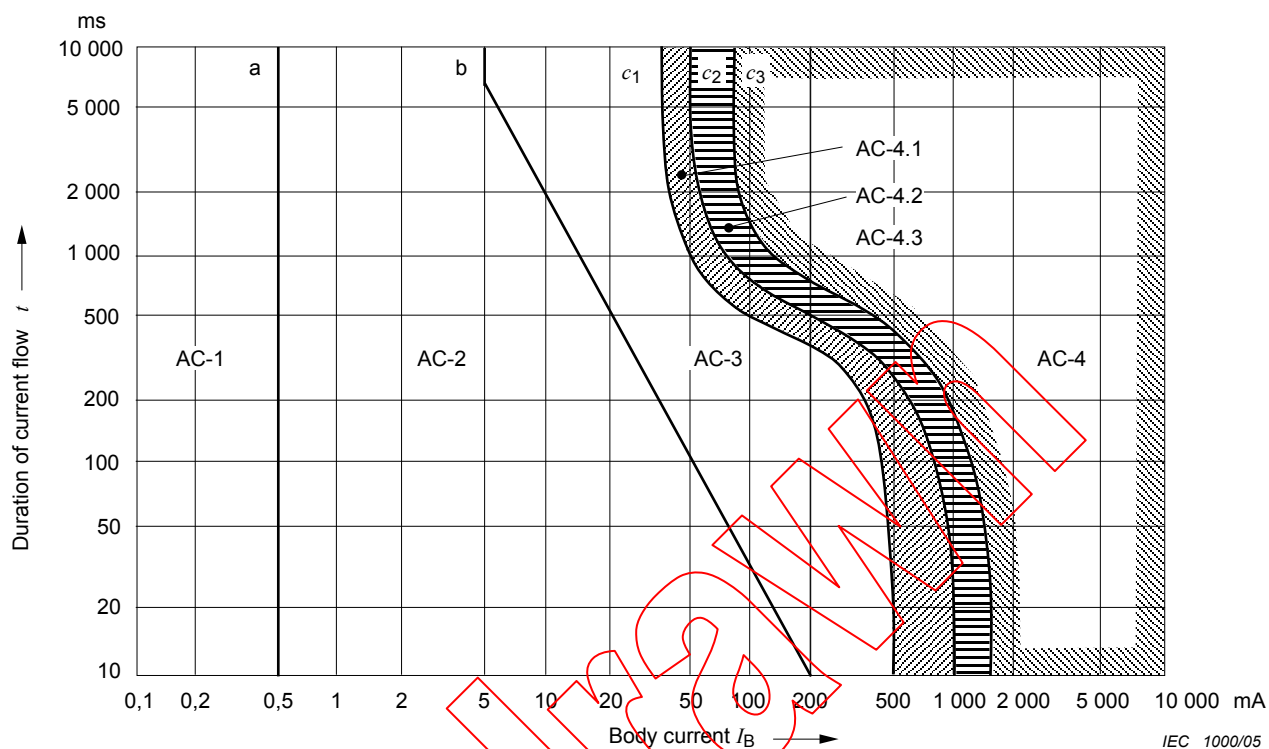


Figure 1 – Conventional time/current zones of effects of a.c. currents (15 Hz to 100 Hz) on persons for a current path corresponding to left hand to feet (see IEC/TS 60479-1:2005, Figure 20)

Table 1 – Time/current zones for a.c. 15 Hz to 100 Hz for hand to feet pathway (see IEC/TS 60479-1:2005, Table 11)

Zones	Boundaries	Physiological effects
AC-1	up to 0,5 mA curve a	Perception possible but usually no startle reaction
AC-2	0,5 mA up to curve b	Perception and involuntary muscular contractions likely but usually no harmful electrical physiological effects
AC-3	Curve b and above	Strong involuntary muscular contractions. Difficulty in breathing. Reversible disturbances of heart function. Immobilisation may occur. Effects increasing with current magnitude. Usually no organic damage to be expected.
AC-4 ^a	Above curve c_1 $c_1 - c_2$ $c_2 - c_3$ Beyond curve c_3	Pathophysiological effects may occur such as cardiac arrest, breathing arrest, and burns or other cellular damage. Probability of ventricular fibrillation increasing with current magnitude and time. AC-4.1 Probability of ventricular fibrillation increasing up to about 5 %. AC-4.2 Probability of ventricular fibrillation up to about 50 %. AC-4.3 Probability of ventricular fibrillation above 50 %.

^a For durations of current flow below 200 ms, ventricular fibrillation is only initiated within the vulnerable period if the relevant thresholds are surpassed. As regards ventricular fibrillation this figure relates to the effects of current which flows in the path left hand to feet. For other current paths the heart current factor has to be considered.

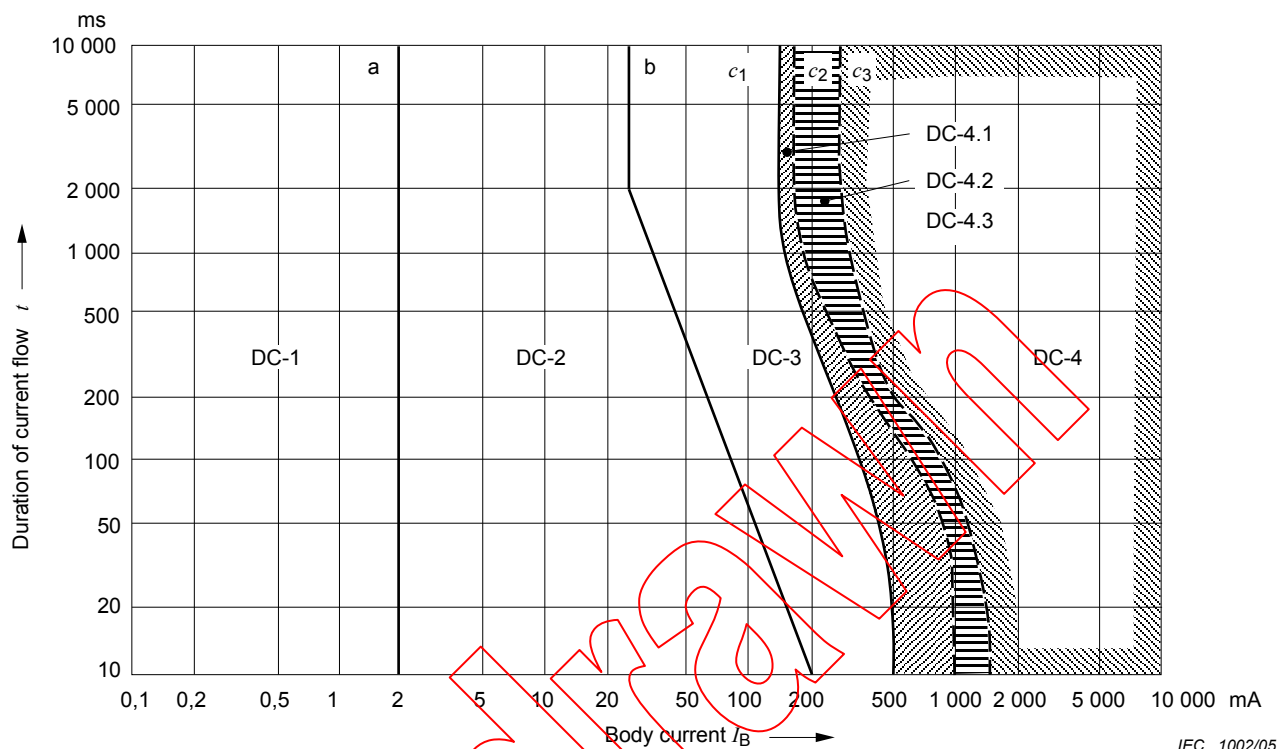


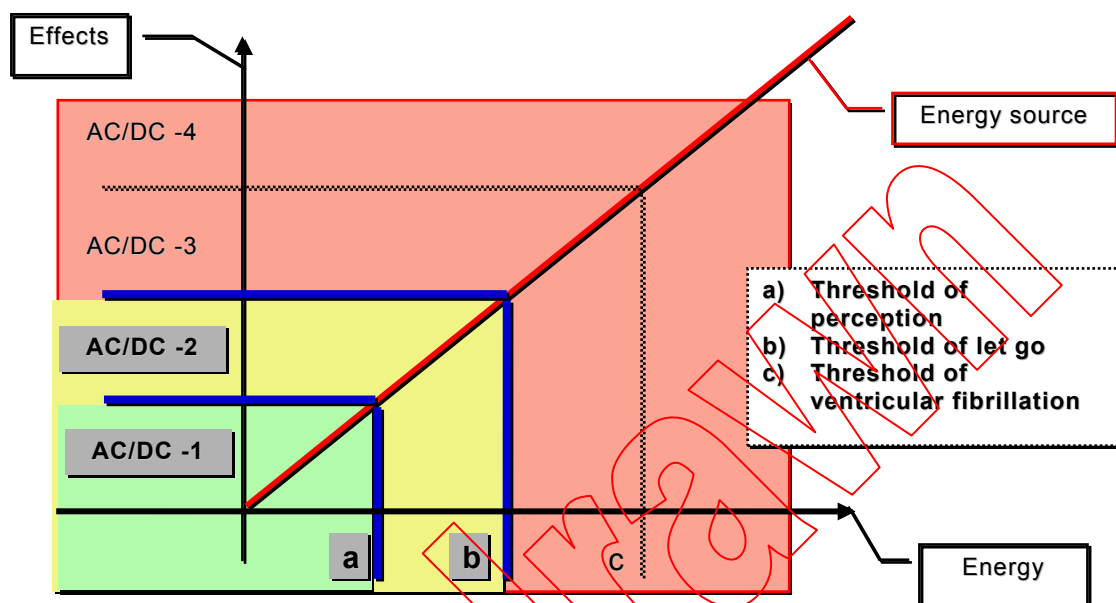
Figure 2 – Conventional time/current zones of effects of d.c. currents on persons for a longitudinal upward current path (see IEC/TS 60479-1:2005, Figure 22)

Table 2 – Time/current zones for d.c. for hand to feet pathway (see IEC/TS 60479-1:2005, Table 13)

Zones	Boundaries	Physiological effects
DC-1	Up to 2 mA curve a	Slight pricking sensation possible when making, breaking or rapidly altering current flow.
DC-2	2 mA up to curve b	Involuntary muscular contractions likely, especially when making, breaking or rapidly altering current flow, but usually no harmful electrical physiological effects
DC-3	curve b and above	Strong involuntary muscular reactions and reversible disturbances of formation and conduction of impulses in the heart may occur, increasing with current magnitude and time. Usually no organic damage to be expected.
DC-4 ^a	Above curve c_1 $c_1 - c_2$ $c_2 - c_3$ Beyond curve c_3	Pathophysiological effects may occur such as cardiac arrest, breathing arrest, and burns or other cellular damage. Probability of ventricular fibrillation increasing with current magnitude and time. DC-4.1 Probability of ventricular fibrillation increasing up to about 5 %. DC-4.2 Probability of ventricular fibrillation up to about 50 %. DC-4.3 Probability of ventricular fibrillation above 50 %.

^a For durations of current flow below 200 ms ventricular fibrillation is only initiated within the vulnerable period if the relevant thresholds are surpassed. As regards ventricular fibrillation this figure relates to the effects of current which flows in the path left hand to feet and for upward current. For other current paths the heart current factor has to be considered.

The effects for an injury increases continuously with the energy transferred to the body. To demonstrate this principle Figure 1 and Figure 2 in this standard (see IEC/TS 60479-1:2005, Figures 20 and 22) are transferred into a graph: effects = (f) energy (see Figure 3 in this standard).



IEC 1342/11

Figure 3 – Illustration that limits depend on both voltage and current

Within the standard only the limits for Zone 1 (green) and Zone 2 (yellow) will be specified.

Curve "a" (limit of Zone 1) will be the limit for parts accessible by an ordinary person during normal use.

Curve "b" (limit of Zone 2) will be the limit for parts accessible by an ordinary person during (or after) a single fault.

It was found to be not acceptable to go to the limits of either Zone 3 or 4.

In the standard three (3) zones are described as electrical energy sources.

This classification is as follows:

- electrical energy source 1 (ES1): levels are of such a value that they do not exceed curve "a" (threshold of perception) of Figure 1 and Figure 2 in this standard (see IEC/TS 60479-1:2005, Figures 20 and 22).
- electrical energy source 2 (ES2): levels are of such a value that they exceed curve "a", but do not exceed curve "b" (threshold of let go) of Figure 1 and Figure 2 in this standard (see IEC/TS 60479-1:2005, Figures 20 and 22).
- electrical energy source 3 (ES3): levels are of such a value that they exceed curve "b" of Figure 1 and Figure 2 in this standard (see IEC/TS 60479-1:2005, Figures 20 and 22).

5.2.2.2 Steady-state voltage and current limits

Table 4 – Electrical energy source limits for d.c. and low frequency a.c. currents

Source:	IEC/TS 60479-1, Dalziel, Effect of Wave Form on Let-Go Currents; AIEE Electrical Engineering Transactions, Dec 1943, Vol 62.
Purpose:	Current values for ES Sources.
Rationale:	The current limits of Table 4 line 1 and 2 are derived from curve a and b, Figure 1 and Figure 2 in this standard (see IEC/TS 60479-1:2005, Figures 20 and 22). The basis for setting limits for combined a.c. and d.c. touch current is from the work of Dalziel which provides clear data for men, women and children. Since we are working with consumer appliances under this standard we need to provide protection for children, which are generally considered the most severe case. The formulas of IEC 62368-1:2010, Table 4 addresses the Dalziel investigations.

Table 5 – Electrical energy source limits for d.c. and low frequency a.c. voltages

Source:	IEC 60950-1 and IEC 61201:2007(see Table 3 in this standard)
Purpose:	Voltage values for ES sources.
Rationale:	In most cases the electrical power source is a voltage source. Therefore it is practical for the design and testing of electrical equipment to specify voltage limits. The values chosen in the table are for dry conditions only. Typically, physically larger people in the population have lower internal body resistance because of their larger cross sectional area. Physically small people in the population generally have higher internal body resistance. Some measurements of body impedances show that the body impedance is not greatly influenced by the body weight. Therefore there is not sufficient correlation between the body weight (children or adults) and the physiological current values corresponding to a particular effect. – ES-1 and ES-2 voltage limits are taken from IEC 60950-1, based on experience. – ES-1 voltage limits correspond to the limits of SELV circuits of IEC 60950-1 and to Table A.1 of IEC/TS 61201:2001 environmental situation 3 (dry). – ES-2 voltage limits correspond to the limits of TNV circuits of IEC 60950-1 and to Table A.1 of IEC/TS 61201:2001 environmental situation 3 (dry) “single fault.” The basis for setting limits for combined a.c. and d.c. touch current is from the work of Dalziel which provides clear data for men, women and children. Since we are working with consumer appliances under this standard we need to provide protection for children, the worst case. The formulas of IEC 62368-1:2010, Table 5 addresses the Dalziel investigations.

Table 3 – Limits for steady-state voltages (see IEC 61201:2007)

Environmental situation	No fault	Single fault	Two faults
1	0 V	0 V	16 V a.c. 35 V d.c.
2	16 V a.c. 35 V d.c.	33 V a.c. 70 V d.c. ^b	Not applicable
3	33 V a.c. ^a 70 V d.c. ^b	55 V a.c. ^a 140 V d.c. ^b	Not applicable
4	Special applications		

^a For a non-grippable part with a contact area less than 1 cm², limits are 66 V and 80 V respectively.

^b For charging a battery, limits are 75 V and 150 V.

Table 6 – Electrical energy source limits for medium and high frequency voltage and current

Source: IEC/TS 60479-2 and IEC/TS 60479-1

Purpose: Voltage values for ES Sources with higher frequencies.

Rationale: The effect of a.c. current with higher frequencies (above 100 Hz) is documented in IEC/TS 60479-2. With increasing frequency an increasing current has the same effect to the human body (Figures 9 and 12 of IEC/TS 60479-2:2007). For high frequency currents of about 100 mA burns may occur. Therefore the maximum HF current limit is specified to 100 mA. The formula used for the ES1 limits of the HF current is already used in IEC 60215 and in IEC 60950-1. The body impedance falls with increasing frequency. The effect is documented in IEC/TS 60479-1. Therefore the voltage limits has a different formula than the formula for the current.

5.2.2.3 Capacitance limits

Table 7 – Electrical energy source limits for a charged capacitor

Source: IEC/TR 61201:2007 (Annex A)

Purpose: Limits for capacitances.

Rationale: Where the energy source is a capacitor, the energy source class is determined from both the charge voltage and the capacitance. The capacitance limits are derived from IEC 61201:2007.

The values for ES2 are derived from Table A.2 (IEC 61201:2007).

The values for ES1 are calculated by dividing the values from Table A.2 (IEC 61201:2007) by two (2).

While Table 4 in this standard shows a value of 60 kV for 0,133 nF capacitor, because this value results in an energy greater than 350 mJ (using $\frac{1}{2} CV^2$ formula), it was changed to 50 kV.

Table 4 – Limit values of accessible capacitance (threshold of pain) – (IEC 61201:2007)

U(V)	C(μF)	U(kV)	C(nF)
70	42,4	1	8,0
78	10,0	2	4,0
80	3,8	5	1,6
90	1,2	10	0,8
100	0,58	20	0,4
150	0,17	40	0,2
200	0,091	60	0,133
250	0,061		
300	0,041		
400	0,028		
500	0,018		
700	0,012		

5.2.2.4 Single pulse limits

Table 8 – Voltage limits for single pulses

Table 9 – Current limits for single pulses

Source: IEC/TS 60479-1:2005

Purpose: Values for ES Sources of single pulses.

Rationale: For ES1 the limit of single pulse should not exceed the ES-1 steady state voltage limits for d.c. voltages.

For ES2 the voltage limits have been calculated by using the d.c. current values of curve b Figure 2 in this standard (IEC/TS 60479-1:2005, Figure 22) and the resistance values of Table 10, column for 5 % of the population (see Table 5 in this standard).

The current limits of single pulses in Table 9 for ES-1 levels are from curve a and for ES-2 are from curve b of Figure 2 in this standard (IEC/TS 60479-1:2005, Figure 22).

Table 5 – Total body resistances R_T for a current path hand to hand, d.c., for large surface areas of contact in dry condition

Touch voltage V	Values for the total body resistance R_T (Ω) that are not exceeded for		
	5 % of the population	50 % of the population	95 % of the population
25	2 100	3 875	7 275
50	1 600	2 900	5 325
75	1 275	2 275	4 100
100	1 100	1 900	3 350
125	975	1 675	2 875
150	875	1 475	2 475
175	825	1 350	2 225
200	800	1 275	2 050
225	775	1 225	1 900
400	700	950	1 275
500	625	850	1 150
700	575	775	1 050
1 000	575	775	1 050
Asymptotic value	575	775	1 050
NOTE 1 Some measurements indicate that the total body resistance R_T for the current path hand to foot is somewhat lower than for a current path hand to hand (10 % to 30 %) NOTE 2 For living persons the values of R_T correspond to a duration of current flow of about 0,1 s For longer durations R_T values may decrease (about 10 % to 20 %) and after complete rupture of the skin R_T approaches the initial body resistance R_0 NOTE 3 Values of R_T are rounded to 25 Ω			

5.2.2.5 Limits for repetitive pulses

Table 10 – Electrical energy source limits for repetitive pulses

Source: IEC/TS 60479-2 and IEC/TS 60479-1

Purpose: To define current and voltage limits for repetitive pulses.

Rationale: For repetitive pulses with a pulse-off time less than 3 s the steady state peak values of Table 4 are used.

For repetitive pulses with a pulse-off time more than 3 s the limit values of single pulses from Table 8 (voltage) or Table 9 (current) are used.

5.2.2.6 Ringing signals

Source: EN 41003

Purpose: Limits for analogue telephone network ringing signals.

Rationale: For details see rationale for Annex H. Where the energy source is an analogue telephone network ringing signal as defined in Annex H, the energy source class is taken as ES2 (as in IEC 60950-1:2005, Annex M).

5.2.2.7 Audio signals

Source: IEC 60065:2001; IEC 62368-1:2010, Annex E

Purpose: To establish limits for touch voltages for audio signals.

Rationale: The proposed limits for touch voltages at terminals involving audio signals that may be contacted by persons have been extracted without deviation from IEC 60065:2001. Reference: IEC 60065:2001, 9.1.1.1a). Under single fault conditions, 10.1 of IEC 60065:2001 does not permit an increase in acceptable touch voltage limits.

The proposed limits are quantitatively larger than the accepted limits of Tables 5 and 6, but are not considered dangerous for the following reasons:

- the output is measured with the load disconnected (worst case load);
- defining the contact area of connectors and wiring is very difficult due to complex shapes. The area of contact is considered small due to the construction of the connectors;
- normally, it is recommended to the user, in the instruction manual provided with the equipment, that all connections be made with the equipment in the “off” condition. In this case we could consider the user as an instructed person;
- in addition to being on, the equipment would have to be playing some program at a high output with the load disconnected to achieve the proposed limits (although possible, highly unlikely). Historically, no known cases of injury are known for amplifiers with non-clipped output less than 71 V r.m.s;
- the National Electrical Code (USA) permits accessible terminals with maximum output voltage of 120 V r.m.s.

5.3.2 Protection of an ordinary person

Ordinary person

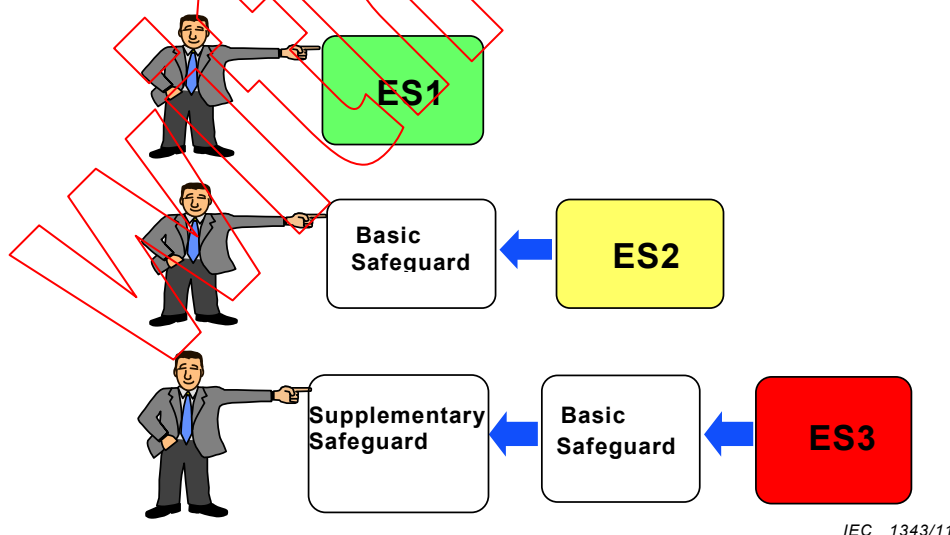


Figure 4 – Safeguards between an energy source and an ordinary person

5.3.2.1 Safeguards between energy source ES1 and an ordinary person

Source: IEC/TS 60479-1

Purpose: No requirement for a safeguard.

Rationale: Because there is usually no reaction of the human body when touching ES1, access is permitted (IEC/TS 60479-1; zone AC-1 and zone DC-1). See Figure 4 in this standard.

5.3.2.2 Safeguards between energy source ES2 and an ordinary person

Source: IEC/TS 60479-1

Purpose: At least one equipment safeguard.

Rationale: Because there may be a reaction of the human body when touching ES2, protection is required. But one safeguard is sufficient because there are usually no harmful physiological effects when touching ES2 (IEC/TS 60479-1; zone AC-2 and zone DC-2). See Figure 4 in this standard.

5.3.2.3 Safeguards between energy source ES3 and an ordinary person

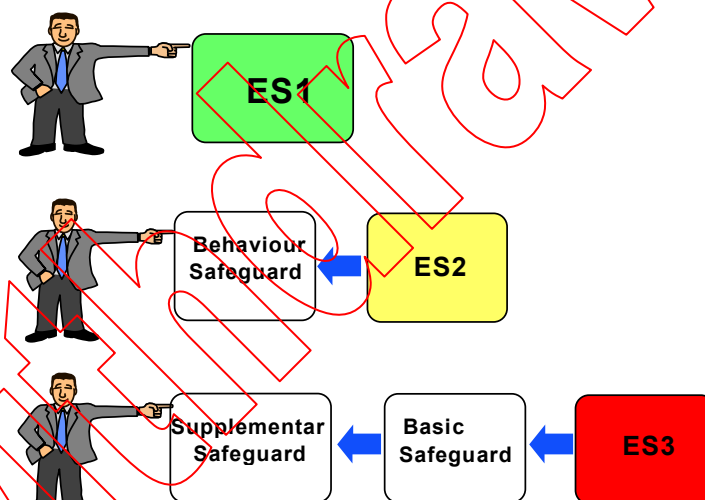
Source: IEC/TS 60479-1

Purpose: At least two safeguards, one basic and one supplementary.

Rationale: Because harmful physiological effects may occur when touching ES3, (IEC/TS 60479-1; zone AC-3 and zone DC-3), protection is required including after a fault of one safeguard. See Figure 4 in this standard.

5.3.3 Protection of an instructed person

Instructed person



IEC 1344/11

Figure 5 – Safeguards between an energy source and an instructed person

5.3.3.1 Safeguards between ES1 or ES2 and an instructed person

Source: IEC/TS 60479-1

Purpose: No requirement for a safeguard.

Rationale: For ES1: because there is usually no reaction of the human body when touching ES1 access is permitted (IEC/TS 60479-1; zone AC-1 and zone DC-1). (See Figure 5 in this standard.)

For ES2: An instructed person is instructed that there may be a reaction of the human body when touching ES2 but no harmful physiological effects may occur when touching ES2 (IEC/TS 60479-1; zone AC-2 and zone DC-2). (See Figure 5 in this standard.)

5.3.3.2 Safeguards between ES3 and an instructed person

Source: IEC/TS 60479-1

Purpose: At least two safeguards, one basic and one supplementary.

Rationale: Because harmful physiological effects may occur when touching ES3, (IEC/TS 60479-1; zone AC-3 and zone DC-3), a protection is required including after a fault of one safeguard. (See Figure 5 in this standard.)

5.3.4 Protection of a skilled person

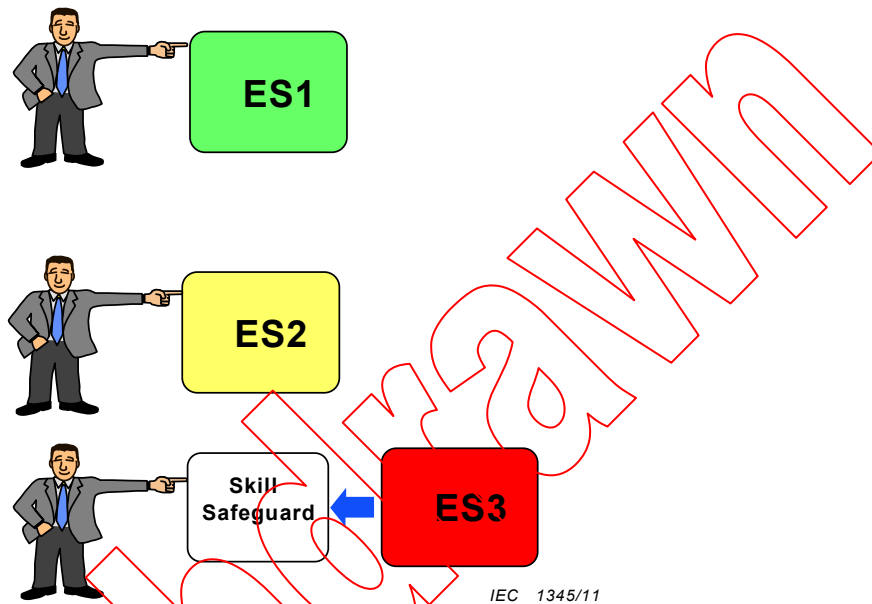


Figure 6 – Safeguards between energy sources and a skilled person

5.3.4.1 Safeguards between ES1 or ES2 and a skilled person

Source: IEC/TS 60479-1

Purpose: No requirement for a safeguard.

Rationale: For ES1: Because there is usually no reaction of the human body when touching ES1 access is permitted (IEC/TS 60479-1; zone AC-1 and zone DC-1). (See Figure 6 in this standard.)

For ES2: A skilled person has the knowledge that there may be a reaction of the human body when touching ES2, but that there are no harmful physiological effects when touching ES2 (IEC/TS 60479-1; zone AC-2 and zone DC-2). (See Figure 6 in this standard.)

5.3.4.2 Safeguards between ES3 and a skilled person

Purpose: Unintentional contact has to be prevented.

Rationale: A skilled person has the knowledge that there may be harmful physiological effects when touching ES3. (See Figure 6 in this standard.)

5.3.5 Safeguards between energy sources

5.3.5.2 Safeguards between ES1, ES2 and ES3

Purpose: At least one basic safeguard between ES1 and ES2.

Rationale: ES1 could be accessible for an ordinary person; ES2 should not therefore, the same protection as for ES2 applies (see 5.3.2.2).

Purpose: At least two safeguards between ES1 and ES3, one basic and one supplementary.

Rationale: ES1 could be accessible for an ordinary person; ES3 should not, even after a single fault, therefore the same protection as for ES3 (see 5.3.2.3).

Purpose: Example of determination of ES1 class for interconnected sources.

Rationale: ES1 circuits must be examined for voltage and current for both normal operating condition and single fault condition. If the voltage does not exceed the ES1 limit or, under single fault conditions, the ES2 limit, then the current does not need to be measured. Several examples are provided.

Example A, normal operating condition

EXAMPLE A normal operating conditions					
volts d.c.					
	A	B	C	D	E
A	0	40	0	0	n/a
B	40	0	0	0	n/a
C	0	0	0	40	n/a
D	0	0	40	0	n/a
E	n/a	n/a	n/a	n/a	n/a

IEC 1346/11

All voltages are within ES1 limits. Terminals A, B, C, D, and E may be accessible. If A, B, C, or D is connected to E, the results are the same.

Example B, single fault conditions (capacitor short-circuit)

EXAMPLE B single fault conditions					
volts d.c.					
	A	B	C	D	E
A	0	40	40	<i>80</i>	n/a
B	40	0	0	40	n/a
C	40	0	0	40	n/a
D	<i>80</i>	40	40	0	n/a
E	n/a	n/a	n/a	n/a	n/a

IEC 1347/11

All voltages that exceed ES1 limits are within ES2 limits (shown in *italics*, *blue* if color is available), therefore the two sources are ES1.

The capacitor is not required to be a safeguard.

Terminals A, B, C, D, and E may be accessible. If A, B, C, or D is connected to E, the results are the same.

5.3.5.3 Protection of ES2 against ES3

Purpose: At least two safeguards between ES2 and ES3, one basic and one supplementary.

Rationale: ES2 could be accessible for an instructed person or after a single fault for an ordinary person; ES3 should not, even after a single fault. Therefore the same protection as for ES3 applies (see 5.3.2.3 and 5.3.3.2).

5.3.6.2 Contact requirements

Source: IEC 61140:2001, 8.1.1; IEC 62368-1:2010, 4.3

Purpose: Determination of accessible parts for adults and children. Tests are in IEC 62368-1:2010, Annex V.

Rationale: For voltage below 420 V peak (300 V r.m.s.) no clearance breakdown will occur according to "Paschen-law".

5.3.6.3 Compliance

The reason for accepting different requirements for components is because you cannot expect your supplier to make different components for each end application.

5.3.6.4 Terminals for connecting stripped wire

Source: IEC 60065

Purpose: To prevent contact of ES2 or ES3 parts.

Rationale: Accepted constructions used in the audio/video industry for many years.

5.4 Insulation materials and requirements

Rationale: The requirements, test methods and compliance criteria are taken from the actual outputs from TC 108 MT2 (formerly WG6) as well as from TC 108 MT1.

- The choice and application of components shall take into account the needs for electrical, thermal and mechanical strength, frequency of the working voltage and working environment (temperature, pressure, humidity and pollution).
- Components shall have the electric strength, thermal strength, mechanical strength, dimensions, and other properties as specified in the standard.
- Depending on the grade of safeguard (basic safeguard, supplementary safeguard, reinforced safeguard) the requirements differ.
- Components complying with their component standards (for example, IEC 60384-14 for capacitances) have to be verified for their application.
- The components listed in this subclause of the new standard have a separation function.

5.4.1.1 Insulation

Source: IEC 60664-1 (IEC 62368-1:2010, 5.4.2 and 5.4.3)

Purpose: Provide a reliable safeguard

Rationale: Solid basic, supplementary, and reinforced insulation shall be capable of durably withstanding electrical, mechanical, thermal, and environmental stress that may occur during the anticipated lifetime of the equipment.

5.4.1.4 Frequency

Source: IEC 60664-4

Purpose: To address insulation requirements for frequencies above 30 kHz.

Rationale: Above 30 kHz, IEC 60664-4 identifies deteriorating means, and effects need to be considered.

5.4.1.5 Maximum operating temperatures for insulating materials

Source: IEC 60085, IEC 60364-4-43, ISO 306, IEC 60695-10-2

Purpose: Temperature limits given in Table 14:

- limits for insulation materials including electrical insulation systems, including winding insulation (Classes A, E, B, F, H, N, R and C) are taken from IEC 60085 (see IEC 62368-1:2010, G.7);
- limits for insulation of internal and external wiring, including power supply cords with temperature marking are those indicated by the marking or the rating assigned by the (component) manufacturer;
- limits for insulation of internal and external wiring, including power supply cords without temperature marking of 70 °C are referenced in IEC 60364-4-43 for an ambient temperature of 25 °C;
- limits for thermoplastic insulation (5.4.1.4) are based on:
 - data from Vicat test B50 of ISO 306;
 - ball pressure test according to IEC 60695-10-2;
 - when it is clear from the examination of the physical characteristics of the material that it will meet the requirements of the ball pressure test;
 - experience with 125 °C value for parts in a circuit supplied from the mains.

5.4.1.6 Pollution degrees

Source: IEC 60664-1

Purpose: To use same description as in source.

Rationale: No values for PD 4 (pollution generates persistent conductivity) are included, as it is unlikely that such conditions are present when using products in the scope of the standard.

5.4.1.7 Insulation in transformers with varying dimensions

Source: IEC 60950-1

Purpose: To consider actual working voltage along the winding of a transformer.

Rationale: Description of a method to determine adequacy of solid insulation along the length of a transformer winding.

5.4.1.8 Insulation in circuits generating starting pulses

Source: IEC 60950-1, IEC 60664-1

Purpose: For clearances:

- a) clearance can be determined in accordance with 5.4.2.7; or
- b) an electric strength test can be applied using regular test procedures and at a test voltage as given in 5.4.11.1; or
- c) simulate the internally generated pulse trains by means of an external pulse generator, with a peak that is not less than the peak of the test voltage determined in 5.4.11.1 and whose pulse width is not smaller than the pulse width of the starter impulse.

5.4.1.9 Determination of working voltage

Source: IEC 60664-1:2007, 3.5; IEC 60950-1

Rationale: The working voltage does not include short duration signals, such as transients. Recurring peak voltages are included. (Transient overvoltages are covered in the required withstand voltage). Ringing signals are not carrying external transients.

5.4.1.9.1 General

Functional insulation is not addressed in Clause 5, as it does not provide protection against electric shock. Requirements for functional insulation are covered in Clause 6, which addresses protection against electrically caused fire.

5.4.1.9.2 RMS working voltage

Source: IEC 60664-1:2007, 3.5

Purpose: RMS working voltage is used when determining minimum creepage distance.

Rationale: See IEC 60664-1:2007, 3.5.

5.4.1.9.3 Peak working voltage

Source: IEC 60664-1:2007, 3.8

Purpose: The peak working voltage is used when determining the required impulse withstand voltage for minimum clearances and test voltages for the electric strength test.

Rationale: In other product safety standards “Circuit supplied from the mains” has been used for a “primary circuit”. “Circuit isolated from the mains” has been used for a “secondary circuit”.

“External circuit” is defined as external to the equipment. ES1 can be external to the equipment.

For an external circuit operating at ES2 level and not exiting the building, the transient is 0 V. Therefore, in this case, ringing peak voltage needs to be taken into account.

5.4.1.11 Thermoplastic parts on which conductive metallic parts are directly mounted

Source: ISO 306 and IEC 60695-2 series

Purpose: The temperature of the thermoplastic parts under normal operating conditions shall be 15 K less than the softening temperature of a non-metallic part. Supporting parts in a circuit supplied from the mains shall not be less than 125 °C.

Rationale: See 5.4.1.4 of this standard.

5.4.2 Clearances

5.4.2.1 General

Source: The dimension for a clearance is determined from the required impulse withstand voltage for that clearance. This concept is taken from IEC 60664-1:2007, 5.1.

Purpose: To provide a reliable safeguard.

Rationale: Overvoltages and transients that may enter the equipment, and peak voltages that may be generated within the equipment, do not break down the clearance (IEC 60664-1:2007, 5.1.5 and 5.1.6).

Minimum clearances of safety components shall comply with the requirements of their applicable component safety standard.

Clearances between the outer insulating surface of a connector and conductive parts at ES3 voltage level shall comply with the requirements of basic insulation only, if the connectors are fixed to the equipment, located internal to the outer electrical enclosure of the equipment, and are accessible only after removal of a sub-assembly that is required to be in place during normal operation.

It is assumed that the occurrence of both factors, the sub-assembly being removed, and the occurrence of a transient overvoltage have a reduced likelihood and hazard potential.

5.4.2.2 Compliance

Source: IEC 60664-1:2007, 5.1.1

Rationale: IEC 62368-1:2010, Annex O figures are similar/identical to figures in IEC 60664-1.

Tests of IEC 62368-1:2010, Annex T simulate the occurrence of mechanical forces:

- 10 N applied to components and parts that may be touched during operation or servicing. Simulates the accidental contact with a finger or part of the hand;
- 30 N applied to internal enclosures and barriers that are accessible to ordinary persons. Simulates accidental contact of part of the hand;
- 100 N applied to external enclosures of transportable equipment and handheld equipment. Simulates expected force applied during use or movement;
- 250 N applied to external enclosures (except those covered in T.4). Simulates expected force applied by a body part to the surface of the equipment. It is not expected that such forces will be applied to the bottom surface of heavy equipment (> 18 kg).

During the force tests metal surfaces shall not come into contact with parts at hazardous voltage.

5.4.2.3 Procedure for determining minimum clearances

Source: IEC 60664-2 series, *Application guide*

Rationale: The method is derived from the IEC 60664-2 series, *Application guide*.

5.4.2.4.1 Determination of a.c. mains transient voltages

Source: IEC 60664-1:2007, 4.3.3.3

Rationale: Table 15 is derived from Table 1 of IEC 60664-1:2007.

The term used in IEC 60664-1 is 'rated impulse voltage'. Products covered by IEC 62368-1 are also exposed to transients from external circuits, and therefore another term is needed, to show the different source.

5.4.2.4.3 Determination of external circuit transient voltages

Source: ITU-T K.21

Purpose: Transients have an influence on circuits and insulation, therefore transients on external circuits need to be taken into account. Transients are needed only for the dimensioning safeguards. Transients should not be used for the classification of energy sources (ES1, ES2, etc.).

Rationale: Practical approach.

Purpose: It is expected that external circuits receive a transient voltage of 1,5 kV peak with a waveform of 10/700µs from sources outside the building.

Rationale: The expected transient is independent from the application (telecom; LAN or other). Therefore, it is assumed that for all kinds of applications the same transient appears. The value 1,5 kV 10/700µs is taken from ITU-T K.21.

Purpose: It is expected that external circuits using earthed coaxial cable receive no transients that have to be taken into account from sources outside the building.

Rationale: Because of the earthed shield of the coaxial cable, a possible transient on the outside cable will be reduced at the earthed shield at the building entrance of the cable.

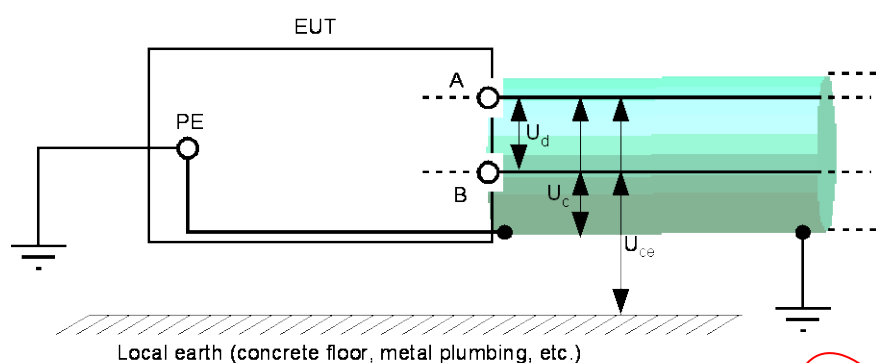
Purpose: It is expected that for external circuits within the same building no transients have to be taken into account.

Rationale: Practical approach, no real technical data available

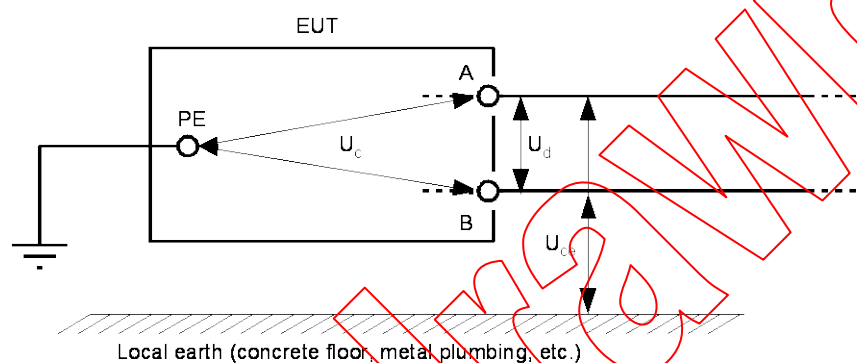
The transients for an interface are defined with respect to the terminals where the voltage is defined. For the majority of cases, the relevant voltages are common (U_c) and differential mode (U_d) voltages at the interface. For hand-held parts or other parts in extended contact with the human body, such as a telephone hand set, the voltage with respect to local earth (U_{ce}) may be relevant. Figure 7 in this standard shows the definition of the various voltages for paired-conductor interface.

The transients for coaxial cable interfaces are between the centre conductor and shield (U_d) of the cable if the shield is earthed at the equipment. If the shield is isolated from earth at the equipment, then the shield-to-earth voltage (U_s) is important. Earthing of the shield can consist of connection of the shield to the protective earth, functional earth inside or immediately outside the equipment. It is assumed that all earths are bonded together. Figure 8 in this standard shows the definition of the various voltages for coaxial-cable interfaces.

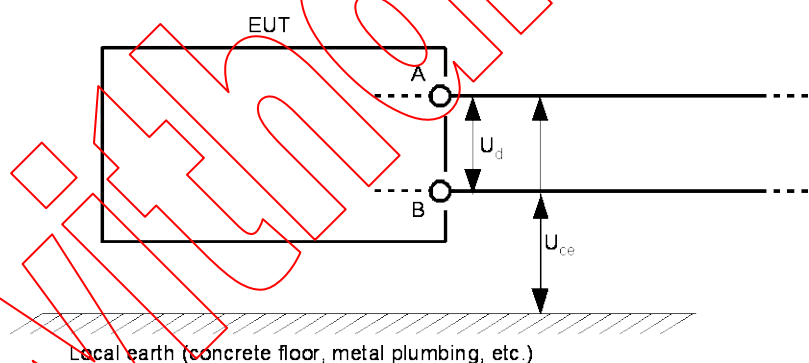
Withdrawn



Paired conductor interface — shielded cable



Paired conductor interface — unshielded cable



Paired conductor interface — no earth

Figure 7 – Illustration of transient voltages on paired conductor external circuits

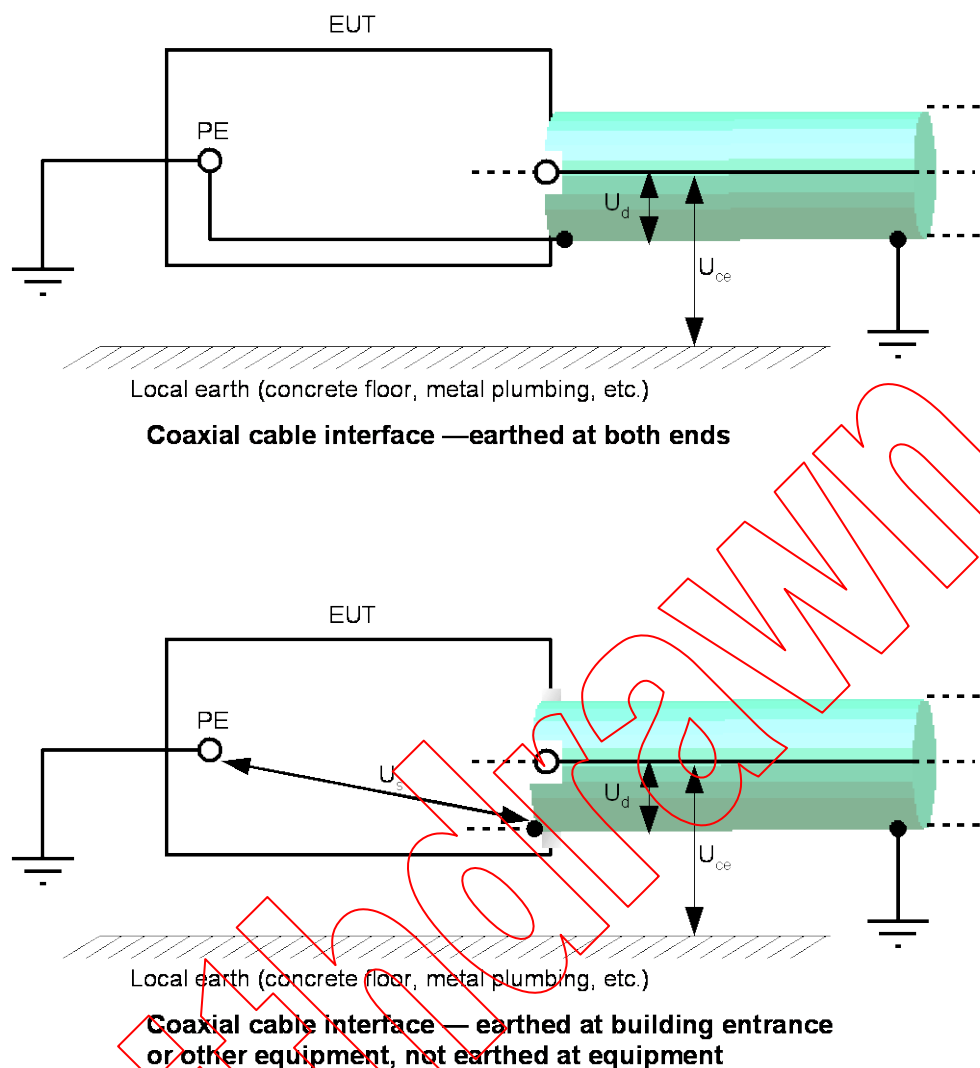


Figure 8 – Illustration of transient voltages on coaxial-cable external circuits

Table 16 – External circuit transient voltages

Purpose:	Transients have an influence, if the d.c. system extends beyond the building structure.
Rationale:	When the d.c. power distribution system is located outside the building, transient over-voltages can be expected. Transients are not present if the d.c. power system is connected to protective earth and is located entirely within a single building.

5.4.2.5.1 Mains transient voltages

Source: IEC 60950-1 and IEC 60664-1:2007 (3.1)

Rationale: The rules are developed in alignment to IEC 60664-1.

5.4.2.5.2 DC source transient voltages

Rationale: Transient overvoltages are attenuated by the capacitive filtering.

5.4.2.5.4 Combination of transient voltages

Rationale: Clearance is affected by the largest of the determined transients. The likelihood of their simultaneous occurrence is very low.

5.4.2.6 Measurement of transient voltage levels

Rationale: Test method is taken from IEC 60950-1:2005, Annex G.

5.4.2.7 Determination of the minimum clearances

Source: IEC 60664-1:2007, Table F.2 Case A (inhomogeneous field) and Case B (homogeneous field)

Rationale: Values in Tables 18 and 17 are taken from IEC 60664-1:2007 Table F.2 Case A (inhomogeneous field) and Case B (homogeneous field) and include explicit values for reinforced insulation. Clearances for reinforced insulation have been calculated in accordance with 5.1.6 of IEC 60664-1:2007. For reinforced insulation 5.1.6 states clearance shall be to the corresponding rated impulse voltage that is one step higher for voltages in the preferred series. For voltages that are not in the preferred series, the clearance should be based on 160 % of the required withstand voltage for basic insulation.

When determining the required withstand voltage according to 5.4.2.7, interpolation should be allowed when the internal repetitive peak voltages are higher than the mains peak voltages, or if the required withstand voltage is above the mains transient voltage values.

No values for PD 4 (pollution generates persistent conductivity) are included, as it is unlikely that such conditions are present when using products in the scope of the standard.

For frequencies above 30 kHz the values given in Table 19 are the same as in Table 1 of IEC 60664-4:2005.

5.4.2.8 Minimum clearances based on electric strength test

Source: IEC 60664-1:2007, Table F.5

Purpose: Tests are carried out by either impulse voltage or a.c. voltage with the values of Table 21.

Rationale: The impulse test voltages in Table 21 are taken from IEC 60664-1:2007, Table F.5. The calculation for the a.c. r.m.s. values as well as the d.c. values are based on the values given in Table A.1 of IEC 60664-1:2007. (See Table 6 in this standard for further explanation.)

This test is not suited for homogenous fields. This is for an actual design that is within the limits of the homogenous and inhomogeneous field.

Calculations for the voltage drop across air gap during the electric strength test may be rounded up to the next higher 0,1 mm increment. In case the calculated value is higher than the value in the next row, the next row may be used.

Enamel Material: Most commonly used material is polyester resin or polyester

Dielectric constant for Polyester: 5 (can vary)

Dielectric constant for air: 1

Formula used for calculation (voltage divides inversely proportional to the dielectric constant)

Transient = 2 500 V = 2 500 (thickness of enamel/5 + air gap/1) = 2 500 (0,04 / 5 + 2 / 1 for 2 mm air gap) = 2 500 (0,008 + 2) = (10 V across enamel + 2 490 V across air gap)

Table 6 – Voltage drop across clearance and solid insulation in series

Enamel thickness mm	Air gap mm	Transient on 240 V system	Transient voltage across air gap	Transient voltage across enamel	Peak impulse test voltage for 2 500 V peak transient from Table 21	Test voltage across air gap	Test voltage across enamel
Material: Polyester, dielectric constant = 5							
0,04	2	2 500	2 490	10	2 950	12	2 938
0,04	1	2 500	2 480	20	2 950	24	2 926
0,04	0,6	2 500	2 467	33	2 950	39	2 911
For 2 500 V peak impulse (transient for 230 V system), the homogenous field distance is 0,6 mm (from Table A.1 of IEC 60664-1:2007). Our test voltage for 2 500 V peak is 2 950 V peak from Table 21. This means that a minimum distance of 0,79 mm through homogenous field needs to be maintained to pass the 2 950 V impulse test. This gives us a margin of $(0,19/0,6) \times 100 = 3,2 \%$. In actual practice, the distance will be higher as it is not a true homogenous field. Therefore, we do not need to verify compliance with Table 20. We are always on the safe side.							
Material: Polyamide, dielectric constant = 2,5							
0,04	2	2 500	2 480	20	2 950	23	2 927
0,04	1	2 500	2 460	40	2 950	46	2 904
0,04	0,6	2 500	2 435	65	2 950	76	2 874
For 2 500 V peak impulse (transient for 230 V system), the homogenous field distance is 0,6 mm (from Table A.1 of IEC 60664-1:2007). Our test voltage for 2 500 V peak is 2 950 V peak from Table 21. This means that a minimum distance of 0,78 mm through homogenous field needs to be maintained to pass the 2 950 V impulse test. This gives us a margin of $(0,18/0,6) \times 100 = 3,0 \%$. In actual practice, the distance will be higher, as it is not a true homogenous field. Therefore, we do not need to verify compliance with Table 20. We are always on the safe side.							

5.4.2.9 Multiplication factors for altitudes higher than 2 000 m above sea level

Source: IEC 60664-1, curve number 2 for case A using impulse test.

Purpose: Test is carried out by either impulse voltage or a.c. voltage with the values of Table 22 and the multiplication factors for altitudes higher than 2 000 m.

Rationale: Table 22 is developed using Figure A.1 of IEC 60664-1:2007, curve number 2 for case A using impulse test.

5.4.3 Creepage distances

Source: IEC 60664-1:2007, 3.3

Purpose: To prevent flashover along a surface or breakdown of the insulation.

Rationale: Preserve safeguard integrity.

In IEC 60664-1:2007, Table F.4 columns 2 and 3 for printed wiring boards are deleted, as there is no rationale for the very small creepage distances for printed wiring in columns 2 and 3 (the only rationale is that it is in the pilot standard IEC 60664-1).

However, there is no rationale why the creepage distances are different for printed wiring boards and other isolation material under the same condition (same PD and same CTI).

Moreover the creepage distances for printed boards in columns 2 and 3 are in conflict with the requirements in G.18.3 (Coated boards). Consequently the values for voltages up to 455 V in Table G.12 were replaced.

Creepage distances between the outer insulating surface of a connector and conductive parts at ES3 voltage level shall comply with the requirements of basic insulation only, if the connectors are fixed to the equipment, located internal to the outer electrical enclosure of the equipment, and are accessible only after removal of a sub-assembly which is required to be in place during normal operation.

It is assumed that the occurrence of both factors, the sub-assembly being removed, and the occurrence of a transient overvoltage have a reduced likelihood and hazard potential.

5.4.3.2.1 Test conditions

Source: IEC 60664-1:2007, 3.2

Purpose: Measurement of creepage distance.

Rationale: To preserve safeguard integrity after mechanical tests.

Annex O figures are similar/identical to figures in IEC 60950-1 and IEC 60664-1.

Tests of Annex T simulate the occurrence of mechanical forces:

- 10 N applied to components and parts that are likely to be touched by a skilled person during servicing, where displacement of the part reduces the creepage distance. Simulates the accidental contact with a finger or part of the hand.
- 30 N applied to internal enclosures and barriers that are accessible to ordinary persons. Simulates accidental contact of part of the hand.
- 100 N applied to external enclosures of transportable equipment and handheld equipment. Simulates expected force applied during use or movement.
- 250 N applied to external enclosures (except those covered in T.4). Simulates expected force when leaning against the equipment surface. It is not expected that such forces will be applied to the bottom surface of heavy equipment (> 18 kg).

Creepage distances are measured after performing the force tests of Annex T.

5.4.3.2.2 Material group and CTI

Source: IEC 60112

Rationale: Classification as given in IEC 60112.

5.4.3.3 Compliance

Source: IEC 60664-1:2007, Table F.4; IEC 60664-4 for frequencies above 30 kHz

Rationale: Values in Table 23 are the same as in Table F.4 of IEC 60664-1:2007.

Values in Table 24 are the same as in Table 2 of IEC 60664-4.

5.4.4 Solid insulation

Source: IEC 60950-1, IEC 60664-1

Purpose: To prevent breakdown of the solid insulation.

Rationale: To preserve safeguards integrity.

Exclusion of solvent based enamel coatings for safety insulations are based on field experience. However, with the advent of newer insulation materials those materials may be acceptable in the future when passing the adequate tests.

Except for printed boards (see G.18), the solid insulation shall meet the requirements of 5.4.4.4 – 5.4.4.7 as applicable.

5.4.4.2 Minimum distance through insulation

Source: IEC 60950-1

Purpose: Minimum distance through insulation of 0,4 mm for supplementary and reinforced insulation.

Rationale: Some (very) old standards required for single insulations 2 mm dti (distance through insulation) for reinforced insulation and 1 mm for supplementary insulation. If this insulation served also as outer enclosure for Class II products, it had to be mechanically robust, which was tested with a hammer blow of 0,5 Nm.